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INTERNATIONAL COMMUNICATIONS R&D

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EXECUTIVE SUMMARY

This study provides an analysis of major communications research and development (R&D) initiatives in Europe, Japan and the U.S.A. in four communications areas:

- wireless personal communications
- extension of electronic information and transaction services;
- enhancement of media services at home and at work; and
- high-speed networks.

The study is part of a series of strategic assessment studies undertaken by the Department of Communications (DOC) to develop a long term communications development strategy.

In **Europe**, the principal focus for communications R&D is at the level of the 12 member European Community (EC). RACE is the main R&D program for communications. In the area of interest to this study, current emphasis appears to be principally in enhanced media services, followed by high-speed networks. Various other programs (e.g. ESPRIT, AIM, DELTA, ORA, DRIVE) support some R&D activities of interest.

While EUREKA, in which 19 countries participate, has some 37 percent of its project expenditures (1990) in the information/communications sector, few projects were related to the four areas of interest.

At the national level, Germany, France and the United Kingdom (U.K.) account for over three-quarters of the total public and private R&D expenditures in the EC. France is the most interventionist and the role of CNET has been central to the development of the communications infrastructure of that country. Germany and the U.K., on the other hand, have limited government intervention in R&D and prefer to structure an environment in which industry can set the directions for the development of communications systems.

Canada has formal and informal relationships with the above countries. The computer and information technology (C&IT) aspects of the formal relationships are most active with Germany.

At the EC level, Canada is currently discussing the possibility of entering into a formal science and technology (S&T) agreement with the EC that would permit Canadian R&D organizations to participate fully, as equals, in EC level programs.

In Japan, communications R&D is driven by visions of what the communications environment could be in the 21st Century. R&D activities related to these visions are supported principally by the Ministry of Posts and Telecommunications (MPT) and the Ministry of International Trade and Industry (MITI).

Japan appears to give a relatively high priority to the development of enhanced media and high-speed networks.

Canada has a bilateral S&T agreement with Japan (since 1986), and the Japan S&T Fund is in place to enhance bilateral S&T collaboration. There is a Canadian-Japan Committee for S&T Co-operation. As well, DOC has been having annual consultations with MPT since 1985.

In the **United States**, industry has traditionally provided the technological leadership in the communications sector. However, recent private sector R&D initiatives such as SEMATECH, have received government support. Moreover, industry leaders released a statement on January 12, 1993 (see Appendix 1) which proposes the development of a national information infrastructure in concert with government. On February 22, 1993 the Clinton Administration issued its own action plan for the development of a national information infrastructure (see Appendix 2).

The U.S. thrust in high-speed networks and high-speed computing have implications for the three "wired" areas of interest to this study. A major implication for Canada is how to position initiatives, such as the CANARIE project, vis-à-vis the emerging U.S. national information infrastructure.

The relative levels of interest in the four areas of the present study, in the three regions surveyed, are broadly summarized as shown in Exhibit ES-1. This relative positioning represents a judgement made resulting from the analysis undertaken. There currently appears to be relatively more interest in high-speed networks and enhanced media than in the other two sectors.

Exhibit ES-1
Relative Levels of Interest: Summary of Findings

	EUROPE	JAPAN	U.S.
High-speed networks	Emerging rapidly	Emerging	Leading
Enhanced media	Emerging rapidly	Emerging	Leading
Wireless personal communications	Ongoing interest	Ongoing interest	Ongoing interest
Electronic information/transaction services	Ongoing interest	Ongoing interest	Ongoing interest

The emerging interest in high-speed networks in Canada and the formulation of the CANARIE project which involves Canada's leading telecommunications companies, is in keeping with the high-level of interest in this area internationally. However, it is not evident that there is such a direct resonance between Canadian interests and technological capabilities and international activities in the other three areas surveyed. However, there are niche opportunities that will link with similar ones in these three areas as there would be in any other technology-intensive sector.

Communications has traditionally been an important technological sector in Canada. This is reflected in the fact that Canada has been spending relatively more on telecommunications R&D as a percentage of total national R&D activities compared to other major countries. However, in both absolute terms and as a percentage of GDP, Canada has been spending relatively less than other major countries on telecommunications R&D.

The fusion of telecommunications and information technologies are presenting new challenges to Canada and to other industrialized countries. For Canada, a country with limited financial and skilled personnel resources, it means, at least in part, striking appropriate international alliances to develop those communications technologies that will ensure that Canadian firms remain internationally competitive.

RÉSUMÉ

La présente étude analyse les principaux programmes de recherche et développement (R-D) en communications en Europe, au Japon et aux États-Unis, dans quatre domaines :

- communications personnelles sans fil;
- extension des services d'information et de transaction électroniques;
- accroissement des services médias à la maison et au travail;
- réseaux à grand débit.

Cette étude fait partie d'une série d'études d'évaluation stratégique entreprise par le ministère des Communications (MDC), afin d'élaborer une stratégie à long terme de développement des communications.

En **Europe**, la R-D en communications se fait principalement au niveau des 12 membres de la Communauté économique européenne (CEE). Le principal programme de R-D en communications est nommé RACE, dans lequel on semble mettre l'accent sur les services médias, et ensuite sur les réseaux à grand débit. Divers autres programmes (p. ex., ESPRIT, AIM, DELTA, ORA, DRIVE) soutiennent certaines activités de R-D qui présentent un intérêt.

Même si le programme EUREKA, auquel participent 19 pays, a réalisé 37 % de ses investissements en projets dans le secteur de l'information et des communications (en 1990), peu de projets ont porté sur les quatres domaines susmentionnés.

Au niveau national, l'Allemagne, la France et le Royaume-Uni effectuent à eux seuls les trois quarts des dépenses publiques et privées en R-D, dans la CEE. La France est le pays le plus interventionniste, et le rôle de la CNET a été crucial dans le développement des infrastructures de communications dans ce pays. Par contre, l'Allemagne et le Royaume-Uni ont limité les interventions gouvernementales en R-D et préfèrent créer un climat dans lequel l'industrie peut orienter le développement des systèmes de communications.

Le Canada a établi des liens officiels et officieux avec ces pays. Dans le cadre des ententes officielles, c'est avec l'Allemagne que les volets informatique et technologie de l'information sont les plus actifs.

Le Canada étudie actuellement la possibilité de conclure un accord officiel en science et technologie (S-T) avec la CEE qui permettrait aux organisations canadiennes de R-D de participer pleinement, à titre de partenaires égaux, aux programmes établis au niveau de la CEE.

Au **Japon**, le moteur de la R-D en communications est une vision futuriste du monde des communications au XXIe siècle. Les travaux de R-D axés sur cette vision reçoivent surtout l'appui du ministère des Postes et Télécommunications (MPT) et du ministère de l'Industrie et du Commerce international (MITI).

Le Japon semble accorder une assez grande priorité au perfectionnement des médias et au développement des réseaux à grand débit.

Le Canada a signé avec le Japon, en 1986, un accord bilatéral en science et technologie, et le fonds japonais S-T est établi afin d'accroître la collaboration bilatérale dans ces domaines. Il existe également un comité canado-japonais de coopération scientifique et technologique. En outre, le MDC tient des consultations annuelles avec le MPT depuis 1985.

Aux États-Unis, l'industrie a habituellement été le fer de lance des progrès technologiques en communications. Toutefois, les récentes initiatives du secteur privé en R-D, comme le SEMATECH, ont reçu l'appui du gouvernement. Qui plus est, des chefs de fils de l'industrie ont publié un communiqué le 12 janvier 1993 (voir l'Annexe 1) dans lequel ils proposent la mise en place d'une infrastructure nationale de communication, de concert avec le gouvernement. Le 22 février 1993, le gouvernement Clinton a publié son propre plan d'action visant à mettre en place une infrastructure nationale d'information (voir l'Annexe 2).

La poussée américaine dans les domaines des réseaux à grand débit et des ordinateurs rapides a des conséquences sur les trois aspects «câblés» étudiés dans la présente analyse. Une conséquence de taille pour le Canada est la façon dont il devra positionner ses projets, comme CANARIE, par rapport à la future infrastructure nationale d'information aux États-Unis.

Le tableau ES-1 ci-dessous résume en gros le niveau relatif d'intérêt pour les quatres domaines examinés dans cette étude, dans les trois grandes régions susmentionnées. Ce résumé subjectif est basé sur les résultats de notre analyse. On semble actuellement s'intéresser davantage aux réseaux à grand débit et aux médias perfectionnés qu'aux deux autres secteurs.

Tableau ES-1
Niveau relatif d'intérêt : résumé des conclusions

RÉGION	EUROPE	JAPON	ÉTATS-UNIS
Réseaux à grand débit	Émergence rapide	Émergence	Chef de file
Médias perfectionnés	Émergence rapide	Émergence	Chef de file
Communications personnelles sans fil	Intérêt soutenu	Intérêt soutenu	Intérêt soutenu
Services d'information et de transaction électroniques	Intérêt soutenu	Intérêt soutenu	Intérêt soutenu

L'intérêt nouveau pour les réseaux à grand débit au Canada et la formulation du projet CANARIE, auquel participent les grandes sociétés canadiennes de télécommunications, correspond au vif intérêt manifesté ailleurs dans le monde dans ce domaine. Toutefois, il n'est pas évident que les capacités techniques et les intérêts canadiens aillent de pair avec les activités internationales dans les trois autres domaines étudiés. Il existe cependant des possibilités de créer des créneaux pouvant correspondre à d'autres créneaux similaires dans ces trois domaines, comme c'est le cas dans tout secteur à forte prédominance technologique.

Les communications sont, depuis longtemps, un secteur technologique de grande importance au Canada. Cela est bien illustré par le fait que le Canada a dépensé relativement plus dans la R-D en télécommunications, en pourcentage des activités nationales totales de R-D, par rapport aux autres grands pays. Toutefois, en termes absolus et en proportion du PIB, le Canada dépense relativement moins que les autres grands pays dans la R-D en télécommunications.

La fusion des télécommunications et de l'informatique présente de nouveaux défis pour le Canada et les autres pays industrialisés. Pour le Canada, un pays aux ressources financières et au bassin de personnel spécialisé limités, cela signifie qu'il lui faudra conclure des alliances internationales appropriées afin de développer les techniques de communications qui préserveront le caractère concurrentiel des entreprises canadiennes sur les marchés internationaux.

1.0 INTRODUCTION

This document provides a description and analysis of policies, key programs and projects related to major communications research and development (R&D) initiatives in Europe, Japan and the U.S.A. It is based on an extensive review of the literature as well as interviews with representatives of key private and public sector research organizations in these jurisdictions.

The communications areas covered are:

- wireless personal communications;
- extension of electronic information and transaction services;
- enhancement of media services at home and at work; and
- high-speed networks.

The report covers current policies and activities that governments, and their agencies, in Europe, Japan and the U.S.A., have in place to support the development of the communications sector, generally, and in the areas of interest to this study, specifically.

The governments of industrialized countries consider the communications sector strategic because it supports economic development as a whole. Governments try to position their domestic firms to capture the economic benefits generated by this sector. However, with deregulation and the increasing internationalization of the communications industry, the roles that governments can play in ensuring the welfare of national firms has changed. Traditional support of industrial R&D is now being complemented by the support of national and international strategic alliances to reduce risk, share costs and access foreign technology.

The report also describes some specific programs and projects in detail. An assessment is provided in Chapter 5.0.

2.0 RESEARCH AND DEVELOPMENT ACTIVITIES IN EUROPE

In Europe, much of the communications R&D activity is centred on the so-called framework programs of the European Community (EC). The following describes these activities and related policies as well as related activities in the major European countries.

2.1 EC Program on Research and Technological Development (R&TD)

EC R&TD activities are structured as framework programs as umbrellas for large themes under which activities in specific sectors are undertaken. Currently, EC activities are undertaken under the Third Framework Program (1990 to 1994). This is an ECU[1] 5.7 billion program, 39 per cent of which is devoted to information and communications technologies. Planning is under way for the Fourth Framework Program (1994 to 1998). Expectations are that R&D activities will be increased by 50 per cent. Information/communications comprise key elements of the Fourth Framework Program.[2] R&D investment in these areas is driven by the perception that Europe is in a "catch-up" position vis-à-vis the U.S.A. and Japan.

The principle of subsidiarity, which has recently been accepted to guide EC activities, will favour information and communications R&D because they are considered priority sectors. The principle of subsidiarity is cited as follows:

> "In areas which do not fall within its exclusive competence, the Community shall take action, in accordance with the principle of subsidiarity, only if and in so far as the objectives of the proposed action cannot be sufficiently achieved by the Member States and can, therefore, by reason of the scale or effects of the proposed action, be better achieved by the Community (Article 3b of the Maastricht Treaty)."

In the information/communications sector the principal programs are the following:

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1 One ECU is approximately $1.50 (Canadian).

2 Recherche et Développement Technologique: Press Release P(92)24: E.C. Brussels, Sept. 10/92.

- <u>RACE (R&D in Advanced Communications Technologies in Europe)</u> was set in place in 1987 and is aimed at promoting pre-competitive R&D in the area of Integrated Broadband Communications (IBC) to enable Europe to establish an IBC network in the 1995 to 2000 time frame. The total budget is about ECU 1.2 billion for the period of 1987 to 1992. The conditions for participation are that projects involve at least two independent industrial partners, not all established in the same country, with the partners providing at least 50 per cent of the funding. RACE is now entering Phase 5-5II which puts the orientation of R&D activities closer to exploring options for the implementation of the IBC network. The total community funding allocated to Phase II is approximately ECU 1 billion (EC contribution is ECU 489 million) for the period 1990 to 1994.

  Exhibit 2-1 illustrates the principal direction of Phase II, the links to Phase I and the relative level of funding.

- <u>ESPRIT (European Strategic Program for R&D in Information Technologies)</u> was launched in 1984 to promote industrial co-operation and to provide the technological base to ensure international competitiveness. The budget is ECU 2.7 billion for the next phase which will focus on industrial projects.

  The projects are shared-cost contracts with at least 50 per cent of the funding coming from participants. At least two partners must come from different countries. Since 1988 some 1500 participants have been involved.

  Exhibit 2-2 illustrates the areas that are covered in the current phase of the ESPRIT program.

- <u>Telematics</u>, which promotes the development of integrated information/communications systems in seven areas; public authorities (e.g., border police), transport services, health care, distance learning, libraries, linguistics, and rural areas. The budget is ECU 380 million allocated on a 50 per cent cost-shared basis.

Recently, an EC Working Group reported to the Commission of the European Communities on the state of high-performance computing in Europe. Among its recommendations was the following:

Exhibit 2-1
Current Orientation of the RACE Program

PHASE I	PHASE II
• CAC/ATM/BB CPN program infrastructure	IBC DEVELOPMENTS: (20-24% of projects; MECU 225 in funds) • Optical passive components • Optical amplifiers • Photonic switching
• Network management	INTELLIGENCE IN NETWORKS: (6-8% of projects; MECU 90 in funds) • Programmable networks • Communications management • Customer mobility
• Fixed network/air interface	MOBILE COMMUNICATIONS: (8-10% of projects; MECU 110 in funds) • High-speed non-voice services • Cell planning • Advanced mobile design
• Video coding • HDTV	IMAGE COMMUNICATIONS: (11-16% of projects; MECU 140 in funds) • Interworking • 3D HDTV images • Impact of ATM
• Customer service functions • Usability engineering	INTEGRATED SERVICES TECHNOLOGIES: (6-8% of projects; MECU 80 in funds) • Usage metaphors • Service management • Service machine
• IBC integrity	INFORMATION SECURITY: (6-8% of projects; MECU 60 in funds) • Secure systems and network technologies • Tools for security administration
• Usage reference model • Application pilots	ADVANCED COMMUNICATIONS EXPERIMENTS: (20-25% of projects; MECU 250 in funds) • Development of resource packages • Advanced communications experiments
• Integrated broadband communications	TEST INFRASTRUCTURE & INTERWORKING: (1-3% of projects; MECU 45 in funds) • Experiments and applications
TOTAL BUDGET = ECU 1.2 billion	TOTAL BUDGET = ECU 1.0 billion

Exhibit 2-2
Current Orientation of the ESPRIT Program

AREAS	RESEARCH OBJECTIVES	BUDGET (%)
MICROELECTRONICS	• emphasis on application-specific integrated circuits (ASIC) • work on the manufacturing technology to produce better and cheaper integrated circuits with higher density and higher speed • priority topics: equipment for semiconductor processing; packaging & connectivity; and advanced materials • work will progress towards the "system on a chip"	ECU 729-837 million (27-31%)
INFORMATION PROCESSING AND SYSTEMS SOFTWARE	• work covers the main elements which will determine future systems: parallel architecture; improved interfaces; and systems for perception & synthesis of information from very complex signals • work to overcome the constraints in European software production - promotion of new software production	ECU 621-729 million (23-27%)
ADVANCED BUSINESS & HOME SYSTEMS; PERIPHERALS	• function integration in business and home environment • home - integrating IT in security, protection of privacy, voice communications and document transmission, lighting & energy management • office - integrating mobile terminals and improved working conditions • improved reliability and reduced cost of peripherals • intelligent homes & buildings	ECU 405-513 million (15-19%)
COMPUTER INTEGRATED MANUFACTURING & ENGINEERING	• emphasis on technological base needed for open systems and multi-supplier environments & integration of advanced information processing systems in engineering • to help users apply new technologies • encourage collaboration between users and suppliers	ECU 459-567 million (17-21%)
BASIC RESEARCH	• to make progress in such fields as superconductivity, electronic circuits on a nanometric scale, the logical and algebraic foundations of computing, large-scale, parallel systems, and neural computers	ECU 243-297 million (9-11%)
TOTAL BUDGET		ECU 2.7 billion

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> "....the development of an advanced Pan-European High-Speed Network is of strategic importance. The present generation of data communications networks should be rapidly evolved into a large scale high-performance (multi-mbits/sec), multi-protocol backbone, while the necessary research and development is to be encouraged in order to allow Europe to compete in the gigabits links race. This involves substantial investments both in hardware and software. This will permit the formation of a European high-performance computing community and would identify the real user's needs and present them to the suppliers."[3]

Recent developments related to RACE, ESPRIT, Telematics and high-speed networking/computing are presented in the following sections.

2.1.1 RACE (Research and Development in Advanced Communications Technologies in Europe)

As of January 1992, more than 550 organizations were involved in 186 RACE projects.[4] Of these organizations, 4.55 per cent (26 organizations) were participating in more than ten projects. Exhibit 2-3 illustrates these players.

As indicated by the list of key players, participants generally included private firms and government funded laboratories. Of the 71 universities involved in the program, the National Technical University of Athens was the only key player.

By early 1992, these 26 key organizations were involved in 179 projects, or 96 per cent of the RACE projects. In addition, the organizations acted as project manager (prime contractor) for 62 of the 179 projects, or one third of the RACE projects.

Exhibit 2-4 depicts the intensity of collaboration among the key players in RACE. The top 14 organizations collaborated in more than 10 projects. For example, selected organizations collaborated on as many as 19 projects (e.g. BT Plc and PTT Netherland NV, BT Plc and Swedish Telecom). As such, these organizations can be said to be the most involved collaborators. Only one university appears as a major player. The reason that the National Technical University of Athens appears as a major player is apparently that it is advantageous to include partners from lesser developed EC members when seeking funding from EC programs.

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3 Report of the EEC Working Group on High Performance Computing; February 1991, p. 16.

4 At the time, many of the RACE II proposals had progressed to contract signature, while others were still in the process of contract negotiation.

Exhibit 2-3
RACE - Key Players
Organizations Involved in More Than 10 Projects

ORGANIZATION	COUNTRY	Number of Projects in which the Organization is Involved	Number of Projects in which the Organization is the Project Manager
BT Plc	UK	51	5
Alcatel SEL AG	D	41	16
PTT Netherland NV	NL	37	3
Telefonica de Espana	E	33	0
Televerket - Swedish Telecom	S	32	1
Siemens AG	D	30	4
France Telecom - CNET	F	28	0
CET - Cento de Estudos de Telecommunicacoes	P	27	3
Deutsche Bundespost Telekom	D	24	1
National Technical University of Athens	GR	23	0
Thomson Csf	F	22	3
CSELT	I	21	1
Compagnie IBM France	F	20	2
Philips International BV	NL	18	4
Alcatel Standard Eléctrica SA	E	17	0
ASCOM Technology	CH	17	1
GPT Ltd	UK	16	0
BNR Europe Limited	UK	15	3
KTAS	DK	15	2
Broadcom Eireann Research	IRL	14	5
Intracom SA	GR	13	0
Philips Kommunikations Industrie AG	D	13	2
AT&T Network Systems Nederland BV	NL	12	1
GEC Marconi	UK	12	3
Televerket - Norwegian Telecomm. Adm.	N	12	0
Alcatel Bell NV	B	11	2
Number of Organizations Involved in More Than 10 Projects			**26**
Total Number of Organizations Involved in RACE			**572**
Per Cent of Organizations Involved in More Than 10 Projects			**4.55%**

Source: Research and Technology Development in Advanced Communications Technologies in Europe - RACE '92

Exhibit 2-4
RACE - Collaboration Scheme of Key Players

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
1	BT Plc	51	17	19	15	19	7	18	11	13	7	6	11	7	5	6	10	7	6	5	8	6	8	8	6	8	7
2	Alcatel SEL AG		41	10	6	10	7	10	7	10	7	9	5	2	6	8	8	5	6	4	3	2	4	9	1	4	5
3	PTT Netherland NV			37	14	12	8	10	11	11	6	7	11	5	3	10	8	7	2	4	3	3	7	7	4	5	6
4	Telefonica de Espana				33	12	8	9	10	12	12	3	9	4	3	6	9	5	4	6	7	6	9	5	4	7	4
5	Televerket - Swedish Telecom					32	6	6	9	8	4	4	8	7	2	7	7	7	3	6	8	6	4	3	4	9	3
6	Siemens AG						30	7	4	10	1	6	6	6	11	2	7	9	3	5	3	4	3	6	5	5	3
7	France Telecom - CNET							28	5	11	2	7	12	6	3	6	5	4	5	3	3	3	4	5	2	5	2
8	Centro de Estudos de Telecommunicacoes								27	5	9	0	5	5	2	3	6	2	2	6	9	7	3	1	1	7	4
9	Deutsche Bundespost Telekom									24	6	4	8	2	3	5	7	7	3	5	2	4	5	6	1	5	6
10	National Technical University of Athens										23	2	2	0	2	2	4	2	2	3	2	4	2	3	2	1	3
11	Thomson Csf											22	3	1	2	3	3	3	5	0	0	1	2	2	2	1	0
12	CSELT												21	5	0	5	4	5	3	3	3	4	3	4	0	3	4
13	Compagnie IBM France													20	0	3	3	5	2	6	4	2	1	0	0	3	1
14	Philips International BV														18	1	3	3	3	2	0	0	3	3	4	2	2
15	Alcatel Standard Eléctrica SA															17	4	3	1	3	1	1	4	3	3	3	5
16	ASCOM Technology																17	4	1	8	3	3	6	5	0	6	4
17	GPT Ltd																	16	1	4	2	4	0	4	2	3	2
18	BNR Europe Limited																		15	1	1	2	0	2	2	2	0
19	KTAS																			15	4	3	3	2	0	6	4
20	Broadcom Eirann Research																				14	6	1	1	1	3	1
21	Intracom SA																					13	1	0	1	3	1
22	Philips Kommunikations Industrie AG																						13	2	1	2	3
23	AT&T Network Systems Nederland BV																							12	1	2	5
24	GEC Marconi																								12	1	1
25	Televerket - Norwegian Telecomm. Adm.																									12	2
26	Alcatel Bell NV																										11

Source: Research and Technology Development in Advanced Communications Technologies in Europe - RACE '92

In Exhibit 2-5, the projects of the top 14 organizations are broken down by the four communications subsectors covered by the study. An analysis of the number of projects by communications subsector demonstrates that these players are involved in projects which either provided a common technology base or evaluated and developed advanced technologies, cutting across all four areas. This was the expressed direction of RACE Phase I.

It was not until Phase II of the program that a movement towards new applications, services, operations and management structures became very apparent. Of the four communications subsectors, enhanced media services became the technological focus of the majority of organizations. Although not apparent (compared to wireless personal communications and, electronic information and transaction services), high-speed network technology is the second area of interest. This result is inferred from the recent explosive start-up of related R&D.

A major difference between Phase I and Phase II of RACE is that in the latter only up to 7 partners are permitted in any one project to limit the overhead costs. The very large number of players in Phase I led to very high overhead costs (e.g. 20 per cent or greater).

Exhibits 2-6 (a, b, c) show selected RACE project relationships of the top three key players. The exhibits also categorize the projects according to the communications subsectors. Exhibits 2-7 (a, b, c, d) highlight some of these and other (involving other key players) projects for each of the communications subsectors. There are also activities in several other subsectors such as test infrastructure and interworking, service engineering and communications resource management.

To determine the key areas in which other players (smaller organizations involved in RACE) are conducting research, a random sample of 15 organizations was selected. These organizations are listed in Exhibit 2-8. An analysis of the number of projects by communications subsector indicates that, unlike the key players, these smaller organizations are not focusing their technological efforts on enhanced media services or high-speed networks. In fact, it appears that there is no defined pattern or trend in their research endeavour. What does emerge from this analysis is that these organizations are involved either in projects related entirely to their field (i.e. Rai Radio Television Italiana is conducting R&D on HDTV) or in projects providing a common technology base. In addition, only in a few instances were these organizations acting as project manager.

Exhibit 2-5
RACE - Top 14 Key Players

ORGANIZATION	COUNTRY	Number of Projects in which the Organization is Involved	Number of Projects in which the Organization is the Project Manager	COMMUNICATIONS SUBSECTORS					
				Wireless Personal Communications	Electronic Information and Transaction Services	Media Services	High-Speed Networks	All Subsectors[1]	Other[2]
BT Plc	UK	51	5	4	4	8	4	15	16
Alcatel SEL AG	D	41	16	2	3	8	6	9	13
PTT Netherland NV	NL	37	3	4	2	11	0	9	11
Telefonica de Espana	E	33	0	3	2	5	3	8	12
Televerket - Swedish Telecom	S	32	1	3	2	5	1	12	9
Siemens AG	D	30	4	2	5	3	1	13	6
France Telecom - CNET	F	28	0	2	3	4	3	9	7
CET - Centro de Estudos de Telecommunicacoes	P	27	3	1	0	4	0	9	13
Deutsche Bundespost Telekom	D	24	1	0	2	5	2	8	7
National Technical University of Athens	GR	23	0	4	1	1	4	7	6
Thomson Csf	F	22	3	4	2	6	3	5	2
CSELT	I	21	1	2	0	4	2	6	7
Compagnie IBM France	F	20	2	1	3	2	0	7	7
Philips International BV	NL	18	4	1	2	3	1	6	5

1. Includes projects relevant to all four subsectors.

2. Includes all other projects. These are projects which provide a common technology base and are general concerned with system aspects, components and level of performance.

Source: Research and Technology Development in Advanced Communications Technologies in Europe - RACE '92

Exhibit 2-6a
Selected RACE Project Relationships
BT Plc

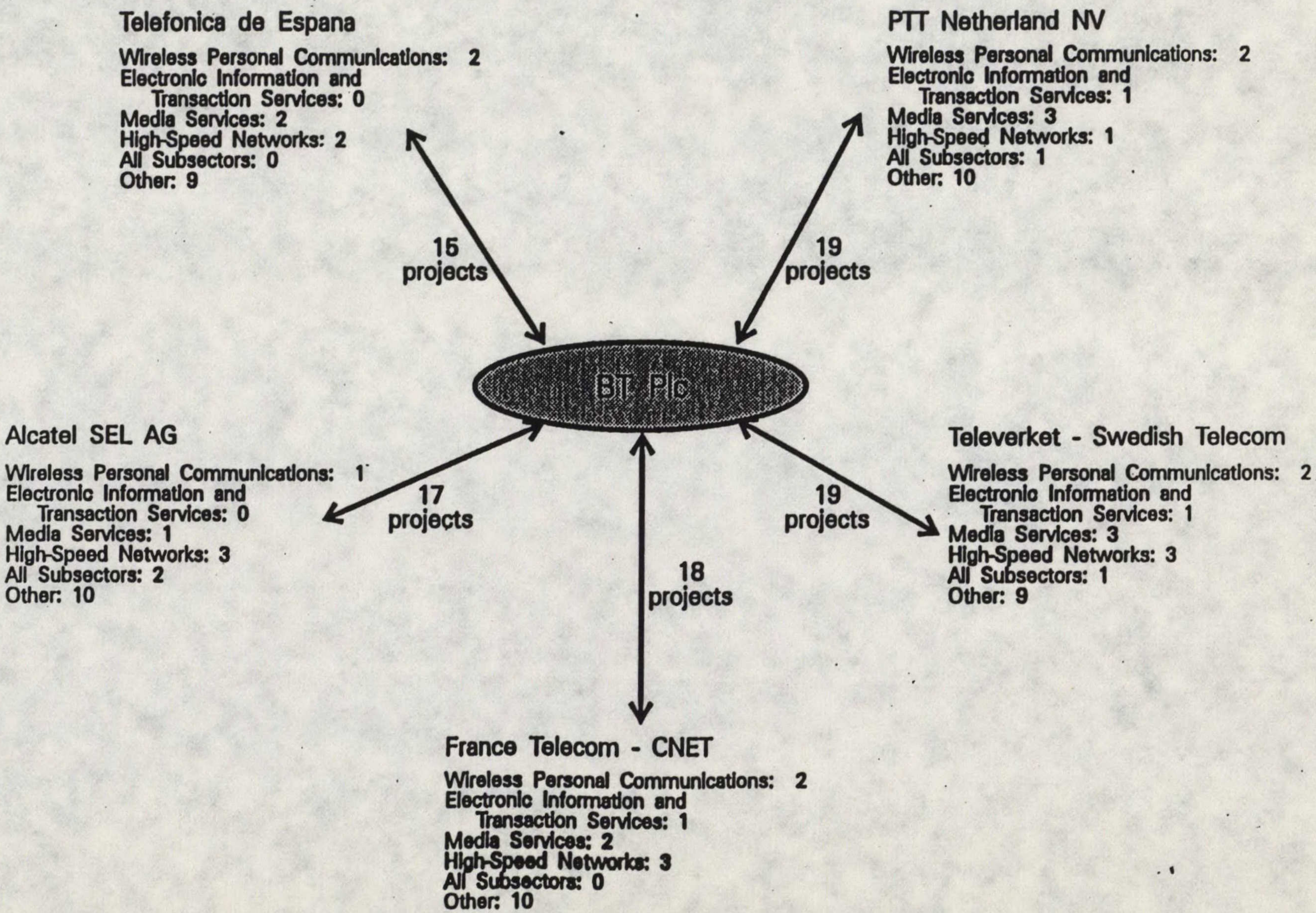

Exhibit 2-6b
Selected RACE Project Relationships
Alcatel SEL AG

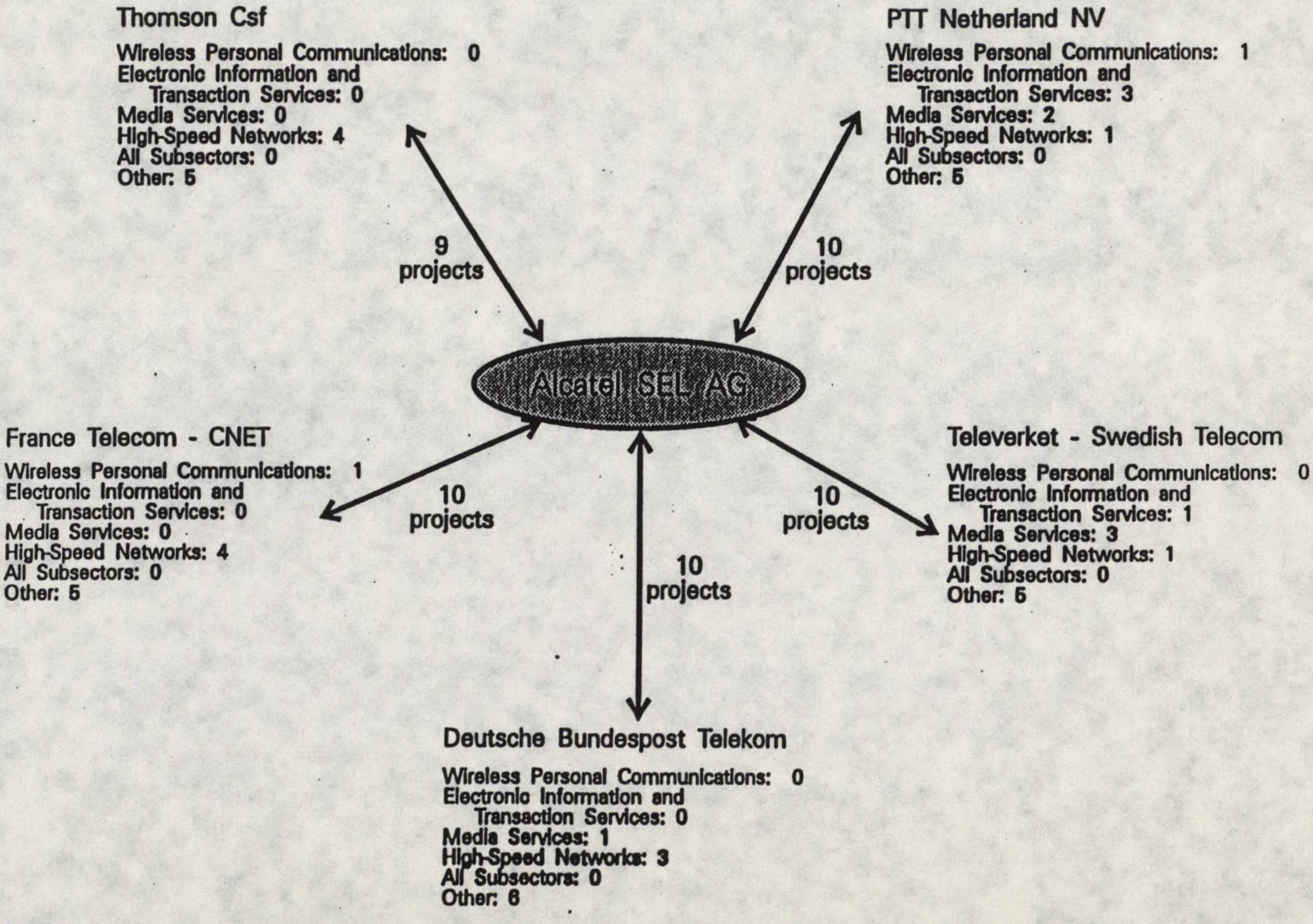

Exhibit 2-6c
Selected RACE Project Relationships
PTT Netherland NV

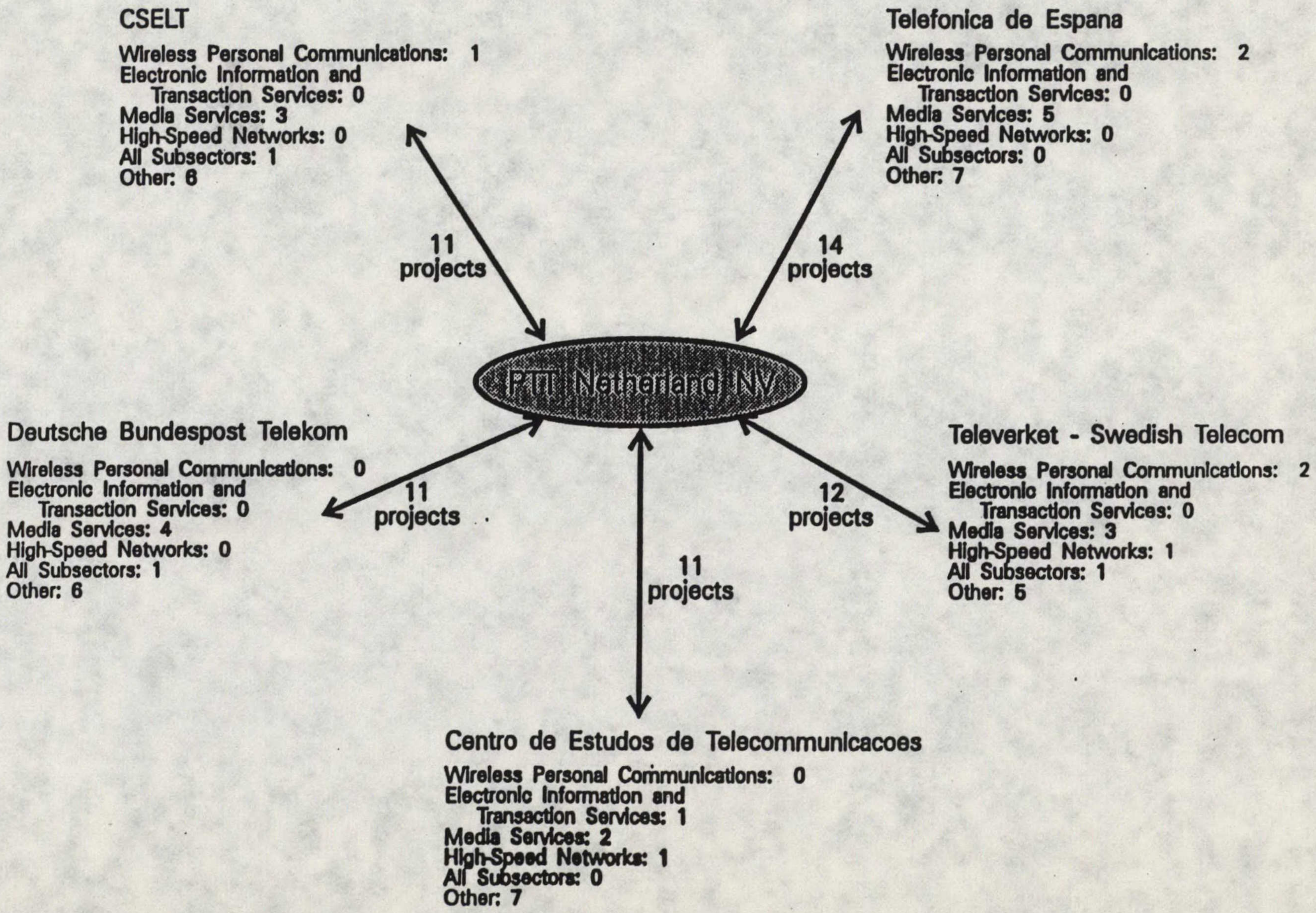

Exhibit 2-7a
Selected RACE Projects
Wireless Personal Communications

PROJECT NUMBER	TITLE	OBJECTIVE	PARTICIPANT[1] (COUNTRY)
R1043	Mobile Telecommunications Project	To consider two main classes of mobile services, namely UMTS and MBS. The five primary aims are: an air interface specification for personal communications; sufficient 'radio spectrum' capacity; fixed network; to provide technical inputs into CCIR, CCIT, ETSI; and, to identify a viable transitionary rout from pre-existing systems to UMTS and MBS. This project expects to provide the framework for the work to be carried out in RACE Phase II.	Philips Kommunikations Industrie AG* (D) Alcatel Standard Electrica SA (E) BT Plc (UK) GEC Marconi (UK) PTT Netherlands (NL) Televerket - Swedish Telecom (S) plus 13 additional organizations
R2066	MONET - Mobile Network Project	To develop network standards for UMTS. Two goals are (1) to integrate the infrastructure for mobile and fixed communications, and (2) to offer the same range of services as provided by fixed communications networks.	PTT Netherland NV* (NL) Alcatel Bell NV (B) Alcatel SEL AG (D) ASCOM Technology Ltd (CH) Broadcom Eireann Research (IRL) BT Plc (UK) CSELT (I) France Telecom - CNET (F) Philips Kommunikations Industrie AG (D) Siemens AG (D) Telefonica de Espana (E) plus 16 additional organizations
R2067	MBS - Mobile Broadband System	To address the system concepts, techniques and technology required for the transition to the MBS, and the market and economical issues relating to the widespread introduction of the corresponding systems and services.	BT Plc (UK) France Telecom - CNET (F) Thomson Csf (F) plus 12 additional organizations

1. Project manager/leader denoted by *.

NGI

Exhibit 2-7b
Selected RACE Projects
Electronic Information and Transaction Services

PROJECT NUMBER	TITLE	OBJECTIVE	PARTICIPANT[1] (COUNTRY)
R1055	MERCHANT - Methods in Electronic Retail Cash Handling using Advanced Network Technologies	To study the impact of IBC on electronic fund transfers. The project architecture should contribute to the building up of a new generation of ERP systems that respects the role, independence and responsibilities of each existing ERP actor.	BT Plc (UK) plus 6 additional organizations
R1086	TELEMED	To demonstrate the potential of IBC for medical image and data transmission, management and control in order to allow clinical and research staff to cooperate on diagnostic and therapeutical methods.	Alcatel SEL AG (D) BNR Europe Limited (UK) Televerket - Swedish Telecom (S) plus 15 additional organizations
R2063	DITTO - Developing Information Technology and Telecommunications for Tomorrow's Office	To demonstrate the need for an IBC network to handle the type and intensity of information traffic generated by the future office environment. To demonstrate how the efficiency of the industry can be improved by storing and transferring documents electronically and by providing video and audio services integrated into the case handling system.	BNR Europe Limited (UK) BT Plc (UK) plus 8 additional organizations

1. Project manager/leader denoted by *.

Exhibit 2-7c
Selected RACE Projects
Media Services

PROJECT NUMBER	TITLE	OBJECTIVE	PARTICIPANT[1] (COUNTRY)
R1018	HIVITS - High Quality Videotelephone and (High Definition) Television System	To prepare a harmonized and compatible family of video coding systems for high quality videotelephony, conventional television and high definition television, including the necessary network and standardization aspects.	Thomson Csf* (F) Alcatel Standard Electrica SA (E) BT Plc (UK) CSELT (I) PTT Netherland NV (NL) France Telecom - CNET (F) Philips Kommunikations Industrie AG (D) Telefonica de Espana (E) Televerket - Swedish Telecom (S) plus 11 additional organizations
R2025	MIMIS - Multipoint Interactive Multimedia Interpersonal System	To further develop signalling and protocol infrastructures in the area of multimedia conferencing. To specify and implement a human interface meeting human user requirements in a multi part, multimedia environment and supporting the merits of broadband communications.	PTT Netherland NV* (NL) CSELT (I) Telefonica de Espana (E) plus 4 additional organizations
R2060	CIO - Co-ordination, Implementation and Operation of Multimedia Services	To specify and implement, as prototypes on various end-systems, two advanced multimedia teleservices (a multimedia messaging service and a joint-viewing and tele-operation service).	ASCOM Technology (CH) Centro de Estudos de Telecomunicacoes (P) PTT Netherland NV (NL) Siemens AG (D) plus 15 additional organizations

1. Project manager/leader denoted by *.

NGL

Exhibit 2-7d
Selected RACE Projects
High-Speed Networks

PROJECT NUMBER	TITLE	OBJECTIVE	PARTICIPANT[1] (COUNTRY)
R1051	Multi-Gigabit Transmission in the IBC Subscriber Loop	To develop and demonstrate a very high speed, 5 and 10 gbits/sec, transmission systems for various applications in the subscriber loop such as: broadcasting of TV and HDTV channels on the subscriber line, concentrator lines for switched services signals, or very high speed LANs and MANs.	Alcatel SEL AG* (D) AT&T Network Systems Nederland BV (NL) Deutsche Bundespost Telekom (D) Telefonica de Espana (E) National Technical University of Athens (GR) plus 3 additional organizations
R2006	WELCOME - Quantum Well Components for High Speed Transmission Systems	To develop the highly advanced quantum well components for speed transmission systems.	Alcatel SEL AG* (D) France Telecom - CNET (F) BNR Europe Limited (UK) Deutsche Bundespost Telekom (D) plus 6 additional organizations
R2015	ARTEMIS - Advanced Research on Transmission and Enhanced Multi-Gigabit Interconnection by Solitons	To investigate optical fibre sub-systems (with a throughput of greater than 10 gbits/sec) for use in ultra-short pulse generation, amplification, switching and transmission in order to assess and evaluate their potential for future use in the IBC network.	Alcatel SEL AG (D) National Technical University of Athens (GR) plus 3 additional organizations

1. Project manager/leader denoted by *.

Exhibit 2-8
RACE - Other Players

ORGANIZATION	COUNTRY	Number of Projects in which the Organization is Involved	Number of Projects in which the Organization is the Project Manager	COMMUNICATIONS SUBSECTORS					
				Wireless Personal Communications	Electronic Information and Transaction Services	Media Services	High-Speed Networks	All Subsectors[1]	Other[2]
Alcatel ISR	F	7	0	1	2	1	0	1	2
ANT Nachrichtentechnik GMBH	D	7	1	0	0	0	2	2	3
Clemmessy SA	F	5	0	0	0	0	0	0	5
DETECON	D	9	6	0	5	2	0	0	2
Ericsson Telecom AB	S	7	1	0	0	0	1	0	6
Irish Science and Technology Agency	IRL	2	0	1	0	0	0	0	1
Italtel	I	7	0	2	0	0	1	0	4
Laboratoires d'Electronique Philips	F	6	0	1	0	2	0	1	2
Nokia Corporation	SF	10	0	2	0	0	0	3	5
Rai Radio Televisione Italiana	I	2	0	0	0	2	0	0	0
Robert Bosche GMBH	D	6	2	1	0	3	1	0	1
SAS Denmark	DK	2	2	0	2	0	0	0	0
Sistemas Expertos	E	2	0	0	0	1	0	0	1
Teles	D	2	0	0	0	2	0	0	0
TRT	F	2	0	2	0	0	0	0	0

1. Includes projects relevant to all four subsectors.

2. Includes all other projects. These are projects which provide a common technology base and are general concerned with system aspects, components and level of performance.

Source: Research and Technology Development in Advanced Communications Technologies in Europe - RACE '92

2.1.2 ESPRIT (European Strategic Program for Research and Development in Information Technologies)

ESPRIT has already completed two phases (Phase I: 1984 to 1988 and Phase II: 1988 to 1992). The next Phase has begun under the Third Framework Program as the specific program for research and development in information technology. With emphasis on industrial projects, this third phase of the program will continue to promote co-operative R&D projects while focusing on well-defined strategic objectives and technology priorities that take full account of the fast-changing industrial scene. A new element, market forecasts, is now needed as part of any proposal.

This third phase of the program, formally approved on July 8, 1991, is comprised of six technological areas: microelectronics, information processing systems and software, advanced business and home systems with peripherals, computer-integrated manufacturing and engineering, open microprocessor systems initiative, and basic research. The areas most relevant to this study include information processing systems and software and, advanced business and home systems with peripherals.

The work in the area of information processing systems and software aims to apply software-intensive system design and engineering techniques to user needs; to develop information servers and their interfaces that are appropriate to different users' tasks and levels of expertise; and to develop advanced architectures and their applications. The R&D tasks will consider the major technology transfer and awareness initiative, ESSI, one of the "second generation" large scale targeted projects.

Exhibit 2-9 illustrates selected software engineering and information processing systems projects currently being conducted by ESPRIT.

The objectives in the area of advanced business and home systems with peripherals are to develop user friendly support for co-operative working; promote the development and use of multimedia systems; demonstrate loosely coupled distributed systems; promote the introduction of information technology into the home; and develop selected peripheral technologies.

Selected projects in this area are shown in Exhibit 2-10.

Exhibit 2-9
Selected ESPRIT Projects
Information Processing and Systems Software

PROJECT NUMBER	TITLE	OBJECTIVE	PROGRESS AND RESULTS	PARTICIPANT (Country)
2710	Portuguese National Scientific Community Network (RCCN)	To organize and implement the National Scientific Community Network, RCCN. To achieve a position where harmonised and standard network services can be offered to the whole Portuguese R&D community, especially to the benefit of the large groups engaged in ESPRIT projects. The service will be installed at various sites allowing users to exchange files between any other FTAM.	Not Available	Portuguese Foundation for the Development of National Computing Resources (P)
2715	Computer Conferencing and Electronic Mail (EUROKOM)	To provide a centralized computer service that supports the national and international requirements of research teams, business and government organizations during their participation in European Community R&D programs.	Current services include: an electronic mail and conferencing service; gateways to all international research networks; fax and telex gateways; document and file transfer and repository services; a user directory; and access to the UNIX News bulletin boards. The project has also resulted in the establishment of the EUROCONTACT service, a database designed to provide partner search facilities to potential ESPRIT program participants.	EUROKOM Ltd (IRL)
5700	Y-NET	To establish a pan-European distributed Open System Interconnection (OSI) network to provide all participants in ESPRIT and other EC R&D programs with improved communications and exchange of data, using OSI conferment software and equipment. The Y-NET services will be linked to COSINE and other associated national and international infrastructural network, facilitating access to these services.	X.400 electronic mail lines are available.	Teleo (I) Bull (F) Olivetti Systems & Networks (I) Siemens-Nixdorf Informationssysteme (D)

Exhibit 2-10
Selected ESPRIT Projects
Advanced Business and Home Systems - Peripherals

PROJECT NUMBER	TITLE	OBJECTIVE	PROGRESS AND RESULTS	PARTICIPANT (Country)
2382	Elusive Office (ELO)	To address the problems of office workers who routinely work away from company offices. To demonstrate the need for an information system that integrates: applications available to the office worker without the need to re-key information; the personal workstation and the company's data sources; individual mobile workers (for the exchange of information); and access to data sources external to the company. To develop an ELO system that maximizes a worker's mobility.	Work undertaken and results achieved so far: investigation of distributed and mobile forms of work; identification of trigger applications for mobile IT&T; requirements capture, analysis and specification for the two ELO trigger groups and the ELO trigger applications; specification of the overall architecture of the ELO system; specification and selection of generic elements and integration framework for the ELO demonstrator; specification and software and hardware implementation; specification of data encryption/decryption, tool and data access, security services; etc.	Empirica GmbH (D) CLS Computer Lernsysteme GmbH (D) Standard Electrik Lorenz AG (D) Rutherford Appleton Laboratory (UK) Franhofer Institut für Informations und Datenverarb (D) Oeva-Versicherungen (D) Realace Ltd (IRL)
2649	Visual Arts Systems for Archiving and Retrieval of Imaging (VASARI)	To define the technical requirements for measuring colour differences and detecting cracks in a painting's surface texture. To promote computer aided learning for art historians.	Ability to measure colour differences; detect hair thin cracks in a painting's surface texture; study research into the impact of differing environmental conditions (fading, transportation impacts, existing and new cracks); and educate art historians. In use by leading art museums to help European technology to move forward.	Brameur Direction des musees de France (F) Dörner Institut Elkon National Gallery Syseca (UK) Telecom Paris (F) Thomson CSF TÜV University of London (UK)
5233	Telestation (TELESTATION)	To integrate and extend existing developments in portable workstation design, mobile and land-based communications, multimedia user interfaces and application architectures to develop a prototype portable workstation.	Not Available	Active Book Company (UK) Alcatel Radiotelephone (F) Hewlett-Packard Ltd (UK) Ing. C. Olivetti & C. SPA (I) Daimler-Benz AG (D) ARG Spa (I) Perihelion Software Ltd (UK)

The review of ESPRIT I[5] which was completed in 1989 began by stressing that the overall strategic goal of the program was to provide the European IT industry with the technology base needed to become and stay competitive with the U.S.A. and Japan in the 1990's. Comments in the report were generally restricted to illustrating that the technology base was enhanced, as well as associated matters such as the dissemination of results. The benefits of collaborative working were also stressed, as were contributions to standards. In concluding and looking ahead, the report saw the problems of risk aversion in new product investment as the main feature obstructing European industry compared with the U.S.A. and Japan.

A number of problems have been raised regarding evaluations of the impact of R&D on competitiveness.[6] Firstly, evaluation panels have faced difficulties in dealing with, or even comprehending the competitiveness issue. One reason for this is that the programs they were evaluating may have represented a necessary step to improvement of competitiveness but they certainly did not represent a sufficient one. An enhanced technological base still requires investment and successful entrepreneurial activity to support it. Products may draw upon multiple sources of knowledge, and an R&D project may contribute to the development of a number of products (or processes). Collectively these problems of attribution make it difficult to assess the economic return on R&D, even in industry. Moreover, these economic returns may appear over the longer term, possibly long after an evaluation has been undertaken.

2.1.3 Telematics

The European single market has created a unique situation with the elimination of frontiers and the free movement of persons, goods, services and capital. As such, the Telematics program has been implemented to contribute to the completion of the internal market by endeavouring to provide truly Europe-wide services through the exchange of information using increasingly powerful, integrated and interconnected information exchange systems.

The AIM (Advanced Informatics in Medicine in Europe) telematics systems for health care, for example, was designed to help improve health care in Europe through the application of IT to biomedical instrumentation, monitoring and medical computer systems.

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[5] ESPRIT Review Board; The Review of ESPRIT 1984-1988; May 1989.

[6] Metcalfe J.S. et al: Evaluation of the Impact of European Community Research Program upon the competitiveness of European Industry - Concepts and Approaches: PREST 1991.

After a call for proposals in June 1991, 193 project proposals were submitted, representing ECU 600 million. By the end of the year, 37 (19.2 per cent) were in the phase of contract negotiation (EC supported amounts to ECU 97 million for these projects).[7] Projects under negotiation addressed issues such as:

- the development of a European database on drug terminology;
- the improvement of breast cancer screening through computer aided detection of mammograms;
- the development of a concept for a European integrated picture archiving and communications system in the hospital; and
- the development of a concept for computer assisted computer interventions (i.e. in cranial neurosurgery and orthopaedic knee surgery).

Similarly, the aim of the DELTA (Developing European Learning through Technological Advance) telematics systems program was defined as helping to improve the access to learning in Europe by the provision of new flexible tools and systems providing for flexible ways of learning, interactivity between users, the enabling of remote access to learning resources and optimum user support.

In response to the call for proposals in June 1991, 110 proposals were received, involving some 900 different organizations and representing ECU 260 million. Of these projects, 22 (20 per cent) were selected for contract negotiations, supported by ECU 54 million of EC funding. The 22 projects involved 232 different partners (four from EFTA countries), of which 36 per cent were universities or other establishments representing education or learning and 26 per cent represented the telecommunications sector or industry.[8] Projects under negotiation included:

- advanced communications for training which aimed to develop the tools and telecommunications configuration for a European training network based on ISDN and direct broadcasting by satellite;
- contribution to the development of favourable conditions for distance learning by farmers and people in rural areas; and

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7 "Telematics systems for health care (AIM)", XIII Magazine News Review, Fourth Quarter 1991, p.11.

8 "Distance teaching/flexible learning (DELTA)", XIII Magazine News Review, Fourth Quarter 1991, p.11.

- pilot implementation project "Multimedia Teleschool", which would provide for a series of large scale pilot projects with real learners.

The ORA (Opportunities for Rural Areas) program is another part of the telematic systems program. The objectives of ORA are to create the conditions for small businesses to provide more diverse employment opportunities; to establish a basis for the provision of improved services; to raise the level of awareness of telematics; to encourage manufacturers and service providers to make equipment and services easier to use; and to ensure that the applications of information and communications technologies do not contribute to further centralization of business and administrative activities or a loss of the culture and economic diversity in Europe.

As a result of a call for proposals in June 1991, 50 proposals were received requiring more than eight times the available funding. Of the 200 organizations associated with the proposals, 85 per cent had not previously been associated with EC R&D and 55 per cent were from less favoured regions.[9]

Work under 11 of the contracts awarded began in January 1992, involving 84 organizations, 28 of which were users or potential users of telematic systems in a rural environment. The core of the research focuses on the development of common specifications and demonstrators of telematic systems to support rural tourism, local and regional administrators, small business and teleworking. Projects include:

- the development of distributed multimedia systems for rural tourism, one building on work in Ireland and Italy, the other on that in France; and

- the development of teleworking, one from the point of view of major companies that may benefit commercially from the decentralization of some functions to smaller rural offices, the other considering the social, psychological and organizational issues.

The request for proposals was re-opened in January 1992 for three tasks concerning the development of telematic systems for small business, provision of financial and professional services, and the development of a consensus between users, telecommunications network operators and equipment manufacturers on development strategies.

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[9] "Opportunities for Rural Areas - The R&D programme for R&D in telematic systems", XIII Magazine, May 1992, p.14-15.

In the area of transport services, the Telematics program builds on the EC's Dedicated Road Infrastructure for Vehicle Safety in Europe (DRIVE). The activities of the DRIVE program aim to contribute to the development of information technologies to improve road transport efficiency and road safety, and at the same time reduce the impact of road transport on the environment. Work in this area covers the interface between road and rail transport as well as that between road and sea.

The activities of the DRIVE program are divided into three interactive parts:

- the definition of functional specifications in the context of a strategy for the use of technology and telematic systems for communication and traffic control;
- the development of new technologies and experimental systems; and
- validation work.

The total community funding allocated to the transport services area is ECU 124.4 million for the period 1991 to 1994.

2.1.4 Implications for Canada

Current EC directives state that full participation of Third Countries in the R&D Framework Programs must be within the framework of a formal agreement. Canada has initiated discussions regarding such an agreement and it is expected that negotiations of an agreement will begin in 1993. In the absence of a formal S&T agreement with the European Community, Canadian participation has been limited to the following categories:

- as a sub-contractor funded 100 per cent by a Member State consortium to provide speciality expertise;

- as a contractor on R&D required and funded by the Joint Research Centre;

- as a complementary research participant in a project of the Framework Program (funded 100 per cent from Canada); and

- as participants in information exchanges, workshops, symposia, multilateral activities, etc. where the Canadian-side carries its own costs.

For all the above cases, the Canadian-side is not eligible to have access to the proprietary information and intellectual property developed in projects and specific programs.

Following the formalization of an envisaged Agreement to Co-operate in S&T, the following categories of participation in the R&D Framework Programs would be open to the Canadian organizations:

- **At the Project level**, as a partner of a competing consortium headed by, and including two or more Member State organizations, but with the funding provided 100 per cent from Canada. The Canadian participant would have access to proprietary information and intellectual property of the project. An administrative fee of ECU 5,000 is levied per project by the EC Commission.

- **At the Specific Program level**, where Canada participates as if it were a Member State and contributes financially to the global budget of the Specific Program based on its relative GNP (about 10 per cent). This participation would require significant amounts of funding by Canada. Canadian organizations participating would then be funded 50 per cent by the EC Commission at the project level and have access to information on the whole program under the same conditions as Member States. The Canadian participants would still be required to fund the other 50 per cent of their project costs.

In addition to the above forms, there can be extraordinary co-operation for special circumstances. For example, Canadian organizations can also participate in the Commission's "Concerted Action" programs where the priorities and workplans are determined at the Community level but the research is funded by Member States. The Commission's role is concerned with the coordination of work and the exchange of research results.

In regard to handling the intellectual property (IP) associated with trans-national participation in projects and programs of the Commission, experience is yielding clearer mechanisms and guidelines. For example, the EC Commission requires that a Joint Technical Management Plan on how the IP will be handled be an addendum to all contracts between the research performers in a consortium.

Canada, to date, has been co-operating with the EC on S&T under an Industrial Co-operation Agreement signed in 1976. There is a joint EC-Canada Working Group on C&IT Research which promotes and facilitates joint projects. The areas for joint activities are decided pragmatically depending on the interests of researchers at any one time. Currently there is interest in areas such as data networks, digital audio broadcasting, HDTV, EDI, distance learning, machine translation and language technology health and telematics as well as intelligent vehicle highway systems. DOC provides the Canadian co-chair to this Working Group.

Specific projects currently in play which are related to the fields of interest to this study include:

- two joint projects are in the planning stage involving the adaptation of Canadian informatics technology to road safety in Europe. The EC program involved is DRIVE and in Canada, Transport Canada is the lead department;
- Canada will host a workshop on distance learning technologies in May 1993. EC delegates will report on DELTA project results. DOC is the Canadian leader of this project;
- DOC is the Canadian lead in a joint Canada - EC two year study of the telecommunications requirements for EDI.

Much of the activity is focused on the exchange of information.

2.2 EUREKA (European Research Coordination Agency)

EUREKA is not an EC program but rather a framework for encouraging industry-led, market driven collaborative projects aimed at producing high technology goods and services to compete in world markets against the U.S.A. and Japan. However, these projects are normally downstream of, and complementary to, EC programs. EUREKA has minimal government involvement compared to EC programs where member states are closely involved in the identification of programs and projects.

The EUREKA program was collectively launched by eighteen European countries in the fall of 1985, as a result of a French-German initiative. The program consists of selected high technology research and development projects to be carried out by industrial enterprises and government level research initiatives. EUREKA-sponsored projects are designed to be a set of near-market business deals between European high technology firms and research institutes. The ultimate aim of EUREKA is to intensify European co-operation in major strategic technology areas directed at the highly competitive, technology driven markets of the future. EUREKA coordinates activities but does not provide funding per se.

EUREKA projects are designed to exploit the following technologies: information and telecommunications, robotics, materials, manufacturing, biotechnology, marine technology, lasers, environmental protection and transport technologies. In addition, projects are for civilian use only and involve both the public and private sectors. By January 1990, information/communications projects represented 37 per cent of the total investment in EUREKA projects.

In 1988, Canada established the $20 million Technology Opportunities in Europe Program (TOEP) to give Canadian firms access to the EUREKA program. However, due to the modest Canadian participation (e.g. 6 projects), TOEP was terminated. The complexity and cost of accessing EUREKA projects combined with the ineffectiveness of the TOEP delivery mechanism were the main factors which undermined TOEP. No new program has been set in place.

On May 22, 1992, members of the EUREKA initiative announced 102 new EUREKA projects. The new projects - which included five in communications and 20 in information technology - at a total value of ECU 627 million, brought the number of on-going projects to 539 worth a total of ECU 8.84 billion.[10] The projects, adopted for the period mid-1992 to mid-1996, emphasize the need to increase co-operation with non-member European countries as well as the synergy between EUREKA and EC research programs.

Exhibit 2-11 (a and b) illustrates eight new EUREKA projects which fall in the areas covered by the study. Three of the projects are in the field of communications, while five are in the realm of information technologies.

Stressing the need to sustain interaction between EC R&D activities and EUREKA, the Commission underlined that it would contribute - either financially, through the transfer of results or through supporting measures - to 68 new projects, at a total cost of ECU 3.2 billion, representing 40 per cent of the total cost of EUREKA's projects. The Commission financed 21 of these projects, worth an estimated total cost of ECU 1.7 billion.[11] Currently, more than 2,000 companies and research organizations are involved in the EUREKA projects.

With regards to existing or recently completed projects, EUREKA is presently wrapping up its COSINE (Co-operation for Open Systems Interconnection Networking in Europe) project. The project, which began in 1990, was dedicated to furthering the use of OSI-based communications by the European research community. The approach was to unite National OSI networking in the R&D domain through a set of specific sub-projects at the European level. Support for the project was provided by the Commission.

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10 "New opportunities for cooperation between EC R&D and Eureka", XIII Magazine News Review, Third Quarter 1992, p.10.

11 "New opportunities for cooperation between EC R&D and Eureka", XIII Magazine News Review, Third Quarter 1992, p.10.

Exhibit 2-11a
Selected EUREKA Projects
Communications

TITLE	DESCRIPTION	PARTICIPANT[1] (COUNTRY)	DURATION AND FUNDING
Multi-Application Variable-Rate Digital TV/HDTV	To design, develop and pre-market a television transmission system which employs reduced data rate signals. Developments include: compatible bit rate reduction system for TV and HDTV; large bit rate range for multiple applications; and software-based coding allowing for future enhancements.	Digital Vision Sweden AB* (S) Vistek Electronics (UK)	July 92 - Jan 94 ECU 1.4 million
Video-Audio Digital Interactive System - Digital Television at Bit Rates up to About 10 mbits/sec.	Primary goal of the project is to develop a European enabling technology for digital television at bit rates up to about 10 mbits/sec, including the development of the related microelectronics.	CSELT* (I) Oy Nokia AB (SF) France Telecom (F) Philips Microwave (F) Thomson Laboratories (F) Deutsche Bundespost (D) Siemens AG (D) Intracom (GR) Alcatel Telettra (I) RAI (I) Swedish Telecom (S) Telefonica (E) BBC (UK) BT Plc (UK)	Jun 91 - Dec 93 ECU 20 million
Cost Effective, High-Speed Method for the Production of Optical Fibre	Target of the project is to develop a technology to manufacture larger pre-form sizes with improved manufacturing efficiency and higher drawing speed to make the overall process cost effective and efficient.	Nokia Cables Ltd.* (SF) Cableoptic SA (CH)	Jul 92 - Jul 94 ECU 2 million

1. Project manager/leader denoted by *.

Exhibit 2-11b
Selected EUREKA Projects
Information Technologies

TITLE	DESCRIPTION	PARTICIPANT[1] (COUNTRY)	DURATION AND FUNDING
Real-Time and Interactive Communication Network/Commercial Seafood and Fishing Information System on Sea and Ashore (INFOMAR)	INFOMAR involves the organization of a real-time and interactive seafood and fishing information system and a multi-cultural communication network for vertically integrated commercial communication at all stages of processing and distribution of seafood from fishing vessel to consumer, in addition to, communication connected to fishery management.	Fisket* (NL) Roskilde University (DK) Fang (NL) JPR Communications (NL) Nordic Fisheries (N) International Maritime (UK)	Apr 92 - Jan 96 ECU 48 million
Integrated Transaction Processing Information and Support System (IRISS)	The IRISS project aims to improve business decisions and company competitiveness by integrating current divergent information support processes carried out by separate systems dedicated to on-line transaction processing, decision support and management information.	Telmat Informatique SA* (F) James Martin Strategy (B) Bristol Transputer Centre (UK) National Transputer Centre (UK) Trustee Savings Bank (UK)	Apr 92 - Apr 95 ECU 8.3 million
Vertical Bloch Line Memory Development	The project aims to develop, by 1995, a non-volatile, magnetic memory device at an initial capacity of 64 mbits/sec, with wide applications in information technology.	Laboratoire d'electronique et technologie de l'informatique* (F) Soc. d'applications generales d'electricite et de mecanique (F) Radstone Technology Plc (UK) University of Manchester (UK)	Duration not available ECU 20 million
ECMA-PCTA EUREKA Project (European Computer Manufacturers' Association- Portable Common Tool Environment)	The technical approach of the project is based on the ECMA reference model for computer-assisted software engineering environments. There are three levels of functionality in the architecture for project support environments. The purpose of the project is to develop the first two levels in order to meet the needs of production environment developers, of ISPE developers and of those wishing to integrate their software tools into cooperative frameworks.	Emeraude* (F) Cediag (F) Societe française de genie logiciel (F) Softlab Gmbh (D) Systemhaus Mbh (D) International Computers Limited (UK) SD Sicon Limited (UK)	Nov 91 - Nov 94 ECU 30 million
High Performance Printed Wiring Boards (HPBS)	The purpose of the project is to develop the manufacturability of high performance printed wiring boards (HPBS) by developing new technologies. HPBS are panels, for this purpose limited to a size of 30 x 30 inches, on which smaller print wiring boards (PWBS) can be mounted and interconnected.	Mommers Print Services BV* (NL) Digital Equipment International (IRL)	Apr 91 - Apr 94 ECU 2.3 million

1. Project manager/leader denoted by *.

COSINE has already launched several sub-projects, expanding on the services already used at local and national level to bring Europe-wide connectivity in electronic mail, directories and information services. Further sub-projects and services are being established. The sub-projects being implemented include:

- FTAM North American gateway;
- international x.500 directory services (PARADISE);
- support and information service (CONCISE);
- activities to support typical international user groups; and
- OSI connectionless-mode network service trials.

Other EUREKA projects, in the areas of communications and information technologies, which were recently completed include:

- Very High Bit-Rate Optical Transmission System (ECTRANS): An ECU 53 million project which designed and developed a high bit-rate system for transmission of telecommunications signals on trunk and local networks to support the implementation of the future broadband integrated service digital network (B-ISDN or IBCN).

- European-Based Global Computerized Distribution System to Meet the Future Needs of the Travel Industry (AMADEUS): An easy-to-use, automated, personal computer-based system designed to meet international standards and requirements. This ECU 350 million system allows for instant reservations, ticketing and payments.

- GALILEO: A new generation computerized distribution system designed to meet the total future needs of the travel industry. The system cost ECU 69 million.

- Medical Digital Information System (MEDIM): An ECU 10.8 million project designed to improve the organization of the radiological resources, both human and technical, available in any area, by using telematics for medical images and text.

- AIT Tourist Information System (ATIS): A tourist information base for European clubs affiliated with the Alliance internationale de tourisme (AIT) and their members, costing ECU 3.5 million.

Presently under way, but soon to be completed is the Terrestrial Flight Telephone Service (TFTS) project. The goal of this three-year, ECU 41.5 million project is to research and demonstrate a terrestrial flight telephone service for airborne public correspondence (APC).

Another EUREKA project currently under development is PROMETHEUS (Program for a European Traffic System with Highest Efficiency and Unprecedented Safety). PROMETHEUS originated in October 1986, with a view to contribute to the development of concepts and solutions which would lead to a road traffic system with greater efficiency and less detriment to the environment, combined with a degree of unprecedented safety.

This seven-year, ECU 765 million research program is headed by 18 European car manufacturers. Participants include representatives from the electronics industry and its suppliers, universities and research institutes, traffic engineers and authorities. Their common objectives are to:

- improve the competitiveness of European industry;
- improve highway transportation in all its aspects; and
- stimulate European basic and applied research and technology in general.

The strategy for achieving these objectives include:

- co-operative action involving the automobile industry, supply and electronics industries, the state and scientific community; and

- pan-European co-operation in research, system development and solution implementation.

A co-operation agreement has already been signed by the automotive companies. Associate contracts are currently under negotiation between automotive companies and electronics and supplier companies.

PROMETHEUS combines applied research conducted by industry and basic research conducted by over 40 university and government research institutions. There are seven sub-programs, three being carried out by the motor industry and four by the research community.

The industry sub-programs cover:

- the development of driver-assisting electronic systems;
- the development of systems for vehicle-to-vehicle communication; and
- the development of communication and information systems between roadside and on-board equipment.

The basic research sub-programs cover:

- basic research into software and artificial intelligence methods;
- basic research into microelectronics for vehicles and the highway;
- system research into protocols and standards for mobile communications; and
- system and basic research into scenarios for road transportation of the future.

It is expected that the research results will benefit all Europeans. Developments will initially be used by numerous sectors, in particular the automobile and electronics industries, and automobile subcontractors. The European motorcar industry will then be able to increase its competitiveness vis-a-vis the U.S.A. and Japan.

2.3 Germany

2.3.1 Overview

The role of the Government in Germany is to put in place the framework conditions within which the public can best take advantage of IT. This means the creation of an environment which favours the increase of the use of IT in the economy. The framework conditions include international co-operation, tax incentives, promotion of technology transfer, and further improvement of IT education. The recent deregulation of telecommunications services is also one of the factors which constitute the fundamental framework conditions which favour further development of competition in telecommunications; thus the use of IT-based systems via telecommunications infrastructure development.

Government intervention in initiating R&D, product-development and IT use in the private sector is minimal. It is generally accepted that IT R&D is carried out mainly by the private sector in Germany. While statistical information on the IT sector per se is not available, it is well known that in Germany, the share of business R&D expenditures is the second highest after Japan among the major economies of the OECD member countries.

The IT manufacturing sector, such as computer and telecommunications equipment, is one of the main industrial sectors with strategic importance in Germany. The country has one large domestic manufacturer, Siemens, which has been leading R&D activities in the whole country in a way which eventually took over part of the role of the Government in guiding the direction of the German IT-manufacturing sector. As long as the IT manufacturers are successful, there is little need for the Government to intervene in their activities.

In the telecommunications sector, the Deutsche Bundespost (DBP) had restricted its role in computer communications to the sole provider of the network facility, i.e. the integrated text and data network (IDN). It has a leading role as a provider of infrastructure for telecommunications and basic public service. Shared use and resale of the private circuit was limited. This indicates that economic concerns, or the encouragement of the strategic use of telecommunications in economic activities, especially private corporate networks which involve computer communications systems, was not necessarily one of the priorities of the DBP. Now that competition is allowed in Germany (except for terrestrial telephone services), with the DBP Telekom as one of the competitors, the market environment will change. Allowance of shared use of leased circuits will also open up vast opportunities to exploit corporate networks (both intra- and inter-firm networks) to reinforce their competitive advantages. It is, however, too premature to foresee the results of the restructuring of the DBP and the telecommunications market structure.

The level of Government intervention in promotion of IT-applications is low in Germany. Decisions on the use of IT-applications are left to individual entrepreneurs.

The same can be said of the promotion of IT-based networks. In fact, the development of IT-based networks is not the central concern in policies for IT, although the Government recognizes that the use of such networks is increasing its strategic nature by integration in corporate strategies, notably in the U.S.A. and in Japan.

In summary, the Government prefers to take advantage of the mechanism of the free market as a stimulus to increase the strategic use of IT-based systems and equipment in the economy. The role of the Government is to ensure the basic conditions to develop the use of IT.

IT development is taking place within an S&T context in which the three main trends in German government policies are:

- the increased importance of basic research with support shifting to the biological sciences and away from the physical sciences;
- a higher priority being given to strategic technologies including IT; and
- major channelling to social priorities (e.g., health, environment).

These directions are being taken within an S&T expenditure envelope of DM[12] 90 billion of which DM 70 billion goes towards R&D (2.8 per cent of GDP). Industry accounts for 64 per cent of R&D expenditures and 71 per cent of all R&D. The Ministry for Research and Technology (BMFT) is the key institution setting S&T policies and programs. Increasing importance is being given to participation in international programs.

Canada has had a bilateral S&T agreement with Germany since 1971. This bilateral agreement is considered to be the most effective among the agreements with European countries. DOC represents Canada's information/communications interests within the context of this agreement. In the IT sector the areas of collaboration in the past have been in computer/communications, artificial intelligence, software engineering and the social/economic/legal impact of IT.[13] Currently, the areas of interest include, in addition, satellite communications, multimedia, OSI/ODP/LAN networks, high performance computing, natural language knowledge-based systems and man-machine dialogue.

2.3.2 Siemens

Siemens, Germany's leading electronics firm, is active in most IT and electronic equipment markets, in particular: semiconductors; commercial and industrial electronics; computer communications; and telecommunications. In 1990, the company earned revenues of DM 63.2 billion, of which DM 34.8 billion were international sales.[14] Siemens expects international sales to continually increase as it aggressively expands its activities into new world markets.

With approximately 43,000 employed in the company's R&D activities and a budget of almost DM 7 billion, Siemens has one of the largest financial commitments to R&D of any leading IT corporation. In addition to the significant monetary contribution to R&D, Siemens' maintains R&D projects with other companies including Toshiba, Fujitsu and IBM.

In an attempt to improve the profitability of its R&D expenditures, Siemens has become more selective in the commitment of its R&D efforts and funds. The company divides its R&D efforts between its product-oriented groups (90 per cent of R&D resources) and its corporate divisions (10 per cent). Long-term R&D plans are coordinated by a central

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[12] One DM is approximately $0.76 (Canadian).

[13] Canadian German Co-operation in Science and Technology; 20 years (1971-1991).

[14] "Siemens AG", Datapro Reports on International Telecommunications, May 1991, p. 101-108.

body while short to medium term plans are the responsibility of individual divisions. The advantage of this structure, according to Siemens, is that each industry specific division or group has a much shorter response time to market and technological developments.

R&D activities in the communications areas have resulted in several technological developments, which the company is now promoting. These include:

- A switching computer for LAN oriented connections. The processing speeds (up to 300 million instructions per second) accommodate broadband ISDN operating over the public services network.
- The new Fibre Distributed Data Interface (FDDI) standard for applications in computer networks with high data rates.
- Surface acoustic wave components for use in satellite television, radio relays and in handling frequencies up to 2.6 GHz for future optical telecommunications systems.
- Flexible network management system developments.
- New international SONET standards.

In conjunction with Toshiba, Siemens developed a 1M bit computer memory chip in an effort to narrow the gap between itself and its competitors in semiconductors.

2.4 France

2.4.1 Overview

France has built up an almost wholly indigenous telecommunications industry. Government contracts have played a key role in structuring the telecom industry in France. The formation of the CNET (1944) proved to be a decisive factor in this process since it was used by the Ministry of PTT to publish the technical standards that provided some of the impetus needed to "lever" French industry into the equipment supply sector.

One notable feature was the way in which several technologies were maintained in place at one and the same time. By operating within such an organizational structure, and particularly by posting for digital technologies at a very early stage in the 1970s, the DGT successfully identified emerging market trends and thereby succeeded in raising itself into its current central position.

The public authorities, and particularly the administration of the PTT working through the DGT and the CNET, have successfully pursued a three-fold objective:

- development of indigenous industries and technologies;
- concentration of enterprises and then, by means of a policy of alliance, their multinationalization; and
- digitalization of the network.

The development of an indigenous French industry was an extremely long-term project that has only reached completion in the last few years. In the early 1970s, although the DGT and CNET had succeeded in introducing some French technologies, the vast majority were still provided by ITT (47 per cent of the market) and Ericsson (19 per cent). The 1976 consultations led to the first major upset with the formation of two industrial groups financed with French capital. Thomson-CSF and CIT-Alcatel who together bought up LMT (ITT) and SFT (Ericsson). Only CGCT (with a 17 per cent share of the market) is still in the hands of ITT. This process was completed during the 1980s. CGCT was nationalized and reprivatized, while a new group, Alcatel-Thomson, was formed.

Multinationalization developed during the 1980s in the wake of the 1982 nationalizations and 1986 privatizations. The choice of partners was deliberately restricted to Europe, with the formation of two groups with majority stakes held by French shareholder, Alcatel.NV through the purchase of ITT's European subsidiaries; MET through joint buy-out of CGCT by Matra and Ericsson (when the company was returned to the private sector).

Digitalization is probably one of the most original aspects of the development of telecommunications in France. As early as the late 1970s, and well before all other national operators, DGT opted for digital technology and, amazingly enough, proceeded to go ahead with digitalization, despite the fact that France's underinvestment in equipment which had started to be remedied in the 1970s meant that it still had much ground to make up. Thus, the decision taken by France at an extremely early stage in the development of its industry to invest in digital equipment, at a time when France was still relatively underdeveloped produced results at the end of this period that are essential to our understanding of the implications of the current situation. France now has the most digitized network in the world.

The DGT, which sponsored this modernization, quickly sought to capitalize on the situation. Pursuing a policy of expansion through the creation of subsidiaries, the DGT, more swiftly and audaciously than its domestic counterparts, introduced new services, some of which (Transpac and Télétel) have the highest user ratios in the world.

These thrusts are supported by a national science and technology policy framework that places a priority on industrial technology development. More than 80 per cent of France's research personnel and budget (i.e. F[15] 150 billion - 2.4 per cent of GDP) is tied up in four areas: aerospace, telecommunications, nuclear energy and defence. Recent budgetary allocations have increased government support of industrial R&D in:

- European Community programs (JESSI, HDTV);
- EUREKA;
- agriculture and food, TGV third generation, cleaner automobiles;
- innovation assistance to small and medium sized enterprises;
- European space programs (Ariane V, Hermès, Columbus, SPOT); and
- Aeronautic programs (Airbus, A330 and A340).

France has a bilateral Science and Technology Co-operation Agreement with Canada. Some 30 scientists from each country have the opportunity to work in the laboratories of the other country each year. However, the communications/information area is not very active aside from some informal contacts.

Canada's areas of interest in collaboration with France are in biotechnology (food/medical), aerospace, oceans and telecommunications. Regarding the latter DOC, for example, had a Memorandum of Understanding with CNET regarding R&D in the area of microwave hybrid integrated circuits. At the subnational level, Ontario has an agreement with the Rhône-Alpes Region which covers IT and is the umbrella for the Telepresent Project which is led by the Telecommunications Research Institute of Ontario (TRIO).

2.4.2 Alcatel

According to a recent company profile, Alcatel claims to be one of the world's largest communications systems and equipment supplier, holding a 17 per cent share of the global switching market and a 23 per cent share of the global market for line transmission systems.[16] In 1991, the company realized record sales figures of ECU 15.7 billion, representing a 17 per cent increase over the previous year total.

In 1991, Alcatel spent approximately ECU 1.9 billion, or almost 12 per cent of total sales, on research, development and engineering. The company is heavily committed to R&D and has a Research Group, consisting of 12 research centres and employing some

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15 One F is approximately $0.23 (Canadian).

16 "Alcatel NV", Datapro Report on International Telecommunications, September 1992, p.101-108.

1,300 researchers, located in seven countries within Europe. Research is conducted to support all of the company's core businesses. Nonetheless, there are a number of areas on which Alcatel is focusing its attentions. For example, Alcatel's advanced digital switches and SDH/SONET technology.

Alcatel is very strong in the development of SDH/SONET technologies. In fact, it was one of the first to supply SDH/SONET equipment to the U.S. As such, the company is keen to establish a leading position in the U.S. market, where the technology is the most advanced.

Alcatel's R&D efforts also extend into the following complementary areas:

- broadband network technology and ATM technologies;
- optoelectronic, ASIC and VLSI components for optical switching and transmission; and
- new software methods and tools.

In addition, Alcatel is investing heavily in digital cellular networks and particularly in systems based on the GSM standard.

Alcatel's Research Group is active in the European RACE, ESPRIT and EUREKA projects. The company also works closely with the European Telecommunications Standards Institute (ETSI).

2.5 United Kingdom

2.5.1 Overview

To a greater extent than any other European country, the U.K. has sought to fashion a market-driven regulatory regime that allows business users to take full advantage of the opportunities afforded by the new telecommunications. Liberalization has been the midwife to more dynamic market and industry structures, both of which acted as major constraints on the corporate use of telecommunications in the public monopoly era. Compared to that period, there can be little or no doubt that business users are today more able to use telecommunications to greater competitive effect.

These firms are becoming more and more internationalized, such that the significance of the national regulatory regime is not what it was in the past. For example, Ford operates on a pan-European canvas and therefore its new networking strategy is constrained by the multiplicity of regulatory regimes on the continent. Courtaulds and

Barclays are similarly becoming more concerned about the need for greater regulatory uniformity at the transnational European level. To the extent that major regulatory differences survive the European Commission's drive to achieve a unified internal market in 1992, these firms will locate their information-intensive activities in countries which offer the most permissive regimes.

This liberalization of the telecommunications environment is also attracting foreign investment, especially Japanese investment. The U.K. is seen as a prime entry point to the EC. For example, Sony has set up its Broadcast and Communications Development Centre at Basingstoke while Fujitsu's Stockley Park Centre works on new communications and computer systems.

This openness is leading the U.K. to participate in more EC programs. In recent years cutbacks in research funds and new restrictions on the availability of funds have encouraged a shift to participation in EC programs.

2.5.2 Major Research Activities

Domestic research activities (i.e. expenditures are 2.2 per cent of GDP) that encourage industrial development include the following:

1. LINK: Cost-sharing of joint precompetitive research involving companies in collaboration with Higher Education Institutions and Research Councils. LINK programs under way include Molecular Electronics (5 year program, total value £[17] 20 million), Advances Semiconductor Materials (5 years, £ 24 million), Industrial Measurement Systems (5 years, £ 22 million), Eukaryotic Genetic Engineering (4 years, £ 4.6 million), Protein Engineering (5 years, £ 10 million), Nanotechnology (4 years, £ 15 million), Optoelectronics (3 years, £ 30 million) and Catalysts (5 years, £ 5 million). About 20 programs have been launched with an expected 500 industries participating and government contributions next year at £ 76 million.

2. EUREKA and EC Programs: EUREKA (launched in 1985) encourages industrially-led projects with European Community and other European partners with the U.K. participants receiving varying proportions of financial support from the U.K. Department of Trade and Industry (DTI). U.K. companies are also encouraged to obtain support from the EC programs, and are participating in many, e.g. BRITE, EURAM, RACE, ESPRIT. The U.K. contributes to the EC Framework Program.

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[17] One £ is approximately $1.85 (Canadian).

3. Advanced Technology Program (ATP): Collaborative research among companies supported by the DTI to promote long term research and industrial application. For instance, the Information Engineering programs have replaced the well-known Alvey program. ATP also supports Advanced Robotics, Wealth from the Oceans, High Temperature Superconductivity, etc.

4. Interdisciplinary Research Centres: University-based Centres of Excellence in fields such as Superconductivity (Cambridge), Molecular Sciences (Oxford), Optics and Lasers (Southampton/Univ College), Surface Science (Liverpool), Process Simulation and Control (Imperial), Engineering Design (Glasgow), and Population Biology (Imperial). University Research Councils fund the Centres at a cost of £ 15-20 million annually.

5. SMART (Small Firms Merit Award for Technology): DTI assistance for small high-tech firms to improve strategies and management. This program is a "set-aside" program on government procurements.

6. CLUBS: Groups of companies jointly funding projects in particular areas of common interest (e.g. biotransformation) with contributions from DTI.

7. The Teaching Company Scheme: Assists manufacturing companies to form partnerships with higher education institutions including specialist support or placing science or engineering students in the company as well as preferred access to universities, polytechnics or the Scottish central institutions. This popular and successful scheme has proven to be an excellent mechanism for diffusing technological innovations.

The U.K. has a long history of S&T co-operation with Canada, fostered by an information network of British researchers who emigrated to Canada in the post World War II. This network has since evolved into a mosaic of linkages through the presence of Canadian firms, such as Northern Telecom and Cognos, in the U.K. Formally, Canada and the U.K. have a large number of bilateral projects under an Exchange of Letters.

Canada and the U.K. participate in multilateral S&T co-operation, through agencies such as the Commonwealth Science Council, the European Space Agency, and the International Energy Agency.

2.6 Sweden

2.6.1 Overview

In contrast with the three previously mentioned countries, Sweden is a small highly developed country which spends about 3 percent of its GDP on research and development (R&D), 70 percent of which is performed by industry. Industrial R&D is dominated by ten or so large multinational firms including Ericsson.

Swedish telecommunications is dominated by the Swedish PTT, Televerket, a monopoly. Televerket has a close relationship with its major supplier, Ericsson.

2.6.2 Ericsson

Ericsson is one of Sweden's largest companies, with over 100 years of experience in communications. It develops, manufactures and sells a range of telephone, telex, and data switching systems for public and private networks. Since Sweden offers a relatively small home market, the company exports a large portion of its products. In 1990, Ericsson reported net sales of SEK 46 billion, of which 88 per cent were international sales.[18]

Ericsson's main R&D strategy is to find partners to share R&D costs for specific projects. Two major joint ventures include Ellemtel, a 50:50 joint venture with Televerket, and RACE.

Nevertheless, in 1990, Ericsson spent SEK 4.9 billion, or almost 11 per cent of net sales, on R&D activities. The company employs approximately 9,000 people, located in 40 R&D locations around the world and has research centres dedicated to the following:

- fibre optic research, including fibre interconnects;
- high-speed electronics, including micro interconnects;
- computer sciences; and
- radio technology.

The company also operates several applications laboratories, including:

- a telecom applications lab for modelling network architecture;
- a fibre-to-home lab;
- an intelligent networks lab; and
- a Computer Aided Design (CAD) lab.

Products still under development involve: digital cellular systems, in particular for GSM; large DXCs for the German public network; IN gateways for the AXE switch; and SDH/SONET compatible transmission products.

[18] "LM Ericsson AB", Datapro Report on International Telecommunications, January 1992, p. 102-105.

3.0 RESEARCH AND DEVELOPMENT ACTIVITIES IN JAPAN

Japan's telecommunications policy and associated regulations are not perceived as an obstacle for business activities. Rather, users' fees, for example, have been regarded as an inevitable tax imposed for making use of public telecommunications systems.

Businesses and consumers' campaign for the liberalization of telecommunications regulations in Japan began in the late 1960's, especially in free use of leased circuits and permission of value added networks. The 1985 reform of telecommunications regulations resulted from a tacit market pull based on strong demands from telecommunications users, as well as from a supply push or a politically-driven stance.

This politically driven approach is reflected in the setting of related R&D directions which is done by government agencies, principally the Ministry of Posts and Telecommunications (MPT) and the Ministry of International Trade and Industry (MITI). Both Ministries support activities that flow from 21st century visions of the telecommunications and information technologies environment.

In May 1992, MPT issued R&D guidelines for telecommunications technology that flowed from these visions[19], having completely revised its 1986 "Research and Development Guidelines for Telecommunications". The guidelines were as follows:

- continue a long term approach to R&D;
- promote basic research with greater enthusiasm than in past;
- promote R&D in telecommunications technology; and
- take into account social trends and user needs.

A primary objective of the guidelines was to carry out "leading research", from basic to application (i.e. basic research with a practical target). It also recommended that research and development in telecommunications must be done hand in hand with standards development.

Under the R&D guidelines, telecommunications services were specified to include functions that would:

1. meet user needs;
2. be easy and intelligent to use;
3. be transparent;
4. be ubiquitous; and

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[19] Ministry of Posts and Telecommunications; Research and Development Guidelines for Information and Communications Technology; May 1992.

5. ensure safety and reliability. Systems functions were to be: personal, private, intelligent, visual, multimedia, global networking, high-speed, open, and reliable.

3.1 Centres for Government Research

The following sections describe the main Japanese government research centres.

3.1.1 Japan Key Technology Centre

Established jointly by MPT and MITI in October 1985, this centre supports/finances pre-competitive risky R&D. Information technology is included in the field of R&D financed by this centre.

3.1.2 Communications Research Laboratory (CRL)

This centre is a national institute for the study of telecommunications technology, radio science and radio applications in Japan. Being a key organization in MPT, its activities include research in telecommunications, radio science, space communications, space science and atmospheric science.

Projects undertaken at CRL are high risk, long term research of a "highly public nature". They include "Frontier" technology. The Lab also conducts R&D for the development of radio frequency resource, standardization of telecommunications systems, R&D of protection technology in electromagnetic environment - in order to support all telecommunications administration.

There is active co-operation between the Communications Research Centre (CRC) and CRL laboratories.

3.1.3 Kansai Advanced Research Centre (KARC)

KARC, the newest branch of CRL, was established in May 1989 to pursue basic research in telecommunications. It is a centre for MPT's Frontier Research in Telecommunications program. Employing 43 research staff, it covers three broad research areas: informatics, material science and laser technology, and biological information science. It is organized under eight research sections:

1. Auditory and Visual Informatics Section: Develops efficient image and speech processing and transmission methods based on the visual and auditory information processing of biological nervous systems and the human brain.

2. Knowledge Systems Section: Conducts research on network-human interface in order to ensure that future networks are human-friendly.

3. Intelligent Processing Section: Builds functional models of human intelligence related to language and image understanding.

4. Superconducting Radio Physics Section: Covers techniques of the near-millimetre wave region - one of the last frontiers of the electro-magnetic spectrum.

5. Optoelectronics Section: Researches and develops novel sorts of lights such as highly stabilized laser, and squeezed light with lower noise levels than normal lasers.

6. Laser Physics Section: Conducts basic research in new laser technology.

7. Biological Function Section: Investigates the functions of biological supra-molecules aimed at developing a basis for future intelligent and humanistic information processing machine systems.

8. Structural Biology Section: Studies the structure and functions of chromosomes in living embryos.

3.1.4 Institute for New Generation Computer Technology (ICOT)

This institute was established in 1982 following approval from MITI. The objectives of ICOT are to promote research and development of new generation computer technology, perform investigative studies, and work toward the spread of new technology.

The main project of ICOT is the Fifth Generation Computer System (5G) whose main activities are:

- research and development of new generation computer technology;
- investigative studies of new generation computers and related technologies;
- leadership and guidance in the field of new generation computers;
- surveys on new generation computers and spread of results of R&D; and
- promotion of international exchanges in new generation computer research and development.

This 10-year project was scheduled to be completed by the end of fiscal 1991 (March 1992), but was extended in order to obtain some international assessment. The results were discussed at the Fourth International Conference on Fifth Generation Computer Systems held in Tokyo in June 1992. About 1,600 researchers from Japan and other countries participated in the conference. Reviews of the 5G project have been mixed. While the Japanese have claimed success, others have been less favourable towards the project. Reflecting these mixed reviews, the chairperson of the Conference, Professor Kowalsky of the Imperial University, summed up diplomatically at the final plenary session saying that ICOT had succeeded in developing the 5G computer and associated software, thus laying down the foundation for logical inference. Now it is time for the rest of the world to promote research utilizing the new tools, he added.

The 5G project has been re-scheduled to be completed by the end of fiscal 1994 (March 31, 1995) in order to realize 5G products' compatibility with UNIX.

3.1.5 Support Centre for Advance Telecommunications Technology Research (SCAT)

This centre was established as a nonprofit organization authorized by MPT in October 1988 for the purpose of providing total support for research and development in the field of advanced telecommunications technology.

The centre supports frontier research in telecommunications, conducts investigations and research on advanced telecommunications technology, provides financial aid to research and development activities for advanced and applied telecom, supports promotion of regional research and development, and manages various conferences and seminars on technology.

3.2 Telecommunications Research Programs

Principal research programs are highlighted in the following sections.

3.2.1 The Frontier Research in Telecommunications

This project was initiated by MPT in 1988. It refers to basic, advanced and creative, interdisciplinary research with the ultimate aim of upgrading telecommunications services. The three fields of research are:

1. High-Speed Telecommunications: Applications of superconductors and advanced laser technology.

2. Human and Biological Informatics: Neuro-computing for auditory and visual information processing, realization of highly intelligent functions and elucidation of biological functions.

3. High Performance Network: Advanced communications network architecture, network human interface.

A desirable goal for the 21st century would be to meet the needs of communicating with anybody at any time and anywhere, to transmit and receive any information, and that it should be pleasant and easy for everybody to enjoy communications services.

The project is conducted on a co-operative basis by the industrial, academic and governmental research institutes. Moreover, in order to promote interchange with research organizations in other countries, an International Forum on Frontier Research in Telecommunications is held annually where distinguished foreign and Japanese researchers are invited. The theme of the most recent forum, held in Kobe in December 1992, was "Life and Information", with focus on neuro-intelligence.

3.2.2 The New Generation Telecommunications Network

MPT has started a new project aimed at replacing the existing telecommunications network, which had been configured mainly for analogue telephone networks, with a new network which can fulfil future needs. The New Generation Telecommunications network is to be an enhanced telecommunications network for the 21st century. B-ISDN and intelligent networks will be considered critical to its development. The demand for this network comes from greater customer requirements and more diversified and sophisticated telecommunication services.

MPT will play a central role in promoting the construction of this new telecommunications network. The private sector, which includes NTT, has been undertaking the R&D work on B-ISDN. NTT and KDD, telecommunications equipment manufacturers, and a wide range of users even from broadcasting companies and financial companies will be participating in the network's development.

Some of the technology to support the network includes transmission equipment, optical fibre cable, service control facilities, information media conversion equipment, and the ATM (Asynchronous Transfer Mode) switch.

Some of the government measures to support this project include specially recognized depreciation, special abatement for municipal property tax, low interest government loan and loans without interest, and loan guarantees through the Japan Development Bank.

The government gives financial support to the private sector to construct facilities for R&D on telecommunications technology, systems and the like for the new network.

According to a report by telecom vendors, carriers, users, etc., the projected diffusion rates of B-ISDN to offices and households in 2015 will be 77 per cent.

The investment required for this B-ISDN network is estimated at Y[20] 33 trillion.

3.2.3 Association for Promotion of New Generation Network Services

This Association was established on April 1, 1992, as a non-profit organization by a wide-ranging group of concerned people, telecommunications enterprises including manufacturers, and users. Among the 26 companies now represented in the Association are NTT, KDD and Northern Telecom Japan, Inc. The objective is to promote the use of high-speed, multimedia and intelligent-oriented new generation telecommunications network services.

To support the new generation telecommunications network services, the Association shall conduct feasibility tests, develop a basic system, conduct research and studies, as well as promote diffusion and enlightenment.

Feasibility tests are planned for developing useful applications of B-ISDN which is supposed to be the infrastructure of the 21st century. According to its plan, Step 1 will start in fiscal 1994 (ATM technology is not introduced yet) and will involve "enlightenment" or PR type measures.

Step 2 will be launched during fiscal 1996 (large users would have private ATM-based networks) and specific software experiments will be conducted.

Step 3 (fiscal 1998) will involve large scale public service experiments based on CCITT recommendations.

In order to finance Step 1, two organizations are being set up in the so-called "Kansai Cultural and Intellectual Research City" or KCIRC, which includes the cities of Osaka, Kyoto and Nara.

One organization is Broadband Telecommunications Network Research and Development Facilities Inc. (to start in March 1993). Financed partly by KCIRC local governments and partly by private companies, this organization will invest Y 1.6 billion

[20] One Y is approximately $0.01 (Canadian).

in equipment and necessary infrastructure for B-ISDN experiments, such as laying down of optical fibre network. Buildings used by it will be leased and paid for by the second organization, the Broadband ISDN Application Research and Experiment Promotion Council (set up in December 1992). About 200 companies in the KCIRC region are participating in the voluntary Council which will collect membership fees as well as expenses for experiments.

3.2.4 New Program on Developing a Future Academic Research Network

A new program to develop a Japanese academic research computer network is scheduled to start in fiscal year 1993. It may be dubbed "The Second Generation Science Information Network".

This research network will replace the core of the existing Science Information Network (SI-Net). SI-Net is a private packet switched network, with high-speed digital lines (64 kbits/sec to 1.5 mbits/sec) in its trunk, connecting 180 universities' computers nationwide through its own protocol "N-1". N-1 protocol architecture and software was developed in 1984 at the initiative of the Documentation Centre of the University of Tokyo, which became the National Centre for Science Information Systems (NACSIS) in April 1986. In addition to NACSIS, which is the central institute for conducting the new program, other core researchers will include the University of Tokyo and the Saitama University.

The New Program is to use frame relay switch for some time, and to develop an ATM switch for the basic communications scheme which will allow high-speed communications at the gigabits level. An experimental ATM system, now being manufactured, will provide the means for high-speed transmission and exchange, while an optoelectronic local area network, a new device to meet with the ATM interface, will make it feasible for the institute to make demonstrations.

Interfaces for high performance computers or information processing equipment, control procedure of communication admission and communication quality management, high performance protocols of several layers, and other issues relevant to the efficient use of ATMs, are included in the research objectives.

The enhancement of academic applications, image processing and image retrieval, are essential components of the research.

The New Program will start in April 1993 and end in March 1998. The total budget from the Ministry of Education, Science and Culture (MESC) is Y 600 million for five years (this excludes the communication facility for the research).

3.3 Software/Information Technology Research and Development

This section is being included because it is apparent that the telecommunications R&D draws heavily on the spinoffs in software development being undertaken in other laboratories in Japan.

3.3.1 Real World Computing Program (RWC)

Sponsored by MITI, this project aims at developing new technology to enhance the real time processing of large amounts of information. Computer processing has evolved from numerical processing to knowledge-based information processing. The objective now is to take the process a step further, and develop new innovative information technology that would enhance the processing capability by making the recognition of similar human functions possible.

The new "four dimensional computer" system will be able to "think" in a way that scientists believe the right side of the human brain thinks. Conventional computers handle data in a methodical and rational manner, similar to the way that the left side of the brain operates. As the right side of the brain can handle ambiguous data, so too will the computer systems.

The main applications are seen to be:

- high-speed computing for scientific analysis (i.e. algorithms and solutions will be produced without programs);
- global environment analyses and forecasts;
- weather analyses and forecasts;
- intelligent robots;
- rapid improvement in communication between human and machine (real-time processing of diversified, ambiguous and incorrect information - such as image and sound - which are difficult to process by conventional computers);
- integration of the recognition of sound, understanding of speech and automatic translation; and
- automatic classification of large amounts of raw data.

The budget of RWC is Y 60 billion (in total over 10 years) commencing in 1992.

The Real World Computing is organized as the Real World Computing Partnership (RWCP). Based on the Mining and Manufacturing Technology Research Law, RWCP was established on July 13, 1992, under the approval of the Minister of MITI. RWCP involves universities, research institutes and private firms not only from Japan, but also from other countries such as Germany, U.K., Canada, France, Australia, Singapore and Korea. In fact the German National Institute has already joined the Partnership in February 1993. Canada has been invited to join the RWCP. A cost-benefit analysis of Canada's partnership is planned.

The organization aims at establishing a 21st century information technology system called "The New Information Processing System". Basic fundamental research of advanced telecommunications and computer system requirements of the project, will be handled by MITI's Electrotechnical Laboratory. Highlights of the Partnership are as follows:

1. Participation in RWCP: Direct participation in RWC partnership is possible. Research facilities can be used, and information and results of the program can be accessed.

2. Sub-contract: Without being a partnership member directly, research funds for partnership members can be used to carry out research through subcontracts.

3. Joint Research: Although the RWC program fund cannot be used, active participation in research is possible by mutual exchange of information with the RWCP.

4. Joint Research with the Electrotechnical Laboratory: Although the RWC program fund cannot be used, active participation in research is possible by mutual exchange of information with ETL.

5. Joint Research with a subcontractor: Although the RWC program fund cannot be used, active participation in research is possible by mutual exchange of information with a subcontractor.

3.3.2 Other Research Activities Presently Being Promoted by MITI

Among the various related R&D activities, are the following:

- the promotion of open systems (OSI/EDI);

- the promotion of pre-competitive IT R&D on an international basis (e.g. the Fifth Generation Computer projects; World Computing Programs; R&D project of manipulation of atoms and molecules; development of bioelectronic devices; development of superconductive materials and devices; and development of new structures of software);

- enhancement of information processing functions in cities and less developed regions: (e.g. "New Media Community" programs for informatization of less developed regions; "Advanced Information City" programs for the high informatization of cities; "High Vision HDTV Community" programs to build information networks and reactive local economy and culture; and programs for enhancement of software productivity in less developed regions);

- promotion of video information systems, research of multimedia networks, and research of computer systems for processing high-definition video data; and

- development of information systems for personal use, especially for senior citizens (e.g. "Mellow Society Project" - development of human-machine interfaces for senior citizens or filing systems of personal health data; "Friend 21 Project" - development of technologies for user friendly information systems).

3.4 National Projects

National projects appear to relate to the four communications subsectors covered by the study.

In the area of **wireless personal communications**, MPT is involved in various next-generation telecommunications technology-related projects. The Ministry hopes to introduce a R&D project aimed at developing miniaturized satellite technology that will facilitate land-based mobile communications between portable terminals. The project is anticipated to begin in April 1993 with the launch of its first small size satellite sometime in 1998. A request for research funding was included in the Ministry's fiscal 1993 budget request.

In preparation for this next-generation satellite project, MPT and the Science and Technology Agency (STA) have agreed to carry out a joint satellite communications R&D project, also commencing in 1993. The objective of the project is to study concepts for next-generation communications and broadcast engineering test satellites. The satellite will carry a 10 metre diameter antenna and high-powered transponders and will be used to conduct R&D in the area of mobile digital audio broadcasting and mobile communications services.

MPT and STA have also agreed to carry out joint R&D in the area of inter-satellite optical communications, starting in fiscal 1993.

MPT and the Ministry of Finance are expected to provide research funds for developing next generation telecommunications equipment which could be used in MPT's other next-generation telecommunications technology-related projects. The Advanced Telecom Research Institute (ATR International) is expected to take a lead role in organizing this joint venture involving major Japanese firms such as Sharp Corp., NTT and others. Those who pay license fees are permitted to use the results of their R&D, however, investors in the Labs are not entitled to such privileges.

Established in 1986 to pursue collaborative development of future telecom systems, ATR International serves as an umbrella organization for four other R&D corporations, with an annual Y 7.5 billion research budget. By the end of 1991, the Institute staffed approximately 190 researchers, with some five per cent permanent to the facilities and 75 per cent coming from roughly 50 participating organizations on a rotating basis. The remainder were invited researchers from abroad as well as from Japan, with an average stay of 20 months. ATR Labs are engaged mainly in basic research and study, and not in producing specifications.

In November 1992, MPT disclosed the outline of a joint Asia/Pacific satellite communications experiment project. The PARTNERS project would use 1.2 metre diameter ETS-V engineering testing satellite earth stations to conduct experiments with radio transmissions and remote medical treatment via a communications satellite between Japan and countries in Asia and the Pacific. Fourteen stations would be set up in Japan. The Ministry, the National Space Development Agency of Japan (NASDA) and Tokai University would install four, two and 12 stations, respectively, overseas. The project has budgets for Y 120 million for fiscal 1992 and Y 150 million for fiscal 1993.

Both MPT and MITI are involved in **electronic information/transaction services** related projects, in particular, Automobile Information and Communications Systems. About 200,000 Japanese cars are already equipped with navigation systems, however they are expensive and not very useful because they lack real-time input such as road conditions. This next step is being undertaken.

In 1990, under MITI, a study committee for future transportation was formed to investigate the feasibility of a large scale research project named the Super Smart Vehicle System (SSVS) and to draw up a plan for it. SSVS is a an information system, for drivers 20 to 30 years from now, that assists in their driving tasks and perhaps eventually takes over some or all of their driving tasks. The ultimate purpose of the system is compatibility of both safety and efficiency while taking aging and pollution into account. SSVS integrates both driver information systems (i.e. navigation systems) and vehicle control systems (i.e. collision warning systems, automatic driving systems) and the background is based on info-mobility.

Some of the things being considered for SSVS are automated lateral control to within 2 cm spacing between vehicles in adjacent lanes (accomplishing 3 lanes in the space of 2), an in-vehicle display of a plan view of the vehicle and its surroundings (including other traffic), active roadside lighting, and in-vehicle speed limit and other signing. The proposed budget for the system could be over $200 million.

Also in 1990, MPT, MC (Ministry of Construction) and NPA (National Police Agency), reached a consensus to promote a related system called the Vehicle Information and Communication System (VICS). VICS attempts to resolve the competition between MC's Road/Automobile Communication System (RACS) and NPA's Advanced Mobile Traffic Information and Communication System (AMTICS) and to define a common system that would use the best features of both. A digital micro-cellular radio system has been proposed to provide two-way road-vehicle communications and location information. In-vehicle route guidance may also be provided.

Although VICS may have a long-term future as part of an integrated driver information system for Japan, it will take some years to implement. In the meantime, a common RACS-AMTICS system using roadside beacons, which transmit location to the vehicle to zero-out cumulative navigation errors, and the broadcast of information to drivers via their FM car radios is the likely direction for further development.

MPT also appears to be heavily committed to research and development in the area of enhanced media services. Throughout 1992, the Ministry introduced various projects that flowed from its guidelines for telecommunications research and developments, as discussed earlier.

In April 1992, the Ministry announced that it would sponsor a five-year project aimed at developing three-dimensional television transmission. The annual level of funding for the project, which began in April 1992, had been set at Y 169 million. The project pools researchers from the private sector, universities and government agencies, with the objective to develop technology that would replicate the original object when viewed from any angle.

This 3-D technology is already well advanced and has many possible areas of application. In fact, the government predicts that all TV technology will move over to 3-D in the next century. Initially, however, research is concentrating on the medical sector, especially surgical medicine.

In October 1992, MPT revealed that it would support the development of communications satellite-based digital video transmission systems. Shortly after, the Ministry set up a council, which consisted of representatives from the communications and broadcast industries and related equipment manufacturers, to conduct field tests on transmission systems. Plans called for tests to be conducted with private communications satellites within three years and the promotion of technical exchanges.

At the same time, the Ministry set up a group to study the transmission of cable TV via optic fibre. The group would survey demand, operate a prototype system and evaluate system technologies. By the end of fiscal year 1994, the group aims to establish a standard system for multichannel optic fibre CATV capable of handling high-definition programming.

Japan's former telecom monopoly is also conducting research and development in enhanced media services. In October 1992 NTT opened a multimedia centre to serve as a development site for multimedia software and also to support audio-visual features for computers and telecommunications. So far, NTT has spent Y 3 billion for the high-tech building in Tokyo and will spend an additional Y 4 billion for facilities such as a studio, editing suites, workstations and personal computers. The centre is currently focusing on business customers.

NTT wants to develop multimedia telecommunications technology via its ISDN. Digital communications has just started in Japan, and there is a great deal of potential in this field. In order to cash in on the expected widespread demand, NTT will rent its studio and facilities to third parties.

Japanese public broadcaster NHK is also hoping to conduct research and development in enhanced media services. In July 1992, NHK sought $70 million of funding from the Japanese government to support the development of an all-digital Ultra High Definition Television (UDTV) that would have 3,000 scanning lines. A formal funding request was submitted to Japan's Key Technology Centre.

The Telecommunications Technology Council of MPT has reported to the Minister the study results of digital video technologies toward 21st century, including 2,000 scanning lines UDTV. To follow it further, MPT is going to set up a Committee for the Promotion of Advanced Information and Video Technologies Development, which will consist of approximately 100 organizations.

3.5 Related Regional Projects

In line with Japan's regionalization policy, a number of telecommunications related projects have been set across the country. Most are in the area of **enhanced media services.** However, two projects relate to **wireless personal communications** and **electronic information and transaction services** respectively.

The City of Yokosuka, about 60 km southwest of Tokyo, will start developing a 50-hectare Yokosuka Research Park during fiscal 1993. Companies like those involved in mobile and video communications, software houses and teleworking service providers, will be encouraged to locate in the Park, which is expected to be completed toward the beginning of the 21st century.

The Park's core facility, YRP Research Centre, will be located next to NTT's Yokosuka R&D Labs. It will promote R&D in information and communications fields, exchange and training of researchers.

Japan Development Bank, NTT and several other companies participated in a founders' meeting held in January 1993. Initially capitalized at Y 1.3 billion, it will later be raised to Y 5 billion during fiscal 1994. Kanazawa Prefacture, Yokosuka City and Japan Development Bank will provide 42 per cent of the investment, with private companies putting up the remaining 58 per cent.

In March 1995, Yonezawa City was designated as one of the Tele-topia regions by MPT. In line with this policy, New Media Yonezawa Co., Ltd. was established in June 1986. The company constructed a cable TV system to satisfy a variety of needs of local residents and to drastically enhance their quality of life by providing comprehensive information on a real time basis. The company is also experimenting with new services and technologies for using the CATV network in a variety of ways, based on investments and assistance from the Japan Key Technology Centre.

Related to **enhanced media services**, a study group, consisting of representatives from a number of LCD and electronic equipment makers and universities, was established in 1991 within the Institute of Electronics, Information and Communications Engineers (IEICE). The group, located in Yokohama, aims to develop an LCD-based animation holographic 3-D television for telecommunications applications within 10 years. The participants include representatives from Citizen Watch Co., Ltd., Seiko Epson Corp., Sharp Corp., Matsushita Electric Industrial Co., Ltd., NTT, NHK, NEC, Hamamatsu Photonics KK, Shonan Institute of Technology and Nihon University. Animation holography requires information transmission at least 100 times that needed for current TV, and 10 times that of HDTV.

A non-profit organization named Institute for Hyper Network Society will be established in March 1993 in Oita Prefecture (Kyushu Island). Supervised by the Oita Prefecture, the Institute will be involved mainly in research in B-ISDN and multimedia applications as well as associated institutional issues including intellectual property rights.

With an initial capital of Y 420 million, the Institute will be financed by the Oita Prefecture, NTT, NEC and Fujitsu; with small subsidies from MITI and MPT. Some other private companies, including Apple Computers from the U.S.A., will be invited to participate in the Institute's work, and pay nominal membership fees.

As the Institute's first activity, a public packet communications network called Toyo-no-kuni Information Network, operated by the Oita Prefecture and several local cities, will be interconnected with Tokyo's Keio University's science information network called WIDE.

Yet another facility, to be established in Yokohama during fiscal 1993, is the Yokohama Video Communications Techno Station. The Station will have image evaluation and testing labs which will be made available to communications technology firms and universities. Its aim will be to support private firms' efforts in developing advanced video image communications technology. The initial investment, estimated at Y 2.35 billion, is to be made by governments at various levels and by businesses.

3.6 Japan-U.S.A. Collaborations

MPT and the U.S.A. Department of Commerce have agreed to co-operate in the area of milliwave band research and development. Teams of professionals from both countries will deliberate on specific research themes, while research and information will be exchanged on a regular basis between relevant communications committees of the Japanese Ministry and the U.S.A. Department of Commerce.

Until recently, the milliwave band had not been developed or used much, but its wide frequency spectrum could readily accommodate broadband transmissions such as super high-speed data transmission and image transmission. The physical characteristics of milliwaves would enable equipment to be compact, and there are high hopes for the technology in a variety of applications.

3.7 Relationship with Canada

Canada has had a bilateral S&T agreement with Japan since 1986. Moreover, the federal government has set in place the Japan S&T Fund to enhance S&T collaboration with that country. There is a joint Canada-Japan Committee on S&T Co-operation under this agreement. This committee meets bi-annually with the next meeting in Canada in the fall of 1993. Currently, there is interest in several areas including satellite technology, opto-electronics, OSI standards, HDTV, and ultra high-speed communications.

As well, DOC and MPT co-chair an annual policy consultation meeting, the first of which was held in 1985.

The new Japanese regionalization policy and the promotion of regional centres of excellence also present emerging opportunities for Canadian researchers.

4.0 RESEARCH AND DEVELOPMENT ACTIVITIES IN THE U.S.A.

The U.S. government's telecommunications policy is captured in the following statement:

> "Effectively competitive, unregulated communications and information markets....are the best guarantee that the public will have the communications and information facilities and services they want and need."[21]

U.S. companies have traditionally dominated the telecommunications and information markets. However, the in-roads made by Japanese firms in recent years has led the U.S. government and U.S. firms, both individually and in partnership, to focus their attention more closely on these sectors.

In the U.S., defence programs have been a major driver of advanced communications R&D. Some activities related to the Strategic Defense Initiative (SDI) have a communications R&D component. The Defense Advanced Research Projects Agency (DARPA), the prime funder of defence R&D, has been known to also support the development of civilian R&D (e.g. HDTV). For example, DARPA was the early supporter of research into packet switching networks, which has evolved to the National Research and Education Network (NREN) supported by the National Science Foundation (NSF) and other federal government agencies. Both DARPA and NSF have been supporting the Corporation for National Research Initiatives (CNRI) which coordinates 5 gigabit level test beds.

The National Aeronautics and Space Administration (NASA) supports work on communications R&D through its programs on communications satellites.

In the U.S., however, it is typically industry which bands together, at times supported by government, to undertake communications-related R&D. Consortia such as SEMATECH in semiconductor manufacturing and MCC (the Microelectronics and Computer Technology Corporation) were established to meet the Japanese challenge in these sectors. Recently, projects Kaleida and First Cities have been organized as consortia to pursue multimedia research and applications. Another example is IVHS America, which is a vehicle for disbursing R&D funds within a consortium in the intelligent vehicle applications of C&IT technologies.

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21 National Telecommunications and Information Administration Telecom 2000, Charting the Course for a New Century (Dept. of Commerce, Oct., 1988).

Recently (January 12, 1993), executives of some of the key computer, communications and informatics firms have advanced a common position on the development of a National Information Infrastructure (NII) which will encourage activities in the areas of interest to the present study (see Appendix).

According to members of the Computer Systems Policy Project (CSPP), the U.S. is currently the world leader in computing and communications technologies, although it has not taken steps that will allow it to reach its greatest potential. However, says the CSPP, with the development of the NII, America's ability to communicate and collaborate will be revolutionized by erasing geographical boundaries.

The CSPP believes the High Performance Computing and Communications (HPCC) program is an excellent first step in providing an initial research foundation to create a more extensive information infrastructure that will be widely accessible to the public and capable of meeting a wide variety of information needs. However, it alone is not enough. As such, the CSPP proposes that a new national information infrastructure that builds on and complements the research being conducted in the HPCC program, be created.

Through a public and private partnership to develop and deploy a national information infrastructure, the CSPP is confident that the U.S. will remain internationally competitive and be able to solve many of its domestic challenges (i.e. declining quality of education, rising costs and limited availability of high-quality health care, and the need for businesses to increase quality and productivity). Yet, before the comprehensive information infrastructure of the future can be realized, a consensus vision must be built, as well as a widespread understanding of the benefits of such an infrastructure. With this in place, the private and public sectors can proceed to do what is necessary, independently or together, to make the vision a reality.

On February 22, 1993, the Clinton Administration issued its policy statement on a national information infrastructure with action programs aimed at the development of supercomputers and high speed networks (see Appendix 2).

4.1 Government R&D Agencies

With a combined budget of almost $1.2 trillion, federal agencies are a huge force in the development of technology. Some of the key organizations influencing technology development in the United States are:

Department of Commerce (DOC)

The Department of Commerce supports the Advanced Technology Program (ATP), which is managed through the National Institute for Standards and Technology (NIST). This program is geared to handle high-risk projects that involve precompetitive generic technology development. Candidates must provide detailed research and development as well as business plans for the involved technologies in order to be considered for federal funding.

The ATP promotes technologies that underlie a wide range of potential applications and offer significant benefits to the economy. The program is not restricted to any particular fields of technology.

Rules prohibit universities and federal laboratories from receiving ATP funds. However, they may collaborate with single or joint venture applicants.

The ATP budget for 1992 was $47 million.

Department of Defense (DOD)

With an annual budget of nearly $300 billion (R&D budget over $39 billion in fiscal year 1991), DOD has a major influence on many areas of technology development. Much of this influence has been focused on information technologies, advanced industrial materials and transportation.

The Defense Advanced Research Projects Agency (DARPA)

This is DOD's primary source of funds for advanced R&D. DARPA is the only agency in DOD whose mandate is to maintain United States' technological superiority without having to tie its work directly to a particular defense mission or project. In fiscal year 1993, DARPA is expected to allocate $45 million of its budget to high-speed networking R&D.

National Aeronautics and Space Administration (NASA)

With an annual budget of $10-12 billion, NASA is the largest non-defence funder and procurer of advanced technologies in the United States government. With major programs in space science, space transportation, manned space flight, remote sensing and communications satellites, it funds work in virtually all areas of R&D.

National Science Foundation (NSF)

This is a federal agency which provides a primary source of support for basic research across a broad range of scientific and engineering disciplines (excluding health (NIH) and nuclear and high-energy physics (DOE)).

Priorities are set, and funds are allocated, through a process that involves both "bottom up" and "top down" decision-making. NSF's bottom up budget takes into account university requests, external advice from outside panels, academic reports provided by National Academy of Science (NAS) and American Association for the Advancement of Science (AAAS), and the experience of its program officers. From the top, administration and Congressional policy priorities on funding are decided in general terms.

In its 1993 Budget, the government announced that it intends to double the NSF budget for basic research by 1994. In 1992, the government enacted a budget of $2,572 million. For 1993 the Budget proposes an increase of 18 per cent, bringing the NSF budget to $3,026 million.

The present NSF priorities are:

- investment in science and engineering personnel;
- improved infrastructure and instruments;
- economic competitiveness;
- leverage from federal funds; and
- support for emerging technologies.

National Institutes of Health (NIH)

These Institutes perform or sponsor biomedical research aimed at improving the nation's health. NIH's budget represents nearly ten per cent of all federal R&D spending. Major programs include AIDS research and the Human Genome Project. The latter, with a budget of $200 million per year, has a major information technology component.

Department of Energy (DOE)

The DOE supports three R&D programs: national defence related to the department and testing of nuclear weapons; a general science program of basic research into high-energy physics and nuclear sciences; and an energy program focused on longer-term R&D in support of energy technology development.

Just under $7.4 billion was proposed for 1991 R&D activities. Of this, "Atomic Energy Defense Activities" constitute almost one half. Approximately 20 percent of the total R&D budget is spent on basic research. This research is mostly supported through the Office of Energy Research (OER) whose budget is $2.65 billion. It is the OER which is sponsoring the development of the Superconducting Super Collider.

National Telecommunications and Information Administration (NTIA)

NTIA believes that high-speed network research (e.g. gigabit testbeds) and applications development (e.g. health and education - priority areas for the U.S.) will be the focus of U.S. R&D efforts. In addition, the Administration emphasizes the need for research related to the human resources aspects of networking (e.g. common user interface and training/education to use the network).

NTIA envisions two possibilities to building America's future information infrastructure:

1. Build out the Internet (i.e. migrate from the core network now in place to gradually encompass more and more of the required infrastructure).

2. Build up the telephone network.

The first approach would largely avoid the entrenched structure (corporate and regulatory) but could be financially limited. The second, building on the existing telephone infrastructure, would likely achieve ubiquity earlier and could draw upon existing financial resources. However, it would carry with it the limitations of existing corporate and regulatory structures.

4.2 Major Government Initiatives

4.2.1 <u>Strategic Defense Initiative (SDI)</u>

It is estimated that $57.5 billion will have been spent on SDI by 1993 as the basis for an "informed technical decision" as to whether or not to go ahead to develop a space-based shield against ballistic missiles. However, this program, launched under the Reagan Administration, is increasingly being questioned in light of the disappearance of the Soviet threat as well as the merits of such a defence system. While R&D is continuing, budgetary allocations for the deployment of such a system have been cut.

A major aspect of this work is the R&D related to the communication and information systems needed to support such a major defence system.

4.2.2 High-Speed Communications Networks

The High Performance Computing Act authorizes funding for research and development of a National Research and Education Network (NREN) for the U.S. research community, supporting transmission rates above 1 gbit/sec. The NREN will greatly strengthen the nation's research infrastructure, and will stimulate the commercial development of broadband networks.

The Administration's vision of the High Performance Computing and Communication (HPCC) Initiative is described in the "Grand Challenges" Report, a supplement to the President's fiscal year 1993 Budget. The report was prepared by the Committee on Physical, Mathematic, and Engineering Sciences of the Office of Science and Technology Policy's (OSTP) Federal Coordinating Council for Science, Engineering and Technology (FCCSET). The requested HPCC budget of $800 million for fiscal year 1993 includes $122.5 million for NREN. The report assigns agency responsibility for various aspects of high-spaced computing to the agencies shown in Exhibit 4-1.

NSF recently organized a Workshop to help set the research directions for the future development of high-speed networks.[22] The research areas identified were the following:

- Coding and coded modulation
- Data compression
- Information theory
- Storage channels
- Modelling and system analysis
- Communications signal processing
- Radio systems and networks
- Mobile network management
- Protocol theory, design, and engineering
- Network interface architectures
- Dynamic network control
- Internetworking
- Lightwave network architectures
- Network security and survivability
- Switching systems
- Fundamental limits of networking
- Networking of applications

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[22] National Science Foundation: Research Priorities in Networking and Communications: Report of Workshops held April 9-11, 1992.

Exhibit 4-1
HPCC Program: Agency Responsibilities

AGENCY	ACTIVITY			
	High Performance Computing Systems	Advanced Software Technology & Algorithms	National Research and Education Network	Basic Research and Human Resources
DARPA	• Technology development and coordination for affordable terops systems	• Technology development for parallel algorithms and software	• Technology development and coordination for gigabits network	• University programs
NSF	• Basic architecture research • Prototyping experimental systems	• Research in software tools, databases and Grand Challenges • Computer access	• Facilities coordination and deployment • Gigabits research	• Programs in: basic research; education/training/curricula; and infrastructure
DOE	• Technology development • Systems evaluation	• Energy applications research centres • Energy Grand Challenge and computational research • Software tools	• Gigabits applications and research • Access to energy research facilities and databases	• Basic research and education programs
NASA	• Aeronautics and space application testbeds	• Software coordination • Computational research in aerosciences, and earth and space sciences	• Access to aeronautic and spaceflight research centres	• Research institutes and university block grants
HHS/NIH	• System evaluation and performance analysis	• Medical application testbeds for medical computational research	• Development of intelligent gateways • Access for academic medical centres	• Basic research • Internships for parallel algorithm development • Training and career development
DOC/NOAA		• Ocean and atmospheric computational research • Software tools • Computational techniques	• Ocean and atmospheric mission facilities • Access to environmental databases	
EPA		• Research in environmental computations, databases and application testbeds	• Environmental mission assimilation by the States	• Technology transfer to States • University programs
DOC/NIST	• Research in systems instrumentation and performance measurement • Research in interface and standards	• Research in software indexing and exchange and scalable parallel algorithms	• Coordinate performance assessment and standards • Programs in protocols and security	

4.3 Major Private Sector Initiatives

4.3.1 SEMATECH (Semiconductor Manufacturing Technology)

SEMATECH is a consortium of U.S. semiconductor manufacturers established to ensure leadership in semiconductor manufacturing technology in the face of the Japanese challenge.

The overall program mission is to provide the U.S. semiconductor industry the domestic capability for world leadership. Specifically, the program goal is to enable U.S. industry to achieve parity with, and then overtake, Japan in semiconductor manufacturing, by 1993.

SEMATECH has defined quantifiable goals for the first three phases and is now defining future phases.

Phase 1: To demonstrate manufacturing capability at the current level of technology, at circuit lenswidth of .8 micron.

Phase 2: To achieve manufacturing at the narrower linewidth of .5 micron. At phase 2, the U.S. will achieve manufacturing parity with Japan.

Phase 3: Targets the unprecedented achievement of .35 micron manufacturing. By achieving this goal, the U.S. expects to reclaim worldwide semiconductor manufacturing leadership.

Phases 4 and 5 are now being defined. Phase 4 further extends leadership to take advantage of technical breakthroughs. Phases 1, 2, and 3 are expected to be finished by 1993.

SEMATECH has an annual budget of $200 million with half of the funding provided by member companies and half by the federal government (DOD). The government involvement helps to offset the considerable advantage enjoyed by foreign companies who have benefited from assistance by their respective governments.

In fiscal 1993, the U.S. government will reduce funding to $80 million for SEMATECH. After that, funding will be divided between SEMATECH and other organizations undertaking semiconductor R&D programs.

The fourteen member firms of SEMATECH represent approximately 80 per cent of the semiconductor manufacturing base in the U.S. and combined revenues of $157.7 billion in 1988. The member companies include IBM, Digital Equipment, Hewlett-Packard, Intel, Motorola, Texas Instruments, Rockwell International and AT&T.

4.3.2 The Microelectronics and Computer Technology Corporation (MCC)

MCC was launched in 1982 as a permanent institution, explicitly as an American reaction to the Japanese Fifth Generation Computer Project announcement by ten U.S. companies: Control Data Corporation, DEC, Honeywell, National Semiconductor, Motorola, NCR, RCA, Sperry, Harris and Advanced Microdevices. IBM, AT&T and Texas Instruments are not part of this consortium. MCC is not only a reaction to the Japanese initiative, it is also an effort by U.S. medium size companies to compete against the industry giants such as IBM.

The stated objective of MCC is to strengthen and sustain America's competitiveness in information technologies through application driven research, development and timely deployment of innovative technology. MCC's research programs share a common goal - provide the technology necessary to make computers, applications and processes faster, more reliable and capable of performing more complex tasks at a higher level of quality and at a much lower cost.

MCC conducts research in a number of areas including the following three:

- **Advanced Computer Technology** to develop technologies that will allow the design of complex knowledge-based systems;
- **Computer-Aided Design** to provide a means to greatly reduce the time and improve the resulting design quality of complex microelectronics circuits and systems; and
- **Software Technology** to develop tools and methods that will significantly improve the productivity of the software development process and the quality of software products.

MCC was chartered in August 1982. Austin was selected as its headquarters in May 1983. Research began in early 1984, and by mid-1984 research was fully under way in all of MCC's research programs. It currently has an annual budget of about $70 million and a staff of over 400 people. MCC's staff fall into two categories: direct hires from industry, university and government; and shareholder's representatives who are sent to MCC by participating companies.

MCC develops generic technology and development tools which are transferred to its shareholders for use in their products and processes.

According to MCC, it has:

- delivered 84 technologies to its shareholders;
- been awarded 11 patents (50 more have been filed); and
- transferred more than 1500 technology reports.

In five years shareholders have:

- made multimillion dollar equipment decisions based on MCC results;
- created internal manufacturing and design capabilities based on knowledge obtained from MCC; and
- caught up with international competition in areas of semiconductor packaging/interconnection.

4.3.3 IVHS America

Over the next 20 years, a $35 billion investment is expected for Intelligent Vehicle and Highway Systems (IVHS) research, development, field testing, engineering, and construction.

Future success of IVHS depends on co-ordination of efforts by government bodies, the academic community, and industries, particularly corporations and companies engaged in the design and manufacture of motor vehicles, those developing and producing electronic, communications and computer equipment, and those providing transportation services.

IVHS AMERICA, the Intelligent Vehicle Highway Society of America, has been established to assure this co-ordination.

IVHS AMERICA was incorporated in August 1990 and is recognized by the U.S. Internal Revenue Service as a non-profit educational and scientific association. It was incorporated in Washington, DC, and is headquartered there.

Membership in IVHS AMERICA is open to public and private organizations and groups from any country in the world. Members include corporations and companies, associations, universities, and agencies of federal or national, state or provincial, and local governments whose objectives are furthered by the purposes, goals, and programs of IVHS AMERICA. All member organizations and groups have an equal vote in IVHS AMERICA.

The purposes of IVHS AMERICA are to:

- **Advise U.S. DOT Regarding IVHS Programs**

  IVHS AMERICA has been chartered as a formal advisory committee to the U.S. Department of Transportation. In this capacity, IVHS AMERICA provides advice and recommendations to the department on the DOT's IVHS program. IVHS AMERICA also assists in assuring that DOT's work is co-ordinated with similar IVHS activities being conducted outside the department.

- **Develop IVHS Goals & Programs**

  IVHS AMERICA defines goals, strategic plans, and programs for the development and implementation of IVHS in North America. These efforts could generate billions of dollars in investment in coming years.

- **Foster IVHS Research & Development**

  IVHS AMERICA members set priorities activities. IVHS AMERICA will identify opportunities for combining R&D efforts and resources for government and business sectors and academies.

- **Help Make Decisions on IVHS Deployment**

  IVHS AMERICA members, with ready access to the latest IVHS information, constitute a key resource for public and private decision makers who, in the future, will deploy and make use of IVHS technology.

- **Address Legal & Institutional Issues**

  IVHS AMERICA will anticipate legal and institutional issues, and identify ways to reduce costly development factors before they arise.

- **Coordinate International Co-operation**

  IVHS AMERICA promotes coordination system approaches between nations.

- **Identify & Develop Needed Standards**

  IVHS AMERICA determines what IVHS needs, and helps arrange for their development adoption.

- **Provide Information**

  IVHS AMERICA will be a clearinghouse for information on national and international IVHS activities.

- **Help Alleviate State/Local Jurisdictional Constraints**

  IVHS AMERICA finds ways to facilitate co-ordination across jurisdictional boundaries so that problems do not stop at these borders, and should propose the possible available solutions.

- **Determine System Architectures & Roles**

  IVHS AMERICA identifies appropriate in vehicle-highway system architectures and delineates the divisions of responsibilities between public and private sectors.

4.3.4 Kaleida

Kaleida Inc. is an Apple-IBM joint venture which aims to demonstrate the viability of multimedia technology on networks by linking IBM's prototype video server with Macintosh and PC-compatible clients. IBM's video server will be a reduced-instruction-set-computing (RISC) system running AIX that can reportedly run production-level digital video compression (DVI)-encoded files across a network. Kaleida's first product, the XScript video scripting language, connects the video server to PCs and Macintoshes. Apple's QuickTime architecture supports DVI compression algorithms, but Apple leaves DVI-QuickTime software links to third parties.

Nat Goldhaber, CEO of Kaleida, describes his mission as a "moral imperative" to extend computing beyond the realm of business and empower individual users. Goldhaber believes that today's computer is likely to remain intimidating and inaccessible to much of the population, and as such, hopes to have Kaleida work with mass-market consumer-electronics firms to develop low-cost devices with powerful capabilities that are easy to use. Kaleida will work extensively on software content.

4.3.5 First Cities

The efforts of the telephone, cable television and computer industry, to bring multimedia into the home, suggests that mass market, multimedia information and entertainment services are an immense business opportunity. Accordingly, representatives of the three groups have formed the First Cities project to develop a common architecture for delivering multimedia services over a range of communications networks. The consortium was organized by Microelectronics and Computer Technology Corp. (MCC) in answer to Japanese advances in co-operative research.

The First Cities consortium of a dozen companies will initially spend around $5 million on research into consumer demand and the kind of technology necessary for providing the services. If the response is favourable, the group will wire up approximately 100,000 homes in an unidentified city. Consumers will receive a text, video and stereo sound on their televisions and personal computers, via phone lines, cable systems and fibre optic lines. Once the test is completed, First Cities will likely become an independent company with each partner a shareholder.

First Cities would provide the software and technology for interactive multimedia services but would not own the communications system. The funds required to set such a system up are not known. Schools and homes are seen as target markets, and services under consideration include movies-on-demand, picture phones, computerized libraries and video shopping or banking.

4.3.6 Corporation for National Research Initiatives (CNRI)

The five gigabit level testbeds which support the wide area networking of high performance computers received funding two years prior to the HPCC Act, through a program of research managed by CNRI. The Corporation is a non-profit research and development organization formed in 1986 by Xerox, IBM and DEC, to help focus U.S. strengths in information processing technology. CNRI is engaged with industry, government and academia in scientific research on the design of experimental infrastructure which can improve U.S. long-range scientific and engineering productivity.

In 1988 CNRI received support from the U.S. government to define a high-speed network research program to support the proposed NREN. It issued a call for proposals for research and from the one hundred it received it married carriers and users together to create the give testbeds. CNRI had originally proposed to NSF a $25 million program that included the testbeds and a co-ordinated series of research projects. However, when the funds were finally allocated, they received only $15.8 million (from NSF and DARPA) and so it is a testbeds only program that is now under way.

CNRI's role is to lead the testbed based research effort consisting of collaborators from universities, national laboratories, supercomputer centres and major industrial organizations. The project involves five testbeds which are investigating the design and development of high-speed networks. These are:

- AURORA, which involves researchers in Bellcore, IBM, MIT and the University of Pennsylvania, who are collaborating with Bell Atlantic, MCI and NYNEX. The testbed is to link four sites in New Jersey (Bellcore), Hawthorne, New York (IBM), Cambridge, MA (MIT) and Philadelphia, PA (University of Pennsylvania).

The AURORA testbed research is investigating

- alternative network technologies, ATMN and PTM (Packet Transfer Mode)

- distributed system and network service paradigms

- gigabit network applications

° BLANCA, which involves the Lawrence Berkeley Laboratory (LBL), the National Centre for Supercomputing Applications (NCSA), the University of California at Berkeley, the University of Illinois at Urbana-Champaign and the University of Wisconsin at Madison. IT and telecommunications companies involved are Ameritech, Astronautics, Bell Atlantic, Pacific Bell and AT&T. The testbed consists of two regions: the University of Wisconsin, NCSA and University of Illinois; the University of California and LBL.

  BLANC is conducting research in wide area networking and is investigating:

  - methods for the control of testbed components

  - design for the efficient use of supercomputers on high-speed networks

  - several applications, including: multiple remote visualization and control of simulations; radio astronomy imaging; multimedia digital library; medical imaging.

° CASA, which involves the Los Alamos National Laboratory (LANL), New Mexico; the California Institute of Technology and the Jet Propulsion Laboratory, Pasadena, California; San Diego Computer Centre; and the University of California, Los Angeles. The communications carriers taking part are MCI, Pacific Bell and US West. The testbed is linking all four sites.

  CASA is studying the use of distributed supercomputing over wide area high-speed networks to provide new levels of computational resources for leading-edge scientific problems. It will develop an interactive data analysis and visualization program for geological applications.

- NECTAR, which involves Carnegie Mellon University (CMU), the 2Pittsburgh Supercomputing Centre (PSC), Bellcore and Bell Atlantic/Bell of Pennsylvania. The testbed is connecting the two sites at PSC and CMU.

  The NECTAR testbed is extending several projects already started at CMU involving interconnecting heterogeneous computing resources via fibre links, large crossbar switches and dedicated network coprocessors. The plan is to produce a next generation of NECTAR with links at speeds of 1 gigabit/sec or higher.

- VISTANET, which involves BellSouth, GTE, the University of North Carolina at Chapel Hill, and MCNC in conjunction with North Carolina State University. All sites are in North Carolina.

  Research is focusing on demonstrating the benefits of linking geographically dispersed research teams and their specialized resources at gigabit speeds. The applications focus is radiation treatment planning for cancer patients.

The project started in 1990 and was intended to run for a three-year period. However, as a number of the carriers have only signed agreements in 1992 to provide the optical fibre trunk capacity, the program will need to run beyond 1993 to achieve results. The HPCC program is expected to provide a further source of funds when the current funding expires in the second quarter of 1993.

Discussions with Mr. Stephen Wolff of NSF provided an interesting guide to CNRI's R&D initiatives. Mr. Wolff envisions a future environment in which every person, and every object that people will need to interact with at a distance, has a network address. In addition, he sees immense computing power being made available to all people through the network. This gives rise to the need for research in the following areas:

- addressing (how to increase addressing by many orders of magnitude over that available today);
- network flow control at very high data rates; and
- human interface (the highest speeds and the most computing power will be required for the least sophisticated users).

Mr. Wolff's vision is that computers must migrate from being tools used by the few technically elite to tools used in everyday life by ordinary people. The power behind the network should be of no concern; in this environment, visualization is the most important consideration.

He noted that the sensory input of a human in this environment (i.e. multimedia - voice, data, image and video) is approximately 1 gbit/sec. This might be a guide to the interface speed. Unfortunately, the network speeds will be determined by the need for supercomputers to interact with each other to respond to requirements placed on them (mostly to interact at very high-speeds for very short periods of time).

4.3.7 Bellcore Research Laboratory

The Bellcore Research Laboratory is the research arm of the seven U.S. baby bells. Not only does the organization perform R&D for its owner companies, but also for contract customers such as Bell Canada.

Bellcore's primary function is to enhance its clients' abilities to offer timely, profitable and quality products and services in all aspects of communications and information access. Bellcore also provides a multiplicity of support functions in training, network operations, national security and emergency preparedness.

Bellcore's annual budget of approximately $1.1 billion permits the organization to conduct research in a number of areas. Major areas include:

- robust networks and operations;
- advanced voice and messaging;
- personal, nomadic communications and information access;
- public data networking;
- video dial tone and beyond;
- new information services; and
- enterprise efficiency.

From its research endeavours, Bellcore has envisioned an interesting perspective of new services for the year 2000 and beyond. For example, in the area of **wireless personal communications**, Bellcore expects that advanced personal communications will take a significant share (estimated at more than 30 per cent) of the telecommunications market within the next two decades. The idea is to reach anyone, anywhere with voice, data and image services using a consistent personal communicator interface for computer and terminal connectivity. The principal aim is to provide fast service activation on any transport up to 300 kbits/sec, at a basic access cost lower than today's wireline. Users will be able to access their personal communications through different distribution technologies (from POTS to fibre), while residents on the move have wireless access.

A major research focus of Bellcore is in the areas of **electronic information, transaction services and multimedia applications** (project HOME 2002). Bellcore sees a great potential to increase the network revenues of its client companies by introducing network based entertainment, information and education applications. The organization is experimenting with a broad range of services including video-on-demand, music-on-demand, interactive multimedia for entertainment, education, shopping, personalized advertising, on-line libraries, travel guides, video conferencing and video mail. Other applications under development include home shopping, "how-to" videos, home security, remote monitoring, control of appliances, networked games and so forth. An additional priority is to facilitate tele-work by computer based support for collaborative work at home.

The ultimate challenge of the HOME 2002 project is to resolve the network implications for new residential services and to decide how these applications can be delivered efficiently. Certain applications require a considerable evolution of the network while others demand substantially greater bandwidth than the present telephone service can provide.

Bellcore is currently working with two new technologies to bridge copper wire transmission to the widespread deployment of fibre. HDSL and ADSL technologies can expand the capacity of existing copper plants to transmit signals at higher rates. Although ways to upgrade copper wire transmission have existed for some time, Bellcore's approach is less costly and completely self-adaptive (advanced transceivers, placed at both ends of the copper loop, automatically compensate for conditions that adversely affect the transmission of higher speed signals).

Field trials are in progress and Bellcore is urging manufacturers to accelerate the availability of HDSL and ADSL equipment. Bellcore demonstrated its HDSL technique in a prototype video-on-demand system which was developed at a cost of $5.4 million in a joint venture between Bellcore and Bell Northern Research.

In addition to its HOME 2002 project, Bellcore is prototyping an expert system that automatically filters, sorts and prioritizes messages according to prescribed rules specified by the user. The system is primarily concerned with the ability of subscribers to deal with the inundation of electronic messages which are growing at an exponential rate. The resulting overflow of information leads to missed opportunities, lower productivity and stressful working conditions. It is expected that the system will be available by the spring of 1993.

In the area of **high-speed networking/computing**, Bellcore recently developed SMDS (Switched Multi-megabit Data Service), a high-speed connectionless service, to offer an interface to high-speed, wide area networks. SMDS is based on the ATM standard and is designed to operate with high-speed, cell based switches. Although somewhat different, the technology shares several of the characteristics and is compatible with the emerging B-ISDN protocol.

The key service of SMDS involves the transmission of bursty datagrams according to different classes of service. Early applications of the technology have largely ben used to bridge LANs together (i.e. to extend LAN-like performance beyond the subscriber premises across a metropolitan area).

Also in the realm of high-speed networking/computing, Bellcore is actively involved, as a partner, in the AURORA project. AURORA is one of the five testbeds co-ordinated by CNRI. The project is centred on metropolitan area distribution to determine how Bellcore's owners will deliver Internet type services at gigabit rates. Section 4.4 discusses AURORA and CNRI in greater detail.

4.3.8 AT&T Bell Laboratories

The major focus of research and work at AT&T Bell Laboratories is on the future of high-speed networking and computing. The Xunet project is an experimental university network started in 1986 to promote research in wide area networks. Today, it is used to research high-speed, wide area communications between LANs over an AT&T ATM backbone. Research is conducted in collaboration with the Universities of California (Berkeley), Illinois (Urbana-Champaign) and Wisconsin (Madison).

Xunet has evolved to become a prototype of a nation wide ATM backbone, to which the participating universities and Bell Lab are each connected. The network supports multiple traffic types and serves as a platform to develop high-speed, real-time, multimedia applications in the university environment. A major part of the project is to develop control and management techniques for high-speed networks.

Presently, the network is being expanded to link university campuses with ATM switches using a High Performance Parallel Interface (HIPPI) adapter which is a LAN that operates at 800 or 1600 mbits/sec. HIPPI has become a fascinating alternative in the supercomputer community as a relatively simple network for high volume, high-speed data bursts for point-to-point transmission over short distances . Another development will see Xunet operating at speeds of up to 622 mbits/sec between ATM nodes.

The Xunet experimental research is also another gigabit testbed funded by CNRI with a NSF and DARPA grant.

4.3.9 Sprint International

In its focus session on "The Economics of Gigabit per Second Networks" (September 30, 1992), Sprint discussed its strategies for the Internet going private. Sprint believes that internetworking, internets and the Internet are all part of an interrelated global phenomenon involving not only technology and its deployment, but also people and organizations, the discovery and sharing of knowledge, and the occurrence of collaboration and innovation. This phenomenon appears to be similar all around the world and, as such, the commercial opportunities and benefits are very significant.

However, by building up the electronic superhighway through the Internet, Sprint foresees the following research problems:

- user interfaces (ease of use and access);
- routing and addressing (current activities will buy time for a few years, however, within the next decade there will be a need for 10^{10-11} addressing capability); and
- multicasting services (broadcast TV, audio and multimedia conferencing).

Should the Internet go private, Sprint could likely be a model for commercial involvement in high-speed networking. This comes out of Sprint's early involvement in data communications and is contrasted to AT&T's and MCI's larger emphasis on voice communications.

4.4 National Projects

The U.S. R&D projects relate to the four communications subsectors covered by the study. The greater number of the projects are in the area of high-speed networking and computing.

In the area of **wireless personal communications**, the NSF recently launched a joint study of research and development into satellite communications in Europe and Japan. The study, which aims to track the competitive position of the U.S. in the world's high technology markets, is being conducted by the International Technology Research Institute (ITRI) at Loyola College, Md., and led by the Institute's chairman of computer science. Other members of the group include representatives from Virginia Tech, Mitre Corp., MIT's Lincoln Lab, George Mason University, DOC's Institute for Telecommunications Sciences, NASA's Lewis Research Centre and the Jet Propulsion Lab.

With regards to electronic information and transaction services, the California State University (CSU) system and Pacific Bell agreed to co-operate in bringing the benefits of the Information Age to education in California. The plan focuses on exploring how advances in telecommunications can be used to help fulfil the educational mission of schools serving grades Kindergarten to 14, as well as the CSU's 20 institutions. One of the first co-operative projects involves CSU's participation in the Knowledge Network Gateway, a service being planned by Pacific Bell to provide California schools with online access to NSF's Internet as well as other worldwide databases. Other goals of the co-operative effort include: jointly pursuing a technological solution that facilitates student and faculty access to NREN via CSUnet; jointly seeking support for public interest solutions and affordable access; jointly seeking funds from government in general, and the NSF in particular, to facilitate provisioning of NREN connectivity to California schools; and actively seeking the participation of other interested parties who also want to help in ensure equitable access to the educational resources needed for Californians to be competitive.

Regarding **enhanced media services**, the NSF awarded funds for the development of an educational delivery platform to support multimedia instruction, in the fall of 1991. Georgia Tech proposed to develop a system infrastructure for a delivery platform for multimedia materials about computer science data structures, algorithms and methodologies. The platform would support co-operative work, allowing students and instructors to interact with the presentations and save annotations for others to view and hear. The software system would be portable and available to any other interested institutions.

Over the next four years, the University of Pennsylvania will be using a new instructional delivery system, the "video wall", to develop "telemonitoring" as a long distance learning technique. The video wall is an experimental video conferencing terminal with two large screen projection televisions mounted side-by-side creating the illusion of one large screen. Educational materials developed will be made available to other academic institutions through Internet, and results of the educational experiments will be disseminated through publications and presentations at educational and professional meetings. The project is supported by NSF and had $400,000 of funds available for fiscal 1992.

As mentioned earlier, there are a number of U.S. R&D projects which involve **high-speed networking and computing-related R&D**. In May 1992, the U.S. DOE introduced a $7.1 million, three-year project aimed at achieving dramatic reductions in the time and expense required to retrieve massive amounts of data required for high performance computing applications, such as global change research, high energy physics and fusion energy research. In this effort, Lawrence Livermore National Laboratory and six U.S. companies are combining forces to create a National Storage Laboratory. The project has among its goals 60-fold increases in the speed of data retrieval at one-tenth of current costs. The participants expect the storage lab to develop products worth $100 million. The corporate partners are IBM Federal Systems Co., Apex Recording System Corp., the DISCOS Division of General Atomics, Maximum Strategy, Network Systems Corp. and Zitel Corp.

In June 1992, Sprint disclosed its participation in "Supercomputer Highway" Research. DARPA is providing several million dollars to five major research organizations: EROS; SRI International, Mento Park, California; Lawrence Berkley Laboratory (LBL); the U.S. DOE's national laboratory, based in Berkley, California; the University of Kansas; and MSCI. These institutions, along with Sprint, form the Multidimensional Applications and Gigabit Internetwork Consortium (MAGIC) and have the support of more than a half-dozen additional research institutions and several industry affiliates. The three-year research project involves transmitting computer data over Sprint's fibre-optic network at speeds much greater than has been previously possible.

In August 1992, the Optoelectronic Technology Consortium formed by General Electric Co., AT&T, Honeywell Inc. and IBM Corp. announced its plans to open up the presently static photonics and optoelectronics markets with the development of prototype Gallium Arsenide integrated circuits for optical interconnections within and between computer and communications equipment. The 30 month research project aims to produce a monolithic Gallium Arsenide device with 32 laser light sources that can transmit parallel data at 16 gbits/sec. A separate silicon based integrated circuit is also being developed and with it a companion receiver integrated circuit that will include 32 sensors, decoders and amplifiers all on the same chip.

GE will manage the project and work on the link design, modelling and testing. AT&T will produce surface-emitting lasers and fibre-array interconnections. Honeywell will develop modulation technology and optical sources. IBM will concentrate on optical receiver arrays, link modelling and network analysis. The consortium, which is combining investment of its own with an $8 million U.S. government grant, does not plan to add any further corporate members to its number.

In November 1992, MCC formed a consortium to establish a national high-speed, standards-based information network for the nation's industrial base. Known as the Enterprise Integration Network (EIN), the industry-led, government funded effort plans to expand an infrastructure to develop, manufacture, sell, deliver and support products and services with new speed, flexibility, quality and economy.

Some funding already has been received by the Air Force, which last year awarded MCC $2.6 million in seed grants for development of a common network infrastructure for military and commercial applications. Total funding to create the massive network is expected to climb into the multi-million of dollars, but because it is still in its infancy, it is difficult to speculate final cost.

At about the same time, the San Diego Supercomputer Centre (SDSC) was awarded a three-year, $1.5 million grant from the NSF to work with DOE and NASA to bring the nation one step closer to its electronic data highway - the National Research and Education Network (NREN) - by deploying a new experimental network. Based on high-speed transmission of fixed-length "cells", the ATM network is considered a significant advance in high-speed networking technology. The ATM network will be provided for DOE and NASA by Sprint Inc. as part of a planned commercial offering, beginning next year, with funding from the Federal High Performance Computing and Communications (HPCC) Act.

According to the SDSC principal scientist, the connection will provide the initial interface between the NSFNET, a T3 packet-switching network, and the ATM network and puts the Centre in a great position to compare the two networking environments in collaboration with DOE and NASA. The research group plans to leverage their resources on network performance and traffic characterization from another NSF funded project (R&D) with the ATM connection project.

In early December 1992, AT&T and the Lawrence Livermore National Laboratory in Livermore, California, began to develop a new way of sending information from one computer network to other networks at extremely high-speed. Livermore, with funding from the U.S. DOE, will spend about $2.2 million and AT&T an equivalent amount. Under the preliminary agreement, researchers will develop interfaces to link a high-speed computer network being built at Livermore with U.S. networks elsewhere using the emerging ATM technology.

4.5 U.S.-Foreign Collaborations

The U.S. is participating in various research activities which involve foreign alliances at both the corporate and university levels. As well as supporting large projects, such as NREN, NSF also supports individuals with small grants in its priority areas. Most of the foreign collaborations of interest include Japan.

Related to **wireless personal communications**, EO Inc. announced a partnership with AT&T, Matsushita and Marubeni to design, build and market the first generation of a new class of products called personal communicators. This announcement came in May 1992. AT&T, the world leader in communications, is providing key microelectronic components. Matsushita, the world's largest manufacturer of consumer electronics under the Panasonic, Quasar and Technics brands, is providing advanced manufacturing and component technology, and high volume consumer electronics expertise. Marubeni, one of the world's most powerful trading companies, and its subsidiary Marubeni America, are providing global sourcing and distribution support. In addition to developing product, the partnership between the four companies was created to define open standards for this new industry. EO intends to extend the partnership with AT&T,

Matsushita and Marubeni with a European partner. This would complete a global alliance with major partners in each of the largest economic blocks, the United States, Japan and Europe.

OE's all purpose communications tools are expected to revolutionize person-to-person communications by combining the power of cellular phones, fax machines, modems and pen-based computers into portable communications devices. The organization estimates that more than 100 million personal communicators will be sold by the year 2000, representing $20 billion in annual device sales.

In the area of **electronic information and transaction services**, the NSF awarded a $23,150 (for fiscal 1992) grant to Dr. Israel Boner, of the Colorado State University, in August 1992. The funding would be used to conduct collaborative research with Mr. Hirafiji Masayuki for 12 months at the National Agricultural Research Centre in Tsukuba, Japan. Masayuki's knowledge of recurrent neural networks will be applied to Boner's prototype of a knowledge based expert system to develop a decision support system for agricultural applications.

Regarding **enhanced media services** technologies, the world's largest telecommunications company, AT&T, announced in November 1992 that it would join two Japanese companies in getting into the new field of multimedia. NEC Corp. and Toshiba Corp. said they would co-operate to develop mobile, hand-held communications devices based on AT&T's new Hobbit microprocessor. NEC would also produce the Hobbit, a high-performance chip suitable for computing as well as mobile communications. Within a year, the Japanese companies are scheduled to market Hobbit-based products for less than $1,500.

The announcement shook the market not only because of AT&T's size but also because it is the first attack by a telecommunications company into multimedia.

In April 1992, a $13,150 award (for fiscal 1992) was granted by the NSF to support a two-year U.S.-Japan co-operative research project between Professor V. Ralph Algazi, University of California and Professor Yasuhiko Yasuda, University of Tokyo. The research focused on areas pertinent to high quality image and video analysis, processing, transmission, recording, storage and display for natural and computer generated images, and the use of high-speed multimedia networks in an integrated digital system environment.

In the area of **high-speed networking and computing**, the NSF granted $15,000 for fiscal year 1992, for a three-year, U.S.-France co-operative research in parallel computing and software libraries between Jack Dongarra, University of Tennessee and Bernard Tourancheau, Ecole Normale Superieure, Lyon, France. The investigators seek to develop high performance communication and computation routines for linear algebra algorithms on distributed-memory supercomputers.

The NSF also awarded supplementary support to enable Dr. Stephen Wong of Lehigh University to conduct collaborative research with Dr. Kazumasa Yokota for 12 months at ICOT in Japan. Wong's designs for co-operative artificial intelligence systems to develop a prototype to test this new class of computers. Dr. Wong was awarded $7,750, for fiscal year 1992, in June 1992.

4.6 Implications for Canada

Participation in U.S. R&D programs, be they government or private sector funded, is usually reserved to firms based in the United States. The exception is MCC which is open to Canadian participation (e.g. Northern Telecom/BNR is a participant).

At the U.S. government to Canadian government level, a Memorandum of Understanding (MOU) has to be worked out regarding intellectual property (IP) rights before publicly funded laboratories can collaborate on R&D projects. Negotiations have been going on for the last two and a half years but two major issues still need to be resolved. Firstly, the U.S. would restrict the exploitation of any IP to U.S. firms in the U.S. market. Secondly, in areas where Canada does not protect IP (e.g. genetically engineered "artificial mouse") the U.S. partner would have world rights. Other countries (e.g. Japan) are having the same problem with the U.S. It remains unclear if and when these issues will be resolved.

In the C&IT area, it is felt that there is no pressing need for a formal government to government agreement, given that the activities are principally in the private sector.

5.0 ASSESSMENT

5.1 Europe

5.1.1 EC Level Activities

In Europe, the principal focus for communications R&D is at the level of the European Community's Third Framework Program. RACE is the main R&D program in the communications sector with 179 projects in play in 1992:

- the principal interest appeared to be in enhanced media services, followed by high-speed networks;
- the key players were mainly firms; and
- collaboration was most intense among a very small cluster of firms and research organizations.

The ESPRIT program also supported some activities of interest to the present study. The current phase of ESPRIT stresses industrial projects with a commercial orientation. To force this perspective, market forecasts have been added as a requirement to any proposal. This will bring ESPRIT closer to EUREKA (see Section 5.1.3).

A variety of Telematics programs of interest have also been launched. These include the following:

- AIM, which involves telematics systems for health care (e.g. broadband applications);
- DELTA, which relates to distant education and learning (e.g. ISDN);
- ORA, which relates to advanced communications in rural environments (e.g. multimedia, teleworking); and
- DRIVE, which contributes to the development of information technologies to improve road transportation efficiency and safety (e.g. wireless communications).

This array of programs support projects which cut across the areas of interest of the present study.

5.1.2 Evaluation Studies

A number of evaluation studies of EC Framework Programs (5,[23] 6)[24] agree that the major benefits so far of EC programs have been in the areas of encouraging closer working relationships among Europeans, developing networking, enhancing Europe's technological base, developing common standards and learning new R&D management approaches.

However, it remains difficult to evaluate the impact of these programs on Europe's competitiveness because they represent only one of the necessary elements that determine competitiveness. Other elements include investment, marketing, entrepreneurship, skills development and so on. As well, the economic impact may occur over the longer term, well after the R&D has been performed and programs evaluated. The value of evaluation studies is therefore limited when they attempt to gauge the economic returns of R&D.

5.1.3 EUREKA

While some 37 per cent of EUREKA project expenditures were in the information/communications sector (1990), very few projects appear to be directly related to the four areas of interest of the present study. This is possibly related to the fact that EUREKA focuses on near-market business deals while, as the Delphi survey[25] indicated, three of the four areas of interest of this study are not expected to become business opportunities in the short term, and high-speed networks are only emerging.

5.1.4 National Level Activities

At the national level, Germany, France and the United Kingdom, account for over three-quarters of the total public and private R&D spending in the EC. Of these three countries, France is the most interventionist and the role of CNET has been central to the development of the communications infrastructure in that country. On the other

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[23] PREST/SPRU: The Impact of European Community Policies for Research and Technology in the United Kingdom (Sept. 1992).

[24] Mytelka L.K.: Technological and Economic Benefits of the European Strategic Program for Research and Development on Information Technologies (ESPRIT) prepared for DOC; July 16 (1990).

[25] NGL Consulting Ltd.: Technology Forecast; Communications and Information Technologies: Final Report - prepared for DOC, February 1, 1993.

hand, both Germany and the U.K. have limited government intervention in R&D[26] but have focused on structuring an environment in which industry sets the directions for the development of communications systems.

Organizations in all three countries participate actively in EC programs as exemplified by their level of participation in RACE projects.

5.1.5 Implications for Canada

Canada has formal and informal bilateral relationships with Germany, France and the U.K. On the formal level, the agreement with Germany has been fruitful generally, as well as in the C&IT area specifically.

With a major focus on European R&D activities being at the EC level, Canada needs to enter into a formal agreement with the EC if Canadian R&D organizations are to participate fully, as equals, in EC level programs. It is expected that negotiations of such an agreement will begin in 1993.

It should be recognized that Europeans have expressed their interest in a number of Canadian technologies such as cable T.V., optical fibre, communications satellites and software.

5.2 Japan

5.2.1 Long Term Directions

In **Japan**, R&D activities are being set in place based on visions of what the telecommunications and information technologies environment of the 21st century will be. A theme that cuts across these visions is a communications environment that can provide ubiquitous, transparent, universal and reliable communications/information that meets user needs.

5.2.2 Recent Activities

R&D activities are supported principally by MPT and MITI. Among recent organizations and programs that have been established are the following:

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26 See for example OECD/ICCP: Change in Focus in Information Technology Policies during the 1980s: Comparison of Austria, Germany and Japan, February 1991, p. 43.

- the Kansai Advanced Research Centre (KARC), which is the newest Branch of the Communications Research Laboratory (CRC), Japan's only national communications institute. KARC R&D is linked to the Frontier Research in Telecommunications program which is structured around a vision of communications in the 21st century;

- the New Generation Telecommunications Network, a B-ISDN network destined to replace the existing network;

- the second Generation Science Information Network, a gbit/sec level high-speed network for academic; and

- the Real World Computing Program (RWC), a high-speed computing R&D program.

In keeping with Japan's regionalization policy, a number of R&D initiatives, with special emphasis on enhanced media services, have been launched in a number of cities across the country.

5.2.3 Implications for Canada

Canada has had a bilateral S&T agreement with Japan since 1986 and the federal government has set in place the Japan S&T Fund to enhance bilateral S&T collaboration.

There is a joint Canada-Japan Committee on S&T Co-operation. DOC co-chairs the C&IT sub-committee along with MPT.

While structures are important, they do not by themselves ensure success. Canada does at times have difficulties with Japanese "grand schemes" for R&D. A case in point is the Real World Computing (RWC) program. Canada has been invited to participate but there is no broad Canadian plan for this participation. NRC has a limited interest in the optical computing part of the program. Therefore, full membership in the RWC could not be justified at this time.

5.3 United States

5.3.1 Emerging Industry-Government Collaboration

In the **United States**, industry has traditionally provided the technological leadership in the communications sector. In recent years, private sector R&D consortia have emerged to share the costs and the risks of developing new technologies. Some, such as SEMATECH, have received government support. Recently, industry leaders have proposed directions for the development of a national information infrastructure in concert with government. The Clinton Administration has recently issued a technology policy statement which includes directions for a national information infrastructure (see Appendix 2).

The Federal Government, for its part, is increasingly providing support for the development of advanced communications systems. Agencies such as DARPA and NSF are, for example, supporting R&D into packet switching networks and high-speed networks. NIST's Advanced Technology Program (ATP) is also a vehicle which provides support.

5.3.2 The National Information Infrastructure

A major thrust in the U.S. is the development of a number of projects in the areas of high-speed networks and high-speed computing which will lead to the establishment of a national information infrastructure with implications for the three "wired" areas of interest to the present study (i.e. high-speed networks, enhanced media and electronic information/transaction services).

The development of such an infrastructure brings together the interests of both government and industry as outlined in the Computer Systems Policy Project (see Appendix).

5.3.3 Implications for Canada

The major implications for Canada of emerging U.S. initiatives is how we position ourselves vis-à-vis the national information infrastructure initiative.

The CANARIE project is an important Canadian initiative but Canada still finds itself in a "catch-up" situation versus the U.S. in the area of advanced communications infrastructure. However, if the CANARIE business plan is fully implemented as proposed[27], that network will then have gigabit capabilities within the next 10 years. As such, it should approach U.S. capabilities.

[27] CANARIE Business Plan: December 1992, p. 34.

5.4 The International Overview

Generally it is observed that:

- communication related R&D is a prime focus for publicly funded R&D around the world;
- pre-commercial R&D consortia involving several partners within and across specific jurisdictions have become an established mechanism for undertaking R&D;
- the development of a high-speed communications network has recently emerged as a field of relatively high interest in Europe, Japan and the U.S.A.; and
- there generally appears to be more current interest in R&D activities in the area of enhanced media services relative to wireless personal communications and electronic information/transaction services.

The development of high-speed communications infrastructures internationally will be a stimulus for the "wired communications environment", that is for high-speed networks, enhanced media services and electronic information/transaction services.

As to wireless personal communications, various initiatives are in place. One element that could influence the development of the "wireless environment" is the various intelligent vehicle control systems' initiatives.

The relative levels of interest in the four areas of this study, in the three regions surveyed, are broadly summarized as shown in Exhibit 5-1. This relative positioning represents a judgement made resulting from the analysis undertaken. It needs to be emphasized that interest does not necessarily imply technological strength. In fact, it could indicate an interest in developing a technological capability.

Key activities related to the four areas of interest in the three regions surveyed are listed in Exhibit 5-2.

Exhibit 5-1
Relative Levels of Interest: Summary of Findings

AREA	EUROPE	JAPAN	U.S.
High-speed networks	Emerging rapidly	Emerging	Leading
Enhanced media	Emerging rapidly	Emerging	Leading
Wireless personal communications	Ongoing interest	Ongoing interest	Ongoing interest
Electronic information/transaction services	Ongoing interest	Ongoing interest	Ongoing interest

However, it is difficult to draw major conclusions from this listing of programs because of overlaps in various programs, ambiguities regarding actual levels of financial commitments and indeterminate time frames. Moreover, the type of R&D undertaken and funding sources can vary. For example, EUREKA has no program funds per se and because it is aimed at near-market deals, there is naturally more private sector interest.

5.5 Comparison with Canadian Strengths

The Lapp-Hancock study, prepared for DOC[28] identified intelligent networks and wireless personal communications as areas of Canadian technological strengths. The report also concludes that there is apparently relatively less technological capability and interest in the areas of electronic information/transaction services into the home and enhanced media services at home and at work.

There has been a long standing interest in Canada in the development of intelligent networks. For example, this was a unifying concept of VISION 2000, whose R&D Working Group came up with technological priorities that would increase the "intelligence" of communications networks[29] (See Exhibit 5-3).

However, while there are some common technological areas between intelligent and high-speed networks, the latter bring in the dimension of ever faster transmission of large volumes of information. In recent years, there has emerged a strong interest in Canada as well as in other countries, especially the U.S.A., in the development of high-speed networks. This interest has culminated in the CANARIE Project which if fully

[28] Lapp-Hancock Associates Limited: An Analysis of Canadian Telecommunications R&D Activities; An Assessment of its Strengths, Weaknesses and Fori; (Draft Final Report) March 1993

[29] VISION 2000: Report of the R&D Working Group, July 17, 1990

Exhibit 5-2
Key Activities in the Four Areas of Interest

AREA	EUROPE	JAPAN	U.S.A
High-speed networks	• RACE - IBC Developments ($337.5 million; 1990-1994) • EUREKA - ECTRANS ($79.5 million; recently completed)	• Fifth Generation Computer Project (extended to 1995; funding not available) • Frontier Research in Telecommunications (funding and timeframe not available) • New Generation Telecommunications Network ($330 billion; 1992-2015) • Second Generation Science Information Network ($6 million; 1993-1998) • Real World Computing Program ($600 million; 1992-2002)	• HPCC ($1 billion for FY 1993; includes $153 million for NREN) • SEMATECH (annual budget of $250 million; reduced to $100 million in FY 1993) • MCC (annual budget of $87.5 million) • Five Gigabit Level Testbeds ($20 million; 1990-1993) • SMDS (funding and timeframe not available) • Data Retrieval for High Performance Computing Applications ($8.875 million; 1992-1995) • Enterprise Integration Network ($3.25 million provided by Air Force for military applications development)
Enhanced media	• RACE - Image Communications ($210 million; 1990-1994) • RACE - Advanced Communications Experiments (portion of $375 million; 1990-1994) • ESPRIT - Advanced Business and Home Systems; Peripherals (portion of $688.5 million; 1988-1992) • EUREKA - HDTV ($2.1 million; 1992-1994) • EUREKA - Video-Audio Digital Interactive System ($30 million; 1991-1993)	• 3-D TV Transmission ($1.7 million; 1992-1997) • NTT Multimedia Centre ($3 million for FY 1992; $4 million for FY 1993) • Ultra High Definition TV ($700,000; timeframe not available) • Satellite-based Digital Video Transmission (funding and timeframe not available) • Transmission of Cable TV via Optic Fibre (funding not available; 1992-1994) • LCD-based Animation Holographic 3-D TV (funding and timeframe not available) • Institute for Hyper Network Society (initial investment of $4.2 million) • Yokohama Video Communications Techno Station (initial investment of $23.5 million)	• Kaleida (funding and timeframe not available) • First Cities (initial spending of $6.25 million) • HOME 2002 (funding and timeframe not available) • HDSL and ADSL Technologies (HDSL prototype developed at a cost of $6.75 million) • Educational Delivery Platform to Support Multimedia (funding and timeframe not available) • Video Wall ($500,000 for FY 1992)

AREA	EUROPE	JAPAN	U.S.A
Wireless personal communications	• RACE - Mobile Communications ($165 million; 1990-1994) • ESPRIT - Advanced Business and Home Systems; Peripherals (portion of $688.5 million; 1988-1992) • EUREKA - Terrestrial Flight Telephone Service ($62.25 million; 1990-1993)	• Miniaturized Satellite Technology (funding not available; 1993-1998) • Next Generation Satellite Communications (funding and timeframe not available) • The PARTNERS Project ($1.2 million for FY 1992; $1.5 million for FY 1993) • Yokosuka Research Park (initial investment of $50 million)	• R&D into satellite communications in Europe and Japan (funding and timeframe not available) • Development of Personal Communicators (funding and timeframe not available)
Electronic information/transaction services	• RACE - Advanced Communications Experiments (portion of $375 million; 1990-1994) • ESPRIT - Information Processing & Systems Software ($1 billion; 1988-1992) • Telematics - AIM ($291 million; 1991-1994) • Telematics - DELTA ($162 million; 1991-1994) • Telematics - ORA (funding and timeframe not available) • Telematics - DRIVE ($186.3 million; 1991-1994) • EUREKA - PROMETHEUS ($1.1 billion; 1986-1993) • EUREKA - INFOMAR ($72 million; 1992-1996) • EUREKA - IRISS ($12.5 million; 1992-1995) • EUREKA - ECMA PCTA ($45 million; 1991-1994) • EUREKA - AMADEUS ($525 million; timeframe not available) • EUREKA - GALILEO ($103.5 million; timeframe not available) • EUREKA - ATIS ($5.25 million; timeframe not available) • EUREKA - MEDIM ($16.2 million; timeframe not available)	• SSVS (proposed budget could be over $200 million) • VICS (funding and timeframe not available)	• IVHS America ($43.75 billion; 1990-2010) • HOME 2002 (funding and timeframe not available) • E-Mail Filtration System (funding and timeframe not available) • Knowledge Network Gateway (funding and timeframe not available)

implemented would give Canada gigabit/sec capabilities within 10 years[30]. As can be seen from Exhibit 5-4, many of the founding participants of CANARIE are among the leaders in the development of advanced communications technologies in Canada.

While wireless personal communications emerged as a dominant area of strength in Canada, this domain did not appear to attract the same level of R&D interest in other countries. It has been suggested that the development of strong capabilities in mobile communications technology in Canada could be linked to our geography[31].

The fact that there appears to be less interest and capabilities in Canada in electronic information/transaction services into the home is in keeping with the results of the present study which indicated relatively less interest internationally.

The Lapp-Hancock study also found that there are limited capabilities in Canada in enhanced media services at home and at work. The present survey indicated a significant level of interest in this area internationally. However, as noted earlier, interest and R&D activities do not necessarily imply technological capability. In Canada, there is interest in some quarters. For example, to quote John Tyson, who leads BNR's corporate design group:

> "Any media, any time, anywhere, and for anyone, that's where this industry is going."[32]

Overall, there appears to be a direct broad correlation between the high level of Canadian and international interest in the area of high-speed networks as well as the more limited interest for information/transaction services. While such a broad correlation does not seem to exist in the other two areas, matches can be found in niche areas (e.g. advanced cable TV technology). In fact, Canada's strength in wireless personal communications does provide technological capabilities that can be used as important entry points into the international arena.

The development of telecommunications technologies in Canada has been undertaken with relatively modest funding in both absolute and relative (i.e. on a GDP basis) terms compared to other major countries (see Exhibit 5-5). However, within its overall national R&D budget, Canada appears to have devoted relatively more funding to telecommunications R&D compared to other selected countries. This emphasis reflects

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[30] CANARIE ibid

[31] DOC: Market and Technology Trends in Mobile Communications; prepared for VISION 2000 Market Working Group; May 1990

[32] Ottawa Citizen; March 4, 1993; pg. 13

Exhibit 5-3
VISION 2000: Technology Development Priorities

Category 1: Those technologies which indicate a promise of gaining a major (H) competitive advantage throughout the 1990s, with a low to medium level of investment and where skilled people are at least moderately available;

- high speed circuits
- high density circuits
- directories
- specification languages
- modulation and coding
- multiple access method
- digital signal processing

Category 2: Those technologies which indicate a promise of gaining some competitive advantage throughout the 1990s, with a low to medium level of investment and where some skilled people are available:

- speech processing (broad/narrow band)
- user interface software
- user interface ergonomics
- image/video processing S/W
- security (broad/narrow band)
- antennas (terminal) (terrestrial)
- wire (high speed)
- fibre (photonics) - some applications
- indoor 60 GHz
- handoff
- antennas (access)
- packet switching
- internetworking
- mail services
- personal service agents
- group interaction S/W
- multimedia databases
- information retrieval mediation
- speech store/forward

Category 3: Those technologies which indicate a promise of gaining some competitive advantage at some point in the 1990s, but which would require a high level of investment;

- optoelectronics
- antennas (terminal) (satellites)
- MMIC
- ATM
- satellite (LEO/GEO)
- satellite (connectivity)
- OAM & P
- fibre (photonics) - some applications

Source: VISION 2000: R&D Working Group

Exhibit 5-4
The Founding Members of CANARIE Associates

ABL Communications Inc.
CA*net Networking Inc.
Canada Trust
Canadian Institute for Advanced Research
Digital Equipment Canada Ltd.
DMR Group Inc.
Ernst & Young
Gandalf Technologies Inc.
Hewlett-Packard (Canada) Ltd.
IBM Canada Ltd.
MPR Teltech Ltd.
NCR Canada Ltd.
Newbridge Networks Corp.
Northern Telecom Canada Ltd.
Positron Industries Inc.
Stentor Resource Centre Inc.
Unisys (Canada) Ltd.
Unitel Communications Inc.
University of British Columbia

Source: CANARIE Business Plan Executive Summary

Exhibit 5-5
International Comparison of Military & Civil Telecommunications R&D Expenditures (1987)

	U.S.A.	Japan	Germany	France	U.K.	Canada
Telecom R&D expenditures ($ U.S. billions)	$ 13	4.7	2.5	1.9	2.1	.85
Telecom R&D as % national R&D	10%	10%	10%	11%	13%	14%
Telecom R&D as % GDP	.28%	.29%	.29%	.25%	.29%	.18%
Total telecom service income as % GDP (1985)	2.84	1.59	1.83	2.10	2.18	2.34

Canada's civil telecom R&D expenditures as a % of GDP are comparable to other OECD countries. It should be noted that in the U.S.A., France & the U.K., 30 to 40 % of their total telecommunications R&D expenditures is financed by their defence departments.

Sources: OECD, WIK Report & DOC Estimates

Source: DOC; Telecommunications Research and Development Statistics, July 1991 an historical commitment to the development of telecommunications technologies of importance to Canada[33].

Canada can use its established competence in communications technologies, and stretch its limited financial and human resources, by entering into appropriate international alliances to develop those communications technologies needed to ensure international competitiveness.

33 See for example Voyer, R. and MacKinnon, P., Information and Telecommunications Research and Innovation; in Science and Technology in Canada (J. de la Mothe and P. Dufour, ed.), Longman 1993 Pg. 210-229.

6.0 CONCLUSIONS

There appears to be major R&D thrusts internationally related to the four areas of study with interest in high-speed networks and enhanced media services dominating at the moment.

Japan appears to be setting the challenges for communications R&D through the development of visions of the communications environment in the 21st Century. However, the U.S. and Europe appear to be leading in the actual development of technology by setting in place various short and medium term communications R&D initiatives.

APPENDIX 1

PERSPECTIVES ON THE NATIONAL INFORMATION INFRASTRUCTURE: CSPP'S VISION AND RECOMMENDATIONS FOR ACTION

Computer Systems Policy Project

Jan 12/93 released

John Sculley Apple

Robert E. Allen AT&T

Perspectives on the National Information Infrastructure:

Eckhard Pfeiffer Compaq

CSPP's Vision and Recommendations for Action

James E. Ousley Control Data

John A. Rollwagen Cray Research

Ronald L. Skates Data General

Robert B. Palmer Digital Equipment

Lewis E. Platt Hewlett-Packard

John F. Akers IBM

Edward R. McCracken Silicon Graphics

Scott G. McNealy Sun Microsystems

James G. Treybig Tandem

James A. Unruh Unisys

As the 21st century approaches, our nation's challenge is to find ways to rekindle economic growth, remain competitive abroad, and create the kinds of jobs that will enable Americans to raise their standard of living. This will require that we be more productive and innovative than our competition abroad, and that we act more quickly and more efficiently.

Across a range of industries, Americans are increasingly turning to information technology to do just that. Our ability to generate and exchange information, technology, and ideas is helping us to increase output, decrease costs, improve quality, and bring new products to market. The United States has a unique opportunity to capitalize on this increasing reliance on information technology and the benefits it can bring.

We are currently the world leader in computing and communications technologies, yet we have not taken steps that will allow us to make the most of our potential. This report calls for concerted efforts by the U.S. public and private sectors to develop and deploy an advanced information infrastructure that will put our information technology advantage to work for all Americans.

Throughout history, the United States has been successful, in part, because we have taken bold steps to make our national resources available to individual Americans by creating a variety of underlying foundations or infrastructures. Our transportation, telephone, electric power, and water systems are all solid examples of this tradition. By developing the infrastructures to make these resources readily accessible to individual Americans and easy to use, we have experienced an economic prosperity, quality of life, and global competitiveness virtually unmatched by any nation. We need to build on this tradition to carry us into the 21st century.

A national information infrastructure, which will be as accessible and easy to use as our existing national infrastructures, will revolutionize our ability to communicate and collaborate by erasing geographical boundaries. It will enable us to tap into our existing resources of creativity and knowledge. It will lead to the development of products and services today unimagined. It will create new jobs and economic strength for individual Americans. It will accelerate the development of critical technologies. And finally, it will enable us to address more effectively many societal problems, including challenges in the areas of health care, education, and manufacturing.

The call for a national information infrastructure builds upon the High Performance Computing and Communications (HPCC) Program. The HPCC Program is an excellent first step. It provides an initial research foundation to create a more extensive information infrastructure that will be broadly accessible to the public and capable of meeting a wide variety of information needs. Nevertheless, it alone is not enough. CSPP believes the United States must make a national commitment to create a new national information infrastructure that complements, builds upon, and delivers the advantages of the research being performed in the HPCC Program, enabling the private sector to create new services that will benefit individuals in all walks of life. This will require improving upon and linking together current communications, computing, information, and human resource capabilities. More importantly, it will require developing new capabilities to enable broad access to a variety of public and private information resources. Finally, it will require the integration of a range of computing and communications technologies to enable transmission of text, images, audio, and video to anyone, anywhere, at any time.

CSPP believes the first step is to develop a consensus vision — across industries and with the government — of what the information infrastructure should be. It will also require building a widespread understanding of the benefits this infrastructure could bring to individual Americans. On the following pages, CSPP presents its vision of the national information infrastructure (NII). In addition, CSPP recommends the following actions be taken by the new Administration, Congress, and U.S. industry:

Administration Agenda

1. Make the NII a National Technology Challenge
2. Establish a National Information Infrastructure Council
3. Establish an NII Implementation Entity
4. Invest in Research for an NII
5. Fund Pilot Projects to Demonstrate Technologies
6. Develop a Public Education Program
7. Make Government Information Easily Accessible

Legislative Agenda

1. Authorize a National Information Infrastructure Council and Appropriate Funds for its Operation
2. Authorize and Appropriate Funds for Research and Technology Demonstrations

Industry Agenda

1. Continue Investments to Develop and Deploy an NII
2. Continue to Invest in Research and Development of Applications
3. Reach Out to Other Industries
4. Promote NII Efforts
5. Develop and Participate in Pilot Projects
6. Develop NII Goals and Milestones

Finally, CSPP believes the public policy principles outlined at the end of this report must be addressed jointly by the private sector and government before the information infrastructure of the future can become a reality.

In December 1990, the CEOs of CSPP met with Administration officials to discuss their public policy positions on technology issues. At that meeting, CSPP was asked to assess the High Performance Computing and Communications (HPCC) Program and provide recommendations to increase industry's involvement and interest.

On December 3, 1991, after almost a year of review and analysis, CSPP issued its report and video, *"Expanding the Vision of High Performance Computing and Communications: Linking America for the Future,"* concluding that the HPCC Program is a significant and critical undertaking. It would, CSPP determined, advance research in high performance computing and networking technologies as well as increase the use of high performance computers to solve important science and engineering problems. At the same time, CSPP observed that the HPCC Program could provide a foundation for something more. If properly designed, HPCC research could advance the development of technologies to help solve a wide range of social and economic problems and improve the competitiveness of U.S. industry by providing the foundation for a national communications and information infrastructure.

CSPP continues to support the HPCC Program and believes it should remain a national research priority. CSPP applauds the recent creation of a new, improved management structure for the Program, which will provide a clear mechanism to coordinate, manage, and govern the implementation of the Program and a central point for private sector interaction. In addition, CSPP commends Senator Al Gore and Representative George Brown for introducing the Information Infrastructure Technology Act in the summer of 1992 to move the HPCC effort to a new level.

The research and technology advancements supported by the HPCC Program remain a high priority for CSPP. In October 1992, in the *CSPP Agenda for the 103rd Congress*, we recommended enhancing and expanding the HPCC research agenda to: 1) provide the foundation for an information and communications infrastructure of the future; 2) bring the benefits of HPCC technology to individual Americans in areas such as health care, education, and manufacturing; and 3) develop technology demonstration projects.

In addition to supporting the HPCC Program, CSPP believes the nation must focus on creating the information infrastructure for the future. Together, the HPCC Program and the NII will provide the means to address the difficult challenges the nation now faces. HPCC research advancements will pave the way for the applications a national information infrastructure will make possible, and the infrastructure will provide a vehicle to deliver the benefits of HPCC research. The following report describes our vision for the infrastructure and recommendations for action that will help to make the vision a reality.

Introduction

Information in the 21st Century

In the future, the United States' primary resource for generating economic prosperity, improved quality of life, and global competitiveness will be our ability to quickly and efficiently generate and exchange information, technology, and ideas.

Increasingly, across a range of industries from banking and retail to automotive and aerospace, information technology has become instrumental in product development, manufacturing, marketing, sales, and service. The flow of information has become the foundation for improving productivity and increasing innovation in most every business enterprise. U.S. industry is not, however, the only beneficiary. Information technology continues to become an increasingly integral part of the every day lives of individual Americans.

The information infrastructure of the future will revolutionize the way individuals relate with one another by enabling us to work together, collaborate, and access and generate information without regard to geographical boundaries.

Automated tellers, airline reservation systems, anti-lock brakes, and personal computers are just a few examples.

As we face the 21st century, we have an advantage over our foreign competitors. We currently lead the world in computing and communications technologies. But to make the most of the increasing reliance on information technology and our current strengths, we, as a nation, need to take the bold step of developing and deploying an advanced information infrastructure that will help us remain more productive and more innovative than our competitors abroad.

The National Information Infrastructure

What Is It?

The infrastructure of the future is a nation-wide system that will allow all Americans to take advantage of our rich resources in information, communication, and computing technologies. It will link together a range of institutions and resources, from schools and businesses to libraries and laboratories. More importantly, it will link together individuals, from senior citizens and students, to health care professionals, manufacturing managers, and business people from all fields.

The information infrastructure of the future will revolutionize the way individuals relate with one another by enabling us to work together, collaborate, and access and generate information without regard to geographical boundaries. It will enable fundamental changes in the way we educate our children, train and retrain our workers, earn a living, manufacture products, deliver services of all kinds, and interact with family and friends.

Throughout its history, the United States has followed a tradition of creating underlying national foundations — infrastructures — that have fostered a quality of life in America unmatched by any nation. Our transportation, electric power, and water systems are all solid examples of this tradition. As we move into the 21st century, these existing infrastructures will continue to be important, but they, alone, will no longer be sufficient to meet our national needs.

Today, we think nothing about turning on a faucet and immediately getting hot water for a shower, flipping a switch and getting electricity to make coffee, and another switch to get a weather report. We pick up the telephone without a second thought. We must create an advanced information infrastructure for the future that will provide Americans with the same easy access to all sorts of information and people.

The information infrastructure, used in conjunction with a collection of "information appliances" — tools that will combine computing, communications, and video technologies, for example — will give people in rural areas ready access to libraries, museum exhibits, job information, and medical care now only available to those who live near those resources. People all over the country will be able to work and interact with others, without even knowing their collaborators' locations. By making information resources readily available and easy to use, the information infrastructure of the future will revolutionize our ability to access the information we need and our ability to collaborate and cooperate with others.

This infrastructure will integrate four essential elements — communications networks, computers, information, and people — to create a whole new way of learning, working, and interacting with others. A more detailed description of the elements of the infrastructure includes the following:

Communications Networks

- a network of interconnected and interoperable public and private communications networks ("public" networks refer to those networks, such as the public switched telephone network, that are open to use by anyone; "private" networks refer to those that are limited to use by a specific group of people meeting certain criteria, such as corporate networks), providing services ranging from high to low speed, allowing a range of uses anytime, anywhere;
- agreed-upon technical standards for piecing together the network, having all its pieces work together, and plugging into it;
- the capacity to transmit information, at both high and low speeds, in a variety of data formats, including image, voice, and video; and
- multiple mechanisms, perhaps including digital signatures, to support the electronic transfer of funds in exchange for services received.

Computers

- high-performance computers resident on the communications networks to provide intelligent switching and enhanced network services;
- powerful personal computers and work stations — including machines that respond to handwritten or spoken commands and portable, wireless devices — that are easy to use and mask the complexity of the underlying system so people can tap into it as easily as they dial a phone; and
- distributed computer applications that are widely accessible over the network (which acts like a lending library) and that help people perform a wide variety of tasks quickly and easily.

Information

- public and private databases and digital libraries that include material in video, image, and audio formats; and
- information services and network directories that assist users in locating, synthesizing, and updating information.

- people of all ages and backgrounds who are easily able to use the rich and varied resources available through the infrastructure to improve how they learn, live, and work; and
- people who create, package, communicate, and sell information in the many new ways made possible by the existence of the information infrastructure.

Why Is It Important?

The investments the nation has made over the years to develop our existing transportation, communications, and energy distribution infrastructures were instrumental in making the United States an economic and political world leader. They were also instrumental in improving the quality of life for individual Americans. To remain an economic power in the 21st century, the United States must have in place an infrastructure that allows us to compete in the Information Age by providing a tool to be continually more productive and innovative.

An information infrastructure will enable the U.S. to tap into the vast resources of knowledge and creativity that already exist in this country. As the volume and complexity of our information resources has increased, it has become almost impossible for any individual or business to take full advantage of what is available. An information infrastructure will make the benefits of information technology as available to individual Americans as the transportation infrastructure made available the benefits of automotive technology and the communications infrastructure made available the benefits of telephone technology. It will create new opportunities for the development of products and services we cannot even begin to imagine today, creating new jobs and economic strength for Americans and providing a resource for our current workers to continuously improve and upgrade their job skills.

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In addition, an information infrastructure will accelerate the development of critical U.S. technologies. A strong consensus exists as to what technologies bolster the competitiveness of our economy and where we stand in those technologies relative to the rest of the world. Initiatives to develop, deploy, and use an information infrastructure will create a market demand for many of these technologies, spurring an increase in private sector investment. Moreover, these technologies would be put to work in the real world, a testing ground more powerful than the laboratory and with the potential to directly benefit individual Americans by generating advancements in commercially relevant technologies and creating an infrastructure they can use.

Finally, the information infrastructure will lead to the development of a range of new "information appliances" that will allow Americans to tap into the resources of the infrastructure in ways beyond our understanding today. Some of these tools for the infrastructure could include interactive learning devices, wireless computers capable of simulating design and engineering plans on-site, and pocket size devices allowing doctors access to medical resources from remote locations. The only thing that will limit the shape, form, and use of these appliances is our imagination.

Why Should The United States Act Now?

Today, many of the changes taking place in our economy and influencing our competitive position are driven by the advent of the information age and the new set of economic ground rules this has created. In the information age, the value of the products and services we exchange is increasingly a function of their information content and the knowledge used to create them rather than the raw materials used to produce them. Because of this shift, the ability to easily access and share information and stimulate the creation of new ideas is essential to maintaining a strong economy, developing world class industries, and enhancing the quality of life for every citizen. America now has the opportunity to create the information infrastructure required to achieve this.

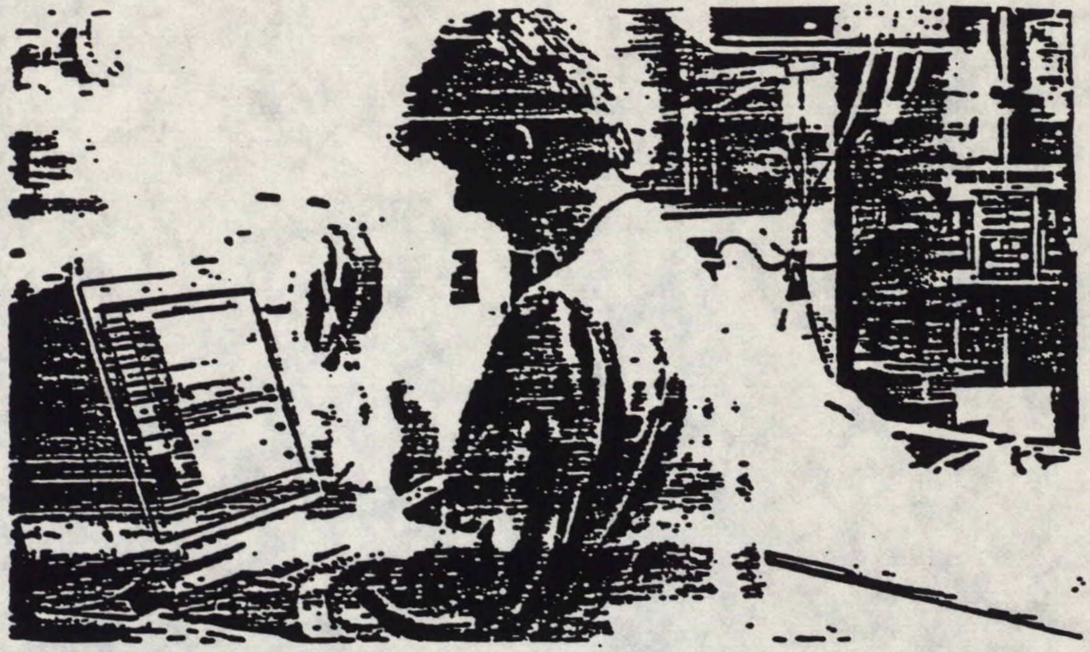
> *A coordinated, focused drive for a national information infrastructure will enable us to more effectively and efficiently devote our collective talents to developing the competitive edge against other nations.*

Other nations, including Japan, Germany, France, and Singapore are taking significant steps to upgrade their own infrastructures and have long-term plans in place to continue doing so. With U.S. industry and government working together as partners, we can build on our already strong lead in information technology to maintain our current lead, help us compete abroad, and improve our quality of life at home.

A coordinated, focused drive for a national information infrastructure will enable us to more effectively and efficiently devote our collective talents to developing the competitive edge against other nations. Working together toward a common goal, America will realize the benefits of an information infrastructure sooner — we will establish the standards the world will need to follow and we will be the first to market with important new products, services, and applications for the infrastructure. More importantly, we will be able to dramatically change the way Americans learn, care for the sick and elderly, and manufacture products.

The following descriptions provide a glimpse of the important benefits an information infrastructure could make possible.

Health Care



Americans spend more on health care than on any other industry, but they are getting less in return for their expenditures than is possible. For many people, health care is too expensive and often unavailable. CSPP believes that computing and communications technologies can provide solutions to both of these shortcomings.

Health care is a large, high growth, recession resistant industry, with spending rising about 2 1/2 times faster than GNP. In 1991, health care spending totalled $738 billion, or 13% of GNP, up from 7.3% of GNP in 1970. The Health Care Financing Administration projects that the nation's health outlays will reach $1.6 trillion by the year 2000. The soaring cost of health care has triggered concern about the ability of the nation to continue providing quality health and medical care as well as the ability of individual Americans to afford it.

Health care is extremely information intensive. Each year, Americans make approximately 636 million visits to doctors' offices for ambulatory care. In addition, 23 million surgical procedures are performed annually. Each visit and procedure generates large amounts of medical and financial data. There is presently no means to preserve or track that information for use in future or related health care situations. In fact, the cost of managing health care information is one of the prime causes of the increasing cost of health care.

Improving the management of this information through a health care information infrastructure will enable efficiency gains and cost savings throughout the entire health care process. First, roughly 20% of annual health care expenditures go to administrative costs, including processing an estimated five million health care claims per day. Computing and communications technologies offer new opportunities to improve the manage-

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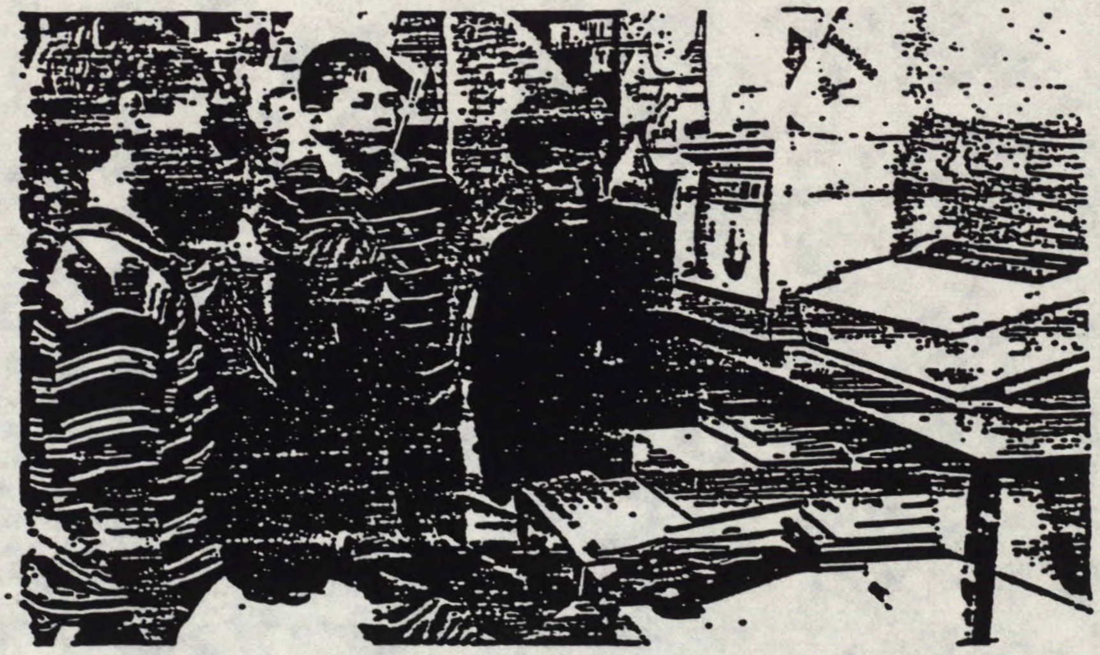
ment of and access to health care-related information and to reduce costs for processing insurance claims through electronic payment and reimbursement. Second, better access to medical data and patient medical histories will help improve doctors' diagnoses by providing fast and easy access to accurate, complete, and up-to-date information. Third, high speed networks will enable residents of rural areas and inner cities to enjoy the benefits of the latest medical technologies and expert opinions without leaving their home towns. Finally, easy access to information by individuals in their homes on self-care and healthy lifestyle practices will enable people to better manage their own health, reducing the number of visits to doctors' offices and hospitals, and increasing the likelihood that medical problems will be identified earlier.

The challenge is to create a medical information infrastructure that will support the following types of applications that could help, in the near and longer term, to solve the health care problems the nation is experiencing:

■ **On-Line Patient Records** — Hospitals, doctors' offices, and community clinics will be interconnected through high speed networks. Patient records, including medical and biological data, would be available to authorized health care professionals anytime, anywhere (with privacy assured) over these networks. This would enable health care providers to access immediately, from any location, the most up-to-date patient data, including medical images from tests, resulting in improved diagnoses and more informed treatment decisions.

■ **Medical Collaboration** — Medical personnel will use interactive, multimedia telemedicine technologies to collaborate and consult with each other over distances. Doctors in hospitals or offices will consult on short notice with experts located anywhere in the nation; emergency room physicians will provide vital assistance to emergency medical personnel on the scene via wireless technologies. Patients and their doctors would have instant access — at affordable cost — to experts and specialists, no matter where the patient is located.

■ **Surgical Planning and Treatment** — Physicians and surgeons will use high speed computing technologies to simulate the function of human organs to facilitate medical diagnoses and treatment decisions, and to plan complex surgical procedures. Imaging and modeling techniques will be used to produce realistic and detailed 3D models of a patient's organ, to develop the most effective and safe surgical procedures, to demonstrate planned procedures to patients and medical students, and to develop alternate non-invasive treatments. With high speed networks, images could be transmitted instantly to experts located elsewhere for confirmation of diagnoses and treatment recommendations.



To ensure a secure and prosperous future, Americans need to be able to think critically and to have access to the widest possible body of knowledge. The work force requirements of the future will increasingly require people to be able to learn new skills to adapt to changing job requirements and new technologies and to use knowledge and information to make decisions. Changes must be made to the United States' education system to ensure that it will give individuals the skills they will need for lifelong learning in a high wage, information-based economy of the future.

Meeting these challenges will require extending America's edge in computing and communications technologies to education services in schools, communities, work places, and homes. An information infrastructure for lifelong learning will offer unprecedented potential for improving lives by making knowledge readily available and usable by all Americans. Such an infrastructure would provide a tool for addressing many of the learning needs the country is facing, including, for example, making additional resources available on-line for teachers who want to improve their skills and update their knowledge; providing a means for Americans to continually acquire the new knowledge to adapt to the multiple careers many will likely undertake; providing seniors and disabled or homebound Americans direct access to information resources critical to their health and welfare; and providing better access to information that affects our quality of life and cultural awareness.

Effective deployment of a computing and communications infrastructure for education and lifelong learning requires well trained and technologically experienced teachers and administrators

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who can facilitate the use, installation, and management of new instructional technologies such as digital interactive video, local area networks, and gateways to national networks. Users and students will need new skills to help them retrieve, review, categorize, and analyze the information and knowledge they will be able to access. This will require investment in training for educators and students in the use of new technologies, development of model curricula and new instructional techniques, development of new information resources, improvement in the quality of existing resources, and extension of public access to electronic schools and libraries.

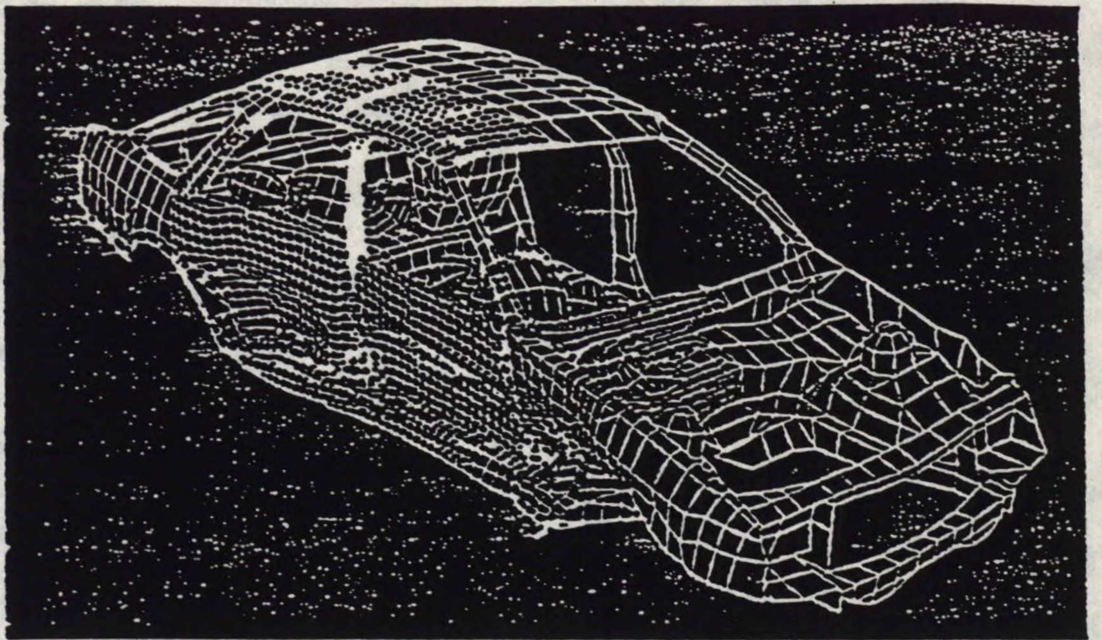
A national information infrastructure will create an enormous range of education and lifelong learning applications, such as:

- **On-line Job Training Libraries** — Interactive, multimedia, digital libraries will be available on job sites to provide workers with task-oriented information that they could use, at their own convenience and pace, to improve and upgrade their job skills and performance. Workers in any job — assembly lines, retail outlets, sales, or offices — would be able to continuously upgrade their skills and learn new skills at any time through customized training libraries.

- **Electronic Libraries** — Students will use on-line electronic libraries in classrooms and at home to learn more about any topic. For example, if a student wanted to learn about the works of Shakespeare — or about a specific play — he or she will simply turn on a computer and, with the flick of a switch, be connected to the entire works of Shakespeare, complete with photographs, videos, and recordings. The electronic libraries will include software tools to help students find the information they need, identify relevant data, analyze, and present the information and will provide access to information and reference specialists to help users locate the material they need.

- **Virtual Laboratories & Field Trips** — Through virtual laboratories, students will perform science experiments using equipment and facilities located anywhere in the United States, including at the national laboratories, in collaboration with some of the nation's best laboratory scientists. Students will also take "field trips" to museums, observatories, science exhibits, and research centers without leaving the classroom.

- **Collaborative Learning** — Students of all levels and ages, teachers, and experts will collaborate, in real time, via high speed networks, on a wide variety of learning projects. The collaborators will access information and high performance computing resources located throughout the country, such as images collected by NASA's Earth Observing System satellites, and would work together to develop research projects that focus on their own interests.



The U.S. manufacturing enterprise faces enormous challenges over the next decade just to keep up with new information and new technologies. The industrial world is rapidly moving to "electronic commerce," in which suppliers and design collaborators will be on-line; factories will be highly programmable and staffed with highly skilled personnel; product design and manufacturing will be fully integrated; and custom-made, high-quality products will be manufactured rapidly in small quantities. Failure to keep pace and maintain technological leadership will threaten our long-term competitive position in the world market.

Increasingly, to stay competitive, companies of all sizes must be able to respond rapidly to customer demands for high-quality products at low cost. This requires manufacturing and design processes that are highly efficient and flexible to enable the shortest possible design, development, and production times. Companies able to adapt and apply the latest information and communications technologies to their manufacturing processes will have an advantage over their less innovative competitors in the future. The challenge, therefore, is to develop, deploy and apply the technologies for a manufacturing infrastructure that incorporates computing and communications technologies to support integrated development, engineering, and manufacturing processes.

It is critical to ensure that small and medium manufacturers are stakeholders in this new infrastructure. Small and medium manufacturers are vital to the nation's economic development and growth, accounting for 40 percent of GNP, half of all employment, and more than half of job creation. Providing small and medium companies with access to computing, communications, and information resources will enable them to adopt new technologies and manufacturing techniques, reducing the cost of doing business and increasing efficiency and productivity.

Companies able to adapt and apply the latest information and communications technologies to their manufacturing processes will have an advantage over their less innovative competitors in the future.

Work is already underway in the private and public sectors to expand the use of advanced computing and communications technologies in the manufacturing process, but much more is needed. HPCC Program research in aerospace vehicle design and advanced materials are just a few examples of the application of high performance computing to benefit our industries. Computer-aided design (CAD) and computer-aided manufacturing (CAM) technologies are being incorporated into U.S. manufacturing enterprises at increasing rates. However, CAD/CAM technologies, which are further advanced than many other intelligent manufacturing innovations, still need improvement before they can be widely implemented and must be integrated into both the design and manufacturing processes to fully realize their benefits.

A national information infrastructure has the potential to significantly increase the productivity and quality of U.S. manufacturing by enabling applications such as:

- **Concurrent and Distributed Design, Engineering, and Manufacturing** — Manufacturers of products, from automobiles to airplanes, and from machine tools to televisions, will distribute scheduling and production across geographically dispersed facilities to reduce production delays, minimize manufacturing, transportation, and inventory costs, perform design, engineering, and manufacturing concurrently, and leverage unique skills and availability of skilled resources. Large amounts of information, such as engineering modeling data, product specifications, test specifications, and bills of materials, will be distributed and shared among dispersed facilities in real time. All of these techniques will significantly reduce the time to develop new products and bring them to market.

- **Electronic Commerce for Manufacturing Enterprises** — Companies of all sizes will increase their efficiency and productivity while reducing costs by incorporating electronic commerce into their operations. Through links with suppliers, customers and local, state and federal governments, companies will be able to conduct virtually all of their essential business opportunities electronically, including: locating the best suppliers to meet their needs, identifying potential customers for their products, placing and receiving orders, exchanging payments, and ascertaining the latest government regulations affecting their businesses and submitting required compliance reports electronically.

- **Virtual Design and Manufacturing Project** — Manufacturers of complex, expensive products will use virtual design facilities to model, simulate, and visualize product designs and manufacturing processes in advance, saving the costs of building prototypes. Eventually, virtual reality technologies will permit product designers to "walk through" new products before actually building the products and through manufacturing facilities before production begins.

By investing in the HPCC Program, the United States has already begun investing in the research for an infrastructure based on high speed networks, high performance computers, and on-line information. CSPP will continue to work with Congress and the new Administration to implement our recommendations to improve the structure of the HPCC Program. However, we must now make a national commitment to take the next step to develop a new national information infrastructure that will provide us with the best opportunity to compete in the global economy of the future.

Through a public and private partnership to develop and deploy a national information infrastructure, we will not only lay the best foundation for remaining internationally competitive, we will also give ourselves the best chance to solve many of our domestic challenges — the declining quality of education, the skyrocketing cost and limited availability of high-quality health care, and the need for businesses of all sizes to increase quality and productivity — which increasingly require the ability to access and use large amounts of distributed information.

We must now make a national commitment to take the next step to develop a new national information infrastructure that will provide us with the best opportunity to compete in the global economy of the future.

The time to act is now. Creating a national information infrastructure of the future will require improving upon and linking together current communications, computing, information, and human resource capabilities. More importantly, it will require developing new capabilities to enable broad access by millions of Americans to public and private information resources and to enable people to generate, transmit and receive text, images, and video anywhere, at any time.

Before the comprehensive information infrastructure of the future can be realized, a broad cross-section of American industries, academic and research institutions, and the federal government need to agree on a common vision for the effort. With a common vision in place, the private and public sectors can make a commitment to do what they need to do, independently or together, to make the vision a reality. While the private sector has primary responsibility for developing and making available the services, products, networks, and applications to make the infrastructure possible, the federal government has an important role as a catalyst in stimulating the effort and creating a regulatory environment that will encourage private sector investment and implementation.

To accelerate the development and deployment of a national information infrastructure, CSPP recommends that the Administration, Congress, and the private sector begin a joint effort to take the following actions:

Administration Agenda

1. Make the NII a National Technology Challenge: The President should declare the national information infrastructure a new national technology challenge. The President should, in his State of the Union address and his FY94 budget submission, issue a challenge to Congress, industry, academic, and research institutions, and potential users to work with him to create a new information infrastructure.

2. Establish a National Information Infrastructure Council: The successful development and deployment of a national information infrastructure will be contingent upon the government adopting a vision and a strategy for its implementation. The best way to accomplish these objectives is to establish a National Information Infrastructure Council, chaired by the Vice President, to provide a management focus for the effort. Members of the Council should include the Secretary of Commerce, the Director of the Office of

Science and Technology Policy, the Chairman of the Federal Communications Commission, and the heads of other federal departments, agencies, and White House Executive Offices who have roles or responsibilities in the information infrastructure, and private sector experts, including representatives of industry, user groups, and research institutions. The Council should have as its initial responsibilities:

- adopting a vision for an NII;
- working with the private sector to develop and adopt several concrete goals for the NII, with accomplishable milestones;
- coordinating the NII activities of the various government agencies and departments; and
- developing a strategy to address the information infrastructure policy principles listed following these recommendations.

3. Establish an NII Implementation Entity: Establish a federal entity to implement the National Information Infrastructure Council's vision, plans, strategies, recommendations, and other directions. The entity should have the responsibility and the authority to:

- manage and focus the NII research agenda, including research performed by the national labs;
- coordinate, in conjunction with other appropriate agencies and departments, the NII technology demonstrations; and
- develop strategies to overcome policy and regulatory barriers affecting the deployment by the private sector of a national communications network of interoperable, interworking networks.

4. Invest in Research for an NII: The FY94 budget request should include funds for precompetitive, generic research on enabling technologies for an NII, such as the following:

- research on the generic, enabling technologies needed to address challenges in health care, education and lifelong learning, and intelligent manufacturing;
- research on the scalability problems associated with aggregating many high, medium, and low speed users;
- technologies and architectures to ensure the security of information available in an NII and to guarantee privacy of information;
- interoperability;
- integrity and robustness of networks and databases;
- human/computer interfaces, such as speech and handwriting recognition and machine intelligence; and
- research on creating and managing distributed electronic databases and libraries, such as indexing databases, digitizing libraries, and organizing material.

5. Fund Pilot Projects to Demonstrate Technologies: In conjunction with industry, the federal government should fund pilot projects to demonstrate the application of high performance computing and communications technologies to health care, education and lifelong learning, and manufacturing. Such projects will help solve problems in scaling technologies and accelerate development of standards.

6. Develop a Public Education Program: Request the National Research Council of the National Academies of Science and Engineering to develop, in conjunction with the private sector, a program to educate the general public about the potential benefits of an NII and the impact it will have on their lives.

7. Make Government Information Easily Accessible: An information infrastructure could provide federal, state, and local governments with a system to better serve their citizens while reducing the cost of providing those services. Through a national information infrastructure, people would have ready access to the most up to date information about their entitlement to health, education, housing, and social security benefits. Citizens could, for example, use the infrastructure to register to vote, renew their drivers licenses, and pay their taxes. The National Research Council should assess federal information collection and dissemination policies and practices and make recommendations on how such policies and practices should be changed to make public information easily available and accessible to citizens through the NII. The NII implementation agency should be charged with developing a strategy to implement the recommendations across all affected departments and agencies

Legislative Agenda

1. Authorize a National Information Infrastructure Council and Appropriate Funds for its Operation: Introduce legislation to authorize creation of a National Information Infrastructure Council to oversee development of the NII and appropriate funds for its operation.

2. Authorize and Appropriate Funds for Research and Technology Demonstrations: Introduce legislation, based on the Information Infrastructure and Technology Act of 1992, to authorize research on NII technologies and demonstration projects in health care, education, and manufacturing, and appropriate funds for such projects.

Industry Agenda

1. Continue Investments to Develop and Deploy an NII: The U.S. computer industry is investing billions of dollars each year in research and development relevant to an NII. Industry must continue to work to develop and deploy the NII, including:

- deployment of interoperable communications networks;
- development of on-line databases and applications;
- development of easy to use computers and information appliances; and
- training people to design, develop, and use the various elements of the infrastructure.

2. Continue to Invest in Research and Development of Applications: Companies must continue independent and collaborative efforts to invest in research on NII technologies and development of new products and services.

3. Reach Out to Other Industries: CSPP will initiate a project to encourage other industries likely to benefit from the applications made possible through an NII to join the effort to achieve an NII.

4. Promote NII Efforts: A wide range of affected industries should form a non-profit group to work with the National Research Council to promote the NII.

5. Develop and Participate in Pilot Projects: Industry should undertake an effort to develop strategic plans and facilitate the formation of teams to design technology demonstration projects in health care, education and lifelong learning, and manufacturing.

6. Develop NII Goals and Milestones: The private sector will work with the Infrastructure Council to develop specific examples of accomplishable goals for an NII, with concrete milestones, such as, for example, a nationwide system of on-line patient records accessible by any authorized health care professional, anywhere; and all small and medium manufacturing companies networked with the manufacturing extension centers.

The public and private sectors have important roles in making the information infrastructure a reality. While the development and deployment of the infrastructure must be led by the private sector, guided by the forces of a free and open market, the federal government can accelerate its implementation by acting as a catalyst and a coordinator.

CSPP has identified the following important public policy principles that will have to be addressed jointly by the public and private sectors before the information infrastructure can become a reality. CSPP looks forward to working with the new Administration, new Congress, and other industry groups to address these issues.

1. **Access** — Because an informed citizenry is essential to the nation's growth, all individuals must have access to the NII.

2. **First Amendment** — To ensure freedom of expression in an NII, First Amendment principles guaranteeing freedom of speech, as articulated by U.S. courts, should apply to electronically-transmitted communications.

3. **Privacy** — Consumers of NII services have a right to privacy in their use of the NII.

4. **Security** — Information available through the NII must be protected against unauthorized access, tampering, and misuse, consistent with the needs of the applications and the desires of the user.

5. **Confidentiality** — NII users must be free to use effective, industry-developed encryption to ensure confidentiality of communications and data.

6. **Affordability** — To promote maximum use, the NII must be affordable.

7. **Intellectual Property** — The fundamental principles of copyright should apply to electronically-available information in the same manner as for other media.

8. **New Technologies** — While it is impossible to anticipate all of the technologies that will eventually be part of the NII, the political and regulatory environment must encourage the development of new technologies and their incorporation in the NII.

9. **Interoperability** — The NII must support maximum interoperability among networks in this country and internationally.

10. **Competition** — Service providers must have fair and open access to the NII in order to assure competition among such providers.

11. **Carrier Liability** — Information services carriers and distributors who have no editorial control over the contents of electronic information should not be liable for the content of the information transmitted over the NII.

APPENDIX 2

THE CLINTON/GORE STATEMENT ON THE INFORMATION INFRASTRUCTURE

Technology for America's Economic Growth, A New Direction to Build Economic Strength

President William J. Clinton
Vice President Albert Gore, Jr.

February 22, 1993

INVEST IN AN INFORMATION INFRASTRUCTURE.

Objectives

Today's "Information Age" demands skill, agility and speed in moving information. Where once our economic strength was determined solely by the depth of our ports or the condition of our roads, today it is determined as well by our ability to move large quantities of information quickly and accurately and by our ability to use and understand this information. Just as the interstate highway system marked a historical turning point in our commerce, today "information superhighway" -- able to move ideas, data, and images around the country and around the world -- are critical to American competitiveness and economic strength.

This information infrastructure -- computers, computer data banks, fax machines, telephones, and video displays -- has as its lifeline a high-speed fiber-optic network capable of transmitting billions of bits of information in a second. Imagine being able to transmit the entire Encyclopedia Brittanica in one second.

The computing and networking technology that makes this possible is improving at an unprecedented rate, expanding both our imaginations for its use and its effectiveness. Through these technologies, a doctor who needs a second opinion could transmit a patient's entire medical record -- x-rays and ultrasound scans included -- to a colleague thousands of miles away, in less time than it takes to send a fax today. A school child in a small town could come home and through a personal computer, reach into an electronic Library of Congress -- thousands of books, records, videos and photographs, all stored electronically. At home, viewers could choose whenever they wanted from thousands of different television programs or movies.

Efficient access to information is becoming increasingly more important for all parts of our economy. Banks, insurance companies, manufacturing concerns, and many other businesses now depend on high speed communication networks. These networks have become a critical tool around which many new business opportunities are developing.

And, by harnessing the power of supercomputers able to transform enormous amounts of information to images or solve incredible complex problems in record time, and share this power with an ever-expanding audience of scientists, businesses, researchers, students, doctors and others, the potential for innovation and progress multiplies rapidly. Supercomputers help us develop new drugs, design new products, predict dangerous storms and model climate changes. They help us design better cars, better airplanes, more efficient manufacturing processes. Accelerating the introduction of an efficient, high-speed communication network and associated computer systems would have a dramatic impact on every aspect of our lives. But this is possible only if we adopt forward-looking policies that promote the development of new technologies and if we invest in the information infrastructure needed for the 21st Century.

Actions

A. Implementation of the High-performance Computing and Communications Program established by the High-Performance Computing Act of 1991 introduced by Vice President Gore when he served in the Senate. Research and development funded by this program is creating (1) more powerful super computers, (2) faster computer networks and the first national high speed network, and (3) more sophisticated software. This network will be constructed by the private sector but encouraged by federal policy and technology developments. In addition, it is providing scientists and engineers with the tools and training they need to solve "Grand Challenges", research problems--like modeling global warming--that cannot be solved without the most powerful computers.

B. **Create a Task Force on Information Infrastructure.** Government telecommunication and information policy has not kept pace with new developments in telecommunications and computer technology. As a result, government regulations have tended to inhibit competition and delay deployment of new technology. For instance, without a consistent, stable regulatory environment, the private sector will hesitate to make the investments necessary to build the high-speed national telecommunications network that this country needs to compete successfully in the 21st Century. To address this problem and others, we will create a high-level inter-agency task force within the National Economic Council which will work with Congress and the private sector to find consensus on and implement policy changes needed to accelerate deployment of a national information infrastructure.

C. Create an Information Infrastructure Technology Program to assist industry in the development of the hardware and software needed to fully apply advanced computing and networking technology in manufacturing, in health care, in life-long learning, and in libraries.

D. Provide funding for networking pilot projects through the National Telecommunications and Information Administration (NTIA) of the Department of Commerce. NTIA will provide matching grants to states, school districts, libraries, and other non-profit entities so that they can purchase the computers and networking connections needed for distance learning and for hooking into computer networks like the Internet. These pilot projects will demonstrate the benefits of networking to the educational and library communities.

E. **Promote dissemination of Federal information.** Every year, the Federal government spends billions of dollars collecting and processing information (e.g. economic data, environmental data, and technical information). Unfortunately, while much of this information is very valuable, many potential users either do not know that it exists or do not know how to access it. We are committed to using new computer and networking technology to make this information more available to the taxpayers who paid for it. In addition, it will require consistent Federal information policies designed to ensure that Federal information is made available at a fair price to as many users as possible while encouraging growth of the information industry.