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**Data Networking for the European Academic
an Research Community:
Is it important?**

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Data Networking for the European Academic and Research Community:

Is it important?

David O. Williams and Brian E. Carpenter

Abstract

Spectacular developments in computer network technology and applications are imminent, but European research and industry are unprepared for them. The gigabit testbeds and the NREN plans in the USA and technology developments in Japan are a clear challenge. Europe has a complex pattern of national and international research networks which provide valuable services for their existing users. Evolution of these networks is hindered by a variety of regulatory, political, economic, and technical barriers to progress, especially the lack of political focus and the small scale of industrial involvement. This paper analyses the situation and makes recommendations for the way forward.

1. Introduction

The authors are responsible for some aspects of data networking for the European academic and research community, so it is not surprising that they believe it is an important topic. However, they are concerned that not only is it important for the research community, but that it will be vital for the future industrial and commercial strength of Europe. This paper aims to convey the arguments behind this wider view of the importance of data networking.

As the use of workstations, personal computers, and terminals has become almost universal in the scientific research community, the baseline data networking applications - electronic mail, electronic news, file transfer, remote file access, and remote interaction - have become the normal way of working for any serious international collaboration. The amazing potential of optical fibre transmission, assisted by satellite transmission for remote areas of Europe, means that there is no technical reason why such electronic working should not be available to a much wider community.

Furthermore, we can expect these baseline applications to merge with digital image transmission and digital voice transmission to bring about a completely new style of networking in which video-conferencing, voice conferencing, multi-media mail, and access to image databases are combined with traditional computer network applications. Such technology is likely to revolutionise business communications. In view of the sharply increased amount of data that must be transmitted, it will also give rise to a strongly increasing demand for bandwidth on data network lines.

It is a shock to discover how unprepared Europe is for this next technology revolution, and indeed how little European research and industry use existing networking technology. We outline the situation outside Europe first, better to illustrate Europe's lag.

2. Situation in the USA

2.1 Present status - the American Internet

There are two forms of data network in the USA, the regional networks and the national networks. Some 25 regional networks deliver data networking services to interested sites in their region, whereas national networks deal with the nationwide connection of subsets of the academic and research community. The regional and national networks are linked together under the name "Internet", which is run by consensus among several agencies of the Federal Government (General Accounting Office, 1991).

The Internet links at least 2,500 sites in the USA, including many huge university systems, and it is believed that it connects roughly 300,000 computers and workstations, and is used regularly by more than two million academic and research workers.

2.2 Current developments - the NREN

There is wide consensus in the USA that advanced computing and advanced networking will be key factors in determining the future economic health of the country. The High-Performance Computing Act, which authorized \$2.9B over five years, had the full support of the White House as

well as of Congress (HPC Act, 1991). As a result, plans for major developments in data networking for the American research and education community are now well advance

The following text is from "Grand Challenges 1993: High Performance Computing and Communications", a supplementary document to President Bush's 1993 Budget (OSTP, 1992).

National Research and Education Network (NREN) - the development of a national high speed network to provide distributed computing capability to research and educational institutions and to further advanced research on very high speed networks and applications....

[The] NREN is the future realization of an interconnected gigabit computer network system ... intended to revolutionize the ability of U.S. researchers and educators to carry out collaborative research and education activities, regardless of the physical location of the participants or the computational resources to be used....

These capabilities and technologies will be developed through the cooperative effort of U.S. industry, the Federal government, and the educational community.

2.3 Gigabit Testbed Collaborations

The American Internet, and in particular the National Science Foundation (NSF) backbone network running at 45 Megabit/s (speeded up by a factor of 800 since 1987), is already an impressive precursor of the NREN. As part of their investment in the future, NSF and the Defense Advanced Research Projects Agency (DARPA) have sponsored five gigabit testbeds, in order to start intensive research and development into the speed range that will be required in 1994/95 (Carpenter, Landweber, & Tirler, 1992).

The planned government funding for the testbeds is almost \$16 M over three years, and industrial partners are contributing several times as much. Indeed one of the most noticeable features of the testbeds is the strong collaboration between the major common carriers, the regional telecommunications operators, the regional and national network organisations, research institutes, universities, computer companies, and government agencies. This is quite unlike the situation observed in Europe.

2.4 Business and schools

There are several areas where new businesses are being started in connection with American data networking.

* The roughly 25 regional network operators see themselves as in the business of supplying data networking services to their local community.

* The technology needed to interconnect computers with data communications lines is leading to the creation of new high technology start-up companies. These companies are already selling hundreds of devices to Europe.

* At least one company, Advanced Network Services, with several ex-IBM staff in prominent positions, has been founded to enter the business of data networking, initially for the academic and research community.

There is a long history of Internet access by the research departments of American high technology companies. This is extremely valuable for collaborations between these departments and universities and research institutes, for example for the rapid evaluation of new products, where time-to-market with a high-quality product is an essential factor for success.

The NREN will not limit itself to universities and research institutes, but has plans to connect all American schools, secondary and even primary.

3. Situation in the Pacific region

Japan seems to be behind the USA, and maybe even Europe, in the field of data networking for the academic and research community. There are few lines above 64 kilobits per second in use (General Accounting Office, 1991). However, a national coordinating committee was formed in 1991, and there are signs that the Ministry of International Trade and Industry (MITI) is starting to focus its attention on data networking. Other countries such as South Korea, Hong Kong, Australia and New Zealand have also taken steps to improve their data networking infrastructure, and a committee has been set up to coordinate academic and research data networking in the whole Pacific region.

On the technology front, Nippon Telephone and Telegraph (NTT) has plans for a gigabit testbed project linking their Musashino and Yokosuka research laboratories by 1993. Companies such as NEC and Fujitsu are also very active in high speed transmission and fibre optics.

4. Situation in Europe

The potential user community for research networking in Europe has been estimated to be at least 500,000 people spread over more than 20 countries (RARE, 1988). It is impossible to obtain accurate estimates of the number of actual users, or even of connected computers, today, since many of the networks mentioned below have overlapping coverage (Neggers, 1991; General Accounting Office, 1991).

4.1 Present status

4.1.1 National networks

Many, but not all, European countries have a national network for their academic and research community. These networks are typically based on leased lines from the national carrier, and operation is often the responsibility of a small team reporting to the ministry responsible for research or education. The networked universities and research institutes typically pay an annual fee to cover operational costs. In view of the high cost of European leased lines it is still common to find institutes with 64 kilobit/s connections, or even less in Central and Eastern Europe.

4.1.2 Disciplinary networks

There are some scientific disciplines which have a tradition of operating on a pan-European level. These include weather forecasting, particle physics, and space science, all of which have an associated European Treaty Organisation which acts as the main data source and as a natural communications hub.

Since no pan-European networks of the required performance existed, all of these disciplines have set up their own networks which they pay for and operate. Of course, they cooperate with other networks, both for European leased lines whose cost is often shared, and for intercontinental lines.

4.1.3 EARN, EUNET, NORDUnet, RARE and COSINE

*** EARN**

The European Academic and Research Network (EARN) was sponsored by IBM in 1984 on the model of BITNET. It was based on one hub site per country, normally a major academic computing centre. Other sites in that country had to lease a low speed line to the hub. The majority of EARN's funding today comes from annual fees paid by the attached institutes. An important advantage of EARN is its use of robust, almost old-fashioned technology, so it was very easy for countries in Central and Eastern Europe and North Africa to join at reasonable cost.

*** EUNET**

The European Unix Network (EUNET) grew out of USENET in the USA, originally offering dial-up connections to an informally run network for electronic mail and news. It is now professionally run and offers access to a very wide and well-organised set of news groups covering many fields of

interest. It is the easiest data network for the research department of a commercial company to join.

* NORDUnet

The national academic networks of the five Nordic countries have created a highly successful regional network, with the particular advantage that they can share the expenses of transatlantic and pan-European connectivity. An interesting recent development is that NORDUnet is cooperating with networks emerging in the three Baltic states.

* RARE

The European Association of Research Networks (RARE, from its French acronym, *Reseaux Associes pour la Recherche Europeenne*) brings together Europe's national research networks and other bodies interested in pan-European networking, and was founded in 1986. RARE has been a key influence in pan-European data networking, but has no current role as a network operating agency. The RARE statutes give strong emphasis to the use of official Open Systems Interconnection (OSI) protocols.

* COSINE

The Cooperation for Open Systems Interconnection Networking in Europe (COSINE) was launched as an inter-governmental project in 1986, but the three year implementation phase started only in 1990. COSINE is committed to OSI protocols. It is not a network operating agency, but aims to create a set of pan-European OSI services by federating the efforts of national networks. COSINE set up the Interim X.25 Infrastructure (IXI) in 1990, providing a virtual circuit service based on about twenty national access points connected via 64 kbit/s lines. IXI has been useful for some countries, but its future remains uncertain at the time of writing.

4.1.4 European Internet

One of the most surprising developments in the past three years has been the explosive growth in use of the Transmission Control Protocol / Internet Protocol (TCP/IP) protocol suite, as used in the American Internet, to create what can only reasonably be called a European Internet. There are now some 160,000 computers and workstations connected to this European Internet, making it by far the largest grouping of European data networks for academia and research. The availability of TCP/IP on a very wide range of systems, the quality and reasonable cost of the software, and the immense efforts going into developments have influenced this rapid growth.

EASInet, based largely on TCP/IP, has been a substantial influence on the growth of this European Internet. EASInet links some twenty computer centres belonging to the IBM-sponsored European Academic Supercomputer Initiative. It is encouraging that the supplier of many of Europe's biggest scientific computers has agreed to sponsor a European network based on open protocols (TCP/IP), rather than on the vendor's proprietary protocols.

In most European countries the growth of the Internet was not officially planned, and until now has had to rely on very informal management techniques. Coordination across Europe is handled by the RIPE (from the Anglo-French acronym *Reseaux IP Europeens*) working group under the umbrella of RARE.

4.1.5 Summary

In Europe today we see a number of data networks, national or international, single- or multi-disciplinary, providing valuable service to academic and research users. But, if we are honest, we know that these networks are a pale shadow of what is available to the American academic and research community, and that connectivity to European industry is poor. Data networking seems to be planned and operated in Europe on a country-by-country basis, and the pan-European strategy and infrastructure are missing. The authors are convinced that Europe is in the process of abandoning, almost by default, a vital segment of tomorrow's commercial and industrial base to our competitors.

4.2 Plans

4.2.1 A European 2 Megabit/s infrastructure

Traffic on European networks has grown to the point where an infrastructure of 2 Mbit/s international lines linking the various national and disciplinary networks would be fully justified. These would offer 32 times the capacity available on the 64 kbit/s international lines that are in common use in Europe today, but less than 5% of the capacity of the present NSFnet backbone lines. We know of only one 2 Mbit/s international line operational for academic and research networking in Europe, which has connected Bologna and Geneva since 1989.

Several national networks already employ national lines running at 2 Mbit/s and above. This is the case, for example, for the Joint Academic Network (UK), with many such lines, for SURFnet (the Netherlands), for SWITCH (Switzerland), and for the Deutsches Forschungsnetz (Germany). There have been many discussions on the creation of a pan-European 2 Mbit/s backbone. Besides the high cost of leasing such lines, there has been a lack of consensus about the technical approach. At the time of writing, an

X.25-based proposal known as the European Multiprotocol Pilot Project is well advanced, and there are upgrade plans for IXI. Also, a consortium known as EBONE92 has been created to consolidate the existing European Internet, but none of its international lines are as fast as 2 Mbit/s.

4.2.2 Operational Unit

In 1991, RARE proposed the creation of a non-profit Operational Unit to take over the running of various international services, such as IXI, for the academic and research community. It is hoped to create this Unit during 1992, but at the time of writing the range of services it will offer is unclear.

4.2.3 Gigabits

We are not aware of any presently funded plan to install long-distance international gigabit per second data network infrastructure in Europe, nor of any international collaborations set up in Europe along the lines of the five gigabit testbeds in the USA. The few projects already under way in Europe, such as those in Germany and Sweden, seem to be strictly national and of limited scope compared to the American efforts. We discuss some aspects of the European RACE programme below, in the section "Europe's conservative approach to telecommunications". In our opinion the lack of pan-European gigabit testbeds is extremely dangerous, since Europe will be late in learning how to deploy an emerging technology where time-to-market will be almost everything for commercial success.

4.3 Barriers to progress

The reader may wonder why the national, international, and disciplinary academic and research networks in Europe have not yet created a satisfactory pan-European infrastructure. Many efforts have been made, but there are many barriers to progress in Europe. These are technical, commercial, organisational, and political, and we give a short introduction to some of them below. As a community, European researchers and academics have failed to convince Europe's politicians, civil servants, industrialists, and carriers that data networking is important and that everyone should collaborate in order to improve the European infrastructure.

4.3.1 European telecommunications regulations

Even in a single market such as the USA, the regulation of telecommunications services is a complex matter, because the technology is sophisticated and evolving, and because enormous economic and political interests are at stake. A major result of the American telecommunications divestiture was the separation of the business of long-distance lines from the business of local services. We believe that this separation has proved to be a

sound move, allowing the USA to make progress in data networking in a healthy competitive market.

The situation in Europe is even more confused because of the interaction of national and trans-national regulations. For European Community (EC) countries, the national telecommunications policies must now conform to EC law, embodied in particular in the Open Network Provision (ONP) directives. These, while considering data networking, are mainly concerned with overall questions of PTT (postal, telephone, and telegraph administration) policy.

Further confusion arises in Europe because we are near another major regulatory transition. A review of ONP has started, and any resulting changes might have important consequences. In addition, the abolition of trade tariffs within the EC in 1993 should provide a major psychological stimulus for companies trying to provide pan-European services. The existing PTTs and other telecommunications operators, such as Cable and Wireless and various US companies, are indeed exploring how to cover the whole European market. Interactions between the rapidly evolving regulatory situation and the changing commercial line-up have created uncertainty for both suppliers and customers, and are impeding progress.

4.3.2 Leased line tariffs

The high cost of leased data lines in Europe is due to lack of competition, resulting from the regulatory situation. Individual countries have national policies which normally give monopolies to the national PTT, and, in particular, reserve for it the right to provide leased lines. Only in the UK and Sweden is there more than one international leased line supplier. International leased lines are supplied at a tariff that is simply the sum of those fixed by the (normally) monopoly suppliers in both countries.

The result is European prices that are three to ten times the price of an equivalent service in the USA. The situation is worst for long distance international leased lines between the most conservative PTTs, and best for UK national lines.

Despite some early signs of price reductions in recent months, we find the continuation of these exaggerated prices to be scandalous. Under the ONP directives, prices charged to the user are supposed to be "cost-based". We cannot understand how anyone can reasonably claim that present leased line charges in Europe are in any way "cost-based".

These prices act as a huge brake on the progress of data networking in Europe. This has two major effects on European industry and commerce. First, and most seriously, European industry and commerce are burdened by

charges which are so high that they completely distort the choices that can realistically be made concerning new data network technologies. If in Europe we charge ten times too much for a new service based on data networking, there will be no business case for industrial and commercial users to use it. The second effect of this distortion is that European high-technology companies are largely absent from a major growth area.

4.3.3 No pan-European providers of leased lines

Depending on where you draw its borders, Europe consists of some 20-30 countries, working more or less quickly towards closer economic and political integration. However, there are no pan-European providers of leased lines, since in most countries the local PTT is the sole authorised supplier. We believe that Europe urgently needs a few competing pan-European suppliers of leased line capacity, so that European industry can benefit from the enormous technical progress that is now being made in networking.

This situation largely results from the distinction made in the ONP directives between basic services, which may be reserved by a national government for a monopoly supplier, and the value-added services, which must be open to competition. At present the provision of leased lines for data networking is a reserved service. We believe that this is a fundamental mistake, and we fear that it may not even be corrected in the 1992 review of ONP.

4.3.4 Europe's conservative approach to telecommunications

Europe has world-famous telecommunications companies, including Alcatel, L.M.Ericsson, and Siemens, with an enviable reputation as suppliers of voice telephone systems. Historically they have worked closely with national PTTs which formed the major market for their voice exchanges. Both the companies and the PTTs have their own research departments, well-respected in advanced transmission techniques for voice and even data networks.

The companies and the PTTs have good working relationships with national Ministries of Telecommunications, European authorities (especially Directorate-General XIII of the European Commission), and the PTT-oriented standards bodies such as the European Telecommunications Standards Institute (ETSI). This community was at the origin of X.25 and associated standards and of the resultant products. It has recently been investing heavily in ISDN, although there appear to be serious pan-European interworking problems. It is currently concentrating its efforts for the future on Asynchronous Transfer Mode (ATM), which aims to switch voice and data streams over 155 Mbit/s and 622 Mbit/s lines.

The European Commission programme for Research on Advanced Communication in Europe (RACE), spending some 200 Mecu (\$250 M) per year, is mainly aimed at stimulating these companies. However, we believe that the approach of this community to data networking is rather conservative, and the situation is reminiscent in many ways of the telecommunications situation in the USA prior to the divestiture. The people concerned do not appear to appreciate the vital significance of the close relationship between workstations, computers and data networking. As a result they do not seem to be very interested in exploring advanced applications aimed at new data networking services, and especially not on a pan-European basis.

These weaknesses seem particularly obvious in the case of the RACE application pilot projects, which we find to be poorly focussed and which do not seem to profit enough from collaboration with the academic and research community, in strong contrast to the situation in the USA. We wish to point out that we support the strong emphasis in Europe on developing networking products for the business and commercial sector. We think that our mistake in Europe has been the failure to exploit the academic and research community, which is good at filtering and testing new products and ideas in data networking, as a natural partner for industry. This mistake is, needless to say, at least as much the fault of that community as of anyone else.

4.3.5 Protocol issues

Network protocols are technically very complex, and they need to evolve continually in order to keep up with advances in technology, such as higher speeds. Ten years ago many people, including the authors, held high hopes that Open Systems Interconnection (OSI) protocols would become available quickly and provide for Open Networking between different computers. For good reasons, including the general wish to be independent of any single computer vendor and a more specific hope that a commitment to OSI protocols would revitalise Europe's local computer industry, the European Commission's Directorate-General XIII has been a strong supporter of OSI protocols. Indeed, many of Europe's officially funded data networking initiatives have based their whole strategy on the assumption that commercial OSI products would become available quickly and widely, and that they would offer full functionality.

Unfortunately OSI products have taken much longer to arrive than expected, and they still only offer limited functionality and performance. Furthermore, products based on another set of Open Networking protocols, the Internet TCP/IP suite, have become widely available on computers and workstations from all vendors. So while OSI undoubtedly will still have an important role to play, it is no longer realistic to use it as the sole basis for Europe's data networking strategy.

Users need to confirm their commitment to non-proprietary Open Networking and to plan the phase-out, as quickly as possible, of proprietary protocols. On the other hand European service providers and their backers, including the European Commission, must recognise the way in which the market has developed and must start to support all Open Networking protocols, including TCP/IP, as well as OSI.

4.3.6 No fully European scientific computing companies

To our knowledge there are no companies controlled from Europe presently delivering state-of-the-art scientific computers or workstations that they have designed and constructed. To a very large extent the scientific computers and workstations used in Europe are designed in the USA and constructed in Europe by the European subsidiaries of American companies. In addition some of Europe's "national champions", such as Bull, ICL, Olivetti, and Siemens, import Japanese mainframes under their own label.

At the request of the European Commission, Professor Carlo Rubbia, Director-General of CERN (the European Laboratory for Particle Physics), chairs a committee which has proposed various measures designed to stimulate Europe's scientific computing potential (Rubbia, 1991). A High Performance Computing and Networking plan, designed to exploit Europe's know-how in the field of parallel processing and networking, is in preparation as we write.

The companies providing Europe's scientific computers are the natural partners for the European scientific community when trying to set up collaborations on advanced data networking. However the fact that many of these companies are controlled from the USA seems to give rise to reservations among some of the other desirable collaborators, including various PTTs and national or European authorities.

While scientific computing is a somewhat specialised field, it has been and is still at the origin of much progress in the general-purpose computing business, and it is an industry that Europe abandons at its peril. The authors hope that Europe will avoid abstaining from the data networking business as well.

4.3.7 Lack of collaboration

As already mentioned, there is a healthy collaboration in the USA between the research and educational community, who know that they need advanced networking, the government, and industry, including the computer companies, the networking companies, and the common carriers. This collaboration is absent in most of Europe. One reason for this is surely

that, as just mentioned, there are no fully European scientific computing companies for anyone to collaborate with. Another reason is that there are no pan-European providers of leased line capacity and the national PTTs do not see the value of taking part in pan-European collaborations. Finally, as also discussed above, the existing community of PTTs and their industrial partners are rather conservative and fail to give sufficient attention to modern data networking.

4.3.8 *Lack of focus*

In the USA a strong focus for networking is provided in Washington, where politicians, industry, and the research and educational community have come together to act. In Europe there is no equivalent strong focus. As we have discussed there is neither a strong scientific computing industry nor a data networking industry. The PTTs all operate on a national basis, and the politicians are unaware of the issues. The European Commission has not proved able to catalyse the creation and operation of an effective pan-European data networking infrastructure and sometimes seems unsure about the role it should adopt. In any case, it is not just the twelve countries of the present European Community that need to be involved in European data networking. Some of the research communities realise how far behind the USA we are, but have tended to concentrate improving their own disciplinary networks rather than on trying to address Europe's global problem.

A recent meeting of a European Consultative Forum for Research Networking (ECFRN), convened by the European Commission, concluded that creating such a focus and establishing a budget for pan-European research networking requires the attention of senior officials and politicians from all European countries (ECFRN, 1992). It specifically recommended that the Commission should convene a Senior Officials Group of government representatives on this topic. This is a mechanism by which the Commission can initiate new programs.

4.4 What happens if we do nothing?

Despite the complex and difficult situation in which we find ourselves, and despite the frustrating lack of progress over the past few years towards creating a viable pan-European infrastructure for data networking, all is not lost. Provided we clearly identify the problems that are facing us and decide how they should be tackled, Europe certainly has the skills, the industrial strength, and, we hope, the will to make the necessary breakthroughs.

However, if we do nothing the authors are convinced that European data networking will remain underdeveloped in the short term and will then quickly be colonised by companies based in the USA who have understood

the developments needed in this market full of opportunity for progress and profit. Put bluntly, we will have abandoned European data networking to some combination of American computing and networking companies. We fear that the undoubted industrial strength of some of Europe's suppliers of voice networking services will not be sufficient to stand up to the American wave, unless they move very quickly to emphasise data networking in the context of the whole of Europe. But, as we have argued, the lack of European common carriers and scientific computing suppliers is likely to make that difficult.

5 Recommendations and Conclusion

Technically it is clear to all parties that Europe needs a properly funded and managed international multi-protocol backbone network for the research community, at the highest possible bandwidth (Neggers, 1991). However, we hope that our description of the barriers to progress will have convinced the reader that the "problem" of European data networking is not simple. There are, therefore, no simple "solutions", but progress will come only if we can improve the understanding of the issues among Europe's politicians, industrialists, PTTs, network providers, and network users, and subsequently improve their collaboration.

We make the following recommendations for breaking through, or circumventing, the barriers.

- * One key element must be the provision of a stronger focus for academic and research networking at the pan-European level. Some small group of people must feel they "own" this problem and must be given the authority, responsibility, and means for making progress. We fully support the ECFRN proposal for a Senior Officials Group.

- * A second key point is the necessity to give a stronger emphasis to the service needs of academic and research users, rather than to the choice of particular protocols. Users want high-performance and high-quality data networking services today, and they are willing to pay reasonable prices for them. These services should be based on a commitment to non-proprietary Open Networking protocols, including TCP/IP and OSI.

- * The third key element is the need to build in Europe the sort of collaboration in the field of data networking that can be observed in the USA, involving government, industry, the common carriers, and the academic and research community.

- * Clearly we hope to see more liberal regulations and competitive international carriers as soon as possible.

* The multi-service Operational Unit originally proposed by RARE should be set up. To be successful, its goals must be to satisfy the needs of all users and to provide a high quality of service so that existing networks will automatically want to use it. It must support all Open Networking protocols.

* It would be beneficial for EARN and RARE to merge as quickly and equitably as possible, despite reluctance on the part of both Associations. At a stroke this would radically improve the European focus on research networking.

* RARE, or the merged EARN/RARE, should concentrate on long-term planning and policy issues and leave day-to-day matters to the operating agency.

It must worry about the infrastructure needed for data networking for the whole of the European academic and research community, defined in the broadest sense. The commitment of RARE users must be to expand the use of non-proprietary Open Networking everywhere in Europe.

* In the medium term (2-3 years) we would like to see the creation of a European Treaty Organisation, or a legally simpler Non-Governmental Organisation, as an agency to plan and oversee the operation of Europe's data networking infrastructure. Membership of such an agency would be open to all European countries, whether from Western Europe, Central and Eastern Europe, or elsewhere. The agency would provide a good forum for future planning, and the fact that it was a treaty organisation should ensure that it receives enough high-level political and industrial attention. It should keep its own staff numbers at a low level and aim to use commercial services as soon as the requirements for those services are clearly understood, but not before.

In conclusion, we are convinced that data networking is an emerging industry where Europe is almost absent. We believe that industrialists and politicians must be given this vision and then encouraged to take appropriate action. We need a commitment from all influential people and bodies for an urgent programme to build a solid pan-European infrastructure for data networking. We believe that, over a period of a few years, the European academic and research community should evolve the existing bodies that are responsible for various aspects of data networking into a small European agency, which would become the main vehicle for future action.

Author notes

The ideas presented in this paper are the authors' personal views, and should not be assumed to form the official position of their employer. The authors have endeavoured to check all facts, and to clearly separate opinions from facts. This paper is intended as a positive contribution to a complex

debate, and even if it expresses criticism of past or present policies, this should not be taken in any way as criticism of the individuals or organisations who formulated those policies. The paper is written from a European perspective, and the remarks on the American and Pacific regions must be understood in that light.

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References

Carpenter, B.E., Landweber, L.H., & Tirler, R.. (1992). Where are we with Gigabits?. IEEE Network Magazine, Vol. 6 No. 2, March 1992, 2-5.

ECFRN. (1992). Computer Networking for European Researchers - the Challenges Ahead. March 1992, European Commission, Brussels.

General Accounting Office. (1991). High-Performance Computing: High-Speed Networks in the United States, Europe, and Japan, GAO/IMTEC-91-69, United States General Accounting Office.

HPC Act. (1991). High-Performance Computing Act of 1991, Public Law 102-194, December 9, 1991, United States Congress.

Neggens, K. (1991). European Engineering Planning Group (EEPG) - Summary Report, Computer Networks and ISDN Systems 23 (1991) 63-68.

OSTP. (1992). Grand Challenges 1993: High Performance Computing and Communications, The FY 1993 U.S. Research and Development Program, Office of Science and Technology Policy, Washington, D.C.

RARE. (1988). COSINE, Cooperation for Open Systems Interconnection Networking in Europe, Specification Phase. RARE (Re'seaux Associe's pour la Recherche Europe'enne), Amsterdam.

Rubbia, C. (1991). Report of the EEC Working Group on High-Performance Computing, February 1991, European Commission, Brussels.