Communications Canada

REPORT ON THE PROCEEDINGS OF SEARCH 20

A Canadian Communications Research and Development Forum

20 YEARS OF SERVICE, INNOVATION AND CREATIVITY

REPORT ON THE PROCEEDINGS OF

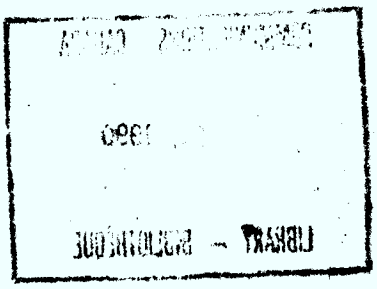
SEARCH 20

A CANADIAN COMMUNICATIONS

R&D FORUM

DEPARTMENT OF COMMUNICATIONS

May 1989



Cette publication peut aussi être obtenue
en français sous le titre:

Acte sur les débats de "Perspectives 20 ans"
Un colloque sur la recherche et le développement dans
les communications canadiennes

Technology Policy and Planning Branch
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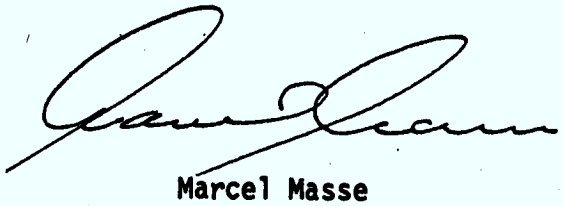
May 1989

It is with pleasure that I share with you the Report of the Proceedings of 'Search 20'.

'Search 20' represents the first step in the formulation of communications R&D strategy for Canada.

I look forward to the sustained cooperation and collaboration which will lead to the development and implementation of that strategy.



Marcel Masse
Minister of Communications

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1. EXECUTIVE SUMMARY

Search 20, a forum of Canadian industry, university and government leaders in research and management in the Canadian communications field, was held at St. Sauveur, Québec on 13-15 March 1989. The aim of the forum was to attempt to reach a consensus on the question: Where should the focus of the Canadian communications research and development effort be and what mechanisms, infrastructure and programs will contribute to the attainment of the best results from public and private sector investment in communications R&D?

The Primary Conclusions of the forum were:

1. A consensus regarding the preliminary definition of and commitment to a major Canadian project to support personal productivity networking and designed to accelerate the process of the development of key technologies. The project will integrate Canadian strengths in the communications sector and position Canadian industry advantageously in the international marketplace. Named Vision 2000, personal productivity networking will use the power of communications to build on the productivity of personal computers, thus enabling Canadians to work and create more effectively.

2. The existing telecommunications regulatory environment is characterized by fractured national markets with resultant high costs. It is complicated by a plethora of regulations and stifling to both the willingness and capability of Canadian industry to conduct communications R&D.

3. Specific mechanisms and processes are required to facilitate collaboration and development. These include data bases, repositories, clearing houses of information on such topics as international standards, technological development, researchers and projects. These should include the promotion of conferences and meetings between universities, industry and government.

4. Time is short. Regulatory issues and disincentives must be resolved within a 12-30 month time-frame or the impetus and advantage will be lost to Canadian industry.

The recommendations of 'Search 20' were:

I THE VISION

i) The private sector should take the lead in developing an action plan for Vision 2000 which outlines the phases, beneficiaries, structure, costs, players, timeframes, etc., for the personal productivity network.

Four related recommendations were:

- Compile an inventory of existing domestic and international networks.
- Develop a work plan for research and policy development which would define the challenges and obstacles.
- A representative group from the 'Search 20' forum should meet with the Minister of Communications to advise him of the outcomes of the forum and seek his agreement in principle to support initiatives related to studying and implementing the vision.
- Representatives from the public and private sectors should work together to develop the master plan and begin implementing the early phases of Vision 2000 within the next 12-36 months.

ii) Support related R&D programs with appropriate levels of funding.

iii) Related technologies for provision of service to rural and remote sites should be targetted as strategic.

II THE REGULATORY ENVIRONMENT

i) Jurisdictional reform of the telecommunications regulatory environment to provide a level playing field must be done immediately and the regulation required for Vision 2000 should be implemented within 12-36 months.

III MECHANISMS AND PROCESS

i) DOC should establish a forum to identify forecasted procurement needs for communications products and services in order to position Canadian industry to develop them.

ii) Develop or acquire enabling technologies, add value and develop systems and products for network users in Canada and around the world.

iii) Institutionalize the 'Search 20' process. DOC should organize a core group of 'Search 20' experts to address the issues raised at the forum and to manage the implementation of the 'vision' project and to organize a follow-up meeting of 'Search 20' participants.

iv) Establish a government steering committee to ensure effective working relationships and a common approach to C&IT.

v) Government must work harder with industry and industry associations to develop consensus in the area of C&IT; specifically, to seek the establishment of a senior C&IT committee to advise Ministers of ISTC and DOC. Associated subcommittees could be formed for such areas as:

- intellectual property;
- database access;
- information dissemination; and
- impact of regulation on R&D collaboration.

vi) Recognize and endorse the network of centres of excellence as instrumental in developing strategic collaboration.

IV DOC FOLLOW-UP

i) The Department of Communications should increase its level of involvement in the standards-setting process and improve its mechanisms for communicating standards information to industry and the universities.

ii) The Department of Communications should emphasize applications research, an area which is relatively inexpensive and in which Canada is strong.

iii) An OSI conformance test bed is important for Canada and the Department of Communications should play a role in building this.

iv) DOC should take the lead to ensure an active and hospitable climate for developing national and international collaboration relationships in the field of Communications and Information Technology (C&IT).

v) DOC should take the lead with other government agencies, universities, and industry associations in the C&IT area to enhance information dissemination specifically to ensure the availability of appropriate directories of firms, research capabilities, and foreign information sources; also to encourage support for national and international conferences.

vi) DOC should work with DSS, DND and ISTC to expand on procurement forecasting activities through appropriate information bases, annual procurement awareness initiatives, and possible long-term technology forecasting as it relates to procurement.

vii) DOC should report back to all Search 20 attendees on progress in implementing these recommendations.

'Search 20' resulted in a consensus among the university, industry and government representatives present that Canada must proceed with the development of the concept of the vision. While it is essential to look at requirements over the long term, the need for action is immediate.

Action is required with respect to changes in the existing regulatory structure in order to create a level playing field and an environment conducive to communications research and development.

Action is required to build the infrastructure - the mechanisms, the processes - which will support Canadian communications companies and assist them in positioning themselves in the market that is available. This fundamental information includes data bases on international companies, on standards development and options, on where and by whom, what research is being conducted in Canada and other countries. This also includes the provision of assistance in the formation of Canadian consortia. Efforts in these areas will improve the knowledge-base and the cross-fertilization necessary to stimulate and support Canadian competitiveness.

'Search 20' demonstrated the willingness to identify and pursue a vision, the demand for cooperative ventures, and the cooperation to achieve both.

2. INTRODUCTION

Search 20, a forum of Canadian industry, university and government leaders in the Canadian communications field, was held at St. Sauveur, Québec on 13-15 March 1989. The aim of the forum was to attempt to reach a consensus on the question: Where should the focus of the Canadian communications research and development effort be and what mechanisms, infrastructure and programs will contribute to the attainment of the best results from public and private sector investment in communications R&D?

Consistent with the recommendations of the National Advisory Board for Science and Technology, the objectives of the R&D initiatives are:

- to build the Canadian communications equipment and service sector;

- to expand the use of communications technology throughout the economy.

This report of the proceedings of 'Search 20' presents a synthesis of the workshop reports and the plenary reports and discussions from each of the three tiers, and summarizes the recommendations of the forum.

The forum led from a context-setting plenary session which was structured around a speech from the Honourable Marcel Masse, Minister of Communications, and two keynote speakers giving both national and international perspectives. These speeches are included in the annex to this report.

The speakers set the scene for detailed workshop discussions in six areas. Three of these focussed on the supply side of the communications sector: product and service needs and opportunities; the R&D environment; strengths or weaknesses of start-ups, threshold companies and large multi-nationals. Three others focussed on the needs and opportunities of user groups in the areas of financial services, industry, public sector and research community.

From the workshop reports at the Tier I plenary session, five themes emerged: Regulatory Issues, Collaborative Strategies, Enabling Technologies, Strategic Applications and The Vision. In Tiers II and III, five workshops examined these themes in the context of "What should we do?" and "How will we do it?" respectively.

The workshops reported in plenary sessions and resulted in the emergence of unanimous agreement on the preliminary outline of a vision for Canadian pré-competitive communications R&D consortia and recommendations which would support, encourage and facilitate its establishment.

3. THE CONTEXT

The six workshops of Tier I focussed on communications R&D from the perspective of the needs and opportunities in terms of what we are and are not doing in Canada vis-à-vis other countries and in terms of the opportunities in Canada. These discussions articulated the characteristics of the Canadian communications technology sector, identified specific problems with respect to R&D, emphasized the requirement for collaboration and indicated the need for an agreed upon strategic direction.

3.1 Characteristics of the Communications Technology Sector in Canada

The communications sector has been characterized by the rapid development of products and services and by the corresponding growth of numerous "small companies". Canada has been fortunate to have creative entrepreneurs willing to start new companies based on new technologies. It was further recognized that this has led to the creation of a large number of small companies. In general, small companies can only handle small markets and it is extremely difficult for them to make the progression to larger markets. The inevitable result of this inability to grow is that companies may be bought out or die because they cannot compete.

Canadian opportunities in the communications sector were seen to be as developers and providers of specialized products and services. This would allow for building on Canadian creative entrepreneurial strength while offering opportunity for the progression to larger markets and the development of larger companies.

It was further recognized that there is a positive climate of opportunity for the provision of communications products and services.

Given the rapid advances in technology itself, Canadian strength in creative entrepreneurship is only sustainable by continuing development. In the past, Canadian companies have not demonstrated a strong ability to evolve. There has characteristically been some difficulty in developing "product number 2" which follows on from the "great idea" and innovation which led to the formation of a company. In general, Canada lacks big players who can invest over the long term.

It was recognized that the communications sector is maturing and that Canadian companies must position themselves within a new environment. Two trends were noted which will directly impact the communications sector in Canada over the next twenty years.

First, there will be more uniformity in the marketplace. This will tend to increase the number of buy-outs and reduce the opportunities for start-up companies.

Secondly, common standards will be in place. This will necessitate large and stable companies in order to compete effectively. To a degree, the disaggregation of standards to date has afforded Canadian companies some protection and allowed them to compete successfully while remaining small in size.

While it may appear self-evident, the requirement for good management and sound business practices - in all aspects from inventory to R&D and from capitalization to quality control - was emphasized as a critical factor influencing the sustainability of Canadian communications businesses.

3.2 Communications Research and Development

It was accepted as a given that growth and viability in the Canadian communications sector could not occur without a greater emphasis on R&D. It was suggested that neither government nor industry has put sufficient funds into communications R&D and that traditionally funding has been piecemeal and small. Small and fragmented funding commitments do not resolve problems.

In Canada, there has been an historic lack of focus on technology, with the notable exception of a few very large enterprises such as BNR. One reason for this is that Canada is a natural resource-based country and our economic strengths have been seen to be in those areas. Consequently, funding has traditionally gone to resource-based industries and the current level of funding to those industries is still higher than that provided to high tech industries. It was noted that while government spending on R&D in Canada is high, it is not being applied with regard to technological priorities. (See Table 3.1)

Table 3.1 Communications R&D Expenditures 1988

Field	% of Total Expenditures Industry	Federal Government*
Communications Telecommunications Equipment (19) Business Machines (7) Computer Services (5)	31	2.5
Other industries	69	97.5
Total Expenditures ($000,000)	4,427	2,721

*Excludes Related Scientific Activities

Source: Selected Science & Technology Statistics 1988
Industry, Science & Technology Canada (government)
Statistics Canada (industry)

The communications industry believes it has demonstrated its competence, as evidenced by the rapid and significant growth with respect to its contribution to the GDP and Canadian employment. The environment is now changing and, in the international marketplace, Canadian companies are competing with R & D programs supported by the governments of other countries. While it was also recognized that increased government funding to industry is not necessarily the entire answer, the requirement for government support is real. Direct recommendations as to the nature of that support evolved from subsequent workshops. In the context of funding it was noted that government could provide greater support to industrial funding of communications R & D through tax incentives.

Table 3.2 lists potential areas of opportunity for Canadian communications R & D. This list has not been priorized and arose from a discussion of areas of strength. This led directly to subsequent workshops which specifically discussed strategic applications and enabling technologies.

Table 3.2 Areas of Opportunity for Communications

i) personal wireless communications
   - paging, cellular, via satellite

ii) instrumentation and control

iii) networks
   - network management and control for products and services
   - neural networks
   - megabit networks
   - network architecture
   - network security and reliability
   - OSI - analogue/digital networks and how to form them so they work

iv) systems integration

v) service providers of data services

vi) microelectronics

vii) value added applications

ix) smart cards

x) optoelectronics

There are a number of areas and activities which directly influence communications R & D performance in Canada. These include the role of universities, the regulatory environment, procurement, and marketing support.

Universities are important to the communications sector because they perform basic research and educate researchers and engineers. Universities are the source of the trained skill set necessary to industry. A major factor working against the establishment of a flow of talent is that the culture in Canada is not one which, through its school system, puts a high value on engineering and science or, more generally, on those skills essential to a strong communications technology industry sector.

The telecommunications regulatory environment was identified as a major impediment to a viable high technology sector generally and to investment in communications R & D in particular. The relatively high cost of telecommunications in Canada is a problem and inhibits R & D. For example, the cost of a T1 system in Canada is seven to ten times greater than in the United States. Two imperatives specified were that the fractured nature of our national markets must be resolved and that telecommunications prices must come down. A more sustained discussion of the inhibiting nature of the existing regulatory environment, the need to reduce regulation and provide a more competitive environment and the imperative to "level the playing field" may be found in Chapter 5.

Another area identified as significant with respect to its impact on communications R & D was procurement. The federal government, as a major procurer of communications products and services, represents a market which is capable of stimulating industry development and, thereby, strengthening the Canadian communications industry.

Recommendation: DOC should establish a forum to identify forecasted procurement needs for communications products and services in order to position Canadian industry to develop them.

Throughout the Tier I discussions the issues of viable marketing strategies and the need for marketing support were raised. As one participant noted in this context: "Doing the right thing is better than doing the thing right".

3.3 Liaison and Cooperation

Given the highly competitive nature of the global marketplace, industry has recognized the requirement to form strategic partnerships with other companies both domestically and internationally. On the international scene, this will be necessary in order to gain rapid access to those markets. In addition, it was felt that federal government departments should be better coordinated for the provision of assistance and support to Canadian companies in the formation of export consortia and for accessing international markets.

While acknowledging the disparity between industry and the universities and the difficulties in maintaining a strong link between them, collaboration was seen to be critical to Canadian success in the communications field. To facilitate the establishment of the necessary and mutually advantageous links the need for an outside change agent was identified. Although a specific change agent was not identified, a suggestion was made that government should create a climate conducive to the formation of partnerships and consortia between universities/industry and government in Canada.

3.4 Strategic Direction

Many of the workshops in Tier I identified the need for a strategy to coordinate communications R & D activities. It was noted that in Japan, the government plays a strong leadership role in articulating highly directed and focussed research objectives.

The formulation of a strategic direction, that is, a reasonably clear, articulated and agreed upon focus, is fundamental to the assessment of communications R & D requirements and to the creation of an environment which fosters cooperation and collaboration.

One of the workshops specified the need for "a vision" as a pre-requisite for action. The challenges as defined in this introductory session were to:

i) define a coherent and coordinated Canadian strategy;
ii) identify an area of communications in which Canadian companies could lead;
iii) find a leader or "champion"; and
iv) persevere.

3.5 Summary

As a result of these discussions of the Canadian context, the environment, with respect to communications, the following subject areas were identified for further analysis and the workshop results are presented in subsequent chapters:

The Vision
The Regulatory Environment
Strategic Applications
Enabling Technologies
Collaboration Strategies.

4. THE VISION

Two workshop sessions were specifically tasked with the development of a national vision or visions and, following that, the identification of the steps required to implement such a vision.

From the discussion of Canadian strengths and weaknesses, of needs and opportunities, there was a general acknowledgement that in order to ensure benefits and develop products which will succeed in both domestic and international markets, the following factors must be considered when selecting which R & D activities and programs to support:

- market pull;
- Canadian strengths in communications;
- gaps in the market;
- our ability to do;
- existing knowledge base;
- finances;
- manpower; and
- basic scientific skills.

These criteria formed part of the analysis which led to the articulation of a vision.

While a number of options were explored, it was found that, within the Canadian context, the concepts put forth could all be contained within a single vision. In its preliminary conception the vision was defined as a Personal Productivity Network.

A Personal Productivity Network vision would mean that by the year 2000 every Canadian will be able, through a personal communications device, to interact with anyone or any machine at any time or from any place. This communications capability will be tailored to each person's individual work or leisure environment. Behind the specific communications device utilized by the individual will be a complex network which will be transparent, distributed and adaptive. Although the various transmission paths will be shared by many users, the network will behave like a dedicated system for the individual user. This will provide an environment of maximum personal choice.

In its conception, a Personal Productivity Network was seen as:

- a powerful personal communication link;
- a delivery mechanism for remote social services;
- a highway for researchers and educators;
- a test bed for new industrial technology;
- an instrument for structural change; and
- a glimpse of the 21st century.

The primary characteristic of this vision is its integration of radio, cable, satellite, fibre and copper into one seamless or transparent network which permits communication by voice, data, facsimile and image.

The 'Search 20' forum adopted the vision and recommended:

> The private sector should take a lead in developing an action plan for Vision 2000 which outlines the phases, beneficiaries, structure, costs, players, timeframes, etc., for the personal productivity network.

Four recommendations were provided as fundamental to the implementation of the vision:

i) Compile an inventory of existing domestic and international networks.

ii) Develop a work plan for research and policy development which would define the challenges and obstacles.

iii) A representative group from the 'Search 20' forum should meet with the Minister of Communications to advise him of the outcomes of the forum and seek his agreement in principle to support initiatives related to further defining and implementing the vision.

iv) Representatives from the public and private sectors should work together to develop the master plan and begin implementing the early phases of Vision 2000 within the next 12-36 months.

An inventory is a fundamental step in identifying those areas in which Canada is weak. An analysis of the inventory would define "road blocks", in the field of technology as well as in the regulatory and political areas, which must be removed to allow the vision to unfold. The workplan for research would cover technologies, including software, and address the structural issues which must be resolved to ensure the development of the full potential of networks.

It was recognized that the major challenge with respect to the vision would be the establishment of a broad base of support and commitment for it. Given its scope and its implications, it will require: political support at various levels, champions for the idea, acceptance by users (including the primary industries and the universities) and public liaison.

The vision, as enunciated at 'Search 20', directs Canada toward the future. It is conceived as giving Canada a head start over competitors in the global marketplace.

The vision has, as its strengths, the ability to provide integration for the development of a coherent set of communications research and development initiatives in Canada; formation of a basis for the establishment of a pre-competitive consortium; and creation of a forum within which Canadians can work together.

5. THE TECHNOLOGY

5.1 Enabling Technologies

'Search 20' identified the development of enabling technologies as key to Canada's economic competitiveness in world markets. Particular emphasis should be placed on the application of enabling technologies to primary, resource-based industries such as mining and farming and to the environment. Future success will be determined by the ability to use technology as an enabler for primary industries in Canada to compete more effectively as well as to expand our base of comparative advantage to include knowledge-intensive industries.

An enabling technology was defined as:

i) generic and, therefore, portable to all industries;
ii) strategic, that is, linked to economic, social and regional goals; and
iii) practical - something that is affordable and can be brought to market soon.

Knowing that there will not be an homogeneous network, it was recognized that Canada should develop equipment capable of operating on a blend of networks. The aim, therefore, would be to provide end users, with the network management capability which matches their own level of comfort and ability.

Table 5.1 lists the enabling technologies determined by the 'Search 20' workshop as priority areas. This table was reviewed by the workshop in the context of the vision of a personal productivity network and it was indicated that development is required in each of the areas in order to support it.

Table 5.1 Enabling Technologies

Input/output devices

voice processing, recognition and synthesis
natural language processing
expert systems
image processing
software

workstation design technologies
systems programming
testing
human factors
database and VLSI architecture

process control

local area networks
protocols and controls

connectivity enablers
OSI/ISDN
routing management
network management

broadband - switching
- distribution systems

wireless communications
microelectronics

satellite communications
fibre optics

These technologies can be covered in their entirety by the following groupings of technologies: microelectronics, optoelectronics, fibre optics, signal/data processing, signal/data acquisition, signal/data storage, switching, network design/management, software development, connectivity and distribution (transmission).

The Science Council of Canada characterizes enabling technologies as the core of the emerging international industrial system. In its paper 'Enabling Technologies: Springboard for a Competitive Future', the Council signals the urgent need for a proactive strategy to develop and apply these technologies. The workshop endorsed this recommendation.

The following recommendations were presented to the plenary session of 'Search 20':

5.1.1 Develop or acquire enabling technologies, add value and develop systems and products for network users in Canada and around the world.

In some cases the required enabling technology (refer to Table 5.1) will exist in another country and if such is the case, it should be acquired, not re-invented, and a system built around it. When the enabling technology does not exist it should be developed by a consortium of government, industry and academia. The importance of strong industry associations was recognized and their increased involvement in this process requested.

5.1.2 The Department of Communications should increase its level of involvement in the standards-setting process and improve its mechanisms for communicating standards information to industry and the universities.

It was generally agreed that DOC should assume a leadership role in the area of standards. With the development of effective information exchange mechanisms, companies could increase their lead time in the development of new products and services. A database of technology and R&D activities was one priority area for information.

5.1.3 The Department of Communications should emphasize applications research, an area which is relatively inexpensive and in which Canada is strong.

5.1.4 An OSI conformance test bed is important for Canada and the Department of Communications should play a role in building this.

As a corollary, it was emphasized that the operation of a technical data base in conjunction with this work was essential to ensure a knowledgeable and "step-ahead" R&D community.

5.1.5 Institutionalize the 'Search 20' process. DOC should organize a core group of 'Search 20' experts to address the issues raised at the forum, to manage the implementation of the 'vision' project and to organize a follow-up meeting of 'Search 20' participants.

Here, too, there was particular emphasis on the need for information exchange and reporting. In addition, the involvement of senior levels of government, through a senior level advisory committee to the Ministers of Communications and Industry, Science and Technology was encouraged.

Although the topic of the regulatory environment was dealt with in a specific workshop, the group discussing enabling technologies reinforced the requirement to resolve the regulatory impediments to 'the vision'.

A strong knowledge base and the availability of an appropriate core of scientists is an important consideration in the field of enabling technologies. Two specific items were discussed with respect to this. First, given that Canada will soon face a shortage of qualified experts in this area, it was proposed that immigration policy be examined as a way to acquire needed manpower and skills. Secondly, university researchers engaged in technology development and implementation programs should be encouraged through the adjustment and expansion of NSERC funding priorities and tenure requirements, in spite of the fact that this would involve a reduction in the number of scholarly publications.

5.1.6 Support related R&D programs with appropriate levels of funding.

This recommendation was addressed to all participants at 'Search 20'.

5.2 Strategic Applications

As noted by participants in the enabling technologies workshops, applications research and development is an area which is relatively inexpensive and in which Canada is presently strong. While the focus of their recommendation was that DOC should emphasize such research, the workshops which discussed strategic applications broadened that scope.

An application is deemed to be strategic if there is some substantiated indication of significant potential, based on usage or ramifications for manufacturing, if it meets the needs of users across Canada and internationally, and if it contributes to economic wealth.

It was determined that strategic applications must be developed within the framework of a vision; that is, a master plan which would drive the development of those key technologies upon which the application is built. Again, it was reinforced that the vision itself must be designed to ensure competitive positioning in the international marketplace.

> Recommendation: Representatives from the public and private sectors should work together to develop the master plan and begin implementing the early phases of Vision 2000 within the next 12-36 months.

Other criteria considered essential in the selection of strategic applications were the ability to licence the products of the application, the capacity to attract more than one industry and a variety of partners, that it can survive in the global market, that it is based in enabling technologies, and the identification of a champion to bring it to fruition.

A fundamental element in the decision to follow through on an identified strategic application is the development of a business model which forecasts markets, technology trends, barriers and opportunities.

Strategic applications cut across sectors, markets, developers and users. The creation of viable partnerships is essential to success. The role of government was described as that of catalyst and facilitator - in achieving consensus on the vision itself, in ensuring the appropriate research and regulatory environment which would permit the implementation of the vision and, therefore, the development of the strategic application, and in coordinating the players and their programs. The role of industry was seen as bringing to market the products and services which will secure our prosperity as a nation and the role of universities, to ensure the continuity into the future, by providing well-trained graduates capable of further developing the work and the vision.

The process of identifying strategic applications is an interactive one which involves industry and industry associations, the university community and government departments through formal and informal meetings, and the presentation of discussion papers.

6. THE REGULATIONS

"Technology is way ahead of regulation."

"Regulation can limit where you put your money in R&D."

"Regulation prevents innovation."

Comments such as these set the tone and the urgency for an examination of the telecommunications regulatory structure in Canada as it impacts the formulation of a communications R&D strategy for Canada and the implementation of the vision.

The workshops which discussed the regulatory issues agreed that the pre-requisite to the discussion of changes to existing regulation is the articulation of "the vision", knowing where it is we are heading. While the group did not define the technology of the vision, it identified some basic precepts upon which the vision should be based. These included: leadership provided by the Department of Communications, a high level of industry support, the provision of a competitive edge, and retention of the fundamental aspects of Canadian social policy.

The policy framework which would follow this model for the vision would then represent a national initiative, ensure universal basic service, provide for a competitive model (one which assumes generic network interconnection) and restructure the social costs.

Implementation, which would follow a shareholder forum to confirm commitment to the vision and to develop the detailed strategic plan, has two major components: regulation and jurisdiction. The regulations would be based on the following assumptions:

1) the model should be competitive and composite;
2) the 4 + 1 backbone players would be satellite, cellular, radio, the existing telephone network plus cable; and
3) there would be one connection per premise to the central core network.

With respect to jurisdictional issues, it was stated that the current patchwork is a strong impediment to investment in communications R&D and to the realization of the vision and that a level playing field is mandatory. Without the latter, industries' options for involvement are extremely limited.

Once these issues have been resolved, restructuring can take place through a combination of: rate rebalancing, an access charge, targetted contribution, taxation and technology. Technology has the capability of not only redistributing costs but also reducing the social costs, for example the cost of service to rural and remote communities. These issues will require considerable study and further elaboration.

Recommendation: Related technologies for provision of service to rural and remote sites should be targetted as strategic.

Telecommunications can reduce time, compensate for geography and change relationships. All of these make business more efficient. In order to realize these efficiencies and increase the competitive viability of Canadian industries, the regulatory environment must be such that it encourages rather than inhibits.

Recommendation: Jurisdictional reform of the telecommunications regulatory environment to provide a level playing field must be done immediately and the regulation required for the Vision 2000 should be implemented within 12-36 months.

7. THE COLLABORATION

The major question addressed in the workshops which focussed on collaborative strategies was "How do we develop national and international strategies involving industry, university and government and how do we promote collaboration among them?"

Discussion centered around the following recommendations which are specific and, for the most part, process oriented. That is, they identify the mechanisms necessary to define the leader(s) and encourage the dialogue and information exchange that will lead to collaborative efforts. Table 7.1 outlines a typology of strategic research collaboration. Five primary categories of collaboration are described, the product or benefit defined and the lead player(s) identified.

Recommendations:

7.1 DOC should take the lead to ensure an active and hospitable climate for developing national and international collaboration relationships in the field of Communications and Information Technology (C&IT).

7.2 DOC should take the lead with other government agencies, universities, and industry associations in the C&IT area to enhance information dissemination specifically to ensure the availability of appropriate directories of firms, research capabilities, and foreign information sources; also to encourage support for national and international conferences.

7.3 DOC should work with DSS, DND and ISTC to expand on procurement forecasting activities through appropriate information bases, annual procurement awareness initiatives, and possible long term technology forecasting as it relates to procurement.

7.4 Establish a government steering committee to ensure effective working relationships and a common approach to C&IT.

7.5 Government must work harder with industry and industry associations to develop consensus in the area of C&IT; specifically, to seek the establishment of a senior C&IT committee to advise Ministers of ISTC and DOC. Associated subcommittees could be formed for such areas as:

- intellectual property;
- database access;
- information dissemination; and
- impact of regulation on R&D collaboration.

7.6 Recognize and endorse the network of centres of excellence as instrumental in developing strategic collaboration.

7.7 DOC should report back to all Search 20 attendees on progress in implementing these recommendations.

TABLE 7.1 TYPOLOGY OF STRATEGIC RESEARCH COLLABORATIONS

TYPE	"CLUBS"	CENTRES OF EXCELLENCE	MAJOR PROJECT CONSORTIA	SUPPLY DIRECTED COOPERATIVE PROJECTS	"SINGLE" BILATERAL COLLABORATIONS
Description	Formal or loose relationships around common horizontal interests, e.g. Mass Spectroscopic Analysis Techniques	Strategic groups of R&D capabilities in universities, industry and government in areas of horizontal technologies, e.g. Superconductivity, Artificial Intelligence	"Sector Change" endeavours built around vertically integrated R&D project or program e.g. Solid State Optoelectronic Consortium	Buyer/Seller(s) groups, vertical projects to develop supply base and offset development costs for suppliers	Joint objectives of two participants, normally vertical projects
Product or Benefit	Information exchange, maintenance of practice at leading edge	Generic R&D focus of expertise to stimulate activity and ensure appropriate development of trained personnel	Major change of industrial technology, a new spectrum of products or services	Stable supply without formal backward integration	Protective move to offset "buy threats" offer a precursor of bigger projects or forward integration
Lead or Leaders	Discipline Association, Industry Association or Centre of Excellence	University, industry and/or government (usually university/government)	Industry with government or university	Buyer industries or Industry Associations	Industry

8. SUMMARY

'Search 20' resulted in a consensus among the university, industry and government representatives present that Canada must proceed with the development of the concept of the vision. While it is essential to look at requirements over the long term, the need for action is immediate.

Action is required with respect to changes in the existing regulatory structure in order to create a level playing field and an environment conducive to communications research and development.

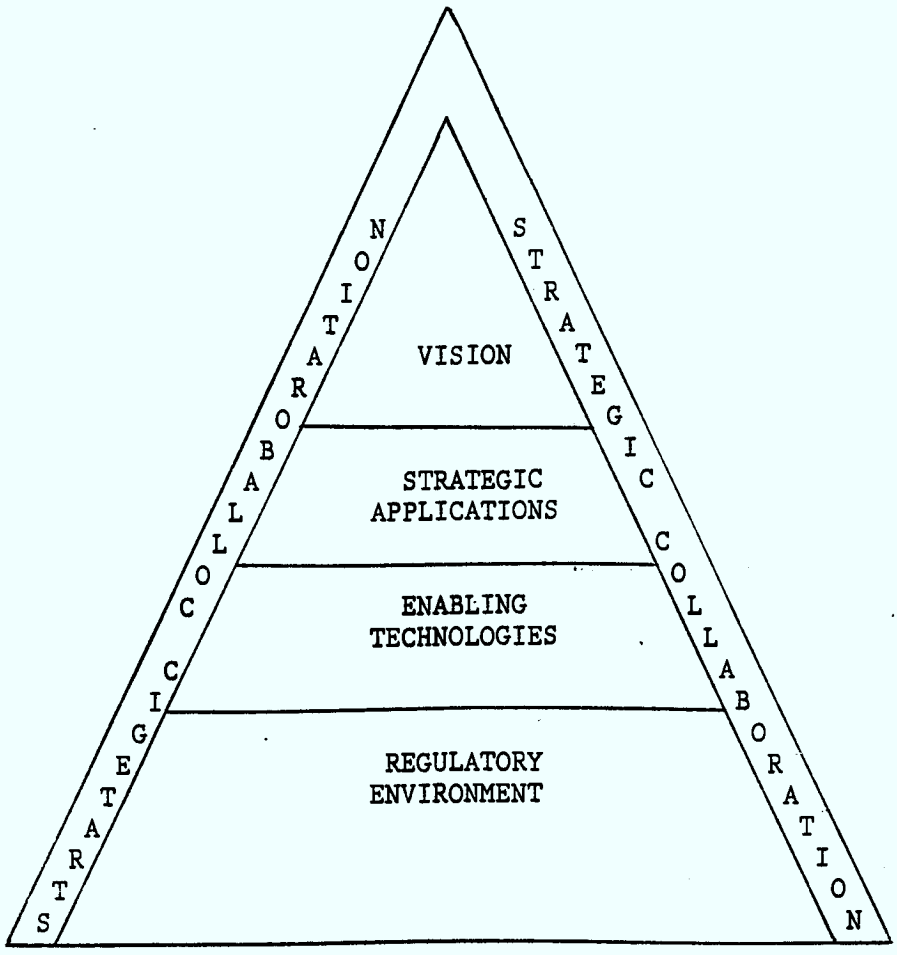
Action is required to build the infrastructure - the mechanisms, the processes - which will support Canadian communications companies and assist them in positioning themselves in the market that is available. This fundamental information includes data bases on international companies, on standards development and options, on where and by whom, what research is being conducted in Canada and other countries. This also includes the provision of assistance in the formation of Canadian consortia. Efforts in these areas will improve the knowledge-base and the cross-fertilization necessary to stimulate and support Canadian competitiveness.

One of the predominant messages of 'Search 20' was that in order to increase the level of industrial R & D in the field of communications in Canada, it is essential to:

- implement the appropriate regulatory environment;
- create the appropriate infrastructure;
- foster cooperation;
- develop export consortia;
- develop products and services based on market-pull; and
- have focussed strategic directions which build on strengths.

'Search 20' demonstrated the willingness to identify and pursue a vision, the demand for cooperative ventures, and the cooperation to achieve both.

The vision pyramid below is a way of seeing how the discussions of 'Search 20' come together.



This is not to suggest that there is only one vision for Canada. The "vision" pyramid itself can be defined as a number of different projects representing strategic applications and enabling technologies which build upon and expand Canadian strengths, which create opportunities for Canadian industry in the global marketplace and which, increasingly, will be characterized by the fact that a consortium of industry, university and government is required to bring it to fruition.

'Search 20' was the first step in the formulation of a communications R&D strategy for Canada.

Welcoming Remarks

Alain Gourd, Deputy Minister

Department of Communications

WELCOMING REMARKS
ALAIN GOURD, DEPUTY MINISTER
DEPARTMENT OF COMMUNICATIONS

Thank you everyone, for coming here this evening. The conference this evening is extremely important to us, since it marks our twentieth anniversary, and that is no doubt why Richard - and I would like to thank Richard for bringing together such a distinguished group of participants - that is no doubt why Richard proposed that it be called "Search 20". If we look at the road we have travelled in those twenty years - I'm thinking of colleagues such as Alex Curran and so many others who have worked with us - I think we can say that the road we have travelled was extraordinary in terms of Canadian communications technology and cultural technology. For twenty years now, the Department and my predecessors have been endeavouring to help with nation-building, to help promote creativity and innovation. However, at the end of those twenty years, when we are about to come of age, as it were, it is appropriate to take stock, to ask ourselves what we want to do in the next twenty years.

My colleagues in the Department of Communications have embarked on a very in-depth, systematic review of our mission, of our mandate, of our raison d'être. Ken Hepburn, the Senior Assistant Deputy Minister, led that exercise to fruition. We concluded that what we want in the next 20 years is basically more of the same, more consensus with you, from industry and university; more partnership with you to continue nation-building, to build this country and to improve technology in the areas of communications and culture. And, it is, in a sense, quite timely to have this gathering of distinguished guests from various horizons to reflect with us on what research orientations we should take for the next few years, for the next decade.

Therefore, for us, from the Department, this conference is important. We are grateful that you could take a few days from your busy schedule to help us. I know that the demands on your time are very heavy. For us, it is important to have your feedback on what we should do during the 21st Century to maintain this country's international competitiveness, to maintain our ability to exchange ideas, information and dreams between Canadians from the various parts of the country.

Speech

The Honourable Marcel Masse, Minister

Department of Communications

SPEECH

THE HONOURABLE MARCEL MASSE, MINISTER
DEPARTMENT OF COMMUNICATIONS

Deputy Minister, Ladies and Gentlemen,

It gives me great pleasure to be here this evening in St-Sauveur, where the Laurentians begin. You are the most prominent communications experts in the country, and communications is one of Canada's greatest strengths, if not the area which has seen our most significant technological accomplishments.

This country has been built by generations of modes of transportation. The vastness of the country and the dispersion of our people have demanded excellence and innovation. And, in fact, without that, I don't think that this country would have even existed. Canada is the result of man's will and not the result of geography or history. And one reason is, as everybody knows, communication. And it's communications decided by Government and by politicians which linked the country together by the railroad, as you know and after that, through the broadcasting system and to the communications and so on. As such, communications can ensure our identity as Canadians. It ties us East to West from the Arctic to the 49th Parallel. It transports our languages, our beliefs and our dreams. In fact, the extension of the telecommunications infrastructure created and defined the social and economic fabric of this country.

Historically, I think we have been successful over the course of the 20th century. One of the central challenges of nation-building has been to extend sophisticated telecommunications to all parts of the country. We have met that challenge. Canada has one of the most advanced network infrastructures in the world, with 98.5% of Canadian households using telephones. We have the highest level of telephone penetration in the world. In 1987, on a per capita basis, Canadians made an average of 1,500 phone calls per year. Probably, most of that was to answer polls, at least, during election time. We have more access to television programming, via satellite, and cable than anyone else. Cable networks carry an average of 14 channels and over 87% of Canadians have access to cable.

Canada pioneered the world's use of digital networks for computer communications. Our country has also led the world in the use of satellites for domestic communication and fibre optics are presently being laid through the Rockies and across the Prairies. In meeting the extraordinary challenges of our huge country we have performed feats of engineering unrivalled anywhere else. In the process, we

developed great commercial and scientific strengths. Our companies are premier competitors in the field of high technology. In the area of satellite communications, SPAR Aerospace is a leading manufacturer of satellite technology. On the services side, there is barely one single major satellite project in the western world right now which has not sought the advice of TELESAT. Our abilities in digital communications are legendary. The discipline in its modern form was essentially invented by Northern Telecom, which has become one of the five most important manufacturers of telecommunications equipment in the world. Our strength in digital communications is also at the heart of our reputation in data networks. Gandalf, Mitel, Microtel and so on are all important players. Finally, we are clearly at the leading edge of advanced radio-based communications. Firms like Novatel, SR-Telecom, Data Radio have growing international reputations. As a result of the efforts of these companies we run a positive balance of trade in telecommunications equipment.

And yet, despite our accomplishments, despite our successes, even greater challenges are now facing us. The transition to an information-oriented society, maintenance of a competitive position on world markets and cultural integrity in a world of high technology will henceforth define the very parameters of our survival as a distinct nation. What is the first challenge we face? The transition to an information-oriented society. It has become obvious that our society is currently undergoing fundamental changes. The Canadian economy, which was once based on extraction of raw materials, now relies largely on the production, accumulation and distribution of knowledge. We have become, through the convergence of telecommunications and computer technology, a society based on information. With this change, as the Prime Minister pointed out in a speech on research and development at the University of Waterloo, this dynamic sector faces challenges of an immense magnitude.

Unfortunately, it is less obvious that we are reacting as quickly as we should to these profound changes. The Economic Council of Canada has already warned us that we are not adopting new information technologies at the same rate as the other members of the OECD. In addition, a 1984 OECD report points out that, as far as per capita spending on information technology research and development is concerned, the US is spending approximately five times more than Canada. In fact, our trade balance for information technology is negative and that deficit is growing yearly.

Canada, for example, is barely starting to look at establishing networks going to 1.5 megabytes to help our scientific community. During that time, other nations are planning to establish gigabit networks that will allow their scientists to transmit vastly more information than us and to work together on competitive super projects. The success with which we make the transition will be of enormous significance for all levels of our society. The vitality of our culture, the quality of our lives and the competitiveness of our economy depend on it. As the Science Council of Canada emphasized two weeks ago in its most recent report, "Mastery of three major groups of technologies (one of which is) information and communications technologies, is vital if Canada is to compete successfully on the world markets." Moreover, the government has identified these three technological groups as being strategically important. What is the second challenge? Competition and world markets.

The first challenge is essentially a challenge to the government. How quickly can a government like that in Ottawa adjust its choices or change its priorities to reflect world developments? The question of competition is of primary importance. The world economy and international markets are becoming more and more integrated. Highly developed computerized communications are making the world market a reality. Our competitors decided a long time ago that information technology would be central to their economic performance. They are already fine-tuning competitive strategies to ensure their position in the new economic realignments. The Europeans, for example, have increased competition within their telecommunications market in preparation for 1992, and are preparing to privatize their existing public monopolies. In addition, they have established precompetitive research consortiums subsidized by industry and governments. In the telecommunications sector, the most important are Race, with $1.2 billion and the second phase of the Esprit project, with $2.5 billion. The free-trade agreement with the United States is providing us with an excellent opportunity to increase our present efforts. For their part, the Americans, who possess industrial-research potential infinitely greater than ours, have already undertaken to establish gigantic precompetitive consortiums. Thus, although IBM spends $5.2 billion on its own behalf each year on research and development, it recently announced that it was joining the consortium on high-definition television.

All our competitors are therefore pursuing dynamic strategies linked to their world economic position, while we in Canada remain silent, continue to invest in the raw materials fields, and, between the provinces and the Canadian government, fail to define objectives and directions. The departments continue to battle with each other regarding research and development, while countries like Japan succeed in defining strategies and setting directions. In Canada, there seems to be a defect in our very system, one that keeps us from adjusting to world changes. In my opinion, the main challenge we face is organization of decision making in Canada. Just consider the fact that we have succeeded in establishing a free market with the United States, while there are still more significant tariff and non-tariff barriers between the provinces than will exist between European countries in 1992. The constitutional problem, the work habits of governments, collective agreements, all those tools the population has developed have become obstacles in the way of decision making on behalf of the people of Canada. Everyone demands leadership, while making sure that leaders are unable to make any decisions. In this sense, where are our great initiatives? How can we ensure the competitiveness of our industries? Can we allow ourselves to do proportionately less than our competitors? We have been doing that for years. How long can we allow these difficult problems to continue without seriously endangering competition with other countries? To my mind, the problem is not between Canada and other countries - it is primarily between us, the people of Canada, and relates to our failure to set directions for ourselves and decide on common objectives.

The third challenge has to do with new technologies and Canadian identity. The world struggle for domination in the information industries is threatening the integrity of cultures and their identity. As Chairman of the Cabinet Committee on Cultural Affairs and Canadian Identity, I am particularly concerned about this problem. It bothers me that we do not seem to realize the impact that information technologies will have on our cultural and intellectual life. I would even say that, in addition to the new technologies, there is the whole issue of the centralization of decision making, with decision-making power lying in the hands of a few businesses. These businesses, as one of their directors has said, will, within a few decades, be making all of the decisions on these issues. Our major banks of knowledge are becoming more and more electronic in

nature. Newspaper, magazines and libraries and being replaced by data banks that can be consulted and manipulated by remote control. There has not been much discussion on this subject and on the effect that this could have on our cultural community. Add to this the fact that our data-base industry is largely underdeveloped relative to its American counterpart. I am also concerned about the absence of dialogue on high-definition television in Canada. It will transform our most important cultural medium, just as the development of colour did. We have so far not accorded enough importance to this development, despite all the attention that our competitors are paying to it. Europe has committed itself to spending $200 million on the high-definition television project. The Japanese, for their part, have spent hundreds of millions more and will start doing high-definition broadcasting as soon as next year. Finally, as I mentioned earlier, the Americans are planning to create a consortium on high-definition television, one made up of their biggest electronics companies. What are we doing in the meantime?

The transition to an information-oriented society, competition, world markets, integration of our culture and of Canadian identity in a world of high technology - these are three challenges of vital importance. Our ability to meet these challenges will depend on our ability to understand the new technologies. As the Prime Minister said, the future belongs to knowledge-based industries and lies in the application of new technologies. He said that we have to do battle with our minds, our ingenuity and our creativity. In short, we must have a solid base in communications research and development in this country, in order to be able to understand and direct the changes that will occur. It is vital that we ensure the quality of research and development in Canada if we are to meet these new challenges. Effective research and development will speed up the rate of dissemination of new technologies within Canadian firms. Our competitiveness will increase as a result, our sense of identity as Canadians will be on firmer technological ground. Thanks to this solid research and development base, we will be able to take advantage of opportunities in the world economy. If we fail to establish such a base, our economy, our sense of identity, our culture and our quality of life will deteriorate. So in this area the facts are disturbing. Despite our legendary ability in communications, our overall effort with respect to information technology has been very weak. The OECD's statistics place us at the bottom for per capita spending. The Americans spend nearly a hundred dollars per citizen, the Germans,

more than eighty, the British nearly fifty. What do we Canadians spend? Less than twenty dollars. Some people say this is because the private sector does not spend enough money in Canada. In my opinion, that is only part of the truth. The Government of Canada contributes only 7.4% of the total information-technology research and development budget. In France and the United States, the figure is nearly 25%. The conclusion is obvious: government and industry have to endeavour to do better. When you look at Canada's budget for research and development, you get the impression that Canada has withdrawn from the communications field. You also get the impression that Canada has withdraw from the effort required to build for the future. I do not wish to go back to the portfolio I had at the Department of Energy, Mines and Resources where research is focussed on reducing production costs. Our competition there is with the developing countries. I think that, if Canada wants to have a place in the world of the future, it must first and foremost invest its meager resources in the competitive fields of the future, not the competitive fields of the past. If we do not do a better job of ensuring investment in communications, it is obvious that this will have a direct effect on our cultural sector and our way of thinking. The world of tomorrow, the world ten or fifteen years down the road will be a world almost completely without economic or industrial borders. Countries will differ from one another mainly in their attitudes, the way they view the world. If we cannot express this perception of the world because our means for communicating the message are diminished or underdeveloped, the cost to our very identity as Canadians will obviously be great. However, if we wish to be part of future blocs, there is obviously room for a nation such as ours. We have a tendency to look at the major blocs and think that the world is built by empires. Empires crumble. That is the lesson history teaches us, and it is clear that the future will not be built by the United States and Russia. It will be built by other countries, blocs organized in other ways. Consequently, there is no reason to believe that, since Canada does not have the base or the population that the United States does, it has no chance in the world of the future. We simply have to position ourselves where we need to be positioned.

What has happened in Japan is a very recent example of this. After the war, Japan had no chance of dominating the United States. Not one observer would have said that, forty years later, Japan would be the leader in exactly those fields in which the Americans had an impossible lead. This happened in twenty, twenty-five or thirty years. Therefore, we can do things if we choose our objectives well and, above all, are able to ensure coherent governmental decision making. That appears to me to be the most difficult thing. It is necessary for governments to be in agreement, for governments and the private sector to do what we are doing tonight - that is, to discuss

those directions, to define those objectives, taking into account their ability to manage the effort, as well as to finance the effort. Then it will be possible to make progress in this area.

Your discussions will bear precisely on what remains to be done. You have agreed to join us today to help us find solutions. Don't believe that there is some final reservoir of decisions on the banks of the Ottawa and Rideau rivers. This country cannot be managed from Ottawa. This nation can be built only through dialogue between Canadians, dialogue like that here today. We have found a consensus that will allow us to develop common, coherent strategies. I have spoken to you about some of our political and economic concerns.

Allow me to submit a few questions that are more specific, that I invite you to think about in the next few days. First of all, in which sector should we focus our efforts? We know very well that it is impossible to do everything. What are the fields that best reflect our strong points as businesses and our needs as a country? Secondly, how should we approach those subjects? Do we need to establish joint consortiums involving government and industry, government with the rest or without the rest? If so, how should we finance them and what will their structure be? If not, what is the best strategy for Canada? Thirdly, what will the next steps be? They have to be specified. Even if this conference is as successful as we expect, that will be only the first step on a long road, since we will have to continue this dialogue and determine what form it will take in the future.

Unfortunately, I will not be able to participate in all your discussions, but I can assure you that I will make it my duty to meet with your advisory committee in the weeks to come and spend as much time with it as necessary to understand well the directions you have chosen, the suggestions you have made, Even the dreams you have put forward. Then, as Minister of Communications, I will be able to make myself the messenger of your hopes. Thank you!

"Communications R&D: A Canadian Perspective"

Richard Stursberg, Assistant Deputy Minister

Telecommunications and Technology

Department of Communications

"COMMUNICATIONS R&D: A CANADIAN PERSPECTIVE"

RICHARD STURSBERG, ASSISTANT DEPUTY MINISTER
TELECOMMUNICATIONS AND TECHNOLOGY
DEPARTMENT OF COMMUNICATIONS

This is basically a talk designed to position some of the issues with respect to communications R & D in Canada. I also want to share with you some work that we in the Department of Communications have done in the area and some work that was done preparatory to this conference, with respect to the kinds of issues and options that we think are likely to arise over the course of the discussions during the next couple of days. Some of this, most of you will already know, so let me skip through that part of it relatively quickly.

The obvious first thing to note is that the communications sector is the fastest growing sector in the Canadian economy (slide 2). It grows significantly faster than the GDP and significantly faster than any other part of the economy by whatever measure. It is, I might mention, also growing faster in Canada than in any other country in the world, with the exception of Japan.

You'll see, in the course of some of these slides that we have grouped together numbers associated with communications and information technologies generally. In part, this is the result of the fact that it is very difficult to distinguish in a fully coherent fashion what is a computer technology and what is a communications technology. The merging of the technologies, I don't have to tell you, is so far advanced we have enormous difficulty distinguishing them. In addition, statistics are now put together in such a way, both internationally and domestically, that we have difficulty distinguishing communications per se. To the extent that I can do it, I will do it; in any case I think that the general impression that emerges will be right. Obviously, it's a very big sector of the Canadian economy and it is interesting to note that it is larger than farming, fishing and mining combined (slide 3). It is striking to note the relative levels of political attention that are given to communications as compared to these other resource areas.

As a corollary to these statistics, employment in the area has been growing enormously and rapidly (slide 4). And as the Minister pointed out, this is one of the few areas that we have a net positive balance of trade (slide 5). The telecommunications equipment area is the premier high-tech area of the country and the area in which we are most successful internationally.

Now, a great deal of the success internationally, is obviously the result of the performance of one enormously important company-Northern Telecom. Northern Telecom is now one of the five largest telecommunications equipment manufacturers in the world (slide 6) and you'll see when we get into the rest of the statistics in R & D that Northern Telecom and the BNR complex overwhelmingly dominate the private sector effort in this area.

So, if you look at Canada in terms of its high technology capacity, communications is the premier industry. However, as the Minister said, we find ourselves in a situation where we really can't rest on these laurels. The problem becomes clearest when we look at R & D performance. This slide (7) shows the general figures for gross expenditures on Research and Development as a percentage of GDP. Of course, these figures are well known to everyone here and you can see that our R & D performance per capita tracks poorly against the R & D performance overall for other countries (slide 8). This relates to R & D generally and I'll come to the communications numbers shortly.

Slide 9 shows the public and private funding of R & D, again generally, as a percentage of GDP. This is what the numbers look like when you look at just R & D and the information technology area. These are the OECD 1986 numbers. As you can see, Canada tracks, on a per capita basis, very close to the bottom of the OECD lists and on an absolute basis given the size of the economy, is much smaller still.

Slide 10 lists the principle players in the area in Canada right now and as I mentioned earlier, Bell Canada Enterprises (these are the BNR numbers) is the overwhelmingly dominant player. IBM Canada is second; although, if I'm not mistaken, the percentage of money expended by IBM in Canada, as a percentage of gross revenues realized in Canada, is less than it is in the United States. Nevertheless, they're a very significant player. Mitel, which as many of you know, was bought a few years ago by British Telecom. The Department of Communications research program, which was alluded to earlier - and it's a small program - is the fourth largest. Control Data of Canada, which is sixth on the list, has recently announced that they are winding up their R & D operations in Canada as part of a restructuring that's going on in terms of their operations internationally. Then, after that, Gandalf and SPAR Aerospace.

As part of the pre-conference material, we sent you a very long and rather windy brick compiled by the OECD titled "Special Programs for the Promotion of Information Technology R & D". What most other countries have been doing as part of their overall positioning strategy with respect to R & D, is establishing very large, very well healed, pre-competitive research consortia that are jointly funded by the private and public sectors (slide 11). The ones, probably, of most interest here are RACE, which is the research in advanced communications technologies for Europe, and which is currently funded at about 1.2 billion dollars over the next five years. ESPRIT, the European Strategic Program for R & D and information technology is funded at about 2.5 billion dollars over the next five years. I might mention that with respect to Eureka, which is just one of their products - Eureka 95 is the high-definition television project that was referred to by the Minister. He cited numbers of 200 million dollars. In fact, the numbers are closer to 600 million dollars and they will employ 500 researchers. The HDTV issue itself is interesting in that, for those of you who have been following the American Press, what's happened in the United States in the course of the last few weeks, is that they are in the process of putting together a very large

precompetitive grouping in the United States which will be looking at HDTV. This is not simply because they think HDTV is important, although I think they think that too, but also because HDTV, and indeed the consumer electronics industry generally, is seen as being a central part of any overall strategy in the area. Beyond that, as you have undoubtedly noticed, the American military has now announced that it will be putting money into the consortium. How much money is going to go in is not yet clear. Last week 30 million dollars was announced and this week they announced that they are looking at those numbers and might even beef them up. I won't go through all these various programs with you. I'm sure you're all familiar with them in one way or another and they're all documented in considerable detail in that very large study we sent you as part of the background to all this.

Now, when we were preparing for this conference, one of the things that we did was organize a series of focus or discussion groups with people in advance to ask them if they would like to see this forum structured and what issues should be discussed. And my sense is that three kinds of areas (slide 12) are likely to emerge. They are described as the kind of options that one might look at as a country and they're not intended as exclusive.

One is "Business as Usual" (slide 13). A lot of people told us that the fundamental problem with R & D in the communications area is not so much a question about putting in more government money or about establishing the European or Japanese style precompetitive consortia. The problems are much simpler. The problems have to do with two fundamental things, one of which is the way in which the R & D tax credits are structured and the second, and people put a tremendous emphasis on this, was the whole question of regulatory policy. People felt very strongly that the issue of regulatory policy in Canada is fundamental. And by that, what they meant is the resolution of three basic questions. One, the issue of the relationships with the provinces and the creation of a national market in the area of communications. And that, I dare say, will be resolved, one way or another, once the Supreme Court case comes down with respect to Alberta Government Telephones.

The second issue that people put a lot of emphasis on was the level of competition. And this discussion about the level of competition is both an issue about the level of competition within those provinces that currently regulate their own telecommunications systems which, as you all know, is not as high as it is in the Federal territories and in Ontario, Quebec and British Columbia and, more importantly, about long-distance voice competition and the implications of long-distance voice competition for the positioning of the major competitors and for access by users to new services.

Finally, there was a great deal of discussion about ISDN technologies and the requirement to establish clear rules and standards for the introduction of ISDN as quickly as possible. The Department has struck a task force on this which reports to the Minister on the 31st of March. It

was chaired by John Lawrence, the past Vice-Chairman of the CRTC. The ISDN Task Force report will go to the Minister at the end of March and will be released some time after that.

That's one sort of option: call it improving what we're already doing. The second option that arose was the whole question of the extent to which Canadian firms can effectively participate in the large precompetitive consortia that have been organized in Europe and in Japan and, increasingly now, in the United States (slide 14). I might add that it's also interesting that in the United States, the Department of Justice is now looking at revisions to the Combines Act to allow pre-competitive consortia to be developed more fully. Over the course of the last year or so we were asked to do a study of the extent to which Canadian firms want to participate in precompetitive consortia in Japan and Europe and the extent to which European and Japanese firms are positioned in different areas and prepared to allow for the participation of Canadian firms. And so, we surveyed Canadian firms; we surveyed also firms in Japan and in Europe and the results were interesting (slide 15).

What we've done for the purposes of this discussion is group the specific sub-technologies into broader categories and then look at the extent to which Canadian firms wanted to participate and the extent to which Japanese and European firms were, in principle, prepared to accept some level of participation. We have the details behind this information and can certainly make the study results available to you. What's interesting is that the two areas in which Canadian firms indicated they were most interested in participating are micro-electronics and opto-electronics. There was very little interest evinced by Canadian firms participating in any of the precompetitive consortia in the area of artificial intelligence, software superconductivity or strikingly, at least for me, in the area of HDTV.

The third general option is one that the Minister alluded to in his speech: Should we be looking at the possibility of creating precompetitive consortia in Canada that would function in a way that would reflect Canadian strengths and Canadian needs and parallel the sort of mechanisms that have been used successfully in Europe and in Japan (slide 16). Some people have suggested various areas in which that might happen (slide 17, 18, 19). One example is that which began to emerge as part of a consensus surrounding the creation of a broadband consortium focussing on the sorts of sub-components that you would expect in that area.

We have identified these options for the future. As I mentioned, what we would like very much from you are your views and your sense of which of these options or combination of options should be pursued further, in the context of the development of an R & D communications strategy in Canada. Not only are these options not mutually exclusive but in some cases, they are mutually reinforcing. But what we need is a clear sense of where and how to move forward.

Thank you very much.

Slide 1

COMMUNICATIONS R & D

CANADIAN
PERSPECTIVE

1971 - 1986

GDP GROWTH	2.3 %	ANNUALLY
VALUE ADDED BY TRANSPORTATION	2.1 %	ANNUALLY
COMMUNICATIONS	7.01 %	ANNUALLY

COMMUNICATIONS & INFORMATION
TECHNOLOGIES

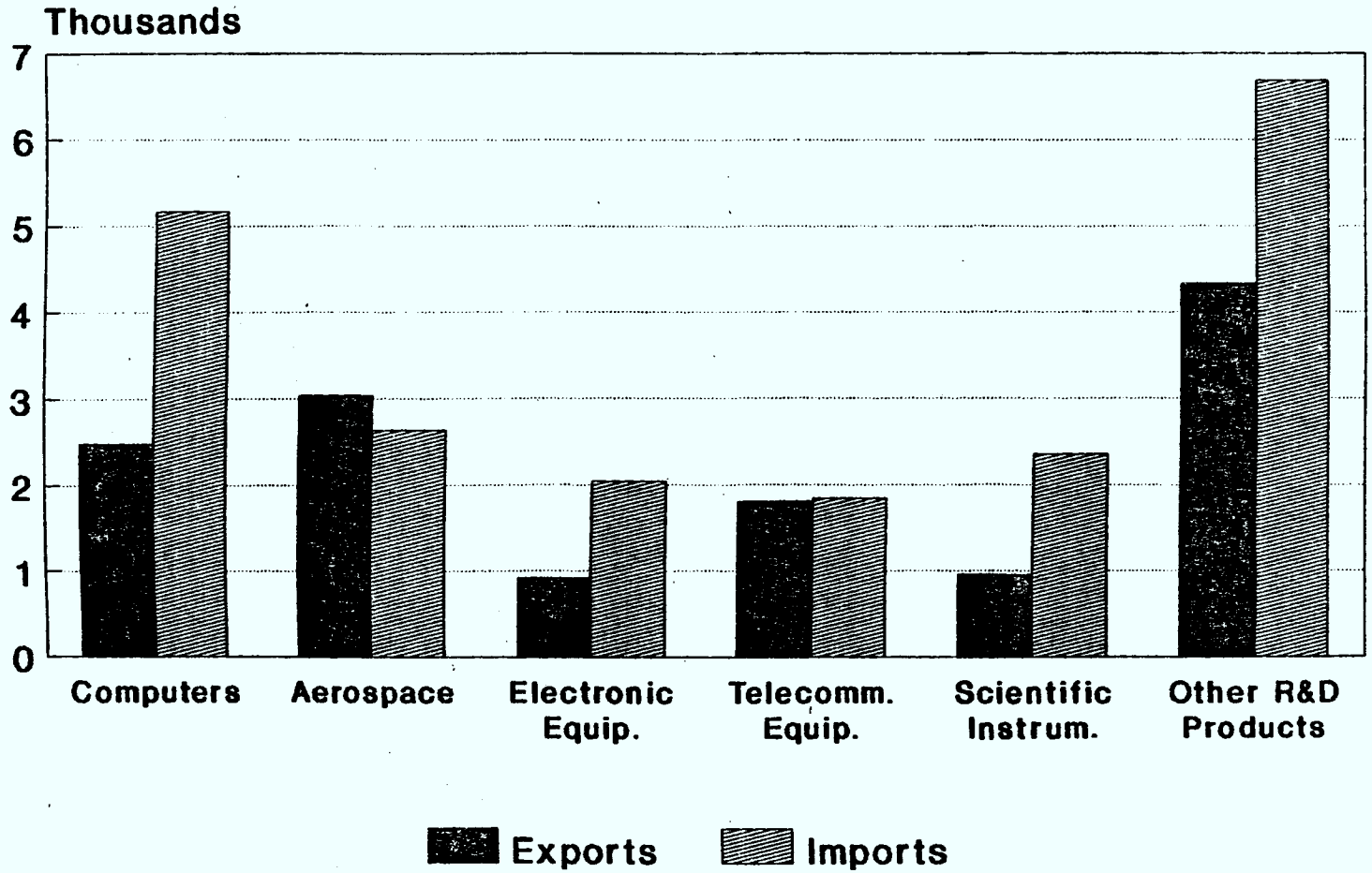
$35 BILLION OF GDP

MORE THAN FARMING, FISHING & MINING
COMBINED

EMPLOYMENT IN COMMUNICATIONS
AND INFORMATION TECHNOLOGY

DOUBLE THE NATIONAL RATE
OVER THE LAST DECADE

1987 Trade in Information Technology
($ Millions)



Source: Statistics Canada, Cat. 88-001

TELECOM EQUIPMENT MANUFACTURERS

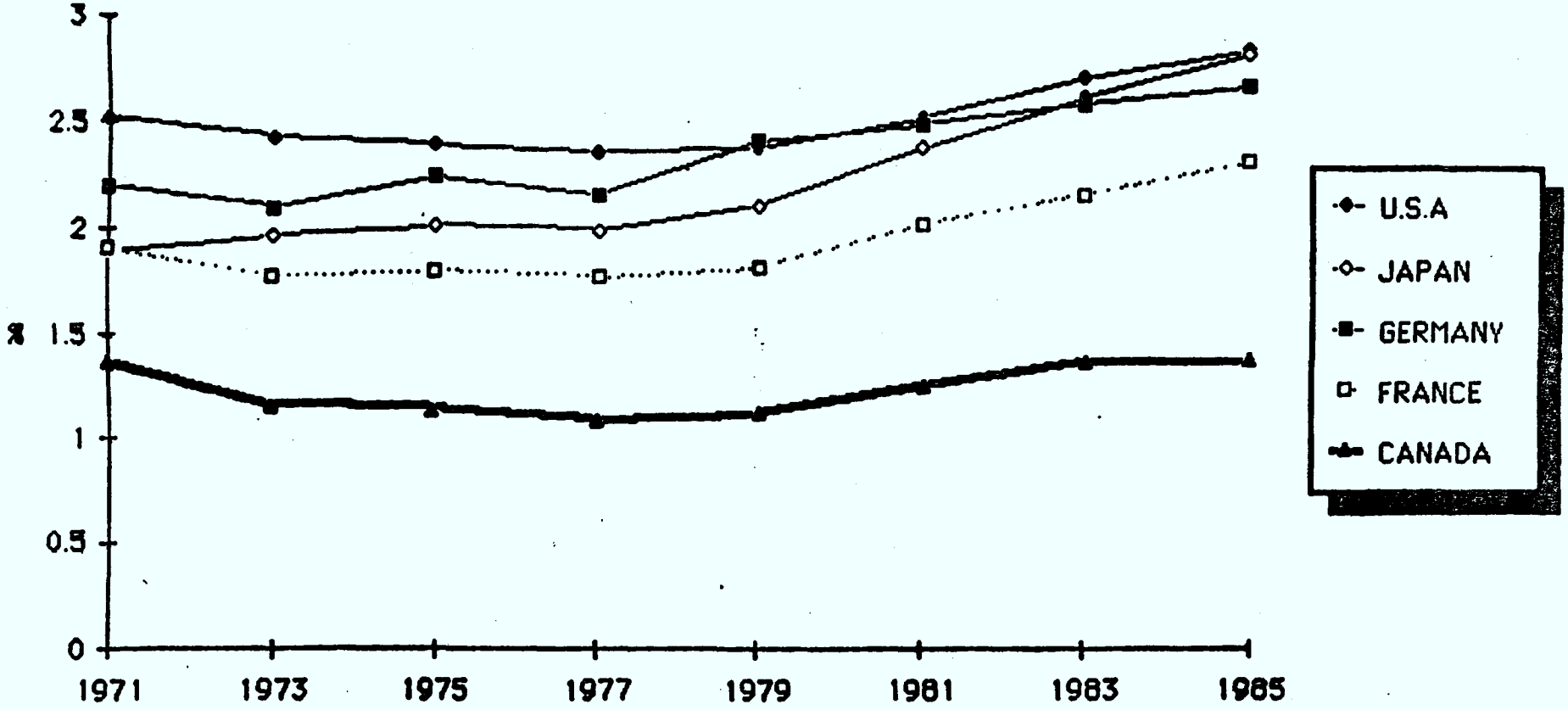
FIVE LARGEST COMPANIES IN THE WORLD
(1986)

COMPANY	REVENUE	COUNTRY
AT&T	10.2 B	U.S.
ALCATEL	8.0 B	FRANCE
SIEMENS	5.4 B	GERMANY
NEC	4.5 B	JAPAN
NORTHERN TELECOM	4.4 B	CANADA

THE CANADIAN R&D EFFORT

GERD/GDP FOR SELECTED OECD COUNTRIES

CANADA HAS TRAILED SIGNIFICANTLY OVER THE PAST 15 YEARS



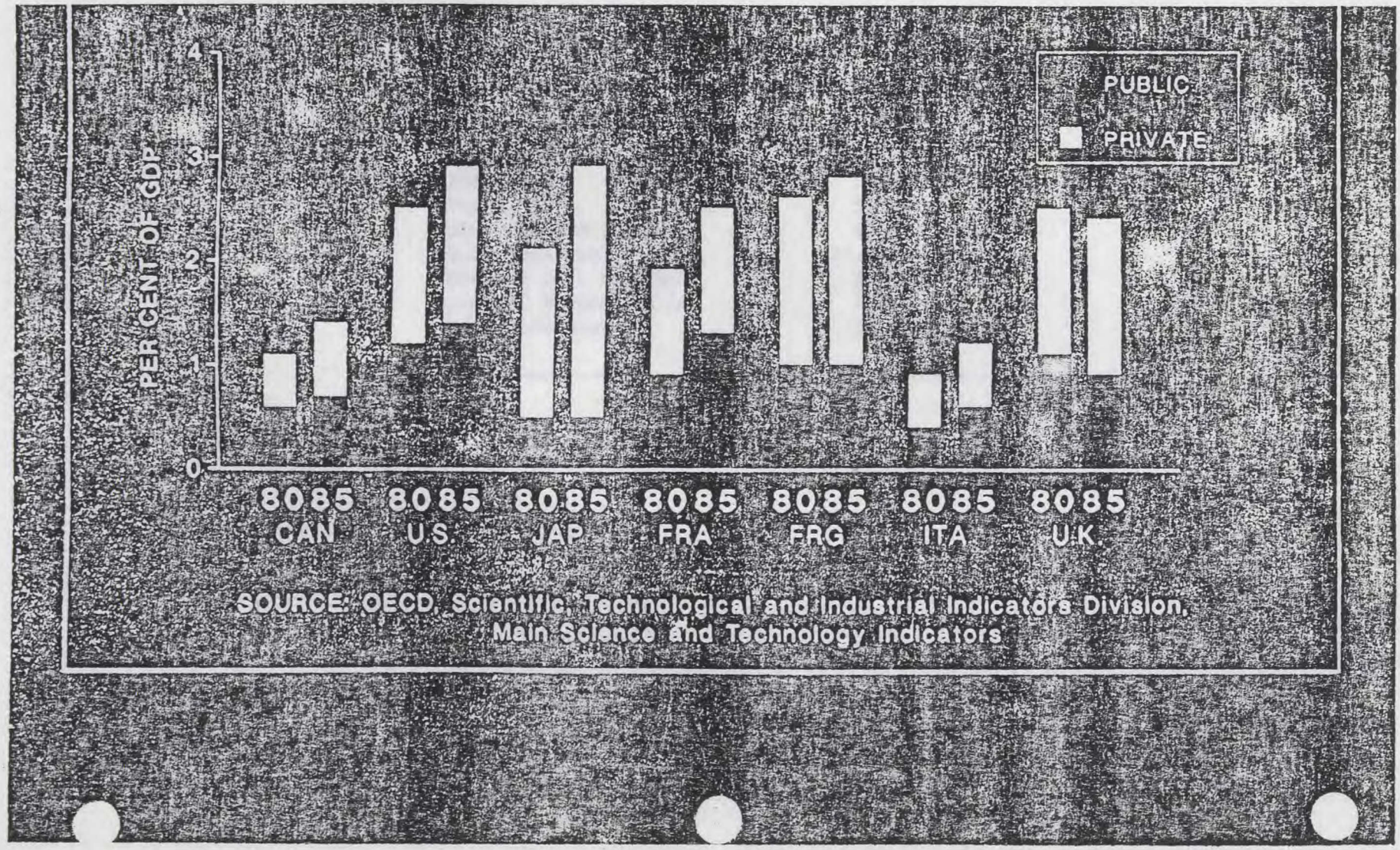
SOURCE: STATISTICS CANADA

INFORMATION TECHNOLOGY R & D
EXPENDITURES

OECD INFORMATION

COUNTRY	$ PER CAPITA
USA	101.0
SWITZERLAND	99.0
GERMANY	82.6
SWEDEN	74.3
U.K.	49.9
JAPAN	49.7
FRANCE	31.7
NORWAY	29.7
BELGIUM	25.7
CANADA	18.4
AUSTRIA	17.3
FINLAND	15.5

PUBLIC & PRIVATE FUNDING OF R & D
AS A PERCENTAGE OF GDP 1980 & 1988



KEY CANADIAN PERFORMERS
OF COMMUNICATIONS AND COMPUTER
R & D (1986)

Bell Canada Enterprises	$623 M
IBM Canada	89 M
Mitel	52 M
DOC Research Program	44 M
B.C. Telephone	27.5 M
Control Data Canada	25 M
Gandalf Technologies	13 M
Spar Aerospace	12 M

WHAT HAVE OTHERS DONE?

EUROPE	:	RACE, ESPRIT, JESSI, EUREKA
U.K.	:	ALVEY
NETHERLANDS	:	SPIN
JAPAN	:	TRON, SIGMA 5TH AND 6TH GENERATION COMPUTER SYSTEMS

OPTIONS FOR THE FUTURE

1. BUSINESS AS USUAL

2. INTERNATIONAL PARTNERSHIPS

3. CANADIAN PRE-COMPETITIVE CONSORTIA

OPTIONS FOR THE FUTURE

BUSINESS AS USUAL

* With some improvements
* More effective support mechanisms
* No emphasis on collective/shared work

OPTIONS FOR THE FUTURE

PARTNERSHIP BY CANADIAN COMPANIES

IN JAPANESE &

EUROPEAN ACTIVITIES

AREAS OF POTENTIAL COOPERATION

	CANADA	JAPAN	EUROPE
ARTIFICIAL INTELLIGENCE TECHNOLOGIES	*	*	*
SOFTWARE TECHNOLOGIES	*	*	*
MICROELECTRONICS TECHNOLOGIES	*	*	*
SUPERCONDUCTIVITY TECHNOLOGIES	*	*	*
OPTOELECTRONICS	*	*	*
HDTV	*	*	*

Based on survey of Canada, Western Europe & Japan

OPTIONS FOR THE FUTURE

CREATE CANADIAN PRE-COMPETITIVE

R & D CONSORTIA

SOME CANADIAN SCIENTISTS HAVE
PROPOSED

CANADIAN INTEGRATED BROADBAND
COMMUNICATIONS R & D CONSORTIUM

CANADIAN INTEGRATED BROADBAND
COMMUNICATIONS R & D CONSORTIUM

CAPABLE OF ALL SERVICES UP TO AND

INCLUDING HDTV

CANADIAN INTEGRATED BROADBAND COMMUNICATIONS R & D CONSORTIUM

BASIC INGREDIENTS

* DIGITIZATION OF NETWORKS (ISDN)
* TRANSMISSION TECHNOLOGIES
  - FIBRE OPTICS, SATELLITES, SHARP
* HIGH SPEED PROCESSING
* HDTV
* LOWER POWER, HIGH SPEED VLSI TECHNOLOGIES
  - GaAs DEVICES
* ADVANCED MATERIALS RESEARCH

"Towards a Gigabit USA Research Network:
Technology & Policy

David Farber, Moore School of Electrical Engineering

University of Pennsylvania

"TOWARD A GIGABIT USA RESEARCH NETWORK: TECHNOLOGY & POLICY"

DR. DAVID FARBER, MOORE SCHOOL OF ELECTRICAL ENGINEERING
UNIVERSITY OF PENNSYLVANIA

I want to do several things tonight. I'd like to take the opportunity to give a sort of motivational overview of what's been happening in the U.S. in networking. I'd like to discuss where I think we're going and I'd like to try to discuss what I think are going to be the big problems of the future. I'd like to do this in a somewhat, almost sacreligious way. I'm going to try not to bore you with an endless history of things. On the other hand, I'd like to go over some of the past, because the past has indicated that we made some errors. We made some errors in the creation of a national infrastructure and I think there are lessons to be learned for other people who are about to do this. And also, I think, when I go into some of the future work I'll address a view that we're beginning to evolve, maybe, on how the U.S. is going to react to the so-to-quote "Japanese threat". This is sort of an overview of some of the things I'll cover. The last several years have been an exciting time in the communications industry. The technology underlying transmission has increased at a phenomenal rate. The fiberization of the United States has been impressive, even by the standards of the people who said, "well, obviously it should happen".

Unfortunately, it has not been impressive in other aspects and I'll talk about that later on. Basically, the networks in the United States I think I could characterize as trying to create a structure which will improve the scientific productivity of the nation. We're putting in networks in the U.S. and we're talking about advanced networks, not so much because we'd like to do networks, although we do, but more because a number of us feel that communications is critical to the improvement of our scientific and engineering infrastructure. That has, to a large degree, been demonstrated in an old experiment, which is now getting a little creaky with age, but I think it is interesting because it shows us what can happen with an infrastructure.

Many moons ago, a bunch of us noticed that in a very restricted community in the U.S., namely, the computer science community, we were facing a major problem. The major problem was somewhat interesting. It was that there were too many Computer Science Departments. As you know, the U.S. has a lot of schools, to put it mildly. And, each one of them decided that computer science was a hot subject and each one of them built a department. And, most of the departments that were being put in were undersized in the sense that you might have one or two good people, maybe even a handful of good people, and they were stuck in the middle of what is a very inhospitable country to get around. It's sort of a two dimensional problem of the way I understand Canada. It is almost impossible to get from someplace here to someplace there in any rational way. This field was beginning to fall apart because people who were out in the middle of the world were cut off from their peers. What we wanted

to do was to try to create something that would allow them to work together. That was a relatively unambitious goal. There was a network in place. There was the military-funded OPA Network and it showed us very clearly that there were advantages to tying together institutions via communications, even if it was just a computer scientist in the act.

Unfortunately, from the standpoint of the vast community in the U.S., what happened is we tied together the "haves" and it just made the have-nots even more have-not. We made a proposal to the NSF, who actually very generously bought this one, considering that there was very little evidence that anything we said would happen. But they had been through this before. But, John Postu of the Computer Science Division said something which we, the networking community, forgot, and it's coming back to haunt us. I'd like to say what he said and show you how it has come back to haunt us. He said, "Look, everybody likes free goods and sure we'll give you money to build a network, but at some point in the game we're going to require that you show that, in fact, this bloody thing is good enough". What that means is that a computer scientist sitting in the University of Mississippi - just to pick a random place - is willing to give up a trip to a conference in order to pay his part of the network. And, if that's not the case some number of years down the line, to pick a number, it happened to be four years down the line then, in fact, you haven't proven anything. You haven't created something which so benefits the academic researcher that he is willing to trade off something to have that. And so, we want a relatively short fuse. Obviously, from the size of this awful mess, we sort of made it.

It's self-sufficient, but if you ask me how self-sufficient, I'll have to tell the truth. It's self-sufficient because we also decided that the academic community, no matter how you play it, can't pull off a network like this given the cost of a network that's professionally managed. And the government wasn't going to, so who else was left, -- industry. But we were in a rather reasonable position there. Industry wanted to recruit people from the academic community. We were supplying people who were going into industry. They didn't want to be cut off from their colleagues, the people they had spent years working with in the academic community. If they went into a research lab, in fact, there was a lot to be gained by being continuously in contact with the people at the academic world. And so, in fact, we ended up with a substantial number of contributing industrial companies who kick in, in the order of $30,000.00 a year for the privilege of connecting into this network; more than that for the support of the university infrastructure, for the support of the infrastructure that would bring networking to the departments.

I should point out that this, for a number of reasons, became the keystone for the United States connection to other national networks. We're connected to an inordinate number of international affiliates, plus a lot of foreign members, mostly in Canada, actually, and Japan, both industrial and academic. The international affiliate CS Net took the position that since it was the first of the U.S. national academic networks, it would deal with peer networks in foreign countries. It was not going to deal

with institutions in those countries because of the turf battles. Why go after the business of some other network? So, in fact, the arrangement was with peer to peer networks, and as you can see there's a fair amount of that, including some interesting cases. We would prefer one peer network per country but try to get the Germans to agree on one peer network! It's actually worse than some of our academic institutions who insisted on buying two memberships because Department "E" and the Computer Science Department wouldn't talk to each other. It's very strange, but true.

Okay, so let me go back to that. So we had an experiment which was a rather outstanding success. And it's still operational. It's about to merge with BIT Net and become one network and we're supposed to have flurries of drums at that point. Along came an interesting problem, courtesy of a very good set of salesmen from the physics community. The Congress of the United States was convinced that super computers were critical to the national research need. I think they were probably right in saying that. I think the creation of the national super computer initiative has had profound effects on the way science is done in the United States. A remarkable number of people have essentially become computational scientists as opposed to the normal sort of old fashioned scientist and it's had really profound results. There may be even a couple of Nobel Prizes which will be based on the computational science aspects. What the Congress did was authorize essentially five or six. It's hard to keep track of how many they authorized and how many were created.

Super computer centres - now, there were <u>two</u> models for a super computer centre. Model 1 was bringing the people to the centre. One of the problems that we faced in the U.S., and I think everybody in the academic community faces it, is that if you bring the researchers to the centres, unfortunately, they leave their institutions. That makes it difficult for graduate students. It makes it difficult for departments. You can't really do that and maintain a viable academic community. So, in fact, that didn't seem to be too successful an idea, either politically or practically. To the rescue came networking, in a very strange set of ways because of the particular time scale of that thing. And a national network was formed. Now, it was formed basically to service the super computer centres. Rapidly that escalated, as one could predict it would escalate, to one that supported science in the broadest sense of the word. All the other scientific fields including physicists and a lot of other people who had the same problem the computer scientists had. They had just as many departments and were just as thinly laid out. In addition, some of them actually wanted to get a super computer. So a network was formed and that network, after a bunch of somewhat annoying name changes, courtesy of people owning names, was called NSF Net.

To cut a long story short, because I don't want to spend a huge amount of time on the past, what happened was that we split the world semi-arbitrarily into things called regional networks. And what we did was sort of sit with a map, and say well that's a region and that's a

region and that's a region. Now, why don't you submit proposals, to the National Science Foundation for money to create a regional network and the NSF would provide some "AT&T" backbone, and provide the inter-regional communications. That was probably, in hindsight, a bad mistake. The problem is that we didn't draw boundaries, or maybe we couldn't draw boundaries, around groups that could actually be self-sufficient. Again, we forgot what John Postu said back in the old days and drew arbitrary divisions that bore no relation to the political realities of the United States and there are some very strong political realities.

We also didn't require these regions to do what CS Networks were required to do and that's to convince somebody before they were formed that they had a business plan; that, in fact, they could operate without an endless subsidy. Now, remember, the term subsidy in the U.S. in the scientific community is a strange term. It's not the question of whether the money comes from the government. Eventually, in this type of science game, the money comes from the government. The question is whether the money comes via the overhead rate of institutions on research and direct charges in contracts for use of a network or whether it comes as a side-funded activity. You know, here $40, $50 million dollars to you, you and you go run a network.

That type of subsidy is very nice, but it doesn't tend to attack the fundamental question of "is the network doing anything for anybody". There's no customer. The customer doesn't have any impact on it. It's sort of free goods and free goods are worth about what you pay for them. What's been evolving over the last couple of years, courtesy of this, and it's a slow painful process because we didn't think about it adequately. Up front is a restructuring of our particular divisions and regionalizations into groups that are politically based and courtesy of a strong set of comments from the Director of the NSF that "I'm not going to support you indefinitely", they're sort of getting the idea that they have to create a market. You have to create customers, and those customers must be willing to pay, pay in the sense of give up a conference or put a line item in their research proposal. So that the test is there.

Now, recently, several things have happened. Remember I said that the NSF would supply a backbone. Well, it's gotten considerably more complicated but let me just talk about the NSF backbone. A competitive procurement contract was let which was won by Merit which is Michigan, the regional network, in cooperation with IBM and MCI to supply a national backbone in support of NSF Net. This network is currently a T1 system supplied by MCI. This is, if you want the long lines of a national network, to use the old AT&T terminology, the nodes are fairly interesting little switching complexes that I won't go into. And, the regionals connect into these. These circles are either super computers or regional connection points. This network is operational; in fact, it's getting a fairly substantial load, maybe too much. This slide shows you the growth of load on a network, on a national network and it's still going at 600 million packards per second.

Now, to be honest, the substantial amount in that package is electronic mail. And, that's good. Because, remember, one of the things I said is that the purpose of the network is to tie together the science community of a widely distributed, geographically dispersed nation. And it's electronic mail and the use of that even with it's funny little sides is a critical part of that. In fact, there are many of us who believe that if you took away the super computers you could justify the network. Try to take away "E" mail. It happened essentially for three days a couple of months ago when that infamous worm hit our network and "E" mail vanished from the network for a couple of days and the impact on the community was severe. It wasn't fun, it was really severe. Papers got off-schedule, some papers missed deadlines, conferences got whacked in pieces, trips got cancelled. It really was an interesting case of the infrastructure the networks like this built.

By the way, the backbone of that network is about to be expanded to a DS3. And that should happen sometime this year, so we'll have a 45 megabit version of that network.

Concurrent with this development, several things happened. It was clear that T1, DS3 - all that stuff - was fine for the short haul. But, in fact, if you went and talked to the scientific community, the more adventurous ones, and I'd like to get back to the term adventurous later on, in the physics and chemistry community, thought that these were crawl speeds. And there are also groups that say "who needs T1? All I need is 9.6 kilobits and I can run forever". In general, those were the people who took the view that a network is something that connects a terminal with a machine. And then there were other people who started asking if it was possible to run the 6 super computers on one problem and have five or six investigators sitting out looking at real time simulated motion movies of these little atomic whoohackies all being simulated and so change the model and do good science. And these guys made very convincing arguments that in fact you could do good science this way. There were also a whole bunch of other things of that type. People who wanted to look at HDTV, class images, multi-colour class images that were generated by super computers in real time. And you say, well, do they need it. Well, you know, it's the old game. If you've got three Nobel Laureates saying they need it, they carry more weight than a lot of people, it turns out.

Also, there were some very, very interesting research issues raised. It's a long, long step between DS3 and 45 megabits and a gigabit, a very long step, and a lot of things happen as you make that step. In fact, several studies were done. There was an ASTP study, the U.S. office of science policy. It generated a summer study, a summer meeting, where in fact we went over the needs of the nation for gigabits and whether anybody would ever use a gigabit. And, of course, with no big surprise, everybody said yes, in fact, the gigabit may just suffice. Well, nobody ever believed some of the studies, so the powers to be asked the National Research Council to form a committee to look at that ASTP report and say whether it made any sense. The group, some of which were in the summer study, like me, took, I think, a reasonable look at it and said YES. In fact, the report makes sense and the whole thing makes sense.

But please realize one very, very important thing - there is no smooth transition. There's no evolutionary path from where we are now in networking to a gigabit speed network. Not if a gigabit speed network means I'm going to deliver, to a host potentially, data at the rate of a gigabit. Protocols probably, almost surely, won't work, unless you want to buy all the memory that Japan produces and sells at under cost. We could bankrupt the Japanese with the buffers we'd need, which is a thought. There's no way known to mankind, conveniently, although you can do it maybe in a super computer, that you're going to get a computer to interchange data with anybody running a conventional protocol at a gigabit. Maybe you could go to a hundred megabits, probably not, in practice, but maybe by stretching the point. So, in fact, a whole set of things sort of fall apart. Protocols don't work, host interfaces don't work, network management doesn't work, nothing works.

Transmission works. There's no problem to build a gigabit network in fact, you know, 2.7, 3.5 gigabits is like relatively falling off a log. And if you can get around the telephone company, you can even get that in one piece as opposed to channelized to death. That's sort of an interesting research question. Now, our estimates of what it would take to do that were relatively impressive. We figure that, probably (and you whisper this because Congress gets very upset over numbers like this) it costs in the range of a billion dollars of R & D to pull it off. It's not going to be a cheap project and then, probably, you know, it will cost three hundred million a year to operate. What are the benefits? Well, it goes back to do you believe that networking is a viable way of tying together the sciences and making them more productive. I think that's taken as an article of faith now in the U.S. One doesn't disturb that faith. I personally think it's correct.

Today, one of the reasons I got up here late is we had a very interesting workshop on something we called "Collaboratory", which is based on the assumption that we have a gigabit class network and now we ask "what do you do with it?" The notion there is to look at how you build distributed laboratories. And, it turns out there are a lot of applications where, in fact, you want to do that for a number of reasons. A simple case is one that was in the New York Times article which identified that there is only one teaching reactor in the United States. There are about ten schools which teach nuclear engineering; there's one reactor. Wouldn't it be nice if you could actually run that reactor experimentally over networks, so in fact, the students in those ten schools could actually get their hands on a reactor when they're taking a nuclear engineering course. You can't do that now. In fact, in nine of those schools, basically the students hardly ever see a reactor - maybe they visit for a day or so. That's sort of dangerous when they're going to be out there building them!

There are a whole host of problems where in fact you "can't get there". The NASA, the space telescope and the space station are the classic things. You're not going to take the researchers up to the space station. I'll volunteer, but I don't think we'll make it. Not only that but, in fact, not just one scientist is doing the experiment. There will be a

whole bunch of scientists trying to collaborate on experiments. They're going to be geographically dispersed because politics in the United States says they're going to be more dispersed.

Now, I'd like to chat briefly on two things. One is, "how do we go about doing this" and the other is "how are we going about doing it". Well, in a sort of a U.S. approach to life, in fact, a relatively rare U.S. approach to life, we decided that in fact we would try industrial/university collaboration for real, in the following sense. It was clear that the government, in its current feeling in the United States, is not about to pour a large amount of money into industry in the early stages of the evolution of such a network. It just doesn't happen. The National Science Foundation does not have that type of money around. And, in fact, if we poured it into our major research laboratories it would go into the Federal systems part of those laboratories which is not where the innovative research is necessarily done. And so, what we wanted was a mechanism where in fact universities and industry could work together intimately on trying to solve the very difficult problems that are raised with the gigabit technology and I talked up at the National Research labs about what those detailed technological things are and I have what I think is a good paper which tries to explain some of those very difficult research problems. I can send this to anyone who wants it. But, how do you go about institutionalizing that in the nation? We took a route which is sort of very strange and is still causing trouble even though it's beginning to run.

First of all, we decided that we needed a fast-acting way of organizing research. Our normal funding agencies, bless their hearts, are not the fastest things in the world. By the time you put a proposal into the NSF and get it refereed and everything, you get two things happening to you. First is this beautiful homogenization that says you haven't solved the problem; therefore, your proposal isn't good. If I solved the problem, I wouldn't be proposing it! The other thing - it takes time. So what we did is to privatize a major project. We proposed to the National Science Foundation that they give us a pile of money, not a huge pile of money, maybe ten million dollars over three years. The aim of that ten million dollars would be to fund the evolution of a plan for how to deploy the gigabit network. Now, that's not just a plan on paper for here's how to do it; it's trying to attack some of these research problems and seeing if they can be solved. The bottom line may be, although none of us believe this - at the end of three years, that the answer is that you can't. You know, we don't know enough. We don't believe that, but conceivably, it could happen.

We determined that we'd like to use that money primarily to fund the academic side of the house and we'd like industry to be involved with this because it would be in their own vested self-interest to be involved. Now, we had done some pump priming on this and we had actually gone around to five of the major companies in the U.S. - DEC, IBM, AT&T Bell Labs, BELLCORP and XEROX - and said if you were asked to work with the universities on the gigabit technology network, your particular part of

it, would you be willing to do it on a zero cost basis, only being reimbursed for out-of-pocket equipment costs, if necessary. They said yes, we'd be willing to do that. So, we went out to a call for a white paper, which is where we are now, asking for people to send in what they would like to do, how much they need to do it. Now, not on the basis of a proposal, but a statement of capabilities, basically, we got 80 responses. We went before a very good panel to look at those and about half of them were clearly relevant to the gigabit development activity and there are some spectacularly interesting proposals there. About half of those, give or take a little bit were from industry who were told repeatedly that they were not going to get any money out of it. So they had to be interested in it from the standpoint of either their own internal research organization or the fact that they felt there was a market there. And that, in order to see what the market would be and see what it's use would be they would be willing to devote the money for that.

We're in the process of actually gathering that together. We have to make the bottom line bill and go back to the Science Board this summer and they will give us, theoretically, the money. And then, we'll be off and running. We had no great surprises when it came to who responded. There were other people we expected to respond. We did not open it up internationally. We didn't constrain it to the U.S., because you can't do that very nicely, but we tried to concentrate on our own national self-interest, to be blunt.

Let me make some mega observations and some of these are not necessarily complimentary to the communications research business. I think, and it showed in some of the replies we got, that we're suffering a crisis of adventurousness. All too many of the very good researchers came back with proposals which, when I was back in Bell Laboratories and if somebody had said let's do that in the research division, I would have laughed them out of the house. And I probably would have said well that may be current engineering or it may be development shop but it ain't research.

We've gotten into the mode and I recommend you not get into the same mode of thinking that research is something you can do in a year. Maybe you can and maybe you can't, but it's very seldom far out research when you can finish it off in a year. We're suffering, I think, from the lack of imagination, more than we are a lack of talent. It's been hitting us quite badly and one of the things we've tried to stir up in our own little community with this gigabit network is to cast them out just a little bit. Now, there are many of us who believe that the gigabit network is current, is short-term engineering, relatively four or five years of engineering and that by the year 2000 we'll be facing networks which are considerably higher speed than this.

Now, let me tell you my way of thinking. When you're running at a gigabit, in excess of a gigabit, you're starting to approach the bandwidth of a computer bus. And that makes life very, very interesting because now when you hook two computers together with a gigabit half between them, you

essentially have a multi-processor which just happens to be physically distributed. It has some funny properties. You make a reference somehow to if you built an interface so that everything will look like shared memory which you could do in that type of environment. When you make a reference to the memory you know some of it's local, some of it may take a long time to come cross-country. But you have the bus bandwidth there. You just have funny latency characteristics. But, in fact, we've seen those before. Paging devices have funny latency characteristics too. In fact, it's quite probable that one of the experiments we'll try is to build a national distributor machine. Back to the good old days of everything including paging over the network. That could provide some very, very interesting tools for the scientific community who think they have immediate needs for those things, again going back to the 15 or 16 super computers all operating on one problem concurrently would be a very interesting experiment and there are integrating problems in science that can be solved that way.

Let me go back to why we're doing all this. I think a lot of us have a lot of objectives. As I said earlier, in some sense the networking community would like to have some fun. We believe that the science community can use these resources and will use them and will improve their efficiency as scientists. I hate to use the term productivity because I don't know how to measure it. I'm not sure I ever want to measure it. But, in fact, if we can convince the science community to do two things simultaneously, one is to work more efficiently even though they distribute over a very large country and be willing to stay in small institutions and still feel they're in the forefront of science, then we've made a major change in the culture in the country and that major change in the culture could have a lot of impact on the way we in the United States evolve our academic environment and our industrial environment. All this goes across industry and academia.

The other thing is a problem which I would like to throw on the floor which is worrying a number of us in the U.S. and that has to do with the nature of the academic community, in particular computer science and engineering. We're evolving very, very rapidly to a large number of theoreticians and a small number of practitioners. And if that continues we're going to have a lot of people teaching software engineering who have never built any software larger than one page; people teaching architecture who have never built a machine. A lot of people are talking about computability, which is not going to turn out the type of scientists and engineers that we need as a nation.

A lot of us feel that activities such as these large projects, properly orchestrated, can spark the enthusiasm of people in the academic community who would like to get involved in real research projects with the system skill to do it and can generate a whole new set of people in the academic community who are happy there because they have problems to turn them on as opposed to going off to industry which is what most of them do now. And maybe we can get people who teach software engineering who have programmed something who would be useful for the nation, and who would be

useful for the students who are our next generation of scientists and engineers.

I am open for questions.

SLIDES

DAVID J. FARBER

"TOWARD A GIGABIT USA RESEARCH NETWORK:
TECHNOLOGY AND POLICY"

Toward a Gigabit USA Research Network: Technology and Policy

David J. Farber

Professor of Computer and Information Sciences

University of Pennsylvania

March 11, 1989

The NSFNet and its background

The for-runners

- CSNET - a proof of concept
- BITNET

ONENET -- The Merger

ScienceNet

- the spur of the Supercomputer
- the initial misstep
- recovery

The NSFNET Backbone

- Academe and industry together

SOME BACKGROUND - ALL FROM THE VIEWPOINT OF THE USA

- THE TECHNICAL SCENE
  - COMMUNICATIONS TECHNOLOGY
  - FIBERIZATION OF THE NATION
- THE NSFNET
  - A NATIONAL SCIENCENET
- OSTP
  - A REPORT TO THE CONGRESS
  - A THREE PHASE ACTIVITY
- THE NRC REPORT

TOWARD A NATIONAL GIGABIT NETWORK

How do we get there; how do we pay for it and how do we manage it

- Phase I is happening
- Phase II (that is 1 megabit service) must be done well and managed well
- Phase Three Research must start soon
  - "Kahn/Farber" Initiative
    - o joint industry/adademic
    - o plan the R&D for Phase III
    - o Why CNRI

IT'S THE TECHNICAL STATE-OF-THE-ART

- PROTOCOLS
  - O NO WAY OF EXTENDING INTO GIGABITS
  - O REVOLUTION NOT EVOLUTION
- SWITCHING TECHNOLOGY
  - O BACHER/BAYONS AND BEYOND
  - O MUST LOWER OVERHEAD
- HOST INTERFACING AND PROGRAMMATIC INTERFACE
  - MEMORY BUS TECHNIQUES

<u>MUST CO-ORDINATE IT ALL BETWEEN INDUSTRY AND ACADEME</u>

USTIFICATION FOR SUCH A NETWORK

INTER-RESEARCHER COMMUNICATIONS

ADVANCES IN NETWORKING HAVE NOT KEPT UP WITH DVANCES IN COMPUTERS

AVAILABILITY OF VERY LARGE DATABASES AND ACCESS O THEM

COMPUTATIONAL RESEARCH TAKES PLACE IN DISTRIBUTE OCATIONS

BENEFITS TO THE COMMUNITY

OF 1ST CLASS INSTITUTIONS GROWS MUCH SLOWER HEN THE # OF RESEARCHERS

BENEFIT THE USE OF MAJOR RESEARCH INITIATIVES -- SE AS DEVELOPED

What are Networks used for now

- ELECTRONIC MAIL
- FILE TRANSFER
- GRAPHICS AND IMAGE FILE TRANSFER
  - o .75 GBITS/SEC 1024x1024x8x3x30/SEC
- REMOTE COMPUTER ACCESS
  - o BOTH INTERACTIVE AND BATCH
  - o REMOTE ACCESS TO DATA BANKS

Examples

- Supercomputer Centers
- NACSIS

WHAT FIELDS CAN BE BENEFITED

MATHEMATICS -- SIMULATIONS AND IMAGE GENERATION

PHYSICS -- SUPERCOMPUTING ACCESS

CHEMISTRY - TRANSMISSION OF 3 D ELECTRON DENSITY MAPS

ASTRONOMY - IMAGE DOWN LINKING AND SC IMAGERY

ATMOSPHERIC SCIENCES

ENGINEERING

LIFE SCIENCES -- 3 D SC GENERATED RT IMAGES

ECONOMICS - ACCESS TO DB AND SC FOR LARGE SIMULATIC

ARTS AND HUMANITIES - LEXICON OF LANGUAGES SMALL GROUP ABILITIES TO WORK TOGETHER

User Concerns

- Researchers are not a homogeneous group
- They are confused by the current state of the AR and don't want to be test animals
- Can a National Network be managed

Given their frustration with the status quo, researchers need systems that demonstrates responsiveness to their concerns

- NOW DO YOU FUND IT

  - A MARKET MECHANISM

    O PROVIDE INSENSITIVE FOR COMMERCIALIZATION

    O USER CHARGES MUST BE REFLECTED IN FUNDING MECHANISMS

- HOW DO YOU MANAGE IT

  - A "FOR REAL" MANAGEMENT ENTITY

THE CASE FOR MACNET

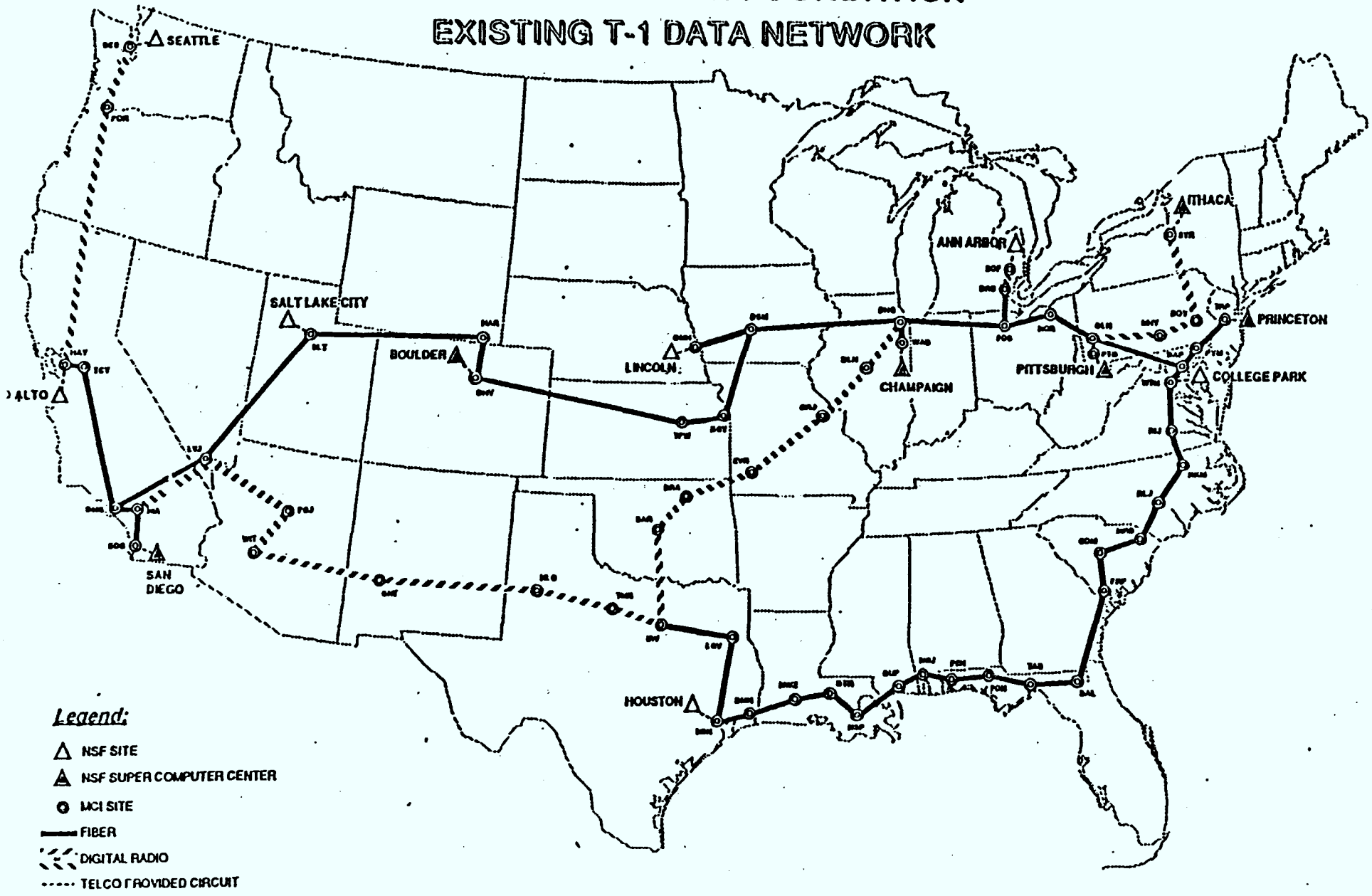
THE PROBLEMS

- EXCESS COMPETITION
  - UNWILLING TO CHARGE
  - AREA CONFLICTS
- NO SUPPORT FOR THE BACKBONE

MACDONALDS (REALLY VAIL) GOT IT RIGHT

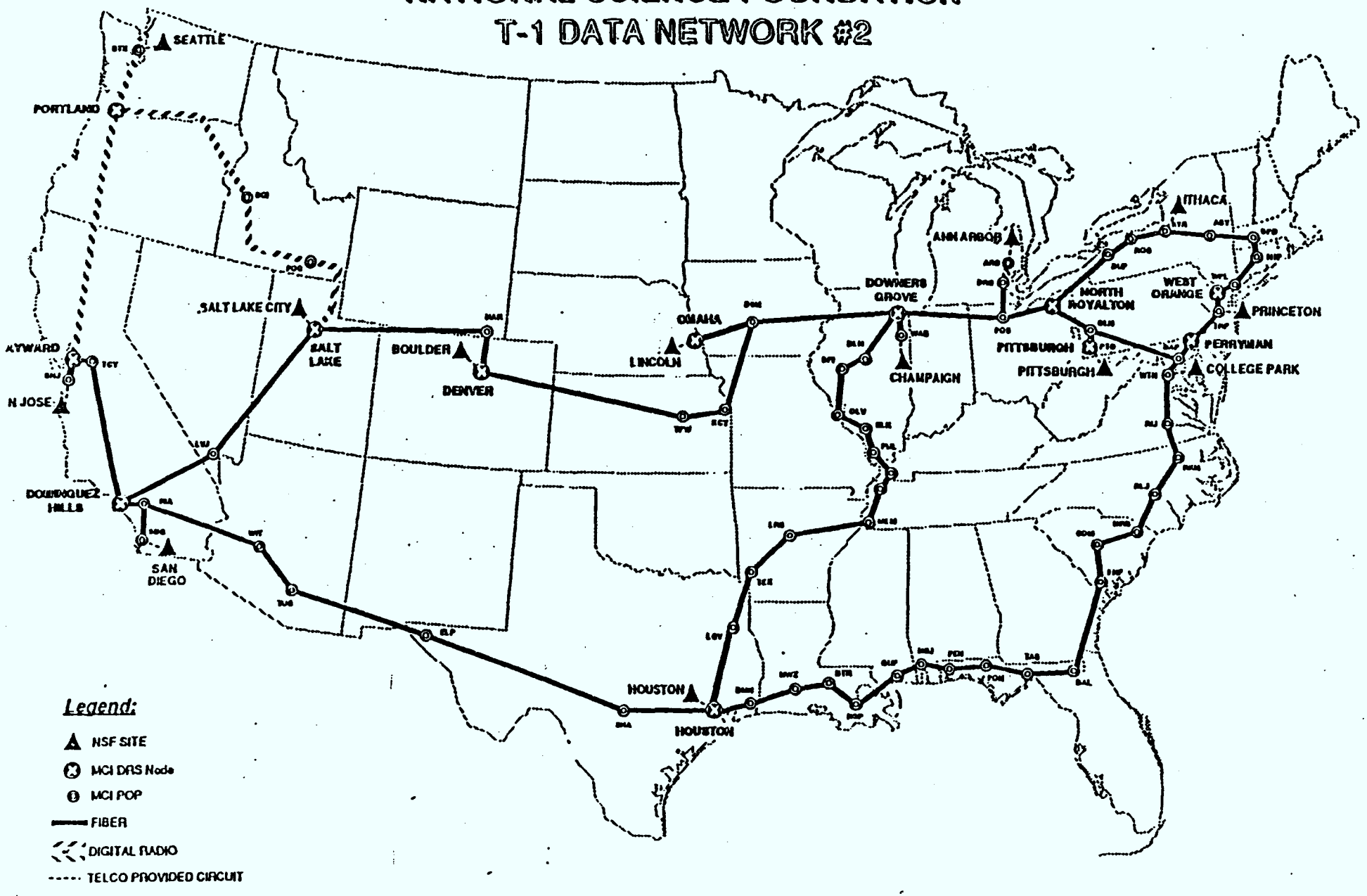
A PROPOSAL

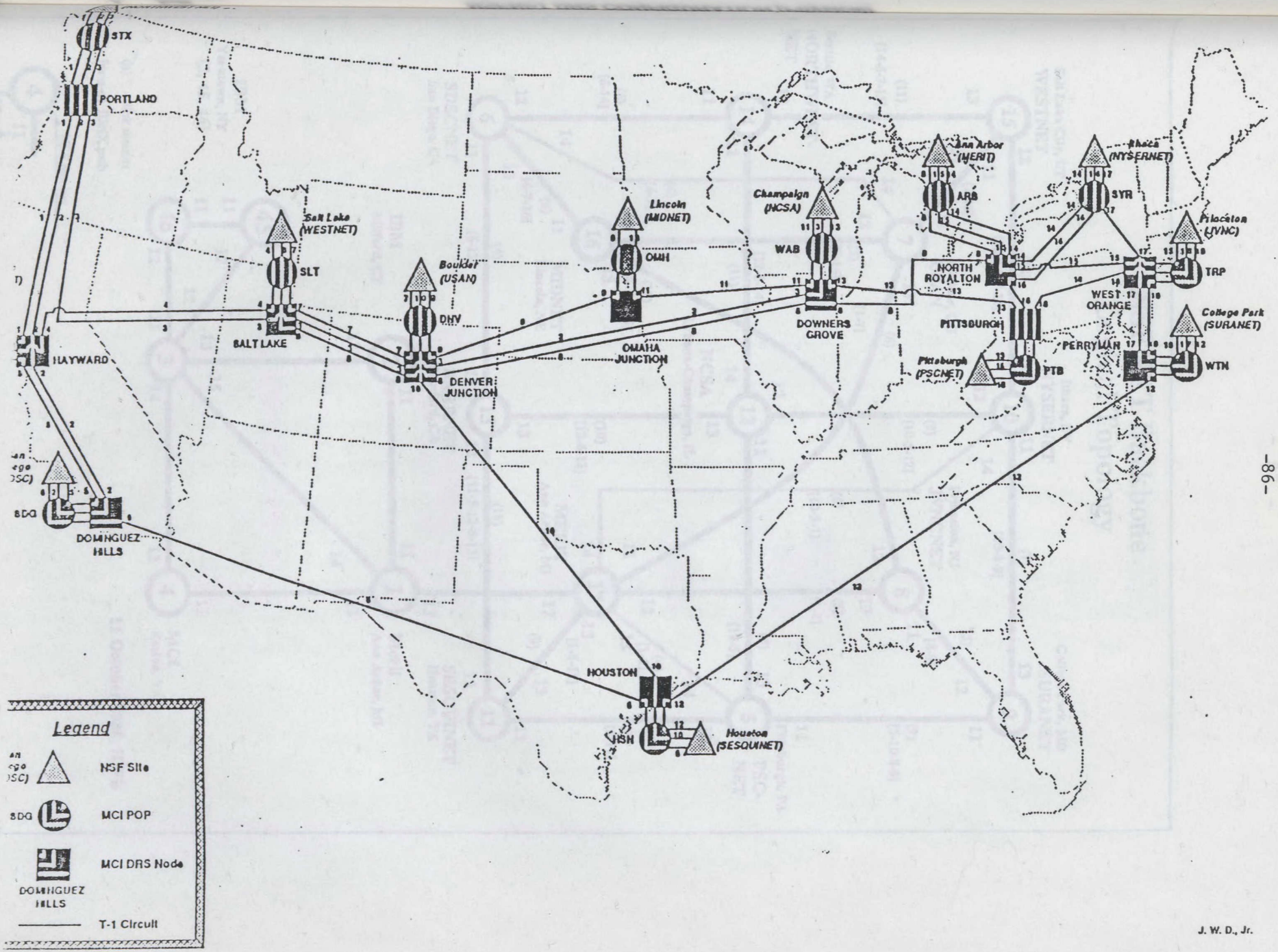
NATIONAL SCIENCE FOUNDATION
EXISTING T-1 DATA NETWORK



J. W. D., Jr.

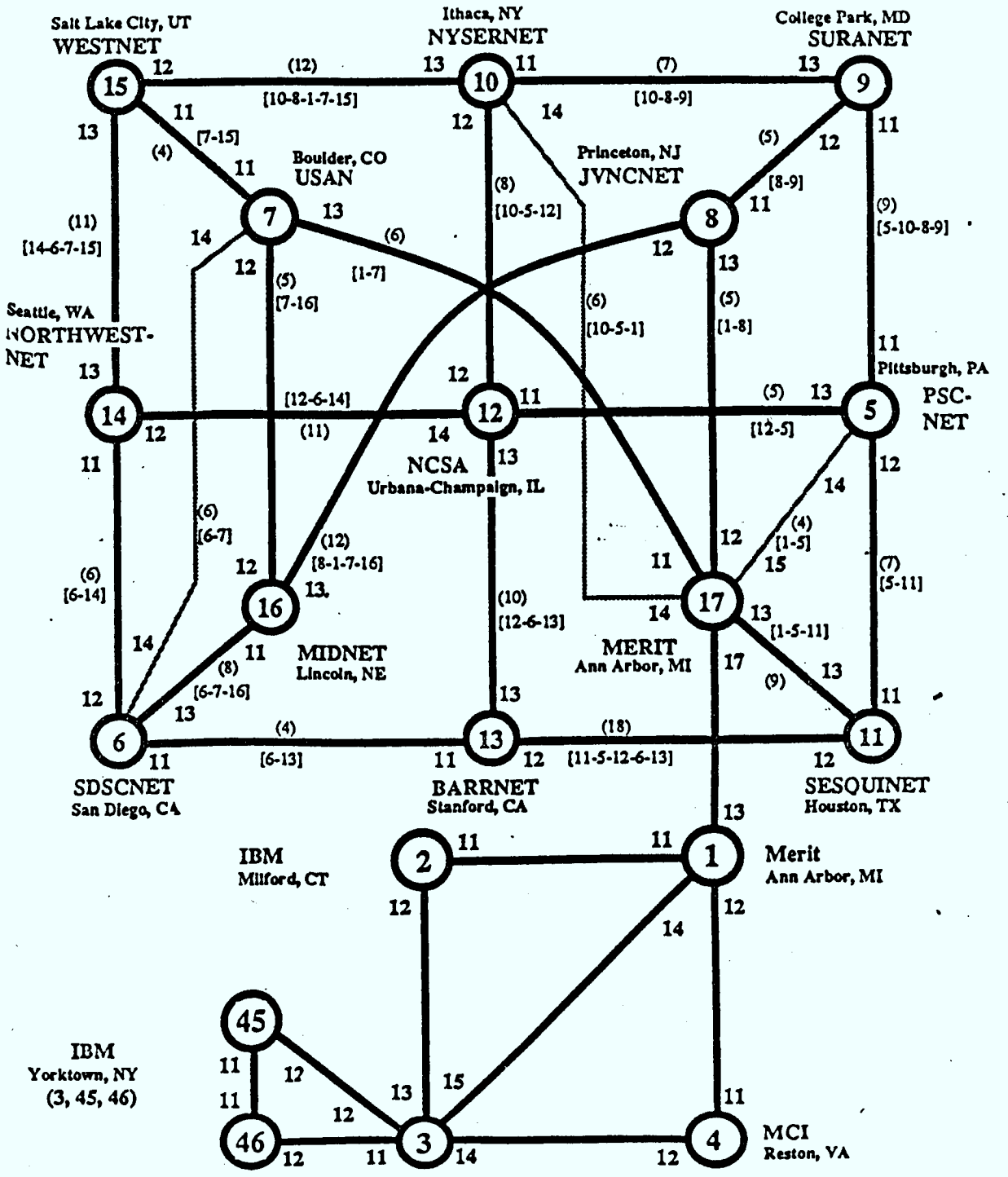
NATIONAL SCIENCE FOUNDATION
T-1 DATA NETWORK #2



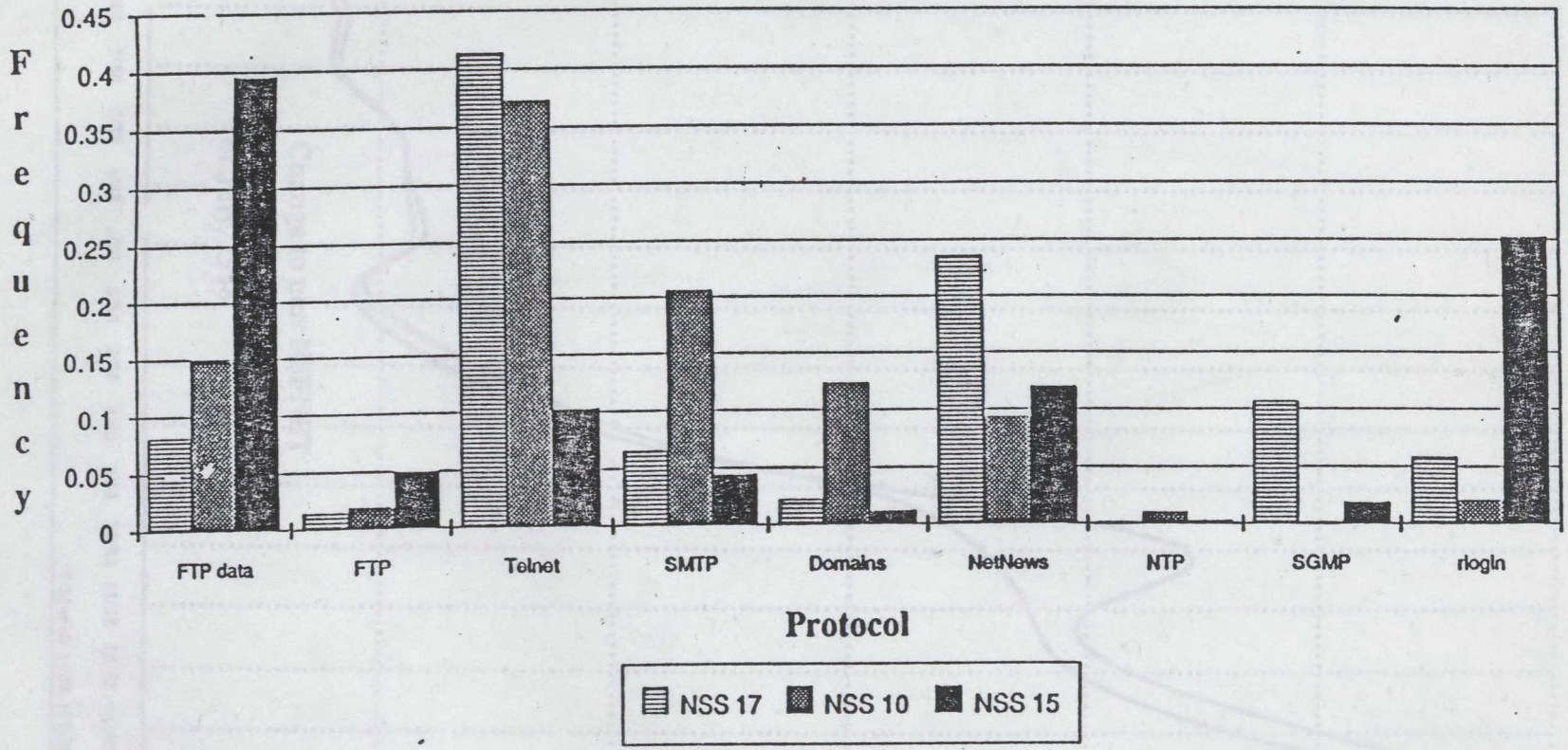

STX
PORTLAND
Salt Lake (WESTNET)
SLT
SALT LAKE
Boulder (USAN)
DNV
DENVER JUNCTION
Lincoln (MIDNET)
OMH
OMAHA JUNCTION
Champaign (NCSA)
WAB
DOWNERS GROVE
Ann Arbor (MERIT)
ARB
NORTH ROYALTON
Ithaca (NYSERNET)
SYR
Princeton (JVNC)
TRP
WEST ORANGE
College Park (SURANET)
WTN
PERRYMAN
PITTSBURGH
PTB
Pittsburgh (PSCNET)
HAYWARD
SDO
DOMINGUEZ HILLS
HOUSTON
HSH
Houston (SESQUINET)
Legend
NSF Site
MCI POP
MCI DRS Node
DOMINGUEZ HILLS
T-1 Circuit

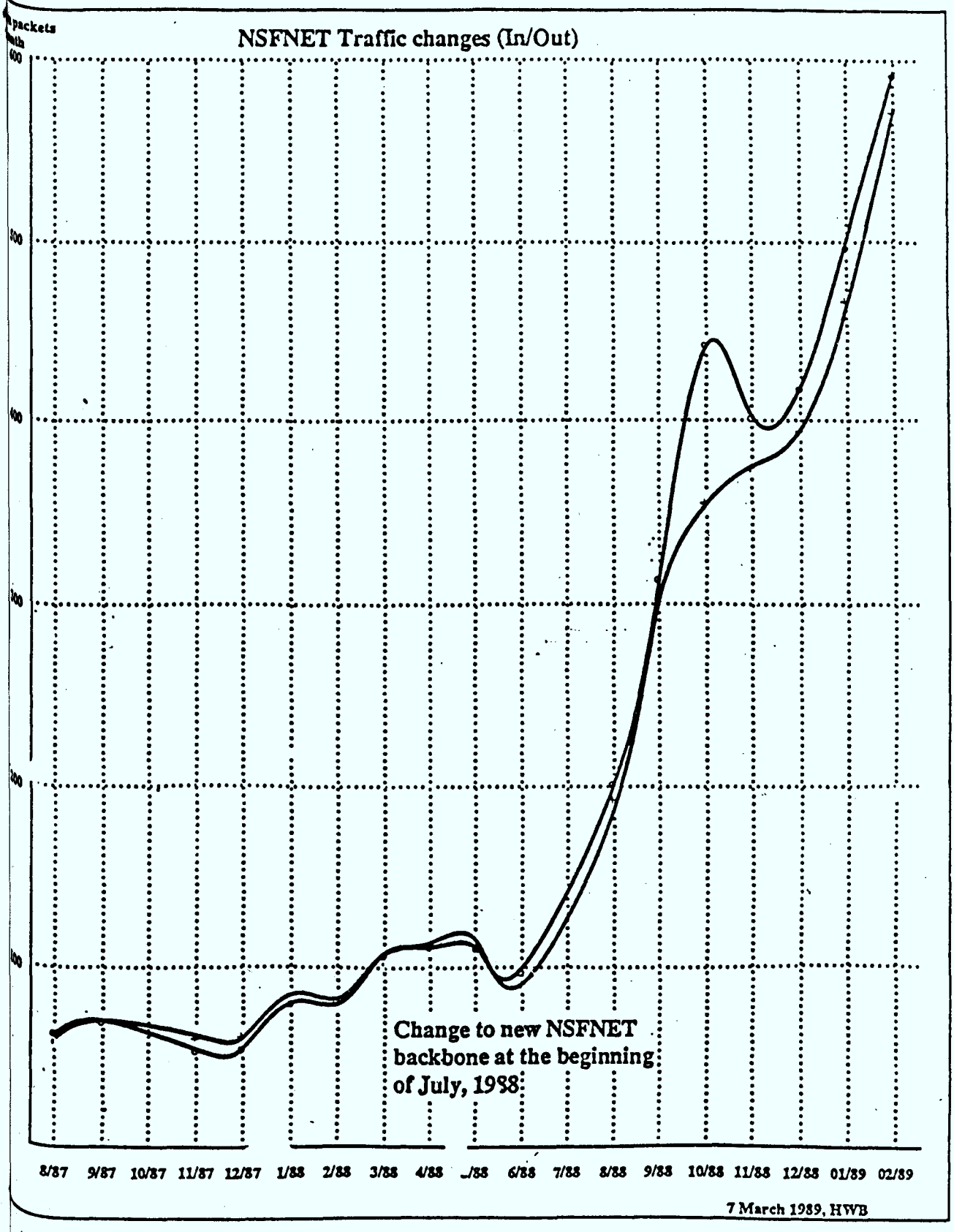
J. W. D., Jr.

NSFNET Backbone
Logical Topology



Activity by Protocol Type




packets
NSFNET Traffic changes (In/Out)
600
500
400
300
200
100
Change to new NSFNET
backbone at the beginning
of July, 1988
8/87
9/87
10/87
11/87
12/87
1/88
2/88
3/88
4/88
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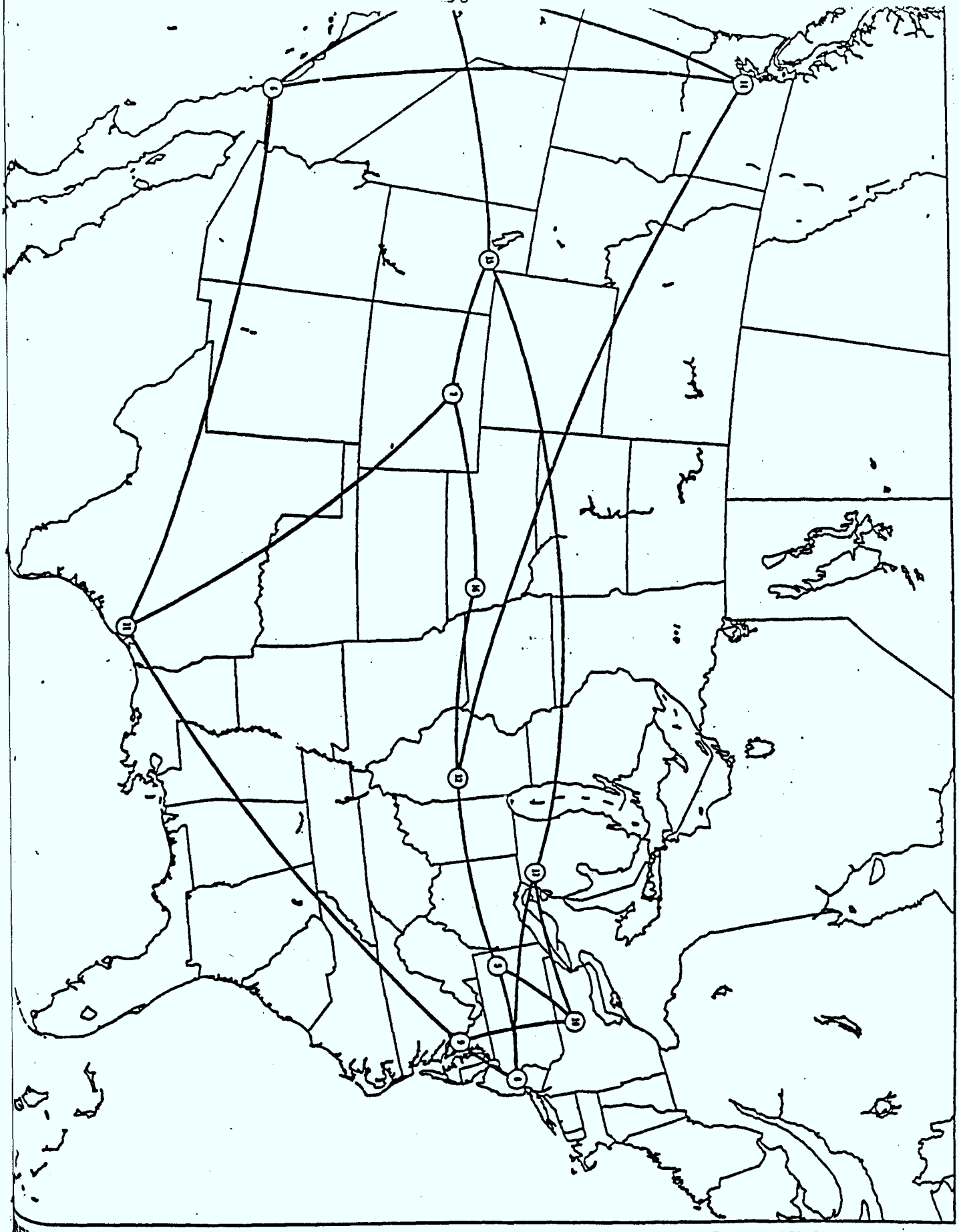
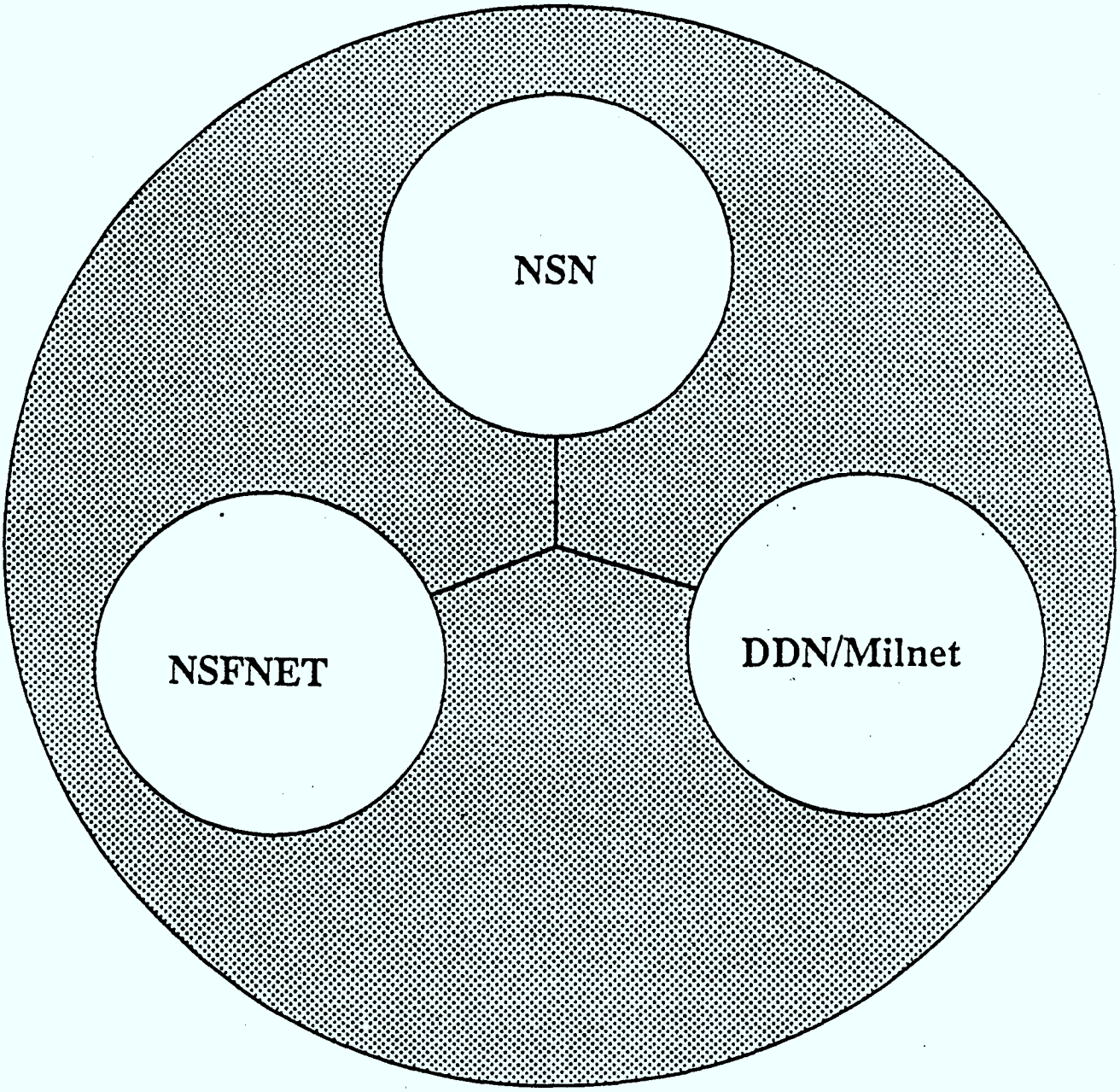
01/89
02/89
7 March 1989, HWB



FNET Backbone
tain NSS number

Prepared by NSFNET-info@merit.edu at Fri Feb 24 13:58:52 1989
netmap-1.5 program by Brian Reid, map data from World Data Bank II
Lambert Conformal Projection [44°N,33°N], Map center: [40°N, 96° 30'W]
Image resolution 300/in., stroke limit 1 pixels

Peer Network Connections



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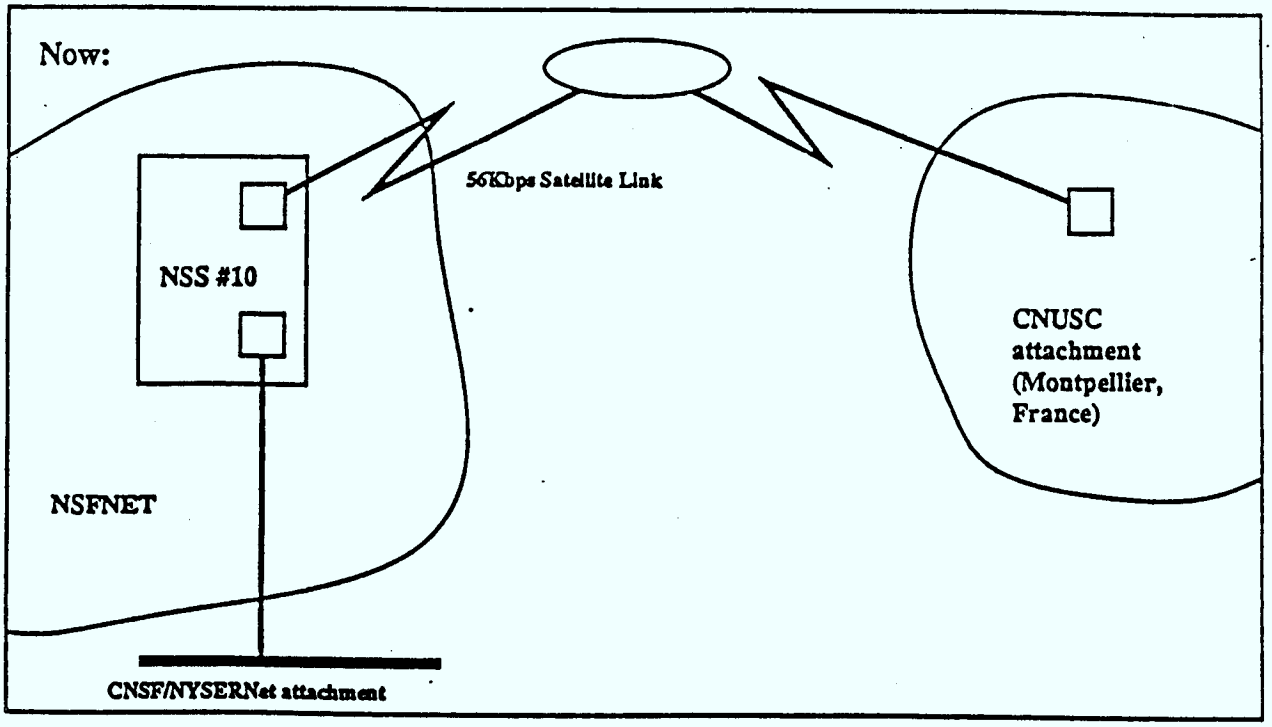
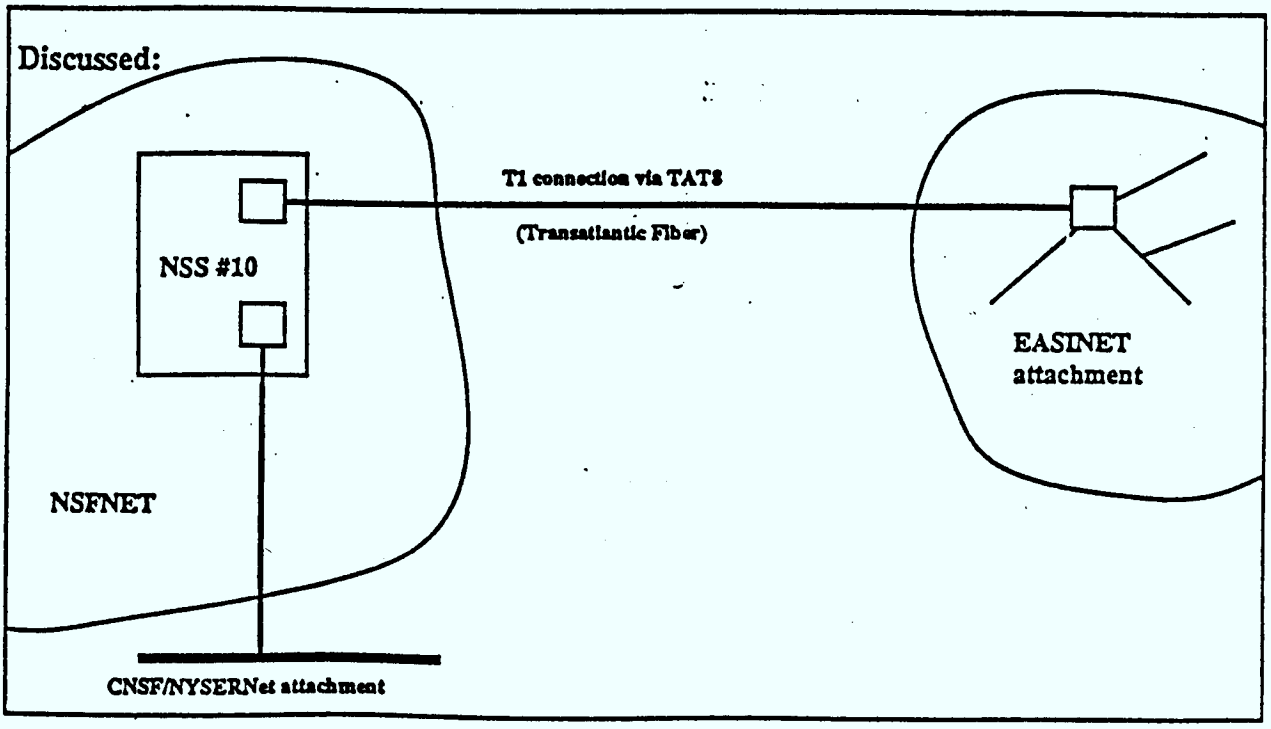




7 March 1989, HWB

Being Tested:

. SNMP support

Planned:

. ISO CLNP support

Proposed:

. T3 upgrade in 1990

Considered:

. X.25 support

7 March 1989. HWB

What is CSNET?

- A Networking Consortium
- Established by the Academic Computer Science Community in 1981
- Initial funding from NSF
- Providing Data Communications Service
- Supporting Research in the Sciences and Engineering

CSNET Membership

- Open to Academic, Industrial, Nonprofit, and Government organizations engaged in research and advanced development in the sciences and engineering

- Current membership includes:
  - 137 educational institutions
  - 41 Industrials
  - 14 Affiliated international academic networks
  - 10 Nonprofit and Government

CSNET Services

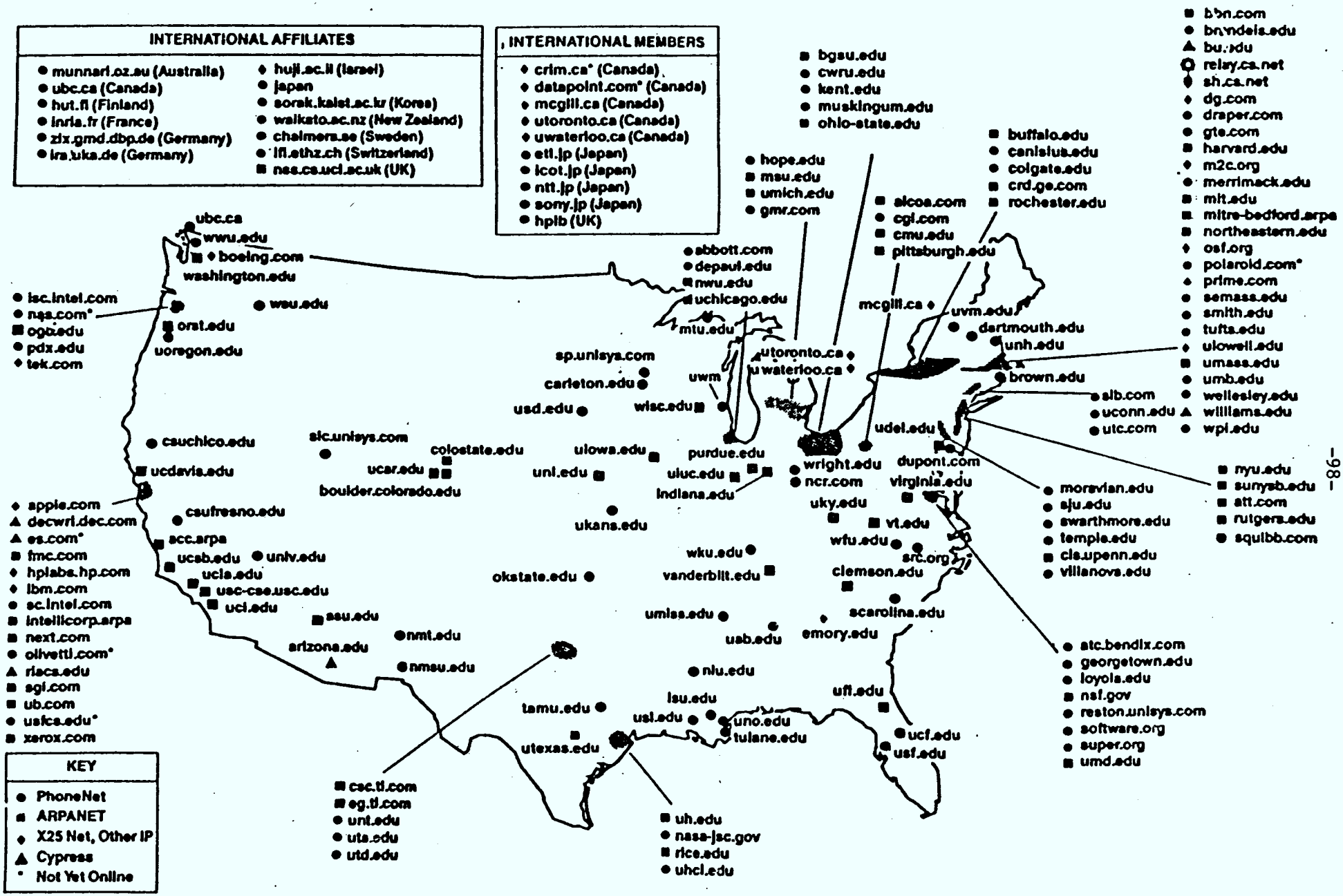
Information and Support Services

- 24-hour hotline
- Online user directory
- Automated document retrieval service
- Online news digest
- Quarterly newsletter
- CIC mailbox for user inquiries
- Technical consulting

CSNET Services

Basic Communications Services

- Electronic mail
- File transfer
- Remote login
- Network operations and management
- Software maintenance and development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loyola.edu
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reston.unisys.com
software.org
super.org
umd.edu

Luncheon Address

Harry Rogers, Deputy Minister

Department of Industry, Science and Technology

LUNCHEON ADDRESS

HARRY ROGERS, DEPUTY MINISTER
DEPARTMENT OF INDUSTRY, SCIENCE AND TECHNOLOGY

Ladies and Gentlemen, it's a great opportunity for me to take part in this important conference and I'd like to thank the organizers, particularly Richard, for including me.

Ever since the government announced the creation of my Department, Industry, Science and Technology Canada I've been doing a lot of public speaking. Many of those speeches have been to private sector representatives and the theme of most of them has been cooperation. I try to explain why the government is so preoccupied with improving the international competitiveness of our industrial base and I try as well to demonstrate how the government strategy for doing so makes a lot of sense. And that's how I get around to talking about cooperation. The government wants to see Canada's scientific, technological and industrial communities working more closely together. The belief is that each possesses skills and expertise that would greatly benefit the others by cooperating or acting as partners, and that they can help Canada achieve two goals. They can maintain and even enhance our reputation for excellence in science and they can make our industrial sector far more competitive internationally than it is today.

Now, an industrial strategy, founded upon the notion of harnessing science and technology and industry into one potent and competitive force is hardly a new idea. But it is somewhat foreign to the way Canadians have historically operated. Traditionally, this country's industrial, scientific and technological communities have operated quite separately from each other. There has never been any hostility and there has been no closed door policy but, by and large, each has had its own agenda. Each has pursued its own goals and each has accomplished its own remarkable successes. And perhaps, in an ideal world, free from the forces of the marketplace such independence could remain undisturbed forever. But ours is the real world and competition is the rule of the day and we know our competitors are tough. And I'm talking about Japan and I'm talking about the so-called Asian Tigers and an united Europe and even the good old U.S. of A.

Challengers like that scrap awfully hard for every percentage point of market share and if you're going to win against them you're going to have to field the best team you've got and you've got to have cooperation.

Your work here is vital. Information technology may well become one of the linch pins of Canada's industrial machine. It's crucial that we have a comprehensive Canadian strategy in this area, and the conclusions drawn at this conference will no doubt serve as a starting point for such a strategy.

Obviously, no such strategy exists now. In that sense, we lag behind some of our major competitors. However, that needn't matter, since we can thus avoid mistakes. Why not steal their best ideas? Nevertheless, no matter how much we learn from our competitors, no matter how many ideas we borrow from them, there remains much to do and we must get to work immediately.

We cannot have a truly effective Canadian strategy in the area of information technology if we work in isolation.

Since I spend so much of my time preaching cooperation, I naturally enough try to live by the same creed. That's why I so readily accepted Alain Gourd's invitation to join you here in St. Sauveur. You are all involved in vital work. Information technology has the capability of becoming one of the lynch pins that holds the wheels of Canada's industrial machine in place. It's crucial that we develop a comprehensive Canadian strategy in this area and your discussions at 'Search 20' will no doubt form an essential element of that strategy. Obviously, no such strategy exists today. In that sense, we lag behind some of our major competitors. But, not being first has advantages. We can learn from our predecessors mistakes and to put it bluntly, we can steal some of their best ideas.

No matter how much we learn from our competitors, no matter how many great ideas we borrow, there remains considerable work that we must do ourselves, unaided. A truly meaningful and effective Canadian strategy in the area of information technology cannot be pieced together from the work of others. Canada, after all, is a unique country with a unique culture with particular structures, institutions and laws with a national perspective that most of us cherish and struggle hard to preserve. It is in this context that any national strategy must be framed. A national strategy on information technology is no exception. It goes without saying, but I'll say it anyway, we're dealing with a lot more than hardware and software. National strategies in Canada must be crafted by minds and hands that are sensitive to far more than the bottom line of profits.

Having raised that flag of warning, let me now raise its counterpart. So, as national strategists, we must be sensitive to the singular nature of this country. We can't allow ourselves to be completely mesmerized by it. Time is very much of the essence in this process. We can't allow our sensitivity to bog us down in endless circular discussions on constitutional constraints, cultural matrises and sophosisms of any sort. After all, there's an enormous amount to lose if we don't tackle this challenge immediately. We're talking here about a major Canadian industry - as Richard highlighted last night - with sales exceeding 35 billion dollars per year and with manufacturing employment of over 135,000 people. That's not small potatoes. But we're also talking about an industrial

sector that is incredibly volatile and unpredictable. Today's success story can be history tomorrow. The capacity for market swings in the world of high-tech is practically limitless. So vital is this industrial sector and so competitive a world is it that my Department can't take the time to create a grand design before it starts to act. Industry, science and technology has already taken a major initiative by declaring information technology as one of three strategic technologies, or in the words of Geraldine Kenney-Wallace, one of three enabling technologies on which we will be concentrating our departmental energies and several hundred million dollars. That means we have moved information technology to the forefront and will give it pride of place in many of our new programs and services.

I'd like to take a few moments to review what our commitment to this sector has meant already. First of all, the new Department is keeping in place many of the activities and programs initiated by its predecessor departments DRIE and MOSST. Last year, working with the industry we developed a software agenda for action. As well, we have taken an active role in procurement policies and in trade and in investment promotions supporting the industry. Specific program initiatives include the 60 million dollar microelectronics and systems development program and targeted segments of the 200 million dollars we spend annually through the defence industry productivity program. As well I can point to the industrial benefits program through which ISTC tries to insure the development of Canadian industrial capacity from federal government procurement. We hold the pin on that in the federal government and coordinate the efforts of the other departments involved.

Information technology development is a priority area of attention here and in one of the workshops this morning, of course, there was specific points made on the priority of procurement as a support role to the small technology firms.

We also have our Technology Outreach Program which is intended to support industrial institutes in the diffusion of technologies to firms in those industry sectors or by some industry associations to firms generally and I think a good many of you here today have some direct experience with one or more of these programs and initiatives that I mentioned.

The Natural Sciences and Engineering Research Council, a sister organization is also involved directly with my department on an important new program you're all familiar with, the Networks of Excellence. As you know, fully 240 million dollars have been earmarked for that campaign. The program's really just beginning, but already we've received a number of exciting proposals in the information technologies area. To be honest, I wish we had a lot more money for what's going to come out of that effort because it's crucial. I think we can look at 240 million as a start.

Another initiative of very recent vintage is one we are calling sector campaigns. These are programs of action of very limited duration, between three and five years, where we will be working out in concert with

industry sectors based on their identified needs and their priorities and involves cooperative activities that make sense to them and to us. Examples are trade promotion, funding of alliances for precompetitive research, demonstration projects and pilot plans. What we're doing in our programming, in a word, is moving upstream from modernization and expansion to what has been perceived by us in consultation with industry groups like your own as a major gap in advanced development, in advanced manufacturing engineering and advanced product development. And we will have to see as we go the extent to which the gap really exists and whether there is a will to fill it cooperatively and whether the players wish to work together in alliances. These are all open questions in my mind and I think they are still open questions in yours if I follow the flow of the discussions this morning. We're trying to share the risks here, not underwrite them, so we'll be looking for substantial financial commitments from our industrial partners. And to that end we have already met with two focus groups in the telecommunications and microelectronics areas. Clearly, I can't prejudge the results of those discussions but there is some likelihood that given sufficient industry commitment we may have sector campaigns in those areas.

Yet another initiative, one that you haven't heard about yet is called our AMTAP Program. AMTAP stands for Advanced Manufacturing Application Program and there our department is expecting to subsidize certain consultants costs, professional fees in assessing a company's needs for high-tech additions to their manufacturing processes will be paid for under AMTAP. The sort of things I'm talking about are the consultants assessments of just-in-time inventory delivery systems and flexible manufacturing systems. What we're finding in our travels, particularly in medium and threshold small Canadian firms, is an absence of awareness of the technology needs for the technology available. And this is intended to pilot a study to see if indeed there is a gap that we should be filling.

We won't be announcing this new program until next month, but among us, I can tell you, it's well underway internally. It's received Cabinet approval and we've earmarked 8½ million dollars for that program for the next three years.

So I think, as you can see, we're busy. We've retained in place commitments to information technology and we fortified those commitments with new programs of our own which have largely been designed in consultation with players in the field, like yourselves.

I think what we're trying to do is move towards a national strategy. We're establishing a framework. But, by no means, are we there. We know we want any strategy to be industry driven. If the private sector isn't committed and excited about a program or initiative, there's little or no use in trying to nurse it along with scarce taxpayer dollars. We know that whatever the final strategy its emphasis will be on excellence and competitiveness through cooperation. As crucial as information technologies are they are only one part of the industrial community. The

goal we're all striving for is a vibrant and competitive Canadian economy. And all national strategies for all sectors would certainly have to fit under that umbrella.

Now, your focus here at Search 20 is on research and development and that's not my area of expertise and I wouldn't presume to second guess the deliberations or their outcome but perhaps you'd forgive a couple of suggestions, especially if I frame them as compliments. First, I was delighted to learn that you had established your plenary and workshop structures through the use of focus groups. In my view, that approach will help insure this conference a success. It's my personal belief that for too long, many of the key decisions on information technologies have been made by technicians and it shows in the final products which have been incredible systems that have never had much market penetration. And I think if in the past and even in the present if more of the present example is followed, if there was more time spent on market testing, on focus groups, if the industry listened to the marketplace and to the consumer it would be even now putting out products that are more user friendly and more saleable. I think the future belongs to those countries with a consumer focus. It doesn't matter whether the consumers are single householders or corporate giants. They want the same things, technology they can use comfortably and effectively.

I doubt, for example, that anyone thought of asking a secretary for her input before putting together most of the word processors I've ever seen. And the same is likely true about everything else from PCs to video recorders. When the manual weighs more than the machine you know there's something wrong. I think heavy emphasis should be placed on focus groups and consumer needs as I said and it's encouraging to see that you, in thinking about your future R & D program, are already oriented to the notion of market testing. As you move towards a national R & D policy for communications, I sure hope that you and your colleagues will maintain that approach.

I think we've covered in the workshops this morning the next point that I had in mind to make and that is the need for R & D targetting and it's self-evident to us that the competition is so fierce that no country, not even Japan and certainly not Canada, can hope to be excellent at everything and if we try to do that we'll fail miserably. We must pick specific areas, niches and achieve excellence in them. It's not just enough to be good. We have to be the best. We have to be excellent and unless we're extremely lucky we have to stake our claims out early in that effort. The reality that we all face is that there's only so many research and development dollars to go around and we have to expend our energies to spend that money wisely and I think here I'm echoing what the Minister said last night in his remarks as well as the comments in the groups this morning. I suppose we could summarize all that by saying that every industrial nation on earth is living in the hope that high-tech will deliver them to the economic promised land. Sometimes I think we all dream nightly of balanced budgets and bull markets spilling endlessly out of a silicone cornucopia. Bureaucrats and entrepreneurs like us are

charged with the Herculean task of making those dreams come true. And I think you've made an outstanding beginning in the way you've planned this conference and established your goals for it. I hope your market orientation will become a hallmark of the way government, the science community and industry work together to develop a complete national strategy for information technologies. We have much to build on in working our way towards this goal.

It's with great pride as a Canadian that I can say how well positioned we are as a country today in the field of communications. And this is due, in a major way, to the role played by the Department of Communications over the past 20 years. We should and we can all take pride, I think, with the Department in their discoveries and innovations in the field of Communications Research and Development over this period of time.

DOC has recognized world class expertise in Communications R & D and it has the lead in the field for the Government of Canada. The work done in DOC labs is of utmost importance to the development of communications networks in this country. It's also imperative that we all continue to work with the Department as we're doing in this forum to keep Canada in the lead.

Thank you for involving me in this work you're doing here and I wish you all the success in the world and I look forward to the results.

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