MILTON KEYNES AND BEYOND, THE NEXT GENERATION SYSTEMS

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ABSTRACT

The all optical fibre switched-star trial system at Milton Keynes will be reviewed. Differences between the British and American markets for cable-TV are considered before describing the services and requirements for the next generation system. This system uses both optical fibre and co-axial cables, with elements of tree and branch and switched star topologies, to provide a network which is well matched to the services to be provided. An outline of the system is given, and reference is made to available UK government reports on cable TV.

INTRODUCTION

For more than a year British Telecom has had in operation an all optical fibre switched star cable network at Milton Keynes, a new town in the centre of England. Although this scheme is on a very small scale, serving only 18 homes, it provided very valuable experience for the design of much larger systems. Much of this design work has already been completed, and major contracts have been placed for the supply of equipment. The first large scale scheme will be ready for service in the last quarter of 1984, if regulatory conditions permit.

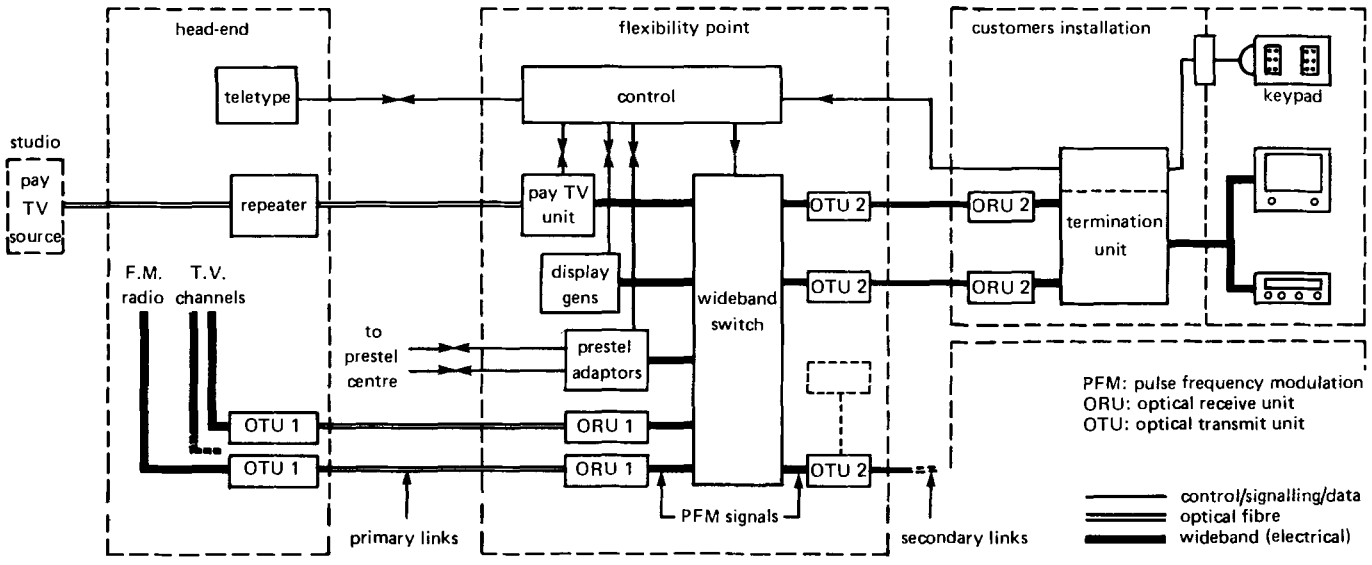

Figure 1: The Milton Keynes System

THE MILTON KEYNES TRIAL

The Milton Keynes scheme has been well documented elsewhere (Ref 1) but to set the scene and provide background to the description of the next system it is as well to review it briefly. The network topology is shown in Fig 1. The primary link carries the channels (one per fibre) from the head-end to the switch. This link uses graded index fibre, 850 nm edge emitting LED's, pulse frequency modulation, and is over 3 km long. At the switch point each incoming fibre terminates on an optical receiver unit employing an avalanche photodiode. The PFM output from the receiver forms an input to the wide-band switch which, under microprocessor control, can route any input to any output. The PFM outputs from the switch feed optical transmitter units, again using 850 nm ELED sources. The microprocessor scans the secondary link signalling information for channel requests from customers, and additionally performs link monitoring functions. From the switch point a two fibre cable goes to each customer. This cable has two copper coated steel strength members which are used to carry signalling information from the customer. The customer's installation consists of an optical receiver unit using PIN diode detectors prior to an FM demodulator. The resultant baseband TV signals are then up-converted to UHF to feed via coax cable to the aerial input of a standard UK television receiver. The customer chooses his required programme by means of a push button remote control channel selector, and has two simultaneous channels available, making it possible to view one channel whilst recording another. Each customer also has access to Prestel, British Telecom's videotex service with more than 200,000 pages of information. This is achieved by putting text generators at the switch point, and using the video outputs from these as inputs to the video switch. In this way, and in conjunction with the signalling path from the switch to the customer, access is given to a videotex service with no additional equipment in the subscriber's home. Videotex generators are shared between customers at the switch point leading to economy in equipment provision. The main features of the Milton Keynes scheme are thus:

- Optical fibre transmission offering excellent signal quality over long distances without the need for repeaters. Not susceptible to ingress or exgress of interference, a point vividly demonstrated on the occasion of a severe thunderstorm at Milton Keynes which severely damaged over one hundred amplifiers on the conventional co-axial system, yet the video transmission over the optical fibre system was unaffected.

- Switched-star topology offering protection against programme theft, no scrambling leading to better signal quality, easy implementation of interactive services.

THE BRITISH MARKET

Before going on to describe the development of the Milton Keynes trial into a much larger cost-effective scheme, it is as well to consider the market situation in the UK. There are a number of factors which make a direct translation of the American experience to Britain uncertain (Ref 2).

- Transmission and production qualities are high and reception is near universal. Broadcast TV offers a wide choice, with 4 TV and two "breakfast-time" channels.

- Viewing figures for the new 4th channel and one of the "breakfast-time" channels have been poor. The take up of the experimental subscription TV service on some existing cable schemes has been disappointing. Overall viewing figures have recently dropped.

- Market studies indicate a substantial discrepancy between the cost of installing and running a cable-TV network (due to high environmental standards it is most unlikely that US installation practices will be allowed in the UK) and the monthly charges that a customer is prepared to pay.

There are however some peculiarly British factors which may have an influence on the take-up of a cable-TV service in the UK.

- 33% of new TV sets purchased are equipped to receive and decode broadcast teletext services.

- The penetration of video tape recorders is at 12% the highest in the world, and is predicted to rise to 33%.

- Home computer penetration is 5%, expected to rise to 10% next year.

From this evidence many conclusions can be drawn, one is that a cable system offering "more of the same" may not be totally successful, although undoubtedly there is a market for good feature films.

The high penetration of video tape recorders may be explained by the viewer wanting control over his time of viewing a particular item, either because he is otherwise occupied when it is shown, or because there is simultaneous showing of items which interest him on different channels. In an effort to maintain their audience ratings, competing broadcast companies show popular programmes at the same time. The advent of the remote controlled teletext set has caused some concern amongst those advertising on the independent channels that during commercial breaks the viewer may switch to the teletext service. Many home computers are used for playing video games.

To be successful a cable system must offer the consumer more than is already available, or similar services packaged in a more convenient way at a lower perceived cost. Desirably it should offer the facilities of a home entertainment centre without the capital cost of extra equipment, and for the cable operator should possess the potential to evolve towards an integrated wideband communications network with capacity for new services when demand arises:

Thus mix of services could be:

- Distribution TV - Basic, subscription, pay-per-view.
- Videotex - Alphanumeric and photographic.
- Home data services
- Individual video - eg video telephone, video library.
- Business services - Data and video.

THE NEXT GENERATION

Unfortunately this mix of services requires a mix of cable topologies. Broadcast type services are best distributed by a tree and branch network, and a limited amount of interactive capability can be provided to cater for pay-per-view services and low speed telemetry type data. However, despite a considerable amount of ingenuity displayed by system designers, the tree and branch network is fundamently limited in the amount of traffic it can handle. Services that demand individual subscriber access are best handled by a star type network, the star implemented either electrically or physically.

Mixed services are best handled by a mixed network topology, and that chosen for BT's next integrated services wideband network is shown in Figure 2. It is basically a switched-star network, but has elements of a tree network to give economies in the provision of broadcast channels.

Broadcast services are fed to each wideband switch over optical fibre cables and passive optical taps. The distances from hub site to switch may be up to 50 km, and fibre was chosen in this part of the network, the primary links, because of its superior transmission performance. Equipment is being developed which will allow transmission of 4 TV channels over one fibre using FM, narrow stripe laser source at 850 nm. The graded index fibre is required to have a loss of 3.5 dB/km, with a bandwidth of 600 MHz km. Initially each switch point will be provided with 5 tapped fibres, giving a 20 channel capacity, and an additional 5 dedicated fibres, two of which are used for a signalling and control path to the hubsite (2 Mbit/second) and three giving an additional 12 channel capacity for individual services.

Switching is done at baseband, the development of a hybrid circuit has reduced the size of the switch such that it can now be housed in a roadside cabinet. Each switch serves up to 300 subscribers, who are connected by a small bore co-axial cable in a star configuration. By keeping the upper frequency on this secondary link to below 100 MHz, a reach of 500 metres can be obtained. Initially, each subscriber has access to two independently switched TV channels, FM radio, and a bothway signalling channel. Provision has been made in the frequency plan for an additional TV channel, an upstream video channel, and a bothway high speed data circuit. Furthermore, account has been taken of a possible extension to the bandwidth required for broadcast TV channels with the advent of DBS signals. As in the Milton Keynes trial, channel selection is controlled by a processor at the switch point, which receives channel requests from the subscriber, and accesses eligibility information from the central management system. Videotex generators are also placed in the switch, their outputs, at video, being transmitted to the subscriber in the same way as standard TV channels, whilst their inputs are fed, via the signalling and control data link, from the videotex subsystem at the administration centre. The videotex subsystem is an integral part of the cable network, offering not only access to interactive information pages eg advertisements, mailbox, shopping and banking, ability to change censorship passwords, general help. Furthermore a games package is incorporated, offering in

addition to customer-computer games, customer-customer games and educational facilities. Gateways are provided in this subsystem to other data bases, such as BT's national Prestel service or private view-data schemes. Customers can be provided with the facility not only to access information from the database, but also to input formation, eg advertisements. To achieve this, the customer signalling system is capable of supporting a full alpha-numeric keyboard, although this will be available only at extra cost. Another gateway is to be photographic videotext system. Here photographic images are stored in a computer file and can be recalled and displayed on the subscribers TV set. In this case transmission is at video from the head end to the subscriber, and uses the channels provided by the dedicated fibres to the switch points. This service will be of interest to those waiting to sell high capital cost goods, eg houses.

The video library subsystem also uses these dedicated channels. Here, customers can access any item held, on video disc, at a centralised library location. Because the customer-disc interaction is one to one, the customer can be allowed to control the disc player, and facilities such as fast forward and reverse, still frame, and search to a frame are available. Each disc can store up to 50,000 frames of information, each one can be accessed individually, opening up exciting possibilities in the area of programmed learning video encyclopaedia, as well as the more normal play through items. This will be a premium service for which the customer will be charged an amount similar to that of renting a pre-recorded video tape, it is therefore expected to be a service that the average customer will use only occasionally. The system design is, however, modular, such that it can be enhanced to meet demand.

The management subsystem keeps a record of customer eligibility for particular services, as well as records of parental lock and other passwords. This information is downloaded to the processors in each switch point when necessary. It also provides data for customer bills, and maintains an overview of the network operation. Interfaces can be provided to programme providers, and statistics on systems use obtained. Associated with it, although able to operate in a stand-alone mode, is a system planning aid which holds geographic information concerned with the location of cables and equipment and has information on transmission planning rules and costs available to it. This enables the system, or extensions, to be planned and costed quickly and easily.

The customers installation consists of three items. A customer's termination unit, which receives the VHF signals from the system and up-converts to UHF to feed a conventional TV set and contains a simple microprocessor to perform signalling and monitoring functions. This box needs to be mains powered from the customer's supply, but can be located

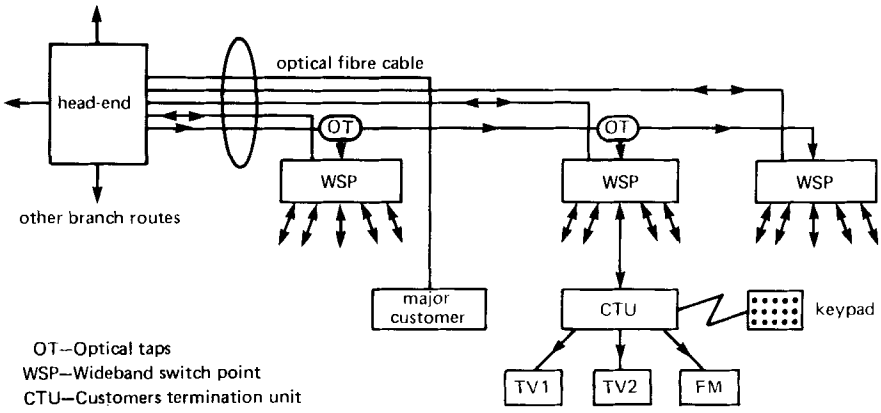

Figure 2: Network Topology

anywhere in the house. It is connected to the TV sets and FM radio by conventional in-house UHF wiring. Communication with the system is achieved by a hand-held infra-red remote control keypad (either full alpha-numeric or simplified service select and library control only), the receiver for which is a very small box mounted on the TV set. Signalling information is passed from this small box to the customer's termination unit over the UHF co-axial cable.

PRESENT POSITION

The most advanced system offering all facilities is doomed to failure if it is prohibitively expensive to install and operate. The mature costs for the switched star system described here; that is the basic system offering broadcast, subscription and pay-per-view TV, access to the videotex and photographic videotex subsystems with all the interactive facilities, is some 20% higher than a conventional one-way addressable co-axial system constructed and installed to UK standards. This higher cost must be considered in the light of the potential revenue earning capacity and operating costs of the two systems. The switched star system, with its sophisticated monitoring and control system, as well as its almost total immunity from programme theft could well show significant savings in maintenance and operating costs over its tree and branch competitor. Add to this the UK governments intention to offer longer franchises to the switched system, and the case for its installation from the outset is very strong. As to the availability of the equipment, all the hardware designs have reached prototype and most are in the production phase. Software definition and preparation for the control system is in-hand for a system that will support 100,000 customers, greater numbers being served by modular addition. Technically the first customers could be receiving service by the last quarter of 1984, but the timescales are likely to be dictated more by commercial and legislative considerations, rather than by system availability.

REGULATION

Britain is in the process of establishing the regulatory framework for new cable-TV systems. The Information Technology Advisory Panels' report (ITAP), published in early 1982, advocated the liberalisation of cable systems. Additionally the Government accepted that direct broadcasting by satellite (DBS) could be introduced. The Hunt committee, established in the wake of ITAP to consider the impact of cable on broadcasting, reported towards the end of 1982, and a Department of Industry committee, chaired by Dr Eden, has been considering technical standards and is due to produce its final report in summer 1983. A Government White Paper is expected by the end of April 1983, setting out policy and franchising arrangements.

EVOLUTION

It must be admiited that the cheapest way of distributing TV signals to subscribers is by a tree and branch co-axial cable network, and indeed British Telecom is actively pursuing this approach as well as the switched-star system described in this paper. However, the provision of switched star topology enables the system to evolve as demand grows, as well as easing some of the problems (picture degradation due to scrambling, programmed theft, limited interactive capability) encounted with tree and branch networks. Indeed, the strength of the star systems is that sufficient transmission capacity is installed on the final link to the subscriber, which is generally the most expensive part of any cable network, to cater for existing and future demands for entertainment and telecommunication services. By upgrading equipment at either end of the link, and with no additional civil engineering work, the system can evolve to an integrated services wideband network.

CONCLUSION

The system described in this paper has evolved from the all optical-fibre trial at Milton Keynes. The advantages of different transmission media have been exploited - optical fibre in the primary links and co-axial cable in the secondary links - allowing an easy mix of services with straightforward installation. Equipment at the customer's premises has been kept to a minimum, yet a standard TV set has access to a range of interactive videotex services as well as entertainment channels. The control system, with both centralised and distributed processing, allows programme packages to be assembled to meet individual customers' needs, and inbuilt maintenance and diagnostic aids will allow speedy fault clearance. Although the cost is somewhat higher than that of a simple co-axial tree and branch network, it should be remembered that in addition to providing a wider range of revenue earning services it allows tree TV sets to be used independently, each having access to the full range of services. Furthermore, the reduction in home visits made possible by the simplified customer's installation and

network resident control system, will lead to lower systems operating costs.

ACKNOWLEDGEMENTS

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REFERENCES

1 Fox J R et Al: Initial Experience with the Milton Keynes Optical Fibre Cable-TV Trial. IEEE Transactions on Communications, Vol. Com-30, No 9, September 1982.

2 Ritchie W K: An Integrated Services Cable-TV Network, International Television Symposium, Montreux May 1983.