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THE PRINCIPAL

Codeletter : GYE2

THE RAPID RESULTS COLLEGE

INTRODUCTION TO COMPUTERS/ PRINCIPLES OF E D P

----oOo----

This set of lectures contains :

LECTURE 1 : Modes of Working

LECTURE 2 : Systems Structures

LECTURE 3 : Communications

TEST GYE2

----oOo----

NOTE : The test on this set is bound in at the back of the book.

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MODES OF WORKING

CHOICES OF SYSTEMS

A. INTRODUCTION

Had we been studying computer systems 20 or more years ago, this lecture would have been extremely brief. There was only one type of computer and only one way in which it could be used, namely a large mainframe computer used as a batch processing device.

The traditional systems were batch systems run centrally. Then came data transmission and remote data entry via teletypewriters and remote job entry terminals. This was followed by a wave of on-line and real-time systems using visual display units linked to a central computer. Recently, the tide has turned and the move is now towards distributed processing, this usually involving a data communications network centred on one or more large mainframe computers, but containing, in addition, decentralised intelligence.

A computer user now has the choice of three classes of computer - mainframe, minicomputers and microcomputers - and of three ways of using them - as batch processors, on-line processors or real-time processors. The development of sophisticated operating systems and major improvements in hardware technology has increased all aspects of computer systems. In this lecture we will look at the range of choice available to the user, explain the terms and briefly consider the suitability of each system for particular applications.

B. BATCH PROCESSING

The traditional batch system involves documents of one type being grouped together in convenient batches (say 50 documents per batch). Batch totals, hash totals or documents counts are used to ensure that all documents are correctly entered. These are entered when the documents are first batched and are checked by the computer validation program and/or the data preparation equipment (if key to disc). Invalid batches are

rejected in whole or in part and must be resubmitted in a later run. Valid batches are usually then sorted and passed against a master file. Totals derived from the original batch totals are used to control subsequent stages of processing.

Batch processing is fine for departments which require documents to be processed in bulk and for which time is not critical. If a user is remote from the computer or if a fast response is required from the computer, traditional batch processing is inadequate.

1. CHARACTERISTICS

A batch processing system has the following characteristics.

(a) Input data is collected over a specified time period until there is sufficient quantity to process.

(b) The data so collected is formed into a batch, (hence the name of the process) and converted into machine-readable form if necessary. Control totals are calculated for the batch, to ensure data is not lost.

(c) The batch is processed by the computer in its entirety against the appropriate master files, and output produced. Usually such a process requires a sequence of programs to be run. The sequence is controlled by a job specification being given to the operating system.

(d) The processing is usually carried out on a regular periodic basis and the output distributed, whether or not the information is required immediately. Thus, the receiver must file the output for future reference. This output can be voluminous and contain information which is never used.

2. ADVANTAGES

(a) Data is collected and processed in a well-controlled and reliable manner.

(b) Serial or Sequential file processing is possible, which can be carried out using magnetic tape - a cheap storage medium. Also, in-built file security is achieved using

the grandfather, father, son method. The "son" master file is updated and overwrites the "grandfather". The new tape is now the "son", the old "son" is now the "father" and the old "father" becomes "grandfather". If the transaction files are kept then, should the "son" be corrupted, it can be recreated by using the "father" tape along with the relevant transaction data.

(c) The workload of the computer can be easily predicted and scheduled.

3. DISADVANTAGES

(a) The information is only as up-to-date as the last time the processing was carried out. This may well be acceptable e.g. for a payroll, which is weekly or monthly anyway, but even daily stock file processing may be unacceptable in some high turnover businesses. For example, airline bookings which rely on the "stock" of seats on aeroplanes produced by batch processes may overbook or underbook flights.

(b) Non-standard file interrogations outside the normal batch process reports have to be planned and the appropriate software written in advance. They will require special runs which may need the file to be sorted. These can be difficult and time-consuming to produce. Exception reports cannot be easily produced except as an in-built feature of the normal batch process.

(c) If serial or sequential file processing is adopted then the process can be wasteful of computer time when the file activity is low, since most of the records read and written to the new master file will have had no change to them.

4. COMMENTS

Batch processing is still a common method of commercial data processing because the disadvantages do not affect a large number of processing requirements.. For example, wages, salaries, customer invoices, customer statements and supplier

payments are produced on a regular periodic basis and, in many businesses, it is quite adequate for the other information requirements also to be produced on a periodic basis.

Batch processing is the cheapest form of computer processing and therefore a careful cost/benefit analysis is required to justify the use of other methods.

C. REMOTE BATCH

Data is batched and entered into the terminals on site but processed by a large computer at another location by using data communications facilities. It is very cost-effective in its use of data transmission facilities in that the lines are highly utilised. Also, the software is usually less complicated than for other data communications applications. The transmission of bulk batch data from a remote job entry terminal can often be done at night, thus leaving the computer free to handle other more time critical data communications applications during the day.

Many remote batch terminals are intelligent, i.e. programmable and can support a wide range of peripherals. Such terminals can perform much of the processing locally and are a very useful part of a distributed processing network.

A remote job entry terminal with intelligence is in fact a small computer with a large computer at its disposal when required.

The remaining modes of working are all examples of transaction processing, i.e. the processing of data a transaction at a time as opposed to its being grouped in batches.

D. ON-LINE WORKING

On-line is the mode of working where terminals are linked to the computer. They may be linked to the computer throughout the working day or linked by dialling up the system when required.

1. CHARACTERISTICS

An on-line processing system has the following characteristics.

(a) Input data is entered into the computer system as soon as possible after its origination. It is supplied to the computer via peripheral devices which can be considered as "terminals", e.g. teletypewriters and VDUs.

(b) The data so collected is stored in files and processed against the master files in a similar way to batch processing.

(c) Output information is produced as reports, as with batch processing, but such systems usually include on-line interrogation of files.

2. ADVANTAGES

(a) The off-line conversion of data into a machine-readable form is eliminated. The users input the data rather than fill in forms for data preparation to convert.

(b) On-line interrogation of files reduces the volume of detailed information necessary in reports. A user wishing to access the details does so through a "terminal".

(c) The need for non-standard reports is reduced as a result of the interrogation facilities.

3. DISADVANTAGES

(a) On-line interrogation and data collection implies that random access is required. It is usual to employ indexed sequential files since these allow both random and serial access. Such methods mean that the file storage medium must be disks, which are expensive.

(b) File security is no longer automatic. A security system of copying (dumping) files must be imposed.

(c) The control procedures employed in batch data capture no longer apply and therefore more complex validation methods have to be included in the direct data entry software used to enter data from the terminals.

(d) The files are updated on a periodic basis and therefore may not be completely up-to-date.

4. GENERAL CONSIDERATIONS FOR ON-LINE SYSTEMS

On-line systems are very different from batch systems. Batch systems tend to have sequential files while on-line systems have more sophisticated file structures. Batch systems are organised in runs which are individual programs processing batched data in a set sequence. On-line systems process transactions, such as a posting to a ledger, which are made up of a number of message pairs. A message pair is a single interaction between the user and the system such as an account number entered and balance in reply. There may be a large number of transactions at various stages at any one time and any one of a number of users can initiate a message pair at any time. The system has to cope with all these activities at once and bring the necessary programs into memory and execute them to process the message pairs.

Further considerations are that:

(a) More than one person may wish to update the same record at any one time.

(b) Files are being updated at the same time that they are being read.

(c) High standards of reliability are required.

(d) Complex recovery procedures may be necessary.

5. ON-LINE COSTS

As a result of all these complications on-line systems can cost considerably more than batch systems. Real-time systems in particular can be very expensive. The major components of these additional costs are as follows:

(a) Complex software necessary for the management and control of on-line systems;

(b) Additional hardware, e.g. larger main memory for holding the additional software and the communications equipment; and

(c) Data communications costs.

Against all these disadvantages we should remember that batch systems are inadequate for many types of application such as airline reservations and order processing.

6. COMMENTS

The advantages of on-line processing are more far-reaching than you may appreciate at first.

On-line data collection by users does mean that errors of recording are indicated immediately. The use of remote terminals via a communications system eliminates any delay caused by the physical transmission of data. Any errors and their correction are under the direct control of the user department and when discretion is required (e.g. accepting an order from a customer over a credit limit) it can be exercised immediately.

The on-line interrogation eliminates delay and can be used to deal with queries or problems without the usual day's wait before details can be produced via a non-standard report from a batch processing system.

The validation checks, although more complex, can include cross-file referencing very easily, since the master files are random access. Thus, errors which are found only during updating in a batch processing system (e.g. a stock code or customer number which does not exist) can be found and indicated during the data entry.

However, on-line processing requires more sophisticated hardware and software, which increases the cost of the system, although the potential elimination of data preparation will reduce running costs. The extra hardware and software needed will include:

Magnetic disks

Communications equipment

Communications software

Multitasking operating system

Sophisticated software for data entry and interrogation

Sophisticated filestore software

Appropriate terminals

7. VARIATIONS OF ON-LINE WORKING

There are four varieties of on-line working and we deal with each in turn.

(a) Enquiry Systems

In this type of system the computer is used only for providing information to the user at a terminal in response to an enquiry. As an example consider a balance enquiry made at a bank. The clerk enters the customer's account number and the computer retrieves the balance from its files and displays it at the terminal.

(b) Data Collection Systems

The next level of complexity is data collection systems where the user enters data at a terminal which is stored for subsequent processing, generally by a batch system. A major advantage of this type of data capture is that the system is able to validate input data before storing which enables the user to correct errors at the time of input.

There must be some provision for recovery after system failure for this kind of system. However, this need only be something as simple as duplication of the collected transactions.

(c) Multi Access or Time Sharing Systems

Time sharing systems are frequently used to allow many users at terminals to have apparently simultaneous use of the system. Many programmers use this type of

system for on-line program development. It is also popular for small single user applications though this is now being undermined by the advent of very cheap microcomputer systems.

The consequences of losing input are less severe than in real-time systems for banking or for airline booking so simpler recovery procedures are sufficient. A potential problem is that of file security and integrity. The system must prevent unauthorised access by password protection at sign on time and must additionally prevent one time-sharing user from accessing the possibly confidential data of another user.

(d) Real Time Systems

We shall look at this briefly at this point, as we shall have a closer look at it in the next section. "Real-time" is a term sometimes used to cover all terminal-based transactions processing systems, i.e. including enquiry and data collection systems. In this lecture we use what is a more precise and useful definition. In an earlier lecture we introduced the idea of data being an abstract model. We shall define "real-time" to mean that in such a system the abstract model inside the computer is changed simultaneously with the real world system that is being modelled.

(i) Example

As an example of this consider an airline booking system. The computer contains an abstract model of the airline schedules and seat availability. When a seat is sold then the model changes immediately, in real time, to represent the sale of the ticket and one less available seat.

(ii) Advantage

To the user a real-time system is more natural since it closely reflects the way the user views his system.

(ii) Disadvantages

A major problem associated with real-time systems is the difficulties of recovering following a system failure. The recovery procedures must restore the system to its state just before the failure without losing any transactions, and this must be achieved quickly since no airline tickets could be sold while the system was unavailable.

E. REAL-TIME PROCESSING

1. DEFINITION

A real-time processing system is an on-line system in which the data entered is used immediately to update the master files.

Essentially, real-time processing was originally developed to provide sophisticated control systems. In these systems the data input (either by humans or by various sensors) is used to update the stored data immediately so that the output can be used to affect the process or system from which the data was collected. Initially, systems were developed to control industrial processes (e.g. steel mills, flour mills, etc.), for military purposes (e.g. missile control) or in air traffic control.

However, the advantages of real-time processing were soon seen as being applicable to business data processing. Business real-time systems are often called transaction processing systems (TP systems) because they process each transaction individually.

2. EXAMPLE

The following example of an airline reservation system shows how a real-time system operates.

Imagine you are a traveller from South America, landing in Miami after a flight from Kingston, Jamaica. You book a

seat on a plan flying from Miami to New York, and you wish to reserve a seat on a certain plane flying from New York to London. The booking clerk goes to a terminal on his desk and presses keys. A few seconds later he comes back to you and informs you that you are booked in seat 17C on British Airways flight 717, leaving New York at 14.30 hours the following day. That mysterious procedure is the end result of real-time processing.

What has happened is that the booking clerk has used a high speed computer terminal on his desk which has taken the first available opportunity to access the random access store of the central computer. (This machine may even be in another continent). As he gains access to the record relating to British Airways flight 717, he at the same time prevents anyone else from gaining access to that record. The computer searches the record, finds an unbooked seat, books it, and informs the clerk via the terminal, at the same time allowing access to the random access store to any further enquirer.

Where a seat is cancelled, the procedure operates in reverse. The booking clerk operates his terminal, and access is gained to the records for the British Airways 717 flight, which are on random access storage. Seat 17C is found and the reservation cancelled; a message via the booking clerk's terminal informs him of this. The seat inventory record is thus kept current.

When flight time is approaching and a seat becomes vacant, the computer may inform booking clerks of the fact so that the seat may be offered to those on a waiting list.

The system may include other features which enable special food to be ordered for in-flight meals, hotels to be booked and even cars to be hired.

Similar systems can be used by banks and building societies to ensure accounts are always up-to-date and cannot be overdrawn. Some automatic cash dispensers will check a customer's account and either quote its balance or ensure that cash is never dispensed from accounts with insufficient funds.

3. ADVANTAGES

(a) All the advantages of on-line systems apply.

(b) Files, and therefore information, is always up-to-date.

4. DISADVANTAGES

(a) Real-time systems are expensive.

(b) Apart from the up-to-date nature of files, all the on-line system disadvantages apply.

5. COMMENTS

A real-time system, where the cost is justified, is the best approach to commercial data processing. As with on-line processing, special hardware and software is required. In addition to that for on-line systems, the following are required.

(a) Very large on-line random access storage.

(b) A more sophisticated multi-tasking operating system.

(c) Sophisticated recovery procedures, should there be breakdowns in hardware or software.

(d) A single transaction updating mechanism in the applications software.

(e) Filestore software which will allow multi-access to a particular file but prevent access to a record which is being updated by another transaction.

Real-time systems are being incorporated with data base techniques to allow very advanced enquiry systems to be developed.

F. BUREAUX

It is not necessary for a business organisation to own or operate its own computer. These facilities can be provided by outside agencies called computer bureaux (singluar, bureau).

1. FACILITIES PROVIDED

A particular computer bureau will provide a range of services. The following list gives those that one might expect from a large bureau.

(a) Data Preparation

The bureau will convert source documents into machine-readable form.

(b) Computer Time

The bureau will hire time on its own computer system or systems. The software used may be standard or specialist applications. In addition to the straight forward hiring of time, the client will be able to hire backing storage. This hire usually includes the generation of security back-up copies at appropriate times.

(c) Do-It-Yourself

Some bureaux make machines available and the client then provides the operations staff. This is not usual except where the machine is a microcomputer.

(d) Time-sharing

Time-sharing on the bureau system is offered by some large organisations. The client can connect one or more remote terminals and carry out on-line or real-time operations. This is a popular bureau facility since a user has access to computer power which may be quite outside what he could afford to buy.

(e) Programming

The bureau will hire its programmers on contract, either to develop specialist applications for a client who will use the bureau's system, or for a client's own computer system.

(f) Systems Development

A client can hire the time of experienced analysts to develop computer systems for his own business. When an organisation cannot afford to have full time analyst and programming staff, this is a very attractive solution.

(g) Standard Packages

The bureau will develop standard application systems and sell or hire them to clients.

(h) A Complete Service

Some large bureaux will provide a complete data processing service. This may involve the bureau computer system or in fact installing and operating a computer and data processing department within the client organisation.

2. REASONS FOR USING BUREAUX

An organisation may use a bureau for the following reasons:

(a) As a standby system in the case of total failure of its own computer or to handle peak loads such as year-end processing.

(b) For financial reasons, in that the use of a bureau computer involves little capital outlay.

(c) To gain experience of computer data processing before setting up their own in-house system, or to evaluate new replacement computer systems. Manufacturers often have there own bureaux to provide this particular facility.

(d) To handle the load of file conversion during the implementation phase of a new system.

(e) To obtain advice and consultancy services.

(f) To hire experienced personnel without having to employ them full-time.

Overall, we can say that the main reason for using a bureau is to cut costs.

3. ADVANTAGES OF USING A BUREAU

The advantages of using a computer service bureau are numerous. Some of the more obvious ones are discussed here.

(a) A client can harness the considerable power of a modern computer without risk and for a known cost.

(b) The client can gain experience in computer management techniques without the irrevocable step of purchase and hence total commitment. All capital expenditure on equipment can thus be avoided, together with the additional expenses of installation incurred with an air conditioning plant, special constructions, false floors and ceilings, electrical wiring, ancillary storage for stationery, cards, tapes, disks, etc.

(c) Also avoided is the large expense involved in recruiting programmers and systems analysts. Training and accommodation costs are kept to a minimum.

(d) A computer bureau offers its clients a whole wealth of experience and knowledge which would be very expensive to "buy in" or recruit by other means.

4. DISADVANTAGES

(a) The biggest disadvantage in using a bureau is in the loss of direct control over one's affairs. This factor, however, often turns to the client's advantage when it forces him into "putting his house in order" before he hands over his files, data, etc.

(b) Security of information is often questioned when using a bureau. In fact the client may well discover that his files, etc. are safer on magnetic files in the modern burglar-proof, fire-proof, highly insured data centre than they are in his outmoded Victorian offices with their quaint filing systems.

The question of unauthorised access to files and the consequent loss of important data must, however, be carefully investigated. With numerous people using a computer, security rules must be laid down and strictly adhered to.

(c) The problems of transferring and moving both data and results can sometimes be critical.

(d) A bureau naturally charges the user for all work carried out by its machines. The user therefore has to pay for each new application he runs at the bureau. With his own machine many jobs are in effect "free", provided that there is sufficient spare computer time available.

5. ADVANTAGES AND DISADVANTAGES OF THE MINI-COMPUTER OVER AN EXTERNAL BUREAU FACILITY FOR SMALL USERS

(a) Advantages

(i) It encourages the distributive processing of data.

(ii) Local management can have control of EDP, even in small user environments.

(iii) On-line data entry and editing can be easily installed.

(iv) Management is fully involved in the development of systems.

(v) There is complete local control of machine utilisation.

(vi) The machines are easily upgraded to meet changing workloads.

(vii) It encourages operating companies to build up their own internal expertise in EDP.

(viii) The advantages of multiprogramming can be used (i.e. more than one job can run at the same time).

(ix) Cost/benefit analysis can show positive results.

(x) The machine can be linked by telephone line to the mainframe for "number crunching" exercises.

(b) Disadvantages

(i) Bureaux will probably have more back-up facilities in terms of manpower and computing power.

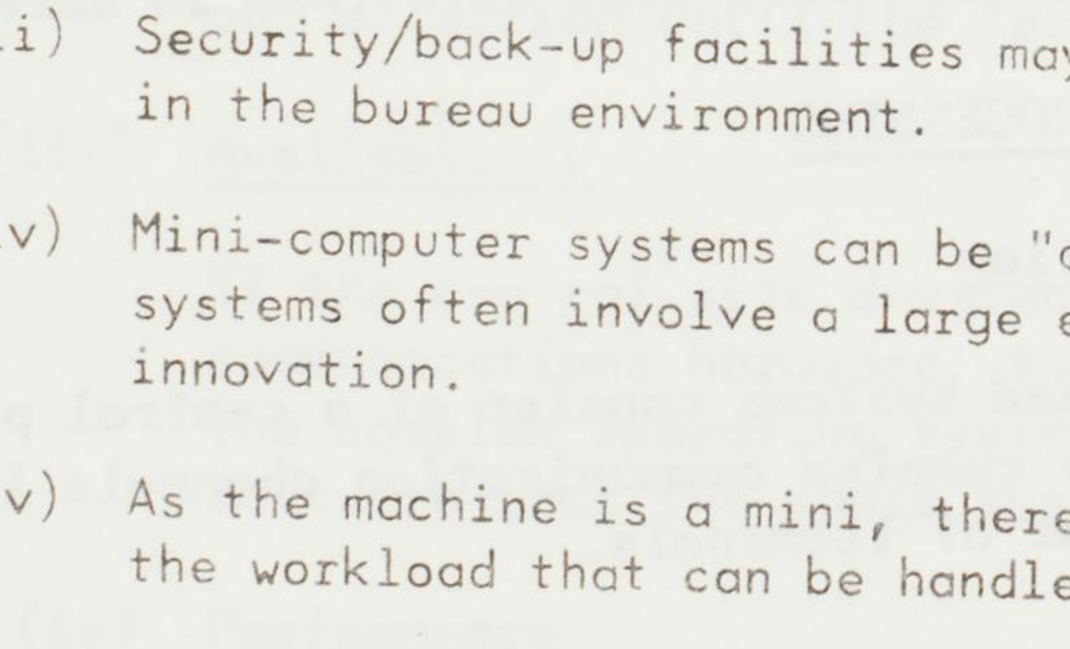
(ii) Development time can be shorter in the bureau environment due to the concentration of effort.

(iii) Security/back-up facilities may be healthier in the bureau environment.

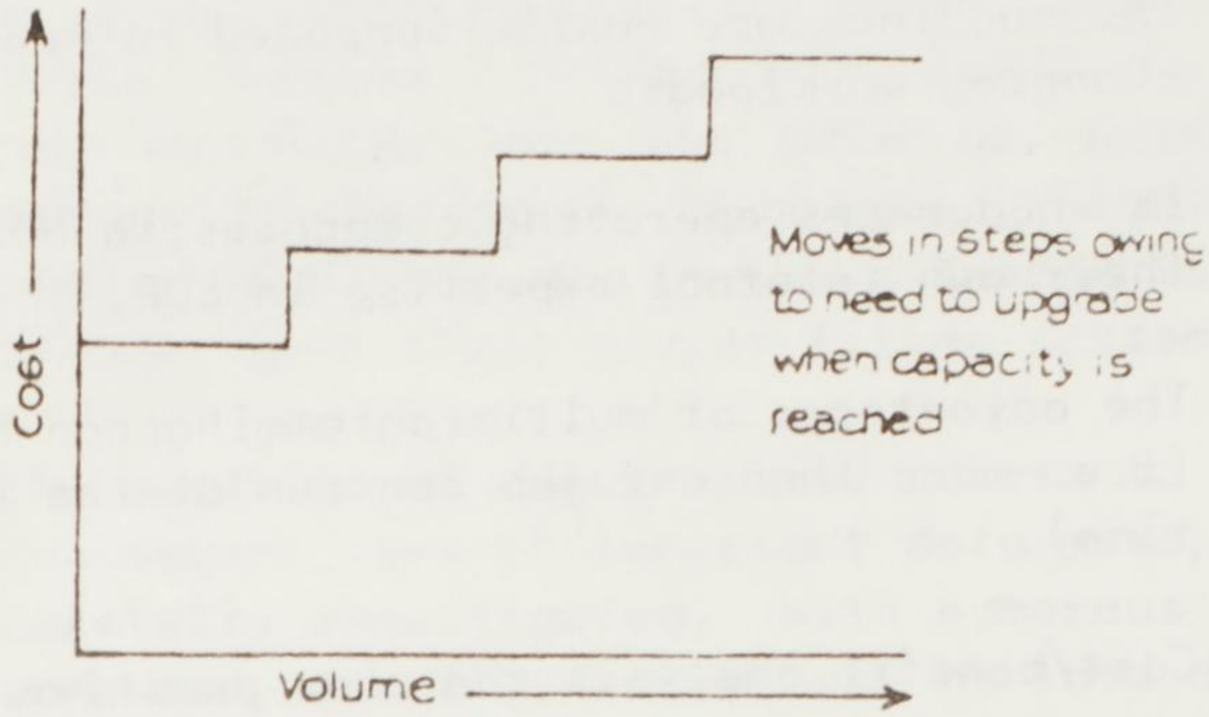
(iv) Mini-computer systems can be "one-off" and new systems often involve a large element of innovation.

(v) As the machine is a mini, there is a limit to the workload that can be handled.

(vi) TYPICAL MOVEMENT IN COSTS
BUREAU



(i) Mini-computer



(c) Software Houses

These specialise in programming and systems analysis and do not usually provide computer operational services.

G. CENTRALISED AND DISTRIBUTED PROCESSING

We shall only briefly introduce these two processing methods now as the next lecture will deal with them in more detail.

1. CENTRALISED PROCESSING

(a) Introduction

Centralised systems consist of a central processing site with complex communication channels linking up any number of terminals.

In the past, the economic advantages of centralisation encouraged organisations to develop single data processing departments used by the whole company, or all companies in a group. Now however, when computers are so much cheaper, it is often better to allow each department or group to have its own machine and work independently.

(b) Advantages

(i) More security and control over the data base making it easier to protect it against sabotage and unauthorised users

(ii) It allows more than one user to retrieve, delete or update data at the same time

(iii) It can provide smaller or separated departments with access to a centralised computer system.

(c) Disadvantages

(i) Data communications costs can be very significant and they are taking an increasingly large share of the total costs of a centralised system.

(ii) Reliability

A centralised system relies on communications and a central processing site. If communications problems arise then some terminals will be put out of action until the fault is rectified.

(iii) Availability

If the central site develops problems in the communications hardware, the processor or in the complex operating system and the communications software then the whole system will be unavailable.

(iv) Performance

For a centralised system serving large numbers of terminals a very large computer is required. For very large numbers of terminals there may not be a computer powerful enough.

(v) Upgrading and Maintenance

With large centralised systems the complexity of the software and the data communications equipment can cause great difficulties in maintenance and upgrading.

2. DISTRIBUTED PROCESSING

Against this background some computer users are moving into a distributed mode of processing. This generally consists of intelligent terminals which may be linked to a large central computer system to help the user conduct inquiries, process jobs or use other data processing operations. The computer system is essentially distributed to accommodate users at the operating level.

(a) Advantages

(i) With distributed processing the system as a whole can continue to operate when individual computers develop faults.

(ii) Data communications costs can be reduced and a more cost-effective mini-computer system can be employed.

(iii) By distributing processing power we can achieve performance beyond that of the very large mainframes.

(iv) The construction of a large system as a collection of simple units can simplify upgrading and phased complimentation. It is also easier to cost justify the individual applications and to have more accurate estimates of running costs.

(v) Better managerial control over specific activities can be achieved.

Of course, a distributed approach can have its own disadvantages. I shall now look at different categories of distributed working and cover the strengths and weaknesses of such approaches.

3. DISCRETE SYSTEMS

In the past, the economic advantages of centralisation encouraged organisations to develop single data processing departments used by the whole company or all companies in

the group. Now, however, when computers are so much cheaper, it may be better to allow each department or group company to have its own machine and work independently of the others. There would be no need to pass data between the centres because they could all operate as entirely separate concerns. Consider the case of a group of companies providing services for the construction industry. For historical reasons they developed a centralised data processing facility. Following growth and the acquisition of companies to expand the group many users become dissatisfied with the data processing department. Data communications costs were very high particularly for those companies which were distant from the computer centre. The on-line systems were slow to develop and have been unreliable, in service. Since each company operates as a separate entity data need not be transferred. In this case discrete systems would be a logical and attractive approach to decentralisation.

4. LOOSELY COUPLED SYSTEMS

A loosely coupled system is a decentralised system whose components normally operate quite independently but have a regular coupling where data is exchanged.

An example of this could be a food products company with many depots across the country. Each depot has its own minimcomputer to support up to thirty VDU's for order processing. Picking notes and invoices are printed at each site for immediate local use. The stock position at each site would be updated in real-time.

At the end of each day data is sent from each depot to the central computer ordering stock and providing sales data for statistical analysis. The data transmission is probably over dedicated lines that would be used as a company internal telephone network during the day. As you can see, this approach offers considerable advantages (particularly in the reduction of data communications costs) for companies where there is a dispersed operation and in which each location serves its own customers.

5. TIGHTLY COUPLED SYSTEMS

A tightly coupled system is a decentralised system whose components normally operate in co-operation with each other but can continue to operate when some of the components become unavailable.

(a) Example

A major international bank is an example of this situation. Each individual department providing a particular service operates its own real-time system and for high reliability and low cost many of these systems are run on minicomputers in the individual departments. A requirement of the system is that the customer must not exceed a certain level of borrowing in all his dealings with the bank. A further requirement is the management's need to have up-to-date information on their business in relation to individual industries, currencies and countries. A loosely coupled system could not provide these up-to-date positions.

(b) Unsuitability of Centralised Systems

A centralised real-time system is not a successful way of handling the situation because:

(i) If a very large number of terminals are to be supported then a single mainframe might not suffice;

(ii) Data communications costs may be high, so providing a very reliable system based on a central mainframe is expensive;

(iii) Failure at the central site could lead to serious financial losses if all systems were unavailable for more than a few hours;

(iv) Even a network of co-operating computers would have considerable problems in the recovery from failure.

6. GENERAL CONSIDERATIONS FOR DECENTRALISED WORKING

(a) Security

Centralised systems are easier to make secure from unauthorised access to the system, or from the theft or sabotage of the equipment. On the other hand the effects of such action may be less severe for decentralised working. A recent development has been the spearhead role of computer staff in industrial disputes. The withdrawal of a few key computer staff can have very serious consequences for centralised working.

Decentralised working causes some increased complexity in the control of data.

(b) Staff

With decentralised systems there is usually a mixture of hardware, mainframe and minis, and often from different suppliers. This requires computer staff to be able to work with the many machines, languages and software packages.

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SUMMARY

In this lecture we have covered the modes of working, from simple batch to on-line, centralised and distributed. We have found examples of applications where certain modes are particularly well suited. Examine you own organisation and try to relate the trends there to your studies.

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PROGRESS QUESTIONS

1. Define "on-line", "real-time" and "remote batch".

2. What are the advantages and disadvantages of using a bureau?

3. How can small users benefit from using a mini-computer rather than a bureau?

4. What potential advantages does a distributed mode of working offer?

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SYSTEM STRUCTURES

A. INTRODUCTION

A business system is a combination of personnel, equipment, and other facilities operating as a unit according to a set of procedures designed to record and control the actions and activities connected with a business. The system must be flexible enough to adapt to any changes in the market or in the structure of the business itself.

The organisational structure of an electronic data processing centre consists of the organising efforts on a number of managerial levels, of authority relationships, and of the general pattern of functions performed by employees at all levels. The chain of command typically flows from the management of a company, to the DP manager, to supervisers of different areas and to the subordinates.

As any successful DP centre employs qualified staff in operating the computer and data processing departments, the organising function is a vital part of any management effort. By grouping work elements and assigning them to the appropriate departments and staff, a manager organises and defines the relationships among his staff.

The overall organisational structure of a computer depends on a number of factors. Included among these are:

the size of the organisation and staff

the extent of managerial control and management philosophies

the age of the computer system

the number and type of products produced by the firm

the geographical dispersion of its operations.

1. SIZE OF THE FIRM AND OF STAFF

In small computer centres (less than 10 employees) one person may perform a number of different jobs. For example, the systems analyst and programmer may be one and the same person. The larger the firm becomes the more the staff functions become separated and isolated from one another.

As a company grows, it becomes more complex, and can no longer be managed effectively through a monolithic organisation.

For these large firms, divisionalisation becomes a solution. Tasks and functions are separated to become distinct operational units. Accompanying divisionalisation in most cases is decentralisation. Decentralisation is when management delegates authority and responsibility. Divisional heads, heads of departments and so forth make certain of their own decisions - those decisions relating to their area of responsibility and within their capacity. As this delegation of authority grows, so too does the degree of decentralisation.

2. MANAGEMENT PHILOSOPHY AND CONTROL

Leading on from the above we have managements approach to the organisation and this personal control. Management has to adjust to its span of control or the number of subordinates who report directly to it. The optimal span of control may vary, depending on the competence of superior staff, the attitude and ability of subordinates, on the level of standardisation of existing procedures, and on the similarity of functions performed. An effective span of control requires some form of skill grouping in a hierarchy, starting with the manager of the computer centre and running down to the technical specialists.

Where tasks and functions are standardised and adhere to present formats, the span of control of any single person can be larger than when the functions are not easily regulated and do not easily conform to routines and patterns.

A system where rules are well-defined and standard operating procedures exist for all acitivities is frequently autocratic. It allows staff little freedom to make their own decisions and provides little motivation for innovative individuals. Such a centralised management philosophy severely constrains personnel and does not encourage the use of creative abilities and own initiatives.

Within a decentralised management philosophy, authority and responsibility are delegated to lower levels of the organisation. Such a philosophy is said to encourage and motivate staff. In this way they will be able to use their own creativity and innovativeness for the good of the organisation. Management encourage particupation and the use of own discretion by lower managers. The overall result is that power is distributed through the system among different managers. Among the advantages of this system are:

(i) better incentive and motivation

(ii) a sharing in decision making, hence spreading the the load

(iii) better decisions because the manager at a given location can act spontaneously on conditions and information

(iv) it allows junior or subordinate managers to become experienced in decision-making so that they will be more competent when promoted to higher management levels.

3. THE NUMBER AND TYPE OF PRODUCTS PRODUCED

The number and type of products will affect the structure of the system. Generally speaking a firm producing only one product or service will be a centralized organisation (although this may not always be the case). On the other hand an organisation producing a variety of products and services is likely to have a decentralized structure and distributed information system. This is because each product which is produced for final output will be reproduced under its own "product" manager. Manager A, Product A, Manager B - Product B. This is what happens when the products are unrelated, or can easily be separated such as food; clothing; paper and so on, or toy motor cars and toy dolls, mens clothing and womens clothing.

4. THE GEOGRAPHICAL DISPERSION OF A BUSINESS

Where an organisations operations are conducted in a number of different locations we may find divisionalisation, as managers will be appointed in charge of activities at a certain place. Provided that the same product is being produced at the various sites, then the firm is likely to be broken up into regions for decision making purposes.

The three diagrams, Figures 1 - 3, give examples of how a firm might be structured. Figures found on next page.

B. ALTERNATIVE STRUCTURES

There are various alternatives and combinations of alternatives ranging between a pure centralized system and distributed system available to designers of information systems. We shall look at three of them and analyse them on the basis of various criteria.

1. CENTRALISED SYSTEMS

With a centralised system, the data processing takes place in a central processing centre. Users who are in remote locations from this central processing facility are linked to it via communication channels. They enter all data into the terminal from where it is transferred to the central processing site for processing.

(a) Personnel

The staff that operates the terminals need not have any computer training other than on how to enter information and make enquiries via the terminal. However staff at the central processing site are generally specialists who are highly trained and experienced in their particular field. The kind of staff who would be found at this site are computer operators, maintenance engineers, programmers and operators.

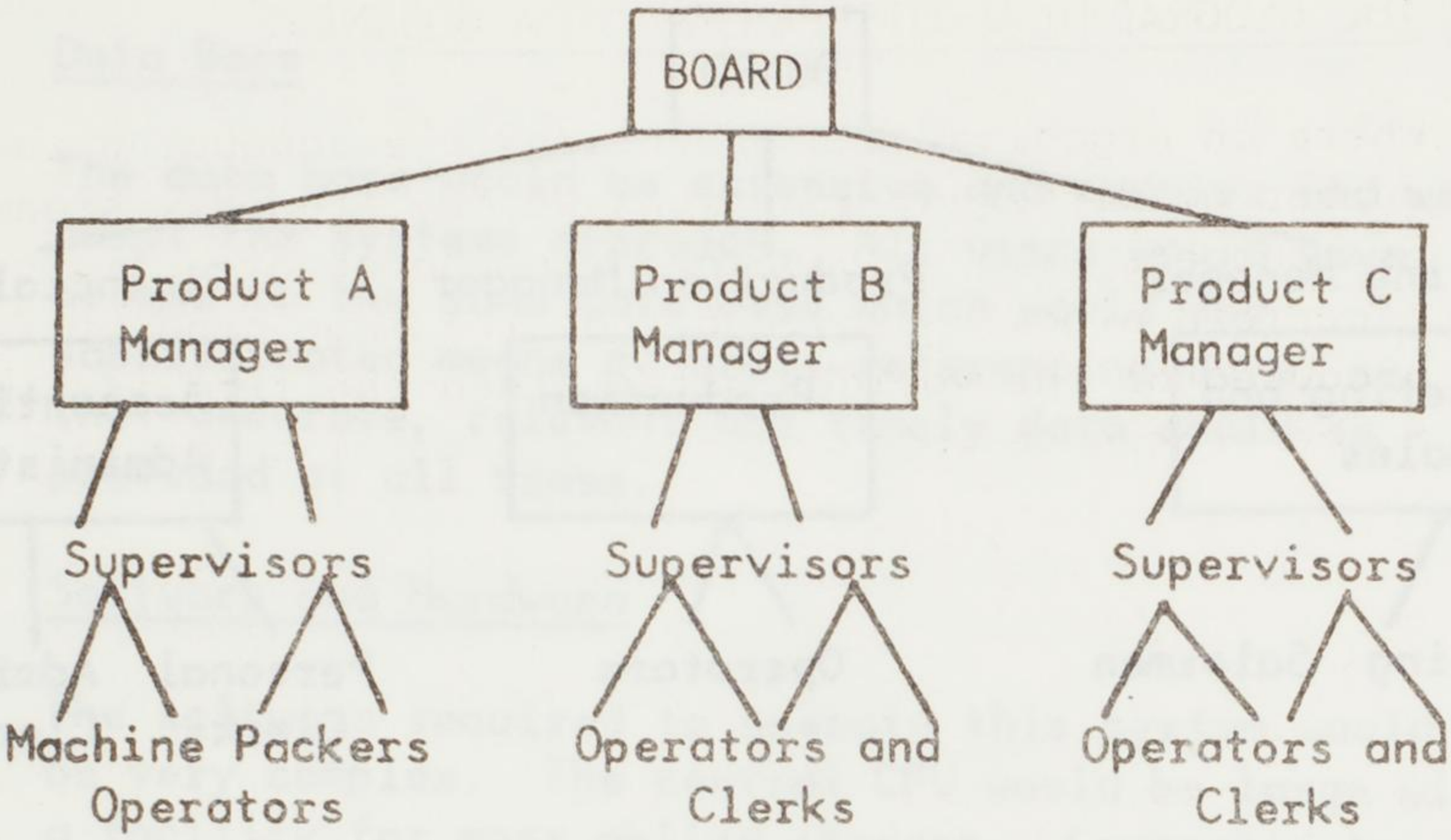

Fig. 1 Firm structured according to products

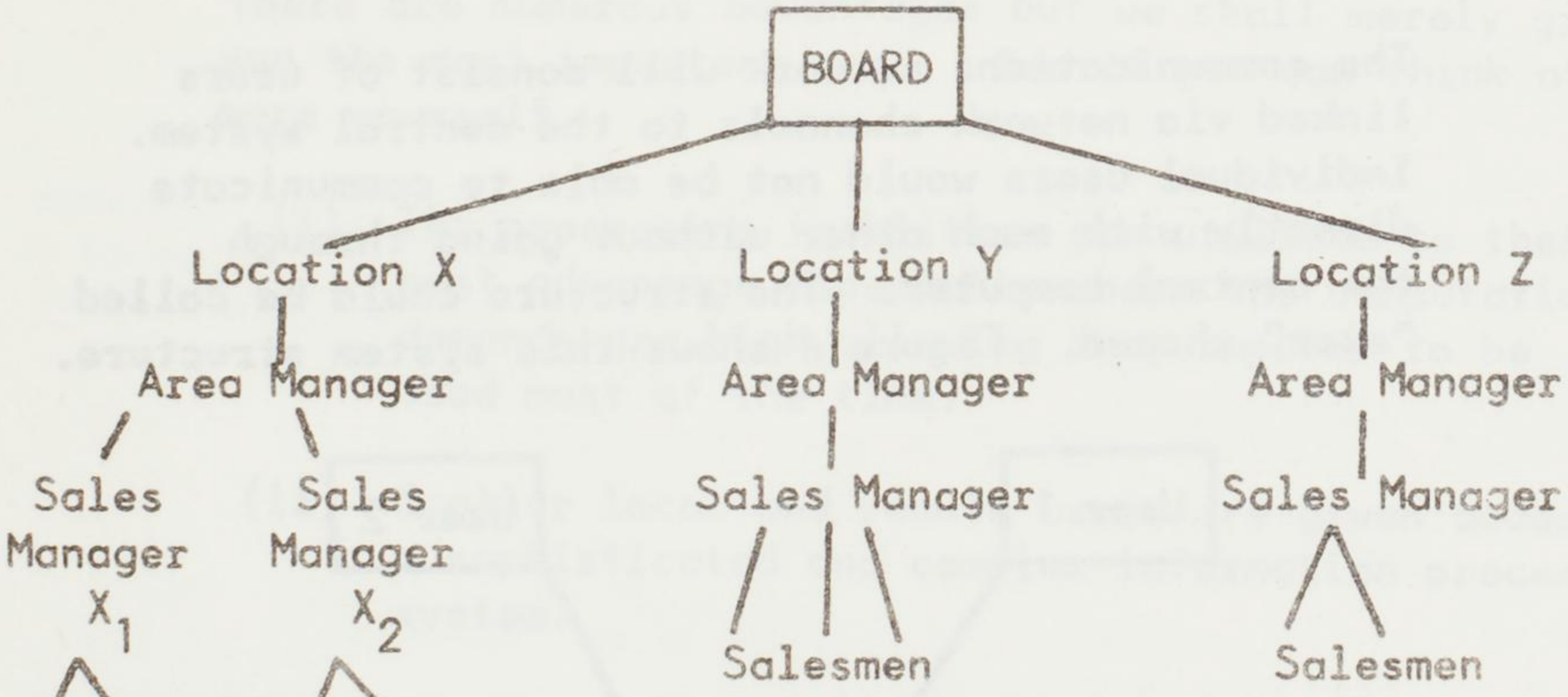

Fig. 2 Organisational structure based on Geographical dispersion

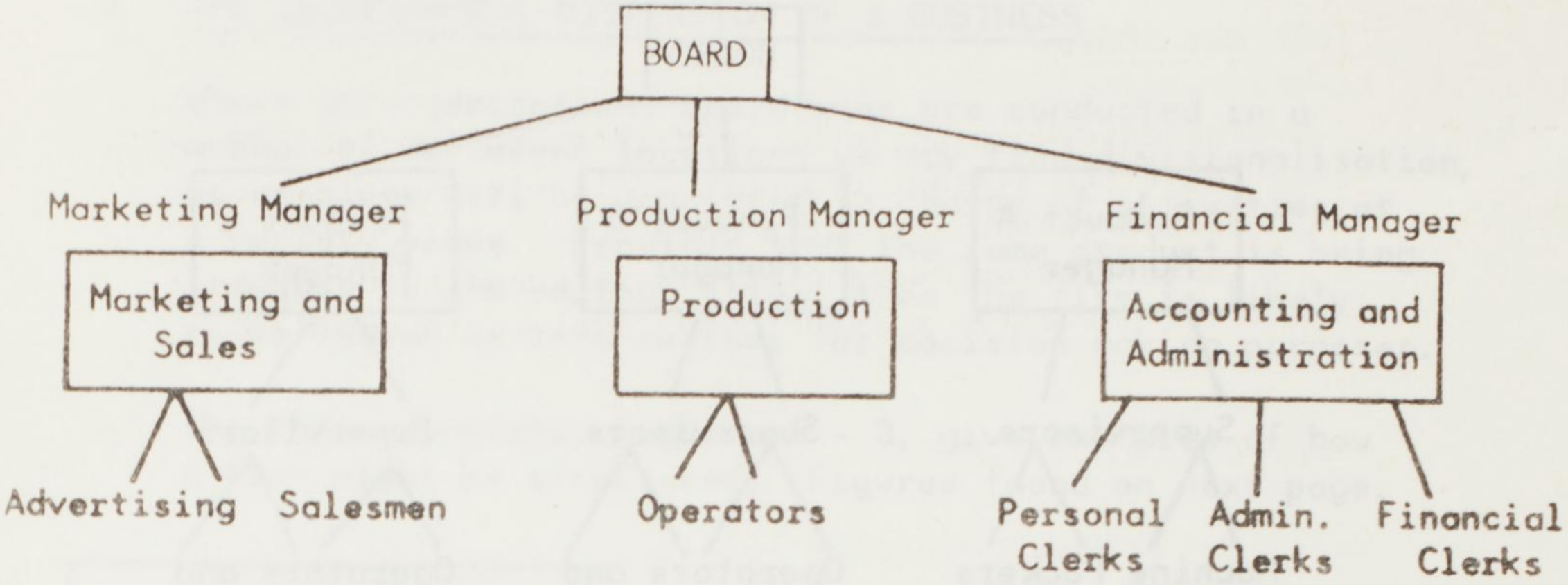

Fig. 3 Organisational Structure based on Functions.

(b) Communications

The communications network will consist of users linked via network channels to the central system. Individual users would not be able to communicate directly with each other without going through the central computer. The structure could be called "star" shaped. Figure 4 shows this system structure.

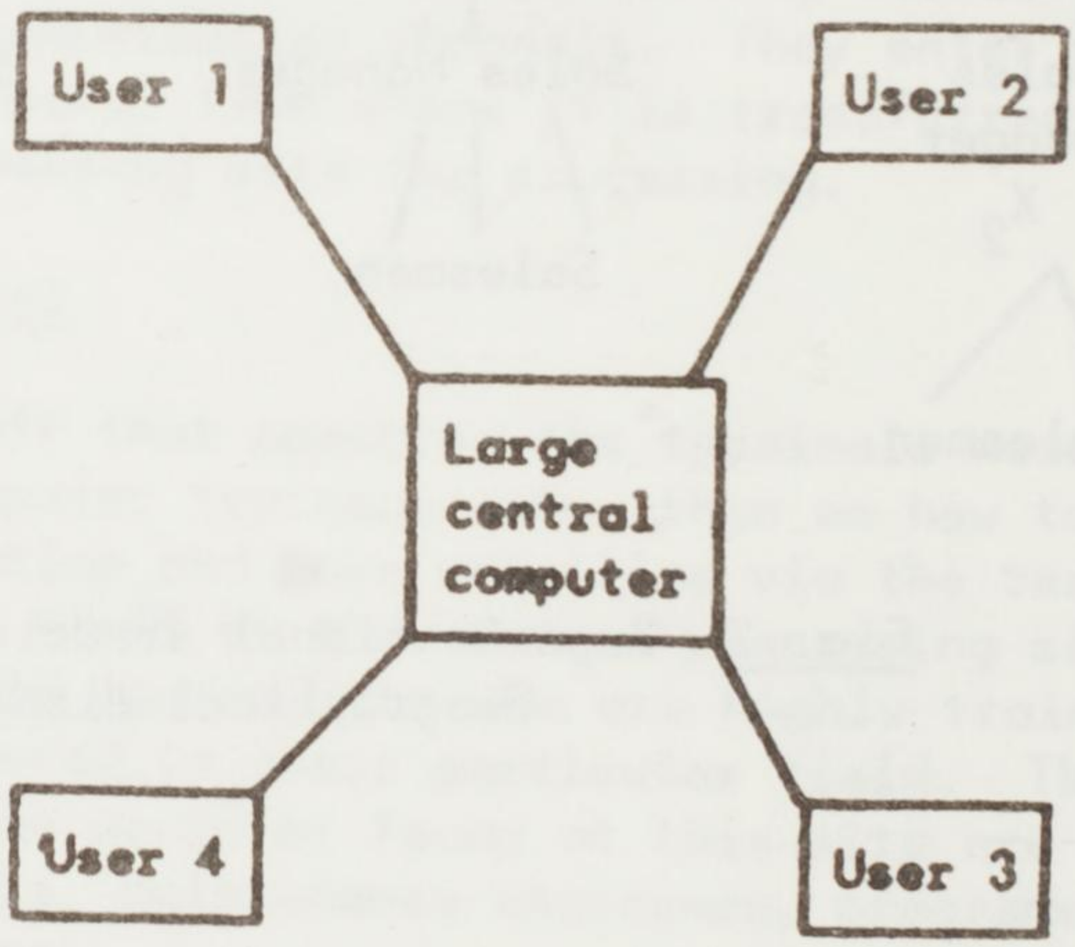

Fig. 4

(c) Data Base

The data base would be extensive and complex and would adopt the systems approach. All users would have access to the same data base which would use sophisticated means of cross-referencing data, so that accurate, relevant and timely data could be provided at all times.

(d) Software and Hardware

The software required to operate this system would be very complex. The central CPU would be large with a facility for mass online storage. Connected to this would be a number of interactive terminals.

(e) Advantages

There are numerous advantages but we shall merely give you the most important ones. See if you can think of more yourself.

(i) The processing facilities are utilised to their best advantage especially where the computational demands are high, allowing the computer to be used most of the time.

(ii) Smaller local and remote users are given access to a sophisticated and complex information processing system.

(iii) The system can be more easily protected and the data base is more secure as all controls can derive from the central system.

(iv) Data redundancy and duplications are reduced since there is only one common data base.

(f) Disadvantages

(i) The system is very complex and often the users and the computer specialists do not thoroughly understand what the other requires.

(ii) It is difficult to modify the system because everything is so interdepedent.

(iii) If the central computer breaks down, then all the users will be unable to continue operations unless adequate back-up facilities have been arranged.

(iv) If there are no adequately qualified personnel to design the system, as well as implement it and then maintain the system, the result could be a poorly designed system which meets few of its expected objectives.

2. DISTRIBUTED SYSTEM

With this system, each application site has its own computer to handle processing. Staff at each site are in charge of their own facilities. There is no large central computer controlling all activities. There is a distribution of processing power.

(a) Personnel

Each distinct site will be under the control of its own data processing staff resulting in a distribution of computer expertise. As there is no control processing facility, there will be no central staff as such.

(b) Communication

Individual departments and sites could be connected directly to each other so that communications could occur between them.

A "web" structure is what this system most closely resembles because of the way all users are interconnected, shown in Figure 5. Although there is no "central" processing facility there would be a "centre" computer which would oversee operations and controls in the entire system, but it would not be ranked differently from the rest of the processors.

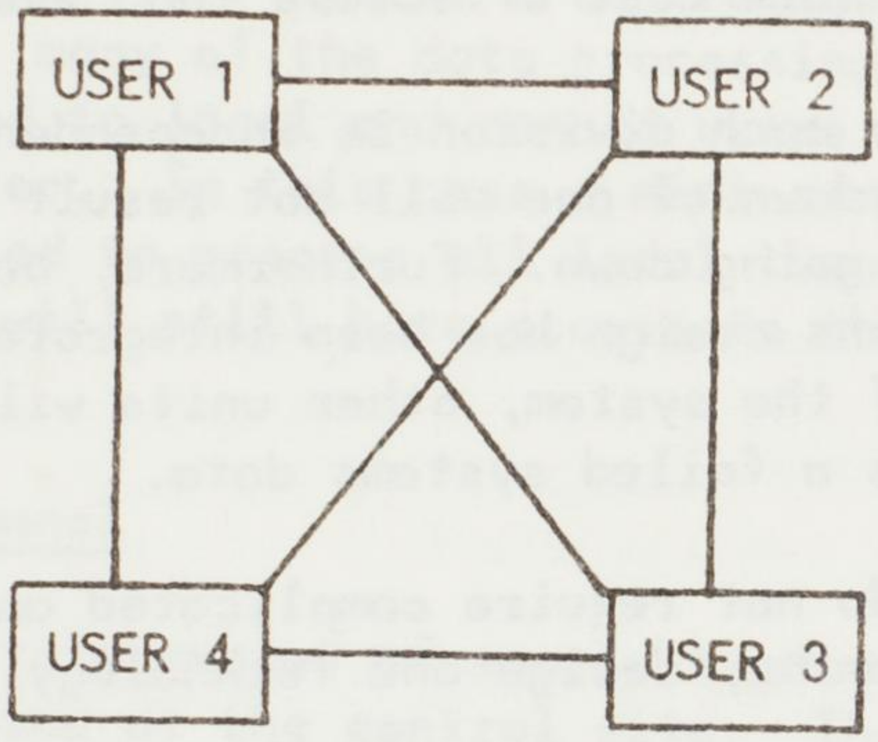

Figure 5

(c) Data Base

There would be a separate data base maintained at each location which would, on a limited scale be able to cross-reference data with other locations, resulting in a network of interconnected data bases.

(d) Software and Hardware

Each application would have its own software and operating system but these would all be compatible with each other. That is, any processor could adopt software from another processor within the system.

At each site there will be a self-contained, stand-alone computer system. Because of the cost/effectiveness of mini-computers these are frequently found in such a system, as huge computers are not often needed (although they should not be automatically omitted).

(e) Advantages

(i) Because each processor handles its own security and control, these can be easily set up and maintained.

(ii) Mini computers with sophisticated and noteworthy computational power have made such a system more cost effective than ever before.

(iii) Because each division is independent of the others, a breakdown of one will not result in the whole system going down. Furthermore, because each divisions design has been integrated with the next of the system, other units will be able to process a failed systems data.

(iv) These do not require complicated and sophisticated programming, design and technology.

(f) Disadvantages

(i) Because each sub-system is independent, a lack of standardisation may occur in the overall system.

(ii) It may be difficult to co-ordinate activities and operations.

(iii) Because of the separate data bases, there may be data redundancy, duplication or inconsistencies (when a file which is common to all users is only updated at one or a few of the locations).

(iv) The overall goods of the system may be undermined by the individual goals of each sub-system.

(v) A more elaborate and complex communication system will have to be set up to facilitate communications between all sub-systems.

3. A HYBRID SYSTEM - A CENTRALISED SYSTEM WITH MINI COMPUTERS

With this system we find a combination of a distributed and a centralised system. It must be remembered that there can be numerous variations on such a combination, and the systems will vary from being predominantly centralised or predominantly distributed.

In this particular system a centralised system with mini-computers, many of the data processing functions have been distributed to local and remote users who have access to their own computer. In this case a mini-computer. These computers will be used to process all local transactions and at the same time will still have access to the centralised computer system.

(a) Personnel

A certain amount of specialised computer staff will be found at the central site. They will design the overall system, the operating system and perform programming and maintenance functions. They will also be able to assist staff at other locations with their operations.

(b) Communications

Communications will occur between users and the central computer system, as well as directly between individual users. The kind of structure which would describe this system is a "ring" structure and this is shown in figure 6.

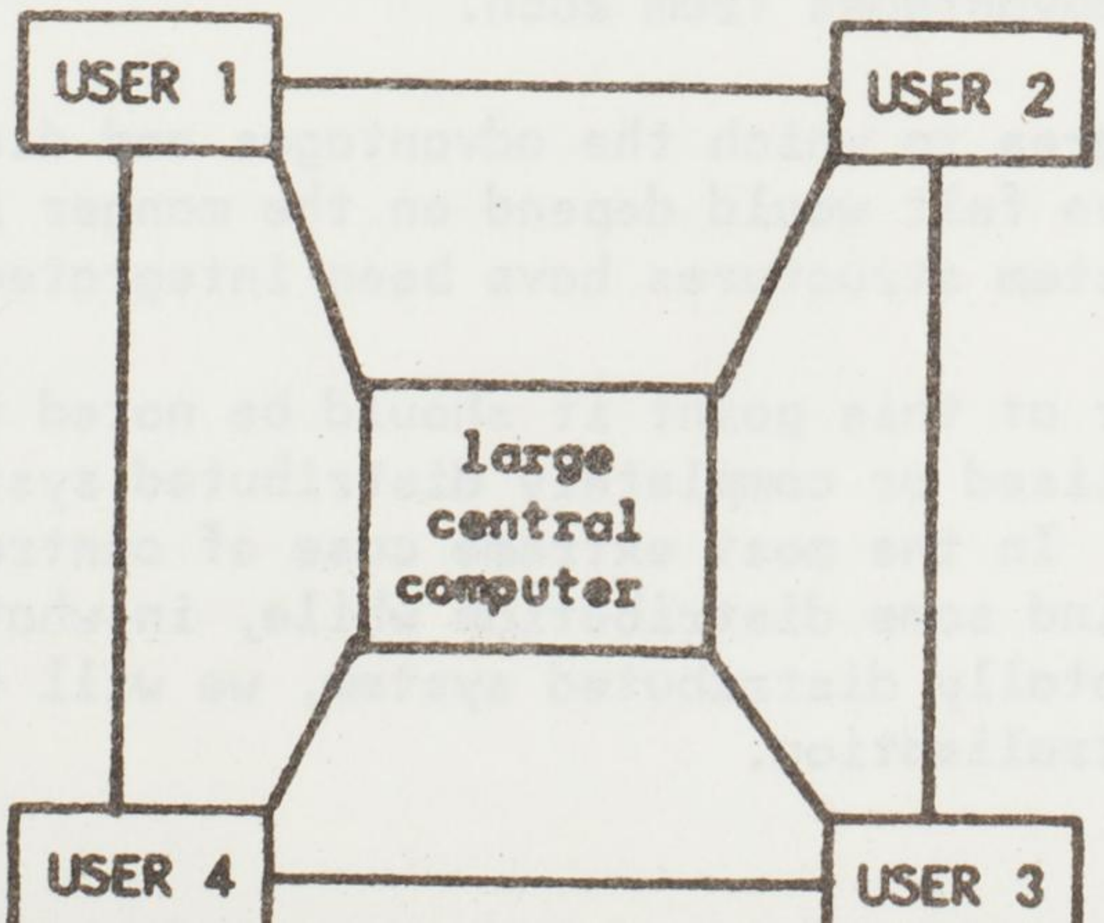

Figure 6

(c) Data Base

By using the systems approach the data base can be logically interlinked, while at the same time being physically dispersed. The important thing to remember is that there is still only one data base (unlike a completely distributed system).

(d) Software and Hardware

There would be a centralised data control, system control and a large program preparation. The central system would provide support for the distributed processors. There would be central operating system to control the overall system. Each distributed processor would have its own software and programs which could be designed with the aid of central staff.

Mini computers would be found at the distributed sites and these would perform appropriate transactions, and would have stand-alone processing facilities. They would also each have mass-online storage. The large computer at the central site would perform any specialised function and any large or significant processing requirements.

(e) Advantages and Disadvantages

A hybrid system could benefit from the advantages of both centralised and distributed systems. The advantages would hence be a combination of the advantages of each. However, the system would also suffer from a combination of disadvantages from each.

The degree to which the advantages and disadvantages would be felt would depend on the manner in which the two system structures have been integrated.

However at this point it should be noted that extremely centralised or completely distributed systems are not found. In the most extreme case of centralisation we will find some distribution while, in what seems to be a totally distributed system, we will find a degree of centralisation.

PROGRESS QUESTIONS

1. How would management philosophy affect the structure of an organisation?

2. Show how the communications structure for each of a centralised, distributed and hybrid system would differ.

3. What are the advantages and disadvantages of centralised and distributed systems? Can you think of any more?

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USE THIS PAGE FOR MAKING NOTES

COMMUNICATIONS

A. INTRODUCTION

An understanding of data communications concepts is very important when considering on-line or distributed modes of working. The data communications system allows data to be transmitted between the central processing unit and peripherals and between the peripherals themselves. This means that the system can be fragmented and geographically dispersed, yet still communicate with and interact. In this country it compulsory to use the services of the Post and Telecommunications Department.

HISTORY

1. TELEGRAPH

This was the first form of electric communication and it used telegraph wire along which currents or pulses were sent. From this the telex system which is an international system, has arisen. The principle behind the telex is the transmission of binary coded pulses by switching a direct current.

2. TELEPHONE

The voice telephone was the second major communication system. This works on a different principle to that of the telex in that a microphone converts sound into a matching alternating current which causes the ear piece diaphram in the receiving telephone to vibrate causing sound waves.

3. COMPUTERISATION

The computer has made it essential to be able to transmit data efficiently from one centre to another, rather than to physically transfer it. The telegraph system is not feasible because it is so slow : the telephone, being faster, was an obvious alternative.

Data however must be converted for transmission over the telephone system, by means of either an accoustic coupler or a modem, because the computer uses a pulsed direct current which is not compatible with the alternating current of the telephone.

B. TELE-PROCESSING

1. INTRODUCTION

In this lecture, we will be considering what data transmission is and how it can be achieved. For this course we shall consider data transmission to imply that a computer has a number of terminals connected to it via telephone lines. By these lines, messages are transmitted between terminals and the computer and this is called "tele-processing".

This may sound like an engineer's paradise - maximum complexity for least return! In practice the reverse is true and a well-run tele-processing (TP) system can prove an invaluable asset to a firm.

2. WHY TELE-PROCESSING?

The origins of data transmission lie as far back as the first computers. These machines read cards in one location and punched copies in another, which was expensive and slow. It needed the advent of powerful, fast, reliable computers and control programs before tele-processing became a widely used and economic techinque. Equally important has been the advent of a wide variety of terminal units, ranging from the simplest of electric teleprinters (typewriters) to fast multi-purpose terminals based in some cases on small computers.

The justification for tele-processing is, as one might expect, economic. It is all based on the principle that "time is money", and we can illustrate it best with a small example.

Consider a firm with a central warehouse and despatch facilities, and a number of branch offices each taking orders from its own local area. This is actually not an unusual situation, and such a firm might operate by having each branch office collect a day's orders (by telephone or post) and despatch them to the central warehouse and offices daily. Overnight they will be punched on to cards and processed on a computer and, possibly, the output received back in the branch office on the next day. Additionally the goods, if they are in stock, can be despatched the day after receipt of the order, or, more probably, two days after receipt.

Consider now the changes to this firm if it installed one or more terminals in each branch office, each connected to the central computer. The sequence can now go something like this :

On receipt of an order the clerk in the branch office can :

(a) Check that the items are in stock;

(b) Check that the customer is registered with the firm and has good credit;

(c) Confirm the price.

Already we can see advantages: the customer gets better, quicker and more accurate service. The firm gets more accurate orders, its files are up-to-date and, it hopes, has fewer bad debts.

Because the firm's management have more up-to-date information, they can plan better and the firm becomes more efficient. Goods can be despatched faster, and the cost of punching and verifying cards is largely eliminated.

(a) Reasons for Development

This is one of the fastest developing approaches in DP. The reasons are :

(i) Organisations require collection and processing of information from various geographical locations more rapidly than traditional communications allow.

(ii) Access is required to a large computer for accessing programs and data, again more rapidly than would conventionally be possible.

(iii) Cost per unit of computing performance diminishes as the size of the computer increases.

(b) Nature of Transmission

Data transmission is where data is sent by a telecommunications link (on-line or off-line) from or to a user who is physically remote from the computer. Thus the transmission can be directly linked (real-time mode) to the computer, or may terminate centrally (input) in tape or cards.

With the former, replies are usually directly returned by data transmission to remote screens (or printers). With the latter, queries are often the reason for the transmission - query tape or cards are taken off central transceivers and fed into the job stream, so that multiprogramming allows access on line to files to produce cards tapes etc.

(c) Consideration

The question raised by the systems analyst when considering data transmission would include.

(i) Are there alternative methods of transferring data to and from the DP facility - eg. by rail, post, etc?

(ii) What are the comparative costs, reliabilities, etc?

(iii) Could data be added to the existing telex? At what cost?

(iv) What alternative methods are excluded because of existing systems constraints? (For example, data may be collected at given times, or at any time)

(v) What locations need to send/receive information and what is their distance from the central processing facility?

(vi) What are the relative merits of duplex (both-ways) and simplex (one-way) transmissions?

(vii) Are on-line operating costs justified in the face of immediacy needs?

(viii) Should there be a private line or a switched network operations?

As we work through this lecture we shall define and become more familiar with the terms introduced here. It is suggested that you return to this section once the entire lecture is completed for a deeper understanding.

3. MECHANICS OF TELE-PROCESSING

Our main concern in this course is not the design of such systems, but what is needed to get them to operate. We will be looking at each component in turn. But first let us put them in context by showing how each fits into the whole.

There are four different parts to a tele-processing system:

(a) Terminal;

(b) Telephone lines and "modems";

(c) Computer and its control unit;

(d) Programs which control the whole system.

Figure 1 shows how they inter-relate to form a working system.

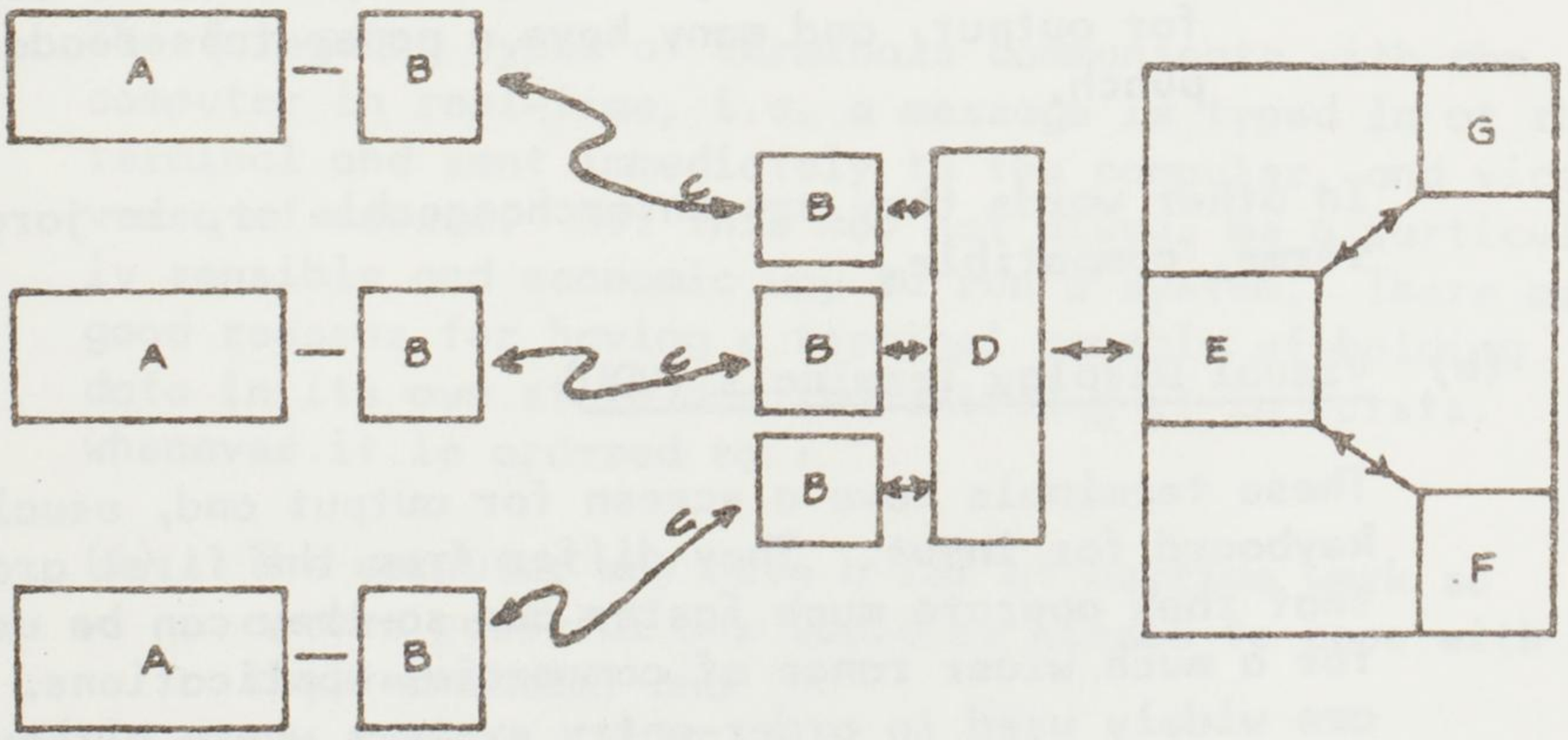

Figure 1 : Components of a Tele-Processing System.

Key

A Terminals; B Modems; C Lines; D Computer control unit; E Tele-processing control program; F Application program; G Operating System.

4. TERMINALS

A wide variety of terminals can be used in a tele-processing system. One convenient way of describing them divides them into rough groups based on their mode of operation and capabilities. We will be discussing them under four sub-headings :

(a) Teleprinters;

(b) Visual display terminals;

(c) High-speed terminals;

(d) Buffered terminals.

(a) Teleprinters

These are almost the "classic" terminal and are very widely used. There are many different versions produced by a number of manufacturers.

They are characterised by these things :

(i) They all use the same transmission codes;

(ii) They all work at 10 characters per second;

(iii) They all have a keyboard and a printer or screen for output, and many have a paper tape reader and punch.

In other words they are interchangeable or, in jargon terms, compatible.

(b) Visual Display Terminals (VDU)

These terminals have a screen for output and, usually, a keyboard for input. They differ from the first group in that they operate much faster and so they can be used for a much wider range of commercial applications. They are widely used in order-entry systems where although no printed output is needed, it is important that the contents of the screen can be changed fast. Work out for yourself how slow it would be to use the 10-character per second screens if ten 50-character messages were necessary for each item ordered. It would be so frustrating as to be unworkable.

It is quite common for these terminals to have their own control unit, which not only controls a number of screens but also handles communication with the main computer. It is also possible for the control unit to have a printer connected so that a "hard-copy" of important events can be kept.

One other feature which is unique to this sort of screen is the so-called "light-pen". This allows an operator to select an item from a list displayed on the screen by pointing to it with a special "pen". Used correctly this is an easy quick way to communicate with a computer; especially suited to the routine clerical type of job.

(c) High Speed Terminals

At the other extreme we find a variety of terminals which are designed to cope with the high input - output demands of commercial data processing. Basically such devices will have a line printer, typically 600 or 1 000 lines per minute, a card-reader and possibly a card punch. In addition they may have tape or disc backing store and paper-tape facilities. Because they have to handle fast peripheral units and a high-speed transmission line, this sort of terminal is often based on a small computer.

(d) Buffered Terminals

The foregoing types of terminals communicate with the computer in real-time, i.e. a message is typed in at the terminal and sent immediately to the computer, and vice-versa of course. But this may not alwyas be a particularly sensible and economic way to run a system. There are good reasons for having a terminal capable of holding data in its own store and transmitting it in bursts, whenever it is ordered to :

(i) The computer may have a lot of daytime work so a more powerful one would be needed to cope with the terminals; and

(ii) The cost of the lines is usually much higher during the day than at night.

A buffered terminal has advantages which may make it unquestionably the best for a particular applicant. Because it can transmit a lot of data at high speed from its store, it is possible to reduce line costs during the day by connecting the terminal for short periods only. This is feasible because many such terminals continue to take output from the operator, while transmitting or receiving and provide the bonus of a simple check on the operator's input. It can, for example, check that a money field contains only numbers and a decimal point in the right position. In turn, this makes the operator's job easier because most typing errors can be detected as they are made and the central computer has less work to do. The converse is that there are delays in transmitting data, which must be taken into account when designing the whole system.

C. THE COMPUTER AND ITS CONTROL UNIT

The final part of a tele-processing system is the central computer and its control unit. This part of the system can be regarded as three separate but closely inter-linked sections; the control unit, the tele-processing control program and finally the application programs which actually make the system do the work it is intended to do. There are two additional items without which no tele-processing system could work; the computer hardware, and the "Operating System" which controls and drives that hardware.

1. CONTROL UNIT

(a) Bridge

The control unit of the computer handles the transmission lines and acts as a bridge between them and the computer by converting pulses from a line to words or bytes (and vice versa) which can be sent to the computer's storage.

(b) Error

It checks that no transmission errors have occurred; and

(c) Distribution

It shares out attention between all the lines (possibly of different speeds) which may be connected to the computer. In practice, there may be more than one unit for a large system with dozens or hundreds of different lines.

The control units which we discuss in the next section perform many more functions than these, and they are frequently based on small computers.

2. TELE-PROCESSING CONTROL PROGRAM

Think back for a moment to the basic tele-processing control unit we described above. It signals to the main computer whenever it has a message waiting from a terminal, when it has completed transmitting a message provided by the computer, and whenever an error occurs. We can see that the TP control program has to react to all these conditions:

(a) Record

It has to keep tab of which application program is expecting a message from which terminal and pass it to the correct one.

(b) Direction

It must direct messages from the programs to the right terminals.

These are two functions which must be performed by the central computer software, and very often the control programs are a completely integral part of the operating system.

(c) Error Handling

The third part of the TP control program is error handling. It must monitor perhaps dozens of transmission lines and, whenever the control unit signals an error (a parity failure for example), the program must decide what action is to be taken. This is time-consuming and expensive since response must be as fast as possible. The computer time could be more profitably employed in working on its normal commercial

jobs, and more core storage and disc units may be needed solely for the tele-processing.

This, then, is the point of having a small computer running the control unit. Because it can take over the time-consuming work of controlling the transmission lines, which must of course be in "real time", it releases the main computer to do useful work, and possibly reduces its main and backing storage needs.

3. APPLICATION PROGRAMS

The hardware and software we have so far discussed form a base for the actual application program. How these are designed and specified is not discussed in this particular course.

The size and complexity of these programs is dependent on two main factors; the complexity of the application, and the amount of pre-written software that is available. This is a very good example of a case where standardised software "packages" can be profitably employed.

Packages of this sort enable the programmer to write programs in high-level languages such as COBOL or PL/1 to process the data received from terminals and prepare replies. The package provides an interface between the control program and the programmer. This interface must be reliable and efficiently coded if it is not to take up too much of the whole computing system's resources, and its functions are fairly standard. Because such software is difficult and expensive to develop, there are increasing numbers of packages available from manufacturers and specialist firms.

D. DATA TRANSMISSION

1. CODES

As in the computer itself, transmitted data is represented by binary codes. The most popular code used is the ISO code defined by the International Standards Organisation. The United States version of this code is known as ASCII. The major competitor is EBCDIC, short for extended binary code decimal interchange code.

EBCDIC is an 8-bit code while ASCII or ISO codes are 7-bit though they are usually sent as 8 bits with the additional bit being used for parity.

2. MODES OF TRANSMISSION

Timing techniques are necessary so that adjacent bits of the same value can be distinguished when they are sent along a communications medium in sequence, one bit after the other.

There are two basic modes of transmission :

(a) Asynchronous Transmission

Asynchronous (or start-stop) transmission achieves the timing synchronisation between sender and receiver by framing each data character with start and stop bits. Its advantage is that since only 8 bits have to be counted between the synchronising bits the timing mechanism does not have to be very accurate and is quite cheap. It also means that each character can be sent separately at any speed as the line is silent while nothing is being transmitted. The disadvantage however is that it is slow because of the start and stop bits. It is mainly used for low volume data.

(b) Synchronous Transmission

The synchronous mode eliminates the start and stop pulses so that characters can be sent as a stream of pulses or as a "full message" with start and stop pulses at either end. Any unscheduled gaps between characters confuse the receiving end, so the terminal usually accepts typing into a buffer memory until the typing is complete and the message can then be sent continuously. It improves the efficiency of data transmission.

synchronous transmission is advantageous for use for high-volume data, particularly remote-job entry.

3. DATA COMMUNICATION CHANNELS

There are three different types of transmission :

(a) Simplex describes a communications channel over which transmission can take place in only one direction

(b) Half-duplex describes a communications channel over which transmission can take place in either direction, but not both at the same time.

(c) Full-duplex describes a communications channel over which transmission can take place in both directions simultaneously. It involves far greater speeds and is more complex and expensive than simplex or half-duplex.

With half duplex there is an overhead in reversing the direction of data transmission. This encourages the use of full duplex mode for applications involving a high rate of change of direction such as interactive data entry where fast response times are required.

4. MODEMS (MODULATOR/DEMODULATOR)

Data which is transmitted over a communications link (as opposed to cable-connected local terminals) must usually be converted to a wave form. This process of converting a digital signal to a wave form is known as modulation, the reverse process is demodulation. Devices incorporating these functions are used at each end of telephone lines used as data communications links and are known as Modems. The modem converts data into AC and feeds it directly into telephone lines. The quality of the transmission will depend on the telephone line, the modem and the computer. There must be compatible modems at each end of the line to modulate and demodulate the transmission.

5. NETWORK CONFIGURATIONS

The telephone lines or other transmission media are very costly so techniques are employed to minimise the total number of lines. If every terminal had its own dedicated line to the computer then this point-to-point network would be very costly and operate at very low line utilisation.

(a) Multiplexors

Multiplexors, provide a "transparent" connection between remote terminals and the computer ports to which they are normally individually attached. The multiplexor combines the signals from a number of devices into a single signal which is then transmitted via modems and telephone line

to another multiplexor where the single signal is separated back into a number of discrete signals as though each device were using a single line. Multiplexors are utilised by using one high speed line between a central processor and the multiplexor and multiplexing all the terminals into the one line. There are low speed channels between the terminals and the multiplexor. The multiplexor can accommodate all terminals because it assumes all terminals to be used all of the time. There must be a multiplexor at both ends of the line for multiplexing.

(b) Concentrators

A concentrator is similar to a multiplexor, except that it does not allow all terminals to use the channels at the same time. It assumes that all of the terminals will not require the available facilities at the same time. The terminals must contend for the available channels which when fully utilised will prevent other terminals from making the connection. They will be busied out. Whenever a channel is vacant, the first terminal ready to receive or transmit will get the channel, and control it until the transmission is complete. The concentrator functions as a switching device which polls terminals or channels.

(c) Multi-dropping

Multi-dropping is based on the idea that a terminal is not used fully all the time. In practice most terminals are probably not using their line at even half their capacity because the operator has to turn pages, answer the phone, etc. Many terminals are buffered and a line is transmitted only when the whole line has been typed in. Similarly a whole line is received before it can be typed out.

This reduces the amount of time which a terminal spends using a line. Multi-dropping allows several terminals to use the same line, thus saving time. They contend for the line when it is busy, meaning that each wait their turn.

(d) Statistical Multiplexors

These are a refinement of the ordinary multiplexor in that they do not share time equally among each users, but in proportion to the transfer rates of individual users. It attempts to make the most efficient use of the line.

6. PROGRAMMABLE COMMUNICATIONS PROCESSORS (PCP)

(a) These PCP's are computers, usually mini computers, which release the central processor or host computer for more important processing functions. It performs a supporting role in the communications system doing front-end processing and message switching. They perform some housekeeping, handle message queues and file management, establish channel connections, route messages to and from periphirals and disconnect after a completed transmission.

The popularity of programmable communications processors has increased as the flexibility of mini computers has grown. They allow the central processor to work more efficiently since it no longer has to cope with interruptions and delays in processing operations, while handling data.

Furthermore, primary storage space is released. The whole system becomes more flexible because the communications processor can adapt to changing requirements.

(b) Front End Processing

With this method, the Front-end processor performs many of the communications functions usually performed by the C.P.U.

It allows the CPU to work more efficiently. The CPU no longer has to face interruptions and delays during processing operations to handle data.

Primary storage space is also released. The system becomes more flexible because the front-end processor adapts to changing requirements.

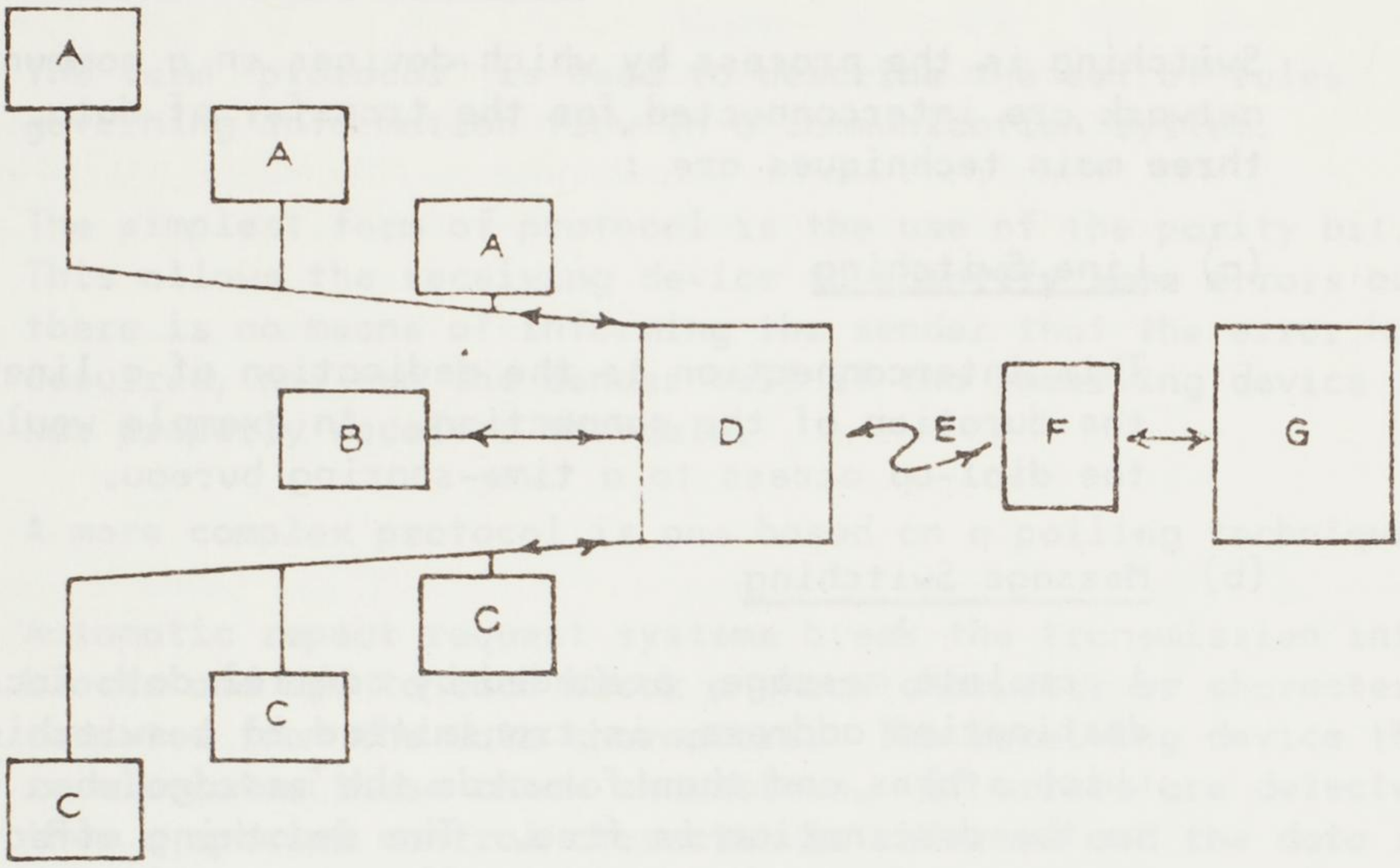

Figure 2 : Example of Multi-Dropping and Concentrators

Key

A Terminals multi-dropped from line 1;

B Single terminal on line 2;

C Terminals multi-dropped from line 3;

D Concentrator;

E High-speed line;

F Computer line control unit;

G Central computer;

NOTE : For clarity no modems are shown in this drawing.

7. SWITCHING TECHNIQUES

Switching is the process by which devices on a communications network are interconnected for the transfer of data. The three main techniques are :

(a) Line Switching

This interconnection is the dedication of a line for the duration of the connection. An example would be the dial-up access to a time-sharing bureau.

(b) Message Switching

A complete message, preceded by control data including destination address, is transmitted to a switching centre which stores and then forwards the message when the line to the destination is free. The smoothing effect of store-and-forward switching allows more efficient circuit utilisation. This technique also allows the interconnection of devices of different speeds and codes since the system can automatically perform code and speed conversions. Major communications network run by organisations such as the clearing banks use this technique. Terminals can connect directly to another terminal by going through the message-switching processor.

The message switching computer moniters data traffic and ensures that messages are directed through the most efficient and less costly routes. It can reroute data if certain channels go down. It can also perform preprocessing and editing, and certain error checks.

(c) Packet Switching

This is a development of message switching where messages are broken into packets of a fixed length. Each packet consists of a header section containing control information, a data section and a tail section containing checking information. Although all packets are delivered to the destination address, they may be handled separately in the network and may follow completely different routes depending on network conditions.

8. INFORMATION FLOW CONTROL

The term "protocol" is used to describe the set of rules governing information flow in a communication system.

The simplest form of protocol is the use of the parity bit. This allows the receiving device to identify some errors but there is no means of informing the sender that the error has occurred, nor can the sender tell if the receiving device has properly received the data.

A more complex protocol is one based on a polling technique.

Automatic repeat request systems break the transmission into blocks and add to each block a check character or characters computed from the data characters. The receiving device then recalculates these check characters. If errors are detected then a special control character is returned and the data is retransmitted, otherwise an acknowledgement character is returned.

E. AVAILABLE SERVICES

1. INTRODUCTION

The voice band or telephone link used in data communication is a medium-speed channel in popular use. Channels can be graded on speed of transmission which is a function of bandwidth. An example of a low-speed channel is the telex communication system. High-speed channels are braodband and can transmit, at high speeds, large volumes of data. Included among these type of channel are selected voice-bands, microwaves and satelite transmissions channels.

2. COMMUNICATION ARRANGEMENTS

The postal authorities have made available two basic kinds of communication arrangements which are medium-speed channels.

(a) Public Line

This is also known as dial-up or public switched net-work. The receiving site is dialled up to make the connection before transmission can begin. The channel

will be available for as long as the connection is made. The costs of this line are on the same basis as telephone calls and vary according to distance, duration of connect time and time of day. The quality of the line is not guaranteed so the modems must access channel characteristics before transmission so that they can compensate for conditions. Users may connect with any point where there is a telephone. A disadvantage, is that it is half-duplex and channels are noisy. Sometimes it may be impossible to establish a connection because channels are busy.

(b) Private Line

This is also known as a dedicated line or "tie line" and is a permanent line connected between two sites (point-to-point). There is no need to dial, and the connection is available 24 hours a day. Usage is unlimited and costs are a flat rate on a monthly basis, based on the kilometer distance of the connection. The lines are often conditioned and less noisy than dial-up lines. It is full-duplex and obviously free from busy signals. Response rates are fast. To be economically feasible volume demands need to be high for this type of service as the costs can be quite high.

3. PRIVATE BRANCH EXCHANGES

The stored-program-controlled telephone exchange has evolved over the last decade to provide a wide range of sophisticated voice-handling, facilities. IBM, Pye, and British Telecom are all suppliers of microprocessor-controlled exchanges.

The major facilities available from stored program controlled private branch exchanges are listed below and show the flexibility that can be obtained.

Call redirection	- diversion of all incoming calls for a particular extension to another extension.
Call pickup	- users able to answer calls appearing on other extensions.

Automatic callback	-	user, on finding an extension engaged, able to instruct the exchange to ring back and connect when both parties are free.
Multi-party conferences	-	several users involved in the same conversation.
Abbreviated numbers	-	library of regularly used external telephone numbers which can therefore be obtained by keying 3 or 4 digits.
Last number calls	-	retrying the last number tried or connected to be re-tried by keying a short code.
Fast call connection	-	internal calls connected in less than one second compared with up to 15 seconds on electromechanical exchanges.
Manager/secretary facilities	-	provided between any extension without special wiring.
Moves and changes	-	amendments to the systems such as renumbering extensions, and changes in class of service can be implemented without rewiring, usually by inputting them on a service terminal.
Route restriction	-	limits external dialling and selectively limits trunk dialling, depending on class of service of the extension.
Route optimisation	-	examined and routed dialled numbers and to route the calls through lower-cost leased lines if these are free.

Call logging - information of individual calls stored for either manual or computer analysis, providing basis for allocating telephone costs to user areas and charging individuals for private calls.

The above list is very long. It illustrates that given a computer then the only limit to the number of tasks the computer can perform is the software and the overall power of the computer.

A quote from a recent conference sums up the situations: "The use of computers is only limited by the ingenuity of man".

F. DATA SECURITY

This subject is sufficiently important to be worth a separate section. In this course we will concern ourselves with the precautions that a systems analyst can take to check that data is correct. What is of concern is how we can check that data was actually transmitted correctly.

There are essentially three ways of testing that no bits were gained or lost during transmission :

(a) Parity Bits

Parity bits can be generated by the originating end of the line and checked by the receiving end.

(b) Longitudinal Record Checking

The 1 or "on" bits in a complete message can be counted and the total of some part of the total number (e.g. the last two digits) sent at the end of the message. The receiving unit also counts the bits and compares the check digit it received with the one it calculated. This is called Longitudinal Record Checking and is a powerful way of testing the integrity of a message, particularly when used in conjunction with parity bits.

(c) Self-Correcting Codes

Self-correcting codes involve extra software and probably hardware. It is possible to use a code which can correct any error that may occur. But there is a price to be paid since these codes contain character, a parity bit, and additional bits which are necessary for error correction but which reduce the amount of useful data which a line can transmit. Thus these codes increase the cost per character of data transmission.

PROGRESS QUESTIONS

1. Explain the meaning and/or the use of each of the following:

   (a) buffered terminals;

   (b) tele-processing control program;

   (c) half-duplex;

   (d) modem;

   (e) multi-dropping;

2. Define synchronous and asynchronous transmission.

3. Define and explain the difference between a multiplexor and a concentrator.

4. Write short notes on each of the switching techniques.

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INTRODUCTION TO COMPUTERS/PRINCIPLES E D P

TEST GYE2

(Time allowed : 2 Hours)

NOTES:
1. Credit will be given for neatness and method.
2. Answer all questions.
3. Scale of marks is indicated at the end of each question.
4. Leave sufficient space at the head of your answer paper for tutor's comments.
5. Answer each question on a separate sheet of paper.
6. Attach this entire question paper to your answers.
7. PLEASE FILL IN STUDENT DETAILS ON THE FORM AT THE END OF THIS TEST AND ATTACH IT TO YOUR ANSWERS.

--------oOo--------

QUESTION 1

What are telecommunications? In what respect can computer technology be combined into telecommunications design?

(25 marks)

QUESTION 2

Distinguish between the following terms:

Synchronous and asynchronous transmission.
Stand alone and front-end configurations.
Switched and non-switched networks
Modems and multipliscors.

(25 marks)

QUESTION 3

(a) What mode of transmission would be appropriate for high volume and high speed data transmission. Explain.

(b) List and briefly comment on the important components of any telecommunication systems.

(25 marks)

QUESTION 4

(a) Differentiate between an off-line and an on-line information system.

(b) Describe a real-time system. What are the advantages and disadvantages of such a system.

(25 marks)

TOTAL : 100 marks

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