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ELECTRONIC DELIVERY OF DATA AND SOFTWARE

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ELECTRONIC DELIVERY of DATA and SOFTWARE

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SESSION 1

THE WORLD SYSTEM TELETEXT SPECIFICATION

D.N. PIM*

ABSTRACT

The British Department of Trade and Industry has recently published a World System Teletext Specification. This is an extension to the teletext specification which is used today by many broadcasters around the world.

The Specification attempts to bring the display aspects of teletext in line with developments in the viewdata field, and also provides for a whole range of added enhancements and facilities including telesoftware and independent data services.

This paper briefly reviews the development of teletext in Britain, introduces the new features and facilities contained in the specification and their implementation, and looks at progress in their adoption in Britain.

1 Introduction

To the British "man in the street", teletext or more often Ceefax and Oracle, the services offered by the BBC and IBA, are only now becoming well known and used. Teletext televisions are now being sold in respectable quantities and manufacturers are starting to consider teletext sets as the norm rather than the special.

But how about the technical side? For a service that, believe it or not, has been in existence for over 13 years, one might expect there to have been many ideas suggested as to how the system can be enhanced and improved.

Over the past few years, much work has gone into looking at how the original teletext specification might be extended, and recently the British Department of Trade and Industry (DTI) has published a World System Teletext Specification[1] which allows for a whole range of enhancements to the teletext system for the future, including telesoftware and independent data services.

This paper aims to give a brief introduction to the new features and facilities which are contained in the specification and to outline the progress of their implementation in Britain.

*The Open University

2 A Potted History

A teletext service has now been in existence in Britain for over 13 years. In the early days, the British broadcasters, the BBC and IBA had different systems, but common sense prevailed and a common system was soon devised. This resulted in the "White Book" specification of 1974[2]. This, together with its enhancements of 1976 which provide mainly for graphic colour changes without the need for a space between for the required control codes, provide the technical specification for the system as used by both broadcasting authorities to this day.

The services themselves - Ceefax and Oracle - in terms of content have vastly increased recently and many new non-technical ideas are being introduced to give better services.

It was only in 1981 when government incentives were introduced that the "chicken and egg" situation - no cheap sets available because of lack of demand, no demand because of no decent services, and no decent services because no one had sets to watch them - was finally broken. Since then sales of teletext sets have increased rapidly, and the United Kingdom still leads the world in its teletext service.

One of the major hurdles to be overcome in the early days was the lack of any dedicated decoder integrated circuits. Decoders in 1974/5 consisted of large boards packed with TTL logic. Dedicated teletext integrated circuits first came onto the market in 1976/7 and usually consisted of around 4 integrated circuits. Recently i.c., manufacturers have started to produce 2nd generation chip sets which incorporate more features and integrate even more of the circuitry onto larger chips and are usually microprocessor controlled, allowing a large amount of "customisation" by the TV manufacturer.

3. The Need For Enhancements

Characteristically for a technological invention, since the publication of the original specification engineers have been working on ideas to improve and enhance the system.

Ever since the early days of teletext there have been comments about the limited graphic capability and the restrictive attribute system whereby attribute changes occupy a character space. The first thing people appear to want to do on such electronic information systems is to put their company's logo on the screen and have some fancy pictures to attract the attention of the viewer. It is questionable, whether for an information service these enhancements are really necessary; extended character sets which allow other languages to be displayed are probably more important in the long term.

The initial response of information providers and users has however led the technical development both in the viewdata and teletext fields, the priority being on enhanced graphic displays and additional attributes (more colours, 3 phase flash etc.) followed by additional character sets.

The need, however, for a new teletext specification, only became really necessary when these extended features were specified for viewdata systems and were becoming available on viewdata services; one of the main leaders in this field being West Germany and their "Bildschirmtext" service[3]. It was considered that since, from the start, the display system of both teletext and viewdata were made compatible, that this compatibility should be extended as far as possible with the new viewdata display specifications.

Recently, also, due to the "Information technology revolution", possible commercial applications for teletext carrying data services and telesoftware have been identified.

4. Levels

The World System Teletext specification, nicknamed the "Black Book" specification to distinguish it from the White Book specification, is divided up into five presentation levels. The features of each of these levels is summarised below. Each presentation level includes the features offered by all the lower levels.

4.1 Level 1

This is the current teletext specification contained in the White Book together with its 1976 enhancements. In addition level one provides for page links to be specified with each page, and also for broadcast service data to be transmitted. This data includes network identification, universal time, television programme details and a status message. It is independent of any other teletext data and is transmitted once a second.

4.2 Level 2

In addition to the level 1 features, this level provides for:-

(a) Up to 8 different basic character sets.

(b) Up to 32 different colours - for each of these, each of the 3 basic colours (red, green and blue) are defined in one of 16 levels.

(c) Non-spacing attributes - i.e. colours etc., can be changed individually on any character space without the need for a previous control code space.

(d) Full row and full screen colours - i.e. the areas outside the normal display area.

(e) Accented and supplementary characters.

(f) Smoothed mosaics.

(g) Double width and double size characters.

(h) Additional flash functions including 3 phase flash to give the impression of movement.

(i) Scrolling of additional teletext pages into a defined area of the currently displayed page.

(j) Dynamic re-definition of the thirteen "national option" positions in the basic character set.

(k) Dynamic re-definition of sixteen of the 32 possible colours.

4.3 Level 3

This level additionally defines a method of implementing Dynamically Redifinable Character sets (DRCS) which enables any character or graphic shape to be displayed.

4.4 Level 4

This level is reserved for Alphageometric Displays which are currently being standardised by the CEPT.

4.5 Level 5

This level is reserved for Alphaphotographic Displays (like "Picture Prestel") which are currently being standardised by the CEPT.

In addition to the above levels, the Black Book contains details on

(a) a method of transmission of data for processing - which includes data for further processing outside the teletext decoder (telesoftware) as well as level 4 and 5 data;

(b) a method of conditional access to a teletext service - pages can be scrambled before transmission, and a "page key" is used to decipher the information. This allows access to certain pages to be limited to certain users rather like Prestel's "Closed User Groups" (CUGs);

(c) a method of implementing independent data services. These are data services which are not connected and do not interfere with the main teletext information.

5 How's It Done?

One of the most important provisions of a technical specification such as that for the teletext service is that it should not define every detail so completely that there is no room for future expansion. The original White Book specification allowed for such expansion in many places, and this has enabled the World System Teletext specification to be produced. Another important provision is that any enhancements should not affect the operation of existing systems and such compatibility has been maintained in the new specification.

It is a credit to the authors of the new specification that this itself has provisions for future expansion - "no action" or "reserved for future expansion" occurring at many places in the specification.

The TV Signal

The teletext data is carried during the active part of lines in a normal television signal. The Black Book caters for both 625 line, 50 field/second and 525, 60 field/second television systems.

When there is a normal broadcast television signal, the data is carried on lines within the field flyback interval. Up to 17 lines (10 for 525 line systems) are allocated for this. In Britain, the BBC and IBA currently use either 2 or 4 of these 16 lines. If, however, there is no broadcast TV signal, then teletext data can be carried on any line except the lines forming the field sync or equalising pulses. This is known as full field or full channel teletext and a transmission rate of over 300 full level 1 teletext pages per second is theoretically possible.

Each teletext TV line contains the data for one row of text, this includes clock run-in, framing code, magazine and row number data and forty characters for display. This set of data is known as a packet and each packet is numbered according to which display row it contains. Current teletext services use 24 rows. Each packet contains 45 bytes of 8 bits each, although for some of the enhancements, the division into separate 8-bit bytes is not explicit.

5.1 Packet Numbers

The main 24 rows of display data are transmitted on packets 0 to 23, which requires 5 bits to specify the actual packet number. These 5 bits can, however, specify up to 32 different packets. These extra packets (packets 24 to 31) are ignored by current teletext decoders.

The new specification uses these spare packets, which have been variously called "extension packets" or "ghost rows", to implement a great many of the new facilities mentioned earlier. This is how they are used:

Packets 24 and 25: These two packets are reserved for extra display rows. Packet 24 could, for example, be used to display information on an extra 25th row, and packet 25 could be used to overwrite the header row (packet 0). Alternatively, packets 1 to 25, and the display data in packet 0 (the special header row) provide a 1K block of data which could be used for transmission of telesoftware.

Packet 26: This packet is used to provide non-spacing attributes and/or to overwrite characters in the main display. After the magazine and packet address (row number), this packet contains a "designation code" which allows up to 15 different packet 26s to be transmitted. The rest of the packet contains 3 byte "triples" which contain an address, mode and data to specify the required attribute or overwrite and its position in the currently displayed page.

The functions available using data in packet 26s are given below:-

(i) Set full screen colour
(ii) Set full row colour
(iii) Set cursor position
(iv) Set start of scrolling area
(v) Set end of scrolling area
(vi) Set foreground colour
(vii) Set background colour
(viii) Overwrite with a character from a supplementary character set (including a DRCS character)
(ix) Additional flash controls (3 phase, invert etc.)
(x) Set parallel (non-spacing) attribute
(xi) Set latching shift to a different character set
(xii) Overwrite with an accented character

Packet 27: This packet is used to provide page "links". Like packet 26, this packet contains a designation code, and two sets of packet 27s have been defined.

(a) Packet 27 with designation codes 0 to 3 (27/0 to 27/3)
These packets provide up to 24 page links rather like the links on a viewdata page. The teletext editor can thus supply links to other relevant pages in the teletext service and so make the service more "user friendly". Special user keys can be supplied to invoke acquision of the linked pages, or alternatively some or all of the linked pages can be automatically acquired and stored in the teletext decoder to be instantly available when the user has finished reading the currently displayed page.

(b) Packets 27/4 to 27/7

These packets again provide up to 24 page links, but the pages that are specified are not necessarily normal pages for direct display. Such pages are called "Pseudo pages" and the packet 27 links associated with the currently displayed page can indicate that the specified pages are of one of the following types:-

(i) Not a pseudo page (i.e. a normal page for display)

(ii) A pseudo page which is to completely overwrite the currently displayed page

(iii) A pseudo page containing information to be scrolled into the currently displayed page

(iv) A pseudo page containing the specification for a set of DRCS characters

(v) A pseudo page which can extend both horizontally or vertically the size of a page (the maximum size can be 160 columns and 101 rows per page - such a page would of course require a number of pseudo pages to be completely specified)

(vi) A pseudo page which requires reformatting using some agreed protocol between the originator and receiver of the data (such as scrambled pages for a conditional access teletext service as mentioned earlier)

Packet 27s with designation codes 8 to 15 have not been defined.

Both types of packet 27 can, in addition, indicate that the page is at the start, middle or end of a chain of associated pages.

Packet 28: This packet is used to provide the following functions :-

(a) It indicates the type of page i.e. a normal page or a pseudo page of one of the types given above.

(b) It allows the 13 "national option" characters in the primary character set to be re-defined.

(c) It allows the complete basic character sets to be re-designated (such character sets as Arabic, Cyrillic, Greek, Hebrew etc. can be specified).

(d) It allows 16 of the 32 colours in the colour map to be re-defined.

(e) It allows the four locations of the DRCS colour pointer table to be re-defined.

Packets 29 and 30: These are presently left undefined except for one special case. This is packet 30 of a page in magazine 8 (known as packet 8/30). This is the "Broadcast Service Packet" and is independent of any other page data. It is specified to be transmitted approximately once a second (being a single packet, it only occupies one TV line) and contains the following information:-

(i) A page link specifying the initial page that the teletext decoder is to acquire on switch on

(ii) A network identifier

(iii) The current time and date

(iv) A television programme label

(v) Data for initial display on switch on

(vi) Whether the TV signal contains full field teletext or teletext in the field blanking period only (multiplexed or non-multiplexed operation).

This packet can therefore indicate to the teletext decoder the initial page it is to capture (which the teletext editor can define, and not, as present, page 100 or some other pre-defined page), the television service being received (BBC1, Thames, Anglia, BBC2 etc.) and the television programme being shown. This information could be used to, say, automatically tune a receiver to a particular channel, or switch on and off a video recorder to record a particular programme.

Packet 31: This packet is used to implement independent data services.

Recently, the potential for using teletext as a means for distributing data nationally and at speed has been realised. However all the packets except for packet 8/30 are related to a particular page, and thus cannot be used to carry data which is not associated with a specific page. It would, of course, be possible at the transmitting end to format the data into pages, but for any arbitary data, this may not be convenient or practical. Packet 31 however is defined to be page independent and can be transmitted at any time without affecting the correct operation of the basic teletext service.

This packet contains the following information:-

(i) Up to 15 different data channels (of which only 4 are so far defined).

(ii) Various different optional data formats and indicators:-
repeat facility
include a continuity indicator
include a data length indicator

(iii) Service packet address - allowing individual data services within a channel to be identified.

(iv) User data - between 28 and 36 data bytes (20 and 28 for 525 line systems) depending on the amount of optional initial data above.

(v) Cyclic redundancy check word.

As can be seen, these extra packets have been used to implement a wide range of extra facilities. The details of how each packet is actually constructed is very complex (many of the packets contain Hamming encoded data in various formats and/or cyclic redundancy check words to reduce the chances of error for important data etc.). It is hoped, however, that the above description will give an overall idea on how these packets are used to provide the additional facilities.

6 Page Numbers

Teletext pages in the current services are specified by a magazine number (1 to 8), a page number (00 to 99) and a sub-code which can take values from 0000 to 3979. The sub-code was originally used to implement time-coded pages, but apart from the Ceefax "Alarm Clock" page and one or two others, these sub-codes are mainly unused.

The page numbers and sub-codes are BCD encoded using 4 bits for each page digit and 2,4,3 and 4 bits respectively for each of the sub-code digits. This therefore creates the possibility of page numbers in the range 00 to FF (hexadecimal) and sub-codes in the range 0000 to 3F7F (hexadecimal). Page numbers and sub-codes above 99 and 3979 respectively are not selectable by current decoders.

Although the Black Book specification does not lay down rules for page numbers, it is sensible to use page numbers in the "hexadecimal" range for pages which are not directly displayable such as pseudo pages. Also one or more digits in the sub-code could be used to define the type of page being transmitted. For example a zero in the first sub-code digit could indicate a page captured from the field flyback interval whereas a page with a first sub-code of 1 could indicate a page captured from a full field teletext service. Thus a decoder could distinguish between the two types of page should two separate teletext services exist on the same TV signal (one field flyback and one full field (outside field flyback)).

The Black Book does, however, specify that in a packet 27 link, a page of FF(hex) indicates no page number specified (i.e. "don't care" page number) and a sub-code of 3F7F indicates a "don't care" sub-code i.e. capture a page with the required magazine and page number but any sub-code - which is how current decoders operate when not in timed mode. In addition, the specification directs that if both of the above conditions are specified in a link (i.e. page FF and sub-code 3F7F) then no page has been specified in that link position.

7 The Current Situation

Recently I.C. manufacturers have started to produce display devices capable of producing World System Teletext type displays, and there are some laboratory prototypes of teletext decoders which incorporate most of the Black Book features (most of levels 1,2 and 3). The problem here, is not only in the design of a commercially viable decoder, but in the original creation of the teletext pages at the transmission end.

To create such pages requires sophisticated editing equipment and equipment to convert the pages into data conforming to the Black Book specification, as well as the personnel to design the pages and operate the equipment.

At present, in this country, the two broadcasting authorities do not have the resources to invest in such a venture. A similar problem exists with TV manufacturers and thus there is the "chicken and egg" situation again.

There has, however, been a start to try to implement commercially some of the Black Book features and this basically involves keeping the display system unchanged (i.e. only serial, spacing, attributes and limited character sets) but adding the packet 27/0 to 27/3 links. This has become known as Full Level One Features or FLOF.

The idea in FLOF is to supply an additional set of four "soft" keys on the user's keypad and to use the extra 25th display row, via packet 24 to give, for each page, a "menu" of associated pages which can be accessed directly by these keys. An additional "index" key is also provided to allow direct access to the current relevant index page. These five links are contained in one packet 27 and can be precaptured ready for instant display.

Also in FLOF is the inclusion of the Broadcast Service Packet which allows the teletext editor to have control over which page should be captured when the decoder is switched on as well as the other features detailed in the packet 8/30 description above.

The main advantage of using FLOF as a stepping point to a full Black Book implementation is:-

(a) The Broadcasters need only supply minimal extra resources and can use existing equipment.

(b) Current 2nd generation teletext decoder ICs can be used.

(c) Only a minimal increase in page storage capacity is required in the TV set. Even with the decreasing cost of RAMs, vast numbers of page stores in a teletext decoder become very expensive.

(d) User friendliness is increased.

(e) Apparent access time is dramatically reduced (even with a four page store).

A draft specification for FLOF has been produced which is compatible with both the White and Black book specifications. At present manufacturers are looking at the technical and commercial aspects of FLOF and the broadcasters are providing some experimental data. The implementation of FLOF has important implications for the broadcasters in general, since they are given greater control over how the service is accessed. This is particularly important for the IBA and other commercial broadcasters with regard to adverts on the teletext service and how users are encouraged to view them.

Developing in parallel with the consumer orientated introduction of FLOF are the business applications of fast and wide distribution of data via packet 31 and conditional access services.

8 Conclusion

The publication of the Black Book specification is an exciting development in teletext and a great deal of thought has gone into the specification to ensure that it is compatible with and upgradable from the current teletext system and also that the display system is as near as possible compatible with viewdata type displays. It remains to be seen whether the specification will actually be successful in practice since no real objective tests have yet been carried out. The main problem that is likely to be encountered, apart from the added decoder cost, is not any basic technical difficulty, but simply (a) how to generate the teletext service and (b) how to keep the decoder access and decoding times as low as possible with the increase in the quantity of teletext data being transmitted, and the additional decoding complexity needed in the decoder.

The implementation of FLOF is a welcome step in the right direction, and it is hoped that decoder manufacturers and broadcasters will work together to ensure a speedy implementation of these new features.

9 Acknowledgement

This paper is based on a paper by the Author entitled "What's happening to teletext?", published in the February 1986 issue of the Institution of Electrical Engineers' journal "Electronics and Power".

The author is grateful to the IEE for permission to use material from the paper.

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CODE OF PRACTICE FOR SECOND GENERATION TELETEXT

C. DOWSETT*

SUMMARY

An abstract model of "Full Level One Features" teletext is used to discuss the code of practice for the UK's second generation teletext systems. A "Table of Conformance" is proposed by which these systems can be assessed.

1 Introduction

The "World System Teletext Specification" can be treated as a catalogue of components for constructing systems. The range of components has expanded to meet the demand from potential applications to such an extent that a code of practice for any given application is essential. Such a code of practice has been produced as the result of collaborative efforts between broadcasters, chip manufacturers and TV setmakers. The code of practice, as appended, identifies components considered suitable for the established consumer market and how they should be used so as to avoid incompatibilties with other applications and future developments.

The components for "Full Level One Features", FLOF, are identified in Section 3 of the appended "Code of Practice" and described in detail in Section 4 including their relation to conformity. A summary is given in the "Table of Conformance" in figure 1 of this paper.

2 Levels of Conformance

A series of levels of conformance are suggested in figure 1 on the basis that manufacturers will align themselves in different ways and broadcasters will concentrate on those aspects of FLOF that interest them the most. The higher levels of conformance are unlikely and commercially unattractive at present.

The levels have been derived from logic and from discussions with manufacturers and broadcasters. Conformance level 1 incorporates some of the characteristic "messages" and processing "threads" that form the basis of FLOF. Level 7 introduces the further control concept of "time".

Figure 1 - Table of Conformance

Level	Component Description	Code Clause
1	8/30 Designation	4.1.1
	Initial Page	4.1.2
	Status Display	4.1.8.
	X/27 Designation	4.2.1
	Editorial Link 0	4.2.4
	Editorial Link 5	4.2.6
2	X/27 Link Control Byte	4.3
	Editorial Links 1,2,3	4.2.4.1.
3	X/24 Prompts	4.5
4	8/30 Network Identifier	4.1.3.
5	X/27 C. Redundancy Check	4.2.9
6	X/27 Editorial Link 4	4.2.5
7	8/30 Time Offset Code	4.1.4.
	Modified Julian Date	4.1.5.
	Co-ord. Universal Time	4.1.6.
8	8/30 TV Programme Label	4.1.8

3. Basic Concepts

3.1 Names and Messages

One of the key concepts of FLOF is the provision of process control information with associated messages, or pointers to messages, for users. Thus, for example, at the lowest level of conformance a decoder should display the Packet 8/30 status display so the user can identify the results of a channel change.

At conformance level 3 the editorial links of with Packet X/27 are associated with prompting messages in Packet X/24.

At conformance level 4 the network label must be included in 8/30 and be processed as an indirect pointer to a message identifying the television network. (See figure 4 of appendix.)

3.2 Threads and Bindings

Fundamental to FLOF is the concept of "page bindings".

*Deaconhouse Ltd., Chertsey, Surrey

With "single page delivery" systems all processing is, by definition, encapsulated within a page thus bindings between pages have a real meaning only in the human minds of the editor and the user.

The success of single page delivery relies on the conceptual magazine, or book. If the book is opened at page 100 both editor and user know the next page will be 101. A book would bind these pages together by threads but the threads cannot be delivered by the system. The binding of pages 100 and 101 is therefore accomplished by means of an imaginary thread. Despite this the "thread" can easily be followed by the user.

Electronic delivery of the thread so that meaningful binding mechanisms can be invoked in the decoder is essential to the success of multi-page delivery systems.

Television receivers now incorporate computers and sufficient memory to allow real threads to be communicated and meaningful page bindings processed . The FLOF code of practice as appended defines the basic rules for communicating and processing threads and should facilitate initial designs of binding mechanisms.

The effectiveness of these designs will depend as much on the editor, who must isolate and specify the threads, as on the designer. The levels of conformance proposed in this paper are intended to identify reasonable objectives bearing in mind the current state of technology and development resources.

4. Conformance and the Reference Model

The basic concepts of the reference model introduced above will now be developed to explain each level of conformance.

4.1 Conformance Level One

Conformance level one sets the objective of two threads per page, the "red" and "index" threads. These give the user and his computer controlled teletext decoder at least one thread to follow whatever the state of the system.

The red thread is the first encountered by the decoder and defines the initial processing:-

i) Set appropriate operating mode (clause 4.1.1),
ii) Acquire a valid index page (clause 4.1.2), and
iii) Display a television service status message (clause 4.1.8)

The thread is communicated via Packet 8/30. Note that Packet 8/30 is page independent and helps bind both television and teletext services together. (Is the "TV/TEXT" binding complete?) Even one thread, however short can get entangled and the designer must rely on the editor to sufficiently specify the thread for any binding and conversely the editor must rely on the designer to produce suitable binding mechanics in the decoder. A single tangle will prevent a proper binding and an example can be found in single page delivery systems which occurs by virtue of the user's choice of remote control operating mode.

The designer, through convention, provides two remote control operating modes, one for TV and one for TEXT. These modes define entirely different operating environments and the editor is obliged to provide text for both. For example the index page within the "TV/TEXT" binding is intended for TEXT mode presentation and the status message is intended for TV mode presentation. Thus the designer is obliged to provide a mechanism to achieve this binding. He is also obliged to provide a suitable mechanism for other pages that require TV mode presentation such as the newsflash and subtitle pages. Ideally these should be within the "TV/TEXT" editorial binding. The editor must therefore extend the "red" thread via the editorial link 0 of the packet X/27 of the initial index page (figure 2).

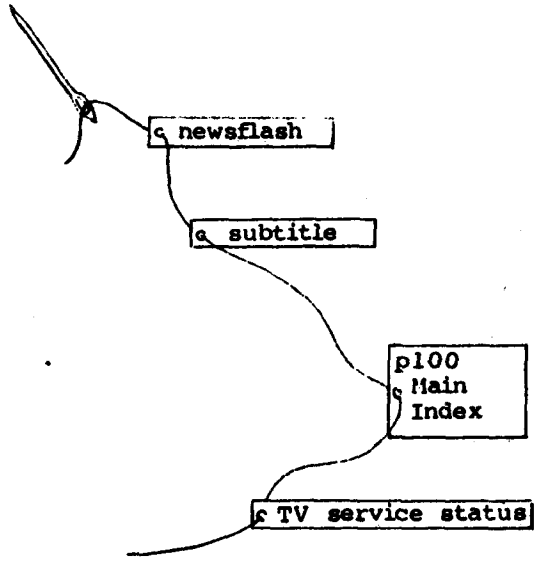


Fig.2 The "TV/TEXT Binding"

In the case of single page delivery systems subtitle tangles (both in the decoder and communications) have existed for some time and have been resolved by the editor pre-setting it's page number to 888. If the designer finds this agreeable he can elegantly incorporate subtitles into the TV operating mode. However, "pre-set" page numbers are bad practice.

Good practice provides the user with the traditional "pick up and put" page number mechanism - the most flexibile method of page selection. Unfortunately for subtitles and newsflashes, this form of page selection is not available in the TV mode and the resulting tangle has to be resolved by the user changing from one operating environment to the other. Whilst the use preset page numbers avoids the tangle conformance to level one of FLOF provides a more simple yet superior solution. It does however require the editor to maintain the thread such that these pages are only bound if the subtitle or newsflash bits are set. Their use in the "TV/TEXT" binding would otherwise be meaningless.

There is scope for the same binding mechanism on other pages via their packet X/27's. The purpose of these threads must be to create bindings for TEXT mode presentation. The rules governing such bindings depend on the overall level of conformance offered by the editor. As a guide the pages must be displayable and be "in sequence" and, for level one conformance, be limited to red bindings and index mechanisms. To complement the "TV/TEXT" binding other red threads should therefore support the traditionally acceptable "numerical" bindings thus enhancing realism of the conceptual book(figure 3a).

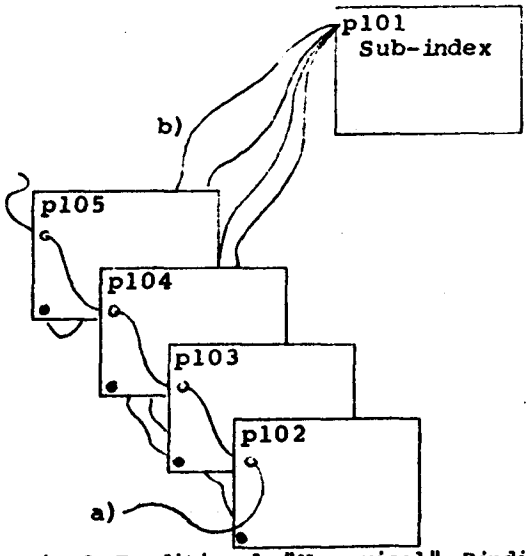


Fig.3 Traditional "Numerical" Binding

Assuming that the editor offers a higher level of conformance the binding strength of threads must be related inversely with link address, for example, link 0 binds the red thread more tightly to its host page than link 5 would. Pages out of sequence are transmitted more frequently than those in sequence thus naturally bind more tightly. To exploit this feature, the least tight link is reserved for the more tightly bound "out of sequence" page.

The user, whether following real or imaginary threads, will inevitably require the services of an index. The Editorial Link 5 is therefore provided (clause 4.2.6) which tightly binds a suitable index to the displayed page(figure 3b). The Code therefore insists the designer incorporates a button labelled "INDEX" on the user's control unit and similarly insists that the editor assigns an index page pointer in link 5 of every page with perhaps the initial index page being one exception.

A suitable convention for index threads ensures that any index thread will eventually run back to the index provided by the initial page. A "no page specified" condition (clause 4.2.2) may be preferred here.

4.1.2 Benchmark for Level One

User sequence	System response
Channel change	TV Service status
FLOF key press	Subtitle or subtitle with no delay
TEXT key press	Initial index page
-normal text mode operation -	
INDEX pressed. Page N selected	Appropriate index N displayed.
N + 1 selected	N displayed with no delay.

4.2 Conformance Level Two

This level of conformance adds the green, yellow, cyan threads and introduces the concept of decoders automatically evaluating the page bindings that are applicable to it. Since teletext spans applications beyond those related to conventional TV/Teletext any decoders intended for such usage should bind together only those pages appropriate to that application.

This problem has been simplified by the adoption of a layered approach to X/27 linking. FLOF deals with the X/27 packets designated zero (clause 4.2.1). The latest layers comprise compositional links which have already been discussed (1). FLOF uses editorial links the application of which should be compared with telesoftware.

4.2.1 Threads, Chains and Branches.

The concept of threads applied at conformance level 2 is equivalent to the "chains and branches" abstraction (2).

Chains and branches describe the use of X/27 page links for telesoftware

applications where a mixture of page classes can be linked together for processing outside the conventional TV receiver environment (figure 4a). Each link from a parent page points to a child page but does not define the class of the child. The class of any page is defined in its own packet X/27 thus a decoder must first acquire a child page before finding it's class (figure 4b). This presents problems within the TV receiver environment where memory cannot be allocated for indeterminate page classes.

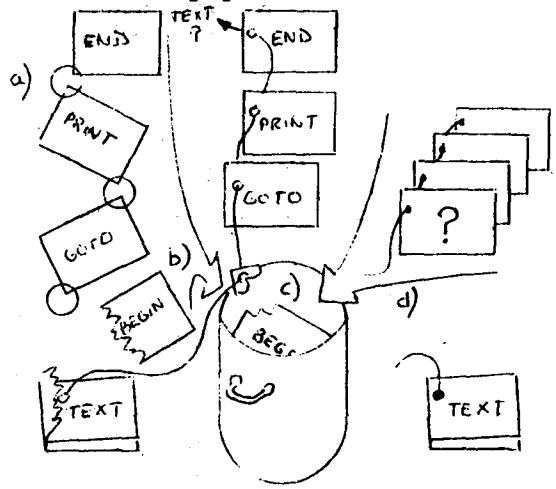


Fig.4 Mechanics of Chains & Threads

The links of a chain imply tightly bound pages. A chain therefore provides a useful abstraction for telesoftware page links. A thread, on the other hand, can bind pages tightly or loosely according to the application. The more loosely bound a page the more easily it can be thrown away (figure 4c).

To allow decoders operating in the TV environment to work more efficiently the link control byte (clause 4.2.3.) now classes child pages as well as the host parent page. Classing of the child pages is achieved enbloc. The link control byte asserts that all child pages either belong to the display class, or are unclassed (figure 4d). A decoder operating in the traditional teletext environment can thus cut all threads to child pages before acquiring them (if it wishes).

The link control byte of a parent page actually defines how well the parent page is fixed to the threads that binds it to child pages and the link control byte of each of the child pages defines how well it is fixed to the threads from the parent. The ability of a decoder to exploit this binding technique sensibly will determine how well it conforms with level 2 of figure 1. The actual binding process depends on the designer who may elect to process more than one class of page.

The threads making these bindings possible must avoid threads of other types of binding such as "rolling pages". These traditional threads are real and exploit the sub-code mechanism.

4.2.2 The Sub-code Thread

Convention allows a user to specify a short address, comprising a magazine number and two page digits. The corresponding page request consists of the short address followed by a "do not care" sub-code. This type of page request, made by the user, both invokes an acquisition mechanism which supports both single and rolling pages and asserts that pages are of the display class.

"Rolling page" bindings behave as though pages were turned automatically by the editor. The binding is specified by the editor choosing page addresses with the duplicate short address and, by convention, an incremental sub-code. This address technique facilitates the "sub-code thread" (figure 5).

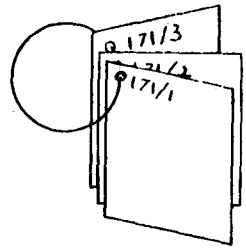


Fig.5 A "Subcode" Binding

When making the conventional page request a user signals his willingness to accept a "rolling page binding" from the editor and the decoder handles whatever page class the editor sends. The same convention is exploited in page links (clauses 4.1.2 and 4.2.2).

The first generation single page decoder demonstrates how the sub-code thread can be handled without prejudice to decoder economy (for example the assertion that pages are of the display class is not tested). Extending the convention to links not only enables a similar economy but can enhance the control editors and user have over the rolling page.

In the single page decoder the sub-code thread rolls sub-pages at an editor determined rate which may not be acceptable to the user. The designer has provided inadequate mechanisms to deal with this problem. As a consequence the sub-code thread is brittle and easily broken. Whilst the thread can be found again pages are lost. The editor can

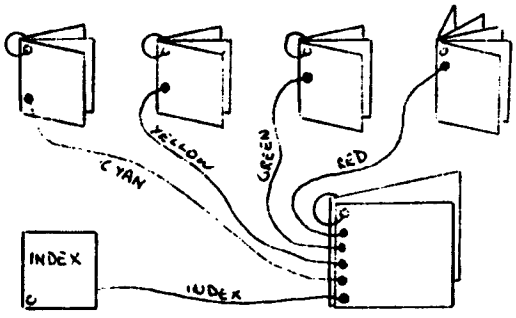
provide additional threads to make the "subcode" thread more elastic but at level 2 it is sufficient to assume established conventions.

The sub-code thread is an example of a multi-page thread created by page addressing. As the second generation (computer controlled) decoders should only be expected to fully process one thread at a time the editor's choice of linked page address is restricted to avoid entangling coloured and subcode threads. Further simplification allows the decoders to automatically process a limited length of each coloured threads - equivalent to one linked page.

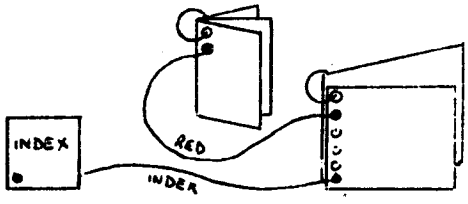
4.2.3 Processable Threads

As the number of pages in a binding is increased decoders must be increasingly protected from threads they cannot process properly. This is achieved by means of the link control byte and voluntary restriction to the red, green, yellow, cyan, index and sub-code threads and minimising the length of any thread processed automatically.

The coloured threads are bound more tightly if bit 4 is set to one (clause 4.3) which also ensures the page address in any coloured or index links does not duplicate the short address of the host page. In addition the threads, as opposed to the links, may be treated as if the link contained a "subcode not specified" condition. Thus each thread tries to bind just one sub-code binding (figure 6a).



a) FLOF control bit = true



b) FLOF control bit = false

Fig.6 General Level 2 Bindings

If bit 4 is set to zero (clause 4.2.4.1.) only the index link has a limited address but the decoder is still obliged to process the red thread. The designer must decide whether he can allow his decoder to attempt to achieve the now colourless green, yellow and cyan bindings (figure 6b). In case of difficulties the user can escape any "illegal" binding via his "INDEX" button (clause 4.2.6).

4.2.4 Management of Concurrency

Teletext relies on the transmission of pages which remain active within a decoder thus page contents changed by the editor are seen "instantly" by the user. Problems of concurrency occur because the editor has "instant access" to all pages and the user "instant access" to only one page.

The term "concurrent" is used relative to the user. The purpose of threads is to ensure the arrival of pages is perceived by the user as concurrent.

The editor skillfully avoids the problem by using the short page address to classify his communications in a non-concurrent way. This limitation is essential for single page decoders but unnecessary in multi-page decoders. To complement editorial skills a system conforming to level 2 should be capable of binding pages with a different, not incremental, short page address to improve the concurrency of the binding without affecting the subcode thread of any page in the binding.

4.2.5 Benchmark Level Two

The level one benchmark applies.

User Sequence	System Response
1 7 1	Rolling page
Wait	Eventually 171(2 of 3)
Hold page	Rolling ceased.
1 7 5	175(2 of 3)instantly
1 7 1	171(2 of 3)instantly

4.3 Conformance Level 3

At this level of conformance the user is able to choose his own bindings from the red, green, yellow and cyan options presented by the editor (figure 7). The number of pages automatically bound in any one colour binding may exceed two. Any of the coloured threads can be rendered visible to the user so enabling diversions into other bindings and excursions.