

## Reprint

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## PLANNING THE EVOLUTION OF THE VIDEOTEX NETWORK

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### ABSTRACT

The purpose of this paper is to discuss the evolution of the videotex system concept with special emphasis on network requirements. In its essence videotex offers information transmission and retrieval using the home TV set, a videotex adapter module with a hand-held keypad, telephone lines, and videotex service centres. Although broadcast videotex-like systems are also possible, based on TV-line/frame grabbing technology, they are not considered in this paper as generally they are not fully interactive.

Videotex services are being tested in a number of countries including Canada (e.g. Bell Canada's Vista), the USA (e.g. Dept. of Agriculture's Green Thumb), England (e.g. BPO's Prestel), France (e.g. CCETT's TITAN), Holland, West Germany, Switzerland, Finland, Denmark, Sweden, Spain, Hong Kong, and Japan (e.g. CAPTAINS). Information retrieval seems to be generally accepted as the introductory service but other interactive services are possible. Once the basic videotex system becomes popular it will open the door to other opportunities which are briefly reviewed in this paper.

Since videotex is basically a visual service, the requirements and alternatives for coding visual information are discussed. Other key factors in videotex network planning are the user distribution and traffic between the access points (customers' premises) and the service centres. The customer's telephone loop is frequently chosen for local access because of its bidirectionality and the generally high penetration of the telephone service. The short-term communications alternatives beyond the local loop are the telephone switched network and packet switched networks.

The logical format of the long term videotex network is presented and examples of possible configurations using the Canadian packet switched network (Datapac) are given. There are two levels of service in videotex : the meta-service and specific services. The videotex meta-service includes the user interface (e.g. character echoing and communication-error handling), the billing mechanisms and the routing of requests to specific services. Specific services may be provided by service suppliers connected to the network.

## I. INTRODUCTION

Videotex is the generic name given to a new class of interactive visual information services for bidirectional transmission of data, usually based on the telephone line. A TV set is often used as the display, with an adapter module interconnecting the telephone line and the TV set to a hand-held keypad with which the customer interacts with the system. Data is retrieved interactively from videotex centres through the telephone line and characters and graphics are displayed on the screen of the TV set. Although broadcast videotex-like services are also possible, based on TV-line/frame grabbing technology, they are not considered in this paper as generally they are not fully interactive.

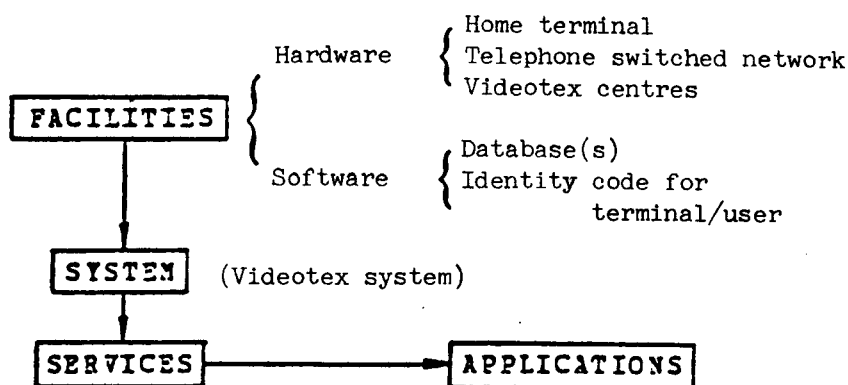
Videotex services are being tested in a number of countries including Canada (e.g. Bell Canada's Vista), the USA (e.g. Dept. of Agriculture's Green Thumb), England (e.g. BPO's Prestel), France (e.g. CCETT's TITAN), West Germany, Holland, Finland, Denmark, Sweden, Spain, Switzerland, Hong Kong, and Japan (e.g. CAPTAINS). Information retrieval seems to be generally accepted as the introductory service but other interactive services are possible. Once the system becomes popular it will open the door to other opportunities. Indeed, to obtain a cost-effective system the facilities must be shared as much as possible among different services. The videotex service possibilities are briefly reviewed in Section II.

Since videotex is basically a visual service, the requirements and alternatives for coding visual information are discussed in Section III.

The expected increasing demand for videotex services will require an expanding network of videotex centres. This is the subject of Section IV. The logical format of a long term videotex network is presented and examples of possible configurations are given.

## II. VIDEOTEX SERVICES

A review of the literature on new services (e.g. [1], [3]) shows that there appears to be much confusion about what constitutes a service. Indeed, most published lists of services turned out to contain applications rather than services. In fact, a combination of facilities (comprised of hardware, software, and network) constitute a system which gives rise to services. The services are then put to several applications by the users; thus diagrammatically for videotex we have the following :



- |    |                         |   |
|----|-------------------------|---|
| 1. | Information retrieval   | News, weather, sports, etc.<br>Stocks levels<br>Timetables<br>Advertising<br>Price lists<br>etc.  |
| 2. | Interest matching       | Houses<br>Cars<br>Jobs<br>Car pools<br>Babysitters<br>etc.  |
| 3. | Messaging               | Greetings<br>Travel status<br>Personal messages<br>Letters<br>etc.  |
| 4. | Commercial transactions | Reservations (restaurants, hotels, car rentals, transportation, etc.)<br>Ticket purchases<br>Catalogue purchases<br>Electronic funds transfer<br>etc. |

- |     |                       |  |
|-----|-----------------------|--|
| 5.  | Questionnaires        | Puzzles<br>Tests<br>Polls<br>Surveys<br>etc.   |
| 6.  | Personal database     | Personal diary<br>Recipes<br>Bibliographic references<br>Mailing lists<br>etc.                                       |
| 7.  | Calculations          | Tax calculations<br>Loans<br>Finances<br>Operational costs<br>Calculated information retrieval<br>etc.               |
| 8.  | Computer games        | Mazes<br>Word guessing<br>Chess<br>Strategy and tactics<br>etc.  |
| 9.  | Education             | School & university instruction<br>Specialized training<br>Education of the handicapped<br>Language-training<br>etc. |
| 10. | Software distribution | for calculations<br>for games<br>for CAI<br>etc.   |

This list is used to illustrate some of the potential applications of videotex services. This particular classification is based on hardware and software requirements. In general, the lists of videotex applications are endless and also overlap each other; for example, reservations and purchasing applications could also be considered part of the message services category.

The importance of the videotex service package will be seen in the following sections. Many important decisions regarding picture coding, terminal design and network topology rest on judgments concerning what will be the most popular videotex services.

### III. VISUAL INFORMATION CODING

An important part of the videotex system design is the coding of visual information which is displayed on the screen of the TV set. The coding requirements for visual information are the following :

#### 1) ALPHANUMERIC TEXT

There are two kinds of alphanumeric text, unformatted and formatted, depending on whether the text can generally be re-formatted.

i) Unformatted : This is the usual form of presenting textual information divided into sentences and paragraphs. This form of text can easily be re-arranged regardless of the number of characters per row and the number of rows in the terminal display.

ii) Formatted : There are two types of formatted text : positional and tabular. Positional text would be used mainly in conjunction with graphics for annotation purposes. Positional text may also be used to compose simple pictures (e.g. histograms) which are aptly described as "typewriter graphics". Tabular text is organized in columns and rows.

#### 2) GRAPHICS

There are two types of graphical figures : lines (e.g. polygons, arcs, circles, rectangles, etc.) and solid shapes or areas defined by closed lines and filled with a uniform colour and brightness, crosshatch, or texture. They may also contain positional text.

#### 3) STILL VIDEO IMAGES

As opposed to graphics, still video images do not have regions of different colour and/or brightness delimited by lines, but rather the variations may be gradual from pel to pel (pel = picture element). Due to the large number of bits necessary to describe an image and the relatively low data rate of the telephone line, it is desirable that the image coding, transmission and build-up at the terminal is done by superimposing layers of increasing resolution rather than by completing each pel before the next is transmitted.

#### 4) SPECIAL EFFECTS

Flashing displays and very simple moving graphics are possible and may be considered as special effects; for example, updating the hands of a clock in real time.

#### 5) FULL MOTION VIDEO

Full motion video such as television is outside of the present scope of videotex. In the future this could be provided by merging videotex and TV technologies.

Having discussed the classes of visual information, we can now examine the three methods of coding this information :

1)           ALPHA-MOSIAC

Examples of systems using this type of coding are Prestel and Titan. Alphanumeric information is fixed on a grid of, say, 20 rows by 32 columns. Graphic information is fixed on a grid of, say, 60 rows by 64 columns. Graphic information is sent in the form of 'graphic characters' or graphic elements which are juxtaposed to build the image. If the picture has been stored in an alpha-mosaic manner in the database, any improvement in the resolution of the user terminal does not improve picture quality or graphics. The information transmitted to the user terminal is almost independent of the complexity of the picture (about 640 bytes for 20x32 character resolution).

2)           ALPHA-GEOMETRIC

Telidon, a videotex system developed by the Canadian Department of Communications, and scribblephone [4], a terminal-to-terminal visual communications system developed by BNR, are examples of systems using alpha-geometric coding. Alphanumeric information (comprising, say, 20 rows by 32 columns) is transmitted by means of ASCII codes; but it can be specified on the screen within one pel accuracy. This permits subscripts, superscripts and annotations. Graphic information is stored as vectors (lines and arcs) on a grid of, say, 4096 lines by 4096 columns. Picture quality depends on the display resolution of the user terminal. The amount of information transmitted to the user terminal depends on the complexity of the picture (25 bytes to 4000 bytes, with 1200 bytes 'typical').

3)           ALPHA-PHOTOGRAPHIC

This method which is being studied by BNR is catered to in the alpha-geometric scheme by permitting a pictorial description mode. One scheme involves transmitting the picture in pel-by-pel format or, better still, as successive layers of increasing resolution.

The alpha-mosaic coding scheme has been adopted for the initial Bell Canada VISTA demonstration, because decoder chips were readily available and because the scheme is simple and relatively inexpensive at the moment. The VISTA pilot demonstration will be upgraded to include alpha-geometric capabilities, to help determine whether the higher-quality graphics justifies the higher costs.

It is desirable that the coding method be as independent as possible of the kind of display terminal, resolution of the display, and the speed of transmission. Hence the alpha-geometric description is to be preferred in the long term with suitable provision for alpha-photographic coding for parts of the image. This allows alpha-geometric and alpha-photographic images to be displayed juxtaposed and/or overlaid.

However the higher cost of alpha-geometric decoders, (mainly due to the requirements of a sophisticated processor, associated firmware, and a bit-mapped memory of the display) makes the immediate and exclusive adoption of this coding scheme a controversial step. Probably firm standards will not be agreed upon until the various strategies are tested in the market place and the user reactions are evaluated. This delay may also allow the sophisticated encoding schemes to become more attractive as the cost of memory and microprocessors go down further. The initial product offering must be inexpensive because the users (and even the providers) of videotex are not fully aware of the cost/benefit tradeoffs.

#### IV. VIDEOTEX NETWORK

The communications network for videotex consists of all the telecommunications facilities among videotex terminals and computers in the network. As far as the customer is concerned, there are two types of communications : direct terminal-to-terminal (e.g. Scribblephone [4], Visual Ear [5], videogames, and home computers) and terminal to videotex centres.

In this section we propose a modular approach to the design of the videotex network. Growth in system capacity is achieved by adding new modules to the system rather than by increasing the size and complexity of a single centralized facility. This proposal is based on current BNR studies of the optimum growth strategy for the intelligent network.

There are two levels of service in videotex : the meta-service and specific services. The videotex meta-service includes the local access to the videotex network and the user interface (e.g. echoing characters to the terminal and handling communication errors), the billing mechanisms, and the routing of requests to specific service centres. Specific services may be provided by information suppliers connected to the network.

At present the division of functions among the service centres and the videotex centre (interface machine) is not standardized. No mature systems exist. Most probably all the functions, including services, will be initially provided by the videotex centre (e.g. for a market trial configuration). However, as soon as a particular service attains a significant penetration and becomes better defined and quantified, a separate (dedicated) processor could provide that service in an optimum way. It is essential to combine the service offerings in such a way that the system utilization is maximized in order to yield a cost-efficient



system (e.g. offer both interactive and batch services). It is also important to aim for fully automated systems which would require little or no maintenance. In the limit the videotex centre will probably be reduced to a concentrator/intelligent-switch/billing machine with the services being provided exclusively by dedicated auxiliary systems.

Keeping the videotex centres as the interface to the service centres has distinct advantages, for example :

- easier routing, accounting, charging, and billing.
- easier use (common log-on procedures) and easier switching from one service to another.
- fewer ports/modems necessary in the system because they are shared.

With the proposed configuration a given user is registered with a single videotex centre and all his requests for service are interfaced through that centre. If for some reason (e.g. when travelling) a user accesses a videotex centre other than his own, that centre would be responsible for obtaining credit clearance and sending accounting information to the centre with which the user is registered. Alternatively the user would be able to access a distant videotex centre through the telecommunication network if he so desires, at an additional cost for communications, of course. Some of the service centres will be the responsibility of independent service suppliers (e.g. information suppliers, real-estate agents and educational establishments). Suppliers in the U.S.A. will be connected to the Canadian videotex network via the existing Telenet and Tymnet interconnections to Datapac. Communications can also be used for load sharing : the computational load of responding to a large number of users can be distributed among several sites rather than being centralized at a single site. Updating duplicated and complementary distributed databases will also make extensive use of communications facilities.

Thus a distributed computer network is formed, and for the purpose of this analysis it is convenient to divide the network into logical subnetworks as shown in Figure 1. It can be seen in that figure that there is a backbone network of videotex centres and a number of service networks. The way in which each service network is connected to the videotex network will depend on the location and distribution of the various computers. They may be connected directly at each videotex centre or through gateway ports, for example.

The salient feature of this configuration is the presence of an intelligent

network which provides the access and vehicle for a number of independent and/or interrelated services. Economical and reliable service will be achieved in the long term by the network of distributed databases and distributed processors with their interconnection logically structured into layers. The main capability of this network will be to provide efficiently interactive communications either between people or between people and service centres.

For technical and economic reasons the responsibilities of each centre in the network will be determined by the demand. For example in the case of information retrieval, rather than divide the centres into local, regional, state or provincial, national and international centres according to the information they contain, the hierarchy should follow a structure similar to that of classes of telephone switching centres whose location and size are primarily governed by traffic. Indeed, the contents of each database is determined mainly by the demand and updating patterns. Each database will keep statistics of the information requested from it and the information it requests from databases further up in the system (tributary databses) and periodically will send those statistics to the tributary databases and also perhaps to networks control centres. These in will decide what information should be stored and updated in each database. This is analogous to stockroom and warehouse management problems; if an item is not in a database the request goes one step higher in the hierarchy. In practice there will be a compromise between storage needs and communication traffic to satisfy user requests and requirements for updating the databases within the appropriate time limits.

It must be emphasized that the diagram in Figure 1 represents a general purpose logical division. The choice of actual communication links which will be appropriate in each case will be made on the basis of the above needs. It is very probable that packet switching networks will prove particularly suitable. An example of an implementation using a packet switched network is shown in Figure 2.

The role of the videotex centre in this approach is that of a front end processor with a minimum of three functions :

- 1) User interface procedures (e.g. handling communication error messages and echoing characters to the user terminal). The module implementing these functions will be referred to as the Videotex Interface Module (VIM)..
- 2) Routing of calls (e.g. establish and control temporary connections between the user terminals and service computers).
- 3) Checking customer identity and keeping track of billing.

No matter what types of communication facilities are used, the above functions will have to be provided; the only question is where. In the diagrams of Figures 2 and 3 these functions are centralized in each videotex centre and the service centres are connected through the 'back door' of videotex centres.

There are two potential problems using a front end processor as a common access for all videotex services. First of all, there is a potential congestion problem (front end bottleneck). Secondly, the reliability of that front end must be very high as its failure would prevent all the users connected through that front end from accessing any service. Thus, from this point of view a large number of front ends are desirable, so that if one of them is down alternative ones can be made available.

An alternative is to have the front end handle user interface procedures only and let the billing and routing be distributed among a number of videotex centres connected via a packet switched network as shown in Figure 3. Such a system can reduce the bottleneck problems but would also be more difficult to manage. With this configuration each videotex centre must monitor continuously all communications under its supervision. If a videotex centre or service centre breaks down the users may easily be served by another machine in the network.

## V. CONCLUSIONS

The videotex service possibilities were briefly reviewed and the conceptual differences between services and applications clarified. The requirements for coding visual information were then described in some detail and coding alternatives presented. Although the alpha-geometric/photographic picture description is preferred for the long term, it is too early to recommend it as a standard, because it is not yet known if the general public will be willing to pay a higher price to get better resolution graphics. The Bell Canada VISTA pilot demonstration will thus offer both alpha-mosaic and alpha-geometric capabilities to permit comparison of the two schemes.

A logical network evolution strategy for videotex has been proposed which can accommodate increasing numbers of users and services. The service possibilities have been briefly reviewed. Introductory systems will be centralized at distant nodes (videotex centres). However, in the long term the network will evolve towards a decentralized (distributed) system. This will be more efficient and reliable. The result will be an intelligent network providing the access and vehicle to a number of different services.

#### ACKNOWLEDGEMENTS

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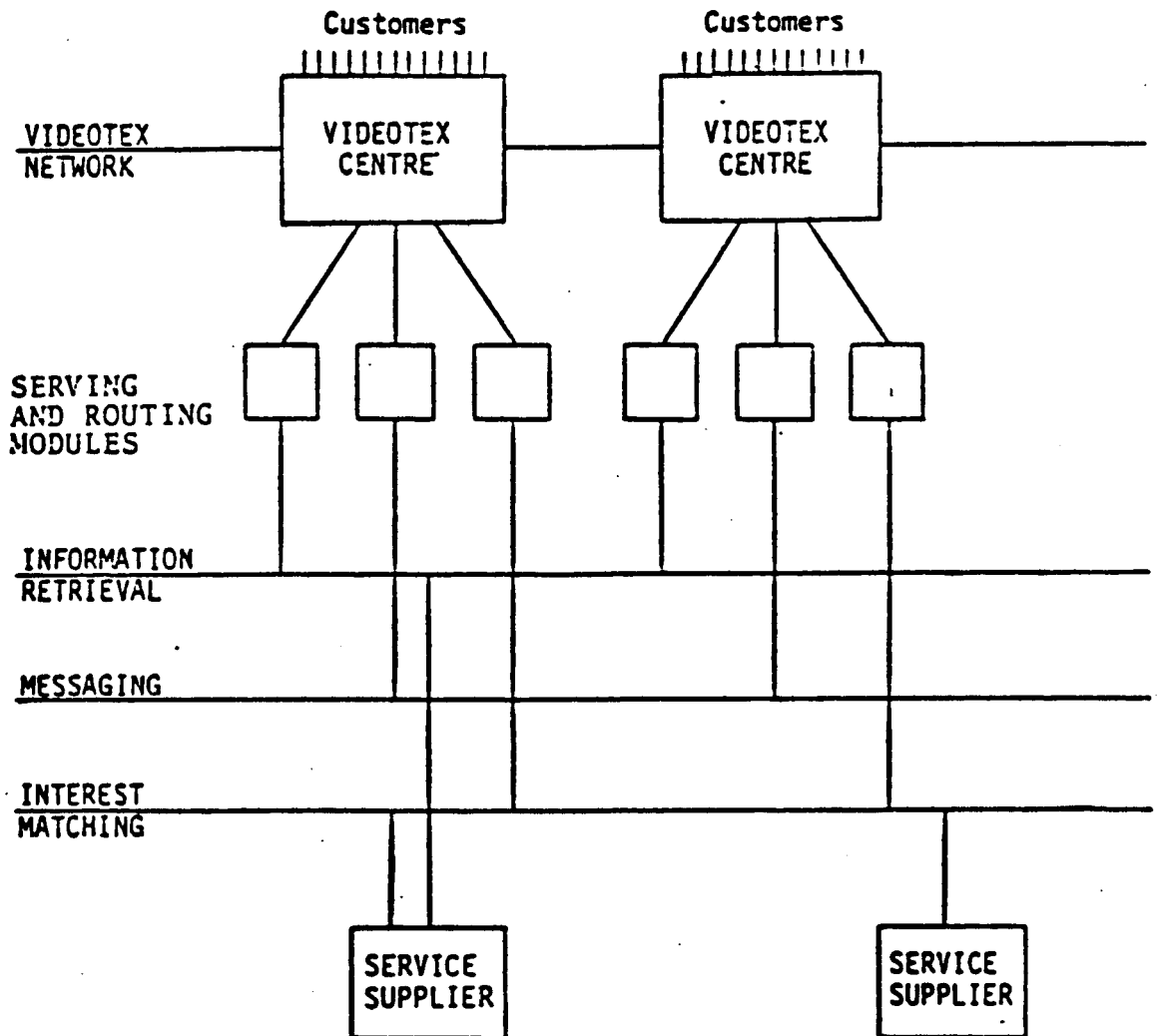
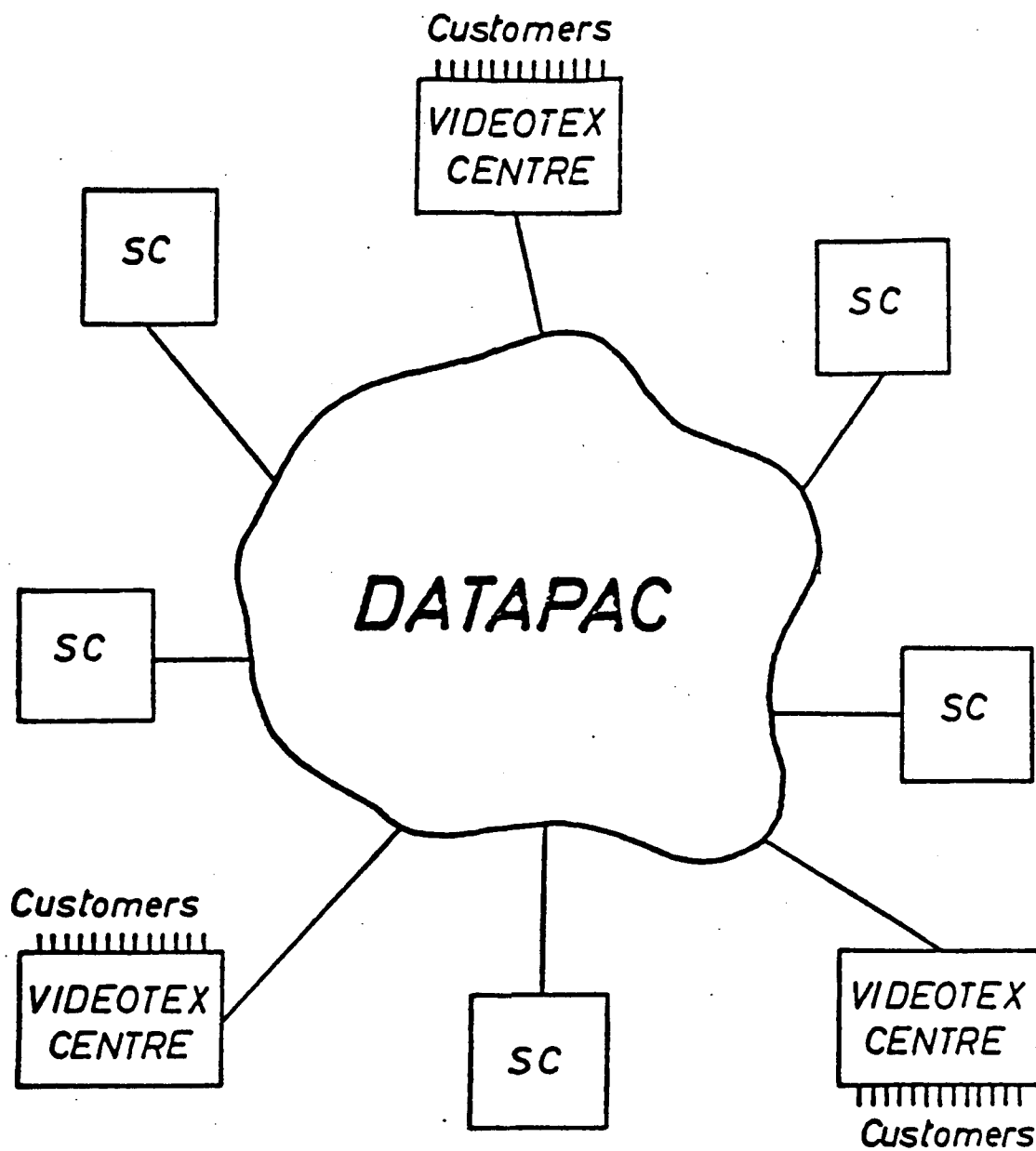
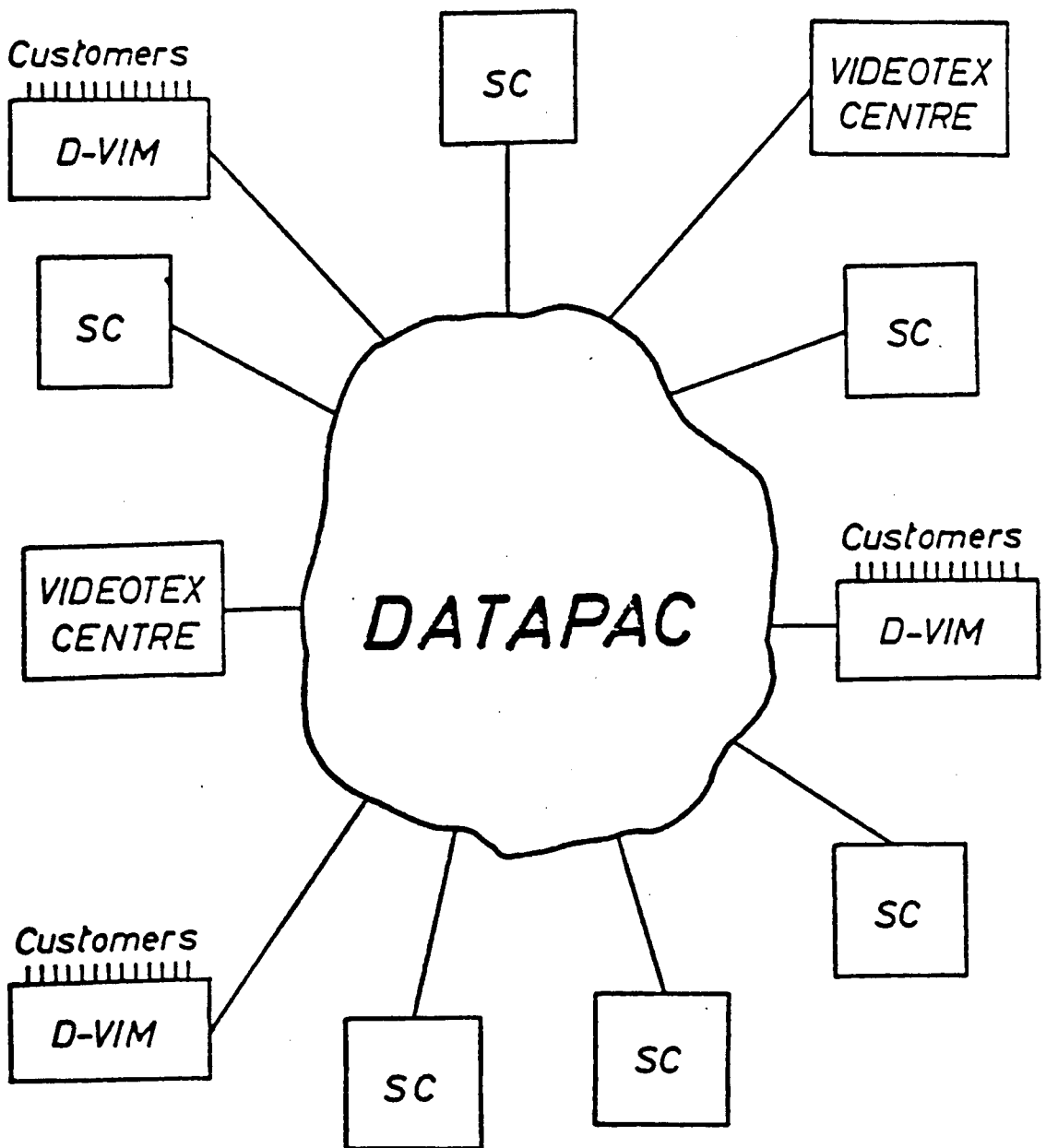


Figure 1. Long Term Logical Videotex Network.



**SC = Service Computer**

**Figure 2. Example of Actual Implementation of Videotex on Datapac**



*SC = Service Computer*

*D-VIM = Datapac-Videotex Interface Module (user interface)*

*VIDEOTEX CENTRE (controls routing and billing)*

Figure 3. Distributed Control of the Videotex Network.