ACE – a new dimension in digital networking

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Summary The article describes the use of the Marconi ACE digital switch in leased-line telecommunications networks, and explains how the remote control capability leads to the provision of a managed network capable of offering new types of service.

The article indicates how sub-systems may easily be added to ACE to provide different service offerings, and how ACE can be seen as a flexibility point in networks enabling telecommunications administrations to react quickly to user demand.

ACE's unique wideband switching capability is described, and it is shown how ACE is likely to be employed as an access switch in the Integrated Services Digital Network. The concept of managed broadband switching is also introduced, leading towards a multiservice capability.

Introduction

The Marconi ACE switch (figures 1 and 2) previously described in *Communication & Broadcasting*, Vol.9, Number 1, is being used in British Telecom's KiloStream service as a means of routeing and supervision on digital leased-line traffic (figure 3). This article indicates how ACE provides this facility, and goes on to describe how its role can be expanded to perform a wider function in telecommunications networks, particularly with regard to new and innovative services.

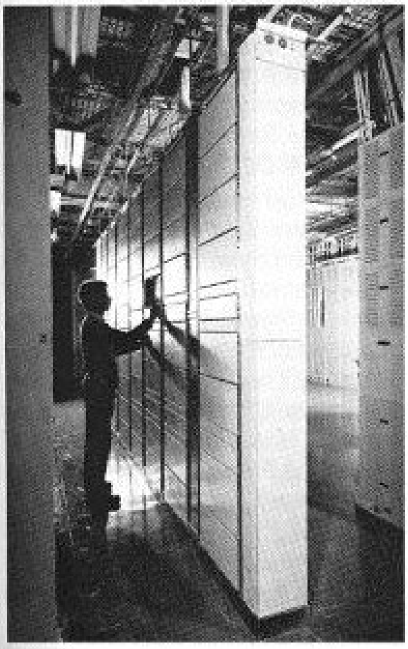

Fig. 1. Typical ACE installation

Basic operation

ACE is an acronym for Automatic Cross-connect Equipment and its basic function is to cross-connect individual or multiple 64kbit/s timeslots between 2Mbit/s ports, under the control of a local or remote terminal (figure 4). Thus, it is not a real-time switch such as a PABX or public switch, but is a routeing device for more permanent traffic connections. None the less, the architecture of ACE makes use of the very latest switching components (figures 5 and 6), and the processor control enables near real-time operation to be provided if needed. A major feature of ACE is its ability to operate under remote control, leading to the concept of co-ordinated control across any number of ACEs, and thereby providing a very powerful networking facility (figure 7).

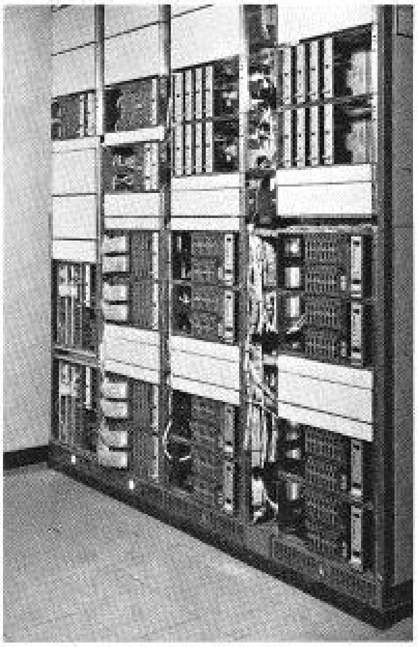

Fig. 2. 128-port ACE

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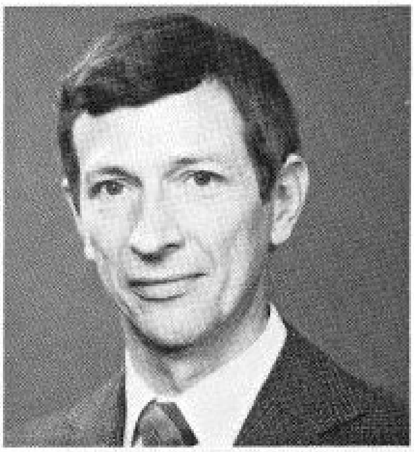

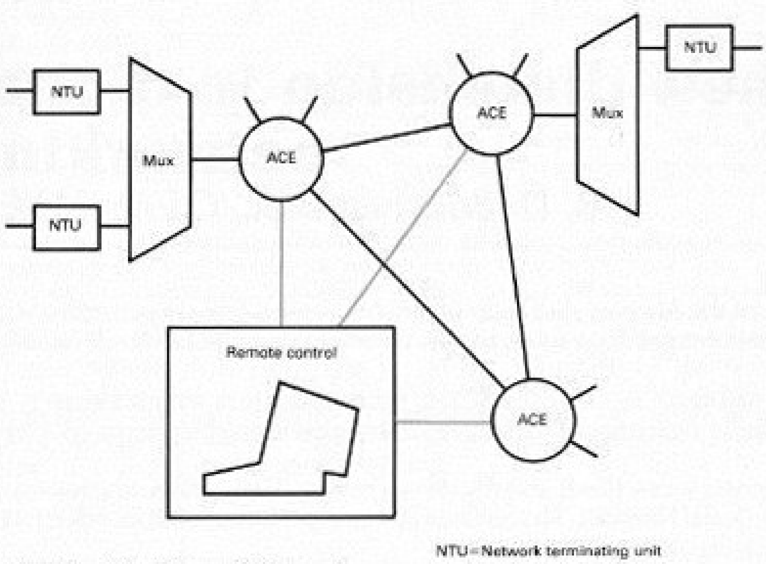

Fig. 3. The KiloStream Network

Due to the highly concentrated nature of the traffic likely to be carried by ACE, it is essential that the switch has the highest integrity, and therefore the switch plane and control may be duplicated separately as shown in figure 8. Additionally, it is essential that the switch plane should not block when adding or re-organizing traffic, and this has been achieved using a single-stage, time-space switch employing VLSI switching devices. This also enables multipoint and wideband (n×64kbit/s) services to be provided with bit sequence integrity across the timeslots.

A smaller version of ACE, called Mini-ACE, is available for common carrier or end user application, and provides similar facilities in a single rack with a maximum 2Mbit/s port capacity of 32.

Network management

Although ACE can usefully be employed as a self-contained, locally controlled facility, it is the remote control capability that adds a new dimension. By providing suitable intelligence at a network control centre (figure 7), facilities can be supplied for the complete management of the network. Thus, the status of all aspects of the network may be fed back to the centre, covering not only operational aspects, such as the connection map in each ACE, but also the availability and performance of switching and transmission equipment throughout the network, including the local drop to the user and the status of the network terminating equipment.

To provide additional security, a number of control centres may be installed, independently linked to ACEs, and inter-linked to keep them in step. Furthermore, packet-switching networks can be used for this linking, providing the security of error correction and alternate routeing, and the advantages of dynamic multiplexing.

Should an individual ACE become isolated from the control centre for any reason, the user traffic cross-connections in that ACE are maintained under local control. In addition, following a power failure at an ACE site, the connections are restored to the state prior to the outage, as the cross-connection map is held locally in non-volatile memory.

With regard to control of network services, the control centre computer, reacting to operator commands, is able to find a route across the network in accordance with a routeing algorithm and to schedule the connections for user service at a specified time. The circuits can be tested prior to handover, can be monitored in use, and can be re-routed under failure conditions.

Testing is undertaken as shown in figure 9, where bus-controlled test equipment at an ACE site can be remotely controlled from the centre, and monitor or break measurements can be made by suitable routeing through the ACE.

User control

Just as the management facilities mentioned above are so useful to the public network operator, a user with a leased-line network is also likely to require similar facilities relating to his portion of the public network. Thus, the ability to know the status of the network and to monitor, test and re-route circuits is particularly valuable, and perhaps can be integrated with the user's management system.

A possible way to achieve this is shown in figure 10, where a front-end processor is used at the control centre to intercept user's control signalling. This processor can be

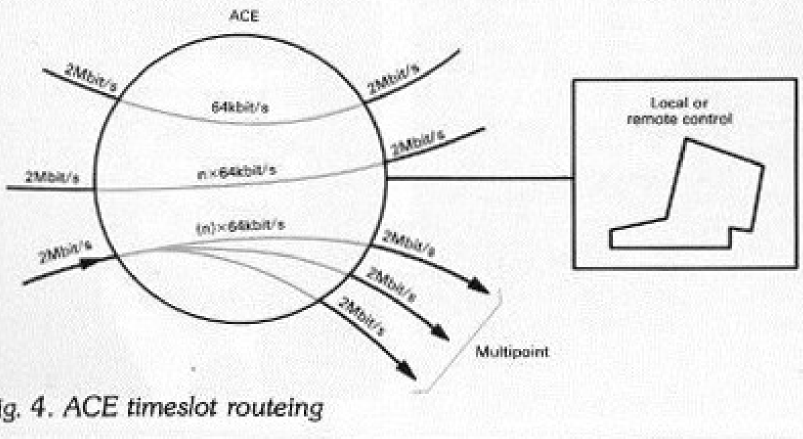

Fig. 4. ACE timeslot routeing

used to authenticate both user and command, in order to block illegal entry to the system.

This control capability may also be used to re-allocate bandwidth and/or to reconfigure the network at certain times of the day in order to provide, for example, circuits for video conferencing or high-speed file transfer.

A new form of switched service may thus evolve which is not essentially a real-time service, but a reconfiguration facility for the most effective use of leased-line networks.

Sub-system flexibility

The basic function of ACE is to route 64kbit/s timeslots between 2Mbit/s ports. However, an attractive feature of ACE is the way in which sub-systems may be added to provide additional capability (figure 11). For example, 64kbit/s timeslots containing multiplexed lower bit-rate traffic may be routed to dedicated 2Mbit/s ports, to which are attached sub-systems designed to cross-connect the lower rate channels. In this way, 32kbit/s or 16kbit/s encoded speech channels, or X50 multiplexed data channels, may be routed individually. Similarly, Timeslot 16 signalling information in 2Mbit/s streams may be groomed to match the 64kbit/s timeslot routeing, and this can be applied to fixed-frame channel-associated signalling or to packet-based common-channel signalling.

A further sub-system indicated in figure 11 is trunk concentration. Depending on the topology of the network, it often pays to reiterate data traffic in the urban environment (i.e repeat the data until it fills a 64kbit/s timeslot) and to multiplex traffic on trunk routes. A sub-system can be provided which removes the reiteration and multiplexes the data traffic for more cost-effective transmission over longer distances. Thus, a balance can be made between the costs of cross-connection and the costs of transmission to provide the most economic solution for a particular network.

Further sub-systems can provide audio conferencing, voice-band data multipoint and digital data

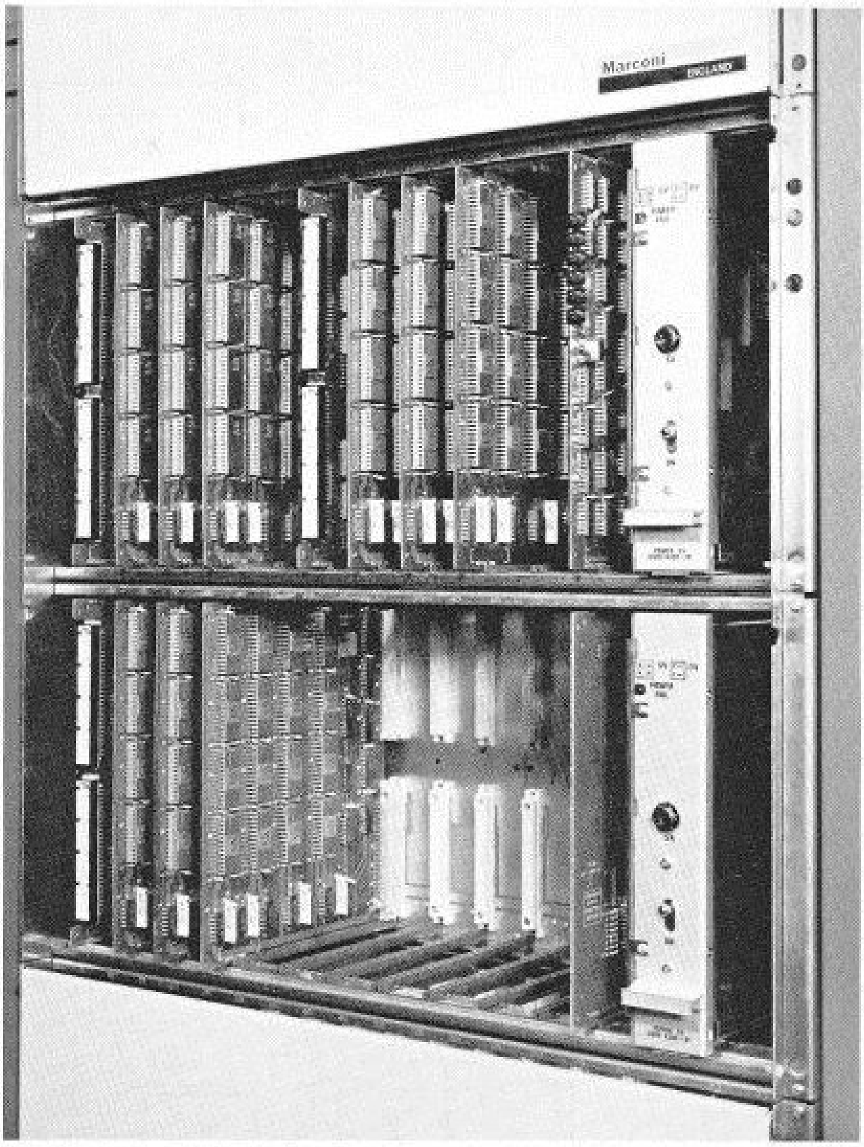

Fig. 5. ACE switch shelf

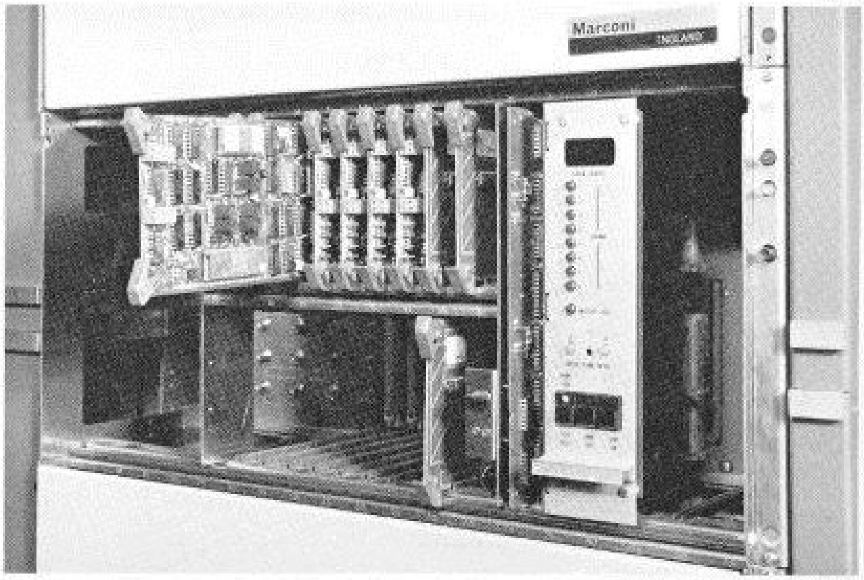

Fig. 6. ACE line shelf

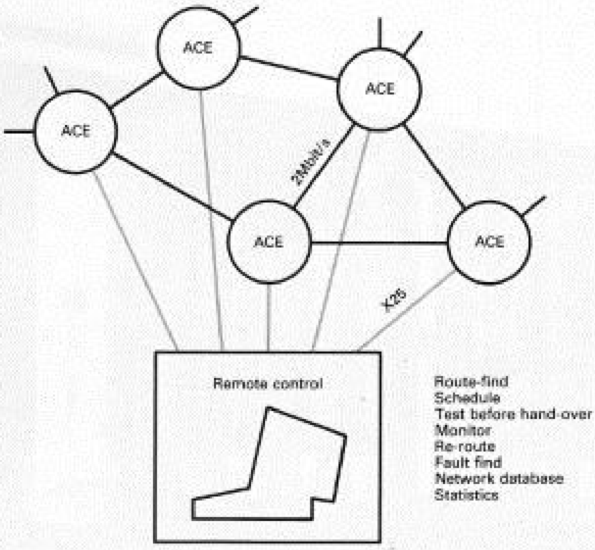

Fig. 7. Remote control

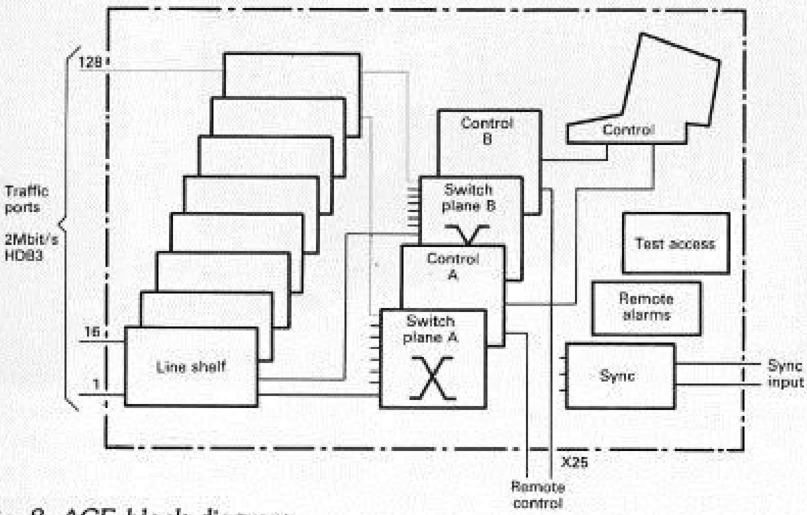

Fig. 8. ACE block diagram

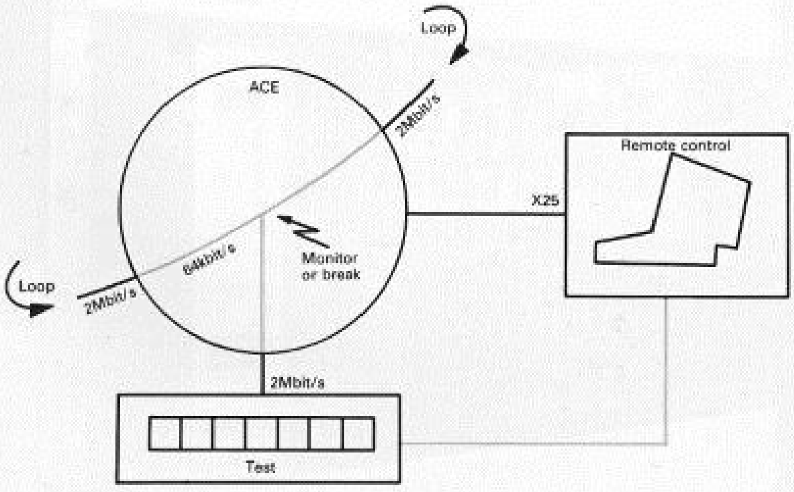

Fig. 9. Remote testing

multipoint services. These facilities make use of the inherent capability in ACE to transmit a 64kbit/s time-slot to any number of destinations, and to provide various mechanisms for the return paths. An audio conferencing bridge digitally combines all paths. Voice-band data is digitally combined into the common return path, and digital data is passed through a contention switch which reacts to an in-slot structuring of the signal (e.g the status bit in a 6+2 envelope structure).

From the above it can be seen that ACE has great flexibility to provide new services and can act as a flexibility point in networks, enabling common carriers to react quickly to user demand.

Wideband switching

In this context, wideband switching refers to the inherent capability of ACE to route 'n×64kbit/s' signals with full bit sequence integrity across timeslots ('n' being a whole number up to and including 31). This is a very powerful feature many years ahead of public digital switching systems, and gives common carriers the ability to carry wideband traffic having a structure entirely different from digital speech traffic.

This is particularly of interest today for video conferencing, where bit-rate reduction techniques are achieving good results at rates considerably below 2Mbit/s, and for high-speed data exchange between computers.

With large corporate networks being set up today based on 2Mbit/s leased-line services between sites, the possibility exists to provide wideband services at different times of the day for different purposes without unduly disturbing transactional traffic at the 64kbit/s timeslot level. This may be achieved by routeing 2Mbit/s services through ACEs in the common carrier network with the possibility of user control of routeing in the network, or by the user installing Mini-ACEs in his premises.

A basic capability of ACE is that of aggregating 64kbit/s traffic for cost-effective fill on the 2Mbit/s trunk connections. The wideband facility adds a dimension to this because it provides a transmission service for terminal equipment requiring a capability of greater than 64kbit/s but less than 2Mbit/s, be it timeslot structured or not, to be cost-effectively provided (figure 12). Access to ACE is via a 2Mbit/s port with Timeslot 0 structuring, but, of course, not all timeslots need be used. Remote terminal access to ACE may be achieved using conventional 2Mbit/s systems for structured traffic, or Marconi's wideband access for non-standard traffic.

Signalling information carried within the wideband signal is, of course, transparently routed. However if, for example, ACE was to act as a hub for a number of corporate PABXs, then by adding a signalling sub-system to ACE it would be possible to aggregate and segregate the signalling information on a common signalling channel. In essence, this would not react to signalling commands, but would route appropriate signalling information to appropriate destinations. This can be undertaken on the basis of Timeslot 16 containing fixed-frame channel-associated signalling, or packet-based common-channel signalling. Obviously, in order to make it worthwhile developing such a system, there needs to be a broad consensus on signalling methods and it does appear possible that in the UK this can be achieved with the Digital Private Network Signalling System (DPNSS).

A further role for ACE may be to act as a gateway between a number of well-defined signalling systems, or indeed, to convert data traffic between various rate-adaption or reiteration schemes. This underlines again the ability of ACE to act as a flexibility point in digital networks.

Traffic segregation and ISDN access

Leading on from the previous paragraphs is the concept of traffic segregation on a common 2Mbit/s access to the network (figure 13).

Particularly of interest is the possibility of segregating digital leased-line traffic from switched traffic, thus providing all the benefits of ACE network control and supervision, which may be lost if leased-lines are

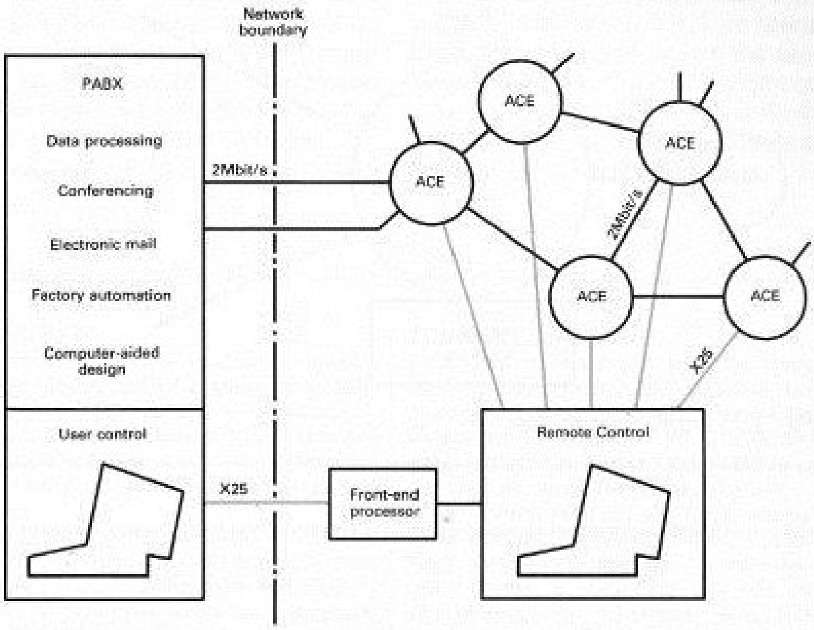

Fig. 10. User control

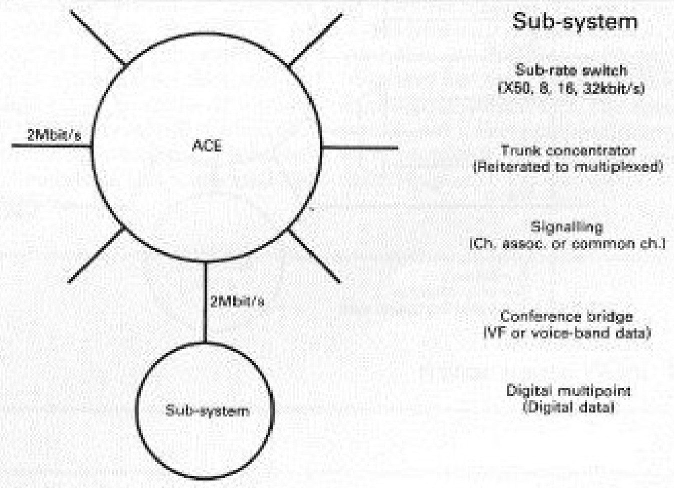

Fig. 11. Sub-system flexibility

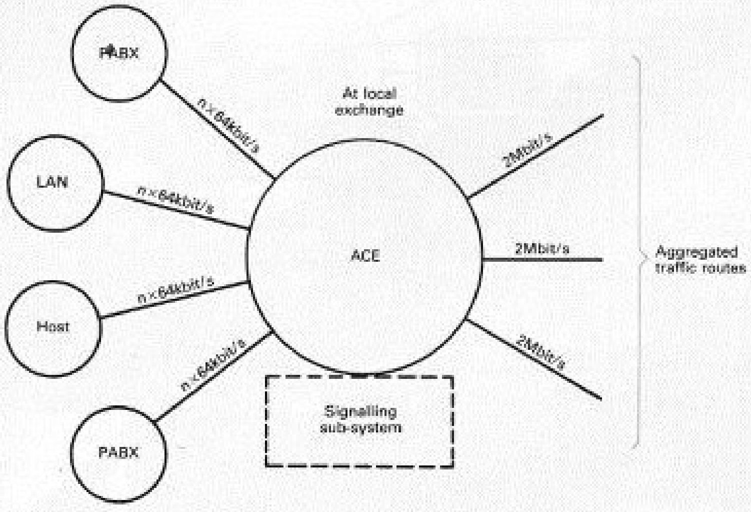

Fig. 12. Traffic aggregation

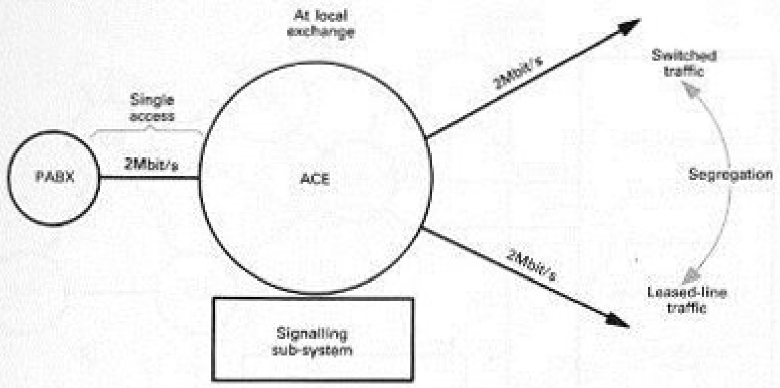

Fig. 13. Traffic segregation

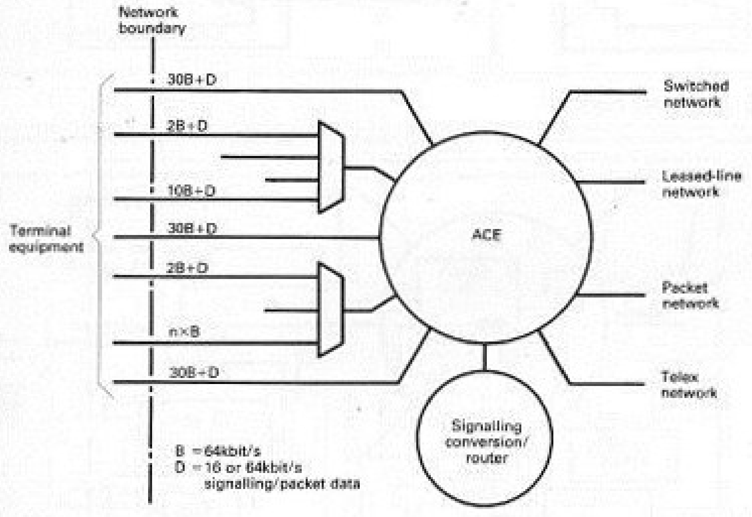

Fig. 14. ISDN access switch

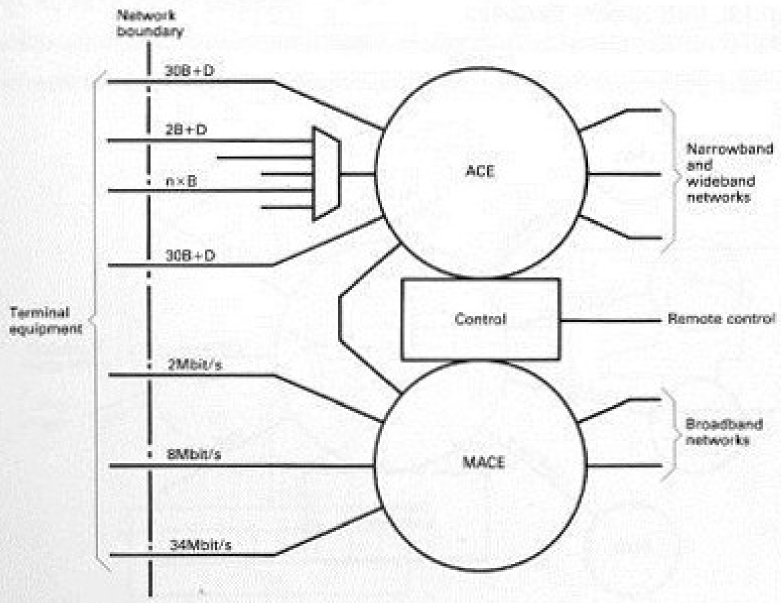

Fig. 15. MACE control

treated as nailed-up connections through the local exchange. For operational convenience it is clearly desirable for a common signalling standard to be established. In the UK, the digital access signalling system DASS2 is proposed for exchange access, which at level 2 of the protocol is similar to DPNSS, and therefore will allow appropriate signalling segregation to occur. Furthermore, it may be sensible to provide a common digital access for analogue voice services and digital data services as a step towards integrated access, allowing ACE to undertake any bridging necessary between protocols.

As Integrated Services Digital Network (ISDN) facilities are introduced into networks, it will be particularly beneficial to provide ACE or Mini-ACE as a service concentrator and access flexibility point as shown in figure 14. It is likely that CCITT D channel signalling protocols will be introduced towards the end of the decade in advance of exchange capability, and the appropriate signalling conversion can be provided in the ISDN multiplex or ACE sub-system.

Broadband switching

Broadband services refer to transparently routed 2Mbit/s services and higher rates such as 8Mbit/s and 34Mbit/s. In the liberalized environment it is likely that telecommunications administrations will wish to offer broadband services in order to compete with bypass technologies such as microwave, satellite and cable networks. If these are managed services such as those offered by ACE, they are clearly more attractive to an end user.

The Marconi MACE (Mega-ACE) is designed to provide such a capability. The architecture is very similar to ACE, employing digital cross-points at 2Mbit/s, but switching transparently in a single-stage switch capable of expansion up to 128 ports.

MACE control may be integrated with ACE control as shown in figure 15, providing a very powerful networking capability, and leading further towards the provision of a multi-service network capable of handling video bandwidths.

A considerable amount of work is currently being undertaken in the research field on the concept of a multi-service network aimed at providing narrowband, wideband and broadband services, and able to vary transmission capacity dynamically with loading. In addition, work on optical switching technology is pushing ahead, leading to the possibility of national cable networks providing two way, high-definition video services.

It is not at all clear how these techniques will be integrated with today's networks, but it does seem likely that managed leased-line services will lead to the introduction of new technology, and that the flexibility of ACE acting as an Access Switch will aid the integration.

RÉSUMÉ

L'article décrit l'utilisation du commutateur numérique ACE Marconi dans les réseaux de télécommunication à lignes louées et explique comment la télécommande permet d'obtenir un réseau géré capable d'offrir de nouveaux types de services.

L'article précise que des sous-systèmes peuvent facilement être ajoutés à ACE pour offrir des services différents et que ACE peut être considéré comme un point élastique dans les réseaux permettant aux administrations des télécommunications de répondre rapidement à la demande des usagers.

L'article décrit la faculté de commutation à large bande de ACE, la seule en son genre et il explique que ACE sera vraisemblablement utilisé comme un commutateur d'accès dans le réseau numérique de services intégrés (RNSI). La notion de commutation à large bande gérée permettant des services multiples est elle aussi introduite.

RESUMEN

El artículo describe el uso del conmutador digital de Marconi ACE en redes de telecomunicaciones de línea arrendada, y explica cómo la capacidad de telecontrol conduce a la provisión de una red administrada capaz de ofrecer nuevos tipos de servicio.

El artículo indica cómo los subsistemas pueden agregarse fácilmente a ACE para proveer ofertas de servicios diferentes, y cómo ACE puede ser visto como un punto de flexibilidad en las redes, permitiendo que las administraciones de telecomunicaciones reaccionen rápidamente ante la demanda del usuario.

Se describe la capacidad de conmutación de banda ancha única de ACE, y se demuestra cómo ACE es probable que se emplee como un conmutador de acceso en la Red Digital de Servicios Integrales (RDSI). Se introduce también el concepto de conmutación de banda ancha administrada, conduciendo a una capacidad de múltiples servicios.

ZUSAMMENFASSUNG

Dieser Aufsatz beschreibt die Anwendung der Digitalvermittlung ACE von Marconi bei Mietsleitung-Netzen und erläutert, wie die Fernsteuerungsfähigkeit zur Erstellung eines verwalteten Netzes führt, welches in der Lage ist, neue Dienstarten zu bieten.

Der Aufsatz zeigt an, wie Untersysteme ohne weiteres der Vermittlung ACE zugeführt werden können, um verschiedenartige Dienste zu leisten und wie ACE als Anpassungspunkt in Netzen betrachtet werden kann, bei denen die Telekommunikations-Verwaltungen schnell auf Anwenderforderungen reagieren können.

Die einzigartige Breitband-Vermittlungsfähigkeit des Systems ACE wird beschrieben und es wird auch angezeigt, wie ACE wahrscheinlich als Zugriffsvermittlung für das Integrated Services Digital Network (ISDN) angewendet werden wird. Das Konzept der verwalteten Breitbandvermittlung wird auch vorgestellt und führt zu einer Vieldienstfähigkeit.