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The Future of the Internet - What Role for Europe?

Interim Report of an Advisory Group

Background

Some Internet history

The origins of the Internet are normally traced back to the ARPAnet developments undertaken by the American Department of Defence (Advanced Research Projects Agency) in the 1960s. Many of the concepts and applications which were to prove so successful later (asynchronous exchange of short messages, or e-mail; file transfer among teams collaborating on a single project; protocol definition independent of the computer architecture; practical encouragement to implement the agreed protocols on a wide variety of computers; etc.) date already from that time.

There then followed a slow but steady spread outwards from the original environment. From defence-oriented research to all aspects of research. From scientific departments in universities to all academic departments. From academia to R&D departments of commercial companies, and thence to whole companies. And, eventually, to the individual home.

In this spread there were two moments of crucial importance. They were both linked quite closely to the widespread introduction of personal computers (of all architectures). One was the moment when the Internet became the "network of choice" for linking all of the desktops inside companies, whether large, medium or small. The other was the moment when access from the home to the Internet via telephone dial-up became a market in itself.

Applications and available bandwidth

If we look at Internet applications we see that the initial applications, such as ubiquitous electronic mail, required only simple (unformatted) text to be transmitted. Then other people wished to transmit formatted text, since most people find reading more than about one page of unformatted text extremely tedious. The success of the World Wide Web was, at least partially, due to the fact that it encouraged the transmission across the Internet, not only of text, but also of "forms" and relatively simple graphics, in a way which did not depend on the architecture of either the server or the client computer. And there are many Internet applications being developed now which are based on the use of very realistic graphics.

For any application to come into widespread use on the Internet, several conditions must be met. The application itself needs to be well-designed, affordable, and catch users' imaginations. But, more important, there must be a sufficiently large body of users with access to whatever equipment, including computers, displays and audio devices, but also Internet bandwidth, is required to run the application effectively. Roughly speaking, a user who has regular, reliable, connectivity at 1 Kilobits per second (Kbps) will only be happy with that Internet performance for asynchronous e-mail (unformatted text). Formatted text requires roughly ten times that bandwidth (10 Kbps), and the use of simple interactive graphics across the World Wide Web needs frequent and reliable access to Web servers at an effective performance of 100 Kbps to be at all impressive. Realistic graphics and other data-intensive applications can easily use up to 1000 Kbps of access bandwidth between the user and the server(s) involved.

To summarise, the "take off" point for any new Internet application depends strongly on a critical mass of users having an Internet access with sufficient bandwidth.

Twin development pushes - High-performance Internet and Commodity Internet

The history of computing, and indeed of many other high-tech industries, has highlighted developments in two complementary directions. Computer vendors have always used technology advances both to

reduce the cost of computers for constant performance, and to increase the performance available at constant price.

The Internet is now showing a very similar behaviour. Supplying access for the general public to the "Commodity Internet" from their homes is obviously a very price-sensitive business, and today depends heavily on telephone or cable TV modems, which tend to have rather limited performance, but the size of the potential market is huge. On the other hand, universities and leading research institutes and companies have a real need to exploit the very highest-performance networking, as a way forward in fields such as distance learning, remote diagnosis, distributed collaborative engineering projects, and remote access to huge distributed databases.

The past two years have shown that these twin pushes, towards the commodity Internet and towards a high-performance academic and research Internet, do not automatically fit together in an easy way. Specifically, the way in which bulk personal e-mail and Web-access traffic interferes with high-performance traffic, and especially with the real-time requirements of graphics and audio traffic, as all packets come together and flow across the major Internet switches and backbone lines, has led to significant congestion. Some of the recent American initiatives, and specifically the Internet2 initiative from the universities, emphasise the need now to separate out these traffic flows, and to develop better technical and commercial models for how Internet growth can be funded.

It may be necessary to point out the complementary nature of these twin development directions. The commodity Internet only exists today because of past developments in the academic and research Internet. The members of the various world-wide academic disciplines and sub-disciplines had both the need for intensive international communication, and more tolerance than the average "commodity" user towards technical teething troubles. We can confidently expect progress in the Internet to continue on this basis. High-performance Internet developments today, whether undertaken in Europe or the USA, will feed through into future products exploiting higher speeds, more advanced switches, and better protocols, which will form the basis of the commodity Internet in a few years time. Of course, the development of the Commodity Internet and High-performance Internet must be properly integrated, in the sense that suitable traffic can pass smoothly between them.

Europe and the USA

If we look at the overall situation of how intensively the Internet is being exploited, both for home and business use, most observers would agree that Europe is lagging some 2-3 years behind the USA. This time-lag is a significant handicap in such a fast-moving field, and tends to ensure that European firms operate in "catch-up" mode, rather than undertaking innovative developments themselves.

While there are undoubtedly many factors involved, those people who have been working to exploit the Internet in Europe, and especially those concerned with exploiting it on a fully pan-European basis, have always had one over-riding obstacle to contend with, which has been the excessively high cost of bandwidth, and especially of international bandwidth, delivered by our existing (quasi-)monopoly suppliers. The rule of thumb that an (international) leased line in Europe (say 2000 km long) costs 5-10 times more than a similar (but national) line in the USA, seems to have remained true over the past two decades, even while speeds have risen and costs have fallen in all countries and all continents. In Europe, great hope is obviously being placed in the forthcoming liberalised telecoms market, which will come into effect in most countries of the Union in January 1998, but the speed with which this change really will increase competition and decrease prices remains to be seen.

Of course we need to avoid excessive self-deprecation. The Americans have some quite serious problems of their own. While they have an extremely competitive situation around the Internet, both for the supply of bandwidth, and for the supply of Internet services to homes and to industry, and for the development of Internet applications, including electronic commerce, they have at least two inter-related areas where progress does not appear to be quite so smooth.

The National Science Foundation Network (NSFnet), which was considered as the "jewel in the Internet crown" was "privatised" in 1994, and many people consider that at least as many problems as successes

followed that change. To over-simplify the situation, the competing commercial networks which were expected to assume the NSFnet mantle do not seem to have proved as capable of managing the required growth of Internet capacity as people had hoped, neither in terms of the network engineering, nor of obtaining the financial resources required.

Another seeming American weakness stems from the apparently rather complex coordination between their different government agencies. In Europe we may have had some problems to coordinate our various national approaches to academic and research networking, but, in general, there has always been rather good coordination among the different agencies inside the various countries. However, in the USA there are several nation-wide academic and research networks provided by different government agencies, such as NSF, DoE, NASA, etc., and the degree of coordination between them sometimes appears to leave something to be desired.

Internet governance and evolution

The way in which the Internet is organised and evolves is sometimes seen as "mysterious", and even by some as "dangerous for Europe", but, while it might seem surprising that the process works, there is no mystery. The basic point is that all companies and organisations with a serious interest (whether as vendors or as users) in the development of the Internet need to reach agreement on technical standards. But, in this fast-moving field, these technical standards have to be developed very quickly and they also need to be very robust. Since 1991 this overall process has been overseen by the Internet Society (ISOC), with important roles being played by the Internet Architecture Board (IAB) and Internet Engineering Task Force (IETF).

While the Internet Society was formed in the USA, and face-to-face meetings of these bodies are largely held, in English, in North America, they must be seen as entirely democratic bodies, with well-defined rules of procedure, which are making a serious attempt to recognise the international nature of the Internet. Indeed it is a rule of the IETF that all decisions are taken by e-mail, to avoid the need for participants to attend all meetings and have good spoken English. *De facto* observation shows that the proceedings and recommendations of these bodies cannot be dominated either by single vendors or by single countries, however powerful they may be. We should further note that some very powerful positions in these bodies have been and are held by non-Americans. This includes the chair of the Internet Architecture Board, which has been held for the past four years by two different Europeans.

There is one aspect of the process of Internet evolution which perhaps deserves special comment. The procedure by which Internet standards are developed contrasts quite strongly with the more formal international standardisation process, whose more gentle pace has proved rather poorly adapted to very fast-moving technical fields. The Internet process involves a very widespread phase of comment and criticism of early draft standards, and ensures that Internet standards are architecture-independent by insisting that protocols may only be finally agreed as standards when at least three independent implementations are available. As the example of the failure to establish independent "commercial" Internets (such as the Microsoft Network) shows, there is an enormous technical and commercial interest from all users and suppliers to ensure that the Internet remains as the single "world-wide inter-connect", and the present Internet standardisation procedure appears to be sufficiently responsive, open and fair to achieve this goal.

Developments under way and needed

Protocol developments for differing levels of service

One theme which emerges strongly from all planning for Internet improvements is the need for the Internet to support different levels of service if it is to continue to expand. Most people are happy if their electronic mail reaches its destination(s) with a delay of some minutes, and would even occasionally accept delays of several hours, especially for overnight delivery, provided that the mail indeed always arrives. On the other hand, delivery of a meaningful stream of audio or video information requires that the packets are delivered "immediately", in good order, and with very little loss.

It may be much more expensive to provide the second service than the first. However, because of assumptions made during the original development of the Internet, it is now very difficult to develop a good technical understanding of the details of how traffic flows, on a world-wide basis, though the various major Internet backbones and switches. Efforts to improve our understanding in this area, which have both research and development components, will obviously be of extreme importance to the companies building Internet switches over the next few years, and also to providers of Internet-based services, who may, or may not, be able to exploit this improved understanding. We can note again the crucial importance of the whole fabric of European commerce and industry becoming involved in this leading-edge work, if we do not want to be faced with *de facto* technical *diktats* coming from across the Ocean.

American High-performance Internet developments

During the recent American Presidential campaign Bill Clinton make a promise that 100 MUSD of funds would be made available to help improve the performance of the Internet, which was seen as becoming saturated by traffic. This political commitment has been given the name "Next Generation Internet Initiative" or NGII. It is perhaps in the nature of politicians' electoral promises that it is not clear to many people whether this investment will come from new funding, and exactly which elements of the Internet, or which groups of users, are to be the target of this generosity.

But either independently, owing to the impact of the congested Internet on higher education, or as a result of Clinton's promise, several groups of American academic and research Internet users have started to make plans to significantly improve Internet performance for their communities.

One of the most advanced and credible of these efforts appears to be the Internet2 Initiative (I2I). This was started at the end of the summer of 1996, and now has the backing of almost 100 American universities. It aims to increase Internet performance in the universities concerned by a factor of ten over the next three years. There are very good records of the very considerable amount of work that has already been undertaken available on the Web at http://www.internet2.edu/. In particular there are excellent descriptions of potential future applications, and of the proposed architecture and engineering approach. Detailed proposals for how the I2I should now proceed were made at a major meeting held in California in January 1997. As has been the tradition in American Internet development, we can again see a strong interest from industry to collaborate with this, primarily academic, effort.

However, this is not the only American initiative. Apparently independently of the I2I, various government agencies, among which NSF, DoE and NASA are prominent, are developing scenarios for a ten-fold performance improvement over the short term, in line with the political initiative. These efforts are also being referred to as Next Generation Internet Initiative, or NGII. In terms of nomenclature there is quite some confusion between the political push (NGII), the technical planning of the agencies (NGII) and the technical planning of the universities (I2I).

European High-performance Internet developments

In September 1996 the TEN-34 (Trans European Networking at 34 Mbps) Project reached agreement on how to improve significantly the international connectivity of Europe's academic and research networks, and it is likely to come into production use in Spring 1997. It represents a truly major step forward for the European Internet, both technically and politically. Technically because the cost barrier, which had been created by linear pricing of international leased lines at and above 2 Mbps, has at last been broken, and at least some of the international congestion of the European Internet should be relieved. And politically because the Commission played a more direct role than in the past in brokering an agreement to which essentially all European academic and research networks could subscribe. On the other hand the length of time, some fifteen months, that it took to reach agreement, and the prices which have to be paid for the connectivity, which still remain surprisingly high, indicate that this is still a very complex field in which to make progress.

We can now also see significant activity as European telecoms vendors try to stake out their positions for the January 1998 liberalisation. On the high-performance side many vendors are making joint

venture and alliances for providing trans-Atlantic bandwidth and services. And on the commodity side there is also significant activity, and search for partnerships. What is not so obvious is the extent to which companies may be able to offer, in the short- or medium-term, High-performance Internet connectivity on a pan-European basis.

Intranets and co-operative working

As companies investigate the ways in which they can use Internet technology for competitive advantage, there has been considerable interest both in Intranets and in improved co-operative working.

"Intranet" is the name which has been given when companies use Internet technology for their internal world-wide networking, but where the network is either not at all, or only in a very limited way, connected to the general "public" Internet. While the company obviously has to bear the full cost of its own Intranet, it is in full control of it, and the advantages in the area of security, and of being able to control the load and correctly manage the necessary evolution, are considerable.

Another area which is attracting major commercial interest at the moment is the push to fully exploit Internet and World Wide Web technology in order to improve work-flow and staff co-operation inside organisations. Existing Internet applications were largely developed in an independent fashion. If they can be brought together on an Intranet, so that workers in a company have access to a more coherent and integrated "information environment", then the potential competitive advantages may be significant. This effect could be very important both for small start-up companies, where there is very strong pressure to provide excellent customer support while containing costs, and for larger companies operating on a fully pan-European basis.

Electronic Commerce

People have started to use the name "Electronic Commerce" to cover the impact that the "Internet Economy" will make on the way in which every citizen and every enterprise, of whatever size, goes about the business of acquiring and providing goods and services. When these goods and services can be inspected and compared on the Internet in a way which provides the buyer with at least as much information as they can acquire in local or even in specialised shops, we can all see that the implications will be very profound, and likely to have a very significant effect on all European economies.

Much of the most interesting work on new "Electronic Commerce" applications is being carried out in the USA, despite the existence of Europeans with enough exciting new ideas, and skills to implement them. This is because the critical mass of Internet connectivity, and especially connectivity at adequate bandwidth, is not available in Europe. The effect of the two to three year time-lag between Internet deployment in Europe and the USA, which does not sound so much, is pernicious, in that it effectively means that very much of the leading-edge work on new Internet applications is being carried on outside the European Union. We risk to see the major "Electronic Commerce" applications develop with a distinctly American flavour.

Applications

In the initial section of this report on "Background" we drew attention to the way in which Internet applications cannot be considered independently of the bandwidth available to the potential users, and to the dual development thrusts of the Commodity Internet and the High-performance Internet.

It is our view that many useful and valuable applications will be developed in Europe, for both the commodity and high-performance Internets, as soon as bandwidth grows and pan-European coverage improves. Besides "Electronic Commerce", areas of great interest include health care, tele-teaching, and support for wide-area collaborative work.

While some stimulation of applications may be useful in efforts to stimulate Internet evolution in Europe, the emphasis should probably be placed on generic aspects, rather than on trying to pick winners. Historically we can note that the World Wide Web, developed initially in Europe and

commonly considered to be the "killer application" of the early Internet, was a huge success which had not been widely predicted. The nature of its success was perhaps that there was a very definite need for its use in one specific community (that of particle physics, where people wanted easy and smooth access to all forms of documentation from around the world) and to the fact that it was designed in a generic way which made it easy to adapt to many other communities, and then to industry and commerce.

Security and Legal Issues

Many people are aware that there are some concerns about the "security" and the "legal framework" of the Internet. These are important fields, which should be neither over- nor under-estimated in importance.

In the area of the Commodity Internet one major security issue dominates the scene. Although many people have become used to quoting (insecurely) credit card information over the telephone in order to guarantee reservations or to pay for goods, the idea of Internet hackers obtaining similar information by stealth has led to the idea that the Internet is not safe for serious commercial use. A number of different technical approaches, both for the secure use of credit cards and for the provision of "Internet cash", are close to entering into general use, though largely driven by work being carried out in America. This work, especially its relationship to encryption procedures, is one where the impact on the European "Single Market" will be important, and where the EU needs to have a clear position.

The Commodity Internet will obviously raise many issues which can be classified as "legal" and/or relate to the way in which the individual citizen interacts with fellow citizens, companies, and government. Europe will have to decide how these are to be handled.

For the High-performance Internet, "security" has traditionally been more about hacking. Either people using the Internet to enter surreptitiously into connected computers, or people attempting to slow down or even shut down areas of the Internet itself. These areas will continue to need attention, and the scant regard that the Internet has for national borders will ensure that good pan-European cooperation will be needed in this field too.

Internationalisation

Software vendors use the term "internationalisation" to refer to the way in which a product is adapted to the multitude of local markets into which it will be sold. Besides the obvious need to translate the input and output dialogue, in all its various forms, into the language(s) of the target market, more subtle, cultural, changes are sometimes required. Trivial examples include the need to allow for residential addresses to have a variety of different layouts and postal codes, and for programs to support different national methods of payment.

If Europe is to obtain its "fair" share of the market for Internet business, and to export software written for Internet use in one country of the Union to other countries, and around the world, the we surely will have to encourage good practice and widespread education in this field.

EU involvement

In order to be logical and consistent, we should ask ourselves to what extent the European Union ought to be involved in any of these Internet developments. For this advisory group the answer is clearly "very significantly".

The development of the Internet, especially in the area of Commodity Internet and Electronic Commerce, over the coming decades, will have truly enormous influence on all citizens of the Union, and on the implementation of the "Single Market". But Europe will not become competitive in the Commodity Internet market unless it can make a push to significantly reduce its present backlog, with respect to the USA, in bandwidth deployment and hence applications development, by investing in the area of the High-performance Internet. We must emphasise again that the "commodity" and "high-performance" aspects of the Internet must be seen as complementary and not alternative

developments for Europe.

We feel that Brussels must have continual access to very good sources of information concerning Internet developments, both in the purely technical, and more broadly commercial and geo-political areas, so that its policies can be well-thought-out and effective. Some of these policies will be focused on the Internet itself, such as the need to follow up carefully on the real level of competition in the newly liberalised market for the provision of bandwidth and other services. But other policies will be based on much more general issues of society, including free speech, privacy, and the coming competition between "physical" and "electronic" commerce, where the Internet will come to play an enormous role.

In the same way that the Internet will increasingly impact each citizen over the next two decades, it will have a strong impact on the work of each Directorate-General of the Commission. It will be important that the Commission obtains a good understanding of the technical background of Internet developments, and that the relationship between the commodity aspects of the Internet and the high-performance aspects is correctly appreciated and handled in Europe. Although all Directorates-General must develop their own understanding of the impact of the Internet on their areas of responsibility, we believe that it will be important for the Commission to have a centre of expertise and coordination for European Internet developments. The Commission staff involved should be able to dialogue at a technical-political level with other regions, and to coordinate action among the various bodies of the EU.

We also feel that it is important that the various measures which are available to the EU in order to help less-advantaged areas of the EU should take full account of the vital importance of data networking. We must urge that all relevant EU Directorates and Programmes should provide financial support for data networking, on the same basis as support for other infrastructure, in such areas.

Recommendations - some general comments

It is already possible to read articles in the press from people who feel that the Internet is merely a "fashionable fad" whose time has arrived, and will soon pass. The members of this advisory group believe strongly that this is a completely false view. The Internet will surely be seen by historians as the very start of a major transformation of society, which will take several decades at least to complete, towards Electronic Commerce and the Information Society. As with all economic and political transformations, Europe will have the chance to adapt well, or to adapt badly, to these challenges. We hope that it will show the ability to adapt well.

The trigger for setting up this Advisory Group came from the American initiatives, mainly starting in the second half of 1996, to improve the (American parts of the) Internet, as a reaction to the "saturation" and poor performance that had been observed following very rapid growth, both in the number of users and in their ability to consume bandwidth, in 1995 and 1996, and the apparent failure of the systems in place to cope with this growth.

We might have imagined that our group would call for one or more European initiatives to match the Next Generation Internet Initiative, or the Internet2 Initiative, in the USA. But, while we feel that there are specific actions that could be useful in that context, our basic message has to be at an even more fundamental level. Europe has to wake up to the Internet at many levels. It will affect us all, in the ways in which we do business and in the ways in which we conduct our lives. If we do not turn our undoubted skills and talents to profit from the coming opportunities offered by the Internet, then we shall find that other regions of the world will do so in our place.

Our first group of recommendations are rather general and political or economic or commercial in nature, and are therefore mainly addressed to "Europe" in general, or to the European Commission, as a more concrete manifestation of this "Europe". A second group of recommendations follow on from the first group, and are rather more specific. In all cases we have added some explanation to the text of each recommendation.

The three fundamental recommendations

Considering the background outlined above, and the developments under way, both in Europe and in the USA, to improve and evolve the Internet, the Advisory Panel feels that the three following recommendations are fundamental to a healthy and economically successful development of the Internet in Europe:-

1. **It is important that the European Union should recognise the key role that the Internet is likely to play in the economic development of Europe over the coming decades.**

   This is a plea for recognition at the highest levels of the EU. We have developed the arguments for the importance of the Internet for Europe's future throughout this report. We note from press reports that this theme seems to have been largely commented on at the recent (January 1997) meeting of the World Economic Forum.

2. **Specific recognition is needed that now is a critical moment for the evolution of the Internet towards Electronic Commerce.**

   This is a plea for both the EU and for European industry and commerce, of all natures and of all sizes from large to small, to sit up and take notice of the dramatic impact that the arrival of Electronic Commerce will have on the future of European businesses and competitiveness.

3. **These acts of recognition must be followed by urgent and effective action, and appropriate budgetary commitments, aimed at ensuring that Europe reduces the extent to which it is lagging behind the USA in the development and application of the Internet.**

   Once the problem has been identified, and the opportunity recognised, concrete action is required.

Other recommendations

The Advisory Panel feels that various other recommendations follow from these first three fundamental points. They are largely more detailed questions of implementation aimed at ensuring that the policy approach can be effectively implemented.

1. **We recommend that the Commission should have a carefully focused and adequately resourced centre of expertise for dealing with the Internet, and its likely ramifications.**

   The Internet is already having a major impact in the areas coming under the responsibility of each Commissioner and Director-General of the EU. This impact is likely to increase significantly over the coming years. While it is obvious that each Directorate-General will need to increase the level of understanding of all staff for the potential of the Internet to impact their fields of expertise, we believe that is very important that the Commission should have access to a team of staff who are specifically responsible for tracking Internet developments and keeping their colleagues apprised of recent, present and likely future developments.

   We also note that the existence of such a team should help to avoid the present situation where each major Internet development made outside Europe has to be analysed and reacted to by fairly *ad hoc* groups of EU staff and outside experts. In our opinion more continuity would be highly desirable.

2. **In parallel we would like to encourage the creation of a forum which would bring together all Europeans having a strong interest in the evolution of the Internet.**

   Paradoxically, it may be easiest to explain what we intend here by starting with some of the things that we specifically do not intend. We do not see this forum as competing with bodies such as the Internet Architecture Board or the Internet Engineering Task Force, which do their difficult jobs well. We do not see this forum as competing with a number of European bodies which already

exist (DANTE, FINE, RIPE, TEN-34 and TERENA are some of their names) and which have various roles to play in the deployment of services and in the evolution of the Internet in Europe.

What we do see is that, above all, there is a need to make European industry and commerce much more aware of the potential and risks of the Internet. In addition there are a number of issues where Europe might have a valid position of its own concerning the evolution of the Internet. We need to emulate the very productive American co-operation between academia, schools, research institutions, telecoms suppliers, and industry and commerce (both as suppliers and users of Internet services) in the development of the Internet. It would clearly be very useful for the European Commission to have a well-recognised organisation to which it could turn for advice on the whole gamut of Internet issues. To be useful, such an organisation needs ideally to be independent of the EU, although we would expect strong encouragement and support from the EU, especially during the start-up phase.

Examples of areas where the existence of such a forum could potentially already have been valuable in developing a pan-European consensus (if it exists) and in offering well-informed advice to the EU, include encryption, the rights of the individual concerning personal data gathered via the use of the Internet, security (hacking), internationalisation, and the development of the Internet name space.

In this context we would like to make one rather urgent proposal. We judge that the present American Internet initiatives are significant and should be followed carefully. We suggest that the Commission should rapidly find a few experts who will follow the American moves on behalf of the EU in the coming months.

3. **All geographic areas of the EU should be able to benefit from timely deployment of the Internet.**

   Provided that a minimum of adequate infrastructure is made available, good Internet access will be possible in all geographic areas of the EU, even those with low population density or *per capita* income. There are even good reasons to think that Internet access can act as a significant positive force for social and regional cohesion, and some recent studies tend to confirm this opinion. As we have noted above, support for Internet infrastructure in less-advantaged areas of the EU should already be possible under existing measures.

4. **The EU must continue its strong emphasis on fast and effective liberalisation of European telecoms. Excessive line costs are still the biggest barrier to the spread of the Internet in Europe, and to the development of European electronic commerce.**

   It is very important not to lose sight of this vital point. It is a requirement if Europe is to move from playing "catch-up" to a position of equality, or even leadership, in the field of Electronic Commerce.

5. **In order to help reduce the 2-3 year lag between Internet exploitation between the USA and Europe, it is essential that funding is made available for a very rapid follow-on of the TEN-34 Project to 155 and 622 Mbps.**

   As part of the process of increasing the available bandwidth, described in the text and in the previous recommendation, it will be important to make sure that the High-performance Internet in Europe quickly moves towards the sort of bandwidths now being exploited in the USA, for highly demanding applications such as meta-computing. The experience of the TEN-34 project shows just how long it can take to reach agreement between the multiple partners involved, so we recommend that the most efficient solution for all parties would not be to set up a new project, but rather to expand the bandwidth available to the TEN-34 project as quickly as possible.

6. **There are a range of research and development and infrastructural activities which the EU should consider supporting. Those which we have discussed included R&D on network**

protocols for supporting different types of Internet traffic; efforts to encourage the deployment of various alternative technologies for delivering Internet access to the home, such as cable TV and satellite; and work to exploit further Europe's strong position in mobile telecoms into the Internet age.

While all of these activities are interesting and should be considered, any decision about which of them should be treated with priority would appear to need further analysis. The suggestion to emphasise mobile Internet access seems especially attractive.

7. **We would encourage European countries to set up "EuroPoPs" along the lines of the GigaPoPs which are being envisaged by the Internet 2 initiative.**

   This short-term recommendation is addressed at governments and national network organisations in Europe. We feel that they can already help by directly tracking the technical approaches which are being adopted by the Americans in the evolution of the Internet. There also appear to a good chance to use such national actions to trigger the involvement of local industry.

Appendix

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