VIDEOTEX SERVICES: NETWORK AND TERMINAL ALTERNATIVES

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ABSTRACT

Videotex has provisionally become the generic name for interactive systems offering visual information services using a suitably modified or augmented home TV set, telephone and/or data networks, and videotex service centres. This paper starts by briefly introducing the videotex system concept and service possibilities. Examples of existing systems are also given. The main body of the paper considers two areas where new technology has a key role in videotex: in the network of service centres and communications facilities, and in the terminals, both at the information provider's end and at the consumer's end. The trade-offs between multiple-format databases, source coding, terminal complexity and compatibility are examined. The possible solutions to terminal design range from a single, rigid design to an arbitrary combination method. The paper proposes a Layered Capability Structure (LCS) which promotes an evolutionary approach to terminal design.

KEYWORDS (FOR INFORMATION RETRIEVAL): Videotex, Teletext, Viewdata, Television, Telephone, Information Retrieval, Terminal.

I. INTRODUCTION

Videotex has provisionally become the generic name for interactive systems offering visual information services using a suitably modified or augmented home TV set, telephone and/or data networks, and videotex service centres. The user interacts with the system via a hand-held keypad or a keyboard. Data is retrieved interactively from videotex centres through telephone and/or data networks, and characters and graphics are displayed on the screen of the TV set.

Videotex services are being tested in a number of countries including Canada (e.g. Bell Canada's VISTA* [1] and Communications Canada's TELIDON [2]), the U.S.A. (e.g. Department of Agriculture's GREEN THUMB), England (e.g. BPO's PRESTEL), France (e.g. CCETT's TELETEL), West Germany, The Netherlands, Denmark, Finland, 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, including interest matching, messaging, commercial transactions, questionnaires, personal databases, calculations, computer games, education and software distribution.

The expected increasing demand for videotex services will require an expanding network of service centres. This is the subject of Section II, where the logical format of a long term videotex network is presented.

In Section III the terminal features are examined. These will depend on the type of information to be marketed such as: textual, graphic, imagery, and aural.

Finally, the terminal design, both at the information provider's end and

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at the consumer's end are analyzed in Sections IV and V, respectively. The trade-offs between multiple-format databases, source coding, terminal complexity, and compatibility are examined.

II. VIDEOTEX SERVICE NETWORK PLANS

The early videotex systems have put all the intelligence in the network and centralized facilities but little or none in the terminals. With the declining costs of memory and processing power, the cost-efficiency factor can be improved by distributing the processing and storage functions. For example, in the case of information retrieval, the information providers can use stand-alone terminals to create and edit pages, and then set up temporary connections to the videotex network in order to update the centralized databases. Furthermore, an independent service/information provider could own and maintain his own database while the public videotex network provides the interface capabilities such as: identity verification, communications, intelligent routing and billing. This concept supports the creation of an intelligent network to provide widespread retail outlets for independent databases. Indeed, a hierarchy of videotex centres could be formed with customers connected to the lower end and information suppliers higher up in the hierarchy depending on the nature of their information and the location of their customers.

A modular approach to the design of the videotex network is therefore shown in Figure 1. 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 our ongoing studies of the optimum growth strategy for the intelligent network.

The videotex service can be functionally divided into two parts: the meta-service and the specific services. The videotex meta-service is provided by the backbone network of videotex nodes in Figure 1. The interconnected videotex nodes are functionally similar to a network of nodal computers [3, p. 63]. Videotex nodes give customers local access to the videotex system and provide communication interfaces (e.g. character echoing and communication error handling), the billing mechanisms, and the intelligent routing of requests to specific service centres matching customer needs. Specific services are provided by service networks as shown in Figure 1. Some services, partially at least, may be offered locally by modules adjoining the videotex nodes. This combination of each videotex node and its local serving and routing modules will be referred here to as a videotex exchange.

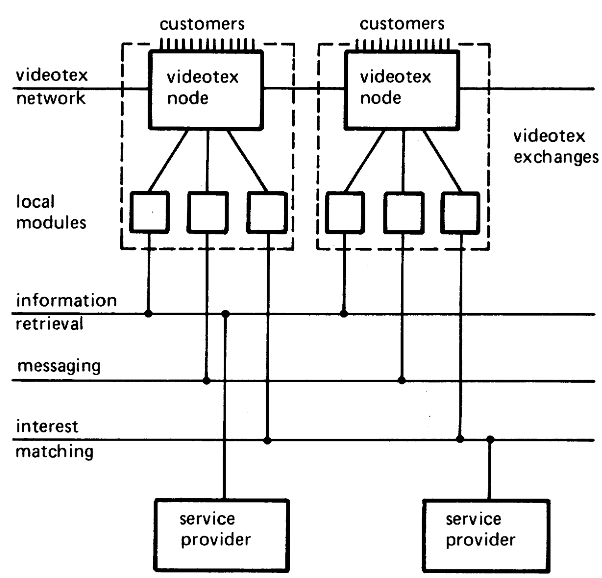

Figure 1. Long Term Logical Videotex Network.

It must be emphasized that the diagram in Figure 1 represents a logical division rather than a definite physical implementation. The choice of the actual communication links which will be appropriate in each case will be made on the basis of the above needs as well as other technical and economic criteria. Also the system is evolutionary. Most probably all the functions, including services, will be initially provided at the videotex exchanges (e.g. in 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. In order to yield a cost-effective system it will be important to combine these service offerings in such a way that the system utilization is maximized (e.g. offer both interactive and batch services).

III. TERMINAL FEATURES

The terminal features and design alternatives depend on the type of information to be marketed (e.g. textual, graphic, photographic, and aural). The coding of that information is also important. The ideal goal is a flexible coding scheme compatible with terminals of different characteristics. It remains to be seen whether this compatibility is required by the videotex market and whether it can be economically realized in the technical design.

At the transmission and display levels there are at least five types of visual information:

1) General text: This mode is used to transmit textual data of the general variety. General (or free-form) text can be re-formatted at the display without loss of meaning.

2) Positional text: This kind of text cannot be reformatted or moved on the display. Positional text is found in tabulated data and in annotations accompanying graphics. Positional text may also be used to compose simple pictures (e.g. histograms and block diagrams) which are aptly described as 'typewriter graphics'.

3) Mosaic graphics: This kind of graphics is exemplified by Prestel and Teletel, where each alphanumeric character rectangle is divided into six cells (arranged in 2 horizontal by 3 vertical format). The cells in each character rectangle can be displayed with any combination of two colours, known as the foreground and background colours.

4) Geometric graphics: Geometric graphics are drawings created in terms of geometric primitives, such as point, line, arc, rectangle, and polygon. Telidon [2] and certain terminal-to-terminal visual communications systems [4], [5], are examples of systems using geometric graphics.

5) Photographic Imagery: Real world scenes which cannot adequately be represented by the previous schemes can be coded in a pel-by-pel format. Single-frame colour images can be represented by digitally encoding either the red, green and blue components of the scene individually or by digitally coding the NTSC composite video signal.

In addition, there are a number of display features that have to be determined such as the number of columns and the number of rows, and the number of pels or pixels (picture elements). These features are basically determined by the bandwidth of the TV set and the number of TV lines in the display area as well as the viewing distance ratio (viewing distance/picture height). Modified TV sets (RGB input) offer much greater bandwidth and colour saturation than unmodified TV sets (RF input). In the remainder of this section we discuss these issues. The numerical values suggested here are meant to stimulate discussion rather than to be accepted as definite standards.

Since most Latin-alphabet countries, such as England, France and West Germany, have adopted forty (40) alphanumeric characters per row, it is preferable to use this value to ease exchange of information with these countries. This holds true whether such international transactions are done via international gateways and/or conversion centres or by direct access by the customer.

A 5x7 dot matrix is normally used to represent upper case English characters. For lower case character representation, two additional rows of dots allow for descenders in letters such as g, j, p, q, and y. If we include one dot space between rows and also between characters, the resulting character rectangle is 6x10 pels. With forty (40) alphanumeric characters per row, and a total character rectangle width of 6 pels, 240 pels will have to be resolved on the display. There is no bandwidth limitation problem with terminals having RGB input. However, if the system is to work with unmodified TV sets (which have limited RF and IF bandwidth, a horizontal overscan of 10% to 20% and a vertical overscan of 10% to 17%), the picture quality may be marginal. The total scan-line period on 525-line TV sets is 62.5 μs, while the active scan-line duration is about 50 μs. In the worst case of 20% overscan, the displayed information must be confined to the central 40 μs of the active scan-line duration. This results in a fundamental pel frequency of 3 MHz (=240 x 1/40 x 1/2) which is probably acceptable in most monochrome TV sets but may cause some cross-colour problems in a colour TV set. The seriousness of this problem (if any) needs to be determined by experiment.

The number of rows in the display is basically determined by the number of lines in the display area. In a 525-line TV system, there are about 480 active lines (about 45 lines being used up in the field flyback intervals). Since two fields are interlaced to make up a frame, about 240 lines are theoretically available in each field. Assuming the worst case vertical overscan of 17%, about 200 scan-lines are visible in each field. If 10 scan-lines are used per alphanumeric row, 200 scan-lines per field leads to exactly 20 rows of alphanumeric characters. It is well known that interlace techniques do not decrease flicker as successfully with high-contrast graphic and alphanumeric displays as with low-contrast, continuous tone images [6]. Consequently, in order to reduce flicker, it may be desirable to superimpose the two fields of each frame rather than to interlace them.

The alphanumeric capacity of the screen is thus provisionally established as 40 columns x 20 rows (=800 characters per frame). The geometric capacity of the screen has already been shown to be 240 pels x 200 scan-lines (per field). As far as mosaic graphics are concerned, each character position can be subdivided in several alternative ways. In order to retain nearly square mosaic cells which are believed to produce images more appealing to the eye, and also to maintain compatibility with existing systems such as Prestel and Antiope, a 2 horizontal x 3 vertical subdivision would be preferable. The mosaic capability of the display would thus be 80 horizontal (=40 columns x 2) and 60 vertical (= 20 rows x 3).

The legibility of text [7] depends very strongly on the viewing distance ratio, which is defined as the distance from the viewer to the display divided by the height of the display. Studies have shown that if 20 rows of text are to be read comfortably for long periods of time, the viewing distance ratio should not exceed 8.5. This is believed to be acceptable based on our observations of typical domestic viewing situations.

Since videotex at present is a TV-based service, aimed at the home TV audience (who may be reluctant to adjust their furniture to receive videotex), the legibility of a 20-row display should prove to be acceptable to the majority of viewers. Any further reduction in the number of rows (and columns) of text is unlikely to find favour with the information providers, because of the difficulty in conveying enough information when the number of characters in the display is reduced. In order to cater to those viewers with poor vision or too great a viewing distance ratio, the terminal manufacturer could provide an optional double-height zoom ability (which has been tried out in Europe). With this type of feature, the viewer presses a button on his keypad so that the top-half (upper 10 rows) of the frame is expanded to fill the display (although the width of the display does not change). A second push on the button shows him the lower 10 rows, while a third push restores the 20-row display.

IV. CUSTOMER TERMINAL DESIGN FACTORS

In the previous section we have discussed the various types of visual information that a videotex terminal should be able to handle. Since videotex systems are just starting to appear and the market is still unknown, it would be expensive and risky to attempt to provide them all at once. Consequently an evolution strategy is necessary for terminal design. The purpose of this section is to discuss such a strategy.

The preferred terminal design strategy is a flexible one, so as not to place undue constraints on the service features which may be offered in the future. Ideally there should be a maximum of forward and reverse compatibility between terminals and databases. Forward compatibility means that present day terminals can receive and decode expected future information within the limits of their capability. Backward compatibility means that the system must be designed so that future terminals can access old data. In addition there should be a maximum of upward and downward compatibility between terminals and databases. Upward compatibility means that low-feature terminals should be able to display as well as possible any information from a sophisticated database. Downward compatibility means that sophisticated terminals should be able to access simple data. These are logically desirable objectives although there is at present some doubt whether the business objectives of videotex services will encourage such extreme flexibility. A very successful example of maximum compatibility is television signal standards which allow both monochrome and colour television receivers to display monochrome and colour television programmes.

There is at present much international and national activity aimed at developing standards for videotex. Unfortunately the details of the applications and the needs and size of the videotex market are unclear. There is also much controversy about the perceived cost-benefits of features such as simple graphics, sophisticated graphics, colour, grey-scale, animation, audio, etc.

The foregoing discussion rules out the choice of a single, rigid terminal realization, because of its lack of flexibility. At the other end of the scale, a an arbitrary combination method would allow terminal designers and service centres to offer any combination of features. However, this scenario could soon become chaotic as terminal manufacturers and service providers pursued specific market segments.

In order to steer a middle path between inflexibility and fragmentation, it is proposed here that the visual feature capabilities of a videotex system should be arranged in a Layered Capability Structure (LCS) as shown in Figure 2. This structure strikes a balance between a single, rigid realization and a multitude of embodiments. This will give the vendor and consumer some freedom of choice without creating confusion (and high costs) in the marketplace. Indeed, given N feature capabilities, the arbitrary combination method could result in M (where M= 2 raised to the Nth power) different types of terminals, generally incompatible with each other. On the other hand, the Layered Capability Structure yields only N different types of terminals with a maximum of forward and upward compatibility.

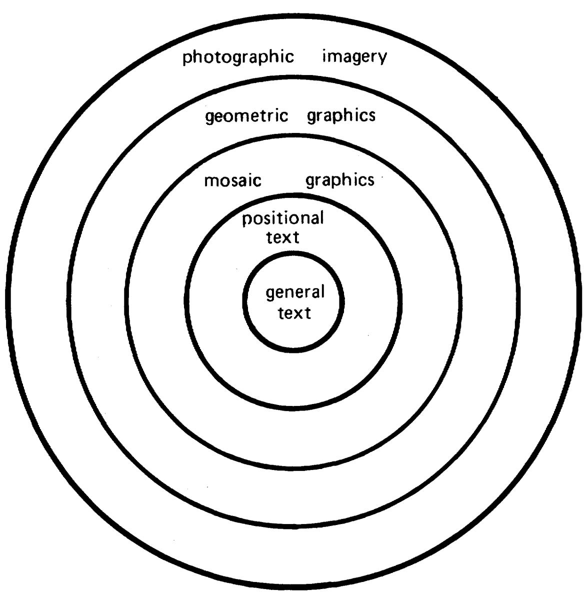

Figure 2. Layered Capability Structure for Visual Information.

The Layered Capability Structure could, for example, consist of a hierarchy of five (5) types of videotex terminal structures, namely:

A. General text only
B. Type A + Positional text
C. Type B + Mosaic graphics
D. Type C + Geometric graphics
E. Type D + Photographic imagery

In practice, these different terminal categories may represent evolutionary phases or a range of terminals that may be available simultaneously in the marketplace. It is important to note that the initial offering can be made at any level desired. Features can subsequently be added to (or subtracted from) future terminal offerings depending upon the results of market trials, cost projections, etc. The Layered Capability Structure can be extended upwards to include animation and even perhaps motion-video. Non-visual features such as audio can be added to any layer of the structure, although additional standards would be needed eventually to cover these areas.

The Layered Capability Structure approach has three major advantages:

1) Every high featured terminal becomes downward compatible with all terminals of lower features than itself. The customer who trades up to a high featured terminal can therefore still invoke (if he so desires) any of the previously familiar features or material.

2) The extra cost of this downward compatibility is borne by the higher featured terminals where it is less perceptible. Moreover, the higher featured terminal may be able to implement a low-featured terminal capability more readily and cheaply than can the low featured terminal, since it already incorporates more sophisticated components (such as

microprocessors and bit-map memories in the case of type D terminals).

3) The information provider has a clear idea of the size and capabilities of the terminal population which can receive any information he creates. This interworking relationship between terminal population and database is shown in Figure 3. The lower the level of features that an information provider employs when creating his database, the larger is the terminal population which can access it. In this way, an information provider can strike a balance between the potential market for his product and its visual appeal.

It should be noted from Figure 3 that geometric graphics can be displayed by a type C terminal (which is normally a mosaic terminal) if a PDI-to-mosaic converter is used (either in the terminal or at the database). The feasibility and cost of such a converter are yet to be determined. Also, the quality of the mosaic pictures produced by such a conversion process must be evaluated. Similarly, photographic imagery can be displayed on a Type D terminal (which is normally text, mosaic and geometric) if a photographic-to-bit-map decoder is employed (either in the terminal or at the database); the bit-map memory required for a photographic display is already present in the Type D terminal.

The Layered Capability Structure can also assist the information providers, whose investment in videotex will be continually growing. For example, the information provider can indicate that, say, only a type D terminal should be able to receive pages that he has created. Or, he might be able to denote which segments of information on a page are general text, positional text, mosaic graphics, etc. In the latter case, any terminal could access the page and would display information within the limits of its capabilities.

terminal type	Terminal capabilities	Type of information in database				
		General text	Positional text	Mosaic graphics	Geometric graphics	Photographic imagery
A	General text	yes				
B	General text Positional text	yes	yes			
C	General text Positional text Mosaic graphics	yes	yes	yes	yes (1)	
D	General text Positional text Mosaic graphics Geometric graphics	yes	yes	yes	yes	yes (2)
E	General text Positional text Mosaic graphics Geometric graphics Photographic imagery	yes	yes	yes	yes	yes

(1) If geometric to mosaic converter is used.

(2) If a photographic decoder is used. Note that geometric terminal already has bit-map memory.

Figure 3. Interworking relationship between Layered Capability Structure terminals and type of information in database.

The Layered Capability Structure encourages the concept of modular television, similar to present day component hi-fi audio systems. Indeed, component television receivers with inputs and outputs at standardized baseband frequencies not only separate the tuning unit from the display but are also more suitable for peripheral devices and provide the means of gradual expansion for future home terminals [8].

In terms of today's situation, the following examples may be appropriate for each of the categories of terminals:

<u>TYPE A</u>: General text. For example, computer terminals, TWX printers, certain special purpose terminals (e.g. for the deaf [9]), and home computers [10]. All of these terminals can in principle receive and transmit

general text information to a videotex database (although some transcoding might be required).

TYPE B: Type A + Positional text. The terminals mentioned under type A are suitable if their display dimensions exceed (or equal) 20 rows and 40 columns (as proposed in Section III).

TYPE C: Type B + Mosaic graphics. Examples of these terminals are the current versions of the Vista, Prestel and Teletel terminals, and some home computers [10].

TYPE D: Type C + Geometric. The Telidon terminal and some home computers have geometric capabilities. If a mosaic-to-bit-map converter were added (in software or in hardware) these could function as Type D terminals.

TYPE E: Type D + Photographic. This type of terminal today is only available for specialized applications. Further research is necessary to optimize the encoding techniques and to bring costs down to a level acceptable to the general public.

Finally, the Layered Capability Structure helps considerably in the design of the videotex network. Since the videotex exchange is the common access point for terminals of diverse characteristics, the conversation between the user and the exchange should be in text only. The desired services and information accessed through the exchange, however, can contain mosaic, geometric or photographic features at the discretion of the service providers.

V. INFORMATION PROVIDERS TERMINAL

In the previous sections we have described the network of service centres necessary to support videotex and the design philosophy for the customer terminals. The final key element in the system (in reality it is the first, especially in information retrieval applications) is the means of creating and editing the database. As these operations are labour intensive, it is essential to simplify them and so reduce labour costs by using the appropriate information provider terminal. Initial capital investment in well-optimized information supplier terminals will result in the creation of more attractive pages, ease of editing and reduced overall costs.

It is expected that in this area also, the Layered Capability Structure could be applied profitably. Good text-editing facilities will be essential since text is expected to form the major portion of the database material. However, there will be an increasing demand for simplified creation and editing of graphics (mosaic, geometric and photographic).

Considerable software development will also be required to produce simple and flexible methods of cataloguing and indexing the prepared pages into a coherent structure. There are several storage-and-retrieval methods ranging from simple menu-selections in a tree-structured database to logical operations on keywords in a totally inverted database. While many of these considerations belong to the database area, they will nevertheless have a significant influence on the design of the information providers' terminal.

VI. CONCLUSION

Two principal technical areas of importance in videotex have been considered.

Firstly, a logical network evolution strategy for videotex has briefly been proposed which can accommodate increasing numbers of users and services. Introductory systems will be centralized at distinct nodes (videotex exchanges). However, in the long term the network will evolve towards a decentralized (distributed) system. The result will be an intelligent network providing the access and transportation vehicle to a number of different services.

A Layered Capability Structure has been proposed regarding the visual features of videotex terminals. This strategy for terminal evolution proposes a hierarchy of five (5) types of videotex terminals to display general text, positional text, mosaic graphics, geometric graphics, and photographic imagery.

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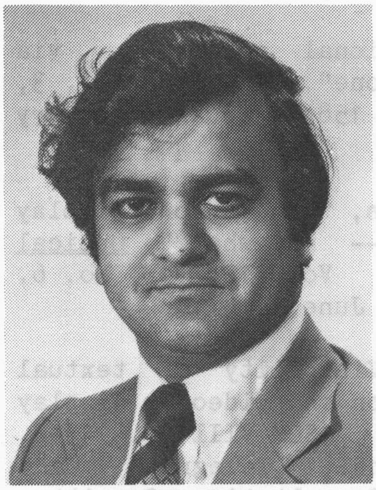
BIOGRAPHIES



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He joined the Systems Planning Department at Bell-Northern Research Ltd., Ottawa, Canada, in 1976. At present, he is the manager of the Videotex System Planning group and also represents BNR at CCITT meetings on videotex.

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José M. Costa (S'72-M'78) was born in Lérida, Spain, on May 31, 1946. He received the Industrial Engineering (Electronics) degree from the Universidad Politécnica de Barcelona, Spain, and the M.A.Sc. degree in electrical engineering from the University of Toronto, Toronto, Canada, in 1971 and 1973, respectively. He is working part-time towards the Ph.D. degree in the same graduate program. His Master's research was based on the design and implementation of two-dimensional recursive filters and his Ph.D. research is based on the design and implementation of digital tomographic filters for radiographs. While at the University of Toronto (1971-1976) he was a teaching and research assistant with the Department of Electrical Engineering.

During 1977-1978 he held a fellowship in the Department of Communications, Government of Canada, Ottawa, doing research on future communication services. He joined Bell-Northern Research Ltd., Ottawa, Canada, in 1978, where he has been working on Videotex System Planning, primarily on service definition, network aspects and long term studies.