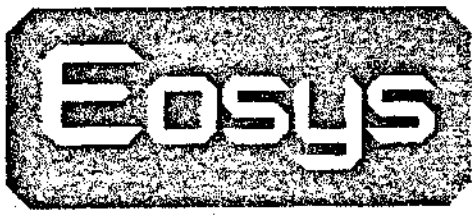

TELECOMMUNICATIONS IN THE HIGHLANDS AND ISLANDS OF SCOTLAND

REPORT TO:

The Highlands and Islands Development Board

and

The Office of Telecommunications

Highlands and Islands Development Board

1986

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On:

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This report for the Highlands and Islands Development Board and the Office of Telecommunications (Oftel) was completed in January 1986 by **Eosys Limited.** Eosys is an independent consultancy specialising in the application of advanced telecommunications and information technology.

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1 PREAMBLE

Telecommunications provide a medium for communication, between people, between machines and between people and machines. The growth in other communication facilities, car ownership and usage, air travel or newspaper readership for example substantially exceeded early forecasts. The very rapid growth experienced so far in telecommunications is merely the tip of an iceberg, and can be expected to continue unabated.

Unlike these other facilities which are energy and/or material intensive, telecommunications technology is decoupled from such influences limiting the pace of its growth. Moreover telecommunications is able to replace or enhance other means of communications.

With the merging of computer and communications technologies three key communication requirements emerge:

- instant mobile man-to-man voice and data communications at any time and place on the planet
- instant voice communication between man and machine
- instant machine to machine communication.

The past history of telecommunications has demonstrated that the market is substantially technology led. Prior to the introduction of new services, little demand can be perceived, but when established frequently the service is underprovisioned. All the technologies to meet the three requirements are available today, albeit some are in a rudimentary stage of development or confined to military applications.

It is clear that these requirements are increasingly being met elsewhere and unless the Highlands and Islands region can offer the same or better facilities, it will become substantially disadvantaged.

Telecommunications, as with previous communication facilities, provide a crucial stimulus to social and commercial activity. The commercial activity in the Highlands and Islands region for fishing, forestry,

agriculture and tourism, and so forth needs information and access to distant markets, and the support of specialist services. New technologies create new opportunities, new forms of employment, new ways of working, new life styles. The social activity of the region, the quality of life and the health and well being of individuals need links to cultural and welfare support services, as well as communication with other individuals.

All of these are dependent upon telecommunications, up to date, cost effective telecommunication services which are at least as good as those available elsewhere in the UK. Arguably because of the remoteness of the Highlands and Islands region and its widely scattered population economic and social activity is more dependent on telecommunications than more densely populated areas.

However, this report which was undertaken by Eosys for the Highlands and Islands Development Board (HIDB) and the Office of Telecommunications (Oftel) demonstrates clearly that the Highlands and Islands Region is at risk. Although there is widespread availability of the basic telephone service the existing telecommunications infrastructure does not provide an adequate foundation on which to build future telecommunication facilities, and the intensity of usage is likely to be too low to attract commercial investment in cost competitive services in the future, unless an innovative approach to the provision of telecommunications is adopted. Technology can enable the provision of cost effective services in rural areas, many of which are explored (but not costed) in this report. In addition, the recent reorganisation within British Telecom that enables more local autonomy, provides British Telecom North of Scotland with the opportunity to choose innovative approaches to the provision of telecommunications services suited to rural conditions.

2 FINDINGS

The report recommends three categories of urgent actions by the HIDB:

- actions to stimulate cooperation between various public and private sector enterprises to share communication facilities instead of each developing and maintaining their own

- actions to increase awareness of the opportunities presented by telecommunications thereby increasing its usage and benefits and, as a result, creating a more attractive market for telecommunication providers

- actions to address the problem of establishing and funding a telecommunications infrastructure for the future.

The body of the report contains detailed analyses and recommendations. The main findings are highlighted below.

2.1 Actions to Stimulate Cooperation

Recent re-allocation of radio frequencies by the World Administrative Radio Conference (WARC) and new Home Office regulations concerned with the construction of radio stations, require substantial changes by many users of mobile and other radio systems. These include the Highlands and Islands Fire Brigade, The Northern Constabulary, The North of Scotland Hydro Board, Scottish Gas, as well as numerous smaller systems run by taxi companies, transport operators, forestry enterprises, landowners and so on.

Mobile radio, in fact radio technology in general, has much to offer the region in terms of increasing the efficiency of businesses and providing a life line to very remote locations.

The large individual systems have good coverage, but are dedicated to single organisations, such as the police. In addition there are the small private radio systems scattered throughout the region.

The siting of radio stations can be subject to planning permission by the appropriate Local Authority. In most cases, each application is treated on its merits with the planners giving little concern to the relationship of the site to an overall radio scheme.

Recommendation No 1

It is recommended that existing and potential radio sites should be considered as a scarce resource within the Highlands and Islands. Radio operators should be encouraged to share facilities and plans should be formulated for the use of these facilities.

Recommendation No 2

It is recommended that the Board and the local authorities should produce an outline plan identifying the optimum sites suitable not only for local radio systems but for trunk networks and consider whether they might fund key sites to encourage public operators to establish systems in the Highlands and Islands by reducing their costs.

Although the emphasis of this study was on telecommunications for the business sector, during the course of the study Eosys has identified opportunities to use telecommunications to provide community services that would otherwise be threatened. The use of public access terminals could provide both statutory and private authorities with a cost-effective means of delivering services and information. For example, in the area of primary health care, services such as remote health monitoring may best be accomplished using telecommunications facilities; availability of employment, or undertaking financial transactions could be other applications on such a system.

Recommendation No 3

The HIDB should investigate the interests of the statutory authorities such as the DHSS, Manpower Services Commission, Post Office as well as financial and other major private sector organisations, in using common access points to telecommunication-based services. The Network Services Agency described elsewhere in this report could provide an appropriate mechanism for supporting such an operation.

2.2 Actions to Increase Awareness and Usage

Telecommunications help commercial, administrative and social activities in two ways:

- they provide easier communications with markets, suppliers and other individuals
- they make possible the provision or use of information and other services.

There has been considerable growth in the variety of telecommunications facilities available in the UK, and of services provided over those facilities. Despite some tariffing problems many of these facilities and services are available to the region.

In general, potential users are not fully aware of all that is available to them. Because of its remoteness and dispersed population, the Highlands and Islands has much to gain from more widespread and effective use of telecommunications.

Recommendation No 4

It is recommended that the Board, with substantial support from British Telecom and the major service providers, should consider producing an attractive 'marketing' document setting out clearly telecommunication facilities and services available in the Highlands and Islands, and the benefits that can be gained from using them.

Recommendation No 5

It is recommended that the Board, in conjunction with British Telecom, should identify specific sectors which stand to gain most from the use of telecommunications, and they should consider collaborating with British Telecom in a target marketing campaign.

There are, however various factors inhibiting the use of telecommunications in the region.

2.2.1 Tariffing Telephone Calls

The charge areas were devised about 50 years ago and reflected the location of the population and communities of interest. At that time a sea channel was as much a barrier to the local population as the telecommunications engineer. However, this is no longer the case and whereas in the past the engineer had to use an expensive submarine cable, high capacity radio systems are now available which are highly cost effective, even in many cases for land links.

Examining the charge structure within the region, areas on the mainland appear generally reasonable. The situation on the Islands is highly anomalous. At one end of the scale Orkney has very favourable call charges, whilst at the other end almost all calls made in the Shetlands are charged at the trunk rate. The situation for the Western Isles is about mid-way between the other two areas.

Recommendation No 6

It is recommended that the Board should negotiate with British Telecom to ensure a more equitable call charge for local calls within the Shetland Islands and Western Isles.

(Since this study and the draft report were completed, British Telecom has revised tariffs for the Shetland Islands and Western Isles. Recommendation No 6 now no longer applies).

Recommendation No 7

It is recommended that the Board and Oftel should discuss with British Telecom tariffs which reflect the economies achieved by the use of high capacity radio, especially between the islands and the mainland.

2.2.2 Data Services

Many data services use BT's Packet Switched Stream (PSS) service, either directly or through BT's MultiStream service. However, local call charge access to PSS is not yet available in the Highlands and Islands. It is expected in Inverness by 1987 at the earliest but this would not provide local call charges outside the Inverness call area.

The BT Prestel service does provide local call access throughout the Highlands and Islands and for most of the UK and there is the BT service, LinkLine, which could provide users with free access to the PSS node, with the charges being met by some third party.

Recommendation No 8

It is recommended that the Board should initiate discussions with British Telecom on how best to provide local call access to dial-up data services.

(Since the completion of this study and the draft report British Telecom has started a 3 month trial that provides local call charge access to MultiStream on a national basis using the LinkLine service described above. The trial is due to finish at the end of March 1986. We, therefore revise

recommendation No 8, and recommend that the Board should review the situation when British Telecom has assessed the impact of this trial).

At first sight, the provision of the digital trunk network in the region by 1988 would appear to be adequate to support the digital private wire service, KiloStream. However, this will make the service available to users in the main towns, but others will have to wait for digital transmission to penetrate the local network, or pay additional charges.

Recommendation No 9

It is recommended that the demand for KiloStream digital service is monitored by the Board if appropriate, and action is taken in the event of hardship.

This action could take the form of grant to a specific user for BT to provide the service, thus benefiting subsequent users within the area. Alternatively, just to be able to coordinate user demands and lobby BT may be sufficient to advance digital implementation plans, or achieve a provision schedule more closely attuned to the needs of the region.

2.2.3 Competition

Despite legislation permitting competition in the provision of telecommunication facilities very little exists or is planned for the region. Effective competition could ensure the most cost effective facilities for large users, and the provision of more efficient services to small local or specialised sectors of the market.

The main potential competitive services are:

Mercury Communications plc, which is the only alternative to licensed national communications carrier service. At present Mercury has no plans to offer services in this Region.

Racal Vodafone is currently setting up a cellular radio service in Inverness with a trunk radio link and other transmitter stations on the route from Aberdeen via Elgin.

Mercury has cooperated extensively with Racal-Vodafone elsewhere in Scotland and hence may be prepared to share facilities again in order to provide a service for large users in Inverness.

Recommendation No 10

It is recommended that the Board should explore further the reasons for Mercury's reluctance to provide services to the Highlands and Islands and what form of collaborative venture might be attractive to them.

Mobile Radio Services. Legislation and the availability of radio freqencies make possible the more extensive use of radio for voice and low speed data communications. This is particularly suited to the remote areas of the Highlands and Islands region, but currently no operator is seeking a licence to provide a service to the region.

Recommendation No 11

It is recommended that the Board should actively seek a wide area mobile radio operator for the Highlands and Islands, offer pump priming funds and support the licence application.

2.2.4 Network Services Agency (NSA)

There is a need to establish in the Highlands and Islands an 'information and interactive services' organisation that will act as an 'umbrella' for business and community services delivered over telecommunications networks. This organisation could be called the 'Network Services Agency' (NSA). The main body of the report highlights the services that could be offered by the NSA, some of which are basic services, others which support the indigenous industries and others that can help to overcome the problems created by dispersed population and peripherality of the region. The organisation should be concerned with telecommunication requirements, host

computer resources, the availability of terminal equipment (at the place of work, home and community centres) and the marketing and management of services. This organisation will be required because:

- the characteristics of the Highlands and Islands peripherality and dispersed population will mean that services of value to users in the region may not be actively marketed by national Value Added Network Service (VANS) providers

- the uniqueness of the regional economy in terms of employment structure and geographic dispersion generates unique requirements

- by coordinating what would otherwise be disparate initiatives, the NSA could maximise upon opportunities to justify improvements to the basic telecommunications infrastructure

- by stimulating the production of these services, the Highlands and Islands will gain experience in information handling which could, in time, have valuable export potential.

Recommendation No 12

It is recommended that the Board initiates a study to define the terms of reference, organisation and budget for a Network Services Agency to provide a focal point, stimulus and advice for business and community services, and coordinate the provision of regional network(s).

2.3 Actions to Create a Telecommunications Infrastructure

2.3.1 Digital signalling

The telecommunications infrastructure is currently provided by BT, and they can be expected to continue as the dominant party.

A major revolution is taking place in telecommunications with the move from wave form analogue communication signals, to digital signalling. This is explained in the body of the report, but in essence, digital signalling enables higher quality, more reliable, more flexible and cost effective communications. The way ahead in telecommunications is in digital signalling, and the infrastructure needs to be able to support it.

BT, along with most other telecommunications authorities throughout the world, is digitising its network with System X and Y exchanges, and putting in place an Integrated Services Digital Network (ISDN) to carry the services of the future.

There are two elements to the infrastructure, the exchanges or switching nodes, and the links between them. Serious long term problems exist with the manner of providing digitisation of both elements.

2.3.2 The Exchanges

There are three types of exchange which are anticipated to be in operation in the Highlands and Islands in the mid 1990s.

The Digital Main Network Switching Units (DMNSU) linked to the digital trunk network will provide an adequate core for digital and ISDN services. However, to connect to them many subscribers have to pass through one or more, smaller exchanges many of which will not support digital services for the ISDN at all (TXE2 and TXE4A) or only partially (UXD5).

The TXE4A and TXE2 exchanges represent a particular area of concern when considering a coherent digital network within the region. Many of these exchanges are at the start of their lives and would not be expected to be replaced until well into the next century. Some of them occupy key positions in the network and thus will deny the benefits of ISDN not only to their own local users but the users on exchanges subordinate to them.

2.3.3 The Links

User to Local Exchange

For the links between the users and their local exchange, the situation in the Highlands and Islands is similar to other parts of the UK. To provide digital services on these links BT has devised a variety of techniques which should be equally applicable in the region as elsewhere.

Inter-Exchange Links

The real Achille's heel in realising a digital network is the inter-exchange links. Almost all of these links use analogue transmission and are of a variety of technolgies. In some cases existing cables can be used for digital working with new transmission equipment at either end of the link. However, in most cases extensive refurbishment, or even complete replacement, of the existing system is required.

The establishment of an infrastructure capable of supporting digital working and the ISDN is essential if the Region is to be provided with cost competitive communications in the future. The existing plans of BT will not provide this.

Recommendation No 13

It is recommended that the Board should enter into discussions with British Telecom and with major funding agencies, including the European Commission, to establish how an adequate infrastructure for digital working can be established.

2.3.4 Fibre Optic Transmission

In addition, the region will, in the next century, require high bandwidth communications that will be provided elsewhere in the UK. This could be accomplished using either satellite or fibre optic transmission. It is our belief that fibre optic transmission will be the most flexible and cost effective medium. However, the use of radio for trunk transmission in the existing network, which is cost effective in the short term, may reduce BT's willingness to upgrade the network to fibre optic media.

Recommendation No 14

It is recommended that a feasibility study should be undertaken into the future provision of a comprehensive distribution network down to local level based on alternative routes for fibre optic cabling, including those currently owned by British Telecom. This will require consultation with British Rail, the North of Scotland Hydro Board and others.

3 CONCLUSION

Telecommunications, by their nature, permeate all aspects of economic, administrative and social activity in all parts of the Region. This report identifies opportunities that telecommunications present as well as problems to be overcome. The report contains a variety of recommendations, requiring actions by many different people and organisations. Some of the recommendations require action by HIDB in an enabling role; others have major financial requirements beyond the capabilities of the Board.

Recommendation No 15

It is recommended that the Board should institute a Regional Telecommunication and Information initiative to retain the momentum of this study and progress its recommendations. Judgements will need to be made as to the priority that should be awarded to each recommendation and the resources they will require.

SECTION 2 MAIN REPORT

1 INTRODUCTION

This report contains the results of a study completed for the Highlands and Islands Development Board (HIDB) and the Office of Telecommunications (Oftel) by Eosys Limited into the current and future availability and use of telecommunications in the Highlands and Islands of Scotland.

The principal objectives for the study, contained in the Eosys proposal presented in September 1985, were:

- to provide a description of the telecommunications facilities that are currently available in the Highlands and Islands or are likely to be available in the near future
- to identify telecommunications media that will be most effective for the Highlands and Islands from the year 2000 onwards
- to identify application opportunities to exploit the existing and future telecommunications infrastructure.

The study concentrated on the current and future requirements of business rather than the needs of the home or the community.

The study was completed during the last quarter of 1985.

The methodology used during the study consisted of:

- Discussions with network operators, principally British Telecom (BT).
- A small number of face-to-face and telephone interviews with large and small users. These interviews were supplemented with discussions with HIDB staff who have knowledge of the principal indigenous industries within the region.
- Desk research using information already held within Eosys. This encompassed two areas: market research information on telecommunication facilities and Value Added Network Services (VANS), and a library search of studies and previous reports undertaken by Eosys.

- 'Brain storming' and internal discussions within Eosys, and with the HIDB and Oftel staff.

- Database searches using online, bibliographic databases to obtain relevant information on services provided to remote areas in other countries.

In addition the HIDB established an Advisory Group consisting of representatives of development agencies concerned with telecommunication issues related to remote areas, representatives of the local authorities in the Highlands and Islands Region and a representative of the Advisory Committee for Telecommunications (Scotland).

We thank the Advisory Group for providing valuable input into this study. We expect that the results of this study will be of interest to the organisations represented in the Advisory Group.

2 BASIC TELECOMMUNICATION FACTS

This section is concerned with telecommunication facilities relevant to the needs of the region. An overview of telecommunications in general is presented in Appendix A. There are, however, some key aspects of general telecommunications that will contribute to the understanding of this section, and these are summarised below :

- **Voice and data traffic.** Overall, traffic can be categorised as either voice or data. The major difference is that the ear and the brain can tolerate a great deal of interference on the line before the voice becomes incomprehensible, whereas the transmission of data, particularly at high speeds, has to be far less prone to interference.

- **Analogue and digital.** Analogue systems use a wave form similar to a sound wave, to carry the communication through the communication medium, such as a telephone wire. This is very suitable for the voice, but far less satisfactory for data communication. Digital systems use electronic (or light) pulses to carry the communication and provide a much more precise representation. Digital systems are far more satisfactory for data communications, and also provide higher quality voice communications. They are being progressively introduced throughout the world. Systems X and Y are the code names for the digital exchange equipment being installed by BT.

- **Integrated Services Digital Network (ISDN).** This is used to describe a network that has been completely converted to digital communication. To connect to this network a subscriber either uses a local analogue line (which to some extent defeats the objective of the ISDN) or will be provided with Integrated Digital Access (IDA).

- **Circuit and Packet switching.** Communication between a sender and a receiver is achieved in one of two ways. Either a complete link is established between the two, available exclusively to them until their communication ceases, or packets of information are despatched through the network, each with the address and a sequence number, to be reassembled before delivery. Packet transmission makes much more efficient use of the network and is used extensively for data communication. It is not currently appropriate for voice traffic, although this may change.

- **Switches and transmission links.** A network consists of two elements: the media (cables or radio channels) which carry the communications and which link the switches or exchanges: these in turn direct the traffic according to its destination. Normally a communication will pass through a hierarchy of links and switches.

- **Switched and direct links.** The telecommunication service widely available to the public is the switched service. However large users, or those with special requirements, can establish direct point to point connections, usually by leasing links from BT, making arrangements with Mercury Communications or in certain circumstances, providing their own facilities.

- **Private networks.** A number of large national and international organisations maintain their own networks. These often consist of a mixture of links leased from BT and their own facilities. By law they are not permitted to carry third party traffic.

- **Transmission media.** Various types of media, each with its own performance characteristics, are described in Appendix A. The main types are the 'twisted pair', co-axial cable, fibre optic cable, microwave (terrestrial) radio, and satellite radio.

- **Transmission capacity.** This is usually measured as bits per second. This is the number of bits, or binary digits, that can be transmitted in a second. For example, normal speech requires 64 thousand bits per second. The measure is usually given as Kbps Mbps, where K = 1 thousand, M = 1 million, or even Gbps, where G = 1,000 million.

- **Cellular Radio and Private Mobile Radio (PMR).** These represent two types of radio telephone facility. Both can transmit calls to and receive calls from the normal telephone network.

2.1 Public Telecommunication Facilities

The public telecommunication facilities in the region by 1987 are summarised in Tables 1 to 3.

2.1.1 British Telecom

BT is the major provider of telecommunications facilities in the region. The BT services that are currently available, or will be available by 1987, are shown in Table 1. The basic telephone service provided by BT is adequate, being comparable to that found elsewhere in the UK. Advanced, digital and data services are very sparse and there is a risk that the Highlands and Islands will lag behind the more populated areas of the UK until well into the 1990s. Before the reasons for the risk can be examined it is necessary to explain the overall structure of the UK network.

The Public Switched Telephone Network (PSTN) is hierarchical with the trunk transmission system being at the top and the individual telephones connected to local exchanges being at the bottom. Figure 1 is a simplification of a part of the network showing the key components.

The trunk network consists of high capacity links (multiples of 2,000 voice channels) forming a backbone up the country interconnecting all the major exchanges. At the present time many of the trunk links in the region are either analogue coaxial cables, or analogue microwave radio. However, BT has embarked on a vigorous programme of enhancement and the majority of the links should be digital (140 Mbps or greater) by 1988. Figure 2 shows the proposed digital trunk network.

The mix of transmission media anticipated to be used in the UK is shown in Figure 3 and, as can be seen, optical fibres will prevail in the long term. Within the region the nature of the terrain will mean that digital radio systems will predominate. At the present time fibre optic links are only planned for the link from Inverness to Ullapool.

TABLE 1

AVAILABILITY OF BT SERVICES BY 1987

SERVICE	AVAILABILITY IN H & I	AVAILABILITY IN REST OF UK	COMMENTS
Telephone	Universal	Universal	• BT licence requirement • Only refuse if property very remote or not permanently occupied • Very rarely change for cost of extra plant to remote location • Disparity in tariffs between mainland UK and the Islands, with the Shetlands being most disadvantaged. • There are no low cost routes in the region. • Approx. 100,000 residential lines and 22,500 business lines in H & I.
Telex	Universal	Universal	• Approx. 450 lines.
Analogue Private Circuits	Universal	Universal	• Some isolated problems caused by unavailability of transmission plant.
KiloStream	Inverness only	Main urban centres	• The provision of KiloStream is primarily dependent on BT's programme to digitise the trunk network. The trunk links should be in place by 1988. • Links could be provided elsewhere in H & I region if of sufficient number and part of a larger private network throughout the UK.

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SERVICE	AVAILABILITY IN H & I	AVAILABILITY IN REST OF UK	COMMENTS
MegaStream	Universal	Universal	• Always require new plant and hence available on demand.
SatStream	None	London, Aberdeen	• Dependent on the availability of KiloStream/MegaStream for linking to the earth stations • SatStream is intended for high-capacity international links. It is not cost-effective for domestic communications.
Packet Switch Stream (PSS)			
• Character terminals • MultiStream	Universal, but costly to access	Universal • PSS nodes in main urban centres • Local call access to MultiStream for 90% of population	• Closest nodes are in Aberdeen, therefore long-distance call charges are incurred, or costly Dataline is used • A Dataline is effectively a private circuit, but the cost is distance independent and standard throughout the UK. • The result of incurring long-distance call charges means a Data line is most effective for 105 or more hours per annum in H & I, whereas elsewhere in the UK it is only economic for more than 585 hours per annum.

SERVICE	AVAILABILITY IN H & I	AVAILABILITY IN REST OF UK	COMMENTS
PSS (Cont'd)			
• Packet terminals	Universal	Universal	• Standard rental charge throughout the UK for all speeds • Availability of high-speed lines could be a similar problem as for KiloStream
Star Services	Inverness only	Main urban centres	• Many of the rural exchanges, which are UXD5s, could support Star Services, but the necessary digital transmission facilities between exchanges are not available.
IDA/ISDN	Inverness only	Main urban centres	• As for Star Services.

TABLE 2 AVAILABILITY OF MERCURY SERVICES BY 1987

SERVICE	AVAILABILITY IN H & I	AVAILABILITY IN REST OF UK	COMMENTS
Leased line • 64 Kbps • 2 Mbps	None	• Main cities and locations close to the trunk network	• Closest locations to H & I is the Glasgow/Edinburgh loop and the spur up to Aberdeen. These are scheduled for 1987.
Switched Services • circuit • packet	None	• As above	• Mercury has a licence requirement to serve 90% of the UK population by 1990. As these 90% are contained within 65% of the land area, H & I have been ignored on these grounds and also on the cost of providing a service in the region.

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TABLE 3 AVAILABILITY OF RADIO SERVICES BY 1987

SERVICE	AVAILABILITY IN H & I	AVAILABILITY IN REST OF UK	COMMENTS
BT Radiophone (System 4)	• Inverness & the East coast up to Wick • Part of Cowal closest to Glasgow	• Good, apart from rural areas	• Being phased out to be replaced by Cellnet • The service is uneconomic to provide in the sparsely populated areas.
BT/Securicor Cellnet (Cellphone)	• Inverness & the East coast up to Wick • Fort William	• Good, apart from rural areas	• Cellnet has a licence requirement to provide 90% of the UK population by 1990 • The service is uneconomic to provide in the sparsely populated areas.
Racal-Vodaphone	• Inverness	• Good, apart from rural areas	• As for Cellnet.

SERVICE	AVAILABILITY IN H & I	AVAILABILITY IN REST OF UK	COMMENTS
BT Radiopaging	• Inverness, East coast, Islands. Main exception is central and Western highlands	• Very good, apart from mid-Wales	
Securicor Relayfone	• Inverness and the East coast up to Wick	• Good, apart from mid-Wales	

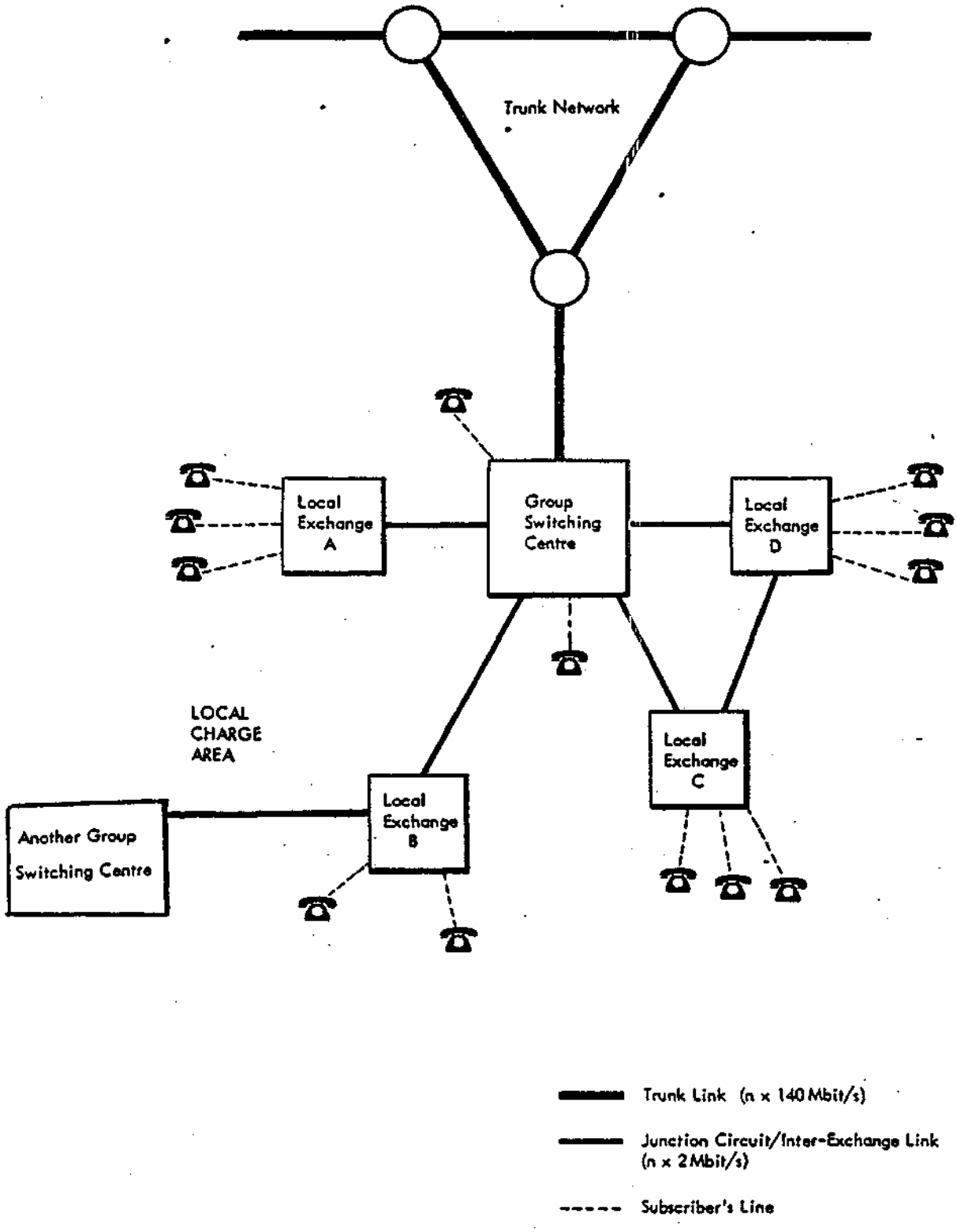


Fig 1 Simplified Structure of the PSTN

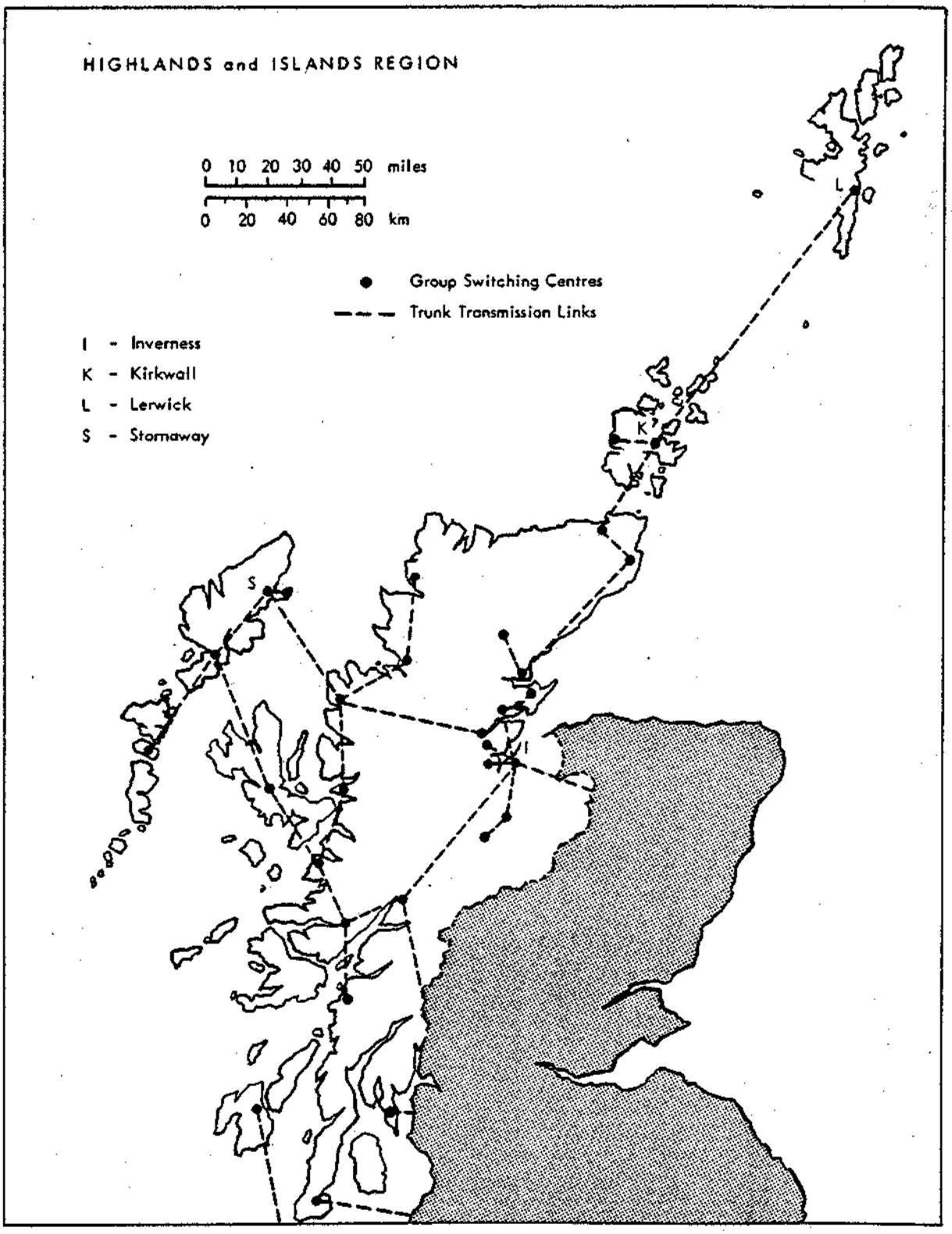
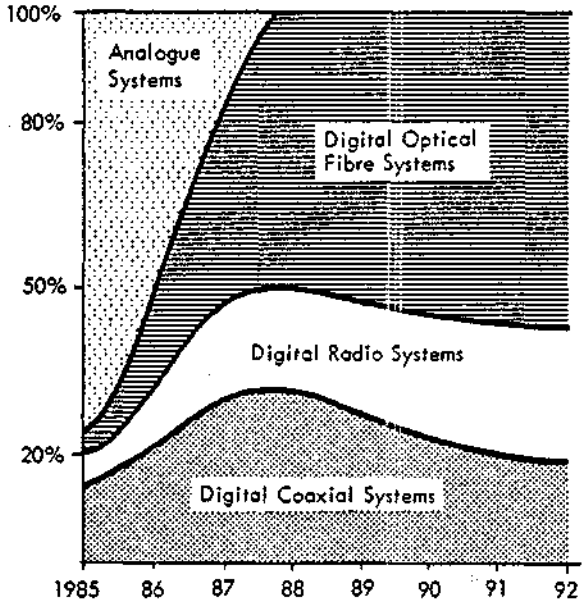


Fig 2 BT's Proposed Digital Trunk Transmission Network

The digital trunk network carries not only voice channels for the PSTN but also the XStream digital services, such as KiloStream, MegaStream point to point links and the Packet Switched Stream service (PSS).

Returning to Figure 1, the main town within an area is served by a major exchange called the Group Switching Centre (GSC). Inverness is an example within the region. The GSC is connected to the trunk network. Smaller towns and villages within the area, having a community interest with the main town, have their local exchanges connected to the GSC (local exchanges A, B, C and D in Figure 1).

The GSC thus handles the routing of trunk traffic, traffic between the local exchanges and its own local subscribers.



Source : Higgs,G: IEE Conf Pub No 246 March 1985

Fig 3 System Mix - BT Trunk Transmission Network

In most cases a call from one local exchange to another would be routed via the GSC. This can be seen from an examination of a "dialling codes" book where a single 9 digit is used to access the GSC and then other digits are used to route the call onward to the required local exchange. Referring again to Figure 1 it can be seen that a call from local exchange A to local exchange D is routed via the GSC, whereas

exchanges C and D have sufficient traffic between themselves to justify an additional link cutting across the hierarchy.

The exchange types and the mix expected in the early part of the next decade is shown in Table 4. Digital Main Network Switching Units (DMNSU) are large System X exchanges which act as GSCs. UXD5s are small digital exchanges based on the popular Monarch PABX and used in rural areas to provide service to about 200 subscribers. TXE4As are medium to large reed-relay exchanges which provide no support for digital facilities. The TXE2 is similar to the TXE4A but for small to medium sized exchanges. Figure 4 shows the location of the GSCs in the region.

Table 4 Current Mix of Exchanges in the Region

Exchange Type	Percentage Mix
DMNSU	35
UXD5	30
TXE4A/TXE2	35

Until recently, the small exchanges have been the old electro-mechanical design called Strowger, but BT intends to replace all of these with UXD5s by 1995. BT's prime motive in replacing electro-mechanical exchange with digital switches is to reduce the maintenance and other operating costs rather than to provide digital facilities.

The UXD5 is part of the System X range and is capable of supporting digital transmission and providing advanced facilities. What is less certain is its ability to form part of the ISDN. ISDN was certainly not one of the design requirements of the UXD5 and internal architecture of the UXD5 is incompatible with the interface requirements for ISDN. It will be costly to upgrade the UXD5 to support ISDN facilities.

The TXE4A and TXE2 exchanges which do not support digital services represent an area of concern when considering a coherent digital network within the region. Many of these exchanges are at the start of their lives and would not be expected to be replaced until well into the next century. Some of them occupy key positions in the network and thus will deny the benefits of ISDN not only to their own local users but to the users on exchanges which are subordinate to them.

Users to Local Exchange

For the links between the users and their local exchange, the situation in the Highlands and Islands is similar to other parts of the UK. To provide digital services on these links BT has devised a variety of techniques which should be equally applicable in the region as elsewhere.

Inter-Exchange Links

The real Achille's heel in realising a digital network is the inter-exchange linking (junction circuits). Almost all of the links use analogue transmission and are of a variety of technologies. To achieve a digital network these links need to be 2 Mbps (8 Mbps or 34 Mbps for higher capacity links). In some cases existing cables can be used with new transmission equipment at either end of the link. However, in most cases extensive refurbishment, or even complete replacement, of the existing systems is required.

A GSC and its immediate local exchanges usually corresponds to a local call charge area. Calls to exchanges outside this area are based on distance or the existence of a natural barrier, such as a mountain range or the sea.

The charge areas were devised about 50 years ago and reflected the location of the population and communities of interest. At that time a sea channel was as much a barrier to the local population as to the telecommunications engineer. However, times have changed and the people within the Highlands and Islands are more mobile and hence small communities are much less isolated, particularly on the Islands. A sea channel is no longer a barrier to people and should not be so to the telephone engineer. Whereas

in the past, the engineer had to use an expensive submarine cable, now high capacity radio systems are available which are highly cost effective, even in many cases for land links.

Examining the charge structure within the region, areas on the mainland appear generally reasonable. The situation on the Islands is highly anomalous. At one end of the scale Orkney has very favourable call charges, whilst at the other end almost all calls made in the Shetlands are charged at the trunk rate. The situation for the Western Isles is about mid-way between the other two areas.

It is understood that Orkney managed to win a concession from BT some years back. This needs to be further investigated to determine the reasons for the change so that similar arguments can be applied to call charges in the Shetlands in an endeavour to realign them more with other areas of the UK.

(Since the completion of this study and the draft report, British Telecom has revised tariffs for the Shetland Islands and Western Isles).

In addition BT should be persuaded to reflect the economies achieved through the use of high capacity radio in their tariffing, especially between the Islands and the mainland.

The telex service provided by BT in the Highlands and Islands is supported by the telex exchange in Inverness. Links to the users are via the same transmission equipment as used for telephones, however, telex tariffs are not distance dependent.

2.1.2 Mercury Communications

Mercury Communications plc, the only other licenced national telecommunications operator at the present time, has no plans to offer services in the Highlands and Islands. However, Racal-Vodafone who provide cellular radio services are currently setting up a service in Inverness with a trunk radio link and other transmitter stations on the route from Aberdeen via Elgin. (See Section 2.1.5 below).

Mercury has cooperated extensively with Racal-Vodaphone elsewhere in Scotland and hence, may be prepared to share facilities again in order to provide a service in Inverness. This option needs to be pursued.

2.1.3 BT Radiophone (System 4)

BT's Radiophone system was previously known as System 4, having replaced System 3. There are still a few users on System 3 but it is being withdrawn in 1986.

System 4 is a wide area Private Mobile Radio system allowing users to make calls via the PSTN or to other mobiles. It uses a limited number of high-powered base stations and repeaters. The UK is divided into a number of zones each operating at different frequencies. Unlike cellular radio, System 4 does not allow automatic hand-off from one zone to another.

System 4 has base stations covering the east coast of the Highlands up to Wick, plus a station on Cowal. The service is being phased out to be replaced by the cellular radio system Cellnet. Current users are being offered favourable trade-in terms to move onto Cellnet.

The coverage is shown in Figure 4.

2.1.4 BT/Securicor Cellnet

Cellnet is a cellular radio system. The service has a chain of radio stations up the East coast to Wick and stations around Fort William. They have no early plans for significant coverage in the region.

The coverage is shown in Figure 5.

2.1.5 Racal-Vodafone

Racal-Vodafone provides a cellular radio service. They have stations around Inverness joined by a chain of stations via Elgin to Aberdeen. They have no early plans for significant coverage in the region.

The coverage is shown in Figure 6.

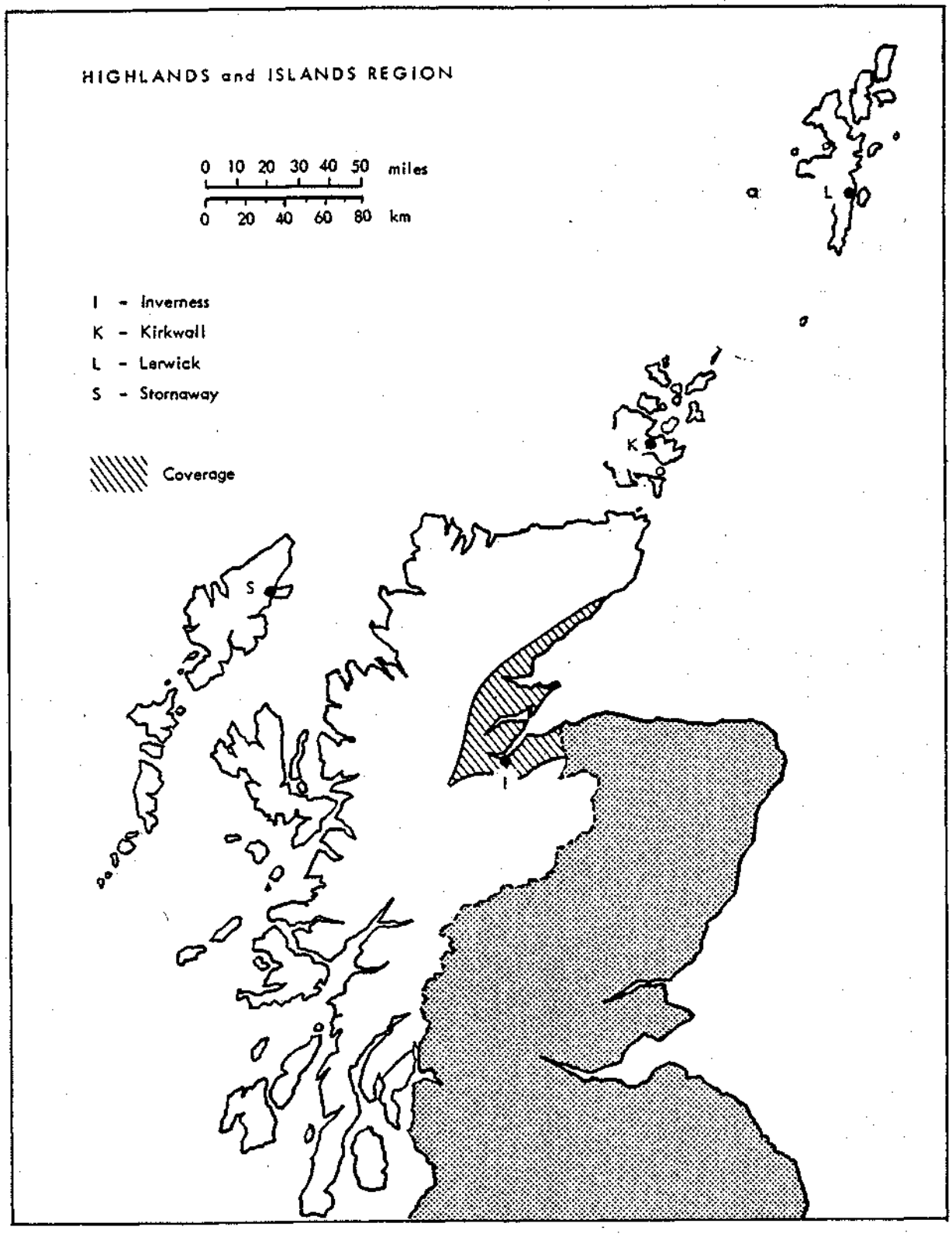


Fig 4 BT Radiophone Coverage

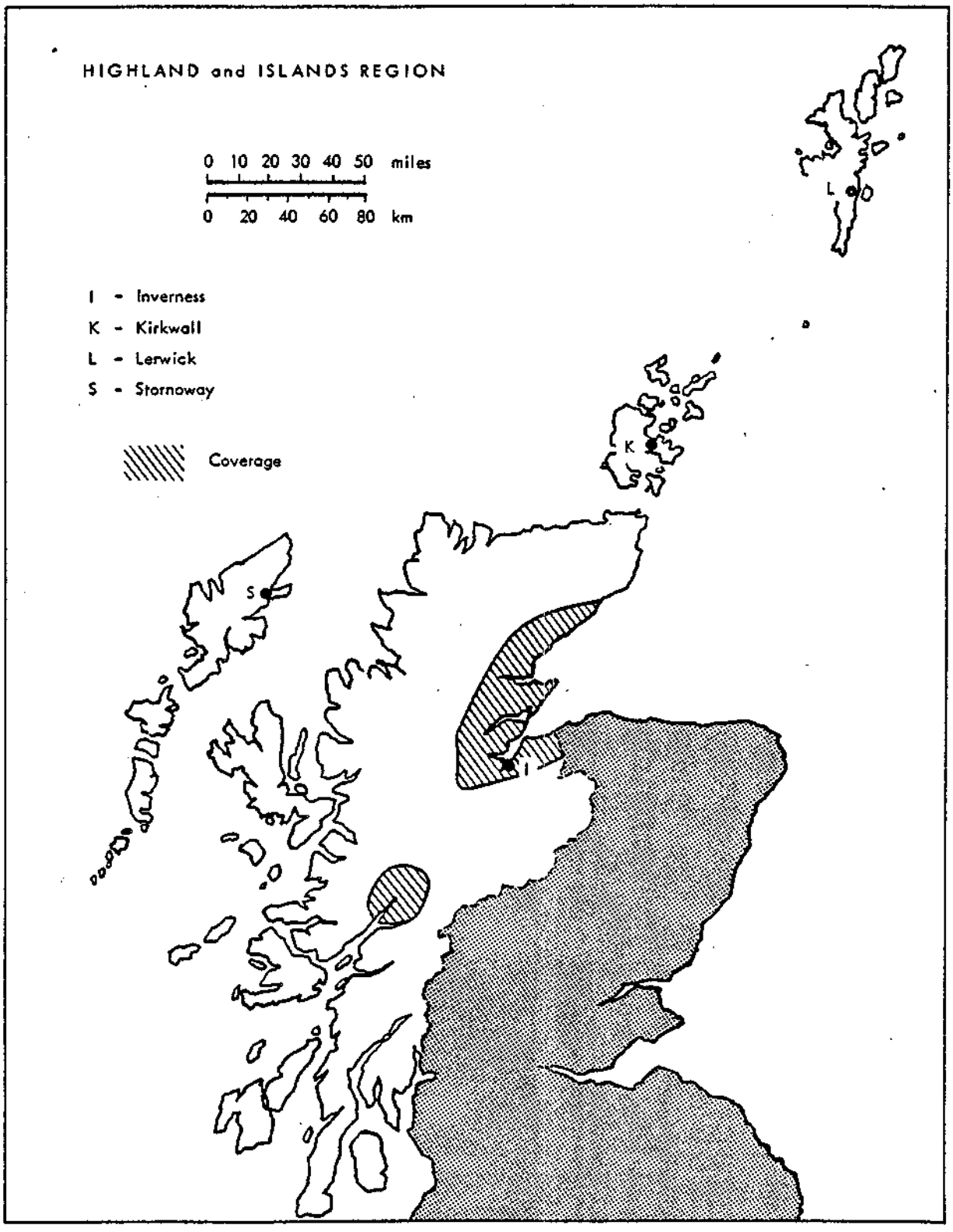


Fig 5 Cellnet Coverage

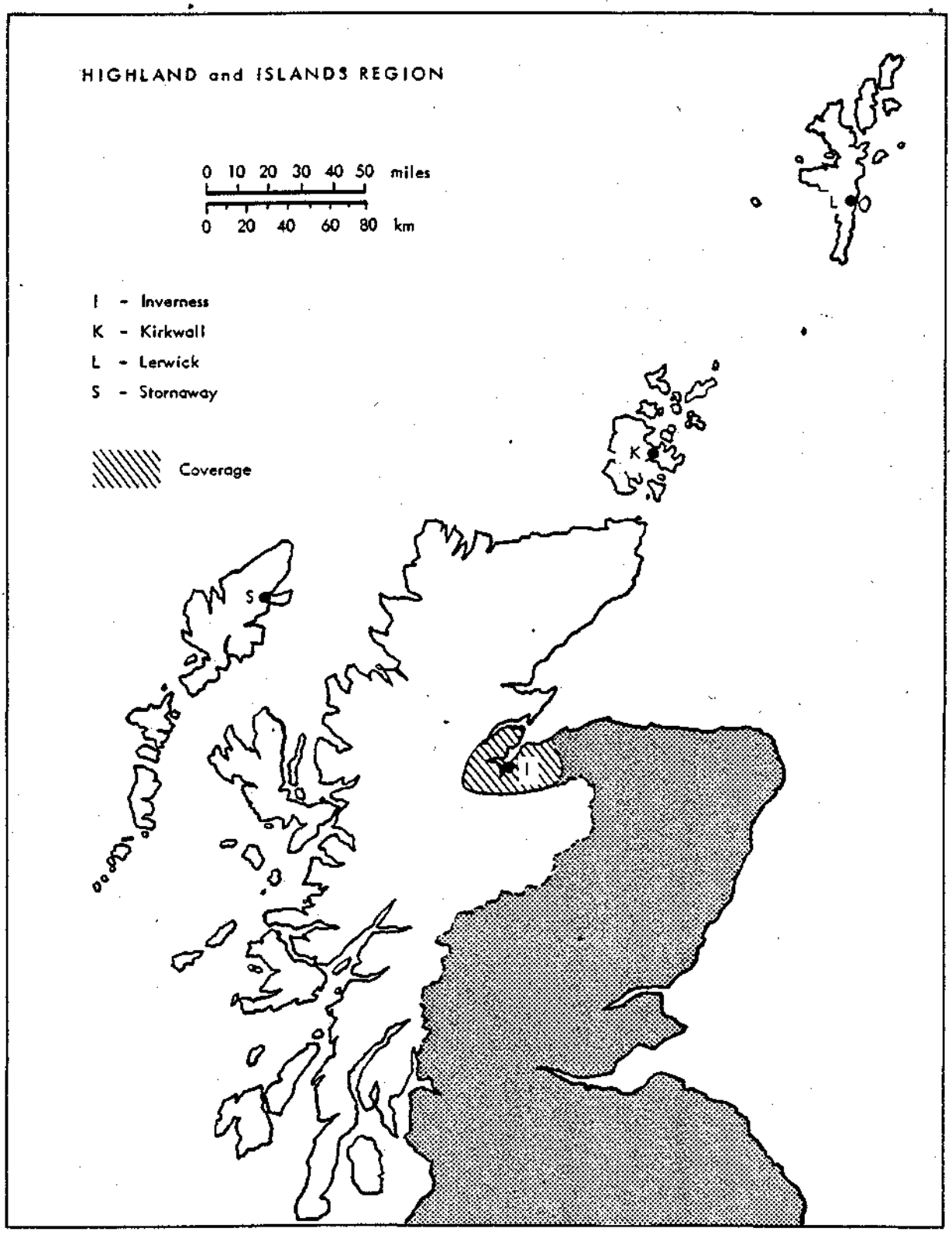


Fig 6 Racal-Vodafone Coverage

2.1.6 BT Radiopaging

Radiopaging is provided by BT in the region with a network of transmitters giving the coverage shown in Figure 7, in common with the rest of the UK, message pagers as well as the simple tone pagers are supported.

2.1.7 Securicor Relayfone

Securicor Relayfone provides a message handling service. Coverage is available in Inverness and on the east coast up to Wick.

Figure 8 shows the coverage.

2.1.8 Mobile Radio Services in Bands I and III

The Department of Trade and Industry and Oftel are currently considering applications from organisations wishing to provide national and regional mobile radio services using Bands I and III. The DTI has not yet received an application from an operator to provide service in the region.

2.2 Private Telecommunication Facilities

2.2.1 Electricity Industry

The electricity generation utility in the region is the North of Scotland Hydro Board. The Hydro Board is responsible to the Secretary of State for Scotland and is independent of the Central Electricity Generating Board (CEGB). The CEGB supplies electricity in England and Wales, although there is close cooperation between the two Boards in order to provide a common electricity grid throughout Britain, the National Grid.

The Corporate Telecommunications Network (CTN), set up and managed by the CEGB, is used by the CEGB and Area Boards throughout England and Wales. The CTN, however, does not extend further north into Scotland than the Hydro Board's headquarters in Edinburgh.

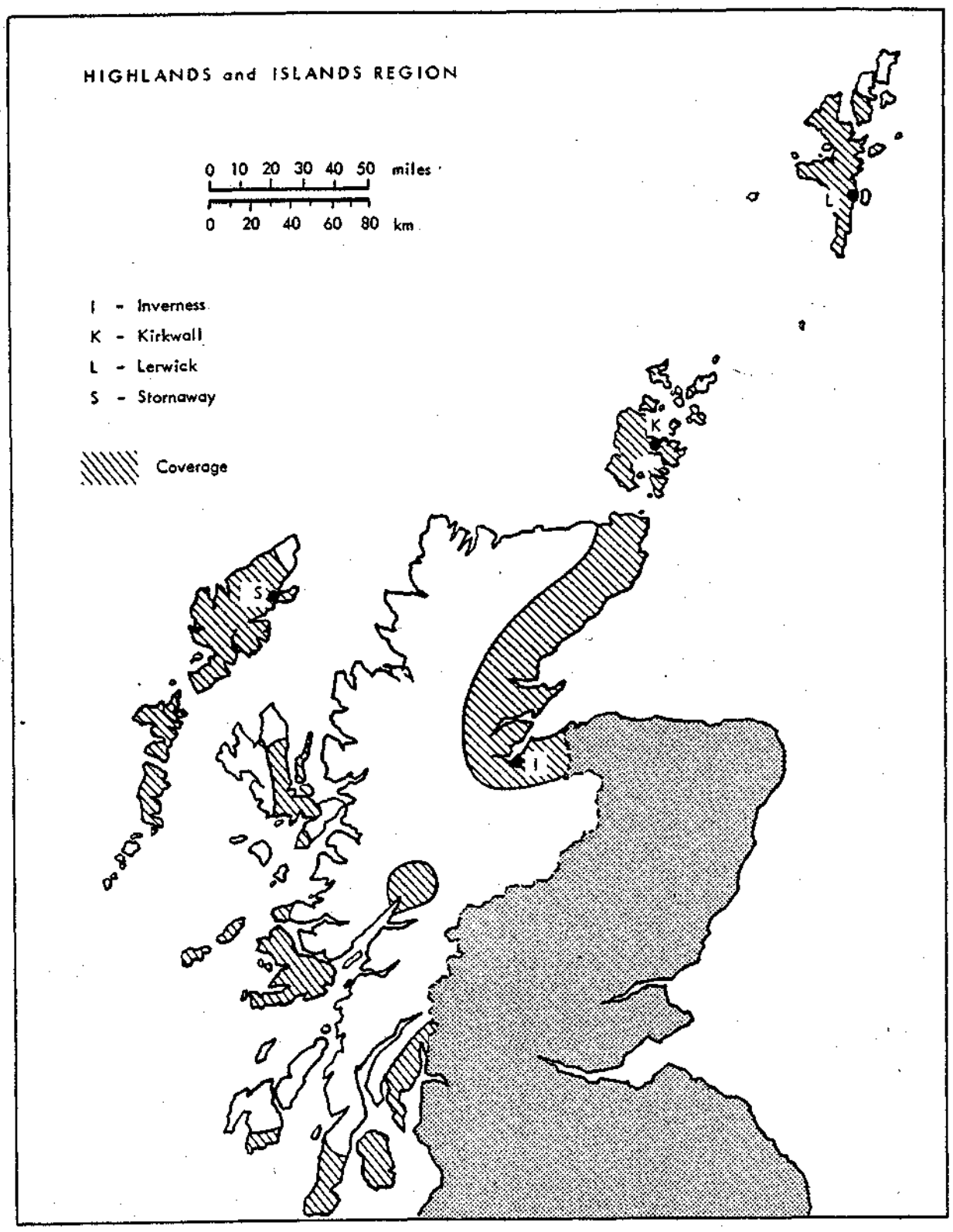


Fig 7 BT Radiopaging Coverage

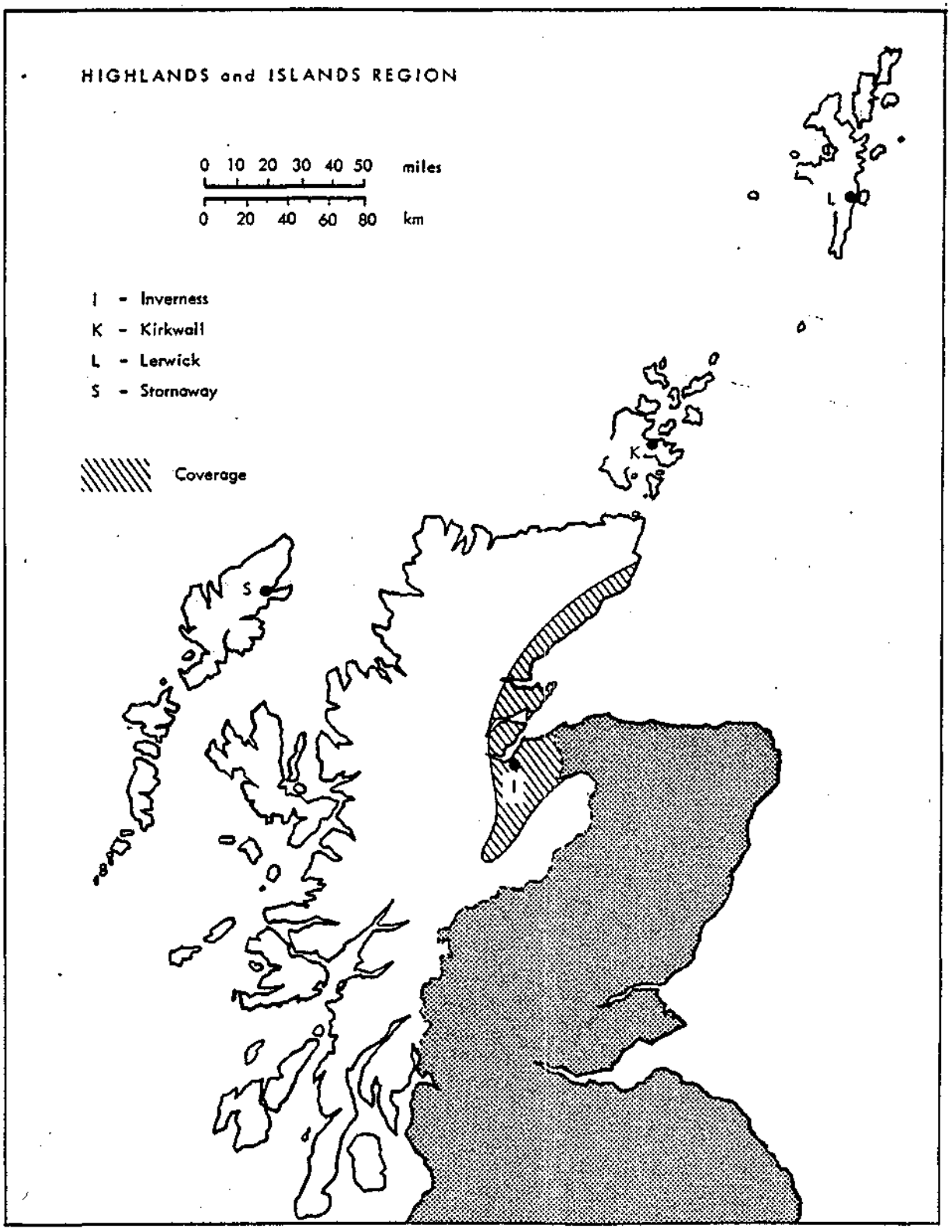


Fig 8 Securicor Relayfone Coverage

A large VHF radio network is used by the Hydro Board in Scotland which provides coverage over most of the region. The radio network is mainly used for mobile radio but a small number of channels are allocated to telemetry and control. Microwave radio is used for trunk links, however, most of these are outside the region. Very few BT private leased circuits are used by the Hydro Board in their telecommunications network, primarily because of the cost.

The Hydro Board has about 80 radio stations in the Highlands and Islands. A typical station provides a tower for radio antennae and an equipment shelter. The Board is willing to lease facilities to other radio operators and believes it is the major owner of radio stations in the region.

Another telecommunication transmission mechanism used by the Hydro Board is the power line carrier which enables information to be transmitted over the electricity power lines. The power line carrier is used solely by the Hydro Board, not elsewhere on the National Grid. The Board only uses the technique in very restricted applications and does not intend to extend them. The main limitation of the mechanism is the limited range of frequencies available.

2.2.2 Post Office

The Post Office (PO) has an existing private voice network and is considering establishing a data network. The voice network interlinks 165 large offices throughout Britain using private automatic branch exchange (PABX) interconnection via BT private circuits. There are no offices in the region connected to the network. This is mainly because of the cost of the necessary private lines, but also because there are few offices of sufficient size to merit the facility.

The data network being considered is primarily for the counter automation project, which will provide computing facilities in POs to automate transactions with the public. The project is still in the pilot phase and is unlikely to make inroads into Scotland, and particularly the Highlands and Islands for at least three years. The data network will most likely take the form of a private packet switching network over BT private circuits.

2.2.3 Scottish Gas

The natural gas pipeline network has very little presence in the Highlands and Islands. The depot at Inverness is the most northern extremity of the network. Coal gas is also supplied at eight other locations in the region through small independent operations.

The Inverness depot has a microwave link to the network control centre at Grantham. This link is used for telemetry and for voice communications.

Scottish Gas operates an extensive mobile radio system serving about 2,000 mobiles throughout Scotland. An overlay on the system provides call-out facilities activated automatically by alarm sensors at the depots.

The Scottish Gas radio service is independent of other users and providers mainly for security reasons, but also because it is operating in areas where coverage provided by other carriers is poor.

2.2.4 Emergency Services

The Highland and Islands Fire Brigade operates in most of the region. The Brigade operates an extensive mobile radio system covering about 75 per cent of the area.

The existing radio system is VHF and uses 29 hilltop sites, but World Administrative Radio Conference (WARC) requires the Brigade to move into the UHF band. As a consequence the Brigade is increasing the number of hilltop sites to 60.

The Northern Constabulary is responsible for policing in the Highlands and Islands. The Constabulary has a mobile radio system which is more extensive than the Brigade's with about 10 per cent more hilltop sites. New frequency allocations also require the Constabulary to change its equipment.

2.2.5 United Kingdom Atomic Energy Authority

The United Kingdom Atomic Energy Authority (UKAEA) has a major installation at Dounreay plus a few smaller sites in the same general locality. The headquarters of UKAEA is Risley in Cheshire and this is the centre of an analogue wideband network which is used for voice, plus a small amount of data.

The UKAEA at Dounreay was very reluctant to disclose any information about the use of telecommunications facilities on its site.

2.2.6 Scottish Office Departments

The Crown Office and the Procurator Fiscal Offices are considering data links over the next ten years to minicomputers in Glasgow, Dundee and Aberdeen. No firm plans have been made for other locations as a telecommunications strategy is still being formulated.

The Scottish Courts Administration is considering links to the courts, but no firm plans have yet been made.

2.2.7 Central Government Departments

Neither the Department of Health and Social Security (DHSS) nor the Department of Employment (DE) have any plans to install telecommunication networks in the region in the immediate future.

The Manpower Services Commission (MSC) is currently installing a nationwide data network to interconnect the majority of their offices. None of the MSC offices in the Highlands and Islands apart from Inverness, will be connected, because the size of the offices and their type of operation do not require a connection.

2.2.8 Oil Industry

Major oil terminals exist at Sullom Coe in Shetland and Flotta in Orkney. Private circuits from BT are used to link the PABXs at the terminals to Aberdeen. The communications to the oil rigs are provided from Aberdeen.

Digital services would be an advantage to the terminals but currently BT does not have the necessary facilities to provide them and there is no evidence that Mercury Communications plans to do so.

2.2.9 Miscellaneous Radio Systems

Within the region there are a number of small radio systems run by taxi companies, transport operators, forestry, landowners, etc. Many of these systems need to be replaced to comply with new Department of Trade and Industry regulations or the recent allocation of radio frequencies.

The standard of upkeep of the radio stations is highly varied with the best being well constructed and maintained, whilst the worst have towers of questionable safety and buildings little more than chicken shacks. Sharing of facilities occurs at some sites but this has as much to do with the relationship between the different local radio operators as technical radio reasons.

At the present time, many operators are having to re-equip and upgrade their radio stations. In some cases they are having to establish new sites because of the need to move to new frequencies, or new regulations relating to the construction of radio stations.

2.3 Network Services - VANS and MDNS

2.3.1 Network Services

A new industry is emerging based on exploiting basic telecommunication facilities by transmitting and selling services through the network or by making the network itself more useful to the end user. The first category is called Value Added Network Services (VANS), whilst the second is referred to as Managed Data Network Services (MDNS).

In order to provide either a VANS or an MDNS a licence is required, currently from DTI. There is much confusion, especially over the definition of an MDNS, proposals for revised and more relaxed licencing requirements by DTI have now been published.

2.3.2 Value Added Network Services

Prestel is the most widely available VANS, with Information Providers (IP) offering a range of services. These include Home Banking, Home Shopping, access to all sorts of information and so forth. Other VANS applications include such things as text messaging, various bureau services, transactional services or information retrieval facilities. VANS may be accessed using private networks or over the PSTN. Their ready availability can offer ways to improve efficiency, thus if they are not available they could reduce business competitiveness in the region.

The present situation in the region of the principal UK VANS providers is that:

- Prestel offers 100% local call access
- Istel and ICL have a node in Inverness
- ICL, Datec and Telecom Gold's nearest nodes are situated in Aberdeen
- Geisco's nearest node is in Glasgow
- IBM did not disclose availability of access - this is subject to demand from users.

VANS applications may be accessed via PSS/MultiStream. However, in the Highlands and Islands local call access to PSS/MultiStream in Inverness is unlikely to be available until 1987 at the earliest. It should be noted that even if a PSS/MultiStream node was installed in the near future, in Inverness this would not offer local call areas outside the Inverness call area.

2.3.3 Managed Data Network Services

Increasingly it is becoming possible for operators, especially those with extensive networks, to now offer facilities comparable to those supported by BT's services, particularly PSS. In this respect, these can provide an alternative to BT or Mercury's data services. This form of usage is likely to become more

important to larger organisations when the current issues surrounding the MDNS licence are resolved.

An issue of particular importance to the Highlands and Islands is the extent to which the resale of capacity will be permitted. If it is, this would allow an operator to purchase an amount of data communications capacity from BT or Mercury and resell perhaps in smaller units to a number of users. It might be possible as a result to provide a cheaper service to those users than that provided by BT.

2.4 The Legislative and Regulatory Scene to 1990

2.4.1 Background

The current legislative and regulatory framework has been established by :

- the Telecommunications Act 1984
- statements issued by the Minister of State for Information Technology on 17 November 1983 and 20 July 1984
- licences issued to the Public Telecommunication Operators (PTOs)
- Branch System General Licence.

2.4.2 'Fixed Link' Services : Voice and the Conveyance of Basic Data

Government statements have established that three licenced Public Telecommunications Operators, BT, Mercury and the City of Kingston-upon-Hull, will be the only service providers for public interactive voice and basic data services including packet switched networks (notably BT's PSS service) between static locations (mobile locations are covered by the radio service operators) until at least 1990.

The PTO's customers will be able to resell capacity on private circuits from a PTO for voice communication but not before 1989.

The concept 'Managed Data Networks' is described in another section of this report. It is likely that the use of residue PTO capacity for data transmission, by VANS operators, will be legal in 1986.

The support of the 'duopoly' is principally to ensure that the PTOs are able to meet their obligations to provide a commercially sound 'universal' service and not to discriminate against individuals, organisations or areas of the country.

Specifically, Section 3 of the Telecommunications Act 1984 provides the Secretary of State and the Director General of Telecommunications with licensing and enforcement powers to "secure that these are provided throughout the United Kingdom, save in so far as the provision thereof is impracticable or not reasonably practicable, such telecommunication services as satisfy all reasonable demands on them including, in particular, emergency services, public call box services, maritime services and services in rural areas".

The Director General of Telecommunications can interpret what services are reasonably practicable for BT to supply. It is likely that, as a general rule, the Director General would not require BT to make services available unless it was commercially practical to do so. However, the liberalisation of telecommunications gives other service providers the opportunity to provide services in the region.

Current legislation does not preclude the PTOs' purchasing capacity on private networks - eg microwave networks used by public utilities - and selling interactive voice and basic data services based on these networks to the public. In the same way, the PTOs have the sole right to use metropolitan cable networks to provide public voice and basic data services.

The Branch Systems General Licence controls the use of private circuits leased from a PTO and the telephone system within a users' premises. The principle behind this licence was to liberalise the use of private networks without enabling the PTO's customers to effectively 'resell' capacity and thereby divert revenue from the PTO.

In its most liberal interpretation legally separate organisations can use a private network to communicate, however the number of 'hops' is limited as to whether the call uses the PSTN. (A 'hop' is a private circuit between two branch systems). Only one 'hop' can be used if the call was initiated or received over the PSTN, or two 'hops' if the message did not, at any stage, use the PSTN.

The 20 July 1984 statement suggests that these conditions may be interpreted even more liberally if individual organisations make a suitable case:

"The Secretary of State will accordingly be prepared to grant licences to individual applicants whose proposals for the use of private circuits significantly enhance the economic performance or the mutual business interests of a defined but closed group of users. The number of connections between different legal groups of companies might well exceed those allowed under the General Licence arrangements. The Government will also be prepared to grant Individual Licences in respect of proposals which provide significant facilities which are not normally available from, or which complement the facilities provided by, public telecommunication operators in the UK".

In summary, the Government's position is:

- to protect the 'duopoly' of supply of voice and basic data services until at least 1990
- by protecting the 'duopoly' in the short term the PTOs will be able to fulfil their 'Universal Service' obligations, minimise duplication of investment in the basic infrastructure and present a coherent range of services to the user
- to permit other service providers to offer voice and basic service where these services are not provided by the duopoly as long as this does not undermine BT's or Mercury's ability to provide a universal service.

2.4.3 Radio Services

Cellular Radio
The Government has licensed two PTOs, Racal/Vodafone and Securicor/BT, to offer national mobile radio services that are interconnected to the PSTN.

The PTO licences issued to the two cellular operators require the provision of service to that part of the UK where 90 per cent of the population lives. This does not include the region.

The Licencees permit these operators to provide only mobile connections, the trunk networks connecting base stations to the PSTN must be provided by either BT or Mercury.

Mobile Radio and Paging Services
BT used to issue licences to mobile radio operators under the terms of the 1981 Act. This responsibility has now been taken over by DTI. A licence is not required (outside the Wireless and Telegraphy Act which controls frequency allocation) to operate mobile radio where :

- the system is dedicated for use by one organisation and is not interconnected with the public network
- the system does not convey messages from a third party.

Currently DTI is formulating a General Class Licence to cover the systems that do not conform to the above conditions.

Private Mobile Radio Systems conveying 3rd party messages require a separate licence.

These services currently :

- are regional rather than national
- can sometimes provide automatic connection to the PSTN.

The 'ending' of black and white TV broadcasting at the beginning of 1985 has enabled the Government to open up more frequencies for PMR operators. DTI and Oftel are currently running competitions for operators for these services in the middle sub-band of Band III. Licences are under consideration to national and regional PMR systems. The Government is only likely to license national PMR systems that at most provide very limited interconnection with the public network; interconnected national mobile radio will be provided by the two existing cellular operators. In addition, the assignment of further frequencies for national radiopaging services is being considered.

Data on Cellular and Public Mobile Radio
There are no restrictions on the transmission of data on cellular radio or PMR systems, except that approval is required for modems used for this purpose. We understand that, at the time of writing, two modems have received British Approvals Board for Telecommunications (BABT) and have received approval for connection to the cellular networks.

2.4.4 VANS

As part of the Government liberalisation programme, service providers were permitted under the Value Added Network Services General Licence (1982) to offer certain services. These services were allowed only when they met certain criteria specified in the general licence. Live speech services were excluded but voice store and forward services were permitted. Packet Switched Networks (PSNs) are considered basic services so proposed services that did not add value to these networks would not receive a licence. The intention of Government was to create new industries to meet users needs without enabling service providers to simply resell private circuits leased from the PTOs.

2.4.5 MDNS

This is covered in the recently published proposals for more relaxed licencing requirements of MDNS. Under the MDNS proposals operators offering managed networks would be licenced separately. Suppliers of value added services would be covered by a revised general licence. The proposed definition of value added services is more comprehensive than that of the 1982 licence.

It is likely that this will enable service providers to provide networks that 'manage' the provision of basic data networks.

BT's licences requires BT to provide connection to the public network to VANS operators without discrimination. In this respect, BT will have to provide other VANS operators with the same facilities as they currently provide to a BT VANS operator such as 'Prestel'.

3 APPLICATION OPPORTUNITIES

The previous section described the availability of basic telecommunications facilities in the Highlands and Islands. This section identifies opportunities for applications to use telecommunications within the region.

Applications that use the telecommunications infrastructure need to reflect the general character of the region:

- peripherality ie remoteness from the large urban centres
- dispersion of population within the region.

Applications to be encouraged should support specific needs:

- the requirements of the indigenous industries (fishing, farming, crafts, tourism)
- to attract inward investment
- to generate new employment opportunities within the region.

3.1 Current requirements

As a result of interviews with key users and suppliers four categories of users have been identified. These categories are listed in Table 5 against the principal telecommunications Services they access.

TABLE 5 : Current Use of Telecommunications Facilities

User Groups	Principal Requirements
1 Public Utilities Emergency Services Banks Large-scale Industry	Voice (leased circuits and PSTN), Telemetry, Mobile Communications, Medium to High Speed Data Communications
2 Local Government/ Central Government	Voice (Leased circuits and PSTN) Telemetry, Database access (education), Medium to High Speed Data Communications
3 Small Manufacturers Financial and Professional Services (excluding Banks) Farming Fishing Tourism Craft Independent Knowledge Workers Retail	Voice, Electronic Mail, Telex, Online Databases, Slow-speed Data, Mobile Communications
4 Home Community Services	Voice (including public call boxes); Slow Speed Data

In terms of the User Groups listed in Table 5 in the short term :

- All users will require inexpensive access to the PSTN for voice. The issues raised by the existing tariffing system will continue to be important, especially to the users in the Islands.
- User Groups 1 and 2 will also require access to KiloStream services to develop private networks and eventually access to IDA/ISDN services.
- Groups 3 and 4 will increasingly require inexpensive access to dial-up data services operating at relatively low speeds.

3.2 Current Applications

The following significant applications that exploit the existing telecommunications infrastructure have been identified during the course of this study :

- the 'Hi-Line' tourist booking services facilitating hotel booking within the region
- the Western Isles Islands Council's educational software service for schools in the Western Isles which enables schools to receive educational software over the public telephone network
- the MSC's 'Job Searcher' scheme involving the use of public access viewdata terminals in libraries to deliver information about MSC programmes.

3.3 Opportunities to use Telecommunications to the Benefit of the Region

3.3.1 Network Services Agency

The use of VANS offered from outside the Highlands and Islands (transactional services such as ICL's Tradanet, electronic mail services such as Telecom Gold and information retrieval services such as Datasolve's World Reporter) can assist the regional economy by increasing efficiency, by enabling goods and services produced within the area to be sold elsewhere and can generate economic activity by selling VANS services elsewhere in the UK and abroad.

However, unless the Highlands and Islands harnesses the opportunities presented by VANS in the short-term, VANS could also detract from the region by enabling goods and services to be sold more easily into the area thus causing a net outflow of resources to pay for the services themselves.

There is a need to establish in the Highlands and Islands an 'information and interactive services' organisation to provide a focal point and stimulus for business and community services delivered over telecommunication networks. The organisation should be concerned with the telecommunication requirements, host computer resources etc.

The organisation, that could be called the Network Services Agency (NSA), is needed because:

- the characteristics of the region, peripherality and a dispersed population, will mean that services of value to users in the region may not be actively marketed by national VANS providers
- the uniqueness of the regional economy in terms of employment structure and geographic dispersion generates unique requirements
- by coordinating what would otherwise be disparate initiatives, the NSA could maximise upon opportunities to justify improvements to the basic telecommunications infrastructure
- by stimulating the production of these services, the region will gain experience in information handling which could in time have valuable export potential.

Although the emphasis of this study was on telecommunications for the business sector, during the course of the study Eosys has identified opportunities to use telecommunications to provide community services that would otherwise be threatened. The use of public access terminals could provide both statutory and private authorities with a cost-effective means of delivering services and information. For example, in the area of primary health care, services such as remote health monitoring may best be accomplished using telecommunications facilities; availability of employment, or undertaking financial transactions could be other applications on such a system.

The HIDB should investigate the interests of the statutory authorities such as the Health Authorities, DHSS, Manpower Services Commission, Post Office as well as financial and other major private sector organisations, in using common access points to telecommunication-based services. The NSA could provide an appropriate mechanism for supporting such an operation.

3.3.2 Services to be provided or initiated by a NSA

Some of the services that could be offered over a regional network are listed below.

Scheduling/'Clearing House'

- Skills availability (craft, tourist industry)
- Local sharing for freight transport
- Passenger Transport Sharing
- Tourist Services

Information

- Local News
- Tourist Information
- Farming Information
- Market Price Reporting (Fish and Livestock)
- Up-to-date information for the professions
- Educational Information/Telesoftware
- Employment Opportunities

Transactional Services

- Teleshopping
- Homebanking

3.3.3 Marketing Goods and Services Produced in the Region

Problems caused by the remoteness of the Highlands and Islands from its national and international markets could be overcome using telecommunications by :

- Ensuring that customers outside the region receive rapid response to queries. This could be achieved by using 'Freefone' or other charge-free telephone facilities together with the means to update regional marketing information, possibly using a regional network.

- The use of videoconferencing to demonstrate and display goods to overseas clients. In this respect the region may benefit from the proximity of Inverness to Aberdeen which has a 'SatStream' link.

3.3.4 Knowledge Based Industries

The knowledge based industries do not require proximity to major markets or sources of raw materials but can be enhanced and extended by the use of telecommunications. Individual activities, some of which are currently being carried out in the region, and which could be further developed are :

- the production, management and maintenance of online databases

- information broking

- translation services

- software development and publishing.

Knowledge based industries that require capital investment but which could be established in the region include :

- environmental monitoring services

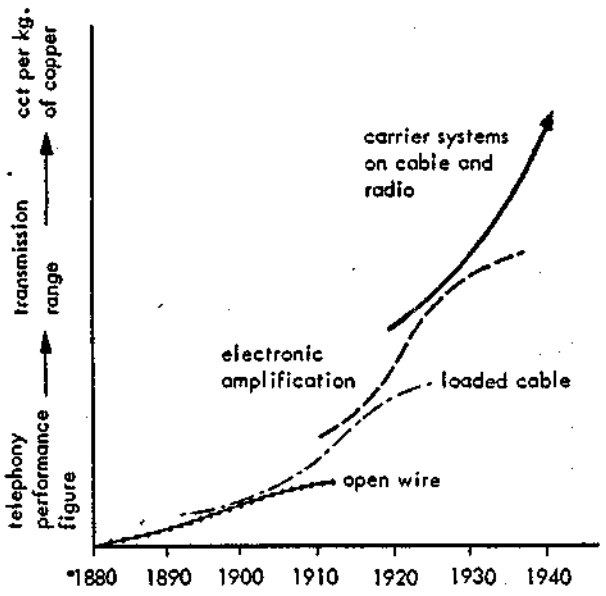
- weather monitoring and reporting

- Computer Aided Design (CAD) bureaux and design bureaux

4 TELECOMMUNICATION OPTIONS FOR THE YEAR 2000 ONWARDS

4.1 Technology Options

Before examining the current position and future trends in telecommunications technology, it is useful to gain an historical perspective. The continued expansion of telecommunications over the past 150 years has followed the classic logistic curve of a slow start-up, technical improvement, gathering momentum, leading to eventual saturation (and sometimes decline for individual technologies). However, in common with other complex technologies, the arrival of new inventions, coupled with rapid innovation and implementation, has created the illusion of continuing exponential growth. As is indicated in Figure 9 this occurs naturally as each new curve overlays the previous one, masking the physical limitations of successive engineering solutions.

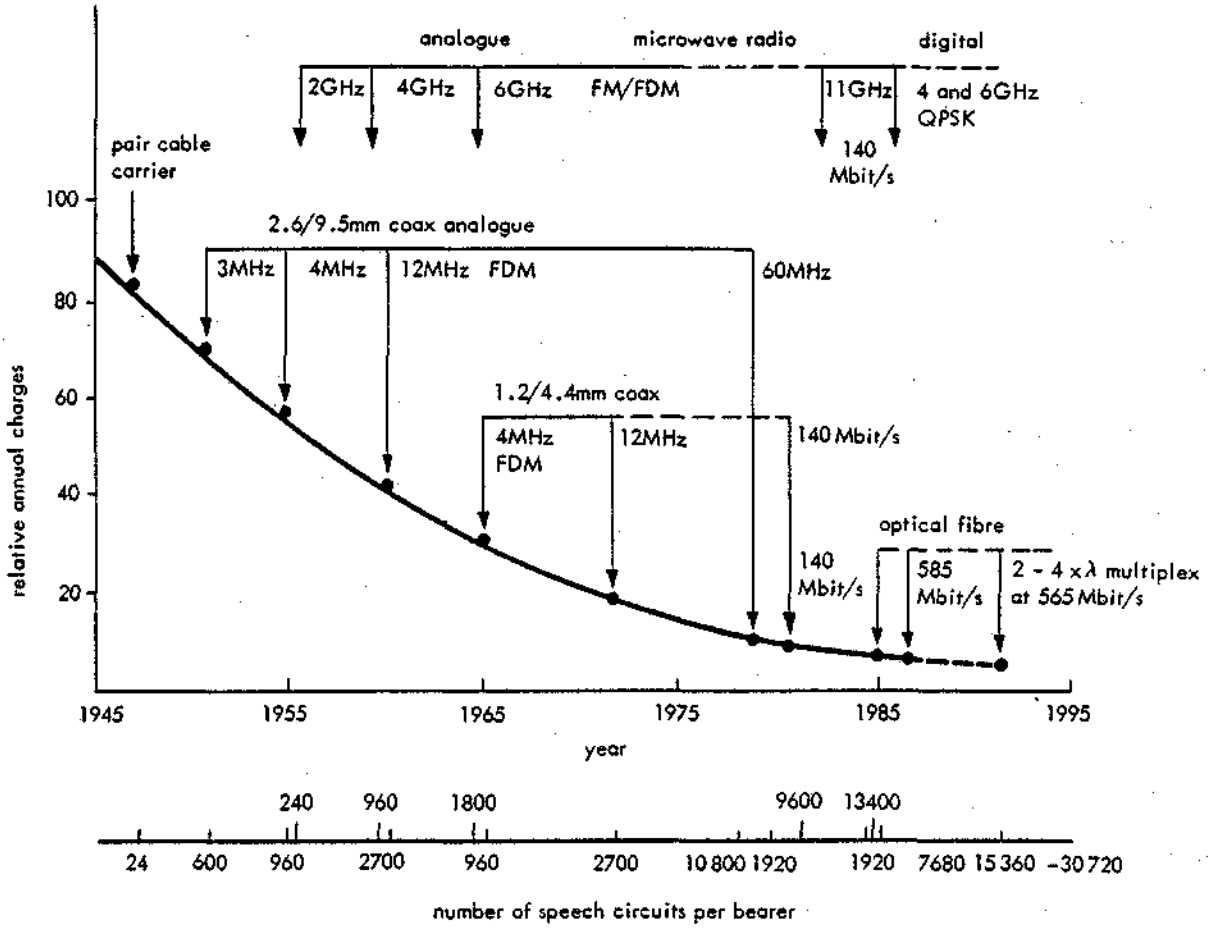


Source: Cochrane, P: IEE Proceedings, Vol 131, PtF, No 7, December 1984

Fig 9 Logistic Curve for Transmission System Development

Principal among the developments has been the widespread use of the transistor and integrated circuit since 1965. This has allowed the deployment of digital transmission and switching systems associated with sophisticated terminal equipment. These developments have, in turn, led to

significant increases in the traffic capacity of copper pair and classical cable transmission plant, which has also been augmented by similar improvements in microwave radio and satellite system performance. As a result transmission costs have continued their steady downward trend (See Figure 10)



Source: Cochrane, P: IEE Proceedings, Vol 131, PtF, No 7, December 1984

Fig 10 Transmission plant relative annual charges for a 100 km circuit

Similar trends exist in circuit switching and combined digital switching and transmission gives the most economic network realisation, by a factor of about 50 per cent of their analogue counterparts.

HDBAAH

Today telecommunications stands at another technological crossroad. The predicted tenfold increase in information flow cannot easily be accommodated by existing copper and radio-based media.

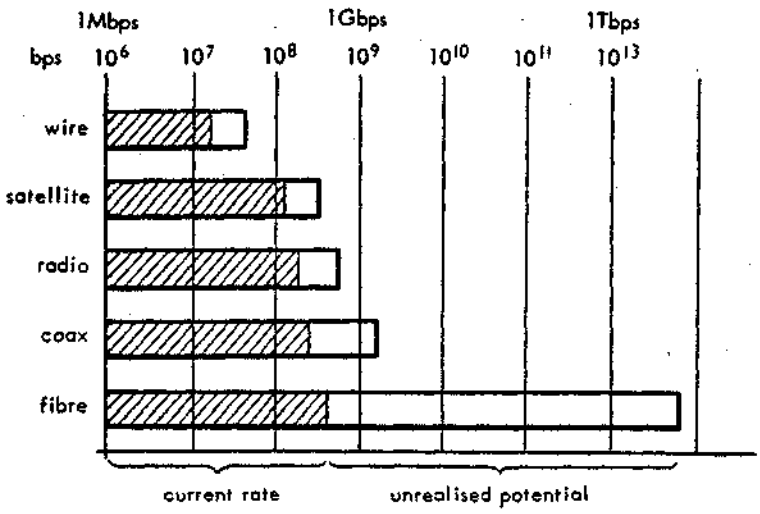
Within most of the UK, much of the trunk traffic is carried by coaxial cables at an equivalent bit rate of 140 Mbps. It has been shown that this capacity can be increased by a factor of four or so with relative ease. However, at an equivalent rate of 565 Mbps and above, repeaters have to be spaced at 1-2 Km or less, which makes both the economics and reliability somewhat questionable. A similar situation also arises in the links between local exchanges, where cables are now substantially exhausted with respect to a tenfold increase in traffic. Perhaps even more importantly, the ducts housing the cables are also full - there is no space for additional cable.

In the Highlands and Islands trunk transmission is principally based on microwave radio links. However, even with new digital microwave links, there is no room for complacency as there is increasing pressure on spectrum and spatial distribution.

Fortunately the developments in microelectronics and the associated manifestation of the above problems, have been coincident with the development of fibre optics, which offers the key to the future. This fact is evidenced by the qualitative comparison of media information capacity given in Figure 11 and the relative costs given in Figure 12. Moreover, the added advantage of very small size compared with copper pair and coaxial cables, coupled with a dramatic reduction in the need for cable cladding and duct space per data bit carried, gives an even more impressive advantage than depicted by data capacity comparison alone.

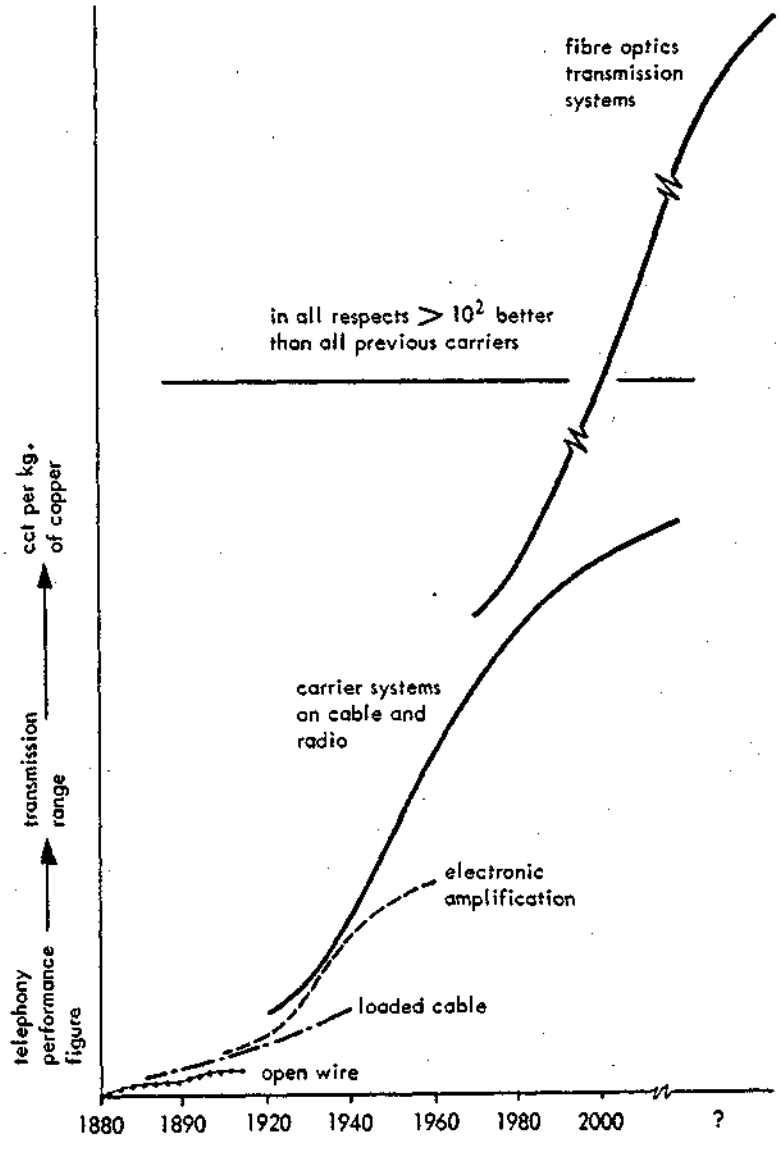
The three main transmission technologies for point to point, rather than broadcast use that will be applicable into the next century are :

- fibre optics
- microwave radio
- satellite systems.



Source: Cochrane, P: IEE Proceedings, Vol 131, PtF, No 7, December 1984

Fig 11 Current data rates and ultimate limits for transmission media



Source: Cochrane, P: IEE Proceedings, Vol 131, PtF, No 7, December 1984

Fig 12 Project logistic curve for future transmission system development

4.1.1 Fibre Optics

The development of fibre optics has so far followed a path similar to the radio counterparts. At present, commercially available or development systems may be likened to the early spark transmitter and receiver. Despite their relative crudeness, the performance of such systems is remarkable when compared with other cable medium. For example the very high capacity optical systems currently in production span 90-565 Mbps with repeater spacings between 20 and 50 Km. This represents a transmission capacity and repeater span increase of 2-4 and 25-50, respectively, over the present coaxial alternatives.

The performance trends in fibre optics are likely to be as follows:

- Today 140 Mbps repeater spacing of 30 Km
- 1986 565 Mbps same fibre as above, but better transmitters and receivers
- 1990 2 Gbps same fibre as above, but still better transmitters and receivers
- 1995 20 x 2 Gps same fibre as above, but 20 wavelength multiplexed channels
- 1995 565 Mbps repeater spacing of 300 Km

The cost of fibre optic systems today are about £200/km. This is expected to fall even when considering the higher capacities available in the future. This compares to the current cost of coaxial cable system of £400/km.

Fibre optics, can be used for both terrestrial and undersea applications. The advantage of a large repeater span is that system costs can be significantly reduced if power and housing for the repeaters can be avoided.

Fibre optics, in common with other cable systems, have the disadvantage of requiring ducts. This is a factor which can greatly increase costs as trenches need to be dug and rights of way acquired. One recent application, which could reduce the installation cost by taking advantage of the electrical isolation of fibre optics, is the stringing of fibres on the pylons of the

. electrical distribution grid. CEGB is making extensive use of this technique for its own telecommunications network and has recently sold some of the spare capacity to Mercury.

4.1.2 Microwave Radio

Microwave radio technology has been in common usage and has undergone significant development from the late 1930s until the present day. It is therefore a mature technology and unlikely to spawn the great advances currently being made in optics. In the future of radio we can thus expect to see an increasing refinement of what already exists.

The future role of radio for point to point communications is mainly one of support for mobile applications or to fill in specific gaps in the telecommunications network. To be specific, in the future, as now, it is likely to be used to support new services which will ultimately be serviced by high capacity fibre optic systems. However, until a high capacity digital network is established, radio systems will be more economic, less risky and will allow services to be tried and tested in advance.

The capabilities of the radio systems of interest are as follows:

• Digital radio relay (4, 6 and 11 GHz)	140 Mbps	less than 50 Km between radio stations used mainly in the trunk network
• Digital radio relay (19 and 29 GHz)	2/8 Mbps	Less than 20 Km between radio stations used mainly for local exchange links

• Digital multipoint radio (19 and 29 GHz)	2/8 Mbps	Less than 20 Km between central station and out-stations Each outstation is addressed and can support several outlets at different rates up to 144 K bps used for distribution between the exchange and subscribers
• Personal Digital Radio (60 GHz)	64 Kbps	Similar to cellular radio, but with a smaller cell size Available about 1995

4.1.3 Satellite Systems

Communication satellites are placed in geostationary orbit above the equator. The satellite accepts a signal transmitted from an earth station and then re-transmits the signal to another station on the earth's surface.

Today, satellites provide a service similar to a fixed link private circuit and require relatively large earth station antennae (3.7m diameter). Up to 2 Mbps can be transmitted over such a link.

The size of the satellite footprint (the area covered by the satellite radio beam on the earth's surface) is expected to decrease and many more spot and scanning pinpoint beams will come available. This will allow more earth stations to be used within a given area.

Future trends will also include reduction in the size and complexity of the earth stations. Antennae down to 1.2m will be capable of being used to handle a duplex channel of 128 Kbps for a total earth station cost of about £10K and usage charge of about £1/minute within the next year or two.

Satellites in the future will perform more on-board processing such as switching between the different channels. Even this facility means satellites are still amost passive "mirrors in the sky". New generations of satellites can be expected to provide extensive signal processing, in addition to switching. It is probable that demultiplexing/multiplexing with dynamic allocation of channels will also be introduced.

By the year 2000 satellites may be providing a world wide personal radio service. Mobile satellite systems (MSAT), providing a forerunner to this service, are expected to be available in the USA by 1988. No plans have been made for a similar system in Europe.

4.2 An Outline of Future User Demand

When considering the future of telecommunications the need can be seen for more communication and thus a need for more transmission capacity. So far in the development of telecommunications this has proved to be the case.

Telecommunications provide a medium for communication between people, between machines and between people and machines. The growth in other communication facilities, car ownership and usage, air travel or newspaper readership for example substantially exceeded early forecasts.

The very rapid growth experienced so far in telecommunications is merely the tip of the iceberg, and can be expected to continue unabated.

Unlike those other facilities which are energy and/or materials intensive, telecommunication technology is decoupled from such influences limiting the rate of its growth. Moreover telecommunications is able to replace or enhance other means of communications.

With the merging of computer and communications technologies three communications requirements emerge. These are :

- instant mobile man-to-man voice and data communications at any time and place on the planet

- instant voice communication between man and machine
- instant machine-to-machine communication.

The past history of telecommunications has demonstrated that the market is substantially technology led. Prior to the introduction of a new service, little demand can be perceived, but when established frequently the service is underprovisioned. All the technologies to meet the three requirements are available today, albeit some are in a rudimentary stage of development or confined to military applications.

It is clear that these requirements are increasingly being met elsewhere and unless the region can offer the same or better facilities then it will become a communication desert. However, the Highlands and Islands have more to gain from the use of advanced telecommunication than urban or less remote areas.

4.2.1 Mobile man-man communication

The current evolution of cellular mobile radio, paging networks and, to some extent, citizen band schemes throughout the world, has demonstrated an increasing demand for instant communication of all kinds. It is not unreasonable therefore to suppose that the businessman and private user of the future will expect to have voice communication via a pocket- or wrist-size device.

Extending this mobility argument to data access, it is also likely that the user, particularly the future businessman, would also require a portable (briefcase size or smaller) terminal giving full VDU facilities. This has already been demonstrated by the interest shown in data facilities on the current cellular radio systems.

4.2.2 Man-machine Interface

A prime limitation in the relationship of man and machine (computers) has been the need to operate a keyboard and very often to write programs also. The advent of speech synthesis and recognition circuits holds out a solution. At the trivial end of the relationship we can see the eradication of the

telephone dial and pushbuttons: products are starting to appear on the market that will accept spoken numbers and names. At a more sophisticated level the eradication of operator services - a telephone exchange that converses with you - seems a not unreasonable target within the next ten years.

4.2.3 Machine-machine Interface

So far the interconnection has mainly been at the behest of man for the transfer of data and accessing of information. The evolution of expert computer systems dedicated to specific disciplines, such as medicine, communication, geophysics, etc will change this situation. A 'reasoning' machine will wish to automatically access data from files scattered across the globe, and it may, in addition, wish to enter into a dialogue with other expert systems on its own as well as other topics. Such systems are a natural extension of existing control systems which automatically manage an operation, distribution of electricity over the grid for example, as a result of telemetry readings of consumption and performance.

This prediction is also supported by the current desire for Open Systems where information can be exchanged freely and applications and data can be located anywhere within a network.

4.2.4 Other Service Predictions

A further set of services which may also exist in the future can be categorised as 'not invented yet'. These are often referred to in analogous terms to the current home computer and video recorder boom that did not exist just five years ago. Suffice it to say that the expansion of video services will demand more transmission capability than any facility seen so far. (See Table 6)

Table 6

Approximate data rates for information services

Information type	bits/sec
Telex	55
Medium-speed computer terminal interaction	4.8k
Telephone speech	64 k
High-fidelity music	200 k
Picturephones	1-2 M
Home colour television	70 M
High-resolution television	400-1000 M

4.3 Future Telecommunications Infrastructure

4.3.1 Trunk Transmission

The main requirement on the telecommunications infrastructure to meet future user demand is the need for a ten-fold increase in transmission capacity. Looking firstly at the trunk facilities of today and the near future, it is difficult to see how they can be expanded economically to meet the level of demand, because the majority of the links will be provided by digital radio.

The technology predictions clearly point to optical fibre being by far the most cost effective transmission media both today and most certainly in the future. The problem is thus of how to overlay the region with optical fibre, a step which will be much more radical than the recent upgrade by BT of the trunk network from analogue radio to digital radio. Which was a reasonably straightforward enhancement.

As a cable medium, optical fibre requires some form of ducting. In some cases BT will be able to use its own resources, but there will be parts of the trunk network where new ducts will be needed and this is likely to be a costly undertaking. To reduce cost, the resources of the region should be examined in detail. However, some organisations can be clearly seen as being potential carriers of optical fibre. These are:

- Electricity grid operated by the North of Scotland Hydro Board
- British Rail ducts used for their signalling system.

One of the difficulties may be to persuade the parties to cooperate, but the region needs to make maximum use of all available resources as, without this sharing, the region will not be able to afford the much needed facilities.

With regard to the links to the Islands, fibre optics is again the best choice as the technology will be such as to allow a fibre optic cable to span the distance between landfalls without the need for repeaters. The

ability to eliminate repeaters in long links would make the Lochs, which cut across the Highlands, a feasible location for fibre optic cables between the east and west coasts.

Satellite communication links are considered to offer no advantage for intra-region trunk tranmission other than, perhaps for temporary facilities, as they will continue to be more costly than other media. Satellites will certainly be cost effective for international links and also, maybe, from the region to London.

4.3.2 Local Transmission

The transmission links between the local exchanges will present a problem because of the huge number of links required to be upgraded. Again optical fibres are expected to be used mainly for these links, with microwave radio being an alternative in specific special cases.

Another way of alleviating the problem is to make the network more hierarchical by eliminating those links which cut horizontally across the hierarchy. This would result in exchanges higher up the hierarchy having to handle more calls, but the modern digital switch has a greater capacity than its analogue predecessor.

4.3.3 Personal Communications

Widespread personal communication will only become available when there are Mobile Satellite (MSAT). Systems available in Europe. Until then, private Mobile Radio is expected to be reasonably widespread but cellular radio is not anticipated to be much more available than is specified in Section 2 of this report.

5 CONCLUSIONS AND RECOMMENDATIONS

This sections draws conclusion from the body of the report and recommends the actions that should be taken by HIDB and others in order to benefit to the full from existing telecommunication opportunities, and secure up to date facilities for the future.

It is strongly recommended that the Board should institute a Regional Telecommunications and Information initiative to retain the momentum of this study and progress its recommendations. Judgements will need to be made as to the priority that should be awarded to each recommendation and the resources they will require.

5.1 Conclusions and Recommendations for Basic Telecommunications Facts

5.1.1 The picture that emerges from an examination of the telecommunications facilities available is that the basic telephone service is adequate, but the region is poorly served by the newer digital and mobile services by comparison with most other regions of the UK. The position is likely to deteriorate significantly in the medium term. The Government's policy of establishing Mercury as competition for BT in order to create a more dynamic market for telecommunications has not yet made an impact in the Highlands and Islands, as Mercury considers the provision of a service to be uneconomic.

It is recommended that the Board should explore further the reasons for Mercury's reluctance to provide services to the Highlands and Islands and what form of collaborative venture might be attractive to them.

5.1.2 The services which are deficient in the Highlands and Islands are as follows:

- KiloStream
- Widespread support by the transmission network for Star Services and ISDN
- Support for digital facilities and the ISDN by the majority of the exchanges
- Cost of access to PSS for character terminals
- Mobile radio services.

5.1.3 At first sight, the provision of the digital trunk network in the region by 1988 would appear to be adequate to support the digital private wire service, KiloStream. However, this will make the service available to users in the main towns, but others will have to wait for digital transmission to penetrate the local network, or pay additional charges.

It is recommended that the demand for KiloStream digital service is monitored by the Board if appropriate, and action is taken in the event of hardship.

This action could take the form of grant to a specific user for BT to provide the service, thus benefiting subsequent users within the area. Alternatively, just to be able to coordinate user demands and lobby BT may be sufficient to advance digital implementation plans, or achieve a provision schedule more closely attuned to the needs of the region.

5.1.4 The widespread support for the Star Services and ISDN is threatened by the problems BT will have in providing digital links interconnecting the local exchanges. Microwave radio will have a vital role to play in alleviating the problem in the region caused by the nature of the terrain and the distribution of the population.

The Board needs to take an initiative with regard to radio facilities which is described in the paragraph 5.1.7 below.

5.1.5 Over half of the exchanges likely to be still operational in the Highlands and Islands at the start of the next century have either limited or no support for digital facilities and the ISDN. The exchanges are the UXD5, which is used to serve small rural communities, and the TXE4A/TXE2, which is used for a small to medium population of users.

The UDX5 is currently being installed by BT in some numbers throughout the region, and will be expected to have a life of at least 15 years. Within this same period, ISDN facilities will be in widespread use throughout the majority of the UK. The support for ISDN by the UXD5 is limited. Consequently, users in

rural communities could be denied the full range of digital facilities until after the year 2000.

The situation with regard to the TXE4A/TXE2 exchanges is much more serious as these will not be able to support any digital facilities. Also the position of these exchanges in the network hierachy will prevent users on other subordinate exchanges from gaining access to the digital trunk network.

It is recommended that the Board should enter into discussions with British Telecom and with major funding agencies, including the European Commission, to establish how an adequate infrastructure for digital working can be established.

Prior to resolution of this matter, the Board needs to decide whether it would be prepared to finance out-of-area lines to System X exchanges for those businesses needing the ISDN services. The likely cost of such a facility would probably be about £4,000 per annum for a 50Km line.

5.1.6 Access to PSS by character terminals (eg tele-typewriters) is costly for all users throughout the region. The actions which the Board could take to remedy the situation are as follows:

- finance a full PSS node in Inverness: cost approximately £120K
- finance a MultiStream node in Inverness: cost approximately £30K
- provide LinkLine (local call) access to a Multi-Stream node
- request that BT provide local call access to PSS using the same mechanisms as provided for access to Prestel.

Provision of a PSS or MultiStream node in Inverness is expensive and only benefits about 15 per cent of the population in the Highlands and Islands. LinkLine access has the advantage of being equally available to all in the region and its use can be controlled by the Board. MultiStream has the ability to provide a selection menu prior to accessing PSS and this could be tailored to allow access to authorised LinkLine users. thus controlling the cost of the facility.

We understand that BT provides local call access to Prestel within the Highlands and Islands by providing a 'transparent' account discount to users by treating Prestel calls as a local call independently from the distance between the user and the Prestel 'node'. We were unable to obtain clarification from BT as to the justification or mechanisms used to offer this facility. Eosys stresses that in terms of the dispersion of the population within the region and the existing local call charge areas, this offers an attractive method of providing local call access to the complete range of data services rather than capital investment in what would be a large number of PSS or MultiStream nodes.

It is recommended that the Board should initiate discussions with British Telecom on how best to provide local call access to dial-up data services.

(Since the completion of this study and the draft report British Telecom has started a 3 month trial that provides local call charge access to MultiStream on a national basis using the LinkLine service described above. The trial is due to finish at the end of March 1986. We, therefore revise this recommendation, and recommend that the Board should review the situation when British Telecom has assessed the impact of this trial).

5.1.7 Mobile radio, in fact radio technology in general, has much to offer the region in terms of increasing the efficiency of businesses and providing a life line to very remote locations. At the present time, the coverage provided by the public systems is small compared to the size of the region. The problems faced by these operators is the low density of the population, making the service uneconomic to provide in much of the region.

Large private systems exist with good coverage, but they are dedicated to single organisations, such as the police. In addition to these there are a number of small private radio systems scattered throughout the Region.

The siting of radio stations is in many cases subject to planning permission by the appropriate Local Authority. In most cases, each individual application

is treated on its merits with the planners giving little concern to the relationship of the site in the overall radio scheme of the radio operator.

Radio sites need to be considered as a scarce regional resource and the radio operators need to be encouraged to share facilities. Having a multiuser site and multi antennae tower reduces the possibility of eventual congestion of a locality by numerous towers which is usually inevitable over the passage of time.
The Board needs to take the initiative with regard to radio sites by producing an outline plan identifying the optimum sites suitable not only for local radio systems but for trunk networks. If sites are allowed to proliferate unchecked, then situations could occur where a single local station breaks the link in a trunk transmission chain.

The Board could also consider whether it might fund key sites to encourage public operators to establish systems in the region by reducing their start-up cost. Multi-user sites would be attractive to operators because they would be pre-engineered and the necessary technical studies would have been performed, thus being more cost effective in terms of manpower and financial resources.

It is recommended that existing and potential radio sites should be considered as a scarce resource within the Highlands and Islands. Radio operators should be encouraged to share facilities and plans should be formulated for the use of these facilities.

It is recommended that the Board and the local authorities should produce an outline plan identifying the optimum sites suitable not only for local radio systems but for trunk networks and consider whether they might fund key sites to encourage public operators to establish systems in the Highlands and Islands by reducing their costs.

5.1.8 Cellular radio is currently not widely available within the region, however it is doubtful whether it is the most appropriate radio technology. This is because of the limited range of the transmitters, thus requiring a large number to give coverage throughout the area. Systems similar to BT's System 4 and Securicor's messaging system are more cost effective.

The Board needs to liaise with the DTI and Oftel to determine which companies, if any, are planning to offer radio services in the region using the recently released Bands I and III.

It is recommended that the Board should actively seek a wide area mobile radio operator for the Highlands and Islands, offer pump priming funds and support the licence application.

5.1.9 The call charges in the Shetland Islands are highly anomalous with the majority of the calls being charged at the trunk rate.

The Board needs to study the situation in an endeavour to win similar concessions from BT for the Shetlands that were granted to Orkney in the past.

It is recommended that the Board should negotiate with British Telecom to ensure a more equitable call charge for local calls within the Shetland Islands and Western Isles.

(Since this study and the draft report were completed, British Telecom has revised tariffs for the Shetland islands and Western Isles. This recommendation no longer applies).

5.1.10 High capacity radio systems provide BT with far more cost effective communications capacity in many cases than the cable installations on which existing tariff structures were based.

It is recommended that the Board and Oftel should discuss with British Telecom tariffs which reflect the economies achieved by the use of high capacity radio, especially between the islands and the mainland.

5.2 Conclusions and Recommendations for Application Opportunities

5.2.1 Awareness

There has been considerable growth in the variety of telecommunications facilities available in the UK, and of services provided over those facilities. Despite some tariffing problems many of these facilities and services are available to the region.

In general, potential users are not fully aware of all that is available to them. Because of its remoteness and dispersed population, the Highlands and Islands has much to gain from more widespread and effective use of telecommunications.

It is recommended that the Board with substantial support from British Telecom and the major service providers, should consider producing an attractive 'marketing' document setting out clearly telecommunication facilities and services available in the Highlands and Islands, and the benefits that can be gained from using them.

It is recommended that the Board, in conjunction with British Telecom, should identify specific sectors which stand to gain most from the use of telecommunications, and they should consider collaborating with British Telecom in a target marketing campaign.

5.2.2 Network Services Agency (NSA)

Currently various organisations, many of them quite small, have established or are considering networked services of one sort or another within the region. This activity is fragmented although many of the services have or will have similar needs and problems.

There is much to be gained by establishing an umbrella organisation to support and stimulate such activity and accordingly this report proposes the formation of a NSA.

It is recommended that the Board initiates a study to define the terms of reference, organisation and budget for a Network Services Agency to provide a focal point, stimulus and advice for business and community services, and coordinate the provision of regional network(s).

Early tasks would involve :

- establishing the existing or likely networked services in the Region
- exploring the most appropriate networking arrangements for them and the feasibility of providing common networking facilities

- coordinate development plans for the services and the network(s)
- identify service needs not likely to be satisfied, and stimulate action to meet them.

5.2.3 Common Access Points for Telecommunication Services

The use of public access terminals could provide both statutory and private authorities with a cost-effective means of delivering services and information. For example, in the area of primary health care, services such as remote health monitoring may best be accomplished using telecommunications facilities; availability of employment, or undertaking financial transactions could be other applications on such a system.

The HIDB should investigate the interests of the statutory authorities such as the DHSS, Manpower Services Commission, Post Office as well as financial and other major private sector organisations, in using common access points to telecommunication-based services. The Network Services Agency described elsewhere in this report could provide an appropriate mechanism for supporting such an operation.

5.2.4 Video Communications

Video communications represent a powerful tool for overcoming the region's disadvantage of remoteness. Not only can they be used for business meetings, as a substitute for travel but also as a valuable marketing aid for the region itself, and for the products and services provided by the region.

However video communications facilities are expensive to install and operate, and there is unlikely to be any single organisation in the area with sufficient need to justify the investment.

5.3 Conclusions and Recommendations : Year 2000 onwards

5.3.1 Digital Services

Many of the actions concerned with establishing an infrastructure capable of providing the digital services for the year 2000 beyond have been included in section 5.1 and are, therefore, not repeated here.

5.3.2 Cable Routes

There is every indication that in the long term fibre optic cables will provide the most cost effective medium for carrying communication traffic. Microwave and other radio systems will have specific uses, but as a supplement to, rather than a substitute for, fibre optics.

Securing routes, sharing facilities and minimising installation costs will contribute to the speedier provision of fibre optic cabling in the region.

It is recommended that a feasibility study should be undertaken into the future provision of a comprehensive distribution network down to local level based on alternative routes for fibre optic cabling, including those currently owned by British Telecom. This will require consultation with British Rail, the North of Scotland Hydro Board and others.

The findings of this study could significantly strengthen the position of the HIDB when negotiating with the PTOs and funding agencies for the widespread installation of fibre optic cabling.

APPENDIX A

TELECOMMUNICATIONS - OVERVIEW FOR THE LAYMAN

Telecommunications : Overview for the Layman

Communication is defined as the exchange of knowledge. It has two aspects: the information to be communicated and the means of communicating that information.

Telecommunication is communication by electro-magnetic means. In other words, using electrical conduction, radio or light. Telecommunication usually involves a two-way interaction, such as a telephone call, in contrast to broadcasting which is non-interactive, since the recipient can only receive information.

At one time, telecommunications was primarily concerned with communicating speech by means of the telephone. The human ear is capable of decoding audio signals even though they are not particularly clear, enabling it to correct for errors in the transmission. This fact led to telephone systems which were cost effective for communicating speech using analogue techniques.

The computer revolution has enabled mankind to create and store vast amounts of information. However, such information is not of practical use unless it can be communicated to others and accordingly methods have been developed to enable this to be done efficiently. The natural language of computers is digital, communicated free of errors. Where this requirement is not met other means have to be employed to overcome the deficiencies of the telecommunication channel.

Circuit Switching versus Packet Switching

The objective of the switching service provided by a telecommunications network is to interconnect any two (or more) users upon request. The two fundamental ways in which a network can provide the interconnections is either by circuit switching or by packet switching.

Circuit switching involves the network making a circuit between the users. Once the connection has been made, the users are at liberty to pass information at will between themselves without the network imposing any restriction on its flow. The network has allocated resources which are dedicated to circuit whilst it exists.

Circuit switching can be used with either analogue or digital information. The majority of today's telephone network uses analogue circuit switching. Analogue and digital applies only to the method of information encoding used on the circuit. Information from one user is passed in the same form to the interconnected user or users.

Packet switching can only be used for digital information. Information from each user is assembled into a number of so-called 'packets' with 'labels' showing origin and destination. Because each packet is identified, the network can send packets from several unrelated users over the same circuit, thus making the optimum use of network resources.

Packet switching, by its very nature of being able to share resources which could be busy with traffic from other users, must have mechanisms to control the flow of information into and out of the network. This flow control has the advantage to users of enabling them to operate at different rates when interchanging information with the network. In other words a packet switching network can provide speed changing between the users.

The formation of information into packets goes hand-in-hand with a packet switching network being able to provide error control mechanisms to guarantee the integrity of information passed between users.

Bandwidth and Bit Rates

Bandwidth and bit rates of communication channels are intimately related, but it is usual to talk about bandwidth for analogue channels and bit rate for digital channels. To clarify the situation consider the transmission of speech.

The normal bandwidth for voice transmission is 3100 Hertz (Hz) - cycles per second. When a single voice channel is transmitted down a wire this is in the frequency range 300 to 3400 Hz. The corresponding bit rate is 64 Kbps for a single voice channel. For the abbreviations relating to bps see the description of transmission capacity in Section 2 of the main report.

Sometimes channels are multiplexed together down a transmission link. A 48 thousand Hertz (Khz) analogue link can carry 12 voice channels. A 2 Mbps digital link can carry 30 voice channels. These or multiples of them are the usual capacities provided by a link.

Public Switched Telephone Networks

In all developed countries there is a comprehensive network specially designed to carry speech, known as the Public Switched Telephone Network (PSTN), which unfortunately was designed before computers were invented.

The PSTN operated by BT is largely based upon analogue transmission and switching with restricted signalling capability. This produces a network in which calls take an appreciable time to be established, following which a duplex transmission path with limited bandwidth and variable quality is available to users. Restricted signalling capability has the consequence of not supporting the features familiar to users of modern PABXs, such as call transfer and call back when free.

Despite these limitations the PSTN has been used to support both telephony and a limited set of non-voice services eg data using a modem at speeds up to 4800 bps. However, the inherent constraints present in the analogue network make it increasingly unsuitable for emerging data transmission applications. This has been partly overcome by the introduction of service dedicated networks such as the Packet Switched Network and the KiloStream service.

Telex

The text-based message service. Telex, uses a network independent of the PSTN. It was established in the 1930s and is still in wide use today even though other more advantaged text message systems are available because telex has the advantage of having 1.25 million users in 200 countries throughout the world.

New methods of accessing the Telex service and enhanced network facilities has resulted in a recent upsurge in its use. Telex can now be accessed via the PSTN using various electronic mail services, such as Telecom Gold. Telex - plus now provides facilities such as repeat calling to overcome the problems repeatedly busy numbers or network congestion.

Private Circuits

Private circuits on leased lines are fixed links provided by BT to use for voice or data between two points. The most widely available are analogue circuits, of which there are two main types relating to the quality of the circuit. Both facilities can be used for speech and low speed data but the better quality can be used for medium speed data. Multiple analogue lines between the same two points are usually provided by a wideband circuit and are typically used to interlink PABXs in a private network.

KiloStream and MegaStream

BT's digital private circuits are known as KiloStream and MegaStream. KiloStream provides any one of a range of speeds up to 64 Kbps and MegaStream offers multiples of 2 Mbps.

Apart from the advantages of digital against analogue transmission, with KiloStream and MegaStream BT have the ability to monitor the performance of a link and respond very rapidly to faults.

Mercury Leased Lines

Mercury provides the equivalent of BT's KiloStream and MegaStream. These services are digital, but Mercury can provide appropriate interface equipment to support analogue connections for voice.

Packet Switch Stream

Packet Switch Stream (PSS) is a Public Data Network (PDN) using packet switching provided by BT. The service is accessed using two main types of terminal: character-mode and packet-mode. The character-mode terminal is the traditional teletypewriter or equivalent, and connection is usually made by establishing a dial-up link over the PSTN to the nearest PSS exchange which then puts the characters into packets. Only one connection can be made at a time.

Packet-mode terminals are usually computers, but they can be interactive terminals and as the name implies, they deal directly with packets. They are connected to PSS by a private circuit. The advantage of packet-mode access is

that independent connections can be made to multiple users by means of one physical connection. Packet-mode terminals operate at medium to high speeds, whereas character mode terminals operate at slow to medium speeds.

MultiStream

A new method of access to PSS for character mode terminals, recently introduced by BT, is MultiStream. This dial-up service provides an easier method of access, plus the ability to use error correction to over poor quality lines or to provide support for IBM type terminals.

SatStream

SatStream provides a digital service equivalent to that provided by KiloStream and MegaStream via a satellite rather than fixed terrestrial links. Satstream is best suited to the provision of long distance links between locations in two or more countries (eg UK and USA) or the temporary provision of a link.

AmeriCALL

Mercury's AmeriCALL is a satellite service to the USA which provides a connection for fixed time slot per day.

Mercury International Leased Lines

Mercury provide international digital leased lines to the USA and Hong Kong.

LinkLine

Linkline is an enhancement of services offered by BT on the PSTN and is available in two forms. Linkline 0800 provides an automatic Freefone service where the caller pays nothing and the cost of the call is paid by the called 0800 customer. Linkline 0345 allow the public to ring a 0345 customer from anywhere within the UK for the cost of a local call, the cost difference is paid by the 0345 customer.

ISDN

BT is in the process of creating a multi-purpose Integrated Digital Network (IDN) based on System X exchanges, interlinked with digital transmission and enabling comprehensive co-operation between all parts of the network. Extending this IDN by providing users with digital access links will create an Integrated Services Digital Network (ISDN), capable of supporting a wide variety of both voice and non-voice services.

The ISDN creates the potential to reduce the cost of providing users with new non-voice services and to reduce the cost of accessing existing services, such as Packet SwitchStream and KiloStream. Also, the ISDN will enable users to choose the most cost-effective service for a given application without being constrained by cost of additional access arrangements, as at present. The ISDN will be accessed by a common multi-service path, capable of carrying all types of communication. This path is called Integrated Digital Access (IDA).

Star Services

The Star Services provide extra facilities to users of BT's PSTN and are similar to those found on many modern PABXs. The new facilities are supported by the System X exchanges which BT are currently installing in the network.

At the present time, even where a System X exchange serves an area, only a limited range of facilities is offered, because full digital interconnection is needed between the exchanges for full control of the more advanced facilities. The Star Services currently available are :

- call diversion - transfer an incoming call to another number depending on the option selected which can be: always, no-reply or engaged
- code calling - frequently used numbers can be called using a shortcode
- three way calling - hold a call, make another and then establish a three-way connection
- call waiting - whilst engaged on a call, notification of another incoming call with the ability to speak to the second caller whilst holding the first

- repeat last call - repeat the last number called by using a short code
- charge advice - call-back by the exchange at the end of call to give the charge
- call barring - restrict categories of outgoing calls or bar all incoming calls
- reminder call ring back by the exchange at a specified time.

Mercury Switched Services

The Mercury Switched Service is available from May 1986. It is a dial-out point-to-multipoint trunk call service, which will enable a user to originate a call via a Mercury Direct Service line between his premises and the serving Mercury Switch. In the future, the service will expand to include incoming traffic and local and international services will also be available. For the current trunk service, the termination of calls is provided via either Mercury and/or BT intercity links and BT exchange lines. The service permits the termination of "voice grade" trunk calls anywere within mainland UK.

Mobile Radio Systems

There are many different types of mobile radio systems, but all of them comprise certain basic items. These are a transmitter which broadcasts the radio signal and a receiver which picks up the signal. In order to have two-way communication, these two elements are combined in one unit, the transceiver.

The transceiver can be fixed, mobile or portable. The transceiver also requires an aerial or antenna for the reception and transmission of radio signals.

The distances for transmission and reception of radio messages depends upon a number of factors, including the power output of the transmitter, the height and location of the aerial, and also the type of terrain. A base station is normally enable to reach mobiles and portables 10 to 20 miles away. Vehicle mounted mobiles are also able to transmit and receive over a similar distance. A hand portable has a tiny built-in aerial and is powered by batteries, so it will normally transmit and receive only over distances of 5 to 10 miles.

The aerial or antenna is an essential component in radio communications and results will depend to a great extent on height and correct siting which needs to be on high ground or a roof, with generally uninterrupted views. The siting of aerials is subject to planning permission and to Home Office approval.

Within the range of frequencies available for mobile radio are low and high-band VHF frequencies, and those at UHF.

- Low band VHF (25-50 MHz) offers the greatest range, but suffers from the heaviest channel loadings and highest noise levels.
- High band VHF (150-174 MHz) offers relatively good coverage in built-up areas and is less subject to noise, although channels remain busy.
- UHF Channels (450-512 MHz) offers lower channel congestion with good penetration in urban areas, but the shortest range of the three bands.

Low band frequencies are generally used by police and emergency services, power undertakings, bus companies and others requiring long distance communications. The high band represents an ideal compromise for urban and rural working, offering distance with reasonable penetration. UHF equipment is ideal for limited area communications, within a city or large complex, where penetration through large masses of concrete is needed.

Radiopaging

A pager is a small pocket-sized device or store a text message which is designed to emit a 'bleep' tone, spoken message when activated by a controller. It is a one-way communication only for people away from their vehicle or offices. More than one tone may be incorporated, and some units are designed to vibrate when activated, for use in extremely noisy locations.

Private Mobile Radio

Systems can within reason be designed to suit any kind of private application of mobile radio. A lot will depend upon the type of use, number of mobiles, location of the base station, and the area it is proposed to cover. Needs will

vary considerably, but examples are given below to illustrate widely varying problems and how they can be solved.

Local base station and mobiles

This is a self-contained system designed to meet a local requirement only and is commonly used by taxi firms, service organisations, transport companies or repairmen. A controller or despatcher mans a central base station, probably at the company's offices and contacts his staff on the move through their vehicle mounted mobile two-way radios. They reply to the base station. The system may be designed so that when the controller puts out a call, all the mobiles can hear him; or selective calling may be employed, to contact just one mobile on the system. Area of coverage will be local and dependent upon the location and height of the base station aerial.

Wide area system

Many businesses do not stay within a local area and require to be in radio contact when travelling fifty miles or more from base. To do this would require a series of local 'base stations'.

Community repeater radio system

A community repeater relay system allows the user to share a permanent base station and aerial with others. This type of system uses an automatic base station, common to several users, linked to a high aerial site. A limited number of subscribers have access to the repeater station and benefit from its high location and extra power to 'talk through' to their group of mobile or portable transceivers. Access is automatic - controlled from the user's own radio - and conversations remain private, because by contacting the repeater to make his call the user temporarily 'locks out' others on the system. A timing device is normally fitted to prevent prolonged use of the system by any one user to the detriment of others, and so helps spread the traffic time fairly among all users.

Message Handling

Message handling services are provided by a public radio operator and saves the cost of owning a private base station. It provides a message passing service between the radio users and the telephone.

Radiotelephone Networks

Radiotelephone networks provide a range of facilities. Some allow automatic (self) dial for making and receiving telephone calls to and from the PSTN. The networks are different from cellular radio (see below) in having a smaller number of high powered transmitters; also calls are lost when passing from one terminal transmitter area to the next.

Alternative networks offer operator controlled facilities to provide 'interconnect' facilities to the PSTN.

Cellular Radio

Cellular radio operates in the 900 MHz radio frequency band and uses a total bandwidth of only 50 MHz. The band is divided into 1000 duplex radio channels, all of which can be systematically re-used to provide the system operators with many thousands of potential telephone circuits. (Note: The present system in service in the UK is only licensed to use 600 channels).

The system is based on the principle of dividing the area to be covered into a number of cells. Each cell is served by a radio station, which covers the area up to and into that of the adjacent cell. The idealised situation can be considered as a honeycomb of hexagonal cells. In reality, the hexagons are distorted but the principles remain the same.

The size of the cell is determined by the number of users expected to operate in that area. In cities, for example, cells may be 2 kilometres across while in less densely populated rural areas the cells may be as large as 30 kilometres across.

Each radio station provides two types of radio channel: a duplex control channel to transfer information when a call is being set up and a duplex voice channel which is used for the telephone conversation. Adjacent radio stations operate on different sets of channels to avoid interference, while non-adjacent radio stations can use the same radio frequency simultaneously.

The radio stations are connected, via the conventional land-line system or microwave links, to a Mobile Switching Centre (MSC). It is the MSC which controls the cellular radio users to each other and to the national and international telephone system. The MSC also monitors the location of the cellular radio telephone when a call is in progress, and by using advanced switching techniques allocates new channels and radio stations to users as they move between cells, constantly maintaining a high quality connection. This process, called 'hand-off', is completed in a fraction of a second and is undetectable to the user.

The computerised control and switching equipment within the cellular radio network can provide a number of useful advanced facilities for users. These include:

- Call diversion - an alternative number can be assigned to receive the call when the cellular radio telephone is busy, turned off or when there is no reply within a certain period.
- Three party conference - an existing conversation can be shared, under the control of the cellular radio user.
- Call transfer - a current conversation can be passed on to another telephone location by the cellular radio user.
- Selective call barring - certain categories of calls can be barred from use. For instance, international access may not be allowed for particular mobiles.
- Alarm call - the cellular radio exchange will automatically call a cellular radio telephone at a time that is pre-programmed by the user.
- Call waiting - an incoming call to a cellular radio user can be held at the switch if the telephone is already in use and the user will be informed of a waiting call.

- Call holding - an existing call can be held at the switch while a waiting call is answered or a new call made.

CB

CB, or Citizen's Band radio, is designed primarily for recreational applications, but it can offer a low-cost alternative for some local business users. However, user discipline, including long conversations and interference with transmissions, creates congestion. It lacks the privacy of more sophisticated systems. Equipment is less advanced and less powerful than that used for commercial purposes but reasonably satisfactory results can be obtained in some areas. Forty channels sets offer a wide choice of frequencies for users.

APPENDIX B

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APPENDIX C

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ADVISORY GROUP ON HIDB TELECOMMUNICATIONS STUDY

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HDBAAT

APPENDIX D

INTRODUCING EOSYS

EOSYS LIMITED

Eosys Limited is an independent consultancy company providing expert and impartial advice, project management and related services in the application of advanced telecommunications and information technology and their implications. The company has worked with many leading organisations and has built up a unique record of experience in planning and implementing information technology.

Chairman of **Eosys** is Sir Anthony Burney OBE and Managing Director is David Firnberg, 1983/84 President of the British Computer Society and formerly Director of the National Computing Centre.

CONSULTANCY AND PROJECT MANAGEMENT

Eosys carries out consultancy assignments in both the public and the private sectors. Clients include large companies who need full strategic business plans for IT, Government Departments, the EEC, medium-sized organisations moving towards comprehensive electronic systems and small companies.

Eosys consultants specialise in:

- advanced telecommunications systems
- cable systems, local area networks
- electronic office systems
- turnkey systems and project management
- pilot trials, equipment selection
- staff training and awareness programmes
- environmental issues
- market research and data collection.

PUBLICATIONS

Eosys publishes practical guides to all aspects of information technology. These have been widely reviewed in the national and technical press. The **Eosys**/'Computing' Office Automation Survey is published twice-yearly.

EDUCATION AND TRAINING

The introduction of new technology and the changes brought about by reorganisations place considerable strains on the smooth running of the departments concerned. Eosys consultants have considerable experience in the human aspects of IT for the successful implementation of new procedures. **Eosys** conducts in-house training and has developed courses for all levels of employee from clerical to senior managers.

The **Eosys** Word Processing Aptitude Battery has been designed in collaboration with a leading firm of occupational psychologists and is of particular use to organisations planning to introduce word processing or to select operators for training from existing staff.

STDACF

APPENDIX E

EOSYS IN TELECOMMUNICATIONS

EOSYS IN TELECOMMUNICATIONS

Good telecommunications facilities are a key factor in the effective application of up-to-date computing and electronic office systems.

Eosys has substantial expertise in the planning and implementation of telecommunication networks for example:

- The British Government spends up to £200m each year on telecommunication facilities to support its administrative activities. Eosys has recently concluded a substantial contract awarded by the Government's Central Computer and Telecommunications Agency (CCTA) for the formulation of a ten-year strategy for all Government administrative voice, text, image and data telecommunications. One recommendation is already saving central government £1m per annum.

- Eosys has extensive experience of both PABXs and Local Area Networks (LANs). Eosys advises the Government on standards for the digital networking of PABXs and on UK national priorities for LAN standardisation. In addition, the Government commissioned Eosys to plan a national LAN protocol testing centre.

- Eosys has developed a range of services for specifying and project managing the installation of new PABXs. The successful completion of these projects has led to our retention to solve organisations' data networking problems.

- A public utility board asked Eosys to appraise their established telecommunications policy and to comment on the organisational effects of the integrated handling of information.

- Eosys was asked to advise a property consortium on the telecommunications infrastructure to meet all the telemetry, telecommunications and home entertainment requirements in a mixed development of 100 hectares.

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