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Abstract

The history of network services for European researchers demonstrates a complex, but progressive rationalization which still leaves much scope for further progress. This paper provides a description the current situation and its evolution. It concentrates on the activities of RARE and on the role of the Operational Unit - recently re-christened DANTE - which has been established as a not-for-profit company by the national networks of 12 Western European countries to provide international services both within Europe and to North America. The planned service portfolio of DANTE and other current developments are also described.

I. Historical Background

It is impossible to understand the plans for developing networking services in Europe without first learning how the present position was arrived at. For many years, the introduction of cross-border services between European countries was the result of independent bilateral agreements between pairs of national organisations, each of which had their own technical goals and administrative constraints. The result was anarchy - and a clear inefficiency in the use of resources. The magnitude of the problem was made visible with the publication in 1991 of the report of the European Engineering Planning Group [1] which, amongst other things, listed all the international data communications lines used by the European research community.'

The existence of the general problem, which resulted from a lack of coordination between the many national and international organizations involved in the provision of network services, had been recognized long before. RARE (Réseaux Associés pour la Recherche Européenne) had been created in 1986 as a forum for the national networking organizations to discuss matters of common interest and, in particular, to resolve the problems of interworking between national services that had been created independently. Shortly afterwards, the Eureka COSINE project was established and one of RARE's first major tasks was to coordinate the technical work necessary for the COSINE Specification Phase.

The broad goals of COSINE were to create a pan-European networking infrastructure for the whole European research community (academic, governmental and commercial) based on the use of OSI protocols. Mainly for organizational reasons - consensus between representatives of the eighteen countries involved had to be reached before each major decision was taken - COSINE developed more slowly than was originally planned.

The first concrete result was the creation of the IXI (International X.25 Infrastructure) Pilot network which started service between all the COSINE countries in July 1990. IXI is described more fully in [2]. In brief, the service was provided by PTT Telecom (Netherlands) under a contract with the Commission of the European Communities (CEC). This contract was originally set up independently of the COSINE framework - the CEC is a party to COSINE and provides the Project Officer function but also took the initiative in pressing ahead with the establishment of the IXI service. IXI provided an X.25 service at 64 kbps to 18 access points and also had connections to the public X.25 services in the 9 countries where suitable tariff arrangements could be agreed with the national PTT. Although the technical characteristics of the IXI service were not especially advanced even when the service started, IXI nevertheless represented a significant step forward as a managed network providing a common service between many European countries. It also provided valuable lessons in the creation and operation of such services which are being applied to new developments.

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1989 saw the start of the COSINE Implementation Phase. RARE was contracted to set up the COSINE Project Management Unit (CPMU) with the task of carrying out the set of sub-projects which made up COSINE through the selection and subsequent supervision of sub-contractors. A full description of the activities and the early work of the CPMU is given in [3].

Supervision of the operation of the IXI Pilot service was included in the CPMU's portfolio of activities, as was the specification and tendering for a 2 Mbps production service to supersede it. The result of the tender was the setting up in October 1992 of EuropaNET which offers a 2 Mbps multiprotocol (X.25, IP, CLNS) service in all COSINE member states (see below for details). The other principal results of COSINE have been the creation of the COSINE MHS service which provides operational support (for example, the exchange of routing and addressing information) to national X.400 messaging services, management of PARADISE, the international X.500 directory service for the research community, the creation of the CONCISE information service, support for discipline-oriented user groups, and the use of network security techniques. Other CPMU activities have covered network management and quality of service issues with results that can be applied to future developments; full details are given in [4] and [5].

COSINE, constrained by its internal organizational procedures, was overtaken to some extent by the explosion in European usage of TCP / IP and the higher level protocols which they support. TCP / IP had been adopted as the basis of the national network service in a number of countries, notably Switzerland and the Nordic countries. Since other countries were also introducing TCP / IP for at least part of their national service, it was essential that the new pan-European backbone could handle multiple protocols.

While the details of the new managed services were being negotiated with potential contractors, the large TCP / IP users set up Ebone92 as an IP backbone service with access points in five countries. Ebone92 was later transformed into Ebone93 with a greater number of participants and higher speed lines. Ebone is described fully in a separate paper [6].

The last few years have seen radical changes in Central and Eastern Europe which have created major new demands for network services from researchers in these countries. Amongst a number of initiatives, the CEC is providing 64 kbps links to some of the Central European countries using an extension of its IXI Pilot contract and funding from its PHARE programme.

II. Current Network Services

Ebone93 provides two distinct services to the IP community: a backbone service between networks in different European countries; and a neutral interconnect service between the participating service providers, including commercial networks. Some members of the Ebone Management Committee have proposed that Ebone users should switch to EuropaNET for their backbone service once certain conditions are met (see below); Ebone would in any case continue indefinitely to provide its neutral interconnect function.

EuropaNET has provided an operational X.25 service with access speeds from 64 kbps to 2 Mbps since October 1992. It operates according to the terms of a 'framework' contract between RARE and PTT Telecom. Besides defining the technical characteristics of the service in detail, the contract also provides for guarantees of service levels and performance, and specifies the commercial terms on which customer networks may access the service. Charges are a function of access bandwidth. National networks (and other organizations) which choose to use EuropaNET take out individual customer contracts (which refer to the framework contract) with PTT Telecom.

The framework contract also provides for IP services at access speeds up to 2 Mbps in the form both of IP tunnelled over X.25 and of native IP. Since PTT Telecom had no previous experience of IP, a pilot phase for the IP service was specified in the framework contract. The EuropaNET IP pilot is currently under way; the initial participants, the national networks of Italy, Portugal, Switzerland and the UK, have since been joined by those of Germany and the Netherlands.

Since many countries (including for example the Nordic countries) rely on Ebone for their international connections and since the national networks of two of the largest European countries (Germany and Italy) have connections to EuropaNET but not to Ebone, there is a clear

short term need for a gateway service between the two networks in order to provide complete connectivity for users throughout Europe. Two such gateways, each with a capacity of 512 kbps, are now being set up.

The use of existing intercontinental links (ie links between Europe and the USA) is also being rationalized. There are currently a number of high speed links, each of which was originally set up either as a bilateral arrangement between one of the European national networks and a US partner or for some specific purpose. Although a number of specific line sharing arrangements had been agreed, the individual lines were until recently used largely for traffic between the US and the particular European partner. The high speed lines are now managed as a common resource available to all Ebone participants (and, via the EuropaNET / Ebone gateway to those countries which subscribe to EuropaNET but which do not have direct access to a US link). Common access to all available intercontinental capacity forms part of the current negotiations between the Ebone and EuropaNET management groups.

III. Operational Unit - DANTE

One of the goals of the COSINE project was to ensure that the services it set up would continue to be available to the user community after the end of the project's fixed lifetime in March 1993. The CPMU was charged, as one of its tasks, with managing the necessary detailed arrangements but more general questions of organization and funding had to be dealt with by the community as a whole.

Following discussions over many months, RARE decided in principle in January 1991 to create an Operational Unit which would have the role of managing network services for the European research community in a commercial manner. A planning group set up by RARE carried out a detailed analysis of service requirements and the possible ways of meeting them; it presented its conclusions in the 'Green Book' [7] in January 1992. The Green Book proposed the creation of the Operational Unit as a non-profit, limited liability company and presented a detailed business case as well as proposals for the structure and management of the company.

A subsequent decision to restrict shareholdings in the company to the national networks greatly simplified matters. All the national networks have broadly similar interests and constraints and it became easier to specify a structure that all participants could accept. More importantly, voting power could be set as a function of country size and national funds are channelled via a single route. This shareholding restriction does not prevent the Operational Unit from supplying services to non-shareholding organizations.

Further planning, managed by a Steering Committee set up by the potential shareholders in the Operational Unit, led to the creation of a 'Heads of Agreement' [8] which defined the principal terms on which the new company would be set up and regulated. Important principles laid down in the Heads of Agreement were limits on the number of shares that could be held by any one country, restrictions on the transfer of shares, and voting rights in proportion to shareholding. The shareholder contributions (in kECU) for the initial set of shareholders is shown in Table 1.

Table 1: Shareholder Contributions to the Operational Unit

Organization	Country	Contribution
RENATER	France	55
DFN	Germany	55
GARR	Italy	55
NORDUnet	Nordic countries	55
JNT	United Kingdom	55
SURFnet	Netherlands	37
SWITCH	Switzerland	37
REDIRIS	Spain	37
SPPS	Belgium	26
ARIADNET	Greece	15
FCCN	Portugal	15
ARNES	Slovenia	7

Cambridge was chosen as the location of the Operational Unit in October 1992 and Operational Unit Ltd was set up in April 1993 as an interim arrangement. The Company's name was changed to Delivery of Advanced Network Technology to Europe Limited (DANTE) in June 1993. DANTE will officially start its activities in July 1993. The two Joint General Managers have been appointed, the process of recruiting further staff has started, and many of the other tasks involved in setting up a new company are well advanced.

IV. DANTE Services

The precise set of services to be offered by DANTE has not yet been finally decided but the

most likely candidates are listed in Table 2. The list contains both services which are continuations of those started under COSINE and others which DANTE can usefully manage on behalf of the community, including some which were originally set up by other organisations.

By far the most important of the services is the backbone network. DANTE will take over the responsibility for the supervision of the EuropaNET contractor and, assuming that the EuropaNET IP pilot is successful, the development of this service as the principal international backbone for the European research community.

Although 2 Mbps international services are still somewhat novel between European countries, the demand for much higher capacities is already evident. Several countries are implementing national services at transmission speeds of around 34 Mbps; in the United Kingdom, five SuperJANET sites are already linked at 140 Mbps. Besides the general increase in load on international services which can only be met by increased capacity, there is a pressing requirement to support international collaborations which can take advantage of the new applications which very high speed networks make possible. An important priority for DANTE, therefore, is to plan (and, subsequently, to manage) the early introduction of a high speed (of the order of 34 Mbps) backbone service for the benefit of the European research community. Links of equivalent capacity between Europe and North America are expected to be included in the plan.

The DANTE portfolio will also include the management of a number of development activities. Although DANTE is not intended to be a development organisation, one of its functions will be to introduce new, advanced services at the earliest opportunity. It will only be able to do this if it is involved in the later stages of the process which is always needed to transform proven research ideas into a well engineered and reliable operational state.

As COSINE comes to an end, several of the projects that it initiated have inevitably created ideas for further developments andnew ideas have also appeared on the scene. The Operational Unit Steering Committee has therefore listed a number of projects for which DANTE may take responsibility and which could be funded from the (relatively small proportion of) COSINE funds which remain uncommitted.

Table 2: The DANTE Service Portfolio

Backbone Services:
Management and provision of a European multi-protocol backbone network with intercontinental connectivity and appropriate gateways.
Availability - July 1993 (EuropaNET umbrella contract)

Mail Services:
Operational service; provides for the coordination of pan-European mail connectivity.
Availability - January 1993

Help Desk:
Operational service; provides a general purpose point of contact for DANTE services.
Availability - July 1993

Directory Services:
A continuation of the Paradise project to provide X.500 directory services to the research community. Availability - January 1993

Information Services:
A continuation of the Concise project to provide a central information base to the community.
Availability - January 1993

Security Services:
A continuation and development of the current pilot security service to provide a Certification Authority and further development to tailor the services to the needs of the users.
Availability - July 1993

IP NCC:
A continuation of the current service provided by RARE via the RIPE NCC.
Availability - January 1994

List Management:
Implementation of a service based on the new Explode software together with the proposed takeover of responsibility for EARN LISTSERV services.
Availability - July 1993 (Explode); LISTSERV subject to EARN agreement

NJE Continuation:
Takeover of responsibility for the existing EARN service. Availability - Subject to EARN agreement

Software Coordination:
Exploitation of available software packages.
Availability - July 1993

V. Outstanding Issues

One outstanding issue which is of major importance for the development of European research networking is the lack of a 'central' funding and support organization (equivalent to the Federal Government in the US) whose responsibilities cover the whole of Europe. The lack has been clearly identified by the European Consultative Forum on Research Networking (ECFRN) which published a report [9] describing the problem and which has since taken steps to increase the awareness of the need for coordinated action amongst high level officials from national governments. RARE is in a position to coordinate technical discussions of development needs and the Operational Unit will shortly be in a position to provide high quality services. A governmental organization which can coordinate the funding of new networking infrastructure is still missing. The CEC has been very supportive within the limits of its authority but these limits do not currently extend far enough in the direction of support for operational services (as opposed to development projects) and, in any case, there are many countries in Europe but outside the EC which need to communicate with others.

Further progress has recently been made with the publication (and discussion) of [10] which proposes a plan of action, the result of which would be to create a permanent agency responsible for all aspects of pan-European research networking. Although the proposal may not be accepted in its present form, the discussion it has generated carries forward the political process of finding a way of coordinating national funding of international network services.

VI. Summary

From the somewhat confused and chaotic state which characterised international network services in Europe during the late 1980s, a more rational picture is beginning to emerge. There are now solid backbone services at speeds in the range 1 - 2 Mbps. The creation of the Operational Unit - DANTE - creates a firm base from which new services, including a 34 Mbps backbone, can be developed. RARE is able to provide the technical coordination of new activities. Only the question of coordination of national funding remains to be solved and, even there, progress is being made.

VII. References

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Author Information

Dr Davies has MA and D.Phil degrees from the University of Oxford. He started his career at CERN (the European Laboratory for Particle Physics) where he subsequently became a Group Leader and Project Leader for the CERN Network. Since 1977, Dr Davies has been Director of the Computer Unit at the University of Exeter, responsible for all aspects of the computing and network services provided to academic departments. From November 1989 to March 1991, he worked part-time as Director of the interim COSINE Project Management Unit. He has recently been appointed Joint General Manager of DANTE and will take up his new post on 1 September 1993. Dr Davies is currently Vice-President of RARE.