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**EuroCAIRN and the Trans-European Research Backbone Project**

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# EuroCAIRN and the Trans-European Research Backbone Project

Howard Davies

## *Abstract*

Networking services for the research community in Europe are about to advance dramatically. The state of development of new communications technologies has reached the point where new services can be introduced; the national research networks in about half of the Western European countries have set up services based on 34 Mbps technology or are about to do so. Applications which make use of constant bit rate services for the support of multi-media (high quality video and audio) are already being tested.

On the pan-European scale, there are still problems to be tackled at different levels: technical (interworking between national services, exploitation of the potential of the new technology); organisational (how can services be provided in advance of routine availability from PNOs); and financial/political (what will be the costs and how will they be met).

## **1. Introduction**

This paper presents a general description of the likely impact on network services for the European research community of recent developments in telecommunications technology.

A major activity at present is the Eureka EuroCAIRN Project which aims to provide the framework for organising the pooling of national funding resources, to promote co-operation between national (high speed) networking activities, and to involve the information technology and telecommunications service industries. It has formal participation from 17 countries plus the European Commission. However, the results of its work will not be limited to the participating countries; the potential beneficiaries are all European countries including those in Central and Eastern Europe.

In July 1994, EuroCAIRN awarded a contract to DANTE to carry out a study which includes a survey of requirements, an examination of available technologies, and the development of an implementation plan for a high speed service which could eventually cover the whole of Europe. At the beginning of November 1994, DANTE submitted an Interim Report to EuroCAIRN which includes a first draft of such a plan. A Final Report, which will refine the material in the Interim Report, is due to be submitted to EuroCAIRN in January 1995.

Much of the material in the paper is based on work that DANTE has recently carried out for EuroCAIRN. The views expressed are however those of the author and not necessarily those of EuroCAIRN.

## **2. The New Technology**

For many years, the use of optical fibres has promised to transform telecommunications technology. More recently, the terms 'multi-media' and 'Information Superhighway' have become fashionable and frequently used. Yet, for the average end user who has for years been able to log on to remote computers, transfer files between computers, inspect networked data bases, and send electronic mail to colleagues, little seems to have changed except that the quality of user interfaces has improved and things sometimes work faster. What exactly is different about the new technology, and how soon will it bring real benefits in the form of new applications?

Current network technology, including that of the global Internet which is now the predominant service used by the research community, is based on designs which were invented between 15 and 20 years ago. These designs aimed to make the best possible use of available bandwidth as well as allowing a common infrastructure to be shared between many users. However, they do not include features which allow a defined level of service to be provided for any particular user or even any which allow prioritisation of traffic from

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different users. As a result, the service to individual users suffers from performance degradation when the aggregate network load is high and there is no way of guaranteeing that the delivery of data will be synchronised with its transmission.

The more recent availability of high bandwidth at low cost by itself encourages new applications; a high quality digital image can be transmitted in the same time and at the same cost as was previously necessary for a page of ASCII text. It also diminishes the importance of effective sharing of capacity between users. Accepting this less efficient use of bandwidth and taking advantage of other developments in the use of digital technology, it becomes feasible to introduce new services based on constant bit rate (CBR) delivery in which a stream of data is delivered over the network to end user equipment at a rate which is constant within very narrow limits. If this stream of data represents successive frames of a video picture and its soundtrack, television quality video sequences can be supplied on user demand. Combined with new switching techniques which enable logical transmission circuits to be set up and closed down rapidly under user control, a whole new range of video-based (multi-media) applications becomes possible.

Although the principles of these techniques have already been convincingly demonstrated and a number of pilot schemes which make use of them are already in progress, large scale operational services are not yet available. The technology is not yet pervasive; usage is therefore limited to a very small sub-set of potential users. Standardisation is incomplete, so that although full communication can be established between pieces of equipment from the same supplier, interworking between equipment from different suppliers is not straightforward. In any case, procedures for the management of the more advanced services, including the dynamic creation of logical circuits, and the signalling systems between equipment in different management domains which are needed to implement these procedures are still undefined.

### **3. Requirements of the Research Community**

A recent DANTE survey of national research networks (carried out as part of the EuroCAIRN study) confirmed the general pattern, common throughout the Internet, of exponential increases in activity (as measured in a number of different ways) with an approximate doubling of numbers

every year. The Internet Society's data on the number of connected systems is shown in Fig. 1; the total monthly traffic on the EuropaNET backbone is shown in Fig. 2. This organic growth in current activity is expected to continue for some time. However, the introduction of new multi-media services is also expected to result in a step increase in bandwidth demand of an order of magnitude (factor of 10). National network plans then foresee a slower rate of growth - typically a doubling every two years - but all that can be said with confidence is that much higher bandwidths will be exploited if suitable services are made available at an acceptable cost.

National implementations of high speed services are already demonstrating their utility, especially for example in the fields of medicine (rapid transmission of X-ray images, remote diagnosis by specialists), distance learning, and several uses of video conferencing techniques. There is now a clear requirement for international connections to link the national islands that are growing rapidly. High speed links between Europe and North America are also seen as a vital element of any pan-European service.

A limited survey by DANTE of discipline-oriented user groups was also revealing. The results confirmed the general picture of bandwidth requirements identified in the national networks survey but also put emphasis on quality of service. It is clear that more use would be made even of existing services if they were more reliable, more predictable in their response, and easier to use. This also points to the continuing danger with new technologies that services will be introduced at a quality level that satisfies the technicians who work to develop them but falls short of the minimum requirements of end users whose interest is in the application and not in the underlying technology.

Another danger is of too much dependence on technology alone; psychological factors will have to be taken into account too if new services are to be successful. Some potential applications, eg internal body inspections by surgeons, already use video techniques and it is easy to extend them to work over long distances. Others are more problematic, especially when human-human interaction is involved and 'total system' problems will need to be addressed. User groups have an important role to play in combining the voices of large numbers of people in order to make sure that their real requirements are met.

#### 4. Implementation Issues

The national research networks in Finland, France, Italy, the Netherlands, Norway, Sweden and the UK have already demonstrated through pilot services that it is possible to establish simple high bandwidth (34 Mbps or greater) services on a national scale. Germany and Switzerland have plans (and funding commitments) that will enable them to do so during 1995.

Most of these networks are making experimental use of ATM switches as a way of multiplexing bandwidth use and supporting new multi-media applications. Two countries are relying on a simple IP service at the higher speeds. IP can offer a perfectly adequate service if there is plenty of spare bandwidth and it has the advantage of being proven and well understood. However, even with the improvements planned for IP New Generation (IPng), it will never meet a requirement to support constant bit rate services.

On the other hand, the potential of ATM still remains to be demonstrated and there are voices within the community which claim that its promise will never be fulfilled in practice. The principal justifications for such claims are that: the overhead associated with the small cell size chosen for ATM makes its use of bandwidth inefficient; the fixed cell size limits the scope for devising more effective ways of using network resources; cell loss even at low rates can lead to dramatic degradation of performance if error correction mechanisms at higher levels are not well tuned; and the complexity of the signalling systems that will be needed to implement the variable bandwidth features which are possible in principle is such that the associated problems may never be solved satisfactorily.

These claims may prove to be unduly pessimistic and early experience, for example in the UK, shows that equipment on the market now can adequately support the simpler ATM services. Nevertheless, much work remains to be done on the standardisation and development of end-to-end signalling, ie between two sets of end user equipment which are interconnected via a concatenation of private (site, national research) and public networks.

In addition, resolving the outstanding problems at the basic telecommunications level is not by itself enough to establish user services. Complex management issues also need to be addressed, eg

in relation to booking of conferences, user control of switching, automated conference establishment according to a pre-set timetable, accounting and charging mechanisms. Multicasting - a powerful technique which allows a video or audio feed to be distributed to individual users or groups who choose to join is potentially very powerful (and is already heavily used on the Internet within the constraints of current bandwidths) - has its own management problems. Distribution mechanisms have to be further developed to minimise the risk of multiple copies of the same traffic passing over the same circuits to different ultimate destinations. The essentially manual methods that are used at present to control the Mbone service on the Internet are simply not scalable for use by the hundreds of simultaneous multicasts that the new capacities will make possible.

A major constraint on the establishment of any high speed service at present is the lack of availability of international lines (or services) at 34 Mbps and higher speeds within Europe. Lines at this speed are available nationally in many countries, but there are only a few such international lines and even these are used in special projects in which one or more Public Network Operators (PNOs) are themselves participating. DANTE's conclusions from a survey of European PNOs are that: there is a lot of installed basic capacity (the PNO in one of the smaller European countries said that the aggregate capacity to its neighbours would be 9 Gbps by September 1995); several PNOs claim to be prepared to deliver high speed circuits but few of them have published tariffs; and none was able (or prepared) to point to a reference sale.

When international lines (and services) do start to become available, this will not happen all over Europe simultaneously. There will therefore be a progressive introduction of services, probably starting between countries with the more liberalised telecommunications regimes or where the national PNOs have already formed alliances (eg France and Germany). An important part of the planning which will be required is to include an interconnection between the IP component of the new high speed service and the existing service in order to maintain full connectivity between all countries.

Although the long term aim should be to make use of advanced services offered by the PNOs, the first services are likely to be at the level of simple leased lines even if the PNOs use ATM or

other advanced techniques as the underlying means of supporting them. Because of the development that remains to be done, it is likely to be some time before any PNO offers ATM services which interact directly with customer equipment. The PNOs' ATM pilot which is about to start operation exemplifies this. The PNOs' objective in mounting the pilot to test interworking between their own sets of ATM equipment under realistic usage conditions. It was never the intention to make the ATM facilities visible to customers who see a straightforward (relatively) high speed leased line.

The lack of availability of high speed circuits and the problems of discrimination between countries and their researchers which will arise when such lines do start to become available are both issues which need to be addressed at a political level.

## 5. Organisational Structures

One view of the way that high speed services should be established is that, if the demand exists, the market will provide - and should be left to do so. DANTE and others dispute this view. Experience shows that new infrastructure does not develop without some form of centralised promotion or funding, if only in a catalytic role. It is not at all obvious that the PNOs will be prepared to deliver what the research community wants without being exposed to some form of (political) pressure.

The national services that have been established all involve a collaboration between the national research network and the equivalent PNO. This is a highly desirable state of affairs - both parties can benefit from such collaboration - but it is not so easy to reproduce on a pan-European scale. One of the motives of the national research networks in setting up DANTE to provide them with international services was that there was no organisation already in place which could do this job. The national networks as potential service customers have solved their part of the organisational problem, but the lack of pan-European structures still exists in the areas of supply and of funding.

The European Union has a number of activities which can be used to support the development and early use of new technologies but the European Commission says that it has no mandate to fund network infrastructure. The Fourth Framework Programme will start to provide funds

to support R&D during 1995 via the ACTS, Esprit and Telematics Programmes amongst others but, so far and despite positive comments in the Bangemann Report [1], no funds have yet been made available to create any kind of 34 Mbps service.

Some of the national governments are addressing this issue more directly via EuroCAIRN which, besides promoting the creation of 34 Mbps services and coordinating the provision of the necessary funding, can also make recommendations about other policy issues. The most important of these is likely to be finding ways of limiting inequalities of service in different parts of Europe. On one hand, there is a desire to allow all researchers to have the same opportunities to take advantage of the new technology; on the other had, it is clear that national infrastructures are not at the same stage of development in all countries and that developments in the more advanced countries should not be delayed simply to let the others catch up. Solutions to such problems are likely to involve government organisations in their implementation.

## 6. Costs and Funding

As mentioned above, the PNOs have not yet set tariffs for 34 Mbps and higher speed international services. Some PNOs as suppliers have taken the starting position of suggesting a factor of 17 as the cost of a 34 Mbps circuit relative to that of one at 2 Mbps. A counter position from a customer point of view is that the cost of providing any circuit is now relatively independent of the bandwidth and that the cost of a circuit with the highest available capacity should remain constant, ie the 34 Mbps price tomorrow should be the same as the 2 Mbps price today. A realistic target which takes account of the interests of both suppliers and customers is for a price ratio between 34 and 2 Mbps capacities which is between two and four.

Experience with earlier centrally funded initiatives has shown that it can be unwise to promote new services by offering them initially at zero cost and it is generally accepted that the national networks as users of a new international service will be required to make some financial contribution from day one. National network managers also accept that it is inevitable that 34 Mbps services will cost more than those at 2 Mbps. Several of them are have already budgeted for an increase in expenditure on international services to between

2.5 and 3.5 times the current level. A guide price which is being used for planning purposes is that a 34 Mbps service providing global network access should cost about 2 - 3 MECU per year.

## 7. A Possible Scenario

Given the complexity of the new technology, the different situations in different countries and the constraints on national funding bodies, it is unlikely that a single, uniform service will be established to cover all European countries simultaneously. It is in any case doubtful whether it would be realistic to plan the creation of a single monolithic service which might prevent the testing of alternative methods of working. DANTE's own proposal, which would be implemented in collaboration with a few national networks (and if possible, one or more PNOs) would provide a 34 Mbps IP service as soon as possible. In parallel, an ATM test network would be set up and used for the verification of new services and for the testing of new applications, including those which will be developed within the EC's Fourth Framework Programme. Later, there would be a migration to an ATM based service providing IP-over-ATM plus a constant bit rate service based on managed Permanent Virtual Circuits (PVCs). The configuration of PVCs, which provide logical circuits with a fixed (and guaranteed) bandwidth between two end points, would be changed manually from time to time to allow multi-media applications such as video conferences to be run according to a pre-arranged timetable. The ATM service would be progressively improved by the addition of new operational services as soon as they had been validated on the test network; development of particular interest are those which enable the bandwidth allocation procedures to be automated so that individual applications can be run at short notice in response to user demand. Expansion of service to countries besides those in the initial set would take place as soon as the relevant national service could fulfil the conditions necessary for exploitation: a viable national service in place, available international infrastructure, and committed funding

## 8. Conclusion

Research users of networking services are on the threshold of exciting developments. The technology for basic high speed services is already available but further development work is needed before the more sophisticated applications become operational. The PNOs also have to be persuaded to make their transmission capacity available - at reasonable rates. It is essential that user requirements are taken into account from the earliest stages of the planning phase. User communities should make sure their requirements - especially for quality of service - are well known and well expressed.

### *Reference*

- [1] Europe and the Global Information Society, Recommendations to the European Council, Brussels, 26 May 1994