REPORT 1208

TELESOFTWARE SERVICES

1. INTRODUCTION (1990)

The name "telesoftware" was first used at the time of the pioneering transmissions in the UK from Independent Television in 1977 to describe transmissions of coded data and computer programs.

Telesoftware is now one of the data broadcasting services recognized by the CCIR (Report 802-2) and it complies with the definition of the broadcasting service as given in Article 36 of the Radio Regulation.

The activities described in this Report relate to the following definition of "telesoftware": the provision, via telecommunications or broadcast networks, of software and associated data files intended to be acquired and then executed or used by terminals subject, when appropriate, to certain conditions governing access and payment.

Section 2 of this Report presents a survey of existing operational or experimental telesoftware services within broadcasting organizations. Section 3 summarizes the technical aspects of telesoftware. More detailed information about these technical aspects is given in the Annex. Section 4 identifies potential areas of standardization in the telesoftware domain.

2. TELESOFTWARE SERVICES WITHIN BROADCASTING ORGANIZATIONS

2.1 Current situation and future projects in the UK

2.1.1 Broadcast software by teletext (BBC)

The BBC Telesoftware Service was launched as a regular public service on 22 September 1983. It enjoys the same status as radio, television and teletext, although with lower priority and smaller budgets and audience. Three years after the launch, there were about 12 000 teletext adaptors for the BBC microcomputer in use, the only generally available method of receiving telesoftware by teletext.

The BBC Telesoftware Service is a part of the teletext service (Ceefax) under the control of the Manager, teletext. The day-to-day editorial control of the telesoftware output is with the Telesoftware Editor, who is also responsible for the commissioning and control of software for transmission. Rigorous standards are applied to ensure that the software performs as expected even in the hands of the inexperienced user.

The BBC Telesoftware Service was initially part of the BBC Computer Literacy Project [BBC, 1983], and much of the first year's material has been based on educational and practical applications for schools, colleges and the home programmer. Software already broadcast, covers such diverse applications as creating a weather database and providing programming building blocks. As with teletext itself, there is strong, and generally favourable and constructive feedback from users of the service. The service is now commissioning a new generation of more sophisticated software of the type which depends on, and takes advantage of, regular updating of data by telesoftware or from the normal teletext pages.

As well as presenting software which stands alone, there are many instances of software directly intended to supplement broadcast programmes, particularly those of an educational, documentary or current affairs nature.

The BBC Telesoftware Service has initially been funded by hardware royalties and support from national educational bodies. It is currently provided free of charge once the necessary adaptor has been purchased.

The future offers the possibility of a greater data channel capacity, whether by full-field teletext, or cable or satellite, allowing faster access and larger databases. An encrypted conditional-access option within the telesoftware service would allow commercially valuable software to be broadcast to paying subscribers.

At present, almost the entire output of the BBC Telesoftware Service is intended for use on the BBC microcomputer, and the computer language and machine specific functions of that particular device are used. Undoubtedly, there will soon be a need to broadcast versions of programmes for other machines. This will entail extra cost and effort by the broadcaster and it will reduce the overall throughput of information as, in some way or other, the different versions will need to be time-shared on the same channel. Although different versions of the programmes will be needed, a common data transmission format to support all versions should be possible.

2.1.2 Broadcast software by teletext (UK Independent Broadcasting)

A recent development in the UK is the transmission of telesoftware on Independent Television's Channel 4 as part of the "4-tel" teletext service. The telesoftware is broadcast in connection with a television programme series "4-computer buffs". An interim protocol has been defined and has been published. A Channel 4 teletext adaptor is available and this facilitates the loading of the telesoftware into the user's personal computer. Initial transmissions are aimed at the Sinclair Spectrum personal computer, but it is hoped to broadcast telesoftware for other personal computers later.

2.1.3 Broadcast software by radio (BBC)

In January 1984, the BBC began to broadcast software by radio using the BASICODE standard [NOS, 1984] - see also Section 2.3.1 - as short inserts in a weekly computer programme called "The Chip Shop" together with separately-scheduled late evening transmissions of about 40 s duration on four nights each week, using the v.h.f. and l.f. UK Radio 4 network. The information pack and an audio cassette of interpretation programmes were distributed by Broadcasting Support Services, about 20,000 sets were delivered as a result of the ten-week first series of the radio programme.

Subsequently the BBC acquired the UK distribution rights for the BASICODE 2 information and interpretation programmes, and this standard was used during the second series of "The Chip Shop" later in 1984 when more than 4000 sets of an improved cassette and bookset were distributed. This time the software transmissions were scheduled for early morning, which was operationally more convenient and which also found favour with the audience. The m.f. Radio 1 network was used and there were many difficulties in making useful recordings of software. Because of this, all of the software was subsequently repeated as a single block lasting 20 minutes using a v.h.f. network late at night.

Comparatively little cost and effort is required by the user to be equipped for receiving BASICODE 2 transmissions, and it was made clear that a continuing service was not being offered by the BBC. Users are, of course, also able to receive BASICODE 2 transmissions from commercial and foreign broadcasters.

It is likely that future transmissions of software by radio will use BASICODE 2 and that they will be related to specific radio programmes. As the language is necessarily a "highest common factor" of the functions offered by a large number of different machines, it is in some respects very limited, in particular in terms of graphic display and input/output facilities. So the technique offers wide coverage at low cost to distribute rudimentary programmes. It is an ideal method of servicing a "club" of BASICODE 2 enthusiasts who wish to offer their own programmes for transmission, indeed there is considerable exchange of material in this standard on the Radio Amateur and Citizens Band channels already. But a radio software service is always competing with conventional radio programmes, and the shock caused to a casual listener when unexpectedly assailed by a high-level mid-band audio tone must not be overlooked.

2.1.4 Other transmission channels

Software is, of course, regularly marketed and distributed on audio cassettes and floppy discs, and in printed form as listings and bar-codes. The BBC already publishes software in these forms and a broadcast software service relates to these in much the same way as teletext relates to the printed words. The broadcast service provides immediate delivery with nation-wide coverage at very low cost, whereas the use of a physical transmission medium allows large quantities of information to be delivered to known recipients in return for payment. The BBC Telesoftware Service is regularly used to provide reviews and examples of commercially published software, and it can also be used to update and even to correct published software.

Software is also distributed by viewdata (videotex) systems in the UK. This offers the prospect of rapid delivery with a simple method of recovering payment, but the capital cost of establishing a source and the costs of the telephone connection and computer time have to be considered.

Alternative digital broadcasting channels may have capacity available for the transmission of software, such as the radio-data system (EBU, 1984), the proposed DBS sound/data packet multiplex system (Report 1073) and a proposed digital stereo sound system for television.

2.2 Current situation and future projects in France

Experimental chains for the production and coding, broadcast or point-to-point distribution, reception and execution of software have been built and tested. The different aspects are detailed below:

2.2.1 Production

In the case of existing software or data files, the problem of production does not arise and the telesoftware service is reduced to a transport service. Several applications of this type have been tried in television broadcast networks and they should lead to operational services in the near future:

- broadcast transmission of software to microcomputers used in the National Education Service
- broadcast transmission of "black lists" (for example, numbers of stolen credit cards).

In contrast, when the application is created specifically for the telesoftware service, it can be enriched by introducing into an existing language a range of additional primitives serving, for example, to allow access to the teletext display module or the data acquisition module. A project of this kind has been effected in PASCAL USCD (the transmitted code being P - code resulting from the compilation) and similar work is under way in BASIC.

2.2.2 Coding

The problem of coding arises when the software is transmitted within the services or infrastructure provided for videography. In other cases, and for data file transmission in particular, the network is transparent and no pre-coding is needed.

Where videography services are involved, the first coding technique to be used was to divide each byte into two hexadecimal-coded ASCII numbers. The technique used now is the "3 in 4" method defined by the CEPT.

2.2.3 Transport

a) On television broadcast networks:

When data files are transmitted the transport protocol used is DIDON 3 (involving data groups, error-detection and systematic repetition).

In the context of teletext (D2-A4 standard) the coded data described in the previous section are transported in sub-articles protected by a CRC 16. These sub-articles are grouped in articles with a dual liaison byte. Correction is achieved by exploiting the inherent repetition in cyclic transmission.

b) On telecommunications networks:

The videotex network provides a synchronous transport service for words of 7 bits + parity, with an error-correction procedure operating in block mode.

2.2.4 Reception

In videographic services (broadcast or interactive) reception is done by the circuits of the videography terminal. Additional error-correction processing is necessary in broadcast services.

For data file transmission services, use is made of special equipment called "DIDEM" (by analogy with "modem"). This equipment takes the form of an autonomous "black box" or a microcomputer card.

2.2.5 Utilisation

In data file services the execution is done by a terminal (microcomputer or specialized terminal) which takes data from the DIDEM.

When an extended language is used, the terminal must incorporate facilities for executing this language. A P - code interpreter has been written for a teletext terminal with extended memory.

Experiments with broadcast software have been done using A2-Antiope.

2.3 Situation in the Netherlands (NOS)

2.3.1 Broadcast software by radio

The Dutch domestic radio programme "Hobbyscoop" broadcast by NOS transmitted its first computer programme in 1978, and it soon became a regular feature of their weekly programme. The programme was heard throughout the Netherlands on FM (VHF) and medium wave, on the Hilversum 2 and 4 networks.

Four different computers were supported in turn, each having a monthly service. Subsequently a common language and transmission format were established under the name BASICODE, and an improved version known as BASICODE 2 [NOS, 1984] has been in regular on-air use since the start of 1983. Some computers require minor modification to accept the signals, and most require a programme to be loaded first in order to interpret BASICODE 2.

Since the medium-wave signal of Hilversum 2 was reaching outside the Dutch borders, letters came from computer enthusiasts in the UK, Germany, Belgium and Denmark asking for more information. Further international interest was obtained when the Dutch external service, Radio Netherlands, which broadcasts worldwide on short wave, took interest in BASICODE. For the time being, a 15-minute English language programme called "Media Network" is sent out to radio stations worldwide, which rebroadcast the programme for their local listening areas. It can be heard on stations in Australia, USA, Canada, Sweden, England, parts of Africa and Asia, and Islands in the Pacific Ocean.

The use of a system as BASICODE requires constant updating in order to cope with new computers.

2.3.2 Broadcast software by teletext

Up till now, no regular transmission of telesoftware via teletext has taken place. Only during an exhibition in September 1984, NOS gave a demonstration of downloading software for home computers, using teletext as a transmission channel.

2.4 Situation in Italy (RAI)

A pre-operational telesoftware service has started on the first and second television networks.

A unified system for broadcasting software on sound channels, called RAI-Radiosoftware, has been specified and is now in operation on the third FM radio network.

2.4.1 Broadcast software by radio

The first experiment carried out by the RAI dates back to May 1984: during the programme "Un certo discorso", of the Third Network, several programmes were broadcast for personal computers like Commodore 64, Spectrum 48K, Olivetti M10, Apple II.

The transmitting technique was very simple: the programmes were recorded on a cassette with the same language, format and modulation of the receiving computer, and transmitted on the FM radio channel in a pause of the main programme. The receiving computer could read the transmitted software directly from the headphone output of the FM radio set.

This way of transmitting is convenient because it does not require any interface between radio sets and home computers but the transmitted software must be dedicated to a single computer, the transmission speed is low and it is not possible to adequately protect the data file from errors.

In order to overcome the above constraints and to establish a standardization for broadcasting software by radio the RAI-Radiosoftware system has been developed for home and personal computers equipped with a standard RS-232 serial port.

This system is a versatile instrument for radio programmes having educational and financial purposes, which allows over-air delivery to the listener of software in the various computer languages (Basic, Pascal, Assembler, etc.), and of texts and graphics intended to be displayed on the terminal or stored on disk.

The system is mainly finalized to be used in audio band channels (15 kHz) but can be advantageously used even on other physical broadcasting supports, such as on an additional subcarrier in the radio channels.

The system bit-rate is of 4800 bit/s, significantly higher than bit-rate used in the previous radiosoftware emissions to home computers on the third FM RAI network.

The receiving system requires a simple and economic interface, containing only a few commercial integrated circuits (less than 10 LSI/MSI chips), wich can be installed in the expansion slot of the computer.

Decoding of the communication protocol is carried out entirely by the computer through an appropriate reception software, developed ad-hoc for the most common computer operative systems (e.g. MS-DOS, CP/M, etc.). This flexible approach enables to introduce, in the future and when necessary, other application modes simply by updating the reception software (supplied to the user on floppy disk or over-air) and without the need of modifying the hardware interface.

The communication protocol, organized according to the 7 layers ISO structure, allows three trasmission modes:

a) single transmission of a data file,

b) repeated transmission of a data file,

c) cyclic transmission of several data files.

In the latter case, a "menu file", automatically acquired when switching the computer on helps the user to choose between the transmitted files. In addition a "commentary file" gives information relevant to the file selected by the user (language, execution modalities, etc.).

Compatibility tests carried-out in the laboratory [CCIR, 1986-90a] have shown that the "Radiosoftware" system can also be adapted for use on the second sound channel of the two-sound carrier TV system [CCIR Report 795-2] adopted in Italy, during television programmes with monophonic sound, without affecting the picture and sound quality of domestic TV receivers.

2.4.2 Broadcast software by teletext

The RAI has started the pre-operational phase of its new service of telesoftware transmission that is based on the structure of CCIR teletext system B.

The system adopts the same transmission rate and data organization (40-character/row) as teletext system B and it allows the use of presently available integrated circuits (VIP 5230, EUROOCT) in the receiver. With respect to teletext it differs only in the higher levels of transmission protocol. Moreover, the system does not require the use of special linking mechanisms, such as ghost rows (e.g. data packet X/27). This information is carried out by a special "configuration" page and additional control codes transmitted on each page.

The telesoftware communication protocol [CCIR, 1986-90b] is structured in seven hierarchical layers in accordance with CCIR Recommendation 653. The Physical and Link layers are the same as in teletext system B. The Network layer adopts the same data packet format as in CCIR teletext system B and at this level the data packets are protected from reception errors by Hamming correcting codes and CRC error detection. In the Transport layer the data files are segmented into one or more chapters each consisting of a single telesoftware page or a set of rolling pages. The Session layer includes character coding, page coding, chapter linking, access control and dynamic protocol configuration. The Presentation and Application layers refer respectively to the conversion/presentation and utilization of the broadcast data and software.

Particular attention is paid to the protection strategy since telesoftware requires the absolute absence of errors in the received data files. To this extent a (40,34) interleaved Hamming code, associated with a CRC (Cyclic Redundancy Check) on each data row, has been adopted in the communication protocol. This allows the correction of any single error in a 40 bit block and detection of residual errors on each data row.

In order to improve the efficiency of the error correcting code the transmitted data are masked by a pseudo-random sequence; this avoids the occurrence of repetitive critical data patterns.

Results of laboratory tests and field trials have shown the efficiency and suitability of the adopted protection strategy to allow correct data reception even in critical receiving conditions [CCIR, 1986-90c and Cominetti et al, 1986].

2.5 Situation in Sweden (SR)

In Sweden, no telesoftware experiments by teletext have been carried out yet. The Educational Radio/TV Company (Utbildningsradio) is interested in such a service, mainly to be able to distribute computer programmes to schools.

One form of telesoftware that is being used is the weekly transmissions by a computer club over a local FM radio transmitter in Stockholm. Transmissions are by audio, using directly the tone-shift recordings from some popular home computers - different for each model, and thus for only one model at a time. There has also been a test series of three such transmissions over one of the national radio networks. "BASICODE" is being considered but has not yet been used.

2.6 Situation in Denmark (DR)

Only some small experiments with broadcast software by teletext have taken place and there are at present no plans to introduce a service for this application.

Concerning broadcast software by radio, the second DR radio programme is broadcasting software programmes as part of one of its radio programmes "Båndbixen". The software is intended for home computers like the BBC, Commodore, Sharp, etc.. and some of it is BASICODE. The programme is heard all over Denmark on FM, and it is also transmitted by long wave (Kalundborg 245 kHz). The transmission takes place between 0.15 - 0.45 local time on Sunday nights.

After some initial problems, the experiments have been good. The data signals are sent 9 dB below maximum level, and the FM stations use "Ball-empfang" to avoid difficulties with the normally used carrier network (Siemens MST 15). The Kalundborg transmitter is provided by a 7.5 kHz digital link.

2.7 Situation in Finland (YLE)

In 1983, the YLE began to broadcast a radio programme for "everyone in computer age" by name "Silikoni". At the beginning, it was a non-regular part of a school radio magazine but from August 1986, it has been an independent half-an-hour programme broadcast weekly and having its own staff of three, its own budget, production and transmission time. The programme purpose is to popularize computing and therefore works on a very general level. According to the abundant feedback, this approach seems to be the right one. The programme consists of news, interviews with experts and small programming competitions for the audience, the format being a very fast magazine type.

From Autumn 1985, experiments of broadcasting software by radio have been carried out by transmitting BASIC programmes as "buzzing" lasting from 20 seconds up to 3 minutes, mostly for Commodore 64, MSX, and Spectrum computers. No problems have occurred in transmission and reception but the amount of different BASIC dialects used in the various home computers makes it difficult to reach all the interested listeners by the same transmission because the language, format and modulation of only one type of computer can be transmitted at a time. To overcome this problem, the YLE plans, in the future, after the copyright questions have been cleared up, to use the NOS BASICODE system [NOS, 1984].

2.8 Situation in Switzerland (SSR)

On an experimental basis, the SSR is broadcasting software specific to certain types of computer on the 2nd radio programme network in Italian. BASICODE 2+ is considered as being inadequate in the long term.

The Teletext AG company is broadcasting software sponsored by commercial companies, on an experimental basis. The software is for IBM PCs, or compatible machines. This is not yet a regular service, although the introduction of such a service is part of the plans of Teletext AG.

2.9 Situation in Canada

At the moment there is no permanent software service being offered. However, facilities do exist to provide such a service using the terrestrial broadcast networks. These facilities are:

1. The field blanking interval of a television channel using CCIR teletext system C.
2. An additional carrier that has been defined for data transmission in the audio channel within the television channel.
3. The Subsidiary Communication Multiplex Operation (SCMO)on FM broadcasting channels where capacity exists for data broadcasting.

2.10 Situation in Japan

Laboratory level experiments on transmission of software to personal computers have been examined. In those experiments, the data broadcasting capacity of CCIR teletext system D and the DBS data channel capability of the digital sub-carrier NTSC system (see Report 1073) have been used [CCIR, 1986-90d].

3. TECHNICAL ASPECTS OF TELESOFTWARE

3.1 Information provided by the BBC

3.1.1 Broadcast software by teletext

CCIR teletext system B provides a method of checking correct and complete reception of each page, and a method of linking pages in a chain of indefinite length. Majority methods of error correction can be used [Chambers , 1979]. Telesoftware programmes are divided into blocks of up to one kilobyte which are sent as linked pages with special control bits [Rayers , 1984]. The method can handle any language, or any other data blocks for any purpose. Compacted codes can be used to improve efficiency. Conditional access techniques for teletext can be applied directly to telesoftware. These points are detailed in the Annex.

3.1.2 Broadcast software by radio

The NOS BASICODE 2+ system is used [NOS, 1984]. Data is encoded at 1200 Baud using an f.s.k. system widely used in domestic equipment. For each microcomputer supported by the service, there is a translation programme containing subroutines starting at common line numbers to implement functions such as "clear screen". Further details are given in the Annex.

3.2 Information provided by TDF/CCETT

Telesoftware takes its support from infrastructures which already exist or which are currently being implemented for telematic services (videotex network), for teletext, or for data broadcasting. The specific features of telesoftware nonetheless require particular attention to be given to the problems of transmission error-correction. Questions relating to access control and payment for services are more difficult to resolve than for videography: they are dealt with in France through the use of the memory card.

Telesoftware poses two quite specific problems:

- the language, which should be as universal as possible
- the control of execution, in order to impede the software pirates who risk becoming increasingly active as software becomes more readily available.

3.3 Information provided by the RAI

3.3.1 Broadcast software by radio

The RAI-Radiosoftware system [CCIR, 1986-90c, e]

has been designed to reach the following targets:

- exploitation of the maximum transmission bit-rate achievable in the bandwidth of the present audio equipment and low-cost commercial re-receivers;
- adoption of a baseband data signal without low-frequency components, in order to facilitate recording on magnetic tape;
- insensitivity to possible polarity inversions of the received signal; simplicity and low cost of the user's receiving interface;
- adoption of a standard user interface independently of the personal computer type;
- possibility to update the system for future applications simply by changing the receiver software;
- exploitation of the message repetition to allow correct data reception even in bad receiving conditions.

Since the user interface functions have been limited to the baseband signal treatment only, the protocol decoding for data acquisition by the computer is carried out completely by software.

Besides simplifying the interface, this approach allows the decoding software to be modified, if requested, simply by transmitting the new version over-air, thus ensuring the maximum system flexibility with respect to future innovations.

However, the part of the receiving program operating in real time is written in the assembly language, specific for the various computers. On this purpose, the reception program has been developed for the most usual computer families: the versions based on Z-80 microprocessors and operating systems CP/M and MSX as well as those on 8086 (8088) microprocessor and operating system MS-DOS.

An outline of the RAI-Radiosoftware communication protocol is given in the Annex to Report 1207 "Reference model for data broadcasting ".

4. AREAS OF STANDARDIZATION

4.1 Terminology

From the definition of "telesoftware", it is clear that a telesoftware service can make use of several different transmission means to provide software and data files to the concerned terminals. It would therefore be helpful to characterize the service and possible telesoftware systems by an appropriate and consistent terminology, as it was done in the past with reference to teletext.

4.2 Conditional access

It is clear that there will be a need for controlled-access services carrying telesoftware in order to provide subscription services in return for payment, or to provide payment for individual products. Controlled-access methods are already being studied in connection with DBS television and sound transmissions and similar principles can be applied to data such as telesoftware and teletext. There are obvious economies of scale in having a standardized common method for encrypting such data, and for distributing the necessary key information.

4.3 Transport

A transport mechanism for use in a packet-switched data system, and in the fixed-length-packet multiplex proposed for DBS transmissions, could be formulated.

4.4 Data file format

Although it is likely that several software languages would be supported in a telesoftware service, there is advantage in defining a unique format for any accompanying data such that it represents a common resource available to all versions of a programme. This is particularly important in a broadcast service where different versions of the same data for different versions of the programme would occupy the available data transmission capacity wastefully.

4.5 Indexing

There may be an advantage in defining a standard language in which the details of the telesoftware service can be broadcast, giving a complete and structured list of the options available. This has aspects in common with the SI (service identification) channel provided in the proposed DBS systems of the MAC/packet family. The principle could usefully be extended to give a teletext magazine index.

4.6 Language

From time to time, it is suggested that a standard computer language be adopted or created for telesoftware, to avoid the need to support several versions of a program for different sets of user equipment. However, the disadvantages of limited scope ("highest common factor") and lack of "future-proof"-ness (once a standard is established, it is difficult to improve its compatibility) may outweigh any advantages.

4.7 Soft decoders

Telesoftware could be used to re-define and update the operation of a teletext decoder to make it able, within the limits of available storage and processing time, to reproduce still images regardless of how they are encoded. Such a "soft" teletext decoder would remove the need to define higher "levels" of teletext, but the re-definition language would itself need to be standardized.

Already telesoftware has been used to broadcast software "patches" to modify or improve the operation of the telesoftware interpretation programme.

4.8 Execution control

In order to impede the software pirates, who might be expected to become increasingly active as software becomes more readily available through telesoftware, execution control has to be developed. This execution control has to fight against pirate commercialisation of software acquired legitimately as a result of an access control operation.

REFERENCES

- BBC,[December 1983]: "Towards computer literacy" ISBN 0 563 21079 6 published in 1983 by the BBC.

- NOS,[March 1984]: "BASICODE 2", second revised edition, March 1984 ISBN 90 6833 001 2. Published by NOS-Hobbyscoop, postbus 1200 BE HILVERSUM, The Netherlands.

- EBU,[March 1984]: "Specifications of the radio-data system RDS for VHF/FM sound broadcasting" - Tech. 3244.

- COMINETTI, M., MORELLO, A., PASTERO, N., TABONE, D., TASONI, N.S./1986/ - Campagna di misure per l'introduzione del Telesoftware", RAI Research Centre, Technical Report no. 86/9/I, Torino 1986

- Chambers J.P., 1979 : "Teletext alphabets and error protection" EBU Review (Technical) 173, February, 1979, pp. 25-29.

- Rayers D.J., 1984 : "The UK teletext standard for telesoftware transmissions" IERE Publication No. 60 "Telesoftware" 1984, pp. 1-8. ISBN 0903748 57 6.

CCIR Documents

[1986-90]: a. JIWP 10-11/5 - 29 (Italy); b. 11/140 (Italy); c. JIWP 10-11/5 - 4 (Italy); d. JIWP 10-11/5 - 8 (Japan); e. JIWP 10-11/5 - 3 (Italy).

ANNEX

TECHNICAL CONSIDERATIONS (BBC)

1. BROADCAST SOFTWARE BY TELETEXT

1.1 Data modulation

Telesoftware for transmission by teletext is treated as data in the same way as the character codes of conventional teletext pages. The only difference is that even-parity bytes may also be included. This could, of course, give rise to long strings of all-zero or all-one bytes which might interfere with the clock and byte-boundary recovery in some decoders.

The use of the cyclic redundancy check in the normal Ceefax page output for over three years has confirmed the earlier impression that most users have a substantially error-free reception of teletext all the time. In particular, there is no need for additional coding (such as Hamming) in the data to allow the possibility of forward error correction, it is sufficient to be able to reliably detect errors and wait for a re-transmission on these occasions. It is, of course, possible to use majority logic on parts of the page [Chambers J.P., 1979] so that reception of a complete correct page is possible even if not one transmission is received perfectly.

1.2 Transmission format

A format for the transmission of computer software by teletext [Rayers D.J., 1984] was derived in consultation with other broadcasters, industry and, in particular, Acorn Computers Ltd. who were producing the BBC microcomputer. The format is designed to support any language, and it allows the language to be identified at the start of each page. It offers the choice of translating eight-bit codes into seven-bit codes within the normal character coding range or using the full eight-bit capability of teletext. The first approach produces a string of characters which can, in principle, be transcribed and interpreted manually, the eight-bit approach is more efficient as it does not extend the length of the message.

The format allows the interpretation of individual bytes to be re-defined for the remainder of a message, this includes the possibility of replacing a frequently used string of characters by a single byte, and several pre-defined decoding commands can be called in this way. These decoding commands, such as "inhibit run when loaded" and the re-definition commands themselves, are implemented as subroutines in the decoder.

Provided data can be stored as a file on a BBC microcomputer disc-based system, it may be processed for transmission. When seven-bit transmission is to be used, bytes outside the normal range of character codes are preceded by a "raise" or "lower" byte and modified by the addition or substraction of (decimal) 88. The code is then grouped into 920-byte blocks (teletext pages) including the repeat of necessary protocol sequences at the start. A raised or lowered byte is not split between blocks, neither is a line of BASIC split. This simplifies interpretation and downloading from any point in the programme.

Specific action is taken in the case of programmes in BBC BASIC language, where key-words are "tokenised" as single bytes in the hexadecimal range 80 to FE within the BBC microcomputer. It was decided that these tokens would be replaced by the abbreviated key-words for transmission.

1.3 Future-proof telesoftware

The protocol and format for transmission of data, including computer programmes, by teletext are designed to be very general in application. In particular, they can be used as the basis for enhancements to teletext character generation and graphics, and they can provide machine-readable indexes to the teletext data.

2. BROADCAST SOFTWARE BY RADIO

The technical aspect of the BASICODE 2+ system used in the BBC "The Chip Shop" broadcasts are now summarized.

2.1 Data modulation

The data for transmission or recording is at 1200 Baud rate with one full cycle of 1200 Hz for logical '0' and two full cycles of 2400 Hz for logical '1'. Each byte, least significant bit first, is preceded by one start bit '0' and followed by two stop bits '1'. Seven-bit ASCII character codes have the eighth bit set to '1'.

A programme begins with 5 s of stop bits (2400 Hz) followed by hexadecimal 8D, the entire sequence being terminated by hexadecimal 83 "stop text", a bit-wise exclusive-or'd check sum byte and 5 s of stop bits.

It is recommended that direct connection from radio to tape recorder be used, a fairly good radio cassette recorder being preferable to a hi-fi system. Manual recording level should be set just into the red area and then left alone, automatic level control almost always gives too low a level. Treble tone control should be set high, and Dolby or other noise reduction methods or filters should not be used.

2.2 Translation programme

For each microcomputer supported by the BASICODE 2+ system, there is a translation programme available on cassette. It includes a set of standard subroutines occupying BASIC line numbers in the range 0-999, with fixed starting points and written in the language of the target machine. For example, the BASICODE instruction GOSUB 260 will always find a routine at line 260 that produces a random number between 0 and 1 which is then stored in the variable RV. The other main purpose of the translation programme is to ensure that the target computer responds as specified to the statements, operators and commands in the BASICODE 2+ programmes themselves, which must occupy line numbers in the range 1001-8999. Line numbers 9000-9999 are reserved for REM and DATA statements. Line number over 10000 can be used for machine specific routines that are not part of the BASICODE 2+ programme.

In the case of the BBC microcomputer, there are two translation programmes available, each taking about 120 s to load from cassette and occupying about 6 kbytes of memory. The programme BBCLOAD allows the user to load programmes recorded in BASICODE 2+, including those broadcast with "The Chip Shop". The programme BCSAVE allows the user to save a programme written in BASICODE 2+, which can then be used with the appropriate translation programme, on any other type of microcomputer supported by BASICODE 2+.

2.3 Limitations of BASICODE 2+

Some of the limitations of BASICODE 2+ are now given to emphasize the consequence of taking the highest common factor of the target machines.

There are 41 statements (such as ABS, COS, RUN) and 11 operators (such as + and -) available, which are understood by all machines. Other necessary standard functions such as "clear screen" and "check if a key was pressed" are called as subroutines (GOSUB 100 and GOSUB 200).

The most common screen display format is 24 lines of 40 characters, but some machines have displays as small as 16 lines of 22 characters. The recommended approach is to use subroutines to adjust lines to the size of the screen.

A programme line must not exceed 60 characters, and a string must not exceed 255 characters. Variables may be only two characters long, the first being a letter, with certain pairs forbidden and certain other limitations on the Sinclair Spectrum. Numeric variables are real and accurate to a maximum of six decimal places.

Because there are no graphics, drawing facilities programmes intended for BASICODE 2+ must have output in the form of text. A standard subroutine for a printer is provided.

REFERENCES

CHAMBERS J.P.,[1979] - "teletext alphabets and error protection" EBU Review (Technical) 173, February 1979, pp. 25-29.

RAYERS D.J., [1984] - "The UK teletext standard for telesoftware transmissions" IERE Publication No. 60 "Telesoftware" 1984, pp 1-8, ISBN 0903748 57 6.