RGS

ENG INF

The quarterly for BBC engineering, technical and operational staff

SPRING 1991 No. 44

THE NEW NETWORK IDENTITIES

The new Network Identities for BBC1 and BBC2 were launched on 16th February.

The clocks are generated digitally by new D&ED equipment while the moving sequences (symbols) are stored on special laser videodiscs. The BBC1 symbol is again based on the familiar rotating globe but the BBC2 symbols are individual sequences lasting up to a minute each.

Each symbol can be augmented with text to identify the region and to indicate if Ceefax subtitles or Nicam stereo sound (in the future) is being transmitted.

The equipment used to generate and store the new Identities is described on pages 27 and 28.

H. Pres. Tel.

The new BBC2 network clock

CONTENTS

ENG INF

Edited, designed and typeset by EID, Room 4616, White City Tel: White City (07) 24316

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You'll see from the address above that EID is now based at White City.

We made the move in early April — some six months ahead of schedule. Our floor in HWH was urgently required by Radio Drama, whose existing accommodation in Broadcasting House is now due to be revamped under the "Top Deck Project". So apologies if ***Eng Inf*** is somewhat late this time round.

Contributions for the Summer issue (No 45) should be sent to me — at the new address — by Friday 24th May. However, it would be a great help if you could let me know your plans well in advance, so that I can advise you on the amount of space available for your story.

Farewell Oxford Street, Tottenham Court Road et al — it's been a great delight working in this area over the years.

Mike Meyer
3 April 1991

IEE AWARD

Our congratulations go to Peter Sarginson — a young RD Engineer — who was awarded second prize at an IEE Short Papers evening in mid February. The event was organised for younger members of the IEE's Surrey Centre.

Peter's presentation was entitled ***VCR programming made simple*** and his prize was £50 plus a certificate.

SAFETY

To withdraw or not!

In a domestic environment, should you leave it in at night or, for safety reasons, should you withdraw it? Safety Services Engineering is often asked this question about the mains plug on electrical equipment.

Firstly, switching off at the equipment itself is ***not*** adequate, because the switch on some equipment leaves parts of it powered up — with a potential risk of fire.

Our standard reply therefore is that electrical equipment must be isolated when not in use, and unplugging is a good way of doing this. However, an acceptable alternative is to switch off at the wall socket, if that is possible. This method also has the advantage of reducing the mechanical wear on both the plug and the socket.

Finally, although this is not strictly a safety matter, switches which are combined with volume controls tend not to be so reliable; also, the volume control wears out more quickly. In this case, it may be preferable to simply switch off at the wall (or unplug the equipment, if there is no wall switch) without switching off at the equipment.

David Davis
M.S.S. Eng.

TRANSMITTER NEWS

The following services opened or changed between 15th December, 1990, and 28th March:

TV relays

Finchley	North London
Hamstead	Birmingham
Lewes	East Sussex
Ystumtuen	Dyfed

The Brighton Central relay, which opened on 14th December, was modified on 31st January to provide a service towards the south for the first time (but at reduced power). This followed an agreement reached with the French authorities, after prolonged discussions. Transmissions to the south will step up to full power later in the year.

FM stations

Chalford	Gloucs
Grantham	Lincs
Westwood	Wilts
Weymouth	Dorset

Radio 1 on FM

Bow Brickhill	Bucks
Llanddona	Anglesey
Peterborough	Cambs
Whitehawk Hill	Brighton

Radio 4 on FM

Forfar	Tayside
Llanddona	Anglesey

Local Radio

A new FM transmitter for Radio Suffolk opened at Lowestoft in late January and, on 11th March, Radio Leicester's FM transmitter at Copt Oak stepped up to power. Copt Oak now replaces the Anstey Lane transmitter, which will shut down on 3rd May.

CORRECTION

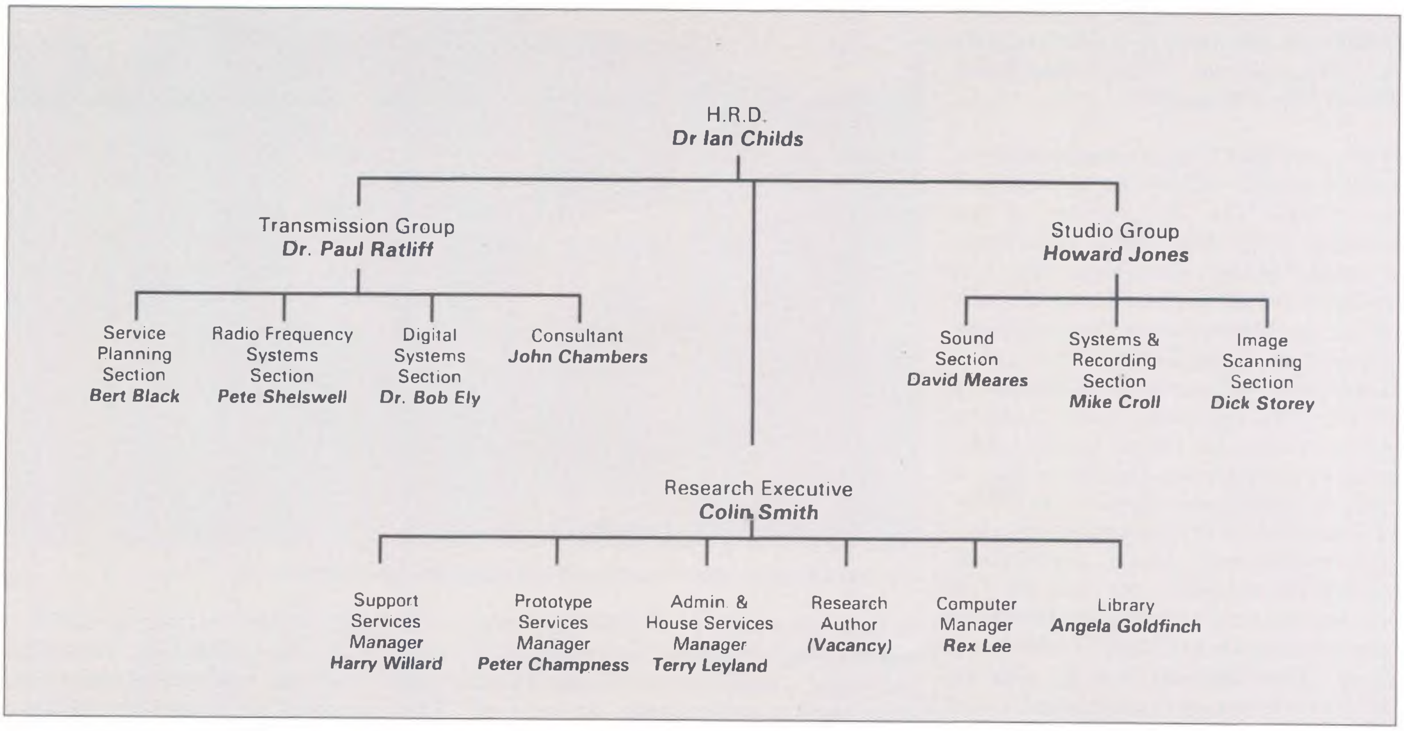
Graham Whitehead of D&ED rang to say that a small error had crept in to his feature on Loudspeakers in our previous issue.

Under the heading ***Yesterday's monitors*** on page 7, the LS3/7 should have a Spendor 12-inch Bextrene cone woofer (LS2/1), and not an 8-inch unit as stated.

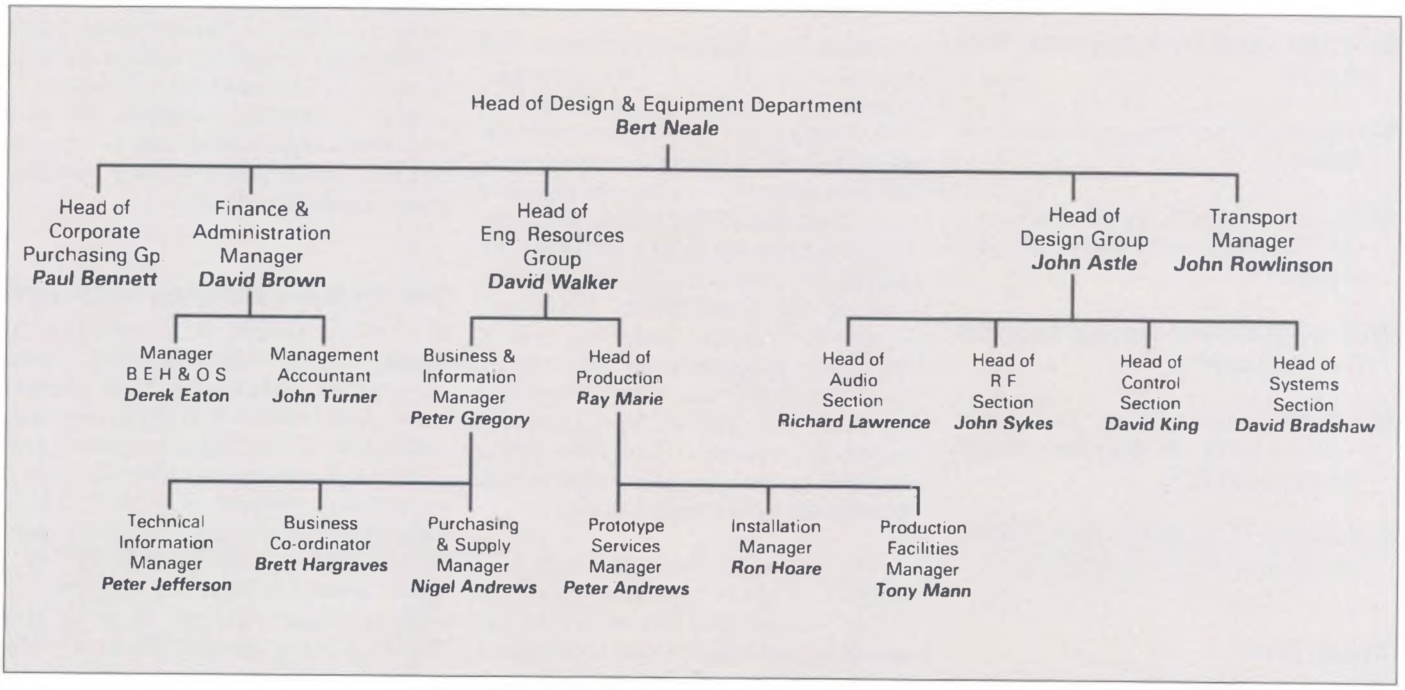
FAMILY TREES

Research Department and D&ED

In our previous issue we published a diagram showing the new structure of Engineering Management. So here are two more family trees for your collection: Research Department and D&ED.



Research Department — March 1991



Design and Equipment Department — March 1991

DIGITAL AUDIO BROADCASTING

Digital Audio Broadcasting (DAB) is at a fairly advanced level of development, although there is still some way to go before we can expect a UK-wide multi-channel service. Henry Price describes the progress so far.

The Compact Disc is one of the most successful consumer products of the last decade. First marketed in the UK in 1983, the sales of CD players were running at just under 2 million per year by 1990, and over 25% of households had at least one player.

The use of the CD (and other consumer digital sound systems) has thrown into sharp relief the shortcomings of the present VHF-FM radio broadcast system. Being analogue, the FM system's overall performance is the sum of the performances of the individual parts of the chain. The quality heard at home or in the car is often limited by either the receiver and antenna performance, or reception problems such as interference, multipath distortion or inadequate signal level. Many dedicated radio listeners go to considerable trouble and expense to overcome such problems and, with care, the FM system can then deliver a performance approaching that of the CD. However, many other listeners end up with an inferior service not comparable with CD quality.

For some years engineers have been looking at ways in which a digital radio service could be broadcast to the general public. Such a service would ideally have the following features:

- Sound quality comparable with the CD
- Capable of offering coverage to all listeners
- Capable of fixed, mobile and portable reception with a simple low gain antenna
- Simple push button programme selection — no tuning
- Frequency efficient so that many services could be provided in any spectrum available
- Capable of operation from satellite and/or terrestrial transmitters


Research Department

The Renault Espace which carried out DAB tests in South London last year

Nicam Tests

Since the 1970s, research engineers in various countries have been looking at ways in which these requirements could be met. In the mid 1970s, BBC Research engineers investigated the possibility of providing a digital radio service based on a Nicam stereo signal. A series of tests was conducted in the North East of England using the Pontop Pike transmitting station near Consett, County Durham. The Nicam digital stereo signal was radiated from this site using 4-phase DPSK modulation of a 47 MHz carrier.

A vehicle was equipped to receive and decode the signals. Two antenna systems were used; firstly, a directional antenna mounted on a 10 metre extendable mast and, secondly, an omnidirectional antenna mounted on the vehicle's roof. It was found that reception on the directional antenna at 10m was generally satisfactory within the predicted service area of the transmitter. However, reception was not possible over a significant proportion of the service area when using the vehicle's rooftop antenna. This failure was generally caused by multipath reception which resulted in considerable intersymbol interference to the digital signal.

It was concluded from the tests that 'simple' digital systems, such as Nicam, could provide an excellent service to fixed directional antennas at rooftop height (as anyone able to receive Nicam stereo tv will testify). However, reception on omnidirectional antennas close to the ground was unlikely to be satisfactory, especially in highly built-up and mountainous areas. Thus in order to cope with mobile and portable reception, a more advanced digital system would be required.

Over the last few years such an advanced system has been developed and tested within Europe. Two project groups — from the EBU and Eureka project 147 — have been jointly working on a system known as Digital Audio Broadcasting (DAB). This system is specially designed for mobile and portable reception and can be transmitted terrestrially or from satellite or even a mixture of both.

The Proposed European DAB System

If a DAB system is to be capable of mobile and portable reception, it should be able to operate in poor signal-to-noise conditions and with significant amounts of multipath interference. Although many digital coding and modulation systems cope well with poor signal-to-noise ratios, the problem of failure due to multipath reception has been more difficult to resolve. In a simple digital system, such as the tv stereo sound system (Nicam), intersymbol interference starts to become significant once the delay between the main and reflected signals becomes greater than about a quarter of the symbol period.

As the delay is increased to a whole symbol period, the interference becomes very severe and if the amplitude of the delayed signal is sufficient it will be impossible to decode the signal. Nicam 728 has a bit-rate of 728 kbit/s and a symbol period of 2.7 μs (each symbol representing 2 bits). Thus reflected signals with delays of greater than about 0.7 μs will cause problems. This delay is equivalent to a reflection from a building approximately 100 metres behind the antenna.

If a DAB system is to operate successfully in heavily built-up and mountainous areas, it must be able to cope with reflected signals of a greater delay than 0.7 μs. In fact, it should be able to operate with delays up to about 50 times as great (ie reflections from objects 5 km behind the antenna). This implies that the symbol period should be of the order of 140 μs, ie about 7.3 ksymbols/s.

This is obviously far too low for high quality sound but, if many such low data-rate channels were available, then the total data-rate could be sufficient. For instance, if a sound system were to need 730 ksymbols/s, then the data capacity of one hundred such low data-rate channels would be required. The sound data would then be spread equally over the hundred channels. The European DAB system operates on this principle using a modulation system known as Coded Orthogonal Frequency Division Multiplex (COFDM).

COFDM

In the COFDM system a large number of low data-rate carriers are packed as close together in frequency as is theoretically possible. Fig 1 shows the way in which this is achieved by frequency-division-multiplexing the carriers in an interleaved fashion. The frequency spacing between the carriers is chosen to satisfy a special relationship with the rate of data transmission, such that the information on the carriers can be demodulated without mutual interference. Thus the individual carriers can be considered as being orthogonal to one another.

As the bit-rate of each of the data carriers is very low, they will be relatively insensitive to multipath interference. However, to further increase the system's immunity to delayed signals, a guard interval is also added between each symbol. Generally the length of the guard interval will be about a quarter of the active symbol period. Provided the reflected signal has a delay of less than the guard interval, it will combine constructively with the main signal and will contribute to the overall signal power. The effect of intersymbol interference does not become damaging until the reflected signal's delay reaches a value equal to about twice the guard interval.

The COFDM system is capable of carrying a large number of sound channels with the data for each sound channel being spread across a number of the low data-rate carriers. Complex error correction codes and advanced decoding techniques are employed in the system, which enables the sound

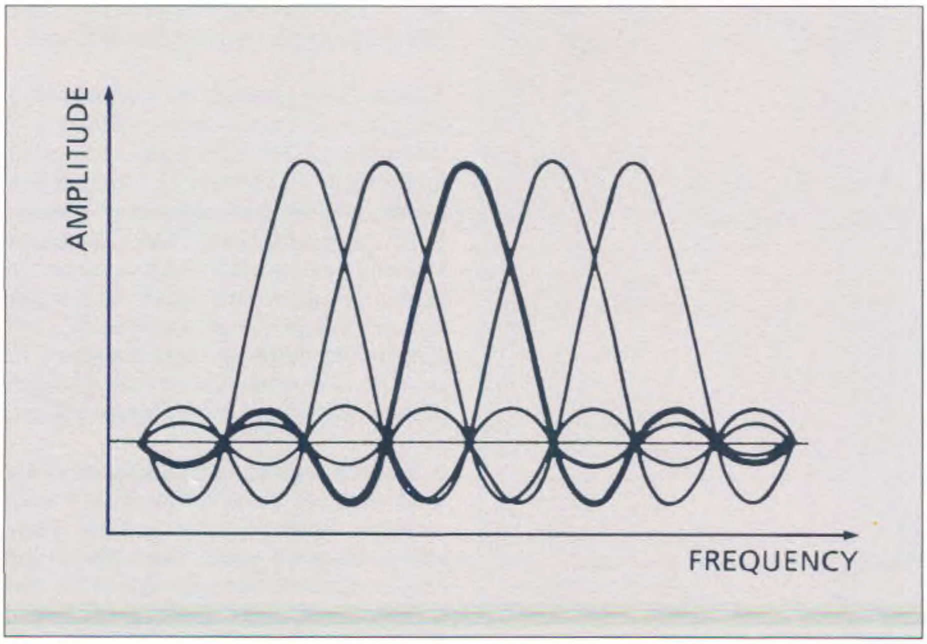


Fig 1: spectrum arrangement for interleaved carriers

~ Glossary ~

DPSK modulation Differential phase-shift-keying (DPSK) is a digital modulation technique where the carrier is switched between two or more phase states. In the simplest system — binary or 2-phase DPSK — the carrier is switched between only two states, separated by 180^0.

A more sophisticated version — known as 4-phase or quaternary DPSK — is used in the Nicam 728 tv sound system. Bits are taken in pairs, and the four possible combinations — 00, 01, 10 and 11 — are represented by carrier phase changes of 0^0, -90^0, -270^0 and 180^0 respectively. Each signalling instant — known as a ***symbol*** —thus conveys two bits, rather than the one of binary DPSK.

Even more complex systems are now coming into use; for example, 8-phase DPSK and 16-phase DPSK with, respectively, 3- and 4-bit symbols per phase state. These systems minimise bandwidth at the expense of more susceptibility to noise.

Fourier Transformation A process in which a signal — mathematically represented as a time-varying expression — is transformed into one which is expressed in terms of its frequency components.

Fast Fourier Transformation (FFT) is an important technique used in signal processing. It is most readily seen at work in spectrum analysers, which accept a time-varying input signal and display the frequency components which make up that signal.

Orthogonal Orthogonality, in the DAB sense, is a particularly difficult concept to explain without recourse of $\int$'s, Σ's and much hand-waving (in the words of one eminent Senior Research Engineer at Kingswood Warren!).

However, the consequence of carriers being orthogonal does enable the data on the various carriers to be separated, despite occupying the same band of frequencies.

Quantisation In a digital system, quantisation is the process of dividing the amplitude of an analogue signal into a pre-defined or restricted number of finite levels. In an 8-bit system, for example, there are 256 quantising levels (2^8).

Symbol See ***DPSK modulation.***

signals to be recovered even if large amounts of data are missing or corrupted. In coping with multipath reception this is particularly important, as reflections can cause deep notches in the signal which would remove one or more of the individual low data-rate carriers.

The COFDM signal is created at the transmitter and demodulated at the receiver using the Fast Fourier Transform (FFT) algorithm. This is the key to making COFDM a practical system, since a vast bank of filters and modulators would otherwise be required.

Low Bit-Rate Digital Sound

Considerable progress has been made in the last few years in developing low bit-rate coding systems for high quality sound. It is now possible to code a 15 kHz audio signal using a bit-rate of about 100 kbit/s, ie a little over a quarter of that used by the Nicam system.

The bit-rate reduction technique used is based on a recognised property of human hearing. It has been shown that if a loud sound is present at one frequency, then it will mask quieter sounds at similar frequencies — see Fig 2.

The audio spectrum is divided into a number of sub-bands, each of which is separately quantised using individual scale factors covering short time blocks (like the Nicam process). In order to keep the bit-rate low the quantising process is relatively coarse and, as a consequence, the level of quantising noise generated is correspondingly high. However, as the noise is restricted to the same frequency sub-band as the signal, it will be inaudible because it is masked by the audio signal.

The original system developed along these lines is called MASCAM (MAsking pattern Sub-band Coding And Multiplexing). In combination with powerful error correction systems and COFDM modulation, such highly efficient sound coding techniques make DAB a spectrum efficient and effective sound broadcasting system for the future.

Active Deflectors

Because the DAB system has been designed to be relatively immune to multipath effects, the receiver should operate successfully when two or more signals are received — provided the total delay between the signals does not greatly exceed the guard interval. So far we have considered the situation where the delayed signal is caused by a reflection from an object. However, the source of such a delayed signal could equally be another transmitter which simply amplifies and re-radiates the signal on the same frequency (a device known as an active deflector). The delay would then be equal to the difference in path length between the direct signal and that via the active deflector.

On this basis, active deflectors could be used to supplement coverage of a satellite service. The satellite would give 'bulk coverage' to rural and urban areas, while active deflectors would boost the signal strength for heavily screened areas, such as city centres. A mobile receiver in such an area would receive two signals, one from the satellite and the other from the active deflector. Provided the relative delay between the two signals was not significantly greater than the guard interval, then the system would operate well. This mix of satellite and terrestrial transmission is known as a 'hybrid system'.

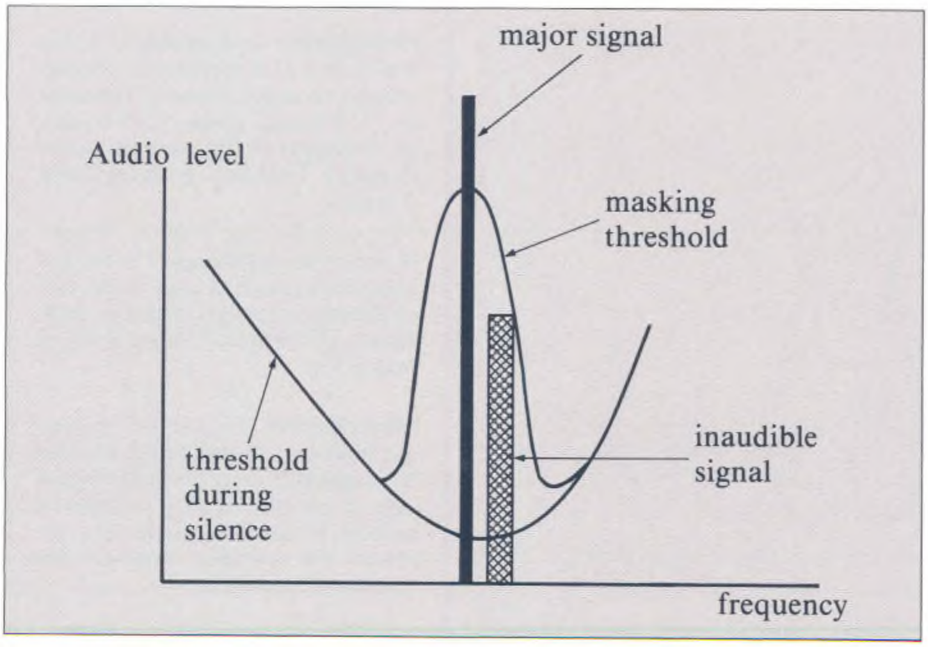


Fig 2: noise masking by a loud audio signal

BBC Tests of a DAB System

During 1990, Research Department conducted a series of DAB tests in south London. The system used employs an early version of MASCAM and can transmit up to thirty-two sound channels, ie sixteen stereo programmes. Each MASCAM sound channel requires a data-rate of about 136 kbit/s, with another 32 kbit/s of error correction data being added to give an overall bit-rate of some 168 kbit/s. For the thirty-two sound channels, a bit-rate of 5.5 Mbit/s is required; this data is carried on 448 carriers, each spaced 15.625 kHz apart. The spectrum occupied by the signal is therefore about 7 MHz.

Each individual carrier conveys useful data at a rate of 12.5 kbit/s with an overall symbol period of 80 μs. Each 80 μs symbol consists of a guard interval of 16 μs and an active data period of 64 μs. The system will therefore be completely immune to reflected signals with delays up to 16 μs, and should not be substantially degraded until the delay reaches about 32 μs (minimum distances of 2.4 and 4.8 km, respectively, from reflecting objects behind the antenna).

A main DAB transmitter was located at the Crystal Palace mast radiating a maximum of 140 W erp in a southerly direction on 531 MHz (TV channel 28). At the Kenley television relay station, 12km south of Crystal Palace, an active deflector was located which received the incoming signal and, after amplification, re-radiated it at a power of 3 W. The active deflector was designed to cover an area of the Kenley valley which is heavily screened from Crystal Palace.

A Renault Espace was equipped with a DAB receiver connected to a $\lambda/4$ whip antenna mounted on a ground plane above the car's roof. The vehicle was used to measure the coverage of the two transmitters and the results are shown in Fig 3. Throughout the non-shaded area, the DAB system operated perfectly — giving effectively CD-quality sound. At the edge of the coverage area the system experienced near 'brick-wall' failure. Amusingly, in the brief period between the error rate becoming high and the receiver muting, the sound took on a curious 'Donald Duck' quality. The active deflector at Kenley successfully provided coverage to the heavily screened valley, and the vehicle was able to cross between the service areas of two transmitters with no audible effect to the service.

International Frequency Allocations for DAB

The system used for the south London tests transmits sixteen stereo channels in a bandwidth of 7 MHz. Further development of the MASCAM coding technique suggests that a twelve stereo sound channel DAB service could operate in a 4 MHz bandwidth. The outstanding question now is where in the spectrum could sufficient space be found for such a service?

The DAB system tested in south London has been designed mainly with satellite and hybrid transmission in mind. The satellite service could operate from a geostationary orbit to both mobile and portable receivers equipped with simple low gain antennas. Alternatively, a number of satellites in a highly inclined elliptical orbit could be used with higher gain antennas being employed on the receivers. No frequency band is yet allocated for such services, but it appears as if the uhf range (300 to 3,000 MHz) might be the most appropriate. However, there are many demands on this spectrum, and it is difficult to identify where an allocation might be found. The World Administrative Radio Conference (WARC) to be held in 1992 will attempt to identify a suitable spectrum allocation for a DAB satellite service. The BBC is playing an important role in the UK's preparatory work for this conference.

The DAB system may also operate terrestrially, but the tests in south London have indicated that uhf may not be the most suitable frequency range for such a service. Diffraction losses at uhf are high, and this causes deep shadow zones behind obstacles such as hills and buildings. It therefore appears that the vhf range (30-300 MHz) may be a more suitable spectrum for terrestrial DAB. Once again, no international spectrum has been allocated specifically for such a

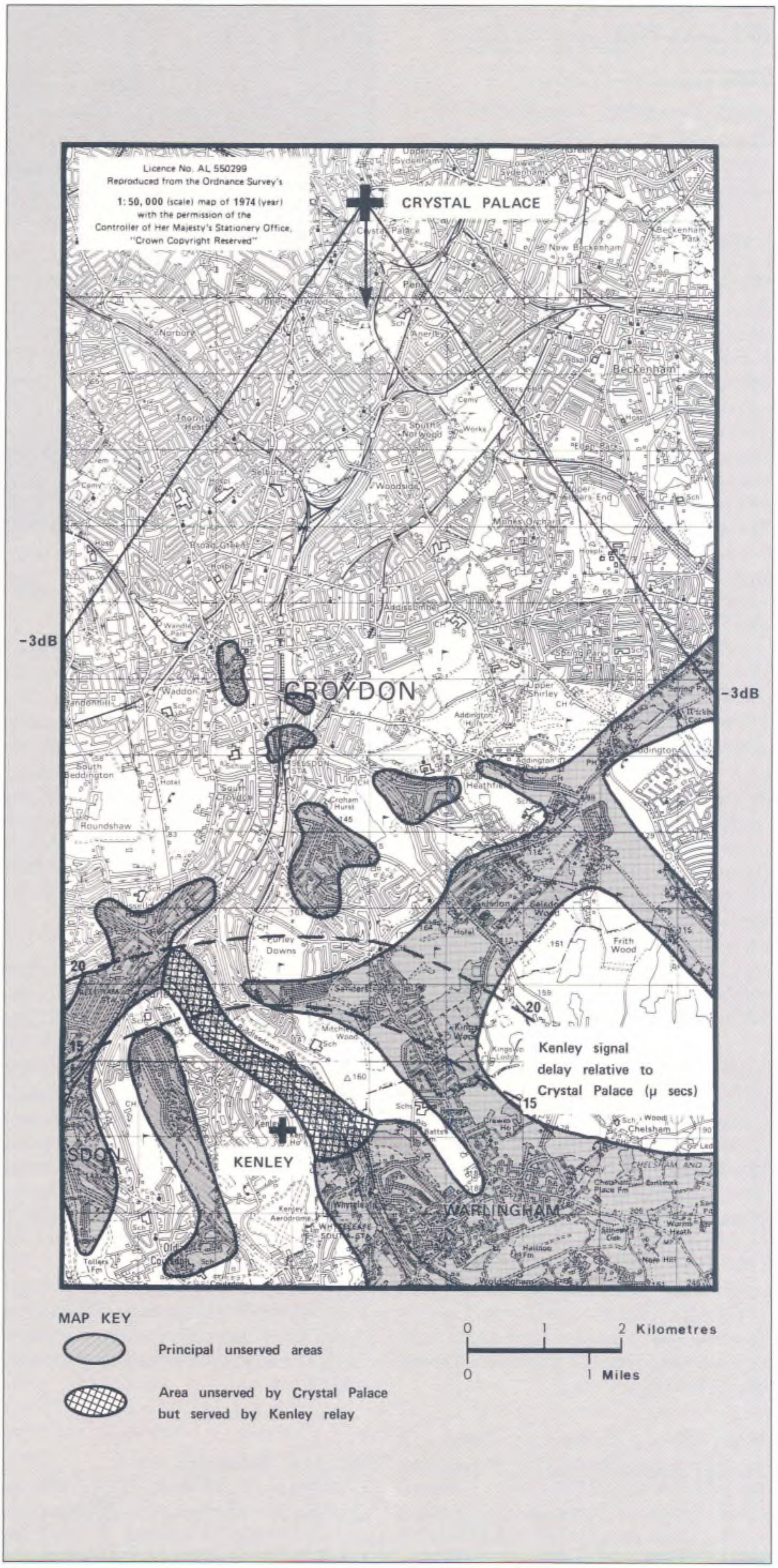


Fig 3: location of the Crystal Palace and Kenley sites, and the coverages obtained

service and it is hard to identify where such an allocation might be found.

Single Frequency Network (SFN)

The ability of the DAB system to cope with two or more signals with large relative delays between them may be further exploited in the development of a terrestrial Single Frequency Network (SFN). In such a system, all the main transmitters would operate at precisely the same frequency, probably in the vhf range. The signal from each transmitter would be timed so that in the cross-over areas between transmitters the relative signal delays would be minimised. However, despite this, path length differences from two or more transmitters to the receiver could now be many tens of kilometres. Therefore the symbol rate of the individual data signals will need to be further reduced. An active symbol period of 1024 μs is now being considered for use in SFNs which, with a guard interval of 256 μs, gives an overall symbol period of 1280 μs. Such a DAB system would laugh-off path length differences of some 77 km and would probably cope with delays of twice this amount.

It has been proposed that the transmitters of the SFN could be fed from a common satellite DAB signal received at some other frequency (probably 10 to 12 GHz). The correct timing of the transmitted signals could then be achieved by suitably adjusting digital signal delays at each site. The system will also need to be locked to a common vhf transmission frequency.

Such a signal distribution scheme has one particular advantage for the listener, and assists the broadcaster in establishing a service. Provided the satellite signal were reasonably strong, it would be receivable throughout the whole coverage area on relatively small simple dish receiving systems from the start of the service. Thus people in rural areas who wanted the service on fixed receivers could opt to receive it immediately, although they might have to wait some time for the full benefits of the terrestrial service.

If the UK is considered in isolation, it would require some 4MHz of spectrum to provide an SFN for 12 stereo channels. As mentioned earlier, it seems unlikely that an international allocation will be found for this purpose in the near future. The BBC is therefore investigating the possibility of a UK allocation being found which is acceptable to other users of the spectrum both in the UK and neighbouring countries, especially Eire, France, Belgium and Holland. Research Department is studying whether any spectrum in the existing international vhf bands I and III can be used. Tests will be conducted during the remainder of 1991 to evaluate the pros and cons of using these parts of the vhf spectrum.

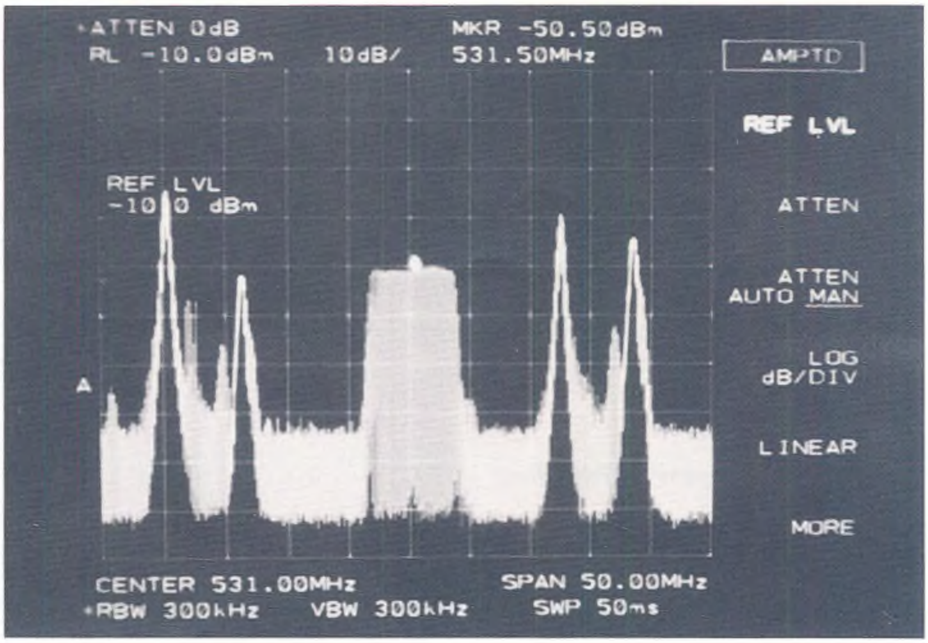


Fig 4: off-air spectrum trace showing the DAB signal on uhf Channel 28, slotted between the BBC1 (Ch 26) and Channel 4 (Ch 30) transmissions from Crystal Palace. (It should be noted that the use of a vertically-polarised receiving aerial has reduced the received level of the television transmissions)

It is worth comparing the spectrum requirements of the DAB single frequency network with the UK's FM national networks. Each FM network needs 2.2 MHz of spectrum to provide coverage to some 98% of the population. In contrast a DAB service would provide a national 12 stereo channel service in 4 MHz, a six-fold improvement over FM. However, this is a somewhat unfair comparison as the 4 MHz of DAB spectrum is needed for the UK alone while the spectrum used for FM has to be shared across most of Europe. Even so, DAB makes very efficient use of the radio spectrum, a factor which is likely to become even more important in the future.

Receiver Technology

Computer-based technology will be used in the receiver to implement the advanced digital systems needed for DAB. After suitable r.f. filtering, the DAB signal will be digitised and all the subsequent processing will be done in the digital domain. The carriers will be demodulated using Fast Fourier Transform processing. The desired audio signal will be selected by altering the demodulation process rather than by modifying or changing components. As far as the listener is concerned there will be no 'tuning' and the receiver will be totally 'push-button'. Virtually the whole receiver will be implemented using VLSI circuits.

If world-wide frequency allocations are made available for satellite DAB and agreement can be reach on a single world standard then, with large scale production, the cost of receivers should be extremely low. It is very important that this technology be inexpensive and readily available if it is to be attractive to developing countries, since in many of these countries it will be cheaper to install such a DAB service than a terrestrial VHF-FM network. Such a development could also enable multinational services to be offered by satellite to areas of common interest such as Europe.

So the development of the DAB system has opened up a number of exciting possibilities for radio broadcasting. Hopefully it will not be too long before our listeners are able to benefit from this development.

Henry Price
H.E.I.D.

TRANSMISSION
FM Re-Engineering

Transmission Engineering Department (TED) has been busy for some while on re-engineering our FM transmitting stations. Here, Phil Young describes how the use of shipping containers will speed up and simplify the process. And below, John Village and Barry Wadsworth describe a new generation of control systems for FM main stations.

CONTAINERISED FM TRANSMITTERS

For several years, the practical aspects of high power UHF re-engineering have been simplified by using containerised temporary transmitters. A complete transmitter system is built into a specially-made shipping container and taken to site, where it takes over the services from the existing transmitters. The old transmitters can then be removed, effectively creating a green field site suitable for contractors to install the new equipment.

In contrast, FM re-engineering has largely been carried out by TED staff working in parallel with operational equipment. Since current policy involves the increasing use of contractors, the decision was taken to commission a pair of FM containerised transmitters. An additional benefit is that the use of containers allows R1 and R4 FM services to be added to a station earlier than would otherwise be possible.

Invitations to tender were issued to several UK and European manufacturers, resulting in Eddystone Radio Ltd being awarded the contract. The specification called for one container to provide five 1 kW services, and a second to provide three services at 2 kW (to maintain existing programmes) and two services at 1 kW (R1 and R4).

The container shells are 6.1 m long, by 2.44 m wide, by 2.44 m high and were manufactured by Bradgates Containers Ltd. This company is a major supplier of containerised diesel generators weighing up to 38 tonnes: our containers, weighing in at 12 tonnes, did not prove too much of a challenge for them.

Hydraulic Lifts

Shipping containers are generally lifted either by purpose-built handling equipment or by a mobile crane. However, as access at many transmitting stations is restricted by mast stay cables, BBC containers have a built-in hydraulic lifting system. This allows the container to be lifted up to five feet from the ground so that the skeleton truck can be driven underneath for loading. At the site, the process is reversed.

Previous BBC containers have had a central hydraulic pump, with the fluid being distributed to all four legs by piping. This has led to problems with levelling, since the fluid takes the path of least resistance and one leg will usually extend faster than the others. The new containers have four separate systems, one per leg. These are set up such that the rate of extension is the same on all legs, but the legs can still be individually operated if so required. The design of this system was sub-contracted to Whitton Technology Ltd.

The hydraulic control system is also an advance on previous models. As well as being able to operate the legs individually or simultaneously, there is an 'auto' setting which senses the load on each leg. Thus, for example, when unloading the container from the lorry, the system will wait until each leg is grounded before continuing to lift.

The lifting system can be controlled either from a remote handset plugged into the control panel on the side of the container, or from the control panel itself. The remote controller, attached to a long lead, allows the operator to check all legs from a safe distance as the system is lifting.

Technical Installation

The shell is fitted out with a five-service, duplicated, receiver-drive system which includes input filtering and a five-channel combiner unit. The transmission equipment, supplied by Eddystone Radio Ltd, consists of a slightly-shortened version of the AM14/51, 2 kW or 1 kW amplifier, fed by TM4M/4 drives.

The control unit is based on that recently installed at Oxford. Although the system is intended to be used primarily at receiver-drive sites, there is provision for line feeds to be used. One service can also be fitted with RDS equipment as needed.

The combiners are provided by Alan Dick and Co, and are identical to those found on many BBC sites. Should it be necessary, there is provision to feed two separate outputs to the container interface. This facility is required at sites where one of the services, eg local radio, uses a separate antenna.

The aim has been to fit the container with equipment which is well understood by operational staff, so as to avoid any difficulties with familiarisation. This will be important once the current re-engineering is completed, as the containers will then be used as emergency transmitters.

The two containers will be handed over in April and May 1991, and initially will be deployed at Ashkirk and Morecambe Bay, where re-engineering of the FM services is scheduled to take place.

Phil Young, Project Engineer
Transmitter Section
TED

FM CONTROL SYSTEM

Until recently, FM re-engineering has entailed much on-site effort by TED engineers to modify and expand the existing centralised Control and Indication Panel (CIP). This seventies-vintage control system, although reliable, had reached the limits of its capability, and expansion beyond five services was not feasible. (Some sites radiate national regional and/or English local radio services in addition to the four national FM services — or at least they will do in the future.)

In developing a new control system, the opportunity has been taken to design a Transmitter Input Equipment (TIE) bay which is individual to each service. This will make future FM expansion much easier, by permitting installation to take place without interfering with any existing equipment. It will also enable equipment to be manufactured and installed easily by contractors.

Design

All the broadcast equipment at FM main stations is duplicated — to ensure that no single fault can cause the loss of service transmission. The ***controller*** lies at the heart of this system and must also be very tolerant to faults.

Two separate sub-systems were therefore required, each controlling the programme routeing chain, mono/stereo operation and overnight closedown for one half of the system. However, in order to make the optimum control decisions, the status of all the equipment in the system would need to be known by each half-system.

Procurement of the new system was undertaken in two stages. Firstly, Cambridge Consultants were engaged to write a full specification in December 1989. This took approximately three months. The resulting seventy-five page document was then used as a basis to invite competitive tenders for the design and supply of the units. Serco Systems were awarded this contract in May 1990.

Hardware

The controller is based on Virtual Machine Environment (VME) bus hardware. VME is a modular computer system, widely used in industrial control applications, and tightly-specified by the IEEE. Systems are customised to the user's requirements by selecting standard modules from a large range, available from several manufacturers. The required modules are then connected via a parallel bus structure over which all data transfer is accomplished.

Each half-controller comprises a microprocessor card and two I/0 modules, connected via a five port bus. This leaves two ports available for future expansion. In addition, a custom I/O board was required to provide immunity against the harsh electromagnetic environment of an FM transmitting site.

The only data transfer required between the two half-systems is a single line used to detect a failure within the controller itself. The front panel of the unit contains manual overriding controls, together with an LED-based mimic display of the service status. A similar layout to the old CIP has been maintained for 'operator familiarity'.

Software

The software for the controller was developed by Serco, utilising the Yourdon methodology for analysis and design, supported by the CASE tool Excelerator. This is widely used within the software industry and provides a rigorous system design, using graphical techniques with supporting text.

Following the analysis, the software was written in the language 'C', under the OS/9 multi-tasking operating system. All controllers use identical software: any site-specific functions are set up with the use of dip switches.

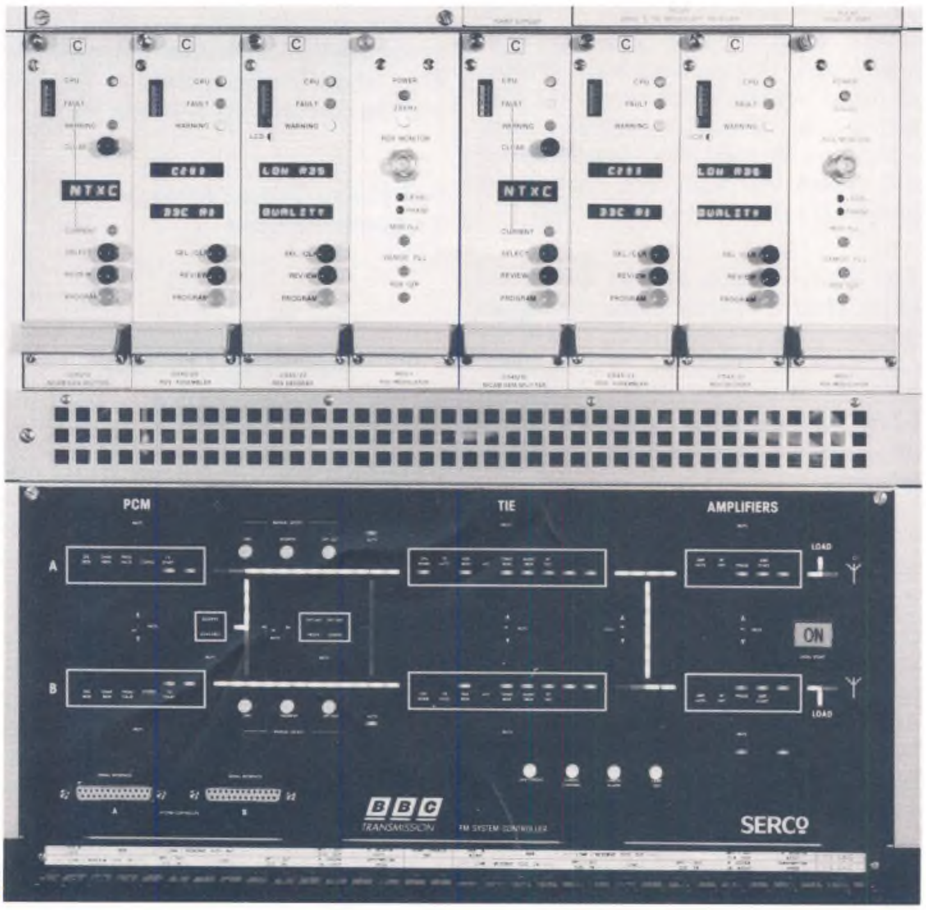
As a final confidence check, D&ED was commissioned to review the software implementation, prior to production.

Production

The first two control systems entered service at the Llanddona transmitting station, Anglesey, in December 1990 — extending Radio 1 and Radio 4 FM coverage by 135,000 people. A further nineteen units are due to enter service in 1991, as part of the re-engineering and expansion of the Pontop Pike, Meldrum, Divis and Rosemarkie transmitters.

The design approach has enabled a five-service TIE system to be installed and commissioned by contractors in under a month — a vast improvement on the old system and making considerable savings in TED staff effort.

A new software version will be released later in the year. This will include extra facilities to aid fault-finding and will produce a printed fault-log, on demand.



TED

Part of a Nicam-fed TIE bay showing the RDS shelf (above) and the system controller (below)

John Village & Barry Wadsworth
Monitoring & Control Section
TED

WORLD SERVICE
Broadcast Coverage Department

In this feature we look at the structure and function of Broadcast Coverage Department (BCD) at Bush House, whose mission is stated as "We aim to cover the world".

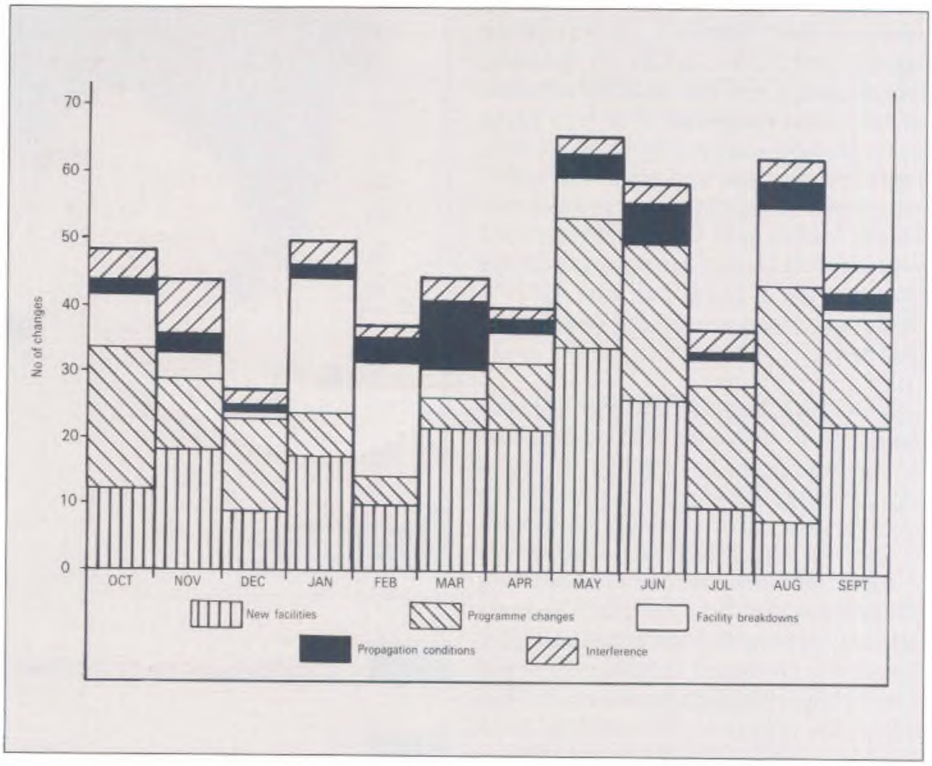
The department was set up in April 1990 — by a reorganisation of the former Transmission Planning Unit (TPU) — and was created to manage the changing and expanding broadcast coverage needs of World Service.

World Service broadcasts about 750 hours of programmes each week, in thirty-six different languages including English. An estimated 120 million people tune in every week.

To provide international coverage, World Service transmits for:

- five hours each day on LW (one transmitter)
- 130 hours per day on MW (seven transmitters)
- 1050 hours each day on SW (eighty-two transmitters)
- 72 hours a day on VHF (three transmitters)

These transmitters are located in twelve countries, at twenty sites — six of them in England. The overseas sites are fed by fifteen Intelsat satellite channels while the sites in England are fed by BT lines.



This diagram counts the changes in each category for each month over a 12-month period. Note in particular the large number of breakdowns in January corresponding to the UK gales, and the large number of programme changes in August when Iraq annexed Kuwait

BCD's main function is to enable listeners worldwide to hear World Service programmes at their best. The department achieves this by ensuring that the correct programme is sent to the correct transmitter site and radiated in the correct direction at the right time, using the best frequency available. Quite a sizeable operation!

The department also undertakes projects to improve audibility around the world and represents World Service at international frequency planning conferences.

BCD is divided into three main units — Planning, Developments and International Liaison — and also has a Support Services section which deals with computing, data and clerical matters, as well as providing Drawing Office facilities. The department is managed by a team of four, headed by Dennis Thompson.

PLANNING UNIT
"Enabling them to hear us"

Planning Unit is a team of six people led by Mike Still. It is responsible for the selection, co-ordination and administration of transmission frequencies — selected to maximise signal level and minimise interference, thereby producing the best possible audibility in the prescribed target countries.

Planning Unit is also responsible for providing frequency schedules for Publicity and Programme departments; for the production and distribution of operational documents; for planning the use of transmission equipment to improve audibility; and for the maintenance of all the above in response to changed programme requirements, changed availability of transmission equipment, changed ionospheric propagation, or changed interference patterns.

The unit also employs an extensive network of 250 monitors (listeners) throughout the world who provide continuing data on reception quality. This data is stored, collected, analysed and studied to enable BCD to provide the best possible coverage of the target countries. Future plans include making these reports diagrammatic and therefore easier to use. Occasionally staff from the section visit key broadcast target areas to investigate the possibilities for improving reception.

The Operational Schedule

This is a chart which shows how the various transmitters are deployed round the clock. The schedule occupies five sheets of A1 paper and is in two parts — Transmission and Routeing.

The schedule changes every season as a result of changing ionospheric patterns which greatly affect short-wave reception. However, changes also occur when equipment fails or when programme priorities alter due to political/military situations such as the Gulf War.

Optimod and AM Companding

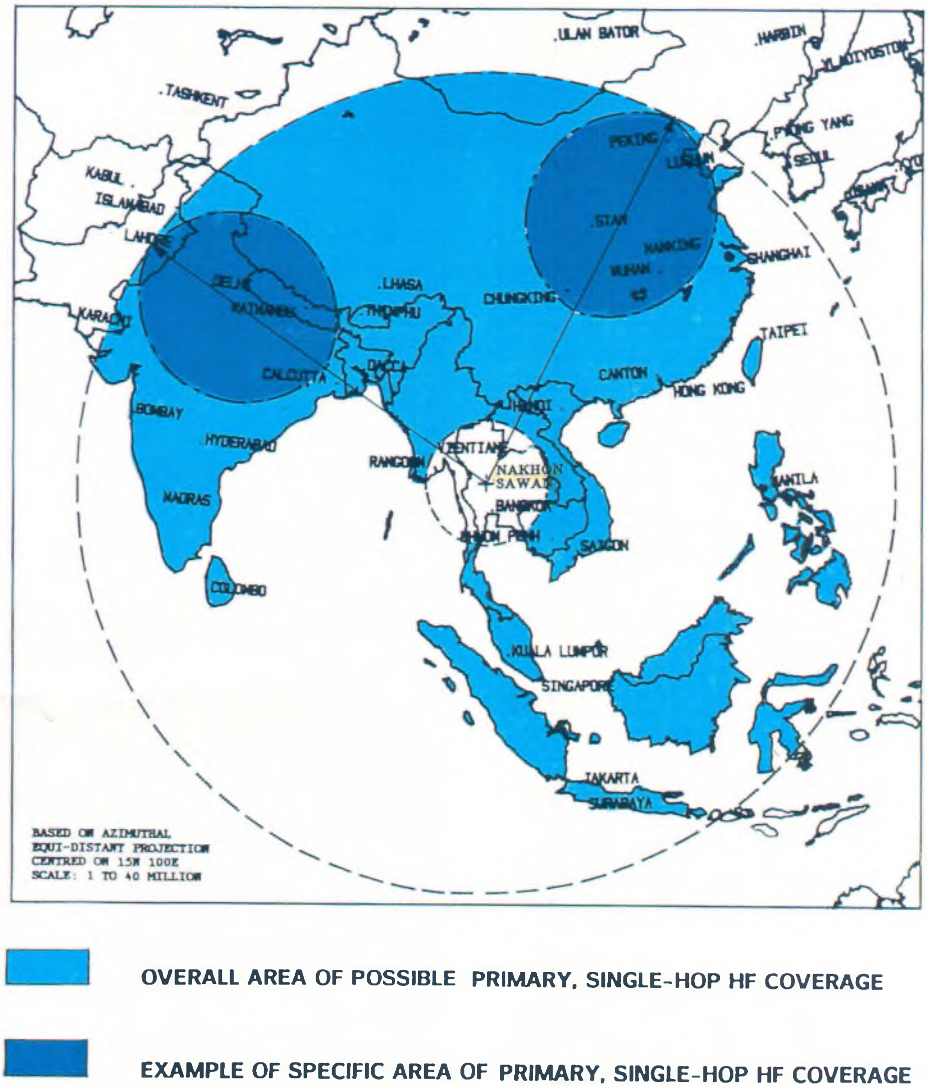
Optimod hf audio processors are currently being installed at all the overseas shortwave transmitters. They have been specifically designed to improve the subjective perception of speech and music in the hf listening environment, and rely on different parts of the audio frequency spectrum being individually compressed. However, even though these processors undoubtedly make World Service transmissions sound louder and hence clearer, they also increase transmission costs because more energy is being put into the AM sidebands. This is where AM Companding can help.

AM Companding is a transmission technique which makes use of the reality that a smaller signal-to-interference ratio can be tolerated when the modulation level on that signal is high, than when it is low. As the modulation level into a transmitter increases, AM Companding progressively reduces the effective transmitter power until at full modulation the transmitter power is significantly lower than would normally be the case. Thus while the signal-to-interference ratio remains substantially unaltered, a significant power saving is achieved. On heavily-processed signals this power saving can be substantial.

AM Companding can also be used to increase the effective transmitter power. Because its application reduces the overall power input to the transmitter (and hence the overall transmitter power dissipation), it is possible to operate the transmitter at a higher power level than normal. Thus, for example, a 300kW transmitter can be run at effectively 420kW output.

Only the newest of existing BBC World Service hf transmitters can make use of AM Companding — namely those at Hong Kong and Seychelles, some at Rampisham and the 300kW transmitters at Daventry. However, the new transmitters being installed at Cyprus, Rampisham and Skelton C (due to come into service in 1991) are all capable of AM Companding.

By the simultaneous use of Optimod signal processing and AM Companding, it will be possible to get the best of both worlds — namely some increase in loudness and some energy cost savings as well.



Projected primary, single-hop, coverage from the proposed new hf relay facilities in Thailand

DEVELOPMENTS UNIT

"Reaching out to new audiences"

Developments Unit — a team of six managed by Fiona Lowry (the Assistant Head of BCD) — is responsible for developing and augmenting the present network of World Service transmission resources. A requirement to improve audibility in a particular area will come to BCD from the Marketing Strategy Group and the Capital Planning Group. It is up to Developments Unit to plan the most effective means of programme delivery (SW, MW, VHF etc).

The unit uses data obtained from International Broadcasting Audience Research (IBAR) to develop the best option. This data will include information on: the ownership of LW, MW SW and VHF receivers in the target area; the density of population in different parts of the target area; the BBC's market share compared with that of major competitors in the area; the transmission developments that our competitors are planning which could have an impact on our market share, etc.

In order to establish what signal strength is required to provide a 'good' competitive signal, a tape is prepared with examples of reception quality at different field strengths. This tape is then played to current listeners and non-listeners in the target area, and they are asked to consider which of the options are acceptable. After analysing the results, the most effective and efficient method of programme delivery is chosen.

Next, an area is identified from which a transmitter could provide the required primary coverage (ie from a single ionospheric reflection). The transmitter power, antenna types and frequency of operation then have to be determined in order to optimise coverage in an economical manner. Prediction programs are run using BCD's mini-computer, and coverage maps produced showing coverage achievable using specific facilities.

BCD sponsors the new project, which involves writing a 'World Service Transmission Requirement' and liaising with TED at Warwick. As Project Manager, TED predicts (and BCD agrees) the costs and timescales of the project, writes the finance case, places contracts and then regularly reports back on the progress of the project. BCD answers any queries which TED may have and informs the Projects and Planning department at Bush House of the capital expenditure.

As well as investigating opportunities in Eastern Europe, the unit is also currently planning coverage improvements in Asia from a proposed new site in Thailand. The accompanying map shows the expected area of primary coverage from this site, which could reach an estimated potential audience of 2.3 billion people (45% of the world's population).

INTERNATIONAL LIAISON
"The future's in our hands"

It is up to the International Liaison Unit — a team of three led by Ian Davey — to ensure that World Service maintains its position at the forefront of all technical, regulatory and policy matters which affect international broadcasting. This includes not only the current terrestrial services but any future satellite services as well.

The regulation of the frequency spectrum is effected by the International Frequency Registration Board (IFRB), using a set of 'guidelines' agreed within the structure of the International Telecommunications Union (ITU) by World Administrative Radio Conferences (WARCs). Of particular interest to World Service are two imminent WARCs which will deal with the reallocation of the frequency spectrum (WARC 92) and with the planning of HF Broadcasting (WARC 93).

An important component of all WARCs is the associated technical standards. While it is necessary that all concerned should work to the same standards, like everything else in life an object perceived by one person as satisfactory is seen to be unsatisfactory by others. The setting of technical standards for HF Broadcasting is no exception. To evolve a set of internationally-agreed standards is a time-consuming exercise. In most cases, their origins are to be found within the work of the CCIR (International Radio Consultative Committee) and the EBU (European Broadcasting Union). It is at this level that the 'foundation stones' of technical standards are produced.

WARC 92

World Service has two interests in the outcome of the 1992 WARC:

- the possible extension of the frequency spectrum allocated exclusively to HF Broadcasting; this could reduce congestion and improve audibility.
- a frequency allocation for the direct reception of Broadcast Satellite Service (Sound) transmissions.

Both requirements are not without their problems. It is likely that the required additional spectrum already 'belongs' to other services who are probably very reluctant to give up their share!

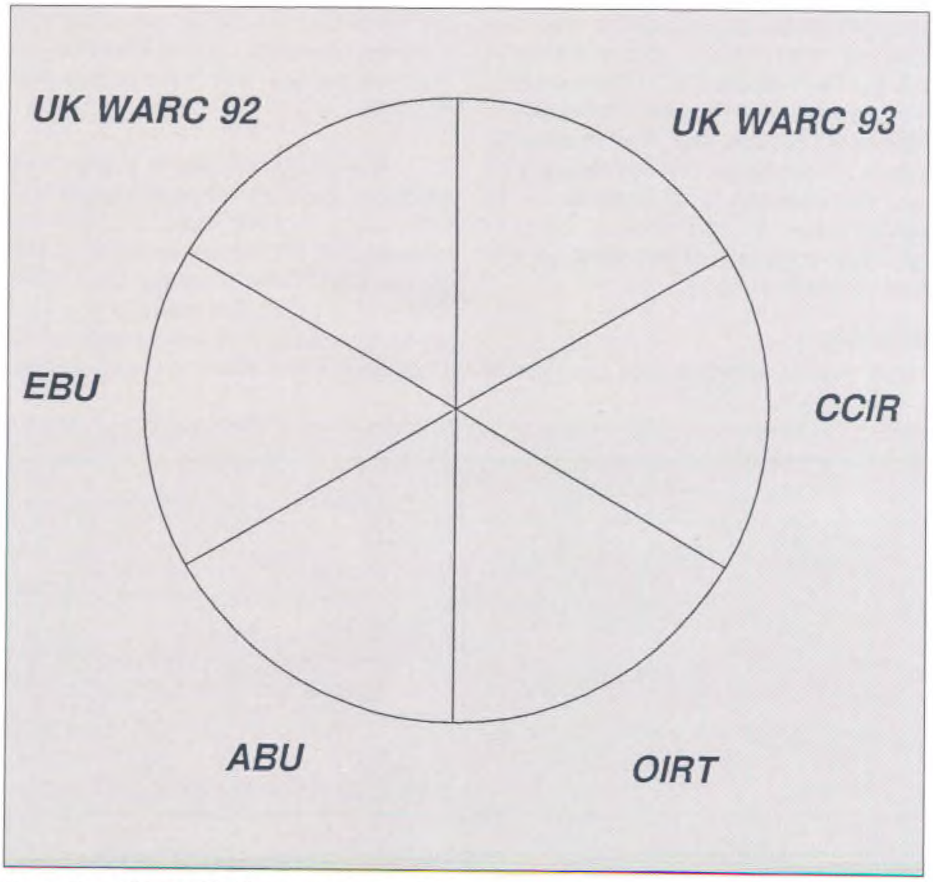
WARC 93

Many countries believe that the present usage of the shortwave bands is unfair, with a handful of very large broadcasters taking the lion's share of available spectrum. An internationally agreed hf plan has been sought since 1947 but thus far all attempts to agree one have met with failure.

WARC 93 will seek to introduce more 'equitable usage' of the spectrum through an hf planning system where each the broadcaster would be much more limited in the choice and usage of frequencies. These restrictions could effectively end international broadcasting as we know it today.

World Service — on behalf of the UK — needs to protect its position as a leading international broadcaster. To do so, BCD must ensure that WARC 93 does not unduly inhibit its aim to 'cover world'.

(This feature is based on literature which was produced for two Open Days held by BCD at Bush House last November).



International Liaison Unit's main areas of activity

NETWORK TELEVISION
Studio TC1 reopens

Studio 1 at Television Centre was reopened on 24 January by Sir Paul Fox (M.D.N.Tel.), accompanied by Michael Checkland (D.G.), in front of a small audience.

Wynne Griffiths and Michael Ward describe the efforts which went into renovating and refurbishing this large prestigious studio.

TC1 — the BBC's largest studio — was built in the early sixties and opened in 1964. It was 'colourised' in 1968 and a stereo sound desk was installed in 1977 but, by December 1987, it was thoroughly worn out! Over the past three years, the sound, vision, and communications systems, winches, lighting system, and acoustics have been replaced. In addition, extensive quantities of asbestos have been removed.

(Originally the refurbishment was to have taken a year but, part way through, the decision was taken to remove as much of the asbestos in the studio as possible. It was this that led to the longer than usual timescale.)

At the time of building, TC1 was the largest purpose-built television studio in Europe, with a floor area of 1000 m^2 and a volume of 16733 m^3. It was built out of bricks and concrete, and the external walls were about 690 mm thick (which included a 230 mm cavity). The cavity was formed for acoustic isolation reasons, but the ventilating engineers seized on the opportunity to use this huge cavity to duct air to the upper parts of the studio, from a specially-constructed air duct in the sub-basement (Fig 1).

Asbestos

In the 1960s, asbestos was a common building material and was used regularly in ventilation systems — for acoustic absorption and also to provide fire cladding for steelwork. In Studio 1, the vertical ventilation riser ducts were made from asbestos cement, built within the studio wall thicknesses (Fig 2). There were also blocks of asbestos in the Paxfelt sound attenuators in the ducts, while six structural roof trusses — each 30.5 m long and 2.8 m high — were clad in 50 mm thick sprayed asbestos (Fig 3).

In 1987, the decision was taken to remove the asbestos from the studio. This necessitated a complete strip-out. The ventilation ducts themselves were cleaned and sprayed internally with a hard protective coating and the Paxfelt absorbers were removed from the basement. The studio had originally been lined with rockwool (up to 300 mm thick) and other acoustic-absorbent materials. While these materials were not in themselves dangerous, they had to be considered as contaminated by the removal process and were completely replaced.

TC1 was the first major production studio to have its asbestos completely removed. A specialist consultant, experienced in asbestos removal, acted as the BBC's agent under the supervision of ACED. The removal contract took six months and was completed in December 1989. The remaining studios at Television Centre will be treated similarly during their refurbishments.

Acoustics

In 1962, the original acoustic calculations were based on a combination of low-frequency roofing felt, hardboard membrane absorbers, and wideband absorbers with a partitioned airspace behind a 25 mm thick layer of mineral wool.

This treatment was originally designed to cover all available wall and ceiling surfaces and on this basis the calculations predicted an average reverberation time of 0.8 seconds, over the frequency range 250 to 4000 Hz. However, only 54% of the wall and ceiling surfaces were finally available for acoustic treatment, the remainder being lost to doors, windows and large wall ducts. This loss of treatment area resulted in a shortfall of some 465 m^2 against the 2600 m^2 originally specified, and a final average measured reverberation time of around 1.12 seconds.

ACED's acoustic specialist, Richard Cole — whose brief was to make the studio deader — set about the task of designing an acoustic treatment which would also provide a flat reverberation time response. He estimated that by treating as much wall area as possible — even to the extent of reclaiming expendable areas of observation

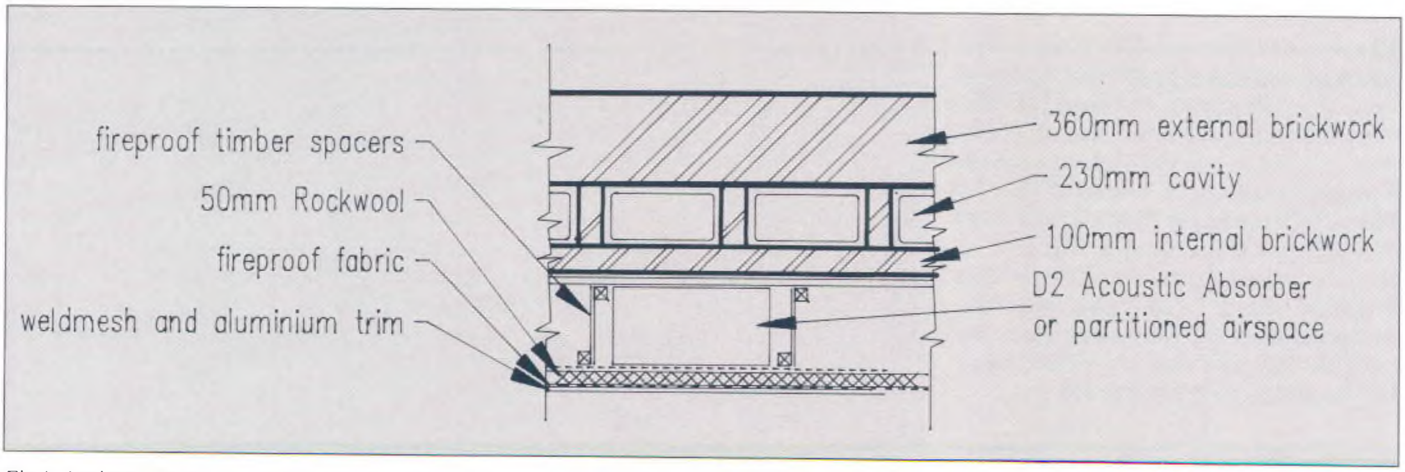


Fig 1: horizontal section through external wall

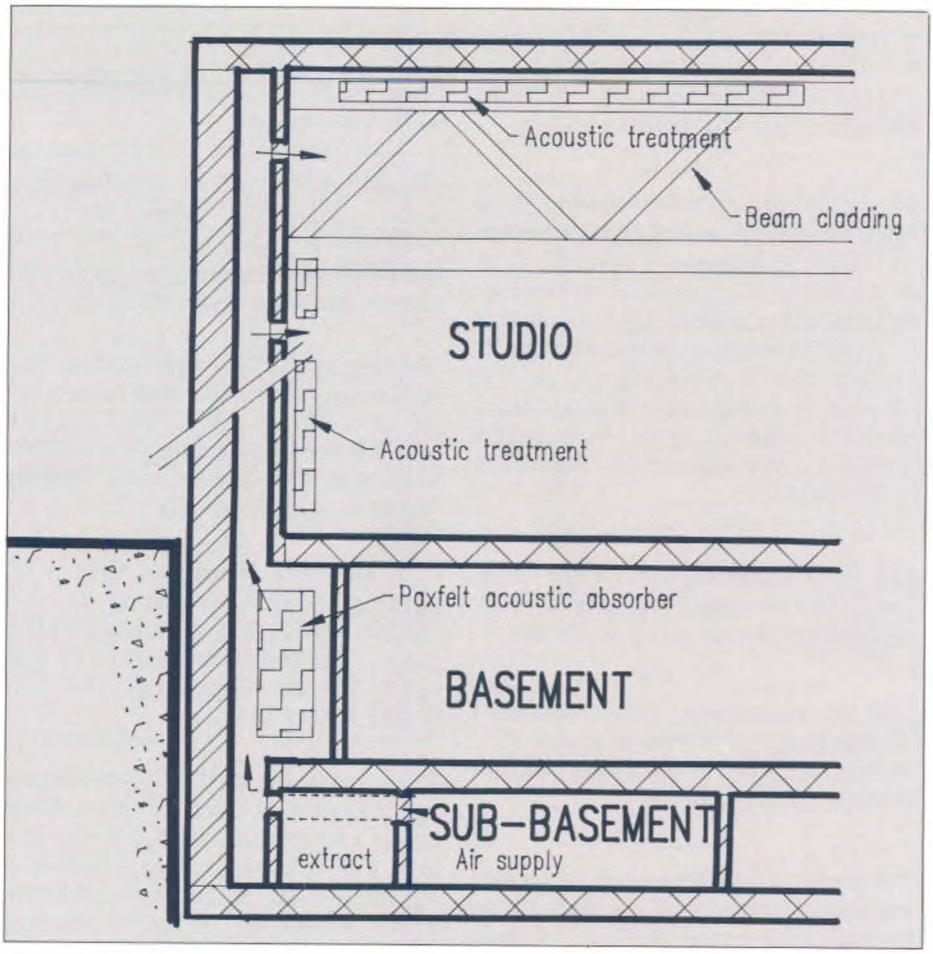


Fig 2: vertical section through studio

window — the acoustic treatment would still have to absorb more than 75% of the sound energy incident on it, at all audio frequencies.

Detailed studies of commercially-available acoustic treatments revealed that they would not have adequate bass absorbing performance. The anticipated uncontrolled 'bass rise' (ie excessive liveness at the lower audio frequencies) was considered to be unacceptable, because it would have been a departure from the characteristics of other studios in Television Centre. Furthermore, in a space as large as Studio 1, reverberation times of two to three seconds might have occurred at some frequencies.

Consequently ACED investigated alternative acoustic treatments, based on common building products. A construction method was devised which took best advantage of the extensive system of fixing bolts in the studio walls and ceiling. Acoustically-absorbent mineral fibre batts (better known in the building trade for their thermal insulation characteristics) were installed over a grid system of airspaces and bass absorbers (Fig 2).

The acoustic treatment was finished with a noncombustible and inexpensive dyed fabric (produced in huge quantities for its normal application as a reinforcement for industrial conveyer belts). Finally, protection from mechanical damage was provided in the form of wire mesh and aluminium cover strips — a reliable technique well established at Television Centre.

Bob Walker of Sound Section, Research Department, tested the acoustics of Studio 1 and concluded that: "*The achieved Reverberation Time is about as low as could be expected in a room of this volume. The RT characteristic is very uniform at low frequencies and is controlled mainly by air absorption at very high frequencies. At the time of these tests no cyclorama was installed. It is anticipated that this will reduce the RT to around 0.9 seconds when the studio is complete*".

Audience facilities

Originally, TC1 did not include any installed audience seating — temporary rostra were brought in when required. However, when plans to build a new Television Theatre as part of Television Centre Stage 5 were abandoned in 1990, it was decided to make TC1 more suitable for major Light Entertainment programmes.

This would be achieved by incorporating extensive facilities for audiences, including permanently-installed seating units which would be collapsible and which could be configured in various arrangements. The brief was to offer the audience a little more comfort than is usual in television studios — more like they would be accustomed to at the theatre. They would have their own entrance at the back of the seating, with a holding area if possible, and there would be appropriate toilet facilities.

Television Centre is aesthetically a very sensitive building. It is a classic for its age, and the local Planning Authority

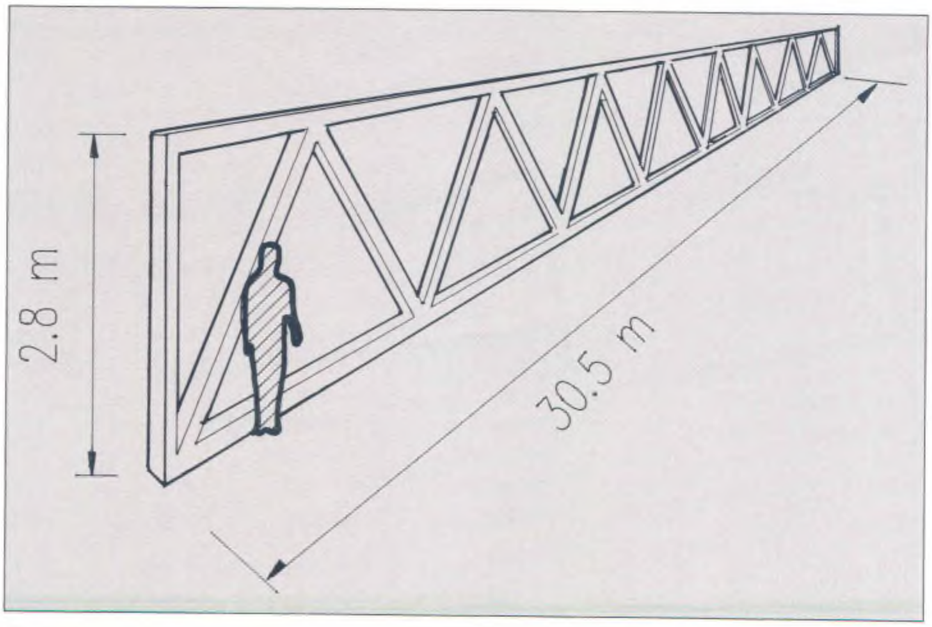


Fig 3: roof truss

strongly resist any alterations to the elevations. The requirement to give access and escape for audiences at first floor level called for major structural and elevation alterations.

The problem for the audience entrance was resolved by constructing a curved bridge on the front of Studio 1, using similar materials, shapes and proportions as the existing design. It connected the existing Staircase 1 to a new opening at a higher level in the studio (Fig 4). The stair was widened by simply erecting a new handrail, cantilevered off existing stair strings.

The emergency exit also had to be at first floor level, but this was straight out onto the Wood Lane elevation of Studio 1. No structure would have looked right there, yet regulations required an escape route protected from the weather. That problem was finally resolved by getting a relaxation on aesthetic grounds for an open stair.

Studio equipment

The vision system installed by Sony Broadcast includes features common to other recent studios. This applies to the vision mixer and effects system which are the Grass Valley 1600 and Questech Charisma designs. However the cameras are new. TC1 is the first Television Centre studio to be fitted with CCD cameras. It is equipped with four Thomson 1542 heavyweight and two Thomson 1647 lightweight cameras.

The sound system revolves around an AMS assignable sound desk, identical to those in Studios 3 and 4. It is a digitally-controlled analogue 96-channel sound desk and was installed by AMS. It is stereo capable and can be configured in various set-ups, so it is suitable for a wide range of programme types. The desk set-ups can be stored on floppy disc and used on the other desks in TC3 and TC4.

The communications system is a Philip Drake 600, as installed in several other studios and as such is conventional.

The above systems have additional circuits included in them to enable TC1 to handle special programmes such as the next general election.

New radio talkback equipment has also been installed in TC1, as part of an overall scheme to replace all such equipment in television studios. This new equipment — operating at 25 kHz channel spacing in the 635 to 715 MHz band — has been designed to replace the ageing Band IV equipment. The channels are allocated by the BBC's frequency management committee. The system was designed and manufactured by Wood & Douglas, in response to a P&ID Tel technical specification, when Band IV frequencies were reallocated for alternative uses.

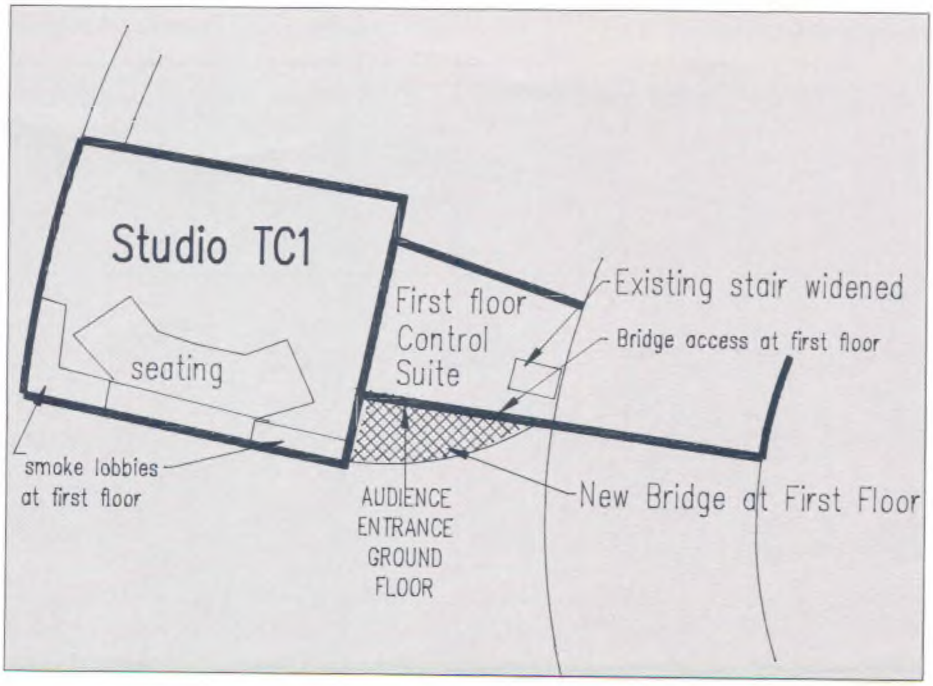


Fig 4: part plan of Television Centre

The main design criteria were: improved audio quality, long battery life (using rechargeable cells), and multi channel capability. To date, results in this studio suggest that these aims have been met.

The system in TC1 comprises four base stations, eight portable transmitters and ten portable receivers. This supports four channels of talkback for Floor Managers, Sound Supervisors, Lighting Directors, and Presenters.

TC1 has been fitted out with a Q2 lighting control system. It has one dimmer per circuit and there are 1103 of them in the studio. Designed and built by D&ED, the Q2 system was described in ***Eng Inf*** No 39.

The state of the lighting system can be seen from the geographic mimic in the vision and lighting control room. It is laid out to imitate the position of lighting outlets in the studio. It shows which outlets are on for the current setting of the control desk and, in addition, which will come on for the next setting. For the first time the mimic uses LEDs instead of incandescent bulbs.

The mechanical parts have of course not been neglected. The lighting winches (247 of them), cyclorama drop out, and undergantry winches have all been replaced with a new design, and the monitor and scenery winches have been refurbished. The cyclorama rails have also been refurbished and the 12 m one (which had been derelict for a number of years) has been reinstated. So the studio now has rails at heights of approximately 6, 9 and 12 m.

The refurbishment was undertaken by a number of contractors working to the BBC. The technical contracts were managed by P&ID Tel, and the building and asbestos contracts by ACED. Our thanks go to all members of the BBC project team and the contractors who successfully brought this project to its conclusion.

Michael Ward, Project Architect
West London Architectural Group
ACED

Wynne Griffiths, Project Manager
Studio & OB Group
P&ID Tel

MRM

Rehearsing for Comic Relief in TC1 on 15th March 1991

MRM

TC1's Vision and Lighting Control Room during Comic Relief rehearsals

RESEARCH DEPARTMENT

The Marriage of Figaro

David Kirby describes how Research Department rescued Figaro's marriage at Christmas.

In early November, Research Department received a request for assistance in salvaging a 24-track digital audio recording of the Marriage of Figaro — due for transmission on the 26th December. Various attempts had been made to recover the recording, made in August 1989, but because of the unusual nature of the problem, these had been unsuccessful.

A pair of tracks was copied to a stereo DAT machine and, after investigation, it soon transpired that odd and even tracks were swapping over every second or so, for the entire length of the recording.

A more detailed analysis of the problem was carried out by Andrew Mason, by transferring a section of the recording to a Sun workstation and displaying it as shown in Fig 1. This shows the signals on each of the two tracks, with the changeover between tracks in the middle.

A closer look at the changeover point revealed that the two tracks were swapping over at slightly different times, separated by somewhere between three and thirty samples. This meant that, as the swap was taking place, between three and thirty samples from each track would be the same and this could be detected without too much difficulty. Once a swapped section had been found, the tracks could then be swapped back during replay.

Test software was written for the Sun workstation to perform the required 'unswapping' and the results are shown in Fig 2. All is now well in the upper track, since no samples are missing. However, the lower track has lost between three and thirty samples and in their place are samples from the other track. (Note that the two waveforms are shown with different vertical scales so the duplicated section between the markers appears to be different).

Tidying up the lower track required a way of filling in this gap inaudibly. Some earlier work on linear prediction of audio waveforms came in useful here: a method based on predicting the waveform into the gap, and combining that with linear interpolation, seemed to work well enough. The next problem was how to apply the technique to 96 track-hours of recording with about two weeks to go before the tapes were needed for post-production.

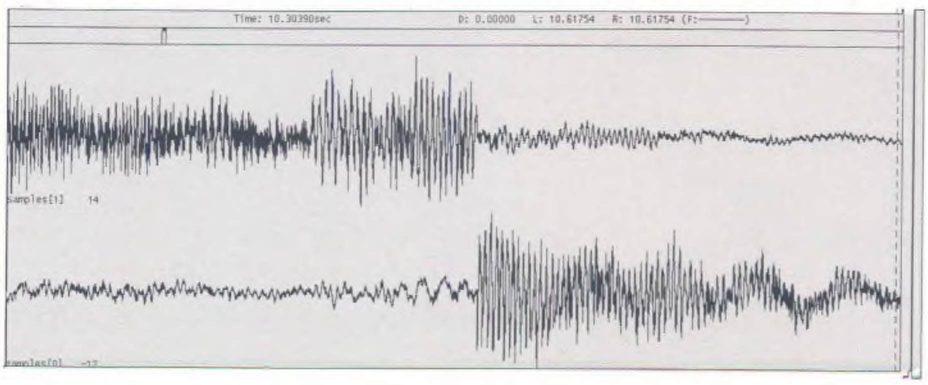


Fig 1: two tracks from the original recording, showing the changeover between tracks in the middle

The only realistic approach was to process the recording in real-time but, even then, several tracks would need to be processed at once to reduce the transfer time. Fortunately, just at this time, a digital audio processing unit was being commissioned for another project and so Bruce Gentles set about the task of implementing the algorithm on its Motorola 56001 processor, to give real-time unswapping and gap filling on six tracks simultaneously.

Further checks now showed that, although the tracks were being unswapped, there were still some clicks present afterwards. By capturing sections of the processed audio on the Sun workstation, a further analysis of these could be made. This revealed that, immediately before and after some of the main track swaps, there could be momentary swaps of a few samples. These were simultaneous in both tracks and so could not be detected by the software.

The only answer at this stage was to develop a click detector and suppressor which could mask these effects. Several ideas were rapidly tried on the workstation to see if reliable detection of the clicks could be achieved. A reasonable technique was developed and used to trigger a further linear prediction and interpolation to conceal the click. This removed the majority of the clicks without appearing to introduce significant artefacts into the signal.

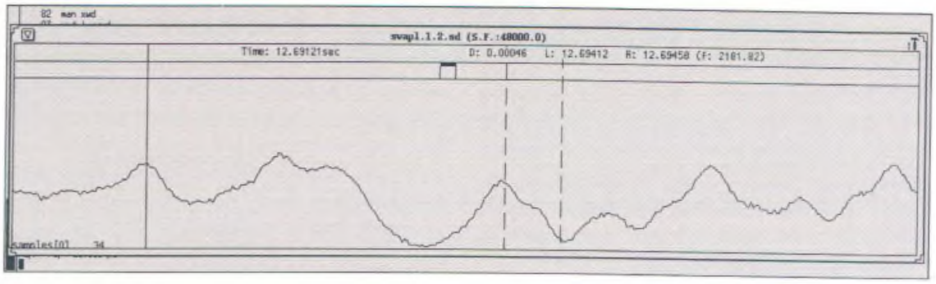


Fig 2a: the first track after processing

With no further time available for refining the technique, the tedious task of dubbing the recordings — six tracks at a time — from one machine to another was started. Following this, the mixing was carried out in the Music Studio at TC and here further problems came to light. Whilst the click removal was acceptable for most of the time, there were sections — particularly those with sustained notes from soloists — where the clicks had been replaced by intrusive plops which were unacceptable.

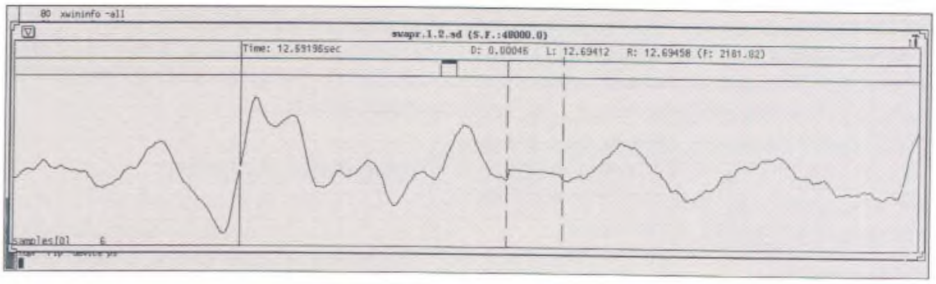


Fig 2b: the second track after processing but before the 'bad' section had been concealed

It was finally decided that the quickest solution would be to unswap, but not de-click, these problem sections using the RD processor and then de-click these using the NoNoise system at EMI. This seemed to do the trick for most of the time but further editing was required to remove some plops which the NoNoise system couldn't conceal. After many long days of mixing and editing, the audio was finally transferred back to the video on the Thursday before Christmas.

For those who had heard the original tapes, it was amazing to hear the broadcast on Boxing Day; few could believe that such an apparently faultless performance had been salvaged from those original flawed recordings.

David Kirby
Sound Section
Research Department

WORLD SERVICE
New Control Room

Dave Singleton describes the new all-electronic Control Room at Bush House.

London is crippled by snow, commuter trains freeze up solid or are stopped in their tracks by terrorist bombs, and there's a war on in the Gulf — Bush House has never been busier covering the news.

But one Bush House project rolls on regardless. Right at the very heart of London, uniselectors whirr then fall silent; code bar switchers fire off like muffled machine guns, then lie still; relays drop out like tumbling autumn leaves, and a rare silence pervades the scene. A few U-links are pulled out, a few more pushed in and, almost imperceptibly, Bush House's new ***all electronic*** Control Room dances into life.

Back in 1986 it seemed an almost impossible task to build a new Control Room alongside the old — there was no free space and practically no ventilation, except limited ductwork lined with asbestos. The main distribution frame was wedged tightly between structural columns with tag blocks literally chock-a-block and could not be expanded. Cable ducts were jammed solid with cables, many redundant but who knows which? There were open switch contacts everywhere — laden with the dirt of decades and just waiting to wreak havoc on Bush House's thirty-eight language services, at the first tap of a builder's hammer.

A little insurance policy was called for and took the form of an emergency control room facility, located in another part of Bush House. It was capable of covering the core switching activities, in the event of a premature demise of the main room. That completed, we set about creating sufficient space and a modern environment for the Control Room of the 90s.

Preliminary Works

Some space came from adjacent offices and a corridor but much had to be won the hard way. The 50 Volt battery was moved and re-stacked to make it smaller; the master clock (pendulum of course) was replaced with a Patek Philip electronic master, a fraction the size; and the tape recording and replay facility was moved (it was subsequently rebuilt and moved three times during the works). We even had to demolish the existing apparatus room walls, to gain a few more vital inches, replacing all the old 50 Volt distribution feeds in the process. We rewired and squeezed up many old apparatus bays.

Then it was in with the pneumatic drills to remove six inches of concrete floor screed, otherwise we would have had trouble fitting apparatus bays under the new air-conditioning ductwork. The old switchgear survived this rough treatment remarkably well, draped in polythene sheeting and surrounded by hissing electrostatic air cleaners.

Building and Air-conditioning

Under ACED's direction the new Central Technical Area took shape. Air conditioning was a major challenge since the only site available for plant was three floors up on the roof and all existing air shafts were fully used. The solution successfully adopted by ACED's Building Services Group was to extract the estimated 50 kW of warm air directly from the apparatus bays, and thus considerably reduce the quantity of cool air supply which would otherwise be required. This made it possible to cut new shafts of manageable proportions through the two floors of offices above.

The roof was heavily reinforced to take the weight of the new plant, which is cooled by the centrally-chilled water supply and, for stand-by use, three direct expansion chillers. As a further precaution against loss of air supply, the ductwork system can be fed in an emergency from the nearby studio ventilation plant, thus maintaining essential control room facilities albeit at some loss of air to the studios.

To maintain future flexibility in layout and to avoid creating a claustrophobic operational area, use is made of a fully-ventilated Burgess ceiling above the control desks.

Transmission Switching

The essential function of the control Room is to switch studio lines to ***chains*** — outgoing circuits to UK transmitters and satellite links to overseas sites. Since international radio is predominantly on hf, it is essential that frequent switching takes place in order to reach the chosen target audience at the most suitable time of day. This involves selecting the most appropriate transmitter site, frequency, array bearing, and so on. Although hf is predictable, much of the switching is very repetitive and can easily be automated.

The new Control Room contains the third generation of automatic programme switching in Bush House. First came the uniselector Automatic Switch Unit in 1958; then in 1972 the Ericsson Codebar Switches, controlled by a PDP/8 computer through Norbit logic elements.

The PDP/8 computer was restricted to something it was good at — handling the schedule of transmission records and decoding them into switching events ten minutes before the required time. The logic elements handled the real time switching — something in practice they were not too good at until the Norbit logic was replaced by TTL in 1978! However, the architecture of that 1970's system has stood the test of time remarkably well, and the new switchers have their requirements firmly set in the facilities provided and lessons learned from these earlier systems. Most enhancements implemented in the new system provide the programme makers with more capacity and flexibility, whilst maintaining the automated schedule-driven operation.

As before, the switching records are held in a mini computer in two switching stages: ***network*** switching and ***chain*** switching. The first stage switches ninety-six studios and other transmission sources to twenty networks. These provide a convenient reference point for distributing programmes within the building and the economical insertion of Optimod hf audio-processing devices.

The second stage switches the twenty networks and sixty other programme sources (such as interval signals and stored digital auto announcements) to sixty-six transmitter chains. The system now provides for switching to within the nearest second and for a modest degree of stereo routeing — in anticipation of the growing demands of other broadcasters who take World Service programmes for rebroadcasting on vhf.

As Bush House is a round the clock operation, it is essential that the transmission switching is maintainable without affecting the output, and is protected against total system failure. The solution adopted is a highly distributed matrix system of 96x2 modules for the networks (80x3 for the chains), each with its own matrix controller which stores up to twenty-four hours of switching events. The matrix stores are refreshed from the main schedule computer at least once every ten minutes. However, they are capable of maintaining the pre-programmed scheduled switching for the next twenty-four hours, in the event of a main computer failure.

The contract for the matrix system was awarded to NTP Electronik A/S.

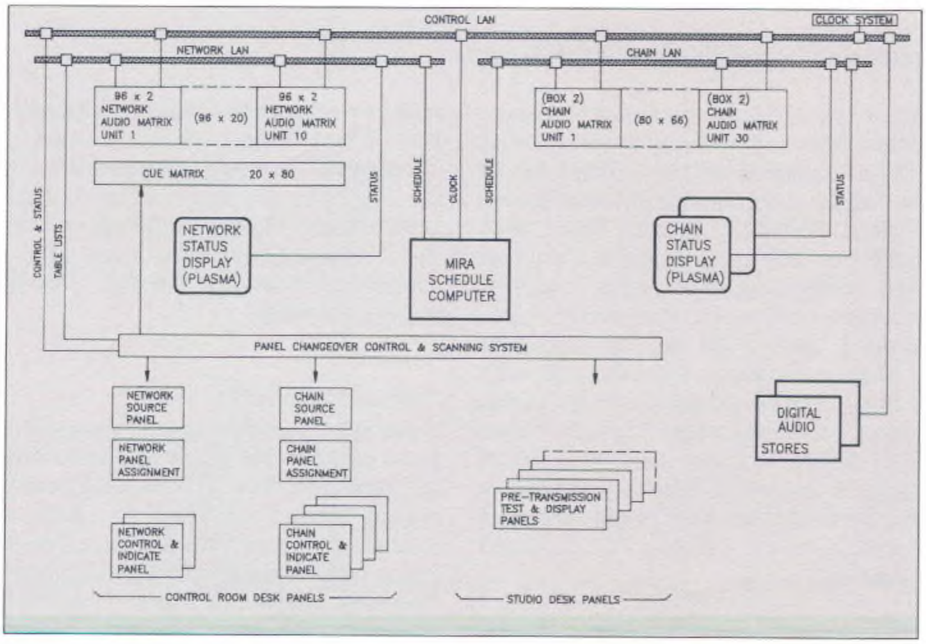


Fig 1: the network and chain switching system

— NEW CONTROL ROOM AT BUSH HOUSE —

Instant operator control of switching is provided at the matrix level by a limited number of assignable (but otherwise conventional-looking) push button and indicator panels. A control panel can be assigned to one network or chain, and displays the currently-selected source and the next two in the sequence, together with their scheduled switching times. Experience has shown that operators prefer to undertake emergency hot switching in this way, rather than using VDUs and keyboards (although the next generation of graphical interface units could conceivably change all this). Plasma screens display the overall transmission status at the main control desks, with high quality flicker-free text.

The whole concept is made practicable through the extensive use of proprietary Local Area Networks (LANs), supplied by Infaplug (see Fig 1).

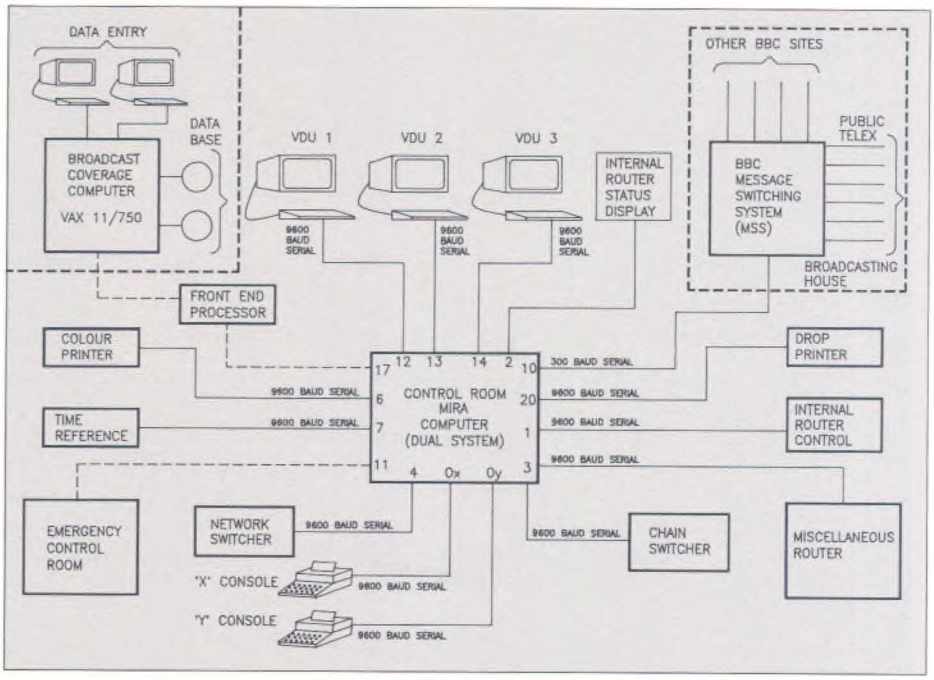


Fig 2: the computer system

Schedule Computer

It was decided to write the computer programmes in-house, capitalising on our experience of RTL2 programming language, running on a PDP/11 with the Micro RSX operating system. A prime consideration was the ability to adapt and extend the software at anytime in the future — at short notice — to meet changing broadcasting needs without the costs and delays associated with third parties. Accordingly, a fully-duplicated Dec MIRA Micro PDP/11-83 — similar to Radio's RDS computer — was purchased (see Fig 2).

Transmission schedules are held as a list of records each containing, for example: the network, studio source, time of start, time of finish, day of the week, date of start, date of finish and several other necessary attributes. Since the switching matrices have little built-in error checking, it is essential that data stored in the MIRA is fully validated automatically at the time of entry, to avoid source or time conflicts. Comprehensive screen editors and context-sensitive help information are provided for the various functions (eg source names, transmission records, network names, message sending to transmitter sites, etc).

Although automatic transmission switching requires split second timing of World Service programmes, a degree of flexibility has been built into the network switcher to give better continuity at chosen programme junctions. Studio desk panels — which are primarily required to check readiness of the studios for transmission — enable studio managers to start automatic announcement machines remotely, or to transfer operations to another studio on voice-cue, in advance of the scheduled time.

Miscellaneous Switching

The MIRA computer system can also automatically switch studio outside sources, ringmain listening feeds and recording feeds, using a 256 (max) destination, multilevel, audio matrix provided by Pro-bel Ltd. Serious consideration was given to routeing the audio digitally, using Pro-bel's TDM, but in the event this approach proved not to be cost-effective at the time. Thus, World Service became the first customer for Pro-bel's new high-density audio matrix.

Programme levels use CMOS switches while the control line level uses miniature relays. However, dc signalling for the red lights and EMX cut-offs are carried on virtual matrices with logic interfaces, specially designed for this application. The usual complement of manual, remote source, selection panels has been installed in the continuity suites and many of the studios, together with a large master control panel on the main control room desk.

All source and destination tables are fully editable from a control room console, as we have come to expect with modern switchers from Pro-bel.

A further automated switcher is employed to route courtesy feeds of World Service programmes to numerous subscribers in the London area. Although not completely new, since it incorporates plug-in cards from two earlier NTP switchers in the old control room, the matrix has been fully rebuilt and adapted to integrate with the MIRA computer schedule system.

Monitoring and EMX

Fundamental to slick operation of the main control desk is the integrated audio monitoring system supplied by DK Audio A/S. Monitoring points automatically shadow all manual assignments and preselections, whether on the transmission switching or the local miscellaneous routeing. Thus a control room operator can simultaneously switch and monitor programme feeds without duplicating selections. In this application, DK Audio make very effective use of the ES control bus standard and all the matrix configurations are adaptable in-house through the use of a standard pc.

Telephone communications between the new control room and other technical areas within and outside Bush House is handled by the Engineering Manual Exchange (EMX). The new 200-subscriber, 8-tie system is based on a well established BBC design but has been re-engineered by Deron Electronics Ltd using modern circuits and packaging techniques to minimise inter-rack wiring. The EMX caters for

Proj. & Plan., W.S.

Dave Buss (ATOM) at the main control desk in Bush House

loop calling, earth recall, 25 Hz ringing and tone dialling, and can thus deal with private wire control lines and most other types.

Despatch Position

Within the operations area but in a separate acoustic booth is the new despatch facility. This enables ten incoming programme sources — especially telephone despatches — to be controlled, monitored, and routed onwards to studios or, if necessary, locally recorded. This facility was supplied by Philip Drake to a World Service specification.

Associated with this area are six bay-mounted reel-to-reel tape machines and three cassette recorders. These provide timed local recordings from the Pro-bel router, or automatic replay into a network under contol of the NTP switcher.

Power Distributions

It is quite usual for transmission areas to have duplicated mains supplies backed up by diesel generators. However, with its twenty-four hour operation, Bush House needed special attention to cater for routine maintenance and safety checks, without breaks in transmission. For example, each switching unit, distribution amplifier and line amplifier is fed from two independent sources of mains supply, through separate power supply units. Thus, under normal circumstances, the failure of one power supply unit or one feed of mains will not affect the control room output.

For time critical functions within the switchers, use has been made of the central 50 Volt battery supply through dc-to-dc convertors. Also, special attention has been given to the MIRA schedule computers, each of which has its own independent Uninterruptable Power Supply (UPS) system. Comprehensive power supply monitoring is incorporated by means of numerous custom-built alarm concentrators and a main alarm system supplied by Highland Electronics.

Wiring Systems

Connoisseurs of installation technology will be interested to read that the site wiring has been almost completely achieved without a drop of solder. The main distribution frame (MDF) — a novel but very effective design from Augat — uses Telzon insulation displacement connectors.

There are eighteen bays of jackfields (even though we vigorously restricted the number to the bare minimum) and nine bays of U-links for maintenance access to the switchers. These were wired as complete modules in the USA, again using Telzon blocks for fast and reliable on-site installation. Nevertheless, the cabling task was not inconsiderable. In relocating the MDF, all the Bush House studios and all internal distributions and external circuits have had to be recabled from scratch. This has required new cable routes and risers throughout the Bush House complex, since the old routes were completely congested and presented a serious fire hazard.

D&ED's sales of PSN50s have never been bettered!

David Singleton
Hd of Proj. Man. (Studios)
WS Project & Planning

EID MOVES TO WHITE CITY

EID moved from Henry Wood House to the new White City building in West London shortly after Easter. The telephone number for general enquiries is now ***081-752 5040***, or ***White City (07) 25040*** if 'phoning on the internal network.

Staff have taken their LBH extension number(s) with them. Thus, someone whose number at Henry Wood House was ***wxyz*** can now be reached by dialling ***081-752 wxyz***, or ***White City (07) 2wxyz*** (internally).

The department currently occupies temporary accommodation on the fourth floor of White City but is expected to move to its final slot — on the third floor — later this year. This further move will not affect the telephone-numbering arrangement described above.

RDS
The Traffic Message Channel

John Riley describes a proposed new feature of the Radio Data System which promises to provide timely, relevant and accurate traffic information to motorists.

We have all suffered the frustration of traffic congestion, whether because of long-term roadworks or accidents. Roadworks can be predicted and those areas avoided but other problems can cause uncertain delays. It has long been recognised that there is a need for up-to-date and detailed information about traffic problems and ways of minimising the disturbance.

The traditional method of broadcasting traffic information to radio listeners has been to include reports in the scheduled programme output of both national and local radio stations. Finding this information can be difficult and generally requires the listener to become familiar with which stations carry it and when. It can also cause annoyance to listeners who are not interested in traffic information.

First generation RDS radios have gone some way to tackling this problem and, by means of a Traffic Programme (TP) flag in the radio datastream, an FM station can be identified as one which carries traffic information. When a traffic announcement is being made, another flag — Traffic Announcement (TA) — allows a receiver to be unmuted or switched from a cassette mode to receive the messages. This is very similar to the ARI system, which is being superseded by the RDS approach but which is still extensively used in the German-speaking countries of central Europe.

Second generation RDS radios are expected to go one stage better and allow a listener to be tuned to any station in order to receive traffic information from another station. This is possible using the Enhanced Other Network (EON) feature of RDS, which was pioneered by the BBC and is now broadcast throughout the UK by all our national, regional and local stations. EON allows a receiver to learn about the other networks carrying traffic information and, if the listener wishes, to detect their TA flags so that the set can re-tune to an appropriate frequency for the duration of the message. A BBC-designed EON receiver, incorporating the 'vectored EON Travel feature' was demonstrated at IBC 90 and was described in the Autumn 1990 issue of ***Eng Inf*** (No 42).

Good though the vectored EON service is, a further improvement in acquiring traffic information is expected using a proposed new RDS feature called the ***Traffic Message Channel*** (TMC). Using this system, millions of pounds a year are expected to be saved in terms of reduced congestion and delays.

What is TMC?

TMC provides an independent channel for traffic information using densely-coded digital data. This information would only be available to listeners who have a special TMC receiver. Other listeners, with no interest in traffic announcements, would not be disturbed.

Listeners who have a TMC receiver would have access to traffic information when they wanted and for the particular area or route of their choice. They could listen to any programme, cassette or CD in the meantime.

The digital nature of the information stored in the receiver permits it to be made available in different ways, such as via a voice synthesizer or in a visual or printed form. A further advantage to the listener is that the message could be presented in his or her own language, regardless of the country of origin of the broadcast. The broadcaster would be able to target the audience, and transmit the information as it becomes available rather than waiting for a convenient time-slot in the programme schedule. However, a danger with such a system is overloading the driver with too much information. The system needs careful designing to provide various useful selection options in the receiver.

The RDS TMC system requires the development of three main areas:—

- reliable and readily updateable sources of information
- a means of collating, encoding and broadcasting the data
- suitable receivers, containing the appropriate decoder and memory, which are simple to use and affordable

How TMC works

Methods of sending the data as sound phonemes*, or in a radiotext format for conversion to synthesized speech, were considered. The only practical way seemed to be to send a series of digital codes to act as addresses to preset message phrases contained within a receiver's memory. The message phrases are drawn from a list containing a number of essential elements. These are:—

- an event description comprising aspects such as cause, effect, advice, duration and start time. Not all elements would appear in all messages and each would be made up as required from a standard set of parts
- a location of the event
- management instructions such as an indication of urgency or importance

Thus, for example, message number 20876 might mean 'A lorry has shed its load on the eastbound carriageway of the M25 between junctions 9 and 8; only the outer lane is in operation; delays are expected until midday'.

The messages are arranged in repeating cycles of around ten minutes. All the currently-available messages are transmitted within this period: urgent messages could probably be repeated more often. New messages are inserted as they become available and obsolete messages are deleted.

TMC and RDS

RDS is a European standard data system for VHF-FM radio and is carried on a sub-carrier at a low level so that it does not interfere with the normal sound programme. Generally in the UK, ±2 kHz of the total ±75 kHz FM deviation is used although lower levels are common in other parts of Europe. In order to provide satisfactory mobile

** a phoneme is the smallest unit of significant sound in a given language* reception and to combat interference such as multipath (ie reflections from hills, buildings or road traffic), the data is structured into packets called ***groups*** and repeated about $11^1/_2$ times a second.

Each group contains four ***blocks***, each comprising 16 bits of usable data, plus additional bits used for error protection. Some of the 64 available bits are used for labelling the groups while others carry data which needs to be repeated in all groups, eg the programme identification (PI) code. This leaves 37 bits available for any new feature.

Among those groups defined so far are: station identification, automatic tuning and EON. Some secondary features such as paging have also been defined. RDS thus provides a convenient framework for a TMC feature and one group — Type 8A — has been allocated for TMC investigations. Fig 1 shows how the TMC could be included in this type of group.

Capacity is limited, however, because the basic RDS features take up more than three-quarters of the total bits available. Even though only about 10% of the capacity would be required for TMC — about one group per second — there are other features such as Radiotext which a broadcaster may wish to provide. The choice of features must be carefully balanced, in order to maintain the integrity of each.

TMC development

Several TMC proposals have been put forward in the past few years. In 1987, the European Council of Ministers of Transport (ECMT) proposed a definition requiring two RDS groups to contain each message. A modified form of this was adopted by CCETT (the French broadcast authority) and Philips for a Eureka-sponsored CARMINAT study of improving the safety of car travel in France.

Another proposal by Bosch and the German road authority (BAST) used just a single RDS group and this was considered more rugged and occupied half the RDS data capacity — it could be used for more than 80% of messages envisaged. The flexibility of this proposal was questioned, however, and a modified single group definition was proposed by a firm of traffic engineering specialists, Castle Rock Consultants (CRC), based in Nottingham. This was basically a paper study based on what had gone before but it contrived to combine the virtues of all.

There were a number of independent field-trails of these early proposals but there was no attempt at standardisation until the EEC sponsored 'DRIVE' programme began in 1988. This is seen as an essential step in the development of RDS-TMC in order to allow traffic information to be exchanged easily and for receivers to benefit from a large market. DRIVE regards TMC as an effective means of improving traffic information and its management, with considerable safety benefits.

RDS-ALERT

As one of about seventy projects within DRIVE, RDS-ALERT had the task of recommending an RDS-TMC coding strategy and seeking a consensus among broadcasters, traffic authorities and receiver manufacturers. The consortium was led by CRC and the other partners were: the BBC and CCETT for the British and French broadcasters; Philips and Bosch-Blaupunkt for the car-radio manufacturers; and the UK Transport and Road Research Laboratory (TRRL) for the traffic authorities. Although this was recognised to be a strong consortium it could not represent all the views within Europe. Furthermore, it would be necessary to seek the approval of the EBU and ECMT.

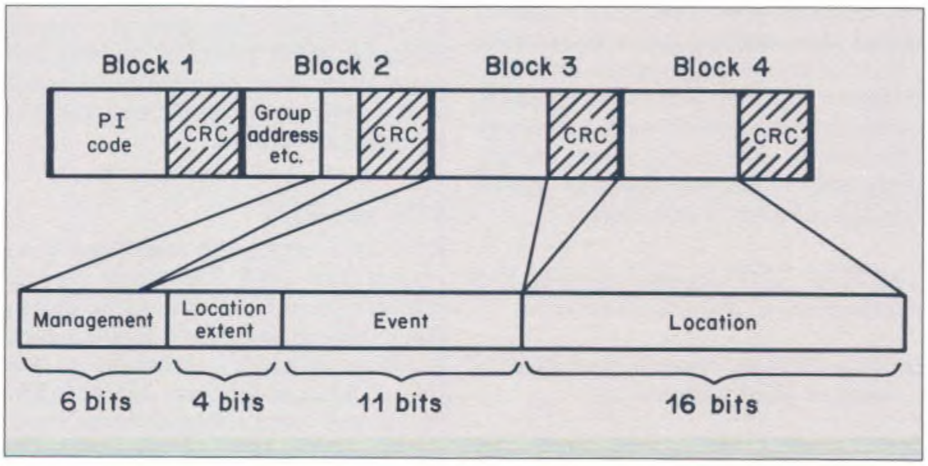


Fig 1: an RDS Type 8A group, which is proposed for TMC

BBC involvement

The BBC has been participating in RDS-ALERT because we must ensure that any TMC service which Radio provides in the future is useful and reliable. Also, we need to ensure that the TMC system chosen does not make unacceptable demands on the very limited RDS capacity. With the fully-implemented RDS service which Radio already provides, there is likely to be at most only one RDS group per second, per service, available for TMC.

The BBC's main role has been to conduct field trails of the proposed TMC coding systems and to provide supporting evidence for the standardisation process. A prime objective of these field trials has been to answer the question 'Will RDS-TMC work and provide a usable service?'. Although RDS reception reliability tests have been done in the past, there has never been a comprehensive study in the UK to gather the real error statistics covering a wide range of road conditions and RDS insertion levels, and including ARI, and using commercially-producible receivers.

It was therefore necessary to establish to what extent TMC messages are corrupted by impairments from mobile reception of the VHF-FM signal, and to determine how these can be minimised by an appropriate TMC transmission strategy.

Novel test approach

A novel method of testing was developed which prevents disturbance to the existing RDS datastream or its associated equipment. This method allows the mobile measurements on the road aspect to be separated from the testing of proposed RDS-TMC coding strategies, which can be done later in a laboratory. The basis of the method is that a new RDS feature can be tested using error statistics gathered from the previous reception of existing RDS data in mobile measurements on the road. A

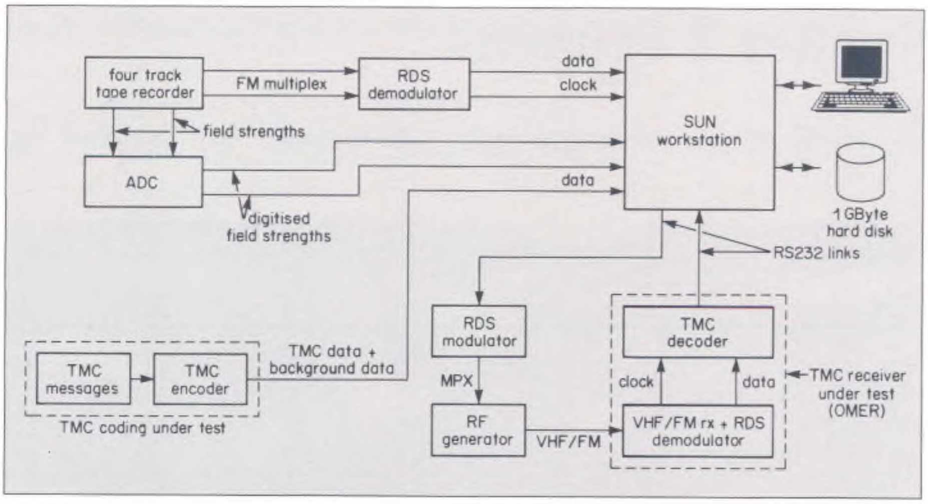


Fig 2: block diagram of the laboratory test procedure

computer workstation is used to store the error files and to analyse the results. A major advantage of this approach is that alternative TMC protocols can be tested under repeatable conditions.

In the first of four stages, existing off-air RDS data transmissions were used. A standard FM receiver, installed in a vehicle, was connected to a wideband tape recorder and, as the vehicle was driven round specially-identified routes, the whole of the VHF-FM multiplex signal was recorded. In a second stage, the tapes were replayed and the RDS data demodulated and decoded as shown in Fig 2 top-left. This data was used, in combination with a corresponding 'clean' data file acquired at the same time the recording was made, to derive an associated error file. This was not an easy task and special algorithms were developed to synchronise the two data input datastreams, bit-by-bit, and to recognise any bit-slips and pass them on.

Thirdly, a list of messages was supplied in an encoded TMC data form and, within the workstation, errors were added in order to simulate those which would have been experienced on the road. TMC test messages were 'broadcast' in real time to a receiver under test through a simulated transmission chain (shown in Fig 2 bottom-right). Finally, decoded messages from a receiver under test were checked against the original list, using the workstation to identify any irregularities which may have appeared.

Test conclusions

Two particular TMC coding strategies were examined — ALERT A and ALERT B — which had been derived from two earlier proposals. By comparing the received messages with those sent, it was possible to measure the relative efficiencies of the coding strategies, in terms of the percentages of lost, erroneous or late messages when subjected to different test conditions. The main conclusions which have emerged from the tests are:—

1. A useful RDS-TMC service could be provided throughout the main service areas of our transmitters;

2. An average data rate of one RDS group per second or less is adequate for TMC;

3. TMC messages should be kept short, such that the vast majority of messages can be contained within a single or half RDS group;

4. At least two identical receptions of a message are required to validate a message in the receiver;

5. Further testing is needed to establish recommendations for optimum message cycle length, repeat frequencies and other message management functions.

The next steps

On the basis of our test results, an improved coding strategy was developed called ALERT C and drew upon the best features of the protocols tested. This has already received widespread backing from the EBU and ECMT. It is considered to provide a comprehensive, flexible and efficient use of the RDS resource. It now has the status of a pre-standard, the specification of which will be frozen for a period to permit further field-trials under a second phase of the DRIVE Programme, commencing in 1992.

Looking further ahead, it is also proposed to develop TMC to be a valuable additional service facility for the future Digital Audio Broadcasting system (DAB) which is described on pages 4 to 8.

John Riley
RF Systems Section
Research Department

Research Department

The RDS demonstration vehicle, equipped with radio receiving and recording equipment, during the RDS-TMC field trials in SE England last spring

NETWORK TELEVISION

Sypher 1 reopens

Sypher 1 at Television Centre recently entered service, following a major refurbishment. It is described here by Alec Whitfield.

A Sypher* suite is a tv sound post-production facility which comprises:

- An automated audio-mixing console
- A U-Matic video tape recorder
- A Studer A80 eight-track audio tape machine
- A timecode synchronising system.

Additional sound equipment includes 24- & twin-track tape machines, gramophone & CD players, an AudioFile, and a wide range of audio enhancing devices such as reverberation units and samplers. A small studio and an apparatus room complete the suite.

In operation, the original studio sound, after editing, arrives in the suite on tracks 3 & 4 of an eight-track tape. The final mix is re-recorded onto tracks 5 & 6 and is later transferred back onto the transmission videotape. Although the installation is very expensive, it does result in considerable savings in operational costs. A Sound Supervisor and his team can complete a programme in very much less time, and to a higher standard, than if there was no automation and the facilities were restricted.

There are now four Sypher installations in the Spur at Television Centre (Suites 3 and 4 were described in ***Eng Inf*** No 30). Sypher 1 was built in 1973 and is the first to be replaced. The sound desk — a Neve type 66 — is a new design and is equipped with:

- 32 mono and 8 stereo channels
- Necam 96 automation fitted to all the mono channels
- 24 tape sends, with full matrix access from all the channels
- Tape send and return monitor bar-graphs
- Two separate line/microphone inputs on each channel
- Six mono and one stereo auxiliary output
- Conventional four stage equalisers
- Full monitoring and studio communications
- Stores for ten settings of the channel input levels and routeing configurations

MRM

Alec Whitfield in the refurbished Control Room of Sypher 1

For the moment, Sypher 1 has been equipped with the well-proven U-matic/Studer A80 combination. The intention is to replace this with a new generation of broadcast-quality VTR, which has four digital audio tracks and timecode facilities.

Overall synchronising is by means of a Soundmaster system, in which a number of synchronisers are under the control of an IBM pc. One of the three twin-track tape machines is equipped with a Studer synchroniser so that it can work independently of the main sound desk with, for example, the AudioFile.

Care has been taken in the Control Room to achieve suitable ratios between the wall-to-wall distances, to inhibit interfering standing waves of the same frequency. The current acoustic treatment comprises re-installed sound absorbers and Soundsoak panels, but further tests on ceiling diffusers are being carried out by Research Department.

The original Studio was large enough for a small group of musicians and served both Syphers 1 & 2. The opportunity has been taken to provide one independent studio for each suite, by separating the common floor into two sections and adding a triple Camden partition between. The resulting sound insulation is adequate for voice and effects recording. The original sound absorbing wall finish has been retained, but is covered with stretch fabric to improve the appearance.

For ACED, the Architect was Richard Westcott who took particular care to ensure that the appearance of the suite is well up to the standard expected today. The Acoustic Architect was Richard Cole while Peter Ong Seng was responsible for the extensive improvements to the ventilation system.

The technical installation was carried out by Television Systems Ltd of Maidenhead. Valuable assistance with the time-code synchronising and the intricate audio record monitoring was provided by Ray Dawson of Sound Facilities at Television Centre. The overall project was managed by Studio and OB Group, P&ID Tel.

Alec Whitfield,
Project Engineer,
S & OB Group, P&ID Tel

** Sypher is an acronym for **SY**nchronised **P**ost-dub, **H**elical-scan and **E**ight-track **R**ecorder*

NEW NETWORK IDENTITIES

As reported on page 1, February 16th saw the launch of the new Network Identities on BBC1 and 2. The equipment used to generate and store the various symbols and clocks is described here by Mike Winston.

The new BBC Network Identities were the culmination of ten months of intensive work involving a combination of engineering and artistic design effort. Equipment to generate the new network symbols and clocks was installed in every BBC regional centre and was commissioned in time for a simultaneous launch nationwide.

The New Symbols

The old BBC 1 globe was well-liked operationally because it could be cut to — at any time — and held in vision for as long as required. The new design was required to offer the same flexibility: it also had to retain the rotating world concept which had become synonymous with the BBC. The result is a much more modern design, based on a continuously moving globe, but with a longer cycle time of one minute. This means that only portions of the complete cycle are seen at any one time.

The BBC 2 symbols are individual sequences lasting up to one minute each. At present, eleven different symbols have been designed but the intention is to add to these so that up to twenty-four can be available on line at a time. Each symbol has its own character, and is selected according to the type of programme it precedes.

The symbols were designed by brand identity consultants, Lambie-Nairn & Co, in close liaison with BBC Presentation Department and the Channel Controllers.

At the beginning of the project, various methods were considered for storing and replaying the new symbols. The existing solid-state equipment has proved very reliable but can only generate relatively simple run-length encoded images. The new requirement was to store many minutes of broadcast quality video, with stereo sound. The choice seemed to be between magnetic tape (questionable durability and poor access time) or magnetic disc (high cost, poor storage capacity). Neither choice was ideal, but fortunately this dilemma was resolved by the timely launch of a new laser videodisc recording system by Sony.

Laser Videodisc Recorders

These machines record up to twenty-four minutes of analogue component video, and stereo audio, on each side of a 30 cm laser disc. The recording format used is known as CVRdisc (Component Video Recording). This uses a time-division-multiplex system to combine Y, C_R, C_B and digitised audio into one signal, which then frequency-modulates a carrier signal recorded on the disc. The discs use the WORM principle (Write Once, Read Many). This means that great care must be taken when making the recordings but there is no chance of accidental erasure or corruption when in use.

Access time to any point on the disc is less than 0.5 seconds, and sequences can be cued instantly from a standing still-frame.

The original symbol masters were supplied on D1 digital component tapes. These were transferred to disc using the D1 edit facilities at Research Department, but it is intended that future videodisc updates will be done by Post Production Operations at TVC.

Separate discs and sets of equipment for BBC 1 and BBC 2 are provided for London and the national regions (to allow simultaneous opt-outs) while English regions use combined BBC1 & 2 discs. The disc machines in London are also used to replay the Open University and Children's TV symbols.

Network Clock

The new clock, known as GNAT (Generator of Network Analogue Time) was designed by a team led by Richard Russell of D&ED. The design has been made as flexible as possible so that graphic designers have a free choice of hand shapes, colours, position, and movement. All these parameters, including details of the hand movements, are stored in EPROMs. Anti-aliased hands are generated from this data and superimposed (with an optional shadow) over one of two background images stored in Rec 601 format frame stores.

The hardware demonstrated its full potential at IBC by emulating the appearance and mechanical action of a grandfather clock. Much interest was generated and discussions are in

Mike Lyons, P&IDTel

The Network Identity installation in Glasgow showing BBC1 & BBC2 systems side by side. The installation technician is Roy Goodship-Patience.

~ Glossary ~

Anti-aliasing A technique employed to avoid the jagged edges which used to be common with electronically-generated images, particularly text.

Pixel Short for picture element. Nowadays, a pixel is regarded as one sample of a picture — whether digital, or analogue (as in the case of CCD cameras).

Quantisation In a digital system, quantisation is the process of dividing the amplitude of an analogue signal into a pre-defined or restricted number of finite levels. In an 8-bit system, for example, there will be 256 quantising levels (2^8).

Rec 601 Defines a family of sampling and quantising standards, of which the version known as 4:2:2 is now in common use. Here, the luminance component is sampled at 13.5 MHz while the two colour difference signals (C_R and C_B) are each sampled at 6.75 MHz. Each component is digitised to 8-bit resolution.

Continued from previous page

progress regarding possible licensing of the design.

The time reference used is the MSF transmission from Rugby. In the absence of MSF, the clock will continue to run locked to station reference and, if this fails (or the mains supply), an internal crystal oscillator will take over. An MSF receiver is provided in all locations where new clocks have been installed, although in London this may be superseded by a new time distribution system currently under discussion.

Regional identification

When transmitted, each symbol and clock must carry regional identification text, and an indication of whether subtitles on Ceefax 888 and/or stereo Nicam sound is being transmitted. At first it was planned to include this on the disc recordings and clock backgrounds, but this would have meant many different versions to cater for all regional combinations. Instead, these captions are generated and superimposed locally at the time of transmission, using a device made by IP Kinloch called ***Logogen 2***.

This has allowed all the symbol discs and clocks to be identical, which greatly simplifies the task of issuing updated versions.

Logogen 2

The original Logogen is a simple caption generator which stores captions in EPROMs. The principle of pre-stored captions with instant access was attractive, but the 2-bit quantisation used was inadequate for generating good quality anti-aliased text.

In discussion with the manufacturers, it transpired that the unit was being redesigned and they agreed to introduce some refinements of particular use to this project. The result is ***Logogen 2*** which stores up to 256 captions and can be configured to generate high quality anti-aliased monochrome text as required for this project.

The captions are originated using a Quantel Paintbox. Using the facilities in the Computer Graphics workshop, the image data is converted to the file format used to programme the Logogen. This conversion process uses a software-implemented sample-rate converter, because the Logogen has more pixels-per-line than the Paintbox.

Control system

A custom-built system to control the disc player, clock, and logogen was commissioned from Connolly Systems Ltd. This comprises a micro controller system with all the disc location data stored in battery-backed RAM. The control panel provides: instant access to any of 24 pre-programmed places on the disc; selection of the required logogen caption and clock background; and controls to run the symbol.

The success of a project like this depends greatly on the hard work and efforts of everybody involved. I would particularly like to thank my colleagues in Central Systems Group of P&ID Tel for completing all the installation work in every region in the UK during those hectic weeks immediately before Christmas.

Mike Winston, Snr Proj Eng
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H. Pres. Tel.

The new BBC1 symbol as seen in Scotland, showing the subtitles and (future) Nicam stereo captions

H. Pres. Tel.

One of the new BBC2 symbols

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