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OPTICAL FIBRE NETWORKS

The use of light to transmit information along a glass fibre was first proposed in 1966 in the UK. Now the technology has advanced to the point where connections could be provided to the home and business to carry an essentially unlimited number of services such as TV, facsimile, computing, as well as telephony. However, current regulatory practice could be seen as a barrier to developing this technology in the UK, with consequent adverse effects on the UK's competitive position in opto-electronics.

This briefing note describes the present and potential applications of optical fibres and examines issues arising from the current regulatory framework within which they and competing technologies operate.

THE IMPORTANCE OF COMMUNICATIONS

Communications play a pivotal role in business, society and politics within all advanced nations. World markets for communication networks are very large - the equipment required for 500 million consumer connections costs $50- 100 billion. The UK market may approach £ 20 billion over the next decade. Communications, however, can be viewed as having other than a commodity value alone. New communications and information technologies are as important as transport infrastructure for many business developments. They also offer the domestic consumer an increased choice of entertainment and interactive services.

Historically, developments in communications have followed two largely independent paths. One has been in the one-way medium of broadcast radio and TV; the other in two-way communication typified by the telephone, using direct connections (fixed links) to the premises.

Optical fibre technology offers the potential to deliver all previous services **and** to introduce new ones such as those in Figure 1- all via a single cable entering the premises.

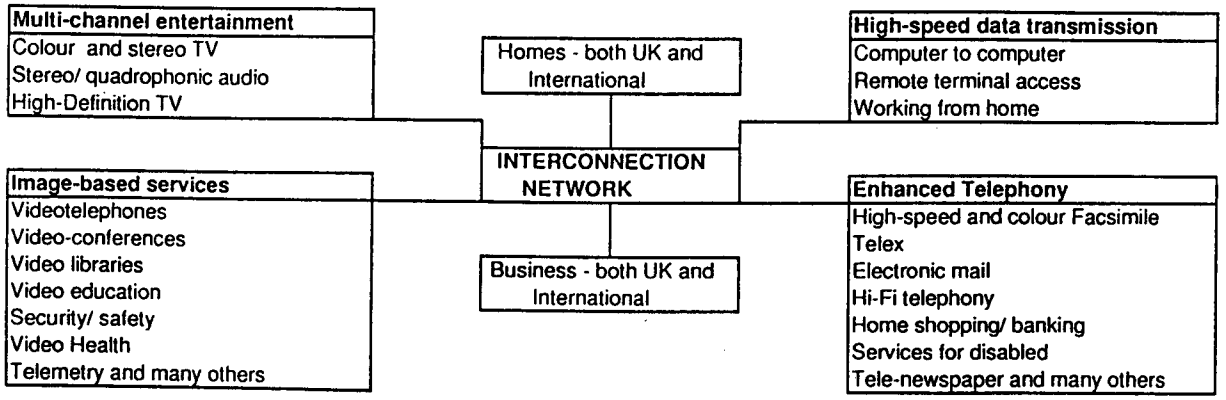
OPTICAL FIBRE COMMUNICATIONS

What is an Optical Fibre?

An optical fibre consists of a central glass fibre core, about 1/100 mm diameter supported by an outer glass cladding with slightly different optical properties. This results in light launched into a fibre being 'piped' along the core rather like water flowing down a garden hose.

Optical fibre technology has advanced sufficiently for so-called 'monomode' fibre (pioneered in the UK and carrying the equivalent of a single ray of light) to be economically useable in the field. The UK is well-placed in both terrestrial and submarine cable manufacture having a number of indigenous suppliers. British Telecom (BT) have also developed an economical, roadside installation method that makes use of ducts already existing for telephone wiring. The UK has a technical lead in some of the more advanced applications involving transmission of multiple services through the same fibre.

FIGURE 1: Potential Services provided by an Optical Fibre Fixed-Link Network



The Potential of an Optical Fibre Network

Optical fibres carry information as light, rather than as electrical currents conveyed by copper wire. An optical fibre can pass light over very large distances without distorting the signal, so that the rate of information transmission can be greatly increased - by a million times or so relative to copper wire. This means that the information-carrying capacity of fibre is effectively unlimited - termed a large "band-width". All the services shown in Figure 1 can be carried, even though many of them have very large band-width requirements. Figure 2 shows the band-width needs of some services compared to a single, digital telephone line, and the comparative physical sizes of an optical fibre and copper wire offering the same capacity.

Fibres are now no more difficult to install and use than metal wires. They are insensitive to electrical interference and also very difficult to intercept, which are advantages in safety-critical or potentially insecure communication links. The low signal loss and distortion in fibres are other advantages. Telephone lines are equipped with 'repeaters' to provide intermediate signal boosting for long-distance communication. With current optical fibres, the repeater spacing increases about tenfold over lines employing copper coaxial cables. For example, in 1988, BT laid the world's longest (126km) repeater-less optical fibre cable between the UK and Ireland.

The advantages of optical fibres have led many to advocate their adoption as the basic communications infrastructure in the UK - the so-called 'fibre-to-the-home' or FTTH network. Such a grid would form a "Broadband" Network over which it is possible to carry any service or combination of services.

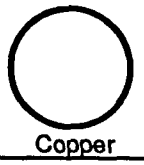
Present Status in the UK

Optical fibre is the preferred technology for high-volume long-distance links for both BT and Mercury. Over 700,000 km have been laid. In contrast, only about 5% of local loop connections (from the exchange to the individual subscriber) are carried by optical fibre. This is a result of the trade-off between installation cost and revenue earned; businesses having 25 lines are the smallest customers served.

Recently, BT has begun field trials of optical fibres at Bishop's Stortford which include single-line connections to domestic users; i.e. FTTH. Two systems are under investigation. The first uses fibre to deliver telephone services only (a narrowband system). The second is a broadband network, carrying telephony (1-5 lines), TV (18-24 channels), stereo-audio (12-16 channels) and videotex (Teletext). Within two years, the trials will provide data on operational costs and permit comparison with conventional copper systems.

Figure 2 :
EQUIVALENT BAND-WIDTH REQUIREMENTS

One telephone - - - - - - - - 1 line
One TV Channel - - - - - - - -2200 lines
One HDTV Channel - - - - - -5000-20,000 lines



Relative diameters of Copper and fibre optic cables with the same information carrying capacity.

The narrowband system is designed to be upgradable to broadband, depending on the emerging market demand for services. This evolutionary approach to optical communication is attracting much foreign interest and BT's concept could set a *de facto* European standard.

International position

Optical fibre systems are under intense development in many countries. In Germany, the Ministry for Research and Technology allocated over £200m during the '80's for the development of optical communications. The French Government has supported demonstration projects on local loop fibre networks (e.g. Biarritz), and have a more ambitious plan to connect 4.5 million households to a mixed coaxial/fibreoptic network. Demonstration projects are also under way in most other European countries. The USA and Japan are also very active, with extensive systems planned or in place. Research, development and the manufacturing base for optoelectronics and communication equipment are very strong in Japan.

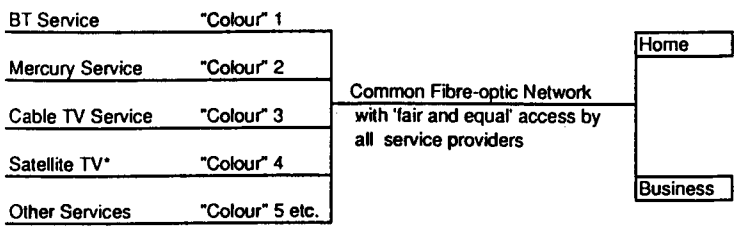
Several pan-European research programmes are also being conducted, including the European Community (EC)'s project "R&D for Advanced Communication in Europe". This programme aims to establish a healthy European optoelectronics manufacturing industry, a community-wide market for services and equipment and to provide the basis for European standards.

Assessing the current position of the UK *vis a vis* its competitors is difficult due to a lack of statistics in the UK. US trade statistics show that the UK has a substantial trade deficit in non-optical telecommunications (e.g. in 1988, the UK imported $313m from the US compared with $66m in return trade), but anecdotal evidence suggests that the optical fibre communications sector is still in surplus, on sales approaching £1000m per year.

Constraints on UK Development

Despite their higher unit costs, optical fibres are currently more economic than copper wires where their

Figure 3 : Provision of Independent and Competing Services via the same Fibre



*Relayed from central reception dish rather than to dishes on individual houses

high capacity can be exploited. Extending the fibre network further to the home or small business would however provide a capacity so far in excess of current (telephone) needs, that it could only be justified commercially if the surplus capacity was likely to be used in the near future. Current regulations, designed to encourage an open and competitive market in telecommunications, restrict the extent to which single links can be used as 'common carriers' of multiple services (e.g. telephones and TV), and are cited by many in the industry as a bar to the further development of optical fibre networks. This is discussed in the issues section, after considering other communication technologies.

OTHER DELIVERY SYSTEMS

Whilst optical fibre could act as the universal transmission medium for all broad and narrowband services, other delivery technologies, with varying degrees of performance, also exist.

Satellite: The sight of satellite dishes sprouting from the side of houses is increasingly common, as viewers take the increasing number of available TV programmes. In addition, satellites have long provided a substantial part of international communications capacity.

Cable TV: Copper coaxial cables can carry many TV channels over distances sufficient for the franchise area of a cable TV (CATV) operator. Alternatively, optical fibres can be used. CATV operators offer entertainment, local interactive services and telephony (local or national), in conjunction with BT or Mercury. By the end of 1989, CATV franchises awarded or advertised stood at 136 with a potential audience of 14 million, although the number of homes connected so far is still relatively small.

Terrestrial broadcasting: The current radio and TV services (4 channels and videotex) use allocated airwave frequencies, which are approaching saturation. Additional channels or High-Definition TV (HDTV) thus require alternative methods of delivery. Short-range, one-way communication, mainly of entertainment, are also provided by microwave radio systems, termed Multipoint Video Distribution Services (MVDS).

Mobile Communications: This is an area of rapid growth through cellular radio, cord-less telephones and radio-pagers. The one-way, cord-less communication system of Telepoint is also in development. Another UK development for mobile use is the Personal Communications Network (PCN), consisting of microwave radio stations covering small, overlapping areas. This is expected to provide a viable means of communication by the late '90's and will thus be competitive to fixed-links for telephony.

CURRENT ISSUES

Communications infrastructure

The Advisory Council on Science and Technology (ACOST) and others have seen development of a communications infrastructure based on optical fibres to all domestic and commercial properties in the UK as a desirable long-term goal in itself. Benefits were seen in creating UK-based leading technologies capable of export, and in promoting the UK to the vanguard of the communications revolution -in telephony, teleconferencing, videophony, TV, data transmission, funds transfer etc. The potential to penetrate further to publishing, education, libraries, newspapers and other services could, in turn, stimulate new industries and opportunities.

There has been considerable debate about communications infrastructure in the UK, and how far its form should be influenced by regulation. At present, licences allow cable TV companies to offer telephony services (in collaboration with BT or Mercury). On the other hand, BT/Mercury may not provide entertainment services direct to the home using their own main networks, although they are free to bid for local licences to offer such services through a separate network. ACOST noted that the effect was to divorce TV from other services and require subscribers to pay for the setting up of duplicate networks.

ACOST also noted that the 1986 Peacock Committee on BBC financing had recommended that national telecommunications systems (BT and Mercury) should be permitted to act as common carriers of a full range of services, including TV programmes, and recommended that the Government investigate options for changing the regulatory framework to encourage the installation of optical fibre networks. The Government has responded by undertaking to review the current restriction on carrying entertainment services when the 'Duopoly review' of network operators starts in November 1990. However, it is now 2 years since ACOST recommended changes as a matter of extreme urgency, and industry observers see more delay as eroding the UK's competitive position in optoelectronics.

An alternative technical means of stimulating competition, which would avoid the need for duplicate networks, could be to allow all service providers fair and equal access to communications infrastructure. The latest fibre technology, for instance, would allow simultaneous and totally independent use of a single connection by several service providers. Independence could even be guaranteed by assigning different light wavelengths (akin to different "colours") to every provider. This system is illustrated in Figure 3.

Currently there is no restriction on such a network being established locally under licence (which could involve BT or Mercury), provided that this network is separate from the existing telephone network. Whether the same system (Figure 3) could be implemented under current licences on the main telephone network is however unclear. (The Telecommunications Act 1984 used terms appropriate to earlier technology and did not envisage that multiple and independently licensed systems could utilise a single physical connection). Were it to be allowed, OFTEL's experience in ensuring fair and equal access on shared parts of the existing and future telephone network would be relevant in dealing with the regulatory issues arising.

Some say that the immediate removal of the restrictions on BT/Mercury described earlier, would leave cable companies disadvantageously placed. The cost of cable installation is high and the present restrictions might need to be maintained well into the decade to allow cable to become profitable. Others say that allowing all services to be provided over a common communications link would still enable cable TV services to compete effectively, along with other service providers.

UK Optoelectronics- Government Support

While the UK (and Europe) have not been successful in exploiting many areas of consumer electronics and information technology, the UK still has a world position (4th or 5th) in telecommunication products, and the optical sector is believed to have a small trade surplus.

In 1988, ACOST recommended two areas where government action might be effective in promoting the UK optoelectronics industry. The first was for Government and Industry to collaborate on demonstration projects. These would have the twin objectives firstly of illustrating the uses of fibre networks, and secondly of allowing UK industry to participate in the definition and production of equipment. In this way, projects such as the UK-Belgium link (supported by the DTI in 1985-6), are seen as helping generate a competitive UK technology base and component supply industry. Public funding of such projects was not accepted by the Government, and the limited trials proceeding at Bishops Stortford (budget less than £10m) are with private support.

ACOST also recommended an extension and expansion of DTI and SERC support of collaborative research. At the time of the ACOST review, this support was through the Joint OptoElectronics Research Scheme (£36m over 5 years) and the Fibreoptic and Optoelectronics Scheme (£55m from 1981-7), both of which were oversubscribed. Since the change in DTI policy away from support of single company or near-market research, both programmes have been superseded by a £30m optoelectronics programme under the LINK scheme with £15m of public funds available over 5 years.

The declining Government support above is in contrast with that in certain other countries (France has committed £300m to provide broadband domestic services; Germany, £260m, with the intent to establish a nationwide Broadband service by 1993; Japan has committed $200m to local loop development). This reveals a basic difference of approach. In some countries, communications infrastructure is likened to national transport infrastructure, justifying Government intervention. In others (including the UK and USA), it is a matter for commercial development.

The view has been expressed in the DTI's report on Communications Infrastructure that the market for broadband services will grow only slowly and that narrowband links, based on a mix of coaxial and optical fibre networks, will be sufficient for the immediate future. In this analysis, it is seen as premature to pursue policies to encourage an infrastructure with capacity in excess of current market needs. Critics see the possible penalties of this approach as: a) a slower pace of technical development and reduced experience in the UK which could reduce further our competitive position in world markets and b) an increasing reliance within our communications infrastructure on technologies which may prove obsolete in the medium term.

FURTHER READING

Additional details and background information are available from POST, 2 Little Smith St., London SW1P 3DL, tel 071-222-2688.