

# Information Technology

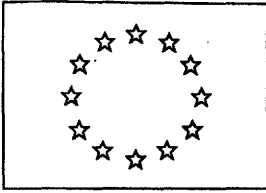
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## **Report of the High-Performance Networking Requirements Group**

*" HPCN enables us to improve the way we work"*

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April 1994



# Information Technology

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## 1. EXECUTIVE SUMMARY

The High Performance Networking Requirements Group was set up in July 1993 under the chairmanship of Dr Soboll of Daimler Benz to define the requirements of industrial users of High performance Networking in the second half of the 1990s and to specify what actions might be initiated at Community level.

The Group found that businesses operate in an increasingly distributed environment. The use of computer networking has become a necessity without which the exploitation of information technologies cannot be brought to fruition. The Group's report is concerned with the use of networks characterised by providing higher levels of connectivity, flexibility, bandwidth, value for money and user control than has been available hitherto.

The Group considered many important issues and questions which relate to the satisfaction of users requirements and the identification of the most appropriate actions to recommend at Community level. It determined that the infrastructure is slowly being put in place. However, even were services widely available and tariffs competitive (neither of which conditions are currently met), users would remain largely unprepared to take advantage of advanced networks.

The Group's proposal, which is wholly complementary to other Community actions which impinge upon the use of networking services, is to stimulate the uptake of distributed applications which use advanced networking services by demonstrating the resulting benefits. Positive experiences which show how to gain competitive advantage through networked distributed applications must be made available on a broad scale. This will stimulate the widespread adoption of proven best practice techniques. Potential users both at the technical level and more importantly at the general management level will be able to see case histories with quantified and detailed analysis of costs and benefits. Specifically, we propose as part of the HPCN budget line within the fourth Framework Programme 120MECUs should be allocated for the following actions:

1. The Commission should finance the promotion of use and publicise the benefits derived from case studies. This should be carried out by one or at most two organisations experienced in such work. The target should be the key decision makers in user organisations.
2. The Commission should support financially the adoption of what may be termed best practice in the use of high performance networking. Targeted should be first time users of multi-site applications as well as existing users of less advanced networking services. As well as the areas of support described in the next paragraph, within this action should be supported the execution of feasibility studies to establish the implementation plan and likely benefits in the user's particular circumstances.

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3. The Commission should provide a strong incentive to users proposing distributed application experiments using advanced networking and who are willing to act as European reference points from which quantified results could be disseminated following quite short (less than two year) projects. The benefits to users who take part in this programme would be that they would provide improved levels of service to their internal customers; they would gain competitive advantage by being one of the early adopters of the new technology/services; they would receive financial assistance with start up costs (equipment, network access, software and staff); and would learn from the experience of others. We recommend that vertical, user led groups be favoured and suggest that any one application experiment need not necessarily involve more than one user organisation.

## 2. THE NEED FOR ACTION

### 2.1. DEFINING HIGH PERFORMANCE NETWORKING

*A Group of industrial and business users*

The High Performance Networking Requirements Group was set up in July 1993 to define the requirements of industrial users of High Performance Networking in the second half of the 1990s and to specify what corresponding actions might be initiated at Community level to improve the situation. The Group was chaired by Dr. H. Soboll of Daimler Benz and was made up of experienced users mainly from business and industry with some members from the research community. The full list appears in Appendix A. page I. The findings of the Group were confirmed through consultation with a larger set of users from a wide range of industry sectors and Member States. The exact list appears in Appendix C. page III.

For many businesses a decisive factor in gaining competitive advantage is the optimal use of information technology. Through it operational efficiency can be maximised and, perhaps more significantly, new social and business practices can be introduced which outstrip the competition.

*Distributed networked applications are key to competitiveness*

Businesses operate in an increasingly distributed environment. Customers, suppliers and trading partners are far away as well as local. Enterprises themselves are distributed. To optimise the use of information technology necessarily requires the deployment of key applications to serve the geographically spread out environment in which businesses exist. Multi-site applications cannot function without the successful use of communication services. The use of computer networking services is not an option for modern competitive businesses. It is a necessity without which the exploitation of information technologies cannot be brought to full fruition.

Many, indeed most, of the computer networking services in use today could not be described as high performance or advanced. Our report is concerned with actual usage of networks and services which are not widely available today but could become so in the future given sufficient user demand. They are characterised by providing higher levels of connectivity, flexibility, bandwidth, value for money and user control than has been available hitherto.

## 2.2. FINDINGS

The Group considered many important issues and questions which relate to the satisfaction of users requirements and the identification of the most appropriate actions to recommend at Community level. In particular, we considered the following important questions, our full analysis of which is contained in the section 4. Detailed Analysis pages 21-52:

*Where do we stand today?*

- Who are the likely early adopters of advanced networking services and what key applications would they deploy
- Whether the technologies and services are adequate
- Are the trends in telecommunications policy and regulation satisfactory
- What are the potentialities which emerging networks and services may offer
- What needs be done and what are the relevant CEC actions are already under way
- What are the barriers to a wide spread take-up

*Technology and Services are likely to emerge....*

The telecommunication equipment suppliers and the network operators are developing the advanced networking technology which can contribute to the emerging information highways which should come into full use early in the next century. The Advanced Communications Technology programme (ACT) contributes an important part in this work and users are involved in demonstrations and pilots to establish that the technology works and is targeted towards their needs. The technology available or emerging in Europe seems likely to compare favourably with anywhere else in the world. We have reservations, however, about the availability of affordable and widespread services based on the technologies which are being developed.

*but affordability is still questioned*



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*Industrial and business users are not ready*

Even where advanced networking services are emerging as precursors to the eventual integrated broadband network, although potential is high demand is still low because potential users are not yet ready to jump onto the bandwagon. They are ill informed of what is possible. They are not convinced of the potential benefits. They lack knowledge of the best ways to move forward from current practice and the relevant applications are not in place. The potential benefits of bringing such services into use on a wide scale basis are immense, not least to establish as effective a business infrastructure in Europe as in the US. In the interests of raising competitiveness and in order to stimulate demand for advanced services, action is necessary to overcome these barriers.

*The need to work with the widest possible spectrum of users*

All the Community actions which we have looked at which one way or the other impinge upon the use of networking services are important. Many contribute to the long term goals of establishing Community wide broadband infrastructure and providing affordable and efficient services. The Group considers that there is a gap, however, in that insufficient attention is being paid to the issue of preparing users and potential users to take advantage of increasing availability of new and advanced services. The Commission can and should play a catalytic role in this respect. In certain selected sectors it is already doing so, for example in Telematics and Aeronautics, and this momentum shall be increased. However, a much greater leverage can be obtained by working with a wider spectrum of users especially those who are faced with day to day competitive pressures.

*Build upon what is available*

The opportunities users will have to expand their experience of using high performance networking are likely to remain both economically and geographically constrained for some time. Nevertheless a number of advanced services based upon interim technologies are becoming available in various forms including early trials of ATM cell switched services. In many instances operational business solutions could be developed and piloted on these and valuable experience gained. It is important that users have access to suitable and cost effective services and try to exploit what is available and build upon it.

## 2.3. PROPOSED ACTIONS

### *Break the vicious circle*

Outside the leading edge research community, which has been calling for a pan European broadband network for a number of years (albeit without the resources to support more than a fraction of the total cost), there is little articulated user demand for using advanced networking services. The network operators have until now given low priority to advanced high bandwidth service provision. Users faced with this situation and uncertain about what to expect in the future, are discouraged and do not express the latent demand. So there is something of a vicious circle. The broad objective of the Community action, which we propose, is to break this vicious circle through a programme which fosters rapid uptake in the use of high performance networking.

### *Realising the potential by turning it into actual demand*

The objective is quite separate from and in addition to Research and Development work going on or planned in other places. The programme which we propose should lead to much greater and more rapid use of the sorts of distributed IT applications which are key to creating decisive competitive advantage. For the objective to be achieved successfully we would expect to see significant results in a two to three year time scale. This requirement for results in a short time scale differentiates what we propose from 'grand challenge' activities and other longer term research and development which are already supported in other programmes.

### *Expand the industrial user base...*

#### *...by demonstrating the benefits...*

#### *...of distributed networking...*

#### *...through application experiments...*

In order to stimulate the uptake of distributed applications which use advanced networking services it is vital to be able to demonstrate all the benefits. It is this which will convince potential users. What we propose is to make available on a broad scale positive experiences which demonstrate how to gain competitive advantage with networked distributed applications. This will stimulate the widespread adoption of proven best practice techniques. Potential users both at the technical level and more importantly at the general management level need to see case histories with quantified and detailed analysis of costs and benefits. There is no substitute for first hand practical experience. Theoretical studies are insufficient. In order to build up rapidly a body of practical experience it is necessary to sponsor distributed networked application experiments.

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The actions proposed are, therefore, three in number. They are further elaborated in section 3. Detailed Proposals and Recommendations pages 13 through 20.

### *Promotion of use*

To promote the use of high performance networking and disseminate information about what advantages its use can bring in the industrial, governmental, research and educational context. It is intended to link on a European scale all the work from whatever source which is relevant to the broad objective of increasing the uptake of multi-site networked applications. The target audience for the promotion should be the key decision makers in user organisations. We suggest that in order that this action be carried out as professionally and as efficiently as possible it be undertaken by one or at most two organisations working across all Member States.

### *Distributed Application Experiments*

To sponsor distributed application experiments, well beyond technical demonstrations including the establishment of full business justifications and evolution to routine use. Applications which are generic should be sought, which have relevance to many industry sectors and different situations. Users who would carry out these experiments must be willing to act as a European reference point from which useful quantified results could be disseminated following quite short projects.

### *Spreading out best practice*

To encourage on a broad scale the adoption of what may be termed best practice in the use of high performance networking. This should include, for example, first time users of multi-site applications where benefits have already been proven as well as existing users of less advanced networking services. Supported within this action should be the execution of feasibility studies to establish the implementation plan and likely benefits in the user's particular circumstances.

## 2.4. FITTING OUR PROPOSALS IN THE COMMUNITY CONTEXT

### *To maximise impact...*

### *put into the appropriate Community context*

The Group has considered requirements and needs from the viewpoint of industrial, business and research users. To some extent these are independent of what actions are already taking place in industrial, national or Community contexts. However, in order to give maximum impact to possible recommendations it is necessary to relate them to the specific activities which are currently being run or are in preparation at the Community level.

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Community actions which impinge upon computer networking and its use include actions on telecommunications policy and regulation, R&D programmes such as the Advanced Communications Technologies programme (ACT), the Telematics programme and the specific programme on Information Technology (IT).

*Regulation essential but  
needs to go faster*

From a regulatory standpoint the Group welcomes the actions being taken to improve the availability of advanced services. The Community appears to be aiming for reasonable tariffs, uniformity of service provision, no cross border anomalies, and a single and competitive market in telecommunications. The implementation of telecommunications policy and the regulatory approach is essential for the establishment of the best conditions for networking users of all sorts - individual, industry, business, government, research. The Community's actions and policies are all in the right direction but too slow in bringing benefits to the user. From a user's perspective we would like to see this process accelerated significantly.

*Focused on the  
competitiveness of all  
industry*

The Group welcomes the new directions which are being taken within the Fourth Framework Programme. Ten years ago the competitiveness of the IT industry was an important focus of research and development policy. Now the competitiveness of all industry is emphasised. The actions which we propose target precisely that - the competitiveness of all industry - and can, therefore, comprise an important ingredient within the Fourth Framework Programme.

The ACT programme has more of a technology and service supply side orientation. Its objective is the development of advanced communications systems and services. The Telematics programme is concerned with the information and communications infrastructure for public services, for research and education, and to improve the quality of life. The presence of pioneering users and the research network itself are aspects of the Telematics programme of particular interest to industrial users.

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### *Best fit within HPCN ...*

It is within the IT programme that a demand side, application focus predominates aimed at delivering the benefits of technology to industry in the short to medium term. In accordance with the orientations set within those programmes we see our objectives being met essentially within the High Performance Computing and Networking area where the proposals which we make in this report fit comfortably. However it is important to point out that the enabling nature of the technologies involved in the exploitation of high performance networking are such that other areas of the IT programme, such as software and multimedia technologies for example, will contribute to certain aspects of the activities proposed.

### *... but strong synergy with other activities*

Co-operative working, conferencing, working with images and the distribution of either the work force or the data are concepts common to all levels of computing and are of interest across industry, research and the public sector. They are also concepts which are addressed in all the Community programmes mentioned in the previous paragraph, between which there need to be strong interactions. Our specific proposals are directed towards meeting user needs but cannot be realised without the necessary infrastructure the creation of which is assisted by other Community, national or private initiatives. This is an essential requisite for the success of the proposed activities.

### *Complementary actions*

The three actions which the High Performance Networking Requirements Group is recommending all work together to achieve the broad objective of increasing the rate of adoption and use of advanced networking services. They are actions complementary to one another which should accelerate the commercial use of advanced networking technology and collectively have a strong impact on the competitiveness of the Community's industry.

### *Articulated with other CEC programmes*

They are also actions complementary to activities within the ACT programme (to which we look for networking technology and eventually a pan European IBCN) and the Telematics programme which is supporting many pioneering applications and important research infrastructure. We expect the results which come from the programme which we propose to be of benefit and interest to the ACT and Telematics programmes and vice versa.

*A definite contribution to the aims of the White Paper*

Our proposals are in line with the themes developed in the recent Commission White paper on Growth, Competitiveness and the Economy. The paper recognises that the economy is becoming increasingly knowledge based and decentralised. It identifies the importance of Trans-European infrastructure to support the "information society" as it develops. The recommendations which we make should promote the build up of applications using the new infrastructure and make a positive contribution to Growth, Competitiveness and Employment.

## 2.5. SUPPORTING MECHANISMS

*Support adapted to the activities*

The Group did not look into the funding mechanisms in detail but felt that the general rule of contributing to 50% of all costs is not ideal. In order to effectively support a broad scale activity such as the spreading of best practice, with applications experiments which require a strong focus to be efficient, the approach and means cannot be the same. The commission should look further into more flexible supporting mechanisms and adapt them depending on the type of contracts and activities.

*Payments to users not suppliers*

With the exception of the promotion action, for which a relatively small proportion of the budget would be needed (even though it should be a high priority action), payments would best be made to users. The funding system should give users an incentive to negotiate, alone or jointly, the best prices with suppliers of software, hardware and services.

*Incentives for all parties*

It is desirable that network operators also perceive the programme as a whole and the application experiments in particular as beneficial to them. This we believe can be achieved without making direct payments to network operators. In carrying out the experiment, users will inevitably spend money with the operators. Following a successful application experiment operators should have an ongoing revenue stream from the routine use of the application. This financial factor together with access to the quantified detail which makes up the case study plus the benefits of the promotion activity should provide network operators with a powerful incentive to participate.

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### *Financial support ...*

*...drawn from appropriate sources*

### *Changing profile over time*

*Adapting estimations to the type of activities*

The level of funding which we propose should be devoted to these actions shall be profiled over the duration of the Fourth Framework Programme according to the goals and means chosen for each activity. Reflecting the fact that our proposal would fit essentially but not entirely within the HPCN area, the budget will also have to be drawn from the most appropriate programme or domain, with the major share coming from the HPCN budget.

Initially we would expect that the budget allocated to the distributed application experiments will represent a relatively high proportion of the total. Over time the balance is likely to change so that the best practice activities will be significantly increased while the application experiments would be of a decreasing importance. The effort and budget necessary for the promotion activities is likely to remain stable over time.

As a first approximation it appears reasonable to devote of the order of a few percent of the total budget to the promotion activities.

The applications experiments should be individually well focused. There will need to be more than ten experiments per year in order to build a critical mass and to establish a sound foundation to the proposed actions. The budget for these can be estimated by considering in the first instance the budget for networking which might form a part of an R&D project; this would typically be below 20% of the total. A figure of 1 to 1.5MECU per experiment should be sufficient in most of the cases.

Regarding the spreading out of best practice a completely different approach shall be followed to cost the activities. There should be many more activities supported compared with the experiments, but they would necessitate a more limited contribution. The mechanisms used for the ESSI activities and the experience gained there could serve as a basis. This would lead to an estimated budget comparable to what would be required for the application experiments activities.

This estimation would lead to an overall budget necessary for the activities proposed in the order of 120 MECUS for the duration of the Fourth Framework Programme, to be drawn essentially from the HPCN budget line.

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### 3. DETAILED PROPOSALS AND RECOMMENDATIONS

#### 3.1. PROMOTION OF USE

The first action set is concerned with promotion of the use and dissemination of the benefits of using advanced networking systems. Our target should be decision makers in user groups.

##### *General management awareness*

The tasks should focus on raising awareness amongst general management as well as disseminating technical information about system configurations, applications and the measurement of benefits. The aim is to link up on a European scale all the work from whatever source which is relevant to the broad objective of expanding the uptake of advanced networking. We do not envisage that the creation and distribution of a special publication would be appropriate but rather that a steady stream of press releases be generated targeting the quality newspapers and publications read by general management as well as the technical press.

##### *Results from all programmes*

The organisations carrying out this work will be expected to arrange appropriate events at which advanced networking users and potential users can exchange information and find out how others have implemented specific applications. They will have to work pro-actively with as many users as possible who are experimenting with or beginning to use advanced services. Bringing together all positive experiences from whatever source is important. These will come from those taking part in the programme which we propose and also from those with relevant experience from the ACT and Telematics programmes and those who have participated directly in experiments with network operators.

##### *One or two organisations only*

We suggest that in order that this action be carried out as professionally and as efficiently as possible it be undertaken by one or at most two organisations working across all Member States. The organisations who would be charged with carrying out this action line would be selected following an open, competitive process. The selection criteria should include a proven track record in public relations, relevant technical expertise and demonstrable capability to organise and promote well attended conferences and seminars. Experience of working with and in many Member States would also be seen as an advantage.

*Evaluation of effectiveness*

Contracts for this work should be short, typically one year. The work should, of course, be continuous. Contracts should be renewable following rigorous evaluation of the effectiveness of the organisation's work. This evaluation should depend partly on the qualitative opinions of network users and those carrying out the experiments and partly on independent surveys of user awareness and the likelihood of using advanced networking systems.

Overseeing their work should be a panel of users who could guide activities linking applications and disseminating results across Europe.

### 3.2. DISTRIBUTED APPLICATION EXPERIMENTS

*Well beyond technical demonstrations*

The second action set is concerned with the sponsorship of distributed networked application experiments, well beyond technical demonstrations including the establishment of full business justifications and evolution to routine use. We draw a distinction between demonstrations and full experiments. A demonstration is designed to establish the feasibility of running an application or exploiting a technology whilst a full experiment explores all the issues which need to be evaluated prior to embarking on regular commercial use. It is these sorts of experiments which we seek to promote.

*Vertical user led groups*

Proposals to carry out application experiments should be sought from users. Proposals for distributed application experiments should entail co-operation between users, service providers and equipment and software suppliers. The most effective application experiment delivering the most convincing results in the shortest time does not necessarily involve more than one user. Having competitors or users with non congruent priorities in a project could be a serious handicap. This is the reason that we recommend that vertical user led groups be favoured and why we suggest that any one application experiment need not necessarily involve more than one user organisation.

*Multinational at program level*

The action as a whole should have a multi-national dimension. However, the most efficient way to carry out a particular project is to address real use cases, and while the use of cross border networking services by a multinational consortium of users is clearly one of them it is not the only one. The results and case histories must have application throughout the Community. A critical mass of results supporting a wide set of activities must be obtained, but it is not essential that every experiment be multinational.

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*Increased interactivity is our target*

It is not possible to anticipate all the applications which users might wish to build into an experiment. We have, however, identified a number of applications which are common to a range of situations and industry sectors and in which we believe early adopters of advanced networking services are likely to be interested. These we have tabulated in section "4.6.4. What are the Likely Applications?" page 43. We also include in the appendix D. page IV examples of applications which specific enterprises contributing to the High Performance Networking Requirements Group might be interested in experimenting with over the next few years.

It should be noted that, whilst some of the applications involve the use of high performance computers, the majority do not. Co-operative working, conferencing, working with images and the distribution of either the work force or the data are concepts common to all levels of computing and are of interest across industry, research and the public sector. From this analysis of potential applications we are able to suggest the criteria which should be used when determining whether any particular proposal for an application experiment should be supported.

*Generic for many market sectors*

Applications should be favoured which are generic, with relevance to many industry sectors and different situations. Applications should be encouraged in as many market sectors as possible. Applications introducing new business and social practices, made possible through the use of advanced networking, should be particularly encouraged. So too should application experiments which could lead rapidly to routine use. Finally, any applications where the transition to the use of network services more advanced than the traditional leased line or switched data networks is likely to bring significant benefits should be favoured.

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Other important criteria, with which to select proposals worthy of support, are the following:

*In the main stream of service evolution.*

The experiments should use tomorrow's networking services. We do not think there is any need to further support application experiments on networking technology which has been widely available for some time. Nor do we wish to support the development or the use of networking technology outside the main stream of service evolution. Having said that, it would be a mistake to be too prescriptive. A networking service may be new in one Member State when it is quite widely available in another. Users making proposals would be expected to have identified the networking services they will be using. Typically a networking operator could be party to the proposal. However in some instances it may be appropriate for the application experiment to be conducted using some dedicated networking services (e.g. a research or other private networking services).

*No new development*

Distributed application experiments should be based on the use of existing equipment technologies. It is not the intention for this part of the programme to become involved in significant hardware developments. Such work should be left to the equipment suppliers, the operators, and leading edge users and be run under the ACT programme where it fits better.

*Potential benefits made clear*

Application experiments should demonstrate some clear advantage through use of the high performance networking services. The justification could relate to a business process which could not be automated without higher bandwidth and lower cost, for example replacing couriers for file transfer. It could relate to an application involving local distribution perhaps on a LAN which would benefit from spreading over the wide area. It could relate to an existing wide area application which is hampered by inadequate networking service capacity and speed; time to market through a distributed design process could be significantly reduced for example. To be selected there must be clear answers to the questions - Why carry out this particular application experiment? What are the expected benefits following a successful experiment?

*Quantitative*

The purpose of the application experiment should include establishing and demonstrating the benefits in a quantitative fashion. Willingness to make public detailed quantitative results and evidence that adequate dissemination mechanisms are in place should be an important selection criterion.

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*Able to disseminate results*

Experiments must lead to visibility of the results outside the project participants. Case histories must become available to use for promotion and dissemination tasks. Users who would be willing to be a reference site and who are able to make resource available to work with the organisation charged with the promotion of the use of advanced networking should be favoured in the selection process.

Important to the success of the application experiments proposal is an efficient mechanism for the gathering and dissemination of information about the experiments and the results achieved. Rapid information exchange between participants should be encouraged through seminars, simple newsletters and electronic means.

*Leading to commercial use*

Where a project is supported as an experiment or a development it is desirable that it leads from the pilot phase directly to commercial use. It is this sort of result which is likely to have a positive influence upon industrial take up of emerging broadband services.

*Typically, less than two years*

The entire project should be as short as possible; typically less than two years, but in no case longer than three years.

The level of Community support for application experiments should be sufficient to give users a good incentive to participate.

*Costs which should be supported*

Support must clearly be provided to pay for the extra network and staff costs incurred by moving from an existing environment to the high bandwidth one and the extra costs of running the application experiment. Included would be equipment with which to connect existing environments to the new services and the service costs during the experiment which should not normally exceed 20% of the costs unless individually justified. Some of the costs of connection to a new service should also be eligible but we do not propose that the costs of actual public network deployment should be paid. Nor do we believe that hardware development costs should be paid. Other costs eligible for support include:

- Development and software integration costs which are necessary to make the application experiment possible
- Network usage charges for the duration of the experiment
- Training costs

- Performance monitoring and network management equipment with which to control and quantify network behaviour and response times
- Costs of disseminating results - for example, attending and presenting papers at Network of Excellence common interest group seminars.

### 3.3. SPREADING OUT BEST PRACTICE

*Applications where advantages already demonstrated*

The third action set is concerned with stimulating enterprises to reap the benefits of changes in working practices achieved through the effective use of high performance networking in circumstances where the advantages have already been demonstrated. We propose to promote on a widespread basis what is identified as best practice in the distributed networked applications field. This will include those organisations which are not currently applying networking technology at all. We believe that many such organisations are small - typically below 200 employees in size - and operate in high tech niche market sectors.

An important task within action 1, concerned with the promotion of the use of high performance networking, will be identifying and communicating with target organisations which might benefit from the best practice part of the programme by adopting distributed networked applications.

*Detailed feasibility studies*

Potential users could apply in the first instance for grants to fund the carrying out of detailed feasibility studies specific to the applicants particular circumstances. For smaller companies the mechanism could be analogous to that which has worked successfully in the CRAFT programme. An institute or other organisation could carry out the feasibility study and implementation on behalf of one or more users in a particular sector.

*Supported costs*

The support given should include a significant proportion of the costs of getting the chosen application up and running. In order to ensure as broad a participation as possible there would probably need to be a ceiling on the budget which could be spent per participant and the time scale which could be allowed for implementation.

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The costs supported should include the start up costs such as:

- interface equipment,
- access costs,
- connection costs,
- software licences,
- training costs and
- staff time to bring the application into full operational use.

Development costs should be excluded on the grounds that we are trying to promote the adoption of best practices which have already been shown to have advantages elsewhere and for which the development and pioneering work has been largely completed.

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## 4. DETAILED ANALYSIS

### 4.1. POSITIONING OF HIGH PERFORMANCE NETWORKING WITHIN THE FOURTH FRAMEWORK PROGRAMME

The Group has considered requirements and needs from the viewpoint of industrial, business and research users. To some extent these are independent of what actions are already taking place in industrial, national or Community contexts. However, in order to give maximum impact to possible recommendations it is necessary to relate them to the specific activities which are currently being run or are in preparation at the Community level.

Relevant appear to be the activities on the regulation of the Telecommunications sector, the Commission White Paper on Growth, Competitiveness and Employment (recently adopted) and the Fourth Framework Programme for research and development.

The White Paper underlines the necessity to promote the Information Society and to accelerate the introduction of the Trans-European networks. The proposed programme to develop European Information Highways has embodied in it three priorities: the interconnection of advanced networks, the development of general electronic services and Telematics applications.

Obviously the Fourth Framework Programme represents the major area of interest for the concerns of the Group, and in particular the Information and Communications Technologies line of activities. In accordance with the orientations set within the IT programme we see the principal objectives of users being met within the High Performance Computing and Networking area where the proposals we are developing seem to fit comfortably.

#### 4.1.1. *R&D Objectives*

Community research and development in the Fourth Framework Programme has a broad two-fold objective;

- The improvement of the competitiveness of all industry.
- The satisfaction of societal needs for a better quality of life.

To achieve the broad objectives of the Fourth Framework Programme, research and development in Information Technology will pursue a user and market led policy contributing to the healthy growth and development of the information infrastructure.

The Information Technologies programme must have the flexibility to deal with an ever more rapidly changing technological environment and focus to ensure that scarce resources are used in the most effective and productive fashion. It must address the particular needs of SMEs, one of the prime sources of industrial innovation.

#### 4.1.2. *The IT Programme*

The IT programme will be designed to tackle these challenges not only through what it does but also through the way in which it does it. Looking at this latter point, the modalities of R&D action, the programme will be marked by several new approaches. The greatest use will be made of opportunities to speed up the process of submission and selection of proposals. **Streamlined procedures** for small projects will particularly benefit SMEs, for whom the costs of preparing proposals are a significant burden. Another approach beneficial to SMEs is **supplier/user pairs**, encouraging the transfer of promising R&D results to the market. **Networks of excellence** have over the past two years already proved their efficacy and cost effectiveness. These thematic groupings of industry, academia and research organisations, co-ordinating research, training and technology transfer within their domains, will have an important role in the programme.

The main new innovative modality in this specific programme is the **focused cluster**. A focused cluster brings together a range of organisations collaborating in the pursuit of a well defined goal involving technologies spanning a number of areas within IT and other disciplines. High Performance Computing and Networking is being organised as a focused cluster. It encompasses research projects accompanied as appropriate by Networks of Excellence, association of suppliers and users, co-ordination with national initiatives, international co-operation, co-operation with Eureka, dissemination of results, and training activities. It is this combination of diverse participants, varied activities and different disciplines in an effort with a single goal that is the defining characteristic of a focused cluster. Individual activities within a cluster may have a duration shorter than the life span of the whole cluster.

The objectives of the **HPCN focused cluster** are;

- To exploit the opportunities provided by high performance computing and networking.
- To expand its application potential, and so,
- To speed the pace of innovation and serve the economy as a whole.

Recent technological developments in computing and networking promise revolutionary changes in the use of the new generation of computing and communications systems. Shorter time to market and better product quality will be the main motivation for uptake by industrial users. New applications previously impossible will emerge as important demand drivers. Experiments will be substituted by computer simulation in an increasing number of industries including traditional ones. Moreover, the use of HPCN systems for commercial applications is expected to be taken up vigorously in the second half of the decade.

High speed networking at affordable cost would allow distributed image-based applications and bring multimedia systems to full fruition. Significant growth is expected in distributed computing as parallel systems and clustered work station technologies converge to provide scaleable heterogeneous multi-computer networks before the year 2000.

The HPCN action lines have been selected to capitalise on these trends in meeting the objectives outlined above.

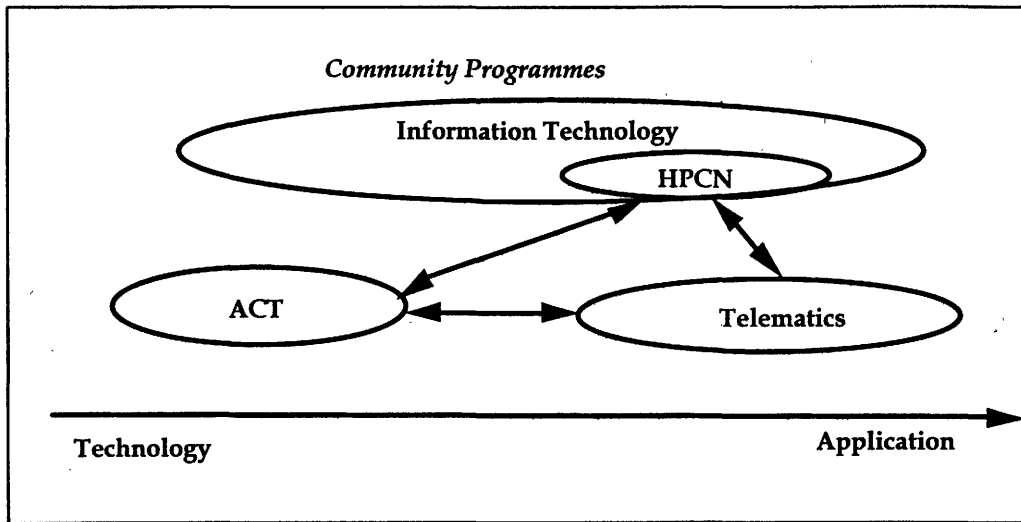
#### 4.1.3. *HPCN Action Lines*

HPCN work will be organised around 5 co-ordinated sets of activities. The first three address applications of major industrial relevance. The fourth addresses underlying generic systems and software technologies, whilst the fifth is concerned with complementary concerted actions.

These activities are :

1. Simulation and design applications. The objective is to demonstrate new applications which need HPCN capabilities for cost effective solution and which have a clear impact on industrial performance. The emphasis will be on computational fluid dynamics, materials dynamics, computational electromagnetism, molecular modelling and other chemical/pharmaceutical applications.
2. Information management applications. The aim is to demonstrate the economic viability of HPCN based applications for complex decision support and high performance on-line transaction processing. The activities include, complex data analysis and storage and retrieval of information in large and distributed databases.
3. Embedded systems applications. The activities include, complex signal processing, pattern recognition, image processing and understanding and applications with demanding real time requirements.
4. Software and systems technology. Work will draw upon activities in software design, environments to ease the use of parallel distributed and embedded systems, and advanced systems architecture.
5. Concerted actions will complement the work to support the development of a pan-European HPCN environment and infrastructure. Further actions will be organised in the form of networks of competence intended to spur training through research and technology transfer to industrial users. Application experiments normally building on existing infrastructures and requiring a community dimension will be supported and will help users to evaluate the opportunities and facilitate the accelerated uptake of HPCN technologies.

4.1.4. *Conclusions on the Fourth Framework Programme*



High Performance Networking cannot be considered in isolation from other activities and our analysis has been a global one. Our findings and recommendations are in line with the underlying concepts of Community actions. However, most of our conclusions are coloured by the industrial and business emphasis which often requires results in a short time scale. These shorter term considerations all go in the same direction as and contribute to the longer term activities of the Community. We see our objectives being essentially met within the High Performance Computing and Networking area.

**It is within the High Performance Computing and Networking area that most of the proposals which we make in this report fit comfortably.**

**However strong co-ordination is needed with the other activities.**

## 4.2. NETWORKING TECHNOLOGY

### 4.2.1. Technology Trends

There is a widely held consensus view of where transmission and switching technology is going in Europe, namely:

- Fibre Cables (end to end)
- SDH Transmission
- ATM Cell Switching (both wide area and local)

The variety of current technologies suggests that this may be an over-simplistic view or at the very least that it will be many years before earlier technologies become obsolete. The technologies available now, excluding those in the mobile and satellite domains (some in use, some being trialled and some still under development) include:

<p>The traditional technologies for voice and data transmission</p>	<p>Copper leased lines manually configured</p> <p>X25 networks (X21 networks in some Member States)</p> <p>Digital circuit switches</p> <p>PSTN and ISDN</p> <p>PDH multiplexing in the Transmission network</p> <p>Standards with considerable national variation.</p>
<p>Emerging technologies</p>	<p>Fibre in backbone and local loop situations</p> <p>Leased lines, software configured</p> <p>2 Mbit/s switches</p> <p>Frame Relay</p> <p>Metropolitan Area Networks based on DQDB technology</p> <p>SDH drop and insert multiplexing for transmission and access</p>
<p>The future</p>	<p>ATM switching</p> <p>Integrated broadband networks</p> <p>European (even world-wide) standards</p>

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On top of these technologies access to which comes through the public network operators one can also consider the technology which industrial/commercial users exploit in building their own networks, which includes:

LANs	Ethernets (predominant)  Token Ring  FDDI
Leased Lines	64 K digital circuits  2 Mbs digital trunks  Voice and data together through the use of Time Division Multiplexors
Privately managed	X25 switches  Frame Relay switches  SNA and other vendor specific products  Bridges and Routers

The data rates available on the customer premises are typically 'on demand' up to standard LAN speeds (10 Mbit/s). They are perceived as free to the user. This can be contrasted with the situation in the wide area where data rates over 2 Mbit/s are extremely rare; 64 Kbit/s or less is probably the norm. Circuits are not available 'on demand' they are provisioned at a rate consistent with budget constraints rather than maximum data rates expected.

### 4.2.2. *What the Technology Should Make Possible for Users*

Users need service and functional capability. They have no other requirements of technology except that it meets their service and functional needs. Given the technologies already in use within networks and on customer's premises and given some knowledge of the applications which users are running over networks we can identify the main elements which they would wish technology to make possible. As follows:

- Significantly higher data rates than 2 Mbit/s.
- Services adapted to 'bursty traffic'. It is uneconomic to pay for peak demand all the time.
- Mixing traditional data traffic (where some delay is acceptable, and where variable delay can be accommodated) with video and speech traffic (where variable delay is unacceptable and even constant delays must be short).

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- Visibility of and control of the network (local and wide area) within the user organisation. The application user does not necessarily need this capability but the network provider / supporter inside the user organisation does.

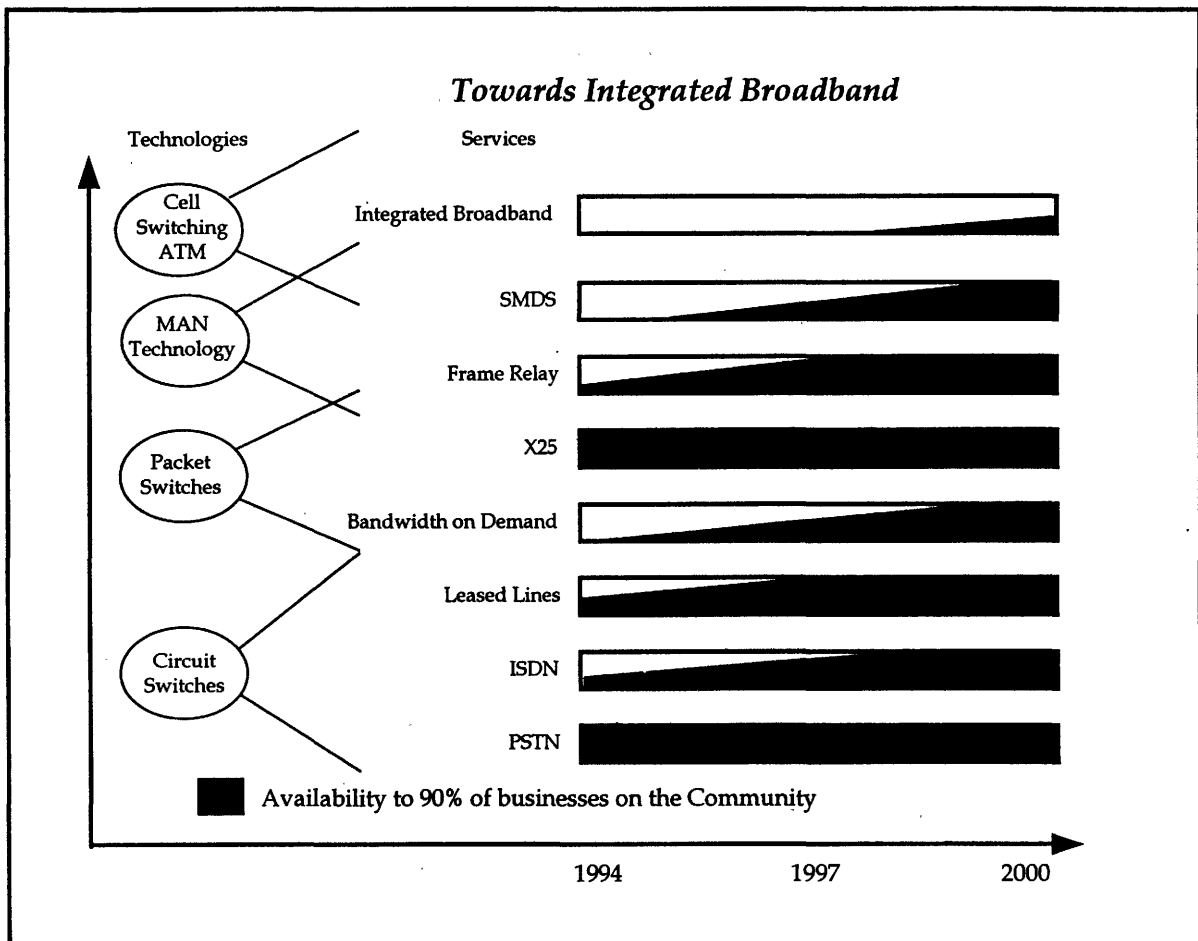
Against these requirements the technologies emerging in the PTO networks and planned for the future seem to be broadly satisfactory (or should be, provided that standards are completed and products are developed as anticipated). R&D to meet these requirements of the networking technology is being carried out within the RACE programme and should be further pursued in the Advanced Communications Technologies and Services specific programme as being planned. There appears, therefore, to be little justification to sponsor additional R&D into new technologies for broadband networking.

**No additional R&D for broadband networking further to what can be planned in the ACTS programme.**

### 4.3. NETWORKING SERVICES IN EUROPE

#### 4.3.1. Current Situation and Medium Term Trends

The relationship of the technology in use and available for building networks to the services which are offered using these technologies is a close one, illustrated in the diagram below. In this chapter we comment upon the status of various services available in Europe which are on the way towards full integrated broadband services. The diagram shows both the variety of relevant service offerings and the rather limited availability / coverage of many of the services at the present time.



#### Leased Lines

They are available in most Member States both analogue and digital at 64 Kbit/s and 2 Mbs. Tariffs are distance related with high charges for cross-border.

Many users envisage building higher bandwidth private networks on the back of leased line services. Whether they will be able to do this depends upon whether PTOs in fact offer leased line services at data rates faster than 2 Mbit/s on a widespread basis and upon tariffs.



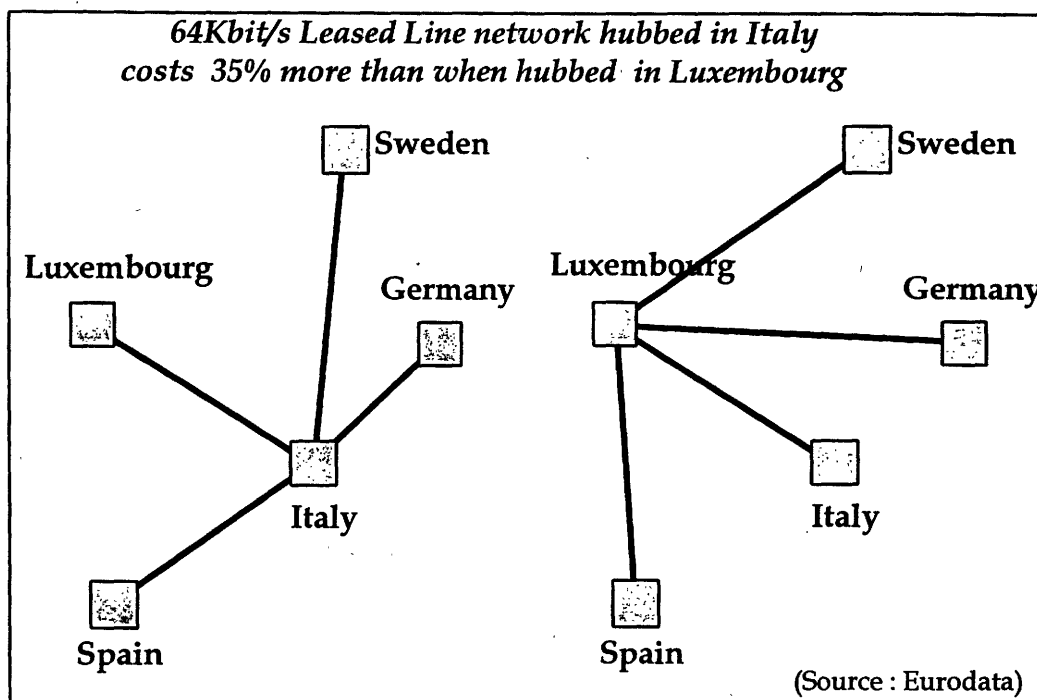
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User problems currently relate less to availability and more to tariffs, provisioning lead times and lack of one-stop-shopping possibilities. The Open Network Provision Directive on leased lines should go some way to alleviating these concerns although it would be true to say that user optimism in this regard is limited. The following are illustrative examples of some of the tariff issues.

1	Some cross border 2 Mbit/s Tariffs as at 10/9/92	UK £
	Denmark - Germany	13,618
	Germany - Denmark	21,086
	UK - France	22,000
	France - UK	21, 979
	Spain - Portugal	33,812
	Portugal - Spain	19,958
	Italy - Netherlands	30,326
	Netherlands - Italy	19,108
		(Source - EuroData)

2	Monthly Rentals voice grade analogue leased line (ECUs)	National (50 kms)	International 1/2 circuit
	Denmark	148	943
	UK	204	558
	Germany	664	1395
	Italy	702	1522
	Portugal	426	1724
			(Source DGXIII, CEC)

- 3 "Earlier this year Reuters published the results of a survey of the cost of leased lines in Europe and the US. The company found that the annual bill from European PTOs for 18 inter-European circuits came to £634,000. Calculating the price of an equivalent network in the US on a link by link, cost per mile basis, Reuters found that AT&T would charge just £62,000." (Reported in Communicate Magazine October 1993).



**Bandwidth on Demand Services**

Bandwidth on demand services are beginning to become available. Not all are the same technically. Some take the form of 2Mbit/s point-to-point leased lines which the user arranges with the Operator to use some or all of on-demand. The Operator has software tools with which the lines can be configured rapidly (in say 30 minutes) so that the user can book extra bandwidth when he wishes, for example, to set up a video conference.

Other Operators are now offering dial up switched bandwidth up to 1920 Kbit/sec. This service is now available in eight European countries - UK, Switzerland, Netherlands, Belgium, Denmark, Norway, France and Sweden. A typical tariff between the UK and Netherlands is priced at £2.85/minute for a 384 Kbit/s circuit or £9.51/minute for 1920 Kbit/sec.

Bandwidth-on-demand services are seen by users as offering valuable additional functionality. These services are particularly useful for video conferencing and for managing peaks in intra-company voice traffic.

**ISDN**

ISDN is available in most Member States and interworking is becoming a reality. Primary rate ISDN service offers 30 x 64 Kbit/sec channels plus signalling over a 2 Mbit/s pipe and is a component which industrial/commercial users may wish to incorporate into their networks particularly where these carry predominantly voice traffic. As with all PTO services in Europe there are inconsistencies in tariffing between Member States and across borders.

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As a key factor in the design of corporate networks carrying large volumes of data (as opposed to speech) and running high performance applications, ISDN Primary Rate Services have not been adopted widely by users. Basic Rate services are beginning to be used for network access from smaller sites. As a network upon which to do more than trial prototype broadband applications, ISDN is not seen as strategically important by potential broadband users.

### X25 Services

X25 services are the most widespread after voice services and leased lines. Customer numbers are high; close to 100,000 in France, Germany, and in the UK. Data rates are voice grade up to 9.6 Kbit/s plus digital access at 64 Kbit/sec in some countries. France's Transpac now offers 2 Mbit/s X.25 capability.

Charges are volume based, by time in most countries, by data segment in the remainder. The range of monthly rentals is over 4:1 between the highest and lowest cost country whilst usage charges vary over an even broader range (more than 100:1).

### Frame Relay Services.

Frame Relay is a data only switching technology well suited for LAN interconnect. It is connection oriented and is based on the establishment of permanent virtual circuits (PVCs). Charging entails a recurring charge for each PVC plus usage charge.

Frame Relay Services have now been introduced in Europe by both national PTOs and VANS providers (taking advantage of the liberalised market in this area). Suppliers include BT, AT&T, Infonet, Sprint, DBT, Transpac, Unisource, Televerket, Denmark and Finland Telecom.

### SMDS (Switched Multi Megabit Data Service)

Numerous PTOs have launched or are about to launch SMDS or its European standardised adaptation CBDS (Connectionless Broadband Data Service). SMDS is designed to perform like a LAN. Like all shared media LANs it is connectionless. Information rates over 34 Mbit/s access paths conform to popular LAN speeds (4,10 and 16 Mbit/s). The underlying technology for SMDS is the Distributed Queue Dual Bus, Metropolitan Area Networking technology although there is a high degree of compatibility with the ATM cell structure. The status in Europe is given in the table below.

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Country	Locations/Connections	Services
Austria	Vienna now, other state capitals by November; cities to be linked in a MAN ring	Commercial services started July 1993; 2 Mbit/s or 34 Mbit/s access speeds for LAN interconnect and frame relay, 2 Mbit/s clear channels
Belgium	Brussels	Man trials started May 1993
Denmark	Copenhagen	Restarted MAN project recently
France	Paris	Trial Man links universities; Connectionless Broadband Data Service (CBDS) supported by an ATM pilot to be launched this year
Germany	Stuttgart, Munich, 10 to 12 other cities by early next year. Stuttgart and Munich linked; link with MCI has been demonstrated	Commercial service started in March 1992; access speeds ranging from 2 Mbit/s to 140 Mbit/s for SMDS and frame relay; also offers N x 64 Kbit/s and 2 Mbit/s clear channel service
Ireland	Dublin; SDH link to Northern Ireland	Trial MAN launched September 1992; Commercial SMDS service by mid 1994
Italy	Turin, Pisa, Florence, Trieste, Naples	Turin MAN trials started September 1991. SMDS pilot to start September 1993. Clear channel pilots planned for Pisa and Florence. Naples pilot early 1994.
Portugal	Lisbon, Porto	Commercial SMDS by end 1993
Spain	Barcelona, Madrid	Trialling
Sweden	Stockholm	MAN trials complete; ATM based service planned.
Switzerland	Bern	Commercial service planned
UK	45 sites through UK by end 1993	10Mbit/s commercial SMDS planned for early 1994.

By the end of 1994, there will be a number of 'MAN islands' where commercial LAN interconnect services will be available. What the tariffs will look like and how the MANs will (from 1995 onwards) be linked to provide services with wider coverage remains to be seen.

SMDS will support many multimedia applications (CAD/CAM, publishing etc.) but will not support real time video and voice where isochronous transmission is mandatory. For LAN interconnect it has advantages over Frame Relay - connectionless working and very much higher speeds being the most important.

#### 4.3.2. *PTO International Infrastructure Actions*

Five PTOs (FT, DBT, BT, STET, Telefonica) have implemented an infrastructure with which to provide Trans-European (or five country wide) leased lines up to 2Mbs on fibre. This is called **GEN (General European Network)**. It has a 16Mbs capacity and has nodes in Frankfurt, London, Paris, Madrid and Rome. GEN permits the provisioning of leased lines in a matter of hours where previously international circuits took months to obtain. GEN is bringing benefit to users already and would merit expansion.

Twenty six European PTOs have signed a Memorandum of Understanding to establish **METRAN**. This is not an overlay network but a pan European capability which will form part of the PTOs future network offerings. The primary bearer mode is fibre; the technology SDH. METRAN is concerned with establishing a meshed path level network connecting SDH transmission systems in the ownership of individual Operators. It is not a new network but an agreement to interconnect national infrastructures in a coherent fashion. This is achieved through cross connects situated at international gateway points. The best implementation plan under consideration would see cross connects in place by end 1994 in the larger countries and end 1995 for the remainder. What data rate is being considered is not clear but the METRAN board envisage seamless evolution to cross connects supporting 2.5Gbit/s transmission. METRAN is important. Until it is in place there will not be an infrastructure to provide cost effective and satisfactory service levels for building a high bandwidth Trans-European network.

Five European PTOs signed the **PTO Memorandum of Understanding on ATM** towards the end of 1992. In this they agreed to carry out broadband interworking trials in 1994 using the ATM technology. As well as the first five PTOs (FT, BT, DBT, STET and Telefonica) a further eight have signed the memorandum of understanding which should result in each PTO buying an ATM cross connect to the ATM Pilot specification, finding some pilot users and starting the trial in the second half of 1994. Transmission will initially be at 34Mbit/s using PDH multiplexing evolving to 140Mbit/s PDH and 155Mbit/s SDH later on.

The trial aims to check interoperability across operators and vendors, to demonstrate the benefits of the ATM technology as an infrastructure, to test applications in conjunction with pilot users, to pave the way for an harmonised introduction of a Trans European broadband infrastructure.

The specification of common benchmark services is not due to be published until November this year. The services will include Frame Relay, SMDS and constant bit rate circuit emulation. Potential pilot users will be selected by each operator. There is no guarantee that the trial will move forward to any particular international service roll out. The hope is that pilot applications which are run on the ATM pilot equipment platform will be sufficiently successful to warrant their retention and transference to full commercial operation.

4.3.3. *What Users May Expect over the Next Five Years*

For true multimedia applications of voice, video and data, 2Mbit/s leased lines are likely to be all that will be generally available for a considerable time.

For data only applications there will be much greater choice. The Switched Multi Megabit Services offer capability and capacity at data rates approaching 34Mbit/s in the 1995/96 time frame.

The opportunities which users will have to expand their experience of high performance networking should be quite plentiful on the new high speed data services. In addition there should be opportunities, but much more limited, for users to take part in early trials of ATM cell switched services or to make use of early ATM deployment in the 1996/97 time scale.

Tariffs are likely to remain high when compared to the US and other locations where tariffs are more closely related to costs.

**The infrastructure is only slowly being put in place. As a consequence, even if services were to be available and tariffs competitive, users are largely unprepared to take advantage of advanced services.**

## 4.4. REGULATION

### 4.4.1. *Users Requirements of Regulation*

In this section we restate what the users expect to be achieved through regulation.

#### Tariffs

- Tariffs for all business services competitive with those to be found anywhere else in the world.
- Minimal tariff anomalies by country or across borders

#### Technical choices

- Ability to have a wholly private network (except for the bearer service) or a network partly private, partly provided by the service provider or network services all from service provider

#### Procurement choices

- Choice of service provider

#### International coverage

- The single market must be made a reality.
- Services must be uniform throughout the Community
- Total network should be available from one service provider
- There should be no cross border anomalies in technology, service or tariffs

#### Network Management

- Users need total visibility of their network (faults, status, performance)
- Some user control of reconfiguration should be possible
- Interfaces for billing and problem resolution should be simple (a single interface should be a possibility)

#### Traffic

- No regulatory barriers to carrying voice, video and data on one network.

#### Network Coverage

- Private and virtual private networks to extend beyond one business customer. (To include customer/supplier networks for example).

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- Break into and break out from private networks to public ones should be permitted

Very few if any of the above list of user requirements can be achieved in Europe and made a reality without some political and / or regulatory action. The requirements on tariffs may eventually be met through the forces of competition but this will take an unacceptably long time to occur. They will not be met through the uncoordinated actions of regulators in different member States. In our view, the most rapid route to harmonising tariffs requires very close liaison between regulators or even some measure of Community wide regulation.

### 4.4.2. *Community Actions*

Following Council recommendations on harmonisation of telecommunications in 1984, and a Green Paper on the development of the telecommunications equipment and services market in 1987, the Council, in 1990, published directives on Open Network Provision (ONP) and on competition in the telecommunications services market. The principles enunciated in the second directive which the implementation of Community telecommunications policy will follow are:

- Full liberalisation of the equipment market with procedures for recognition of equipment conformity,
- Progressive, and ultimately complete liberalisation of the services market,
- Clear separation of regulatory and operational functions in Member States,
- A policy on harmonisation and ONP,
- Application of Community law with respect to competition and the abuse of dominant positions.

In October 1992 the Commission published a review of the situation in the telecommunications services sector and of initial progress towards implementing the 1990 Directives. The review highlighted a number of what it called 'continuing bottlenecks' which are of particular interest to us as a Group of users and potential users of high performance networks. These included:

- The lack of advanced services,
- High cross-border tariffs, and
- The unavailability of high-capacity leased lines.



The High Performance Networking Requirements Group fully supports the comments of the review where:

**according to consumers, these continuing bottlenecks and the current regulatory framework are largely to blame for the low demand, the mismatch between demand and supply, and the small number of private networks in the Community.**

Following the review of 1992, the Council, in June 1993, adopted a resolution defining the main policy goals and timetable. Among the many points in the resolution the following are notable decisions:

- To liberalise telephony by 1998 (except in 5 Member States where a further five years is allowed)
- To study the consequences of liberalising infrastructure, including the use of rail, electricity and television networks; to publish a Green Paper in 1995,
- To decide on the regulatory framework for public infrastructure by 1998.

This is not a rapid time scale from the viewpoint of an industrialist user seeking competitiveness on a world stage in 1994 with the help of modern and cost effective telecommunications.

Open Network Provision (ONP) is an important element in the development of a single market for telecommunications services in Europe. It effectively establishes uniform standards for services and connections. It also embodies legal rights for end users, and service providers, both existing and would-be, to connect into the existing infrastructure supplied by the traditional operating bodies.

For any given service, for which an ONP Directive is in force, customers can expect a consistent minimum service level in all Member States. To date leased lines are the only service in this category, the relevant Directive having come into force on December 31st 1993. This Directive on leased lines (analogue, 64Kbit/s and 2Mbit/s digital) requires Member States to:

- Ensure that they are provided,
- Encourage one stop ordering and billing,
- Ensure that tariffs follow the basic principles of cost orientation and transparency
- Ensure that their telecommunications organisations put in practice a cost accounting system suitable for implementing the above,
- Require their national regulatory bodies to report on service performance in particular delivery time and repair time.

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The Directive also contains clauses suggesting that Member States can defer meeting these obligations by proving that their implementation would impose an excessive burden on the telecommunications organisation in that State.

### 4.4.3. *Conclusions for Users with Respect to Regulation*

The competitiveness of European business and commerce and the efficiency of many of its governmental organisations depend upon pan-European networks and services. We have already commented upon the injurious effects of systematic over charging. The lack of compatibility between national networks and the failure of Europe's Operators to co-operate in the provision of end-to-end services make the search for efficient and effective networks all the harder.

**From a users perspective, the Community's efforts to improve the situation are all in the right direction but slow in achievement.**

#### 4.5. HOW THE EUROPEAN SCENE RELATES TO THE US

The following table sums up the provision of infrastructure for research networks at the moment. These tend to be ahead of commercial networks.

	Europe	United States
National/Regional	64Kbit/s some 2Mbit/s A very few moving to 34Mbit/s Patchy development	1.5Mbit/s standard Moving to 45Mbit/s 45Mbit/s available Nation-wide
Continental backbone	Introducing 2Mbs No plans beyond that	45Mbit/s in service Plans for 155Mbit/s

The national networks in Europe as used by research and academic institutions are analogous to regional networks in the US and offer capabilities comparable but often with slower access (64kbs and occasionally 2Mbs against a US norm of 1.5 Mbs).

Almost all private networks in Europe and the US are built upon lines leased from the telecommunication operators. National leased line tariffs in Europe are typically 5 times as expensive as the same infrastructure in the US.

International leased lines in Europe are often 10 times as expensive as long distance leased lines in the US. (In the UK they are a mere 3 times the price, something which is attributed to be a benefit of allowing competition). Despite the CEC's Open Network Provision Directives that leased line charges should be cost related, the monopoly PTOs backed by their governments show little enthusiasm to comply with the spirit of the Directive. This is a significant distortion of the market when one considers the potential needs of high speed network users.

International leased lines are not widely available at 2 Mbs in Europe; in the US long distance lines are available at 45Mbit/s. There are at least 3 providers competing for long distance leased line business in the US. There are no companies licensed to provide Trans-national links in Europe.

The US has had a nation-wide research network for 18 years. The US R&D network is open to industry to use and there are mechanisms for cost recovery from industrial users. Today there are some 25 regional networks linking in to national networks, the most noteworthy of which is the NSF backbone (funded by the National Science Foundation). The capacity and usage of this backbone is rising rapidly; i.e. 1000 fold in the 5 years from 1987 to 1992.

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President Clinton has proposed a budget of \$784 million from 1994 to 1997 for the HPCC (High Performance Computing and Communications) programme. Within HPCC is NREN (National Research and Education Network) which will receive a significant proportion of the HPCC budget. The aim of NREN is to have a nation-wide broadband network for educational use of say 600 Mbs capacity in place and connected to the current regional and national networks in the 1995/1996 time frame. There seems to be no reason to think that this objective will not be met. After five years of seed funding from the federal agencies it is envisaged that the resulting network will be in the hands of private operators who may run the network on a for-profit basis for the benefit of both educational and business users.

The key message with respect to high performance networking is that Europe is behind the States regarding service availability although technology compares favourably and it is likely to stay that way. Users with or without the help of the Commission cannot do a great deal about the gap in the deployment of high speed services in Europe when compared to the US for example.

**Europe lags behind its competitors regarding  
availability of high performance service**

#### 4.6. THE MARKET FOR HIGH PERFORMANCE NETWORKING

##### 4.6.1. *How Many Potential Users of High Performance Networking?*

The scale of potential industrial/commercial interest in using emerging high performance networking services can be gauged from estimates which have been made of the number of private networks in Western Europe. The users of all these will consider the applicability of new network services as they become available and will eventually adopt them provided they deliver real business benefits.

The number of businesses which use computers at more than one location represents a crude measure of potential users who might eventually network their systems and take advantage of the extra potentialities of high performance networking services.

According to OECD there were 16,000 private networks in Europe in 1990. This figure is growing at 8% to 10%. A 1996 forecast of 25,000 private networks is realistic.

The number of multi-site businesses which use computers at more than one location, according to Inteco Corp. was as follows in the four largest Community Member States (1992 data).

	'000s	
Germany	25	
France	23	
UK	40	
Italy	17	
Total	105	(Source Inteco Corp.)

Extrapolating from these figures to obtain a Community wide figure results in a total of approximately 150,000 enterprises which either already use or have the potential for wide area networking.

##### 4.6.2. *In Which Market Sectors?*

A starting point from which to assess where demand is likely to arise for the use of high performance networking is the distribution of multi-site computer using enterprises by industry sector. The following figures have been derived from original Inteco data. The largest sector is distribution reflecting the large number of retail and wholesale establishments in the Community.

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<b>Distribution of multi-site computer using enterprises by industry sector</b>	
Government	8.4
Communications/Utilities	7.6
Education	5.6
Research & Health Care	4.6
Transportation	4.8
Finance	5.1
Distribution	34.7
Services	10.7
Manufacturing/Engineering	11.7
Process Industries	9.8
	100%

(Source Inteco Corp.)

This data masks two very important additional factors. First, some sectors spend a great deal more on computing and associated telecommunications than others. Second, certain sectors contain what we call the early adopters, those who have applications which would benefit immediately from the use of high performance networks.

There is a wide disparity between what is spent on information technology by different organisations within any sector. There are further disparities when the data is considered by country. However as a generalisation it seems that the two highest spending sectors are the finance sector (banks, insurance, brokers, funds management) and the Communications /Utilities sector (PTOs, Electricity, Gas etc.).

### 4.6.3. *Who will be the Early Adopters?*

Identifying early adopters is important for the achievement of our broad recommendation to accelerate the take up of high performance networking applications. Our actions may assist the process of early adoption and the results and experiences of those who first use the new and emerging services will prove valuable in promoting further uptake.

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In our judgement the "early adopters" of new broadband services will be found in:

- Health care
- The IT departments of Universities
- Aerospace industry
- Automotive industry
- Oil and Petrochemical
- Pharmaceutical industry
- TV/Film, and some parts of the publishing industries.

More generally we expect to find early adopters in large multi-site businesses and in research establishments, where users already have access to quite powerful workstations. They are likely to be:

- Users handling large data volumes
- High performance computer users
- Enterprises with state of the art wide area networks today

It is noteworthy that early adopters are most unlikely to be residential users. However, given the right application scenario of, for example, video on demand or home shopping it is possible that at a relatively early stage, perhaps in the next five years, service providers to the domestic sector could become important exploiters of advanced networking technology and services.

#### 4.6.4. *What are the Likely Applications?*

The early users of broadband networks will be those who have identified a particular bandwidth demanding, response critical application or business process which will produce financial benefit or competitive advantage when moved onto the new networks. In the table on page 45 we give some examples of applications which probably have these characteristics and which stem from the early adopting and/or the high spending sectors of the market which we have already identified.

Our recommendations should complement national initiatives. Applications with an international flavour are notable as candidates for support outside the scope of national programmes. We observe that almost all the applications listed have a strong international dimension. Exceptions may be found in health care, education and some back up applications which as yet seem to be confined within one country. The international dimension of the remainder is in no way confined to the borders of the Community. The largest benefits are likely to be realised when networking not only within the Community but with the USA, the high technology EFTA countries and even Japan.

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The potential market for high performance networking appears to be tremendous, however it is not expressed as a demand yet because there appears to be a vicious circle of 'little articulated demand - so little provision - so little articulated demand'.

**Potential is high but demand is not expressed yet.**



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Examples of some of the applications of early adopters of high performance networking	
Application	Examples of occurrence
Distributed work groups; extending LAN client server systems across the wide area.	Finance Manufacturing -Aerospace, Automotive Process plant construction Chemicals
Co-operative Design	Aerospace Automotive Publishing
Co-operative Manufacture	Aerospace, (Production planning, logistics) Automotive Process plant construction Chemicals, Pharmaceuticals
Remote multi-media training	Health Care Aviation (Aircraft servicing) Electronics
Real time updating of remote high volume data;	Finance (remote back up) Earth observation
Conferencing; Co-operative working with images	Health Care (diagnosis) TV Publishing Managers in general Technical specialists in general
Remote visualisation	Pharmaceutical (Molecular modelling) Automotive (Impact analysis) Petroleum (Seismic models) Meteorological services (satellite image analysis)
Electronic libraries	Higher education Aviation (equipment servicing)
Remote Control	Utilities
Interactive multi-media Video on demand	Entertainment companies Retail
Distributed database access	Finance Government Utilities

#### 4.6.5. *What are the Potential Benefits?*

Industry obtains competitive advantage from its use of computer networking - advantage in all sorts of different ways - time to market, improved service quality, lower costs, increased efficiency and so on. Networking also makes possible new business practices which were never a possibility without the presence of a reliable, available affordable network. Examples are easy to find in credit authorisation, or seat reservation or co-operative working aided by voice, video and data communications.

The emerging advanced network services will produce similar business benefits many of which cannot yet be foreseen. Here we comment on the expectations of potential early adopters.

##### 1. Performance

Few users are likely to say, given the availability of new broadband services, "Now, at last, I can embark upon this new application". They are much more likely to say "Now I can improve the performance of some applications I already run". Examples of improvements include:

- Responsiveness of LAN interconnect applications.
- Quality of and complexity of setting up video-conferencing.
- Co-operative design processes (for example in aerospace or automotive industries).
- Improvements in disaster recovery systems; in backing up large files routinely and in switching to standby systems.
- Timeliness of interpreting complex images (for example X ray or satellite photographs).

Better performance of today's applications is an important driver towards take up.

##### 2. Cost

Cost is important. Users are aware that prices should not be linear with bandwidth; broadband costs are approximately proportional to the square root of bandwidth and prices should be related to cost. A sixteen fold increase in bandwidth (from 2 to 34 Mbit for example) should result in a fourfold increase in price.

Early adopters of broadband do not expect to lose financially. In the long run they would expect to see cost savings. Eventually, users will expect to see speech traffic which for many is the largest cost element in their total networking bill as well as data and multi-media move onto the lower cost based networks which broadband should be.

### 3. Unlimited growth at affordable cost

Most network users increase the total bandwidth they use every year and have been doing so for many years. Except in so far as tariffs fall, their networking costs rise continuously. The move to broadband service infrastructure is seen as stepping onto a lower cost curve which has the potential for almost unlimited growth in network size, speed and scope. It is this unlimited growth at affordable cost which will give rise to the emergence of new business practices where information rather than people or products are moved around to achieve radical innovative objectives.

### 4. Transition from today

Almost all the potential "early adopters" are major network users already. Today's networks services and applications are more important to customers than tomorrow's technology or services. In many instances, the networks they currently have are central for their business success. A serious concern, which may inhibit broadband service adoption, is how applications can coexist on both old and new platforms and how transition should be planned.

### 5. New Applications

The trigger for a user to start to use broadband networks is likely to be a bandwidth demanding, response critical application. However, the pay off for users comes when the broadband network becomes the platform for most and even all their networking.

**Users want better performance now  
with lower costs and new applications later.**

#### 4.6.6. *What are the Barriers?*

##### 1. Inadequate Service Availability

New services tend to be deployed by the operators in the capital cities and business community centres first and progressively over a number of years to the rest of the territory which the operator serves. Only then do international connections become available. For a potential user of a high performance distributed networked application this may be a problem. A multi-site and multinational user will typically only see the benefits of deploying a new application when most of his key plants are connected and possibly some of his customers or suppliers as well.

##### 2. Uncertainty about future technology options

There are so many new services becoming available at the present time that users can be forgiven for holding back because they are unsure which service or technology is likely to prove a transient phenomenon and which will be widely available and much improved in ten years time. The computer industry has been providing users with good strategic statements of direction against which to make their plans for a number of years but the European telecommunications operators have not shown themselves so adept at this.

### 3. Interfaces

Each new advanced service which becomes available requires equipment with which to connect existing computers, work stations, PCs, video equipment etc. The very newness of services results in equipment not being as available as users would wish. There is not the choice, the proven capability, the range of functionalities and prices which users are accustomed to when dealing with traditional established technologies. The shortage of interfacing equipment causes users to defer decisions to implement and use the new services or technologies.

### 4. Lack of awareness

As well as uncertainty about future technological options there is also a more fundamental barrier to up take of advanced networking and that is lack of awareness of what is possible. This tends not to be a problem amongst the research community and those who ensure that they are technologically well informed. For the average user managing a network where day to day operational concerns over-ride considerations about the future, lack of awareness is a serious problem.

### 5. Applications

Without network services in place there are few applications fully developed and ready to be used. Without these, users will stay with what they know because there is no easy transition which can exploit the benefits of new technology.

### 6. Price

Users know that with advanced services should come a significant reduction in unit costs. Computer users know that the computing power and memory which they can obtain for a given price rises steadily each year. They expect to see comparable falls in the cost of transmission or bandwidth as each generation of networking technology is rolled out; they cannot understand why the technology should not deliver such improvements in costs. Even when prices per unit transmitted remain constant with the introduction of advanced networking services users feel that the prices are too high and delay making decisions to adopt the new technology.

**Of all the barriers the lack of awareness is the most important and is not currently addressed**

#### 4.7. SELECTING POSSIBLE COMMUNITY ACTIONS

The following possible actions might form the basis of a work-programme:

1. Research and development of enabling technology. This is clearly important. Without it standards, services and customer and operator equipment cannot be realised. Standards are particularly important because without world-wide agreement on the way forward component costs cannot be driven down to levels which enable low cost service provision and international interworking becomes difficult and complex. Fortunately work is already going on in this area supported by the ACT programme. Additional user involvement would probably be inappropriate at this stage.
2. The evolution, migration and transfer of today's business processes to High Performance networks. As we have already noted, most of the early adopters of distributed networked applications are already large scale users. Existing important business process have been implemented on less advanced platforms both from a computing and a communications standpoint. The issue of redesigning these business processes and upgrading applications to take advantage of the potentialities offered by new technologies is of great importance to users.
3. The integration of applications into high performance networking environments. This is really one aspect of the general issue of migrating to new environments and adapting existing operational practices so that the maximum competitive advantage is derived from so doing.
4. Development of applications and software environments. This in many ways is of lesser importance than the adaptation and evolution of existing applications. In only a few instances do we believe that advanced networking services will enable totally new 'killer' applications which do not already exist in some form or other. If we were to place too much emphasis on application development we might lose sight of the need to actually start to use the new emerging services in the next two or three years and to demonstrate the benefits of doing so clearly and on a widespread basis.
5. Demonstration of applications and/or technology. This is clearly a precursor to bringing something new into full use. Potential users at all levels in an organisation (or in several inter communicating organisations) have to convince themselves that any proposed changes are for the better and have been fully thought through. So in any real world situation there is bound to be some demonstrating and testing. This we should support but only where there is some underlying intent to move forward quickly to a fuller deployment once the testing phase is complete.
6. Experiments with distributed networked applications, including presentation of full business justifications. We draw a distinction between demonstrations and experiments. A demonstration is designed to establish the feasibility of running an application or exploiting a technology whilst a full experiment explores all the issues which need to be evaluated prior to embarking on regular commercial use.

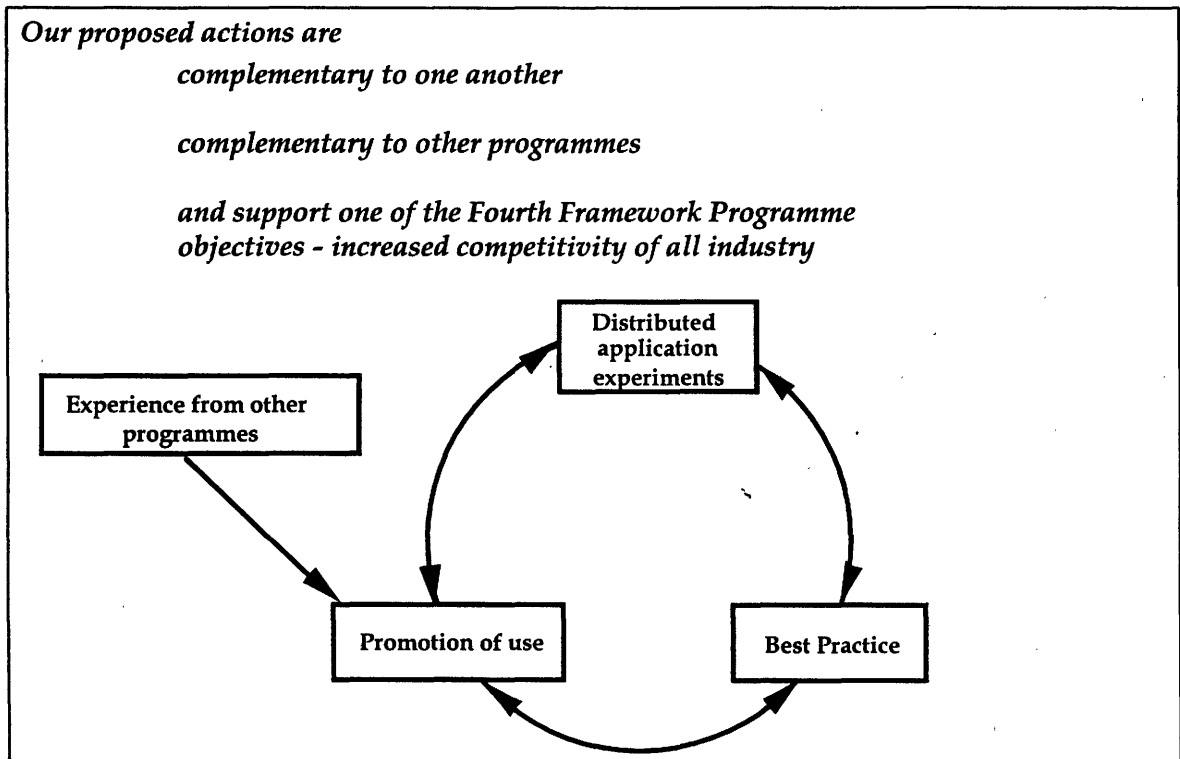
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7. Promotion of the use of high performance networking and dissemination of information about what is available and possible. Arguably this is the starting point for a programme aimed at increasing uptake. Given clear promotional messages supported by strong and convincing evidence, it should be possible to identify ways of raising the motivation of potential users to seek out the benefits of distributed computing applications for their own organisations. It is only when one asks where the foundation for the promotional messages is to be found that the need for well measured and publicised application experiments is recognised.
8. Stimulation of best practice within industry. This too might be thought of as the starting point for increasing uptake. But the stimulation requires a promotion activity and that must feed off the results of the application experiments. So we see that the three actions which are central to the achievement of the objective are in fact complementary to one another and significantly inter-dependent.
9. Regulatory approach; actions aimed at removing regulatory barriers which inhibit the industrial take up of High Performance Networking. This we see as an essential set of activities, orthogonal to the various research and development activities. It is not however, something which we would see as part of a user driven initiative.

The goal which we have set of achieving significant results in a 2 - 3 year time scale, leads us to select five actions for consideration in greater depth. These are actions involving existing applications and where the technology used requires no research and little development. The actions in the proposed list which fulfil these criteria are numbers 2, 3, 6, 7, and 8. These five can be brought together under three headings - promotion of use, distributed application experiments and spreading out best practice.

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The diagram below illustrates how the proposed actions work together towards the broad objective of fostering uptake of the commercial use of advanced network services.. It also shows how work going on in other fields feeds into the body of knowledge about results which can be used to promote the uptake of high performance networking use. The use of broadband networks and the services which run over them is growing. It is important that all the results from Community Programmes such as the Advanced Communications Technologies and Systems and the Telematics Programmes, from PTO trials and from early users notably the research establishments, are collected together to avoid duplication and to maximise the promotional impact of the work.



**Our recommendations are to contribute to break the vicious circle of 'little articulated demand - so little provision - so little articulated demand' by fostering the expression of demand through increasing awareness.**

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## 5. APPENDICES

### A. COMPOSITION OF THE HIGH PERFORMANCE NETWORKING REQUIREMENTS GROUP

Dr H Soboll (Chairman)	Daimler Benz AG
Mr P Alzuyet	France Telecom (on behalf of the ATM Pilot)
Mr D Claude	EANS
Mr B Cooper	SuperJANET
Mr D Davies	DANTE
Dr S Duffy	ICI
Mr P Durrey	SITA
Dr R Gruber	CSCS
Prof. G R Hoffmann	ECMWF
Dr W Johannsen	Deutsche Bank
Mr R Killick (Rapporteur)	Fischer & Lorenz
Mr J Lindemann	Deutsche Aerospace AG
Mr M Lundstrom	SAS
Mr A Mortelette	Aerospatiale
Mr L Ottoson	Bank Giro Centrale
Mr P J Owen	International Business Strategies
Mr J P Peltier	ONERA
Mr R Poll	Ford Motor Co.
Mr P P Strona	Fiat
Mr N J White	Unilever
Dr R Wiley	Meteo Office

**B. TERMS OF REFERENCE**

The Terms of Reference of the group, established in July 1993, were:

- 1 To define the requirements of industrial users for High Performance Networking in the second half of the 1990s.
- 2 To identify likely directions for High Performance Networking and characterise their targets, including the availability of networking services, and different levels of access for users.
- 3 To specify, in terms of approach and means, what additional preparatory and catalytic actions could be initiated at Community level in the context of the forthcoming specific programme in the Fourth Framework Programme.

C. LIST OF COMPANIES PARTICIPATING IN THE CONSULTATION.

Company	Sector	Nat.	Company	Sector	Nat.
Aegon	Insurance	NL	John Laing	Construction	UK
Agfa Gevaert	Chemicals	B	Kaufhof	Retailing	D
AGIP	Petroleum	I	Kredietbank	Banking	B
Alcatel Alsthom	Engineering	F	La Rinascente	Retailing	I
Autopistas Nacional	Utility	E	Ladbroke Racing	Leisure	UK
Autostrada	Utility	I	Littlewoods	Mail Order	UK
Axel Springer	Media	D	Lucas Industries	Automotive	UK
Barclays Bank	Banking	UK	Lyonnaise des Eaux	Utility	F
BASF	Chemicals	D	Mannesmann	Engineering	D
BBC Transmissions	Media	UK	Novo Nordisk	Pharmaceuticals	DK
BEB Erdaz & Erdol	Utility	D	L'Oreal	Pharmaceuticals	F
Berliner Kraft & Licht	Utility	D	Petrofina	Petroleum	B
British Rail	Transport	UK	Philips Research	Electronics	NL
Cadbury-Schweppes	Food	UK	Promodes	Retailing	F
Carrefour	Retailing	F	Quelle	Mail Order	D
CASA	Aerospace	E	Renault	Automotive	F
Citroën	Automotive	F	Shell Oil International	Petroleum	NL
Club Méditerranée	Leisure	F	Siemens KVO	Engineering	D
CVI Dutch Railways	Transport	NL	Siemens Medical	Medical	D
DAF	Automotive	NL	Siemens RKSCN	Electrical	D
Dassault Electronique	Electrical	F	SINTEF	Research	NO
Delta Lloyd	Insurance	NL	Smurfitt	Construction	IRL
Deutsche Lufthansa	Transport	D	St Gobain	Engineering	F
Electrabel	Utility	B	SW Electricity	Utility	UK
Electrica Fernosa	Utility	E	Swiss Railroads	Transport	CH
ELF	Petroleum	F	Tractebel	Utility	B
Express Newspapers	Media	UK	Unilever BV	Food	NL
Fokker Aircraft	Aerospace	NL	Union Bank	Banking	CH
Forte Hotels	Hotels	UK	Wellcome	Pharmaceuticals	UK
Framatome	Utility	F	Wehkamp	Mail Order	NL
Hammersmith Hospital	Medical	UK	Zenica IS	Pharmaceuticals	UK
ING Bank	Banking	NL			

**D. SPECIFIC EXAMPLES OF WHAT MIGHT BE AN APPLICATION EXPERIMENT.**

**Co-operative design and engineering**

An application experiment is envisaged in the area of co-operative design in the aerospace industry. The specific example is in the area of satellite design where networking between 6 European sites and the USA is needed for full co-operative and interactive design processes to be carried out.

The benefits of using advanced networking which would be quantified as a by-product of the experiment would relate to reductions in the overall development costs, the reduction of lead times from start of design to delivery of production versions and improvements in the quality of the design process through, for example, finding mistakes earlier rather than later. Other less quantifiable benefits would be identified, in particular the social acceptance of new working practices amongst the work force.

An experiment with many similar characteristics was suggested from the automobile industry. This would entail performing tests and developing pilot activities in "Concurrent Engineering" involving design and testing departments, manufacturing plants, Research Centres and external suppliers.

Results of these application experiments would be applicable and transferable to design teams in other places within the aerospace or automotive industries and to other manufacturing sectors for example electronics.

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### Banking and Insurance Services

As an example in the field of banking one could think of a scenario where a bank and one of its corporate customers co-operate via advanced multimedia conferencing. The employees of the bank and the customer discuss their business issues from their respective home office, thus having access to all the documents they may need during discussion. They are connected by a multimedia channel. They have to be able to exchange multimedia documents (composed of unstructured text, graphics, photographs, etc.) electronically, to fill forms co-operatively and to print the result on either site. The two employees being in their home offices ensures confidentiality at the end-points of the communication channel. Confidentiality along the communication network has to be guaranteed by appropriate crypto-systems. A system satisfying all those requirements could be embedded in an inter-organisational work group or work flow system.

The viability of high performance networking for a world-wide operating bank will to a large degree depend on the economics of integrating the existing low-data-volume applications into these networks. A critical performance factor is a guaranteed response time for interactive applications. Another important quality property is the network management, e.g. how flexible is the extension to new business partners and to new applications with differing quality of service demands. We expect ATM to play a key role in this field.

**Remote access to shared databases**

An example of the generic set of applications which entail remote access to databases consider the earth observation centre. Its goal is to collect, prepare, archive, interpret and distribute data coming from satellite images. At present, data is sent to the clients of the centre following a request made three weeks before. Data relative to catastrophes like the tanker accident at La Corune or to study an Earthquake cannot be countenanced since it is not possible to request the data early enough. The amount of data sent to earth is constantly increasing and the data already stored on magnetic tapes has to be made available to a wider community of interested persons. This implies important needs in telecommunication to send data to the data retrieval centres and from there to potential users. These have to access the data in a most transparent way, they should not have to care about where the needed data is located. Data should be sent directly to the user or may be pre-processed at the site, visualised and the desired images sent to the user. Typical users are study groups in climate modelling, meteorology, pollution survey, topographical offices, military, etc. An experimental database could be started in a short time., Interested institutions are ESA with its members states and JRC Ispra who may become responsible for the European Earth Observation Centre.

### Network of High Performance Computing Centres

The goal of this network is to offer high performance computing, high performance archiving, high performance graphics and animation as well as a powerful connectivity to the users from academia and industry. Industry then has the opportunity to profit from the advanced hardware and software installed at these centres without a need to purchase the installations and packages at their sites. In addition, industry then can optimally profit from the high level of expertise available at the computing centres in modelling, implementation, validation, visualisation and interdisciplinary computer application. These skills in computer simulation have to be applied not only to problems arising in big firms but also for medium size industries that cannot themselves develop the know-how needed to remain competitive in the development of high technology products. Several interested computer centres are represented by an interest group led by Prof. Paolo Zanella.

The benefits of this sort of network could be demonstrated through one or two relevant applications in the field of for example climatology or biochemistry. As well as showing the direct benefits the experiments could demonstrate how user concerns about latency, bandwidth, security and ongoing service reliability could be overcome in a real situation.

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### **Trials in Compact Areas**

#### Optimising the Cost/Benefit for the HPCN Program

A broadband infrastructure (like ISDN) with a Gbit/s backbone network is an essential of Europe's competitiveness. Introducing the network infrastructure will motivate people to use it and to create applications. We believe that a concentration on focal areas better serves to accelerate the establishment of the "information society" than numerous small projects spread all over Europe.

In order to get the critical mass that is essential for the success of the field trials of the broadband infrastructure, compact areas (CA) in the European Union should be selected. A CA should be a geographical unit (e.g. a city plus its surroundings) with high potential in IT industry and IT education (investors and research institutions) as well as an administration supporting the IT infrastructure set up. Above all, there should be a potential user community comprising industry and private households.

A proposal for a project would be submitted by a CA, i.e. a political unit that is responsible for carrying out the project. The proposals would then be selected by competition. The co-ordination of the program should be in the hands of a European Telecommunication Research Institute (ETRI) that is to be founded. ETRI would have other tasks than HPCN, too. A central research institute in Europe would be able to act as a focal point for EU sponsored projects like Bellcore in the US.

The benefit for a CA would be that the high performance network infrastructure would be provided from the project. In return, a CA has to commit itself to use the infrastructure during the project and continue to do so after the termination of the project. Therefore, a number of applications has to be developed and implemented in each CA. Thus, the CAs would be the first regions of the EU reaching information society. All CAs would be interconnected to demonstrate examples of long distance communications via high performance networks.

The financial support of the Commission would be provided for setting up MANs and installing broadband access for private households.

The outcome of the field trials would be several scenarios for high performance networks. These would allow a thorough evaluation and assessment of the potential of high performance networks including an analysis of their costs and benefits to each of the parties involved (industry, administration, private households, etc.)