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. The logical format of the long term videotex network is presented and examples of possible configurations using a switched data network are given.

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 (or sometimes a keyboard) with which the customer interacts with the system. Data is retrieved interactively from videotex exchanges 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, since generally they are not fully interactive.
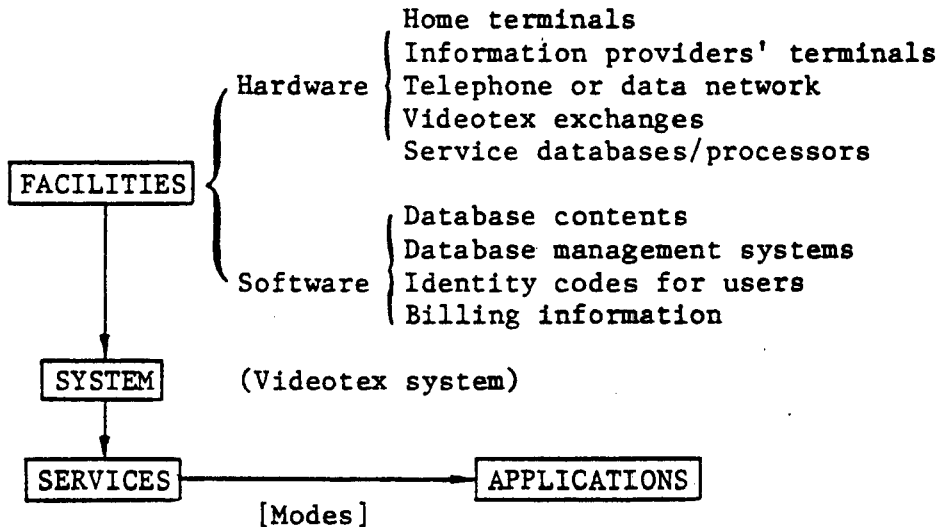
Videotex services are being tested in a number of countries including Canada (e.g. Bell Canada's Vista [1]), the U.S.A. (e.g. Dept. of Agriculture's Green Thumb), England (e.g. BPO's Prestel), France (e.g. CCETT's TELETEL), West Germany, Holland, Finland, Denmark, Sweden, Spain, Switzerland, Hong Kong, 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. References [2],[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; this can be shown diagramatically as follows for videotex:

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                                     Home terminals
                                    ( Information providers' terminals
                        Hardware   { Telephone or data network
                                    ( Videotex exchanges
                                     Service databases/processors

   ┌────────────┐  {
   │ FACILITIES │  {
   └────────────┘  {                 Database contents
        │                           ( Database management systems
        │               Software    ) Identity codes for users
        │                           ( Billing information
        ▼
   ┌────────┐       (Videotex system)
   │ SYSTEM │
   └────────┘
        │
        ▼
   ┌──────────┐                    ┌──────────────┐
   │ SERVICES ├───────────────────▶│ APPLICATIONS │
   └──────────┘                    └──────────────┘
        [Modes]
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1. Information   News, weather, sports, etc.
    retrieval   (Timetables
               [General] Advertising
                        (Price lists
                         Etc.
                        (Shopping basket
         [Customized]   ) Stock price levels
                        (Profiled information
                         Etc.

2. Interest   Houses
    matching   Cars
                      Jobs
                      Car pools
                      Babysitters
                      Etc.

3. Messaging ⎡ Store-&-retrieve ⎤   Greetings
               ⎢ Store-&-alert   ⎥   Personal messages
               ⎣ Store-&-forward ⎦   Electronic mail
                                       Etc.

4. Commercial
   transactions

   Reservations (restaurants,
   hotels, car rentals,
   transportation, etc.)
   Ticket purchases
   Catalogue purchases
   Electronic funds transfer
   Etc.

5. Questionnaires

   Puzzles
   Tests
   Polls
   Surveys
   Etc.

6. Personal
   database

   Personal diary
   Recipes
   Bibliographic references
   Mailing lists
   Etc.

7. Calculations

   Tax calculations
   Loans
   Finances
   Operational costs
   Calculated information retrieval
   Etc.

8. Computer
   Games

   [Customer-computer]
   [Customer-customer]
   [Downline loaded]

   Mazes
   Word guessing
   Chess
   Strategy and tactics
   Etc.

9. Education

   School & university instruction
   Specialized training
   Education of the handicapped
   Language-training
   Etc.

10. Software
    distribution
    for execution
    in terminal

    Calculations
    Games
    Computer aided instruction
    Etc.

   This list is used to illustrate some of the potential applications of
videotex. In general, the applications of videotex are very large in number
and also overlap each other; for example, reservations and purchasing
applications could both be considered to be part of the message services
category.

It is important to mention these applications of videotex, however briefly, since they constitute the bedrock for all subsequent planning, design and implementation. Many important decisions regarding picture coding, terminal design and network topology rest on judgements concerning what will be the most popular videotex applications.

III. VISUAL INFORMATION CODING

An important part of the videotex system design is the coding of visual information displayed on the screen of the TV set. Audio may be eventually integrated with visual information to enhance the user-appeal of the service; however, this topic will not be discussed in this paper. The visual information which has to be encoded can be divided into the following classes:

1) ALPHANUMERIC TEXT
There are two kinds of alphanumeric text, general and positional, depending on whether or not the text can be re-formatted without distortion of meaning.
i) General Text: This is the usual form of presenting textual information divided into sentences and paragraphs. This form of text can easily be re-arranged without distortion of meaning, regardless of the number of characters per row and the number of rows in the display terminal.
ii) Positional Text: This text is encountered in information which is organized in columns and rows, namely tables. It may also be used to compose simple pictures (e.g. histograms) which are aptly described as 'typewriter graphics'. Positional text would also be found in conjunction with graphics for annotation purposes.

2) GRAPHICS
There are two types of graphic 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.

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) FULL MOTION VIDEO
Full motion video, such as television, is outside of the present scope of videotex. In the future this may become possible by merging videotex and TV technologies.

5) 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.

Having discussed the classes of visual information, we can now examine three methods of coding this information which have been proposed in the international arena:

1) ALPHA-MOSAIC

Examples of systems using this type of coding are Prestel and Teletel. With NTSC television standards, the alphanumeric information is fixed on a grid of (say) 20 rows by 40 columns. Graphic information is composed by subdividing each 'window' into 6 'panes'. This creates a fixed graphics grid of (say) 60 rows by 80 columns. Graphic information is sent in the form of 'graphic characters' or graphic elements 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 800 bytes per frame in this case).

2) ALPHA-GEOMETRIC

Telidon [4], a videotex system developed by the Canadian Department of Communications, and Scribblephone [5], a terminal-to-terminal visual communications system developed by Bell-Northern Research (the research subsidiary of Bell Canada and Northern Telecom), are examples of systems using alpha-geometric coding. Alphanumeric information (comprising, say, 20 rows by 40 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 conceptual 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, 1200 bytes being 'typical').

3) ALPHA-PHOTOGRAPHIC

This method, which is being studied by Bell-Northern Research, is allowed for 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 was adopted for the initial Bell Canada Vista demonstration, because decoder chips were readily available and because the scheme was simple and relatively inexpensive at the time. The Vista pilot demonstration has since been upgraded to include alpha-geometric capabilities, to help determine whether the higher-quality graphics justify the higher costs.

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

However, the current 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) might hinder the immediate and exclusive adoption of this coding scheme. Many market researchers feel that 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. A Layered Capability Structure (LCS) approach to terminal design has therefore been suggested to reconcile the opposing requirements of low initial cost and upgradability [6]. Probably firm standards will not be agreed upon until the various strategies are tested in the marketplace and the user reactions are evaluated. This delay may also allow time for the more sophisticated encoding schemes to become more economical as the costs of memory and microprocessors go down further.

IV. VIDEOTEX NETWORK

The communications network for videotex is the sum total of the telecommunications facilities interconnecting the videotex terminals, databases and processors. As far as the customer is concerned, there are two types of communications: direct terminal-to-terminal (e.g. Scribblephone [5], Visual Ear [7], videogames, and home computers [8]) and terminal to videotex exchanges.

This section discusses 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 Bell-Northern Research 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 databases and processors connected to the network.

At present the division of functions among the service centres and the videotex exchange (interface machine) is not standardized. No mature systems exist. Most probably all the functions, including services, will initially be provided by the videotex exchange (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) database or

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 requiring little or no maintenance. In the limit the videotex exchange could probably be reduced to a concentrator/intelligent-switch/billing machine, with the services being provided exclusively by dedicated auxiliary databases and processors.

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

- easier routing, accounting, charging, and billing;

- easier user protocols (e.g. 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 exchange, and all his requests for service are interfaced through that exchange. If for some reason (e.g. when travelling) a user accesses a videotex exchange other than his own, that centre would be responsible for obtaining credit clearance and sending accounting information to the exchange with which the user is registered. Alternatively the user would be able to access a distant videotex exchange 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. could 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 exchanges 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 exchange 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 efficient interactive communications either between two or more customers or between a customer and the service centres.

For technical and economic reasons the responsibilities of each database/processor in the network will be determined by the demand. For example, in the case of information retrieval, rather than divide the databases into local, regional, provincial, and national on the basis of the kind of 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 content 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 databases) and periodically will send those statistics to the tributary databases and also perhaps to network control centres. These in turn will decide which 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 is conveyed one step higher in the hierarchy. In practice there will be a dynamic balance between storage needs and communication traffic to satisfy both user requests and database update requirements for an optimum price within the appropriate response time limits.

It must be emphasized that the diagram in Figure 1 represents a general purpose logical structure. The choice of actual communication links appropriate in each case will be made on the basis of the needs and availability. It is very probable that packet switching data networks will prove particularly suitable due to the fact that videotex data consists of bursts rather than a steady stream. An example of an implementation using a data network is shown in Figure 2.

The role of the videotex exchange 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 1 and 2 these functions are centralized in each videotex exchange and the service centres are connected through the 'back door' of the videotex exchanges.

There are two potential problems when 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, since 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 exchanges connected via a packet switched network as shown in Figure 3. Such a system can reduce the bottleneck problems but would be more difficult to manage. With this configuration each videotex exchange must monitor continuously all communications under its supervision. If a videotex exchange 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 compared. Although the alpha-geometric/ photographic picture description is preferred for the long term, it may be too early to adopt 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 thus offers 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 distinct nodes (videotex exchanges). However, in the long term the network will evolve towards a decentralized (distributed) structure. 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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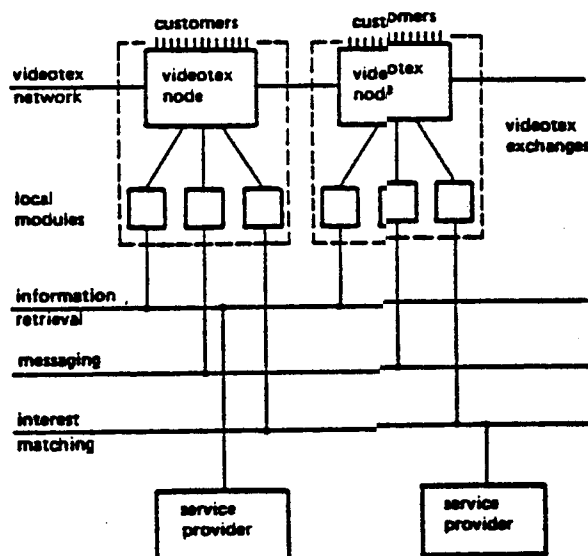
Figure 1. Long Term Logical Videotex Network.

SP = Service provider

Customers

Videotex exchange

SP

Data network

SP

SP

SP

Videotex exchange

Customers

SP

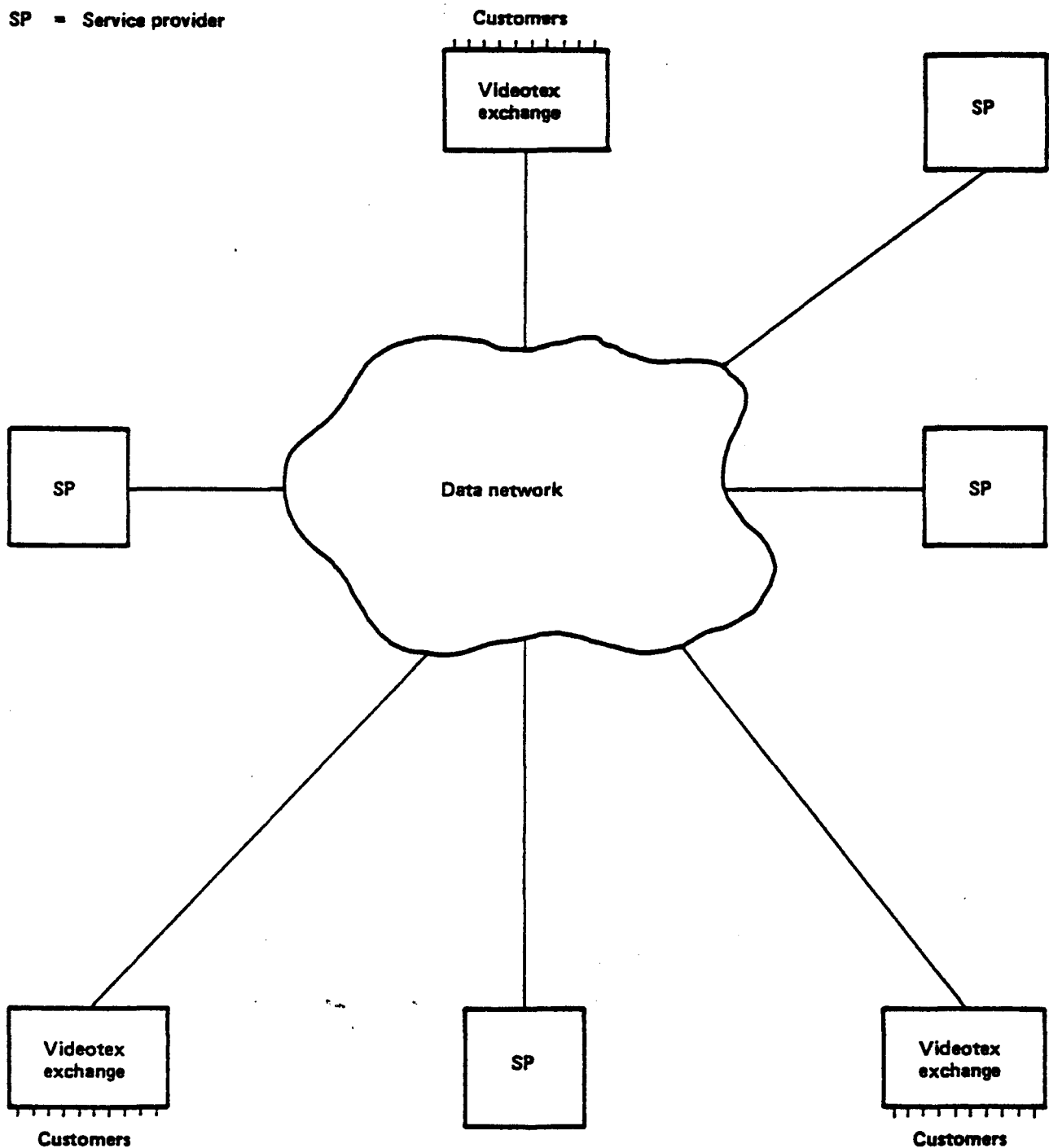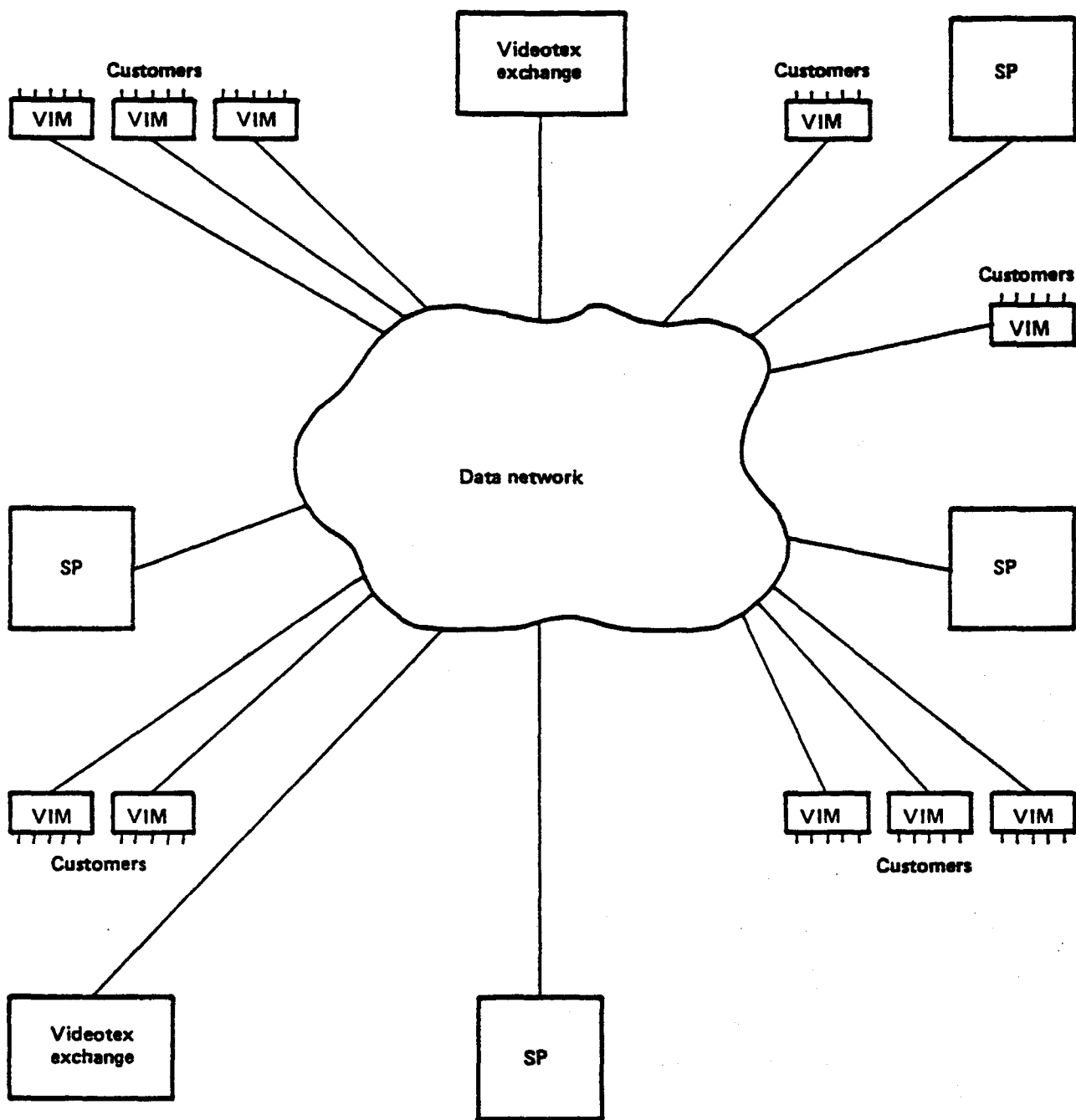**Videotex exchange**

Customers

Figure 2.   Implementation of Videotex on a Data Network: Customers connected
            to Videotex Exchanges.

SP = Service provider
VIM = Videotex interface module (user interface)
Videotex exchange (controls routing and billing)

Figure 3. Videotex Implemented on a Data Network:
Customers Connected to Interface Modules (VIM).