ENG INF

The quarterly for BBC engineering, technical and operational staff

SUMMER 1992 *No. 49*

BH'S 60TH ANNIVERSARY

BH London celebrates 60 years of broadcasting this year. Starting on page 9, Ralph Montagu pays a tribute to this important icon of Public Service Broadcasting.

BBC Photo Library

Artist's impression of Broadcasting House c. 1929, when the architects hoped to 'square off' the corner of Portland Place

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ENG INF

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As ***Eng Inf*** is an internal BBC magazine, it would be appreciated if no reference was made to it in articles, magazines, etc, published outside the BBC.

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Stories for the Winter edition should be forwarded to the editor by Friday 6th November, 1992.

Transmitter News

The following services have opened, changed or closed since our last issue:

New TV relays

Blaenllechau	Mid Glamorgan
Bramford	Suffolk
Deanston	Stirlingshire
Folkestone	Kent
Fowey	Cornwall
Kendal Fell	Cumbria
Leicester City	Leicester
Margate	Kent
Porthtowan	Cornwall
Somersham	Suffolk

Addition of Nicam Stereo

Divis (BBC2)	Belfast
Durris (BBC1)	Aberdeenshire

New FM Stations

Calne	Wiltshire
Folkestone	Kent

Radio 1 on FM

Swingate	Kent
Whitby	North Yorkshire

Radios 1 and 4 on FM

Abergavenny	Gwent
Ebbw Vale	Gwent
Eitshal	Outer Hebrides
Melvaig	Wester Ross

VERTICAL BLANKING INTERVAL

The one-line ITS

Colin Spicer describes the new one-line Insertion Test Signal.

The use made of lines in the TV vertical blanking interval (VBI) has developed over the years to include:

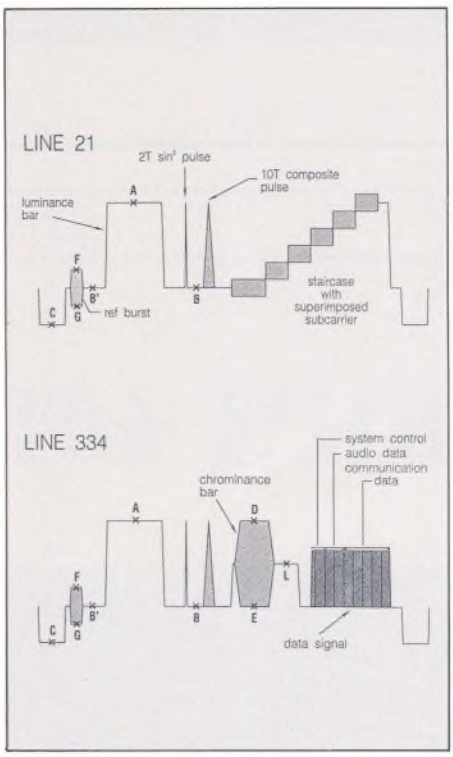
- ☐ Insertion Test Signals (ITS)
- ☐ Blank lines for noise measurement
- ☐ Engineering control signals
- ☐ Teletext

More recently, there has been a requirement to expand the teletext services, resulting in a re-appraisal of the uses made of the limited number of available lines. In consequence, changes have been made to the VBI that enable an increase in the number of lines available for teletext, whilst still keeping the necessary engineering test and control facilities.

The major change has been the development of a new single-line-per-field ITS, to replace the old UK National ITS on lines 19/332 and 20/333. The new ITS has been devised by D & ED and contains substantially all of the existing measurement waveforms, with some components arranged to alternate between fields. All of the necessary video signal measurement facilities have been maintained, along with a limited amount of engineering control data.

6/319	Local Noise
7/320	Network Noise
8/321	Teletext
9/322	"
10/323	"
11/324	"
12/325	"
13/326	"
14/327	"
15/328	"
16/329	"
17/330	"
18/331	"
19/332	Yet to be allocated
20/333	Yet to be allocated
21/334	Insertion Test Signal
22/335	'Local' Test Line

Current usage of VBI lines



D&ED

The single line-per-field ITS

The new ITS data signal, along with spare signalling capacity within teletext, has replaced the obsolete Insertion Communication Equipment (ICE).

The new single-line ITS has been located on lines 21/334 and reduces the number of lines needed for engineering test purpose from three lines-per-field (two lines of test signal plus one ICE data line) to one line-per-field. This has released two additional lines during each vertical blanking interval for future use.

The new allocation of lines during the VBI is shown in the accompanying box.

Colin Spicer
Design Group
D & ED

Correction

In ***Eng Inf*** No 48, on page 15 column 3, Europe and Africa should have been referred to as ITU Region 1, and not Region 2.

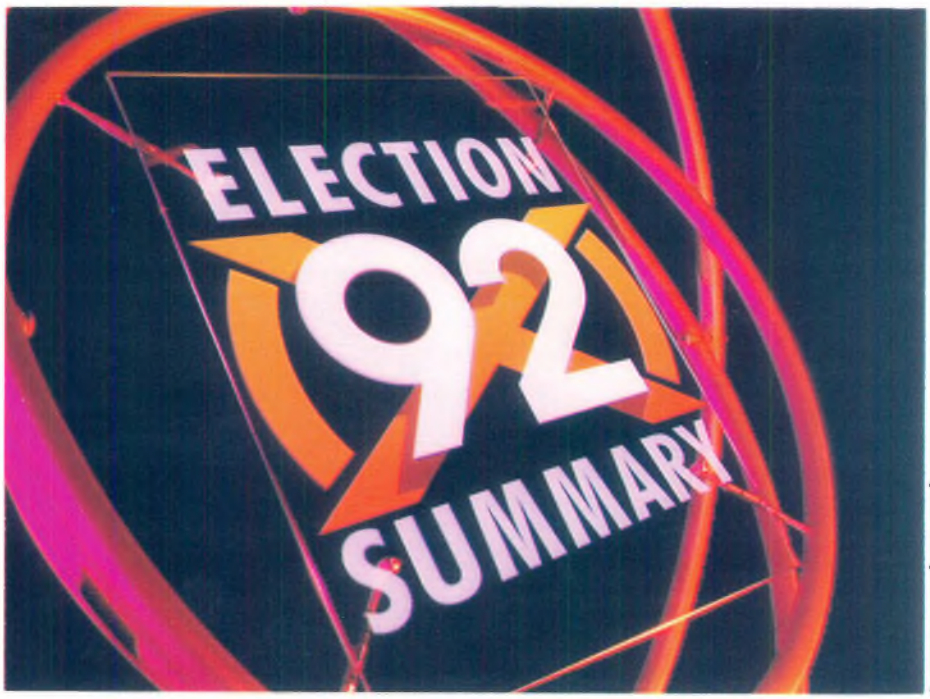
ELECTRONIC GRAPHICS

The Election 92 computer system

Ewen Maclaine describes the computer system, produced by the Computer Graphics Workshop, which brought instantaneous Election graphics to our screens in April.

Coverage of the 1992 General Election offered a considerable challenge to the technical skills of the BBC. This operation was one of the most complex mounted by the BBC and involved the Television and Radio networks, the three national regions (Scotland, Wales and Northern Ireland), the English regions, the local radio stations in England, BBC World Service and Ceefax.

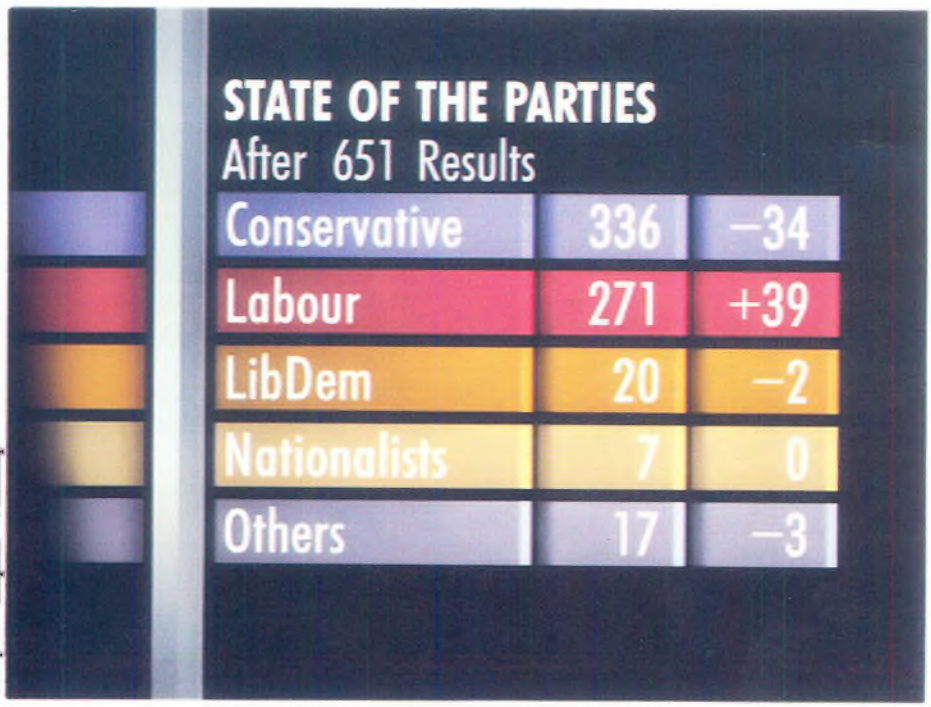
The General Election computer system was simply one part of this giant operation, but it constituted an essential ingredient. The system assisted the information flow which was vital to the reporting of the event. Audiences have now become accustomed to sophisticated instantaneous graphics, which respond dynamically to incoming constituency results. Without the computer system, this would not have been possible.



Computer Graphics Workshop

Gathering the results

The information flow started in the constituencies. A member of BBC staff, perhaps from the local radio station, was used as a 'result provider' in each of the 651 constituencies. Their job was to phone in the result as soon as it was available from the returning officer. The incoming calls were taken by one of twelve input operators who went through a fixed dialogue, asking first the constituency number, then the winning party, followed by the votes for each candidate. A checker also listened to the call to confirm that the figures had been entered correctly.



Computer Graphics Workshop

Avalanche of information

As soon as the winning party had been entered, a message fanned out across the computer system — triggering a number of events in other parts of the system:

- the 'transaction processor' updated the database with the new winner
- a new entry was created in the 'headline' queue
- enquiry terminals were updated to show the new winner
- the constituency was coloured up on Peter Snow's graphics
- an update of the Ceefax system was triggered
- the message was sent out across the BBC's data network to Broadcasting House for Network Radio, to local radio stations around the country and to the systems in

Glasgow and Cardiff, servicing Scotland and Wales respectively.

This avalanche of information propagated rapidly through the system, updating graphics within fractions of a second and refreshing enquiry screens in local radio stations a few seconds later. Another wave of information followed rapidly, as soon as the vote figures for the last candidate in that seat had been entered. At the peak period, results were being entered at the rate of twelve per minute.

"Glenda Jackson wins at Hampstead"

An Election 'headline' — a strip across the lower part of the screen — was used to convey a brief form of the result in a constituency. It was produced by keying the output of a Quantel Paintbox over the studio output. Other graphics, which may have been on-air simultaneously, were designed to leave this lower area of the screen free, so that information was not obstructed.

The headlines were driven automatically by incoming results and each headline was shown for a few seconds. When a large number of results were being entered, new results joined the queue according to their priority; for example, gains and personalities went to the front, while holds were placed nearer the back of the queue. Personalities were marked in the database to allow special headlines to be generated, such as "Glenda Jackson wins at Hampstead" or "Sebastian Coe wins at Falmouth".

"Con hold Finchley" was the form used for constituencies with less famous winners. The headline producer could inject special headlines into the queue to show the current state of the parties, or create 'name supers' for interviewees.

Fullforms

A second graphics channel was used to create full-screen graphics for any result. This showed a picture of the winning candidate; a map indicating the location of the constituency; the name, party and votes of each candidate; and the majority of the winner. It was used to show the most important results, such as those seats likely to change hands. In addition to the result graphic — known in 'election speak' as a *fullform* — were graphics showing the share of the vote for the top four candidates, and the change for each or their parties since the last Election in 1987.

A glass block etched with a map of the UK was one of the graphic design themes of the election. The result, share and change graphics were linked using an animation which moved this block from the flat map position on the fullform, to the base line of the histograms for share and change. This animation was pre-recorded on video disc and intercut with the live graphics.

Only computer control could achieve the necessary, repeatable, frame-accurate timing required for a seamless join. The control software allowed the results producers to create queues of graphics for transmission, by selecting from lists of declared constituencies. The lists were ranked according to the importance of the result — gains, VIPs, personalities, interesting holds, OB available, etc. New results coming in could be inserted into the transmission queue quickly and easily, allowing full information to be presented to the viewer as soon as available.

Waiting for the Returning Officer

One of the most complex aspects of the computer system was the way in which live OB declarations were handled. A group of three terminals was dedicated to handling the input of these results. When the result was expected, the input operator selected the appropriate constituency, this selection being shown on the result output producer's terminal. If editorially appropriate, this result was then selected for transmission.

The results system included a single-channel video effects device. The incoming video from the OB was routed to the foreground and the blank fullform graphic to the background. When the output of the effects device was routed to studio output by the vision mixer, a signal was triggered automatically to tell the computer it was on-air.

As the result was entered, the votes were examined and as soon as the winner could be determined by the computer, the headline system was instructed to show an 'OB flash' in the top right-hand corner of the screen, rather than a normal hold or gain. As soon as the full result information was in, the data was added to the fullform and the video effects device was cued by the computer to zoom back the OB picture — revealing the information on the graphic underneath. The computer system handled this complexity with ease, the only delay being the wait for the returning officer to read the result.

Computer Graphics Workshop

Upsums

Summaries are a vital part of any election programme. Graphics called *Upsums* were employed to illustrate the key points of the election story. This third graphics service provided a range of illustrations using information from

the database; for example, the current state of the parties, quotes from politicians, etc. This part of the system also contained a range of graphics to show which issues people had said would influence their vote, and to show how these issues varied across different sections of the population.

The information provider

Beneath the glass of David Dimbleby's desk lurked a whole host of computer monitors. Amongst the screens showing upcoming OB and studio output pictures, were monitors showing almost limitless information about seats, changes, votes for each party etc, on both a national and a regional basis. One screen carried the latest ten headlines while another conveyed detailed information on the constituency shown by the current fullform graphic. Yet another monitor showed the information on the next summary graphic.

All these screens were orchestrated by the computer and changed automatically to reflect new results as they were entered and when producers selected different graphics on the various outputs. Thus, as an information provider, the computer discretely assisted the presenter in telling the story of the night.

A failsafe database?

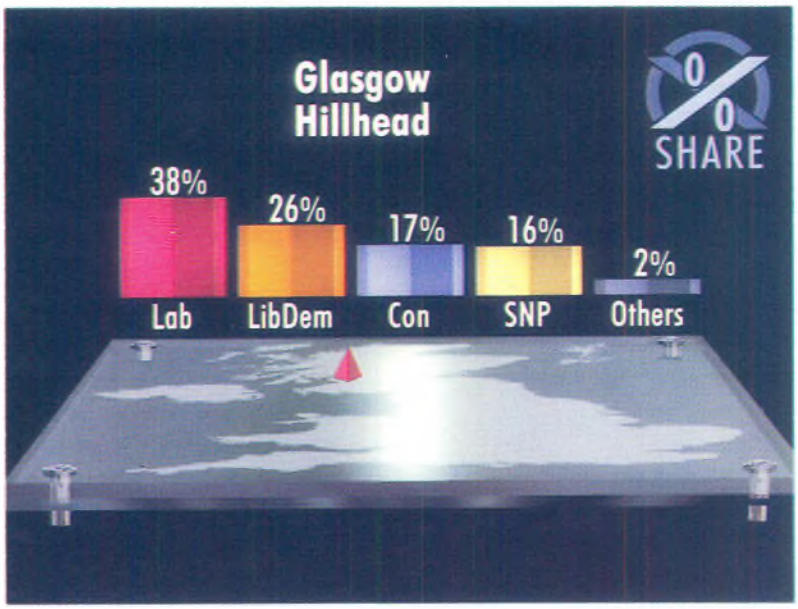
The components of the system were closely interlinked and utilised a single database on each computer. The two main computers each held a separate copy of the same database. Software had been written to keep the information in both databases the same. Thus, a result entered on a terminal attached to one machine was forwarded to the other and both databases updated.

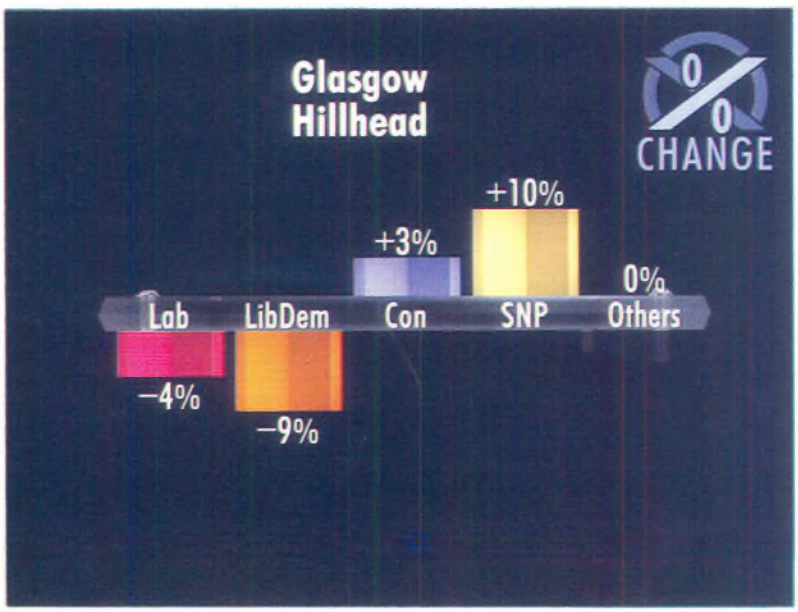
This design provided considerable resilience in the event of failure. As each transaction was processed, an entry was added to an audit trail file. This file could be used to reconstruct every detail of the database if the system needed to be restarted following the unlikely event of a complete power failure to both machines. To add further security, the main computer room and some of the equipment in TC1 were powered from an uninterruptable power supply (UPS).

The Swingometer

The *swingometer*, as used by Bob McKenzie, was little more than a piece of cardboard with a scale and a pointer. Peter Snow set the challenge of bringing it up to date. The cardboard was replaced by images produced by two Quantel Paintboxes, displayed on a large screen by two powerful General Electric video projectors.

To provide a pointer on this scale would have required a pivot point above the roof of TC1! Thus, a double-pivot mechanism was devised,





Computer Graphics Workshop

allowing the pointer to be shortened, but to follow the same arc. Having reduced the size of the mechanism to fit within the confines of TC1, the next step was to provide an interface to enable the computer to determine the position of the pointer. This, in common with the mechanical components, was built by Penny and Giles. A quarter-scale version was also produced which, in conjunction with two large-screen monitors, allowed the development and testing of the swingometer to proceed without the need for large and expensive projectors.

A preliminary test of the full-size version was carried out in February 1991, a few months before what was thought to be the likely date of the election. A final test took place in early January 1992. Following this, minor adjustments were made to both hardware and software, to ensure that the projectors, screens, graphics and mechanical assembly would line up correctly, and to ensure that the assembly of this complex subsystem could be achieved in the few days available for rigging prior to the Election. On the night, the swingometer performed as faultlessly as Bob McKenzie's orginal.

A wide range of other graphics were created for the 'Big Screen' including:

* the Battleground — showing the key marginal seats
* the House of Commons — showing the party line-up in the House
* Records — comparision with previous elections
* Maps — showing the constituencies in party colours

Flying Gains

A further range of graphics allowed Peter Snow to illustrate a wide-ranging analysis of the Election facts and figures. These included:

- ☐ Regional breakdowns — showing map and seats for each party.
- ☐ History of Share — comparision of Labour and Conservative share in elections since 1974.
- ☐ Gains — showing lists of gains by party.
- ☐ Proportional Representation — showing the number of seats each party would have had under PR.
- ☐ Losers — showing personalities who had lost.

BBC-wide system

Presenters, producers and journalists were provided with text-based access to the database, using ordinary computer terminals. Hundreds of pages of information were available, including one on each constituency giving details both of the constituency itself and the candidates. Also included were pages showing gains, losses, targets, swings, high and low turnout, declared and undeclared seats, proportional representation, latest results and many others.

'Enquiry' terminals were available in Television Centre, at Broadcasting House and widely across regional centres and local radio stations. This was achieved using six MicroVax 2000s, located in ATA at Broadcasting House, connected to the BBC's data network.

The Radio connection

The Radio 4 coverage of the Election was assisted by extensive use of enquiry terminals. Something was needed to help producers filter the huge quantities of information available and feed only the most relevant and interesting to the presenter, Brian Redhead.

A system was devised which displayed incoming information on a screen in front of the results producer who could then add it to a queue for the presenter — using a system of priorities — or dispatch it to a printed list to be briefly mentioned in the newsreader's next results summary. In front of Brian Redhead were screens similar to those used by David Dimbleby. These showed summary information and the queue of the most interesting results generated by the results producer. A producer, sitting at yet another keyboard, listened as Brian Redhead commented on the results and removed each from the queue when it had been mentioned.

Fireworks!

As can be seen, designing and building a computer system for the Election coverage is a bit like putting on a firework display: you spend a long time preparing for the event and then it is all discharged in one colourful spectacle.

Ewen Maclaine, Manager
Computer Graphics Workshop
Network Television

HARDWARE

Television Centre, London
2 DEC VAX 6310
2 DEC VAX 3100
4 DEC MicroVAX II
4 Quantel Paintboxes
2 Electronics Graphics Pastiche graphics systems
1 Abekas A64 video disk
1 Abekas A60 video disk
1 Abekas A53 video effects device
4 Sony laser video disk players
98 computer terminals
14 printers

Broadcasting House, London
6 DEC MicroVAX 2000
17 terminals
2 printers

Cardiff (for both BBC Wales and S4C)
2 DEC VAX 3100

Glasgow
A dedicated network of PCs

In each Local Radio station
1 terminal

BROADCASTING HOUSE
Langham Place Leviathan

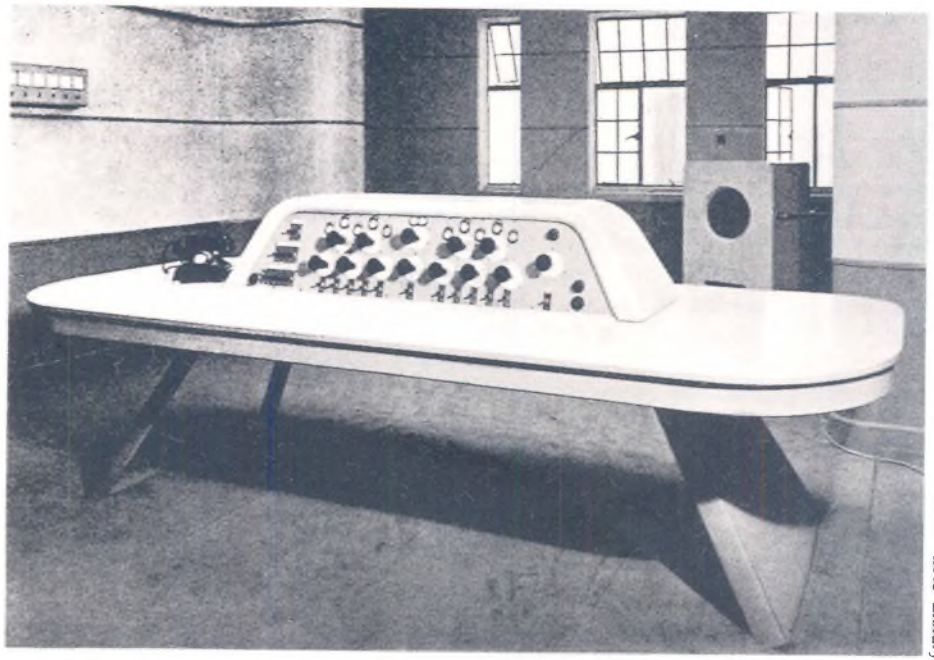
To commemorate Broadcasting House's 60th Anniversary, Ralph Montagu takes a look back to the very early days of the *Langham Place Leviathan*.

May 1992 marked an important broadcasting anniversary, not the 70th birthday of the BBC, but the 60th anniversary of its best known building. Described variously as a modern day Tower of Babel, a battleship sailing down Regent Street, a leviathan or even an iceberg, Broadcasting House in Langham Place has become the symbol of British broadcasting.

Today Broadcasting House is a listed building, a statutory protection given extra validity by six decades of broadcasting history. But for those moving into BH in 1932 the scene was a very different one: many were sorry to be leaving the intimate studios at Savoy Hill, especially when the new purpose-built headquarters seemed so austere and impersonal.

To some, BH was in the wrong place: Savoy Hill might have been cramped but it was within easy reach of Soho for performers and their agents, close to Fleet Street for access to the Press and, let's not forget, surrounded by lots of good restaurants! Various alternative sites were considered including Portman Square, the Strand, and Dorchester House in Park Lane: the final choice of Portland Place came as a surprise to many. Perhaps the location — a respectable distance from the newspaper and entertainment trades — was considered advantageous.

Unfortunately the physical characteristics of the site were less favourable. The original plans were for a largely symmetrical structure but the east side of the building had to be cut away to provide for ancient lights in Langham Street. Also, the front had to be rounded off because of the local authority's refusal to re-shape the corner of Portland Place. Below ground, an old sewer had to be encased in concrete before anything was built above it. But if anything made the site unsuitable, it was the Bakerloo Line whose rumblings — 80 feet below Portland Place — were impossible to isolate. Even to this day, train noises continue to interfere with studio operations in the lower parts of Broadcasting House.



BBC Photo Library

One of the Dramatic Control Panels

Exterior design

Despite the underground vibrations, protecting the studios from outside noise was the overwhelming factor when architect, Lieutenant-Colonel G Val Myer, and civil engineer, Marmaduke Tudsbery, came to design the building. The studios were grouped in a central 'tower of silence', encircled by 42 inches of solid brick, corridors and finally a layer of offices running around the outside of the building. Insulated from natural light and air, the studios were the first ever to be air-conditioned. The ventilation plant was very much the engine room to the studio tower and the subject of much publicity; consuming huge quantities of water, the system was fed from a specially-bored artesian well, 600 feet below the building.

By 1931 the early frustrations had been overtaken by the excitement of the project itself, its lopsided facade becoming a distinguishing feature of the world's first purpose-built broadcasting centre. The sensation of a sizable new structure in central London, housing a national corporation with all the latest technology, proved an irresistable combination to Press and public alike. *No other building excited such interest and speculation* recalls Frank Gillard, whose mother took him to London specially to see the new wonder building under construction.

Val Myer had a particular challenge in reconciling the modern image of broadcasting with the dignified surroundings of Adam's town houses and All Souls Church, designed by Nash. The Architectural Review aptly described it as *a struggle between moribund traditionalism and inventive modernism.* Passers-by more often likened BH to something nautical — its masts, rounded facade and attic porthole windows all being reminiscent of a ship.

Today, BH is regarded as an architectural hybrid — a mix of Georgian monumental and modernist styles with more than a hint of Art Deco. As with most controversial new buildings the critics of the day were divided but those in favour were lavish with their praise:

> *The first building in England ... to deal with this new and vital force in modern life — the radio ... A modern building with a modern purpose ... a worthy edifice, well fitted to house the marvel it contains ... in short, contemporary talent has been*

employed so agreeably that the BBC deserves to be held up as a matchless example of the intelligent person.

The detractors were more succinct:

A petrified dreadnought ... clumsily barbarous ... a damned awful erection ... it lacks urbanity and gentleness of line.

The building was topped by a series of aerial masts which many passers-by assumed to be the main transmitters. The most prominent of these, above the main entrance, was entirely symbolic but served to signify the function of the eight-storey edifice. Another feature was the rectangular clock, to the left of which was a loudspeaker used for relaying the chimes of Big Ben. In practice it was only used at 1pm although, on one occasion, an accidental broadcast at 12.45 sent Regent Street out for an early lunch!

The only truly decorative external features were a series of sculptures by Eric Gill. The largest of these, above the main entrance, depicted the sprite *Ariel* with his master *Prospero*. Its unveiling immediately prompted fierce objections from Violet, Duchess of Rutland, and the MP, George Gibson Mitchelson, who lived in Portland Place. Today, no one bats an eyelid as they walk past, but it seems that the Duchess and others objected to Ariel's full frontal nudity. Gill had already reduced the size of Ariel's organ on instruction from Reith, but Mitchelson, claiming the public's morals to be under threat, demanded in the Commons that the sculpture should be removed completely. The Home Secretary declined to intervene.

A longer running debate arose over the choice of *Broadcasting House* as a name for the building. The papers were full of letters castigating the corporation for its "incurably unimaginative" choice. A Daily Telegraph reader likened it to naming the Albert Hall *Singing House*. Suggested alternatives included *Radio House*, *Sendingforth House*, *Spark's Place* and *Radiation Central*. The latter would obviously have different connotations today as would *The Girdle*, suggested because of its association with Ariel who, as the invisible spirit of the air, put a girdle round the earth. Not surprisingly, it was *Broadcasting House* over which Sir John Reith formally hoisted the BBC flag on May 2nd 1932.

BBC Photo Library

Studio 3D — the 'Library' talks studio

Interior design

On entering BH, it was difficult not to be impressed: the bronzed doors, amber lighting, marble walls and mosaic floor united to humble the individual before the might and wisdom of the BBC. Then, as now, commissionaires stood guard, the golden doors behind them alluding to something momentous happening inside. In the centre, Eric Gill's sculpture *The Sower* presided over the comings and goings. Explained as "a modernistic conception in stone of radio broadcasting", it implied a link between the new science of broadcasting and the age of mythology when every branch of life had its own temple. Today, carpets and display panels soften the impact but, in 1932, it all seemed very uncompromising. The solemnity was reinforced by the Latin inscription dedicating the Temple of Arts and Muses to Almighty God.

Somewhat at odds with its conservative image, the BBC used some of the country's leading modernist designers to undertake the decoration of its studios and offices. Co-ordinated by Raymond McGrath, BH was one of the first corporate construction projects in which modern Art Deco styling was employed throughout. Once open to inspection, every detail of the interior was keenly examined:

Everywhere new ideas have been employed, there are golden lifts that are the fastest of their kind in Britain, attaining a speed of four hundred foot a minute; and dark corridors are skilfully lit through opaque glass windows giving the impression of daylight ... There is gaiety without gorgeousness; functionalism without fanaticism, and a display of inventiveness which has given new and subtle decorative values to many materials.

It that wasn't praise enough, the BBC published its own glowing account in its 1933 Handbook:

The interior of Broadcasting House is the most important example of untraditional decoration yet completed in this country. The accumulated rubbish or wisdom of the ages has been washed away, and some-

thing which is definitely and entirely new has taken its place. Such a phenomenon has never occurred before in the world's history ...

The building's technical statistics were also a matter of great pride: 2,630,000 bricks, a mile of corridors, 1250 stairs, 800 doors (one for every member of staff), 142 miles of wiring, 180 air-conditioned rooms, 98 clocks, 6500 electric lamps, air extracted from the lavatories at the rate of 130 tons an hour, and so on.

In total, 22 studios were installed in BH, 13 more than at Savoy Hill. Each studio was styled according to its use: Light Entertainment was given the Vaudeville Studio (now S2) fitted out with a stage and spotlights to make the performers feel at home. A gallery with seating for a small audience was included to create the right atmosphere.

Religious Broadcasts came from a mock chapel (now 3E) decorated with gold stars on the ceiling and three arches at the east end. The central recess was occupied by a pseudo-altar behind which a cross was projected when required. The studio might have been consecrated until it was realised that this affected all space between heaven and earth and would therefore involve consecrating other studios, the Band Room and part of the Concert Hall.

Talks came from several differently-styled studios. 8B was the most severely contemporary, creating an ambience which clearly impressed architect Lord Gerald Wellesley:

The studios seem to induce bodily well-being and mental alertness. Here one feels is a setting in which lean-faced scientists can discuss relativity, or the more intellectual members of the Communist Party an ideal distribution of wealth. One cannot however imagine oneself making love in them, or playing with one's children in them, or even littering them with books and magazines.

Despite the sobriety of 8B, it was feared that elderly dons and clergymen (no doubt assumed to be regular contributors) might be frightened by the starkness of such modern surroundings.

So ... *as a concession to the conservatism and weakness of human nature* ... a Regency style library studio was fitted out with false books, an artificial window with drapes and an imaginary fireplace above which George Washington's portrait hung. *It is cosy ... in fact there is nothing to offend the most cloistered recluse* ... said the BBC Handbook.

BBC Photo Library

A studio waiting room

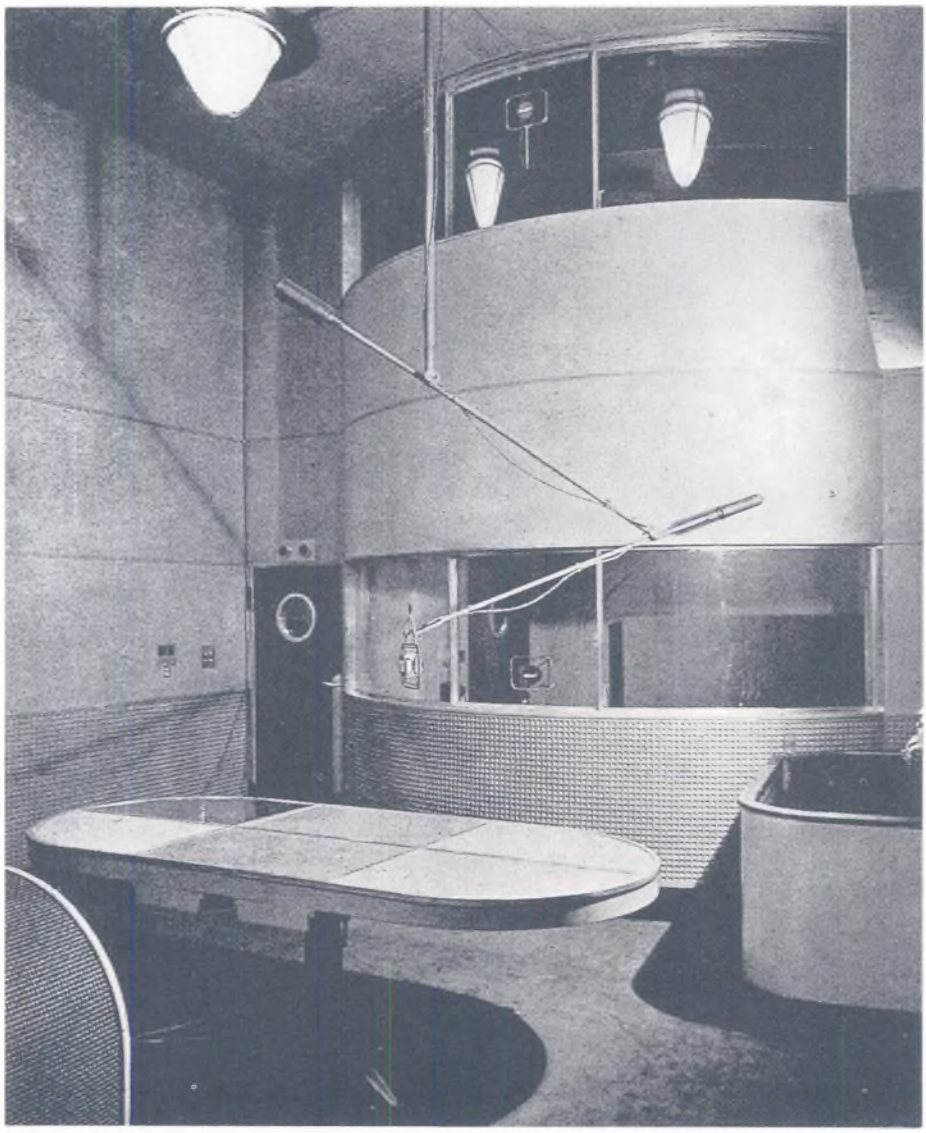
There were plans to decorate the Children's Hour studio (now 3E) like a nursery with microphones concealed inside teddy bears, but this never came to fruition. Carried away with the idea of a studio for every purpose, the News Chronicle speculated on the design of a studio for Weather Forecasts ... *the BBC have already been asked what decoration typifies a deep depression.*

For many, the most exciting place was the Dramatic Effects Studio (now 6A) where every imaginable sound had to be made live. Likened to a hospital operating theatre it was set up with a mass of gadgets: a wind machine, a water tank, fog horns, a great thunder sheet, compressed air apparatus, bells, gongs, even a barrel organ. Railway noises were created by running a roller skate over a tin bath with rivets, and rock falls were produced by dropping potatoes on a large drum.

Initially, there were no control cubicles next to the studios and each microphone was fed back directly to the main Control Room. Positioned at the top of the studio 'tower', within the eighth floor roof space, it had eight control panels for rehearsals and six for transmission. In 1932, the racks of amplifiers, switchgear, relays, and glowing lamps must have seemed like a piece of science fiction. Had one of the dramatic control panels survived it would certainly merit a place in a design museum.

But the ultimate sensation was hidden in the basement studio BB (now S1). Originally designed for Henry Hall's Dance Band, it was here that the BBC's first regular television broadcasts were made in August 1932. Four half-hour programmes were 'radiated' each week until February 1934 when a new studio opened at 16 Portland Place. Working behind the 30-line camera was a young engineer previously employed by Baird — Tony Bridgewater, who would later become the Chief Engineer, Television.

The only studio to survive even partially in its original form is the Concert Hall or 'Super-Studio' as some journalists dubbed it. Intended to accommodate a Symphony Orchestra and an audience of a thousand, the architects somehow got their sums wrong; it was never high enough for a full orchestra let alone a thousand seats. The hall became better known for its state-of-the-art four manual 31-rank Compton organ. There was to have been a duplicate console allowing the organ to be played remotely from a studio, but like the teddy bear microphones mentioned earlier, this never happened. Once



BBC Photo Library

The dramatic effects studio, with two tier gramophone effects area through the window

installed another planning oversight became apparent; with all its stops pulled out, the instrument reverberated throughout the studio tower. So, to this very day, special permission has to be sought before using certain stops, and playing is completely forbidden when the news studios above the Concert Hall are in use.

Despite these problems the hall was hailed as ... *the finest thing in the building. There is something Cyclopean about it which provides a suitably serious air* reported The Listener. The idea of enjoying anything faintly light-hearted or humorous was clearly frowned upon and, to reinforce the sense that you were in a temple, a series of classical reliefs depicted scenes from mythology. Another demonstration of this ethos was shown when the staff first gathered in the Concert Hall for an address by the Director-General. In the best tradition of Reith's religious upbringing, the congregation were segregated, with men seated in the centre flanked by women.

Two other rooms survive largely intact, their function not having changed much over the years. Today the Council Chamber differs only in that its Tasmanian Oak panelled walls are furnished with portraits of former DGs, Reith taking pride of place over the fireplace.

Immediately above was the Director-General's office; since Reith must have seemed like a god to many staff, the position of his balcony above Prospero and Ariel (who were not deities) must have seemed appropriate. The spacious oak panelled room was remarkable because it highlighted just how much Reith's personal taste differed to the building's architects and designers. Whereas the rest of BH was consistently modern, Reith favoured distinctly traditional furnishings. He even specified a fireplace for which coal had to be brought in specially, despite a perfectly good central heating system.

The idea (according to The Architects' Journal) that *anything would do for the servants* influenced the decor in other offices: linoleum for junior grades and a square of carpet for the middle ranks. Senior officers (those with a key to a private lavatory) were clustered in the nose of BH, with the Controller, Rear-Admiral Charles Carpendale, given an interconnecting door to the DG. The lesser proportions of the Chairman's office, significantly placed on the darker Langham Street side of BH, left no doubt as to who was in charge of the BBC.

Publicised by innumerable magazine features and the controversy over its design, the Regent Street battleship rapidly became synonymous with the BBC. Radio Times artists regularly adapted its familiar outline to illustrate special numbers, leading many to regard BH as the source of all BBC programmes. Its dominant presence in Regent Street became a minor cultural phenomenon, inspiring several musical numbers including *I'll BBC-ing* you recorded by Lew Stone, *We're frightfully BBC* by The Western Brothers and *Langham Place* by Eric Coates. Several pre-war films featured BH. One of these was *Band Waggon* starring Arthur Askey and 'Stinker' Murdoch. Satirising the white-coated engineers of the day, Arthur opened the film as the man who made the time pips; scenes which were actually shot at Lime Grove.

The best fictional record of the pre-war atmosphere in BH was *Death at Broadcasting House*, a novel written by Val Gielgud and Holt Marvel. It was later made into a film, casting the austerely modern studios in a distinctly sinister light. Similar atmospheric sensitivity influenced BBC employee George Orwell when he wrote *1984*, particularly the relentless monotony of the corridors. The infamous Room 101 is now the News & Current Affairs Publicity Office!

On 7th July 1932, BH received the ultimate accolade when King George V and Queen Mary made an official visit and set the seal on ten years of British Broadcasting. With the royal standard flying over BH, the King and Queen

were escorted to the Concert Hall where the whole staff sung *God Save the King*. The Royal Party then toured the studios where various specially-contrived rehearsals were in progress: a number from the BBC Dance Orchestra, a drama serial in production and a rendition of *I Want to be Happy* by the Wireless Singers. The tour included a walk past the third floor offices but, to protect Their Majesties against any unrehearsed encounter with a member of the staff, the rooms were emptied of all personnel and the doors left open.

With the BBC rapidly establishing itself as a national institution, it was natural that its headquarters should be designed as a permanent symbol of its values. In practice, the building's symbolism was its only really permanent facet — the rapid growth of radio broadcasting ensured that everything inside BH was subject to constant change. At the planning stage in 1928, the site was considered to have so much spare space that shops and a bank were proposed for the ground floor, explaining the large windows along the Portland Place facade.

Four years later, the expansion of the BBC meant that the building was too small even before completion. Studios dedicated to particular uses were quickly adapted for all types of broadcasting but there was no hope of extending BH, because it was locked into a site with no spare land around it. Before the end of the decade, the BBC had premises all over London, dashing once and for all any hope of putting everything under one roof.

By the mid-thirties, radio had become the product of the epoch and BH appeared to enshrine a corporate regime which, under the guardianship of Reith, would last for all time. In reality, the Corporation and its headquarters would stay at the centre only by adapting to changing circumstances. The utopia of the purpose-built radio wonder building was actually very short lived. In 1938 Reith departed to become Chairman of Imperial Airways and, within another 18 months, Britain was at war. It was the end of the starched shirt and dickey-bow era but the beginning of another in which BH would assume critical importance in the war effort.

The war years

The outbreak of war demanded a very rapid re-organisation of activities. Most programme departments were moved to the regions, leaving just news and talks in London. BH had to be made ready for enemy action: outside there was a permanent armed guard, the entrance was sandbagged and the building was camouflaged. The staff of BH even formed a special home guard troop. Inside, essential operations such as the news room and control room were moved to the specially reinforced basement. Although the hours of home service broadcasting were reduced, the frequency of news bulletins increased and regular broadcasts were made for European listeners. Consequently BH became a 24-hour operation.

Once the air raids started, large numbers of staff had to sleep in the building. The Concert Hall was the main area used although demand was so great that tickets had to be issued for each mattress. With only a curtain of blankets segregating men and women, plus the chaos of people coming and going at all hours, it must have been difficult to get much sleep. Outside the building, an armoured car was always on hand to carry the news reader to the standby studios at Maida Vale. In the event it was never used, although there were several close shaves.

On 15th October 1940, BH was directly hit by a 500lb time bomb. It penetrated the studio tower, crashing though several floors, ending up in the Music Library. The damage caused by the impact was serious — but nothing compared with the explosion which followed about 20 minutes later. Bruce Belfridge was just beginning to read the Nine O'clock news from the basement. Listeners heard a dull thud causing Belfridge to pause only momentarily. The scene above was anything but calm; the device blasted though the ceiling of 3A, wrecking most of the third floor studios including 3E, the so-called chapel. Seven people were killed.

Later that year, on 8th December, a land-mine got caught on a lamp post in Portland Place. The explosion blew out most of the windows on that side of the building, causing fires to start in the wiring. Despite severe damage to the equipment, the engineers managed, against all odds, to remain on-air — a feat little short of a miracle when you consider the conditions they had to work in. But as with the country at large, the war brought out the best in people and drew them closer together. For many of the staff in BH this period was the building's finest hour.

On VE day, the battle-scarred BH was dressed with flags and floodlit. It had survived the onslaught and won a special place in the hearts of staff and the minds of listeners. Ahead lay a period of reconstruction followed by real expansion when the site to the north of BH eventually became available. But that is another chapter for the next issue of *Eng Inf*.

Finally, it it curious to reflect that the building which is so closely associated with the founding Director-General is one that he didn't even like. If this is proof that the high priest of broadcasting couldn't (or didn't want to) manage designers and architects, then perhaps we should be grateful. If Reith's aesthetic taste had prevailed, it is unlikely that we would be celebrating the anniversary of such a distinctive building — now held in the minds of so many as a symbol, arguably even an icon, of public service broadcasting.

Ralph Montagu
Graphics, News & Current Affairs

BBC Photo Library

The Religious Services Studio — the vase of flowers signifies a secular use of the studio

TELECOMMUNICATIONS
Part 2: voice and data networks

Continuing our series on Telecommunications in the BBC, Stratis Scleparis describes the voice and data networks which form the backbone of internal communications.

The BBC Network

At present, the BBC owns a private telecommunications network to support its voice and data communications services throughout the UK.

When first created, this *private network* used analogue (48 kHz group) circuits — provided by BT — to carry predominantly voice traffic (inter-PBX as well as studio control and talkback lines). Over the years, the network has been augmented to meet the demand for extra capacity and the increasing requirements of data communications users.

By the late eighties, the multiplexing equipment which supported this network was reaching the end of its maintainable life. At the same time, BT announced its intention to cease support for the 48 kHz group circuits. Subsequently, the existing analogue network was replaced with a *private digital network*.

As shown in *Fig 1*, the basis of this new **Digital Telecommunications Network** (DTN) consists of BBC-owned Time Division Multiplexers (TDMs), connected mainly by 2 Mbit/s bearers rented from the Public Telecommunications Operators (PTOs). The nodal equipment provides the necessary routeing and diversity facilities. The network provides transparent, underlayed and resilient digital channels between any two locations. Subsidiary functions such as voice and data switching are performed by separate equipment such as telephone Private Branch eXchanges (PBXs), X.25 packet switches and Asynchronous Data switches. Any data rate is supported, from 300 bit/s for Message Switching System (MSS) traffic to 768 kbit/s for video conferencing and even higher rates for special requirements.

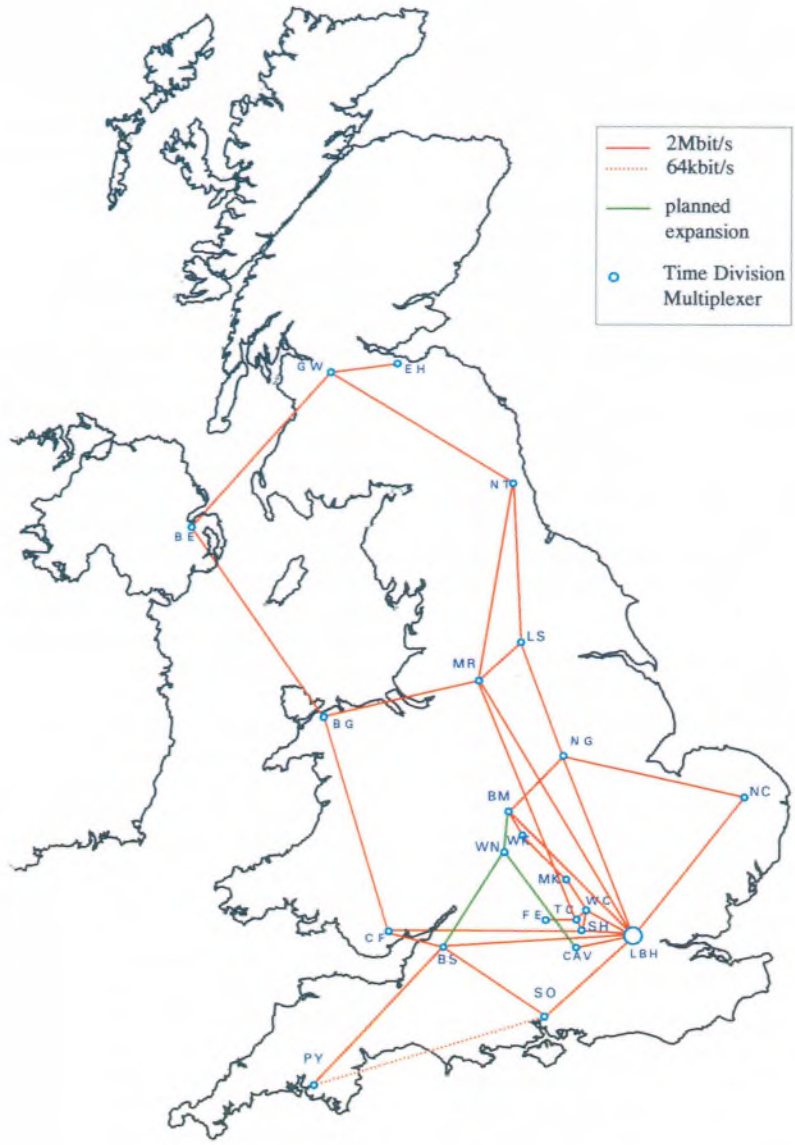


Fig 1: The BBC Digital Telecommunications Network

Voice Communications

BBC corporate telephony is provided by approximately eighty PBXs serving around 29,000 extensions, the majority of them in London (see *Fig 2*). They are connected, in a star topology, via a single tandem switch located at Broadcasting House in London. The inter-PBX channels are carried over the DTN.

In the past few decades, PBX technology moved from the early telephone switchboards with patchcords through the *Strowger* and *Crossbar* type, to the modern digital *Stored Program Control* (SPC) type. All PBXs in use by the Corporation are of the SPC type, with the single exception of Wood Norton which is a Crossbar but is due for replacement this year. The most significant developments in PBXs over the past few years have probably been in the areas of digital signalling. These have developed from theoretical possibilities into realities in a very short time.

1. Digital signalling between the PBX and the telephone set has allowed many improvements to be introduced. For example:

   - interactive display phones: the information given to the user can now be interactively updated

by the PBX, with the ability to display the identity of the caller etc.

- out-of-band signalling: interaction of PBX and extension user without disconnecting the speech path.
- simultaneous voice and data communication.

A consequence of the above is that users of modern PBXs enjoy such enhanced features as fast call set-up, 'call back when free/next used', call queuing, conference calls, automatic call forwarding, automatic call distribution, manager-secretary function, voice mail and other productivity features.

2. Digital inter-PBX signalling enables PBXs to communicate with each other using standard communication protocols, enabling a feature transparency across the telephone network that was not possible with the analogue inter-PBX lines and interfaces.

The BBC telephone network makes use of these signalling systems. *Digital Private Network Signalling System* (DPNSS) links exist between some of the PBXs and the planning of the linking of the rest of the telephone network in such a way is currently in hand.

Recent advances in digital signal processing technology, in conjunction with the relaxation of OFTEL's regulations in the UK, mean that low bit-rate (sub-64 kbit/s) encoding has become a viable solution for the economic transfer of voice traffic within private networks. Indeed, voice compression to 32 kbit/s is widely used on the BBC telephone network. Where regulations permit, the data rate has been reduced to as low as 8 kbit/s to squeeze eight voice channels into one 64 kbit/s digital circuit. In such a case, the inevitable slight compromise in audio signal quality is balanced by the enhancement of telephone facilities to a remote BBC site and the subsequent reduction in *Public Switched Telephone Network* (PSTN) calls.

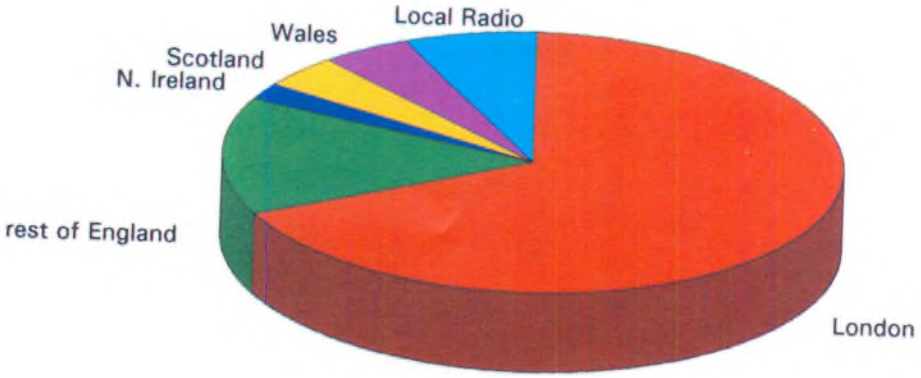


Fig 2: Regional breakdown of telephone extensions

Data Communications

Initially, the BBC established a rudimentary data communications network carrying *teletype* (Telex) messages. This was a 50 baud system which used a *manual telex exchange* that was replaced by the *Automatic Data eXchange* (ADX). In the early eighties, the ADX was in turn replaced by the *Message Switching System* (MSS). This is a store-and-forward system with mailbox facilities and features connections to the PSTN for Telex and public Packet-Switched Network (known as PSS). The MSS currently handles about one million messages per month but services presently supported will be provided by alternative means, where necessary, in the near future.

The BBC has a number of dissimilar E-mail systems running on independent, and in most cases incompatible, computer systems. This makes difficult the exchange of E-mail from one system to the other. To overcome this, the MSS has been augmented with an E-mail facility using the new X.400 standard. This enables corporation-wide exchange of E-mail and access to public X.400 E-mail services. In addition to telephony, some of the services carried over the BBC corporate network are the:

- *News Distribution Network* (NDN), distributing news from Broadcasting House to the Regional Centres.
- *Electronic Newsroom System* (ENS) providing remote terminal access from Local Radio Stations to the twelve Regional Electronic Newsroom computers and high speed links (LAN-LAN) to network all the ENS systems together with the News & Current Affairs system in London.
- *Transaction Processing* applications supported by the ICL mainframe computer centre at Sulgrave

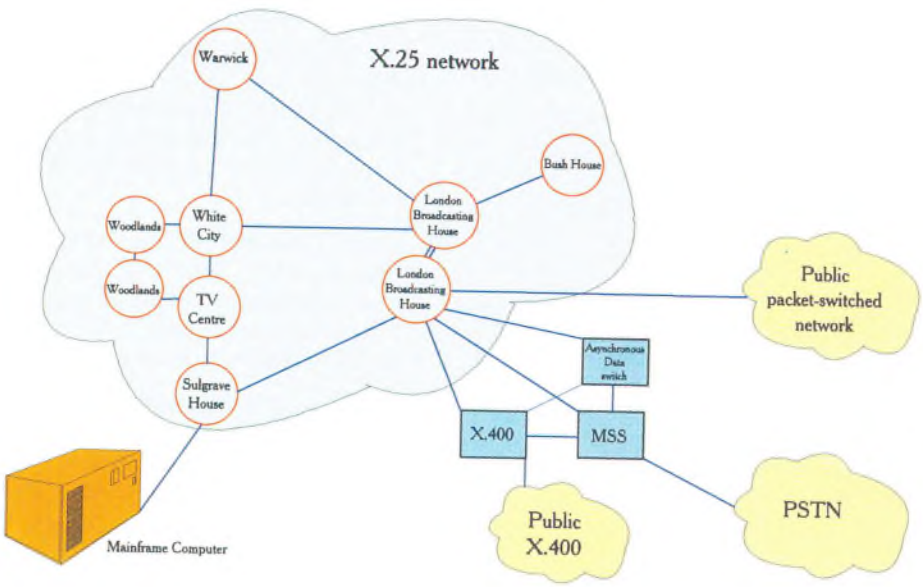


Fig 3: The BBC X.25 packet-switched network with connections to public and private services

House (see the box below for a list of current applications).

- *News Agencies'* traffic.
- Miscellaneous *inter-regional and Local Radio facilities* such as: remote programme routeing, remote-station-identification cartridge start, RDS traffic, etc.
- *LAN interconnections.*

The BBC's X.25 packet-switched network is shown in *Fig 3.*

ISDN

One of the major telecommunications developments of the late eighties was the emergence of the *Integrated Services Digital Network* (ISDN). This is defined as "A network that provides or supports a range of different telecommunications services via digital connections between user-network interfaces". In technical terms it is a new standards-based platform by which public telephone networks can provide multiple, enhanced services to end-users over existing twisted-pair-wiring local ends. In operational terms, ISDN is a digital telephone network which can be used for more than telephony.

The CCITT[1] ISDN recommendations have produced the so called "2B+D" phones. This means that for every ISDN telephone there are two 64kbit/s transmission channels ('B' channels) for either voice or data and one 16kbit/s signalling channel ('D' channel). Such a mechanism gives the ability to establish a link to send and receive voice and data at a very high rate, in the same way as making a simple telephone call.

ISDN will affect office communications and the way that information is exchanged in the workplace. As ISDN offers the possibility of dial-up music-quality audio circuits, it will revolutionise the provision of programme sound circuits in the broadcasting industry. G.722[2] codecs are already in service with Network Radio, World Service and News & Current Affairs. As ISDN offers 'bandwidth on demand' it is also used as dialled back-up for some rented digital circuits.

Current Developments/Trends

The traffic mix that private networks must carry is changing. For the BBC, this is currently around 80% voice to 20% data. The emerging need for LAN-LAN interconnection for the creation of new corporate networking applications (interconnected LANs) will steadily increase the amount of data carried over wide area telecommunications networks and will require the ability to handle sudden surges in network traffic without creating delays. This necessitates the use of more bandwidth-efficient multiplexing techniques and the implementation of wide-bandwidth solutions for the BBC's telecommunications network.

Two recent technological developments look very promising with regard to the efficient use of available bandwidth:

1. **Frame Relay**, a more efficient replacement for X.25, can be added to existing packet and circuit switches. Frame Relay assumes that connections are reliable and dispenses with the overhead of error detection and control within the network. If corruption does occur, it relies on the application systems at the end of the connections to detect or correct the errors. The combination of leaner protocols and higher line speeds means that Frame Relay is much faster than X.25.
2. **Fast Packet switching** is a new switching technology that is based on statistical multiplexing of data into fixed-length cells. The chief advantage is much better utilisation of bandwidth at higher speeds, even allowing voice telephony.

Fig 4 summarises the relationship between these current and near-future systems.

Public Services

Public carriers, such as BT and Mercury Communications Ltd (MCL), are contemplating new services to head off private communications network efforts. These services include:

- **Public Frame Relay:** This public data service is already being offered by some PTOs, in addition to X.25. It makes sense where voice traffic is limited or sites are too small to justify E1 (2 Mbit/s) connections. However, Public Frame Relay is not likely to replace private frame relay any more than public X.25 services have killed off private packet switching.
- **ISDN and broadband ISDN**: Both are designed to carry voice and data, but the broadband standard supports much higher rates. Frame Relay is the data protocol for narrowband ISDN, but a new protocol and new fast packet switching techniques are being defined for *Asynchronous Transfer Mode* (ATM), the broadband ISDN standard.
- **SMDS (Switched Multimegabit Data Service)**: This is a switched, wide-area network designed to carry heavy, unpredictable LAN-LAN traffic as well as voice and video.
- **MAN (Metropolitan Area Network)**: This is campus or

TRANSACTION PROCESSING

Here is a list of the major Transaction Processing applications at Sulgrave House, which are carried over the BBC's corporate data network:

CEMAST	Control of Engineering Material Acquisition Storage and Transport
COPPER	Central Office of Post and Personnel Records
EMIAS	Engineering Management Information and Accounting System
FLOL	Film Library on Line System
JACS	Journal Automated Clearing System
ORPHEUS	Radio 3 Music Planning (Not an acronym)
ECHO	Radio Library System (Not an acronym)
VTOL	Video Tape On Line System
WILL	Radio Drama System (Not an acronym)

[1] *International Telegraph & Telephone Consultative Committee.*

[2] *G.722 is a CCITT recommendation describing a coding system for programme-quality mono audio, giving 7.5 kHz bandwidth at a data rate of 64 kbit/s.*

'village-wide' LAN. BT is currently developing such a system for an area covering the University of London's buildings.

- **CENTREX**: CENTRal EXchange is the generic title for the provision of 'contracted-out' voice telecommunications services, which would otherwise be provided by a PBX. In the UK, the CENTREX service is provided from equipment located at the Public Exchange operated by BT or MCL.

- **VPN (Virtual Private Network)**: These are seen by the PTOs as the future replacement for existing private telecommunications networks based on private leased lines. Customers using VPNs will have access to a switched network with 'bandwidth on demand'. A 'permanent' circuit on a VPN can be considered as a switched circuit but the very short time needed to make a connection via a VPN means that links can be switched in and out of service according to demand.

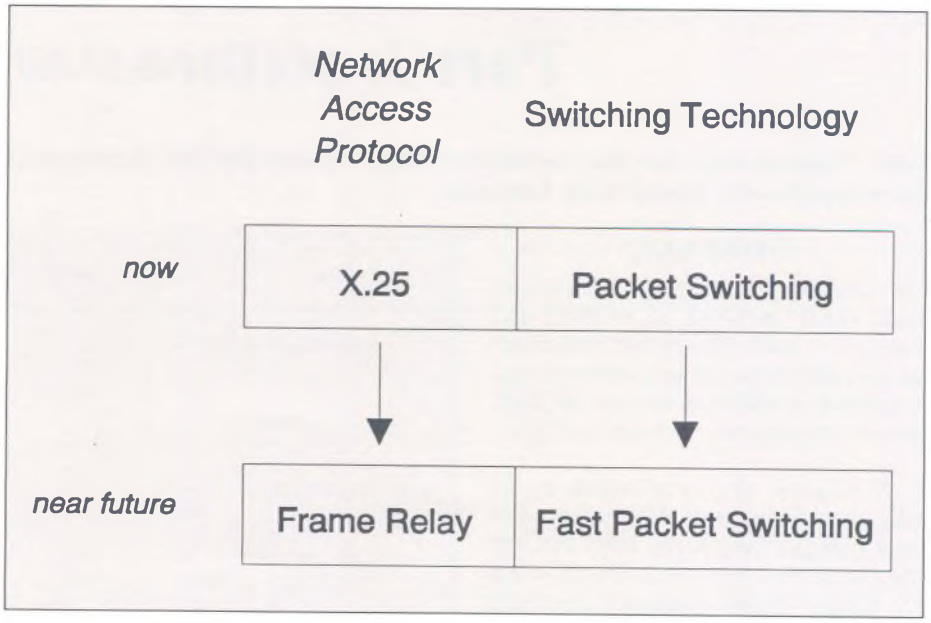


Fig 4: X.25 and Frame Relay

The White Paper

The Government's 'Duopoly Review' of last year and the subsequent White Paper — *Competition and choice: telecommunications policy for the 1990s* — initiated a process that is bringing some interesting changes to the telecommunications industry. Some of these are:

* The ending of the BT/MCL fixed-network duopoly.
* Telecomms also to be provided by public utilities, eg The Post Office, British Rail, National Grid.
* Cable operators can offer telecomms without BT or MCL.
* Mobile operators can offer telecomms without BT or MCL.
* Mobile operators can offer fixed services, and telepoint operators can offer telepoint to the home.
* Self-provision of private circuits is allowed.
* BT is allowed to give volume discounts (subject to conditions) etc.

For the customer, the increasing competition between the PTOs has led to lower prices and new technologies. The BBC has capitalised on that and has:

- ☐ significantly reduced the cost of providing telecommunications services
- ☐ improved the resilience of its networks by leasing circuits for its private backbone network from more than one PTO (ie Carrier Diversity).

The Future

Two major BBC projects are currently in the planning stage:

1. The replacement of the LBH and Television Centre PBXs, totalling about 12,000 telephone extensions. This work will also replace the analogue circuits between the two exchanges as well as the links to their satellite PBXs. Voice mail and Directory Enquiry facilities will also be supported.

2. The establishment of a Managed Telecommunications Network (MTN) capable of rapid response to users' requirements, managed in a way that provides billing information for the users' Departments and employs the latest bandwidth-efficient systems for the cost-effective provision of telecommunications services in the BBC.

The model for telecommunications in the 90s is fundamentally different from that of the past. The key conceptual change was the transition from thinking in terms of *moving* information to *sharing* information processes across complex networks. Interoperability and interconnectivity became the ultimate common goal. Constant change in technologies has become a way of life. Telecommunications is becoming a set of open and standardised 'tools' made available competitively by diverse networks and users.

In this continuously evolving framework, the BBC is also reshaping and developing. The state of its telecommunications facilities — like everything else — is constantly examined in the light of market forces and optimum provision. The implementation of any corporate telecommunications network must be driven by business needs rather than historical or technical issues.

The current vogue of companies is to concentrate on their 'core' businesses and let other — external — organisations manage their telecommunications facilities for them. The BBC is considering this approach, in order to ensure that it can benefit from expertise and resources available in the open market, for a price. In this context, all the recent offerings by the PTOs such as ISDN, CENTREX, Public Frame Relay and the emergence of VPNs are now being examined as possible enhancements of the BBC corporate network in a diverse and efficient way.

For more information on any of these aspects of voice or data communications, please contact Telecommunications Network Section at Warwick on extension 16801.

Stratis Scleparis, Sen Proj Eng
Telecommunications Network
Section, TED

ELECTRONIC GRAPHICS

Part 3: picture storage

Mike Winston describes the methods available for storing digital pictures, how the equipment interconnects, and the principles of Central Stills Libraries.

STORAGE

All stills stores and painting systems need some method of storing the pictures — both *on-line* for immediate use and *off-line* for longer term storage. A number of different devices are used, almost all magnetic, as listed in Fig 1.

Device	On/Off Line	Capacity	Recall time per picture	Cost per picture
Fixed Winchester Disc	On	330 Mbyte	approx 1.0 sec	#£15
	On	474 Mbyte		#£13 } obsolete
	On	700 Mbyte		#£ 8 }
	On	1.2 Mbyte		#£ 5 }
	On	2.2 Mbyte		#£ 2.50
Removable Winchester (RSD)	Both	82 Mbyte	1.5 sec	£ 4.00
" (Syquest)	Both	44 Mbyte	2.0 sec	£ 2.50
Optical WORM Disc	Both	600 Mbyte	*4.0 sec	£ 0.20
(Write Once Read Many)	Both	2 Gbyte	*3.0 sec	£ 0.15
Magneto optical disc (Rewritable)	Both	650 Mbyte	*2.0 sec	£ 0.15
Floppy Disc	Off	c.1 Mbyte	10 sec	£ 1.00
Streaming Tape Cartridge (Slidefile)	Off	c.50 Mbyte	12 sec +spooling	£ 0.25

\# *Cost includes drive mechanism because discs are non-removable*
* *Record times for optical discs are typically 2-3 times longer than the recall time.*

Fig 1: summary of storage devices in common use

All pictures stores and painting systems need some method of storing the pictures — both *on-line* for immediate use and *off-line* for longer term storage. A number of different devices are used, almost all magnetic, as listed in Fig 1.

A Winchester disc is provided on all painting systems and stills stores. The most popular sizes in the BBC are 330, 700 and 1200 Mbyte (1.2 Gbyte) while 2.2 Gbyte is the standard for new Paintboxes.

Removable-cartridge Winchesters are used extensively on Quantel equipment and, unlike other off-line storage methods, they are as quick as the fixed discs and so can be used on-line. However, the particular drive used has become obsolescent, and the newer Quantel equipment uses removable optical discs. Similarly, the Aston Wallet uses optical or more compact magnetic discs.

The large capacity of optical discs makes them especially suitable for Central Stills Libraries. The original type which were *write once read many* (WORM) devices are still in demand, because non-erasability is often desirable for archive use.

The availability of small, cheap removable Winchesters means there is less interest in *streaming computer tape* systems, although the recent development of a large capacity data recorder using a Video-8 cassette (EXABYTE) is causing a slight revival, particularly for off-line storage of animation work. The main disadvantage is lack of speed; it takes nearly an hour to store 30 seconds of animation.

Data Compression

As shown in Fig 2, the storage capacity required is about 1 Mybte per picture. This is a lot of data and so some form of compression is very desirable. A popular technique is ***Run Length Encoding***, which relies on pictures having uniform areas where a number of adjacent pixels are identical. Instead of recording every pixel, the pixel value and the number of times it is repeated along the line (the run length) is recorded. Thus, an enormous saving of storage capacity can be achieved.

Unfortunately, any real picture from a camera includes noise and so the chances of any two adjacent pixels being identical is negligible. This makes run length encoding useless for general-purpose picture storage.

Electronically-generated pictures are different. Large uniform areas are easily generated and often specifically required. Painting systems would seem to be an obvious candidate, but 24- and 32-bit machines need to handle real pictures as well, and so they are not very suitable. However, run length encoding comes into its own in 8-bit painting systems where it is almost universal. With only 256 pixel values possible, even quantised pictures from a camera can be compressed. There is one disadvantage — the degree of data compression possible is very dependent on picture content and so you never know how many pictures will fit on the disc.

More complex image-processing methods can be used for compressing 'real' pictures. All pictures carry redundancy, but it is difficult to remove this directly. The trick used by these coding algorithms is to re-arrange the data by various mathematical transforms so that the redundant information is isolated and can be discarded easily. Various techniques are used such as the *Discrete Cosine Transform* (DCT), *Block Truncation Coding* (BTC), *Variable Length Coding* (Huffman) and the *Fractal Transform*. The commercial drive behind this comes from the multimedia market and the desire to transmit moving images on national data circuits such as ISDN (see page 4) for conferences etc, as well as saving on data storage.

A standard for still images has emerged called *Joint Photographic Experts Group* (JPEG) which uses DCT followed by Huffman Coding. Compression ratios of 10:1 are possible with barely perceptable degradation, and even 100:1 can produce reasonable results. VLSI chips for JPEG are now available and a number of boards for PCs have been produced in the multimedia market.

The Sony *DIH 2000* (DCT and BTC) and Rank Cintel *Piximile* (JPEG) use these compression techniques for image transmission. These systems may well

come into use with stills libraries for long distance links.

The Thomson Stills Store (PIXTORE) uses JPEG so that several hundred pictures can be stored on standard PC hard discs.

The Fractal Transform shows potential for enormous compression ratios. However the coding process is very compute-intensive, needing special hardware, whereas the decoding process is much simpler. For this reason it is most suited to multimedia applications where images are compressed once and distributed to many users for viewing.

Storage of Captions

Character generators allow storage of completed captions on discs (hard or floppy). For simple machines, all that needs to be stored are the Ascii codes and co-ordinates of each character, the font style and colour, and some control data. This needs far less data than a still picture and thus, typically, 100 captions and their fonts can be stored on one floppy disc. The fonts themselves are usually run-length-encoded and can be recorded on the same disc.

Assuming stills are to be stored in the Rec 601 (4:2:2) format, it is easy to work out the number of bits needed:

Y component	=	720 x 576 x 8	=	3,317,760
C_r, C_b	=	2 x 360 x 576 x 8	=	3,317,760
			=	6,635,520 Bits
Total picture data			=	829,440 Bytes

If a generous allowance is added for picture title, miscellaneous related data (eg type fonts) and disc housekeeping etc, a good rule of thumb is:

TOTAL = say 1 Mbyte per picture

If a key channel (equivalent to another Y channel) is included, the total required is about 1.3 Mbyte per picture.

Fig 2: storage capacity required

INTERFACING

Any electronic graphics area needs some way to transfer pictures between devices. This can either be by *video* signals, or via some form of *data* line or bus, or by transferring a *removable* storage medium. The various methods are summarised in Fig 3.

Successful transferring of storage media between machines obviously needs a common data format and removable media. Merely using the same disc drive or data bus is not sufficient.

Historically, the computer industry was well known for its lack of standardisation, and initially this attitude was adopted by broadcast users of their equipment. So, although everyone may sample pictures according to Rec 601, there is no guarantee that any two manufacturers will store this data in the same way on disc. Even different machines from the same manufacturer can use different data formats on the same discs. Customer pressure has led to some response from manufacturers, but rather than use the same format, they provide software which allows the different formats to be read by each other.

The only common standards are the video ones, and so Rec 601 / Tech 3267 is the only universal means of transferring pictures in digital component form between devices.

In the absence of a common data format standard, much use continues to be made in the BBC of machine-specific digital systems:

Slidefile uses a streaming tape cartridge to transfer pictures between machines.

All ***Quantel*** graphics areas make extensive use of the RSD system (see *Fig 1*) mainly for off-line storage but also for transferring material. However, this system is now being superseded by the optical discs used by the new Paintbox, which can be networked together with *Picturebox* using an Ethernet-based system called *Picturenet*.

The ***Digital Dump System*** (a pseudo vision signal containing binary data rather like full-field teletext, but of low enough bandwidth to record on a U-matic tape machine) is now rarely used, and is not provided on new Quantel equipment.

VIDEO

Analogue Component	—	RGB, YUV, YC_bC_r, MAC, ACLE
Analogue Composite	—	PAL, NTSC, SECAM
Digital Component	—	EBU Tech 3267 (Defines interfacing standards for pictures sampled according to 4:2:2 Rec 601. Includes parallel Rec 656 and serial 'Sony' protocol)
Digital Composite	—	Serial or parallel interfaces as used on D2 and D3 VTRs

DATA

Disc drive buses such as:

SMD (Storage Module Drive/Device),
SCSI (Small Computer System Interconnect)
QIC-02 (which is used for Slidefile streaming tape and as an interface to Gallery library systems)
Serial lines such as *RS232* and *RS422*
Computer networks such as *Ethernet*
Long-range networks such as *ISDN*, *FDDI*

REMOVABLE MEDIA

Optical disc (WORM or magneto-optic)
Cartridge Winchester
Floppy disc
Streaming tape data cartridge
Video tape

Fig 3: common methods of interfacing

The ***Aston Wallet*** uses removable hard discs (magnetic or optical) for transferring pictures.

The assembly of graphics material usually requires multiple passes to build it up, layer by layer. There is an obvious parallel here with VT editing. The degradation of multi-generation Pal signals is well known, but fortunately this is avoided in graphics areas, as a result of using component video. In analogue component systems, quality loss is caused by repeated A-D/D-A conversions and the difficulty of maintaining three accurately-aligned and matched analogue routes; visual deterioration sets in beyond about sixth generation, with colour shifts and ringing becoming noticeable.

Graphics equipment has always been digital internally but, until there was a digital standard, interconnections had to be analogue. The advent of agreed standards means it is now highly desirable to use digital interconnections.

The BBC encouraged manufacturers to fit digital ports but, initially, manufacturers were not convinced that there would be sufficient demand from broadcasters for what might have been quite a costly option. However, facilities houses were quick to demand digital interconnection wherever possible and we have now reached the stage where most manufacturers provide digital ports as standard. It is the analogue ports that are now sometimes extra.

Existing BBC graphics areas still use analogue RGB routeing and distribution, but digitial routeing is considered for new areas, particularly where signals are being routed repeatedly around the same path. The monitoring of digital signals is less convenient, although the development by D&ED of a low-cost monitoring D-A converter has helped.

The first Rec 656 parallel digital routeing system in the BBC was installed in the Computer Graphics Workshop. Future systems are more likely to use serial routeing, as serial ports become standard on equipment.

For long distance transmission, there are several possibilities such as Datacast, audio and video lines, and BT data circuits. *Kilostream* for example has a maximum speed of 64 kbit/sec. At this rate, it would take about two minutes to transmit one still. In the absence of anything faster, even a telephone circuit could be used, but it would take nearly half an hour at 4800 baud!

These long times are obviously impractical, and so people are looking at using the data compression techniques referred to earlier (eg Rank Cintel *Piximile*, Sony *DIH 2000*). At 10:1 compression, a picture could be transmitted in twelve seconds on kilostream, or about three minutes on a telephone line.

CENTRAL STILLS LIBRARIES

Graphics departments over the years have built up large libraries of photographic stills which are meticulously catalogued. These need to be transferred to electronic storage for transmission, and increasingly new stills are being originated electronically rather than photographically. An obvious development therefore is to set up a central library of these stills in electronic form.

The basic requirements of a central library are:

- ☐ Large on-line storage capacity (currently magnetic or optical discs) which, ideally, is expandable indefinitely.
- ☐ Computerised indexing and searching system with central database.
- ☐ Digital links to local workstations — stills stores, painting systems etc
- ☐ Digital long-distance links, eg to other BBC regions.

Some commercial systems use the disc bus for interconnection, but this is very restricted in range:

SCSI	6 metres
SMD	10 metres
QIC02	200 metres

For this reason the newer systems use stand-alone workstations linked by a computer network. This provides a means of exchanging pictures easily but unless there is some common pool of picture storage and overall library management facilities, it is not strictly a stills library as described above.

Commercial Systems

Finally, here is a list of the most commonly available CSLs:

Lietch

- Uses *Still File* stills stores as workstations
- Network is Ethernet
- Separate PC provides library management.

Logica Gallery 2000 and DPA (Digital Picture Archive)

- Uses Slide Files as the work stations.
- Interfacing is by the disc data busses — SCSI between the central discs and the QIC-02 bus to the Slide Files.
- Library management runs on a DEC Micro PDP11 computer.

Quantel CLL (Central Lending Library) – now obsolete

- Uses Quantel DLS stills stores and Classic Paintboxes as workstations.
- Interfacing is via the disc data bus (SMD).
- Library management runs a DEC Microvax computer.

Quantel Picturenet/Picturebank

- Uses Pictureboxes and new Paintboxes linked by a modified Ethernet.

Sony DNS (Digital Network Stills Stores)

- Uses DNS100 stills stores as workstations.
- Network uses Ethernet for control/data and a serial digital video matrix for the pictures.

Thomson DIANA (Digital Image Archive Network Architecture)

- Uses Pixtore stills stores — images compressed to JPEG standard.
- Network is standard Ethernet with optional interface to ISDN.
- Library management uses ODISNET document management system running on separate computer.

Mike Winston
Central Systems Group
PID Tel

Logica Gallery 2000/Digital Picture Archive

1 Gallery system in News & Current Affairs.
8 DPA systems in TC5, Leeds, Elstree, Belfast, Glasgow, Cardiff, Norwich and Birmingham.

Quantel Central Lending Library

1 system in News & Current Affairs.
1 system in Network Presentation.

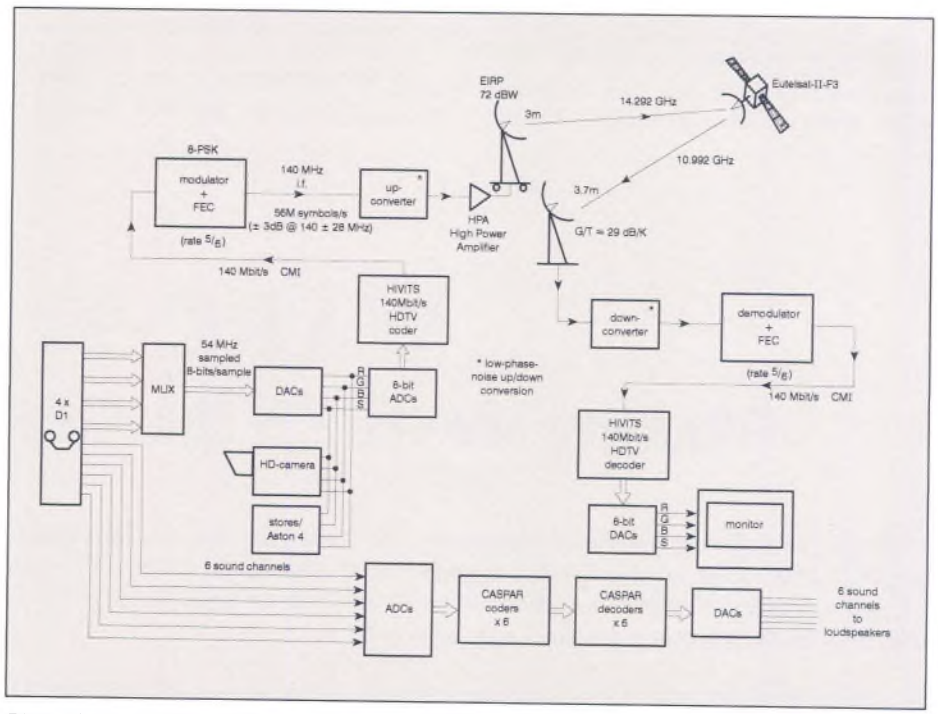
Library systems in the BBC

DIGITAL HDTV
RD demo via satellite

A transmission of digital HDTV, encoded at 140 Mbit/s and transmitted via the Eutelsat II-F3 satellite, was the main demonstration at an exhibition held recently at Kingswood Warren. Nick Wells takes up the story.

HIVITS (High Quality Video and TV/HDTV Television System) is a project funded by the Commission of the European Communities under the RACE Programme (**R**esearch and development in **A**dvanced **C**ommunications technologies in **E**urope).

An exhibition of equipment and research results from the HIVITS project (RACE 1018) was held at Research Department on 12-13 May, with the assistance of Tel OBs who provided the satellite earth station. Many technical experts involved in the European RACE and Eureka programmes visited the exhibition.



Block diagram of the equipment used

The demonstration

As shown in the diagram, the HDTV demonstration consisted of playing digital recorded sequences and other test material through a digital encoder, which reduced the bit-rate of the source signal from around 1000 Mbit/s to 140 Mbit/s. This signal was then modulated (using 8-PSK modulation) and beamed to the satellite using equipment provided by EutelSat and the BBC. Finally, the signal received from the satellite was decoded, demodulated and displayed on a large-screen monitor, together with multi-channel sound. The HDTV and sound encoding/decoding equipment were developed specifically within the HIVITS Project, using state-of-the-art digital processing techniques.

The *transparency* of the digital compression and the *ruggedness* of the digital satellite transmission were fully demonstrated. A major application for this equipment is to provide studios with very high-quality picture and sound signals from, for example, OB events such as the Olympics.

RD also demonstrated the following equipment and research results:

- Flexible 34 Mbit/s digital coding equipment for conventional-definition (ie 625-line) TV. Here, the codec was fitted with variable bit-rate interfaces for packet-oriented *Asynchronous Transfer Mode* (ATM) networks.
- An ATM network simulator, connected to the 34 Mbit/s TV equipment.
- Simulation results of HIVITS recommendations for extension of the new video-telephony standard of ATM networks.
- Simulation results of HIVITS recommendations for digital TV/HDTV multi-resolution coding.

The HIVITS Project

The main objectives of this project are to prepare a harmonised family of video coding systems for high-quality **video-telephony**, **conventional-definition** and **high-definition television**, including the necessary network and standardisation aspects. It involves the definition of algorithms, the specification of required components (VLSIs), and the construction of prototype demonstration coding equipment. The project is organised into two application-oriented subprojects, labelled A and B. Research Department has been working within the B subproject.

- Subproject A addresses video telephone coding for point-to-point and conferencing applications.
- Subproject B addresses TV and HDTV coding for distribution and contribution applications.

The partners in *Subproject A* have contributed significantly to the definition of the new CCITT Recommendation H261, for video telephone and conferencing applications. A number of compatible improvements have been studied and adaptation to packet (ATM) networks is under study. VLSI chips are being developed to integrate an H261 codec on a single board, which includes the possibility for operation in an ATM environment.

The partners of *Subproject B* have been key players in defining an international standard for the high-quality coding of conventional-definition television within 34 Mbit/s. Nine companies, including the BBC, have cooperated in the building of a prototype 34 Mbit/s codec to this standard which, in addition, is

able to work in an ATM environment. The integration and testing of this codec took place at Research Department.

Also, Thomson of France, the BBC and TRT (a Philips telecom subsidiary in France) have cooperated within Subproject B to build 140 Mbit/s HDTV coding and decoding equipment for high-quality applications. This codec is based around an extension of the standard for 34 Mbit/s coding of TV signals; it consists of six TV codecs operating in parallel, on adjacent stripes of the HDTV picture. Some of the boards for the high-definition video bit-rate reduction, and the sound coding/decoding equipment for the multi-channel sound, were constructed by RD.

Besides TV and HDTV codecs for high-quality applications, HIVITS Subproject B is also active in the field of video and associated sound coding algorithms for compatible (or multi-resolution) distribution of digital TV/HDTV. Partners in the project are contributing their work to the relevant international standardisation committees for this application.

Nick Wells
Digital Systems Section, RD

WARC-92

Making waves on the Costa Del Sol

What do the following have in common? **28 tonnes or six million sheets of paper in white, yellow, green, blue or pink; 2601 documents; 16,500 international telephone calls; 1500-plus delegates from 124 countries; cost to stage – approximately ten million Swiss Francs (about £4 million); and Torremolinos, that sunshine destination of British holidaymakers on the Costa Del Sol.**

Answer: **The *World Administrative Radio Conference* (WARC-92) which was held under the auspices of the International Telecommunications Union (ITU) in Spain earlier this year.**

Ian Davey and Peter Shelswell describe – from a BBC viewpoint – the outcome of WARC-92 which has overseen the most intensive revision of the Radio Regulations since 1979.

The ITU is one of the specialised agencies of the United Nations which, at intervals, holds conferences to discuss and legislate on the rules of spectrum management. The 1992 conference — held at the Palacio de Congresos, Torremolinos, Malaga, Spain in February-March 1992 — was the first major opportunity the 'World' has had to allocate frequencies since the great WARC in 1979.

Those with long memories may recall the 1979 event. That conference covered the entire spectrum, took place in Geneva in the depths of winter and lasted for ten and a half weeks. By way of comparison, WARC-92 had a limited agenda, lasted four weeks and two days over the period 3rd February through to March 3rd, and the climate was not so sunny as the holiday brochures would have us believe!

The 1500 or so delegates in Spain — government administrators and their advisers, plus a range of other groups who were observers only — spent many long and at times arduous hours debating frequency re-allocation issues, covering all aspects of radio communications.

The current allocations are outdated because advances in technology — particularly in the last decade — have led to a mushrooming of new (future) services that also require a slot in the frequency spectrum. These new services cannot get their own frequency allocations — unless existing services are transferred elsewhere in the spectrum, or some suitable sharing arrangement between old and new services can be worked out. Obviously, these knock-on effects can (and do) cause major problems at such a conference.

BBC involvement

The agenda covered many general areas of spectrum management of which there was major BBC interest in the following issues:

- HF Broadcasting
- Sound broadcasting by satellite
- HDTV broadcasting by satellite

Of secondary interest to the BBC was the future use of a band around 2 GHz (possibly for OB links), while we were also concerned over provision being made for *wind profile* radars, which could have caused severe disruption to our uhf television network.

WARC is an international conference and, within Europe, the dominant co-ordination body is CEPT — a grouping together of government agencies including most European countries west of Russia. The European Broadcasting Union (EBU) is also very active in coordinating the views of the broadcasters. Before the Conference, these views were widely published and discussed, and formed part of the input to the CEPT machinery.

The BBC people attending the conference were all official UK delegates — representing the UK administration — and so UK policy reigned supreme. Life thus got a little difficult for the BBC when the EBU view and that of the UK administration differed!

The UK delegation was led by Mike Goddard of the *Radiocommunications Agency* (a part of the DTI). It consisted of 35 full-time members, plus many other observers, and represented all UK major users of the spectrum. BBC World Service interests were covered by Ian Davey and Geoff Spells on a full-time basis, with Simon Spanswick attending for the last two-week period. BBC Radio and Television were represented by Dr Paul Ratliff, Peter Shelswell and Nigel Laflin of Research Department.

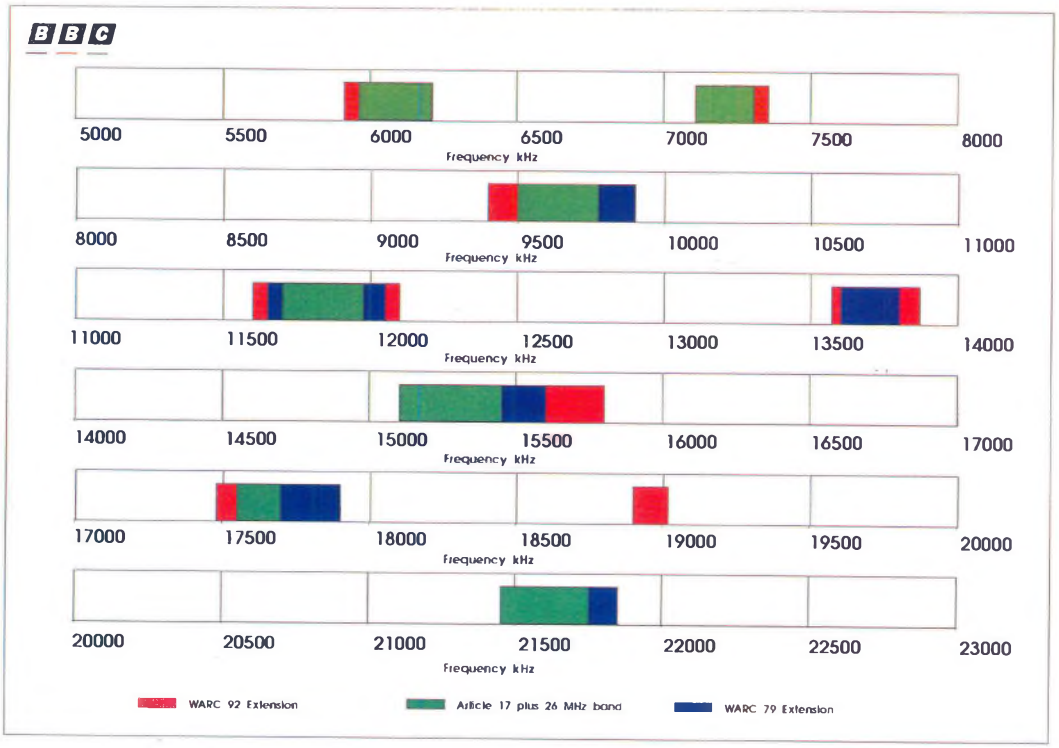


Fig 1: HFBC spectrum following WARC-92

We'll now summarise the outcome of the Conference, in those areas which concerned the BBC.

HF BROADCASTING

WARC-92 agreed an additional 790 kHz for HF broadcasting: 690 kHz located in the 9 MHz band and above, but only 100 kHz split between the 6 MHz (49 metre) and 7 MHz (41 metre) bands, where there is greatest overcrowding. (By comparision, WARC-79 provided just 780 kHz of extra shortwave frequencies — all at 9 MHz and above, with none at 6 or 7 MHz).

However, there were a number of conditions attached to the availability of this new spectrum:

- Transmission will be *single sideband* (ssb) only
- The new spectrum is to be *planned* (ie the ITU is being asked to try yet again to succeed where it failed at the WARC HF Broadcasting conference in 1987)
- The spectrum won't be available for broadcasting officially until the year *2007*

The overall result for HF broadcasting is a patchwork of spectrum as shown in *Fig 1*. This shows the existing 'regulated and available' spectrum, agreed in 1959 (Article 17 of the Radiko Regulations); the additional spectrum agreed in 1979 (but still not available for HF broadcasting); and the additional spectrum agreed at WARC-92, but not available until 2007.

SATELLITE SOUND BROADCASTING

There has been some discussion on broadcasting radio signals from satellites for the past thirty years or so. Initially HF broadcasting was considered, but this was too difficult. So people modified their ideas to FM and, more recently, *digital* operations. The hope is to provide a mixture of national and international transmissions which can be received easily without the need for complex antennas or dishes. Ultimately, the signals could be picked up on portable radios which are affordable throughout developing and industrial countries alike — as well as on car radios with simple aerials.

Previously, the problems had been largely political: the USSR had seen these broadcasts as a threat to their security. Now, with the Russian Federation and *glasnost*, the problems at this conference were technical: there was just no spectrum that was readily available. Someone would have to give up some of their services to let us in!

In the UK, the BBC had been responsible for many studies which had shown that the 1.5 GHz band was technically the best. However, it is one of the most intensively-used bands for long-range fixed links. It is used globally for a wide range of purposes: in the developing world it forms a vital part of the telephony network while, in Europe, there are also major telephony interests, with all manner of different private services operating in the gaps. Thus there was no simple way of allocating 1.5 GHz.

At the start of the conference, CEPT was pressing for an allocation at about 2.5 GHz. Several administrations thought it possible for satellite sound broadcasting to take precedence over other interests in this band. And, as UK delegates, we had to argue the case for 2.5 GHz!

Late in the fourth week of the conference, the matter had still not been resolved. Other interested parties were also seeking spectrum around 2.5 GHz for a future Mobile Satellite service, and a new Future Public Land Mobile Telecommunication System (FPLMTS,

or *Flumps* as it was called in debate). As the formal session of the Conference was getting nowhere in open discussion, a 'corridor discussion' involving interested parties evolved, and attempted to reach a compromise deal acceptable to all.

A 'state of emergency' was reached on the final Sunday night (March 1st) which resulted in the need for two successive all-night sessions. The final decisions were not reached until 0730 local time on Tuesday March 3rd — the final day of WARC 92! It was suggested that it would be sensible to put the Mobile Satellites in the region of 2.5 GHz. As *Indsat* and *Arabsat* are already operating in this band, there was no extra spectrum to allow satellite sound broadcasting in the same frequency range.

Some European countries were prepared to move to 1.5 GHz — in the hope of gaining a single worldwide frequency allocation. This was the breakthrough which the UK had to accept as the best compromise then achievable. Nevertheless there was still not worldwide acceptance, as other countries such as the USA, Japan, China and the Russian Federation have additional arrangements above 2 GHz.

At the eleventh hour, the Conference agreed a 40 MHz world-wide allocation for satellite sound broadcasting — in the frequency range preferred by broadcasters (1.452-1.492 GHz) — and resolved to convene a WARC before 1998 to plan this future service. However, the following conditions were imposed:

- Transmission will be limited to digital audio broadcasting
- The upper 25 MHz of this allocation is available for immediate use but conditional upon coordination with existing services
- There are date restrictions placed on the use of the new spectrum for satellite sound broadcasting — with many countries, including the UK, placing a *Secondary* status on this allocation until 1st April 2007
- Alternative and additional allocations at 2.310 — 2.360 GHz and 2.535 — 2.655 GHz, respectively, are available for some countries.

Fig 2 shows how countries opted to implement the world-wide allocation: those in green placed no specific restriction on implementation; those in red reduced the status of the satellite sound allocation to *Secondary* until the year 2007; and the countries in light blue added an additional national usage relating to aeronautical telemetry.

There is already considerable pressure for the rapid implementation of sound broadcasting from satellites. The European Space Agency and British Aerospace both see opportunities for experimental/pre-operational satellites in the near future. Australia and Papua New Guinea were making very positive statements about new services at the Conference, and Canada will probably

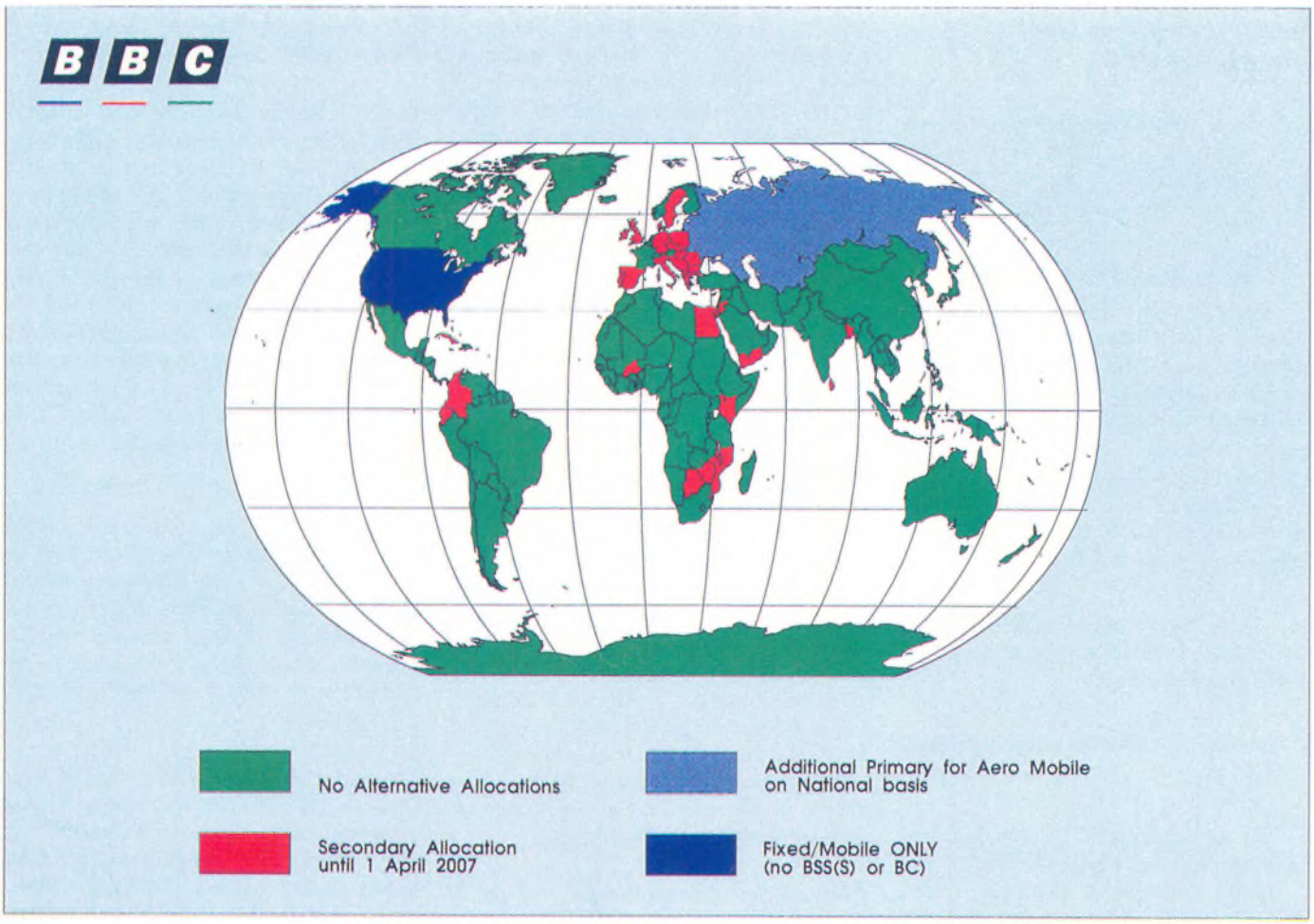


Fig 2: WARC-92 worldwide allocation, 1452-1492 MHz, for Satellite Sound Broadcasting

start an operational terrestrial service in the same band (1.5 GHz).

World Service is very interested in providing programmes over a suitable satellite system. Studies have produced technical solutions which would allow a relatively rapid introduction of a service, once the finance, programme and political infrastructures are in place. But rapid introduction before 2007 is difficult. As a consequence, we are more likely to see a terrestrial *Digital Audio Broadcasting* (DAB) system in operation before a satellite service. If DAB takes off, either by satellite or terrestrially, then there will have to be international planning of the bands concerned. (The ITU made provisions for future planning conferences to be held).

HDTV

HDTV pictures offer a major improvement in viewing experience, when compared with standard 625-line pictures. Unfortunately, the existing television bands do not offer enough spectrum to transmit a digital HDTV service, so what was wanted from WARC-92 was a new band which would allow top-quality HDTV to be transmitted.

At the start of the Conference, the EBU laid on a demonstration of digital HDTV at one of the local hotels (see *Eng Inf* No 48). The effect was mind-blowing on most of the people who saw the pictures. As a result there was no doubt in anyone's mind that real HDTV was something worth having but which would be difficult fitting into an existing DBS channel.

Those countries who have rainy climates are likely to suffer from loss of signal during heavy downpours and therefore want as low a frequency band as possible. The natural band to consider is the 12 GHz band. However this is already allocated and subject to detailed planning which puts severe constraints on any use other than conventional TV broadcasts. The Conference accepted that it might be possible, at some later date, to do something in this band, but not at this conference.

A UK proposal to use the 17 GHz band — which is used for up-links to satellites broadcasting in the 12 GHz band — was opposed at a WARC in 1988. However, as with all ideas given a bit of time, it caught the imagination of other delegations at WARC-92. By this stage, the UK had reconsidered the matter and no longer regarded it as satisfactory! Even so, this formed the basis for the American solution, and the band 17.3 to 17.8 GHz was adopted for their HDTV services.

CEPT proposed 21.4 to 22 GHz and, under pressure from the EBU, stuck to it as this is about the only band that is free of radio astronomical constraints and relatively free of users in Europe. Even so, there is intensive use of this band by Mercury in the UK and they were loath to see it reallocated to another service. Thus the UK, and hence CEPT, could only accept it if a replacement frequency allocation was provided for Mercury. This — and a timescale which limits the extent of use of the 21.4 GHz band before the year 2007 — formed the basis of the solution for the non-American world.

There is still rapid development of HDTV transmission techniques and it is not clear exactly what type of service would be offered. Whereas there are experimental satellites operating at 12 GHz, there is little opportunity at the moment to experiment at 22 GHz. Thus there is still some way to go before an HDTV system can be fully implemented. The fact that the EBU demonstrated one option in Torremolinos does not necessarily mean that this is the best way to go.

OUTSIDE BROADCAST LINKS

Outside Broadcasts use frequencies around 1.5 GHz and 2.5 GHz, both of which were affected by the decisions of the Conference. In order to provide capacity in the future, there was a suggestion that these links could share a band around 2 GHz with Space Operations.

One of the uses for the band in the United States is for ENG links. There was therefore some debate on how the band could be used by ENG links without upsetting communications links with manned space craft.

Any chance of using the bands for OB links in this country must be seen as a longterm solution because BT currently has high-power troposcatter links and some of its trunk telephony in this part of the spectrum.

CONCLUSIONS

WARC 92 has set the framework for a whole range of current and new radio-based services beyond the end of this millennium. As far as the BBC is concerned, we obtained most of the frequency allocations we set out to acquire.

However, the allocation of frequencies must not be taken as a licence to broadcast. In most cases, we still have to develop the full broadcasting system — in conjunction with our European partners — *and* obtain government backing to start any new service. This is by no means guaranteed. Unless we continue to develop our ideas and proposals there is a very strong chance that the UK allocations will never be translated into operational frequencies. Nevertheless, the timescale of *2007* for the introduction of operational services gives us ample opportunity to experiment and develop systems professionally. Thus, for some people the conference may have been the culmination of years of work, but for others it is merely the beginning.

WARCs are difficult and expensive to organise and this one was seen by many to be the last of its kind. The range of topics covered by the agenda was far-reaching, but reallocation WARCs dealing with more specific issues were considered to be the thing of the future — particularly in light of the anticipated decisions of an ITU Additional Plenipotentiary Conference, to be held in Geneva in December of this year. That conference will consider the report of a high-level Committee set up to review the future structure and working arrangements of the ITU itself.

But that's another story ...

Ian Davey
Manager, International Liaison
Broadcast Coverage Department
World Service

Peter Shelswell
Head of RF Systems Section
Research Department

NEWS & CURRENT AFFAIRS

Live news subtitling

Dave Waring describes the system which provides live subtitles for the Six O'Clock News.

On 23rd December 1991, news subtitling went live on the ***Six O'Clock News***. This was a follow-up to the original concept of subtitling the ***Nine O'Clock News*** which went live a year earlier. That system was essentially a prototype as no other system was available to cater for a mix of pre-recorded, and verbatim subtitling. Although it provided 'hooks' for expansion, the Nine O'Clock system had to be redesigned practically from the ground up.

There are other systems around the world which produce stenographic verbatim subtitling for entire programmes, and yet others where fast typists précis the spoken words and intermix them with pre-recorded subtitles. Neither of these systems is completely suitable for live subtitling of news programmes. Complete stenography is unsuitable as it is too stressful and labour-intensive — requiring at least two and possibly three stenographers to subtitle a half-hour news programme. Such a system would involve high labour costs, a reduction in accuracy, and long time delays between the spoken word and the subtitle appearing.

For news it was decided that the best results could be found by a mix of *pre-recorded subtitles* for scripted links and where material was available early enough for normal subtitling, and *stenographic input* for those parts where no scripts exist. In this context, normal subtitling is performed by a typist (subtitle editor) armed with a VHS with jog/shuttle control. This in itself is an art as the teletext system is limited to a practical subtitle width of only 34 characters so a certain degree of précising must be performed. For this purpose, News currently uses a system designed by VG Electronics called the *High Speed Subtitle System* (HS3).

The part of the system of most interest is the stenographic input. This is performed by a special keyboard equipped with only 22 keys, plus a number shift bar (as shown in the diagram). It is played more like a musical instrument than a keyboard, as the stenographer plays chords to represent sounds rather than keying a letter at a time. You can see from this that it is very easy to type words like SPORT and WORD by pressing all those keys at the same time. It is also easy to see how to get words like 'upward' and 'upheld' by pressing UP then WARD or UP then HELD. It doesn't require much imagination to extend this to seeing 'upwards' in UP WARDZ.

The skill of the stenographer is in producing all those words which don't actually have the exact letters there at all. As examples, sounds which start with an M are conventionally produced by stroking PHA and sounds which start with D are stroked as TK even though a D is available to the right hand. With a little imagination you can see how 'executed' can be written as EBGS KAOUT D. In fact any strokes used by a stenographer may be unique to that person. For example the word 'Houston' may be written by one person as HAO STOPB while another could use HU STOPB. Note the use of PB to represent a trailing N.

Obviously the viewer at home can't be expected to make sense of the shorthand which comes out of the stenographic keyboard. To overcome the problem a computer is used to convert the steno output into English (or any other language). A 3-byte word is used to represent the chord pressed by assigning a bit to each character. The computer uses these groups of 3-byte words as a look-up table associated with an electronic dictionary of all known words and phrases. It then outputs these as a serial stream which can go either to the HS3 for later editing or to an Eddystone diecast box containing a single-chip micro which then converts the Ascii stream into a subtitle. Each stenographer has his or her own set of dictionaries which typically contain around one hundred thousand words and phrases. The main dictionary contains all the words which are used in everyday language while there are separate job dictionaries for things such as real names, jargon etc.

The computer produces a simple Ascii stream which is hopefully word for word of the broadcast audio. Unfortunately this can not be broadcast directly on teletext as it requires that a series of subtitles are built up, each a repeat of the previous but with the new word at the end. For example to output 'This is a subtitle' requires the following sequence:

<HEADER> This <TRANSMIT>

<HEADER> This is <TRANSMIT>

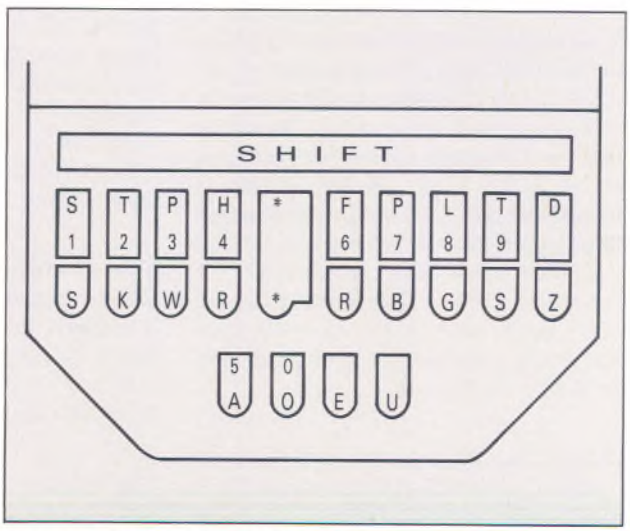
<HEADER> This is a <TRANSMIT>

<HEADER> This is a subtitle <TRANSMIT>

... where <HEADER> contains information relating to the teletext background colour, and the text (eg location on the screen, normal or double height, etc).

The mix of pre-recorded and stenographed subtitles now used by the ***Six O'Clock*** News has proved so successful that it is being extended to cover other BBC news and current affairs programmes.

Dave Waring
Projects and Planning
News & Current Affairs



Layout of Stenographer's keyboard

Printed by WOOD NORTON