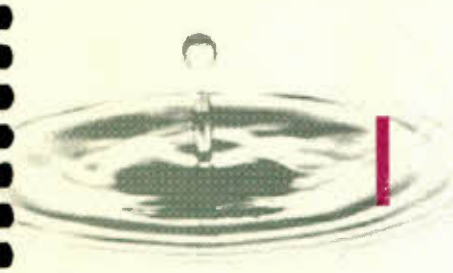

INNOVATION

Ottawa-Carleton Region
Silicon Valley North

Telecommunications and Computing Industry, Leading Companies, and Related R&D Organizations

Industry Profile & Segmentation Analysis

Preliminary Report

April, 1997

Prepared for:
The Regional Innovation Office for the National Capital Region
National Research Council of Canada

In Co-operation with:
The Ottawa-Carleton Economic Development Corporation

Prepared by:
CMG Canadian Marketing Group

Note: Information contained herein has been compiled from sources believed to be reliable. While every effort has been made to ensure accuracy, this is not guaranteed. It is an express condition of the acceptance of this material that the National Research Council of Canada, the Ottawa-Carleton Economic Development Corporation and the CMG Canadian Marketing Group incur no liability.

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Table of Contents

1.0 About this Profile

This profile of the *Telecommunications and Computing Industry, Leading Companies and Related R&D Organizations* has been prepared for the Regional Innovation Forum Roundtable II through a joint effort between the National Research Council of Canada (NRC), the Ottawa-Carleton Economic Development Corporation (OCEDCO), and CMG Canadian Marketing Group (CMG).

This document provides an overview of the telecommunications and computing industries in the Ottawa-Carleton Region, and highlights the key technology segments within these industries. Nineteen technology segments have been identified and are described in this study. Emphasis was placed on identifying the key companies, R&D organizations, products and technologies in development in each of these segments.

This is the first study of its kind. Its goal is to assist regional technology executives to assess our Region's strengths and future development opportunities. Many of the leading companies' and research organizations' corporate profiles have also been included in an accompanying volume. This will assist organizations to develop business and R&D linkages, and thus capitalize on the network synergy for the continued prosperity of our Region, '*Silicon Valley North*'.

1.1 About the National Research Council Of Canada

As Canada's foremost R&D agency, the National Research Council of Canada (NRC) is positioned to be a leader in the development of an innovative knowledge-based economy through science and technology by:

- being dedicated to excellence in advancing the frontiers of scientific and technological knowledge in areas relevant to Canada,
- carrying out focused research, in collaboration with industrial, university and government partners, to develop and exploit key technologies,
- providing strategic advice and national leadership to integrate key players in Canada's system of innovation, and
- taking a more aggressive, entrepreneurial approach to ensure the transfer of our knowledge and technological achievements to Canadian-based firms.

While NRC is a national organization, it has a strong local interest and presence in many regions across Canada, linking partners from marketing, business, finance, government, and educational communities.

1.2 About the Ottawa-Carleton Economic Development Corporation

Acting as the catalyst and mentor, the Ottawa-Carleton Economic Development Corporation (OCEDCO) unites the public and private sectors to promote balanced, diverse, and sustainable economic growth within the Region. Its priorities are:

- to stimulate the growth of local businesses,
- to assist in the formation of viable new businesses,
- to attract investment, economic activity and business to the Region, and
- to build suitable partnerships.

OCEDCO focuses on matching local opportunities to venture capital, developing trade and alliance opportunities and contacts, supporting community economic development initiatives, and helping thousands of aspiring entrepreneurs.

The membership of OCEDCO includes most of the prominent companies in the Region, plus many smaller firms who support economic growth for the Metro Ottawa Region. OCEDCO also operates the Ottawa-Carleton Entrepreneurship Centre to help small business start-ups in the Region.

1.3 About the CMG Canadian Marketing Group

CMG is an Ottawa-based marketing, technology and management consulting firm with both Canadian and international experience in the telecommunications, microelectronics, computer hardware & software, advanced manufacturing industries, and government R&D sectors. Since its inception in 1990, CMG has delivered over 100 major projects in various areas including business and strategic planning, market research and analysis, and market feasibility. CMG has also organized strategic alliances and helped to obtain project and company financing. With its business and technical consultants, CMG is uniquely positioned to serve a wide variety of organizations and needs.

More information about the methodology of this study and data presented may be obtained from Peter Kallai, CMG Canadian Marketing Group, Tel: (613) 567-9406, Fax: (613) 567-9170, E-mail: pkallai@ibm.net.

2.0 The High-Tech Economy in the Ottawa-Carleton Region

2.1 The Global Perspective

Over the last decades there has been a significant increase in the importance of knowledge-based industries. In the world's leading economies more than half of the total Gross Domestic Product (GDP) is earned from knowledge-based industries according to The Organization for Economic Cooperation and Development's (OECD) report, *The Knowledge-Based Economy*, 1996. These knowledge-based industries include telecommunications, computers, software, pharmaceuticals, biotechnology, education and television. In fact, high-tech industries have almost doubled their share of the manufacturing output over the past two decades to about 25% in the leading economies. These leading economies increasingly rely on the creation, distribution and use of knowledge, information and the resulting products and services.

Throughout the globe, key geographical regions of high-tech industries have emerged, as business, government and educational institutions forged strategic linkages to increase the speed of information flow and the rate at which innovations diffuse. Some of the key technology regions in the United States include Silicon Valley in California, Route 128 in the Boston area, Dallas and Austin in Texas, Software Valley in Utah, the Baltimore-Washington Corridor, and the Multimedia Segment in San Francisco. Overseas, the "Four Motors of Europe", Montpellier Technopole, Sophia-Antipolis, Cambridge, England, and Lubeck, Germany are key regions of technology innovation. The Asian bloc has pockets of technology regions in Japan, Taiwan, South Korea, Malaysia and Australia.

Canada, one of the global leaders in technology and innovation, has several well-developed and emerging technology regions, lead by the Ottawa-Carleton Region or *Silicon Valley North.*

2.2 The Ottawa-Carleton Region's High Tech Economy

Home to approximately 700 high-technology companies involved in a diverse range of high-tech product and service groups, the Ottawa-Carleton Region manifests a synergy of innovation and technological growth. Overall, the Region produces $8 billion in high-tech revenues, $5 billion of which originates from exports. This accounts for 25% of all high-technology exports of Canada.

Several characteristics of our Region make Silicon Valley North the preeminent leader in high-technology in Canada and have yielded recognition around the world:

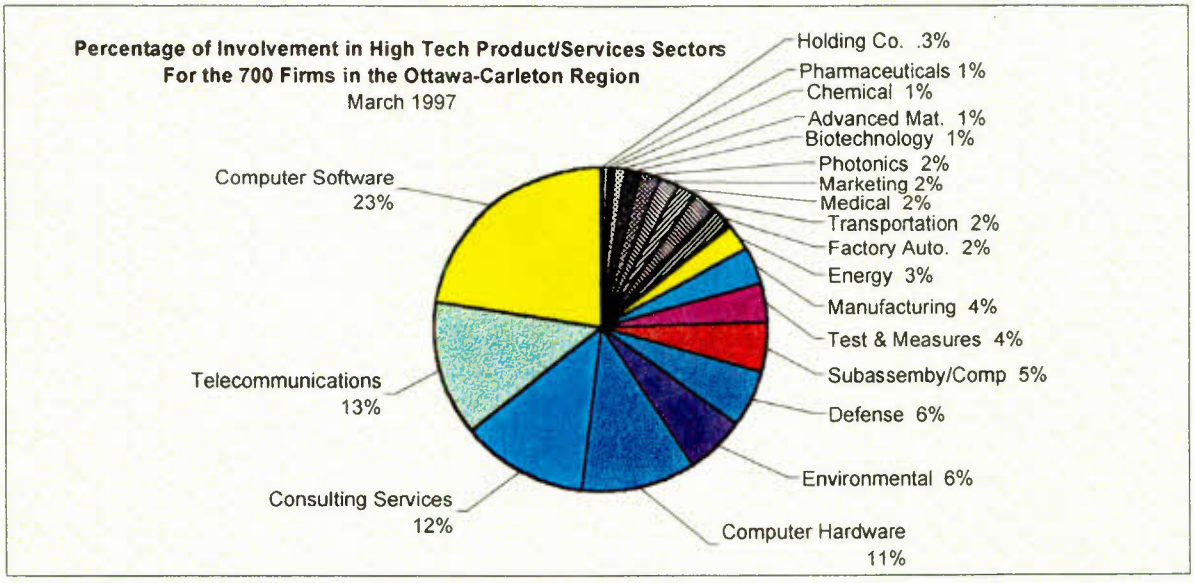
- strong linkages, both formal and informal, in terms of intellectual networking between business, governments, and educational institutions,
- an outstanding presence of entrepreneurial spirit and high-tech company startups,

- a quality of life that is rated best in the world, which attracts highly trained professionals,

- the presence of several leading universities, colleges and other organizations committed to training highly skilled individuals and promoting significant R&D initiatives, and

- a strong federal presence in science and technology infrastructure, through key federal R&D laboratories, networks, industry consortiums, and key government departments.

As the following chart illustrates, the majority of high-tech firms in the Region are in the telecommunications and computing sectors, calculated to be about 70% or 500 firms. Based on OCEDCO's major product group classification, these two industries include computer software, computer hardware, telecommunications, consulting services, defence, subassembly and components, and photonics.

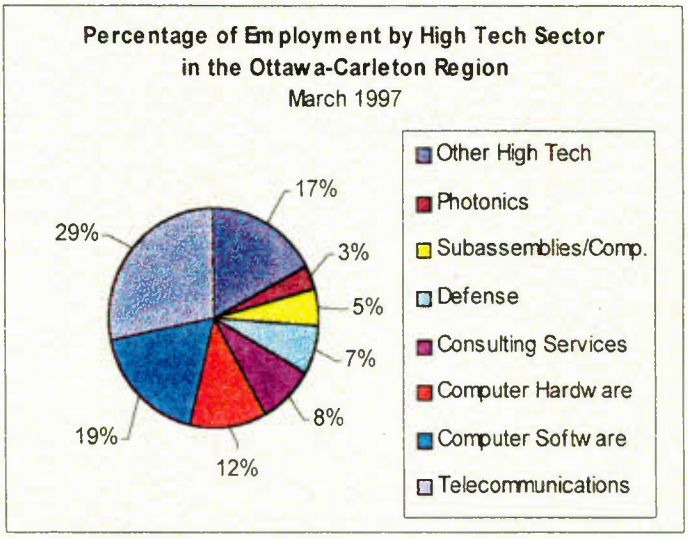


Source: OCEDCO Database

2.3 High-Tech Employment In The Ottawa-Carleton Region

The growth of the high-tech industries has been a significant source of new jobs in the Region with approximately 40,200 individuals directly employed in the various segments of the high-tech industry, according to OCEDCO's latest figures. Some estimates show that the annual employment growth in these sectors is approximately 15%. It is estimated that 100,000 workers are indirectly employed by the high-tech industry. In fact, from 1982 to 1994, the census metropolitan area of Ottawa-Hull, had the second highest overall employment growth of major cities in the country fueled by the growth of the Region's high-tech industries. A significant portion of employment is being generated by the telecommunications sector with over 12,000

direct jobs (28.8%) as shown below, followed by computer software sector with approximately 8,000 jobs (19%).



Source: OCEDCO Database

It is estimated that there are additional 2,000 high-tech jobs currently available in the telecommunications and computing sectors in the Region. Significant initiatives are currently underway by business, government, and the educational institutions to meet the increasing demand for qualified personnel. The following are some of the activities taking place:

- Companies have formed alliances to attract new talent to the Region,
- Universities, colleges and private training organizations are working closely with business to develop new training programs and facilities to meet both the qualitative and quantitative aspects of demand,
- A good example of how the Federal Government assists the Region's high-tech employment demands is the recent announcement of a pilot project for temporarily lifting certain immigration requirements for high-technology knowledge workers. This pilot will eliminate the time-consuming process that forces companies to prove that there are no Canadians qualified to fill key jobs in telecommunications, multimedia, management, consulting, product development and "imbedded" software expertise.

The following table highlights the top 20 telecommunications and computing employers in the Ottawa-Carleton Region.

Top 20 Employers in the Ottawa-Carleton Region in Computing and Telecommunications

Company	Employees
Nortel Technologies	5,500
Digital Equipment of Canada Ltd.	2,400
Newbridge Networks Corp.	1,800
Mitel Corp.	1,500
Nortel North America Components & Supply Operations	1,000
Corel Corp.	972
JDS Fitel	720
Cognos Inc.	659
Computing Devices Canada Ltd.	650
ISM Information Systems Management Corp.	600
SHL Systemhouse	550
Andersen Consulting	500
Telesat Canada	416
Gandalf Technologies Inc.	362
DMR Group Inc.	350
Spar Aerospace Ltd.	329
Oracle Corporation Canada Inc.	300
JetForm Corp.	300
Fulcrum Technologies Inc.	250
Nortel Ltd. Multimedia Network Division	250

Source: OCEDCO Database

Altogether, there are over 200 companies that employ at least 50 employees in the telecommunications and computing industry. These companies represent the core companies of our Region. There is also a significant amount of new company start-up activity, which represents an important source for new jobs.

In addition, about 15 research organizations, such as the Communications Research Center, University of Ottawa, Carleton University, NRC Institute for Information Technology and NRC Institute for Microstructural Sciences, employ close to 1,000 professionals in research and development.

2.4 Public Companies

Many of the top employers are listed on public stock exchanges such as the Toronto, Montreal, New York Stock Exchanges or the NASDAQ. The *Ottawa Citizen* publishes the *Citizen High-Tech Index*, which tracks the share price movements of 37 technology companies with extensive operations in the Ottawa-Carleton Region.

The following table provides a snapshot of the publicly traded technology companies located in the Ottawa-Carleton Region. The total revenue and assets of the public companies is $45,755.50 and $48,216.52 million dollars respectively.

Snapshot of High-Tech Publicly Traded Companies Located in the Ottawa-Carleton Region

Company	Year End	Revenue* M $	Total Assets* M $
AIT Corp.	Sept. 30, 1996	$16.3	$25.7
Bell Canada	Dec. 31, 1995	$ 8,183.4	$18,890.1
CAL Corp. (subsidiary of Electromagnetic Sciences Inc.)		N/A	N/A
Calian	Sept. 30, 1996	$47.9	$33.7
Canadian Marconi Company	Mar. 31, 1996	$251.5	$431.3
Cognos	Feb. 28, 1996	$207.6	$192.1
Computing Devices Can.Ltd. (trading Ceridian)	Jul. 1, 1996	N/A	N/A
Corel Corp. (US$)	Nov. 30, 1996	$334.2	$221.3
Digital Equipment of Canada	Jul. 1, 1996	$14,563.0	$10,075.3
DY-4 Systems Inc.	Sept. 27, 1996	$52.0	$65.2
Fulcrum Technologies	Dec. 31, 1996	$60.2	$46.3
Gandalf Technologies Inc. (US$)	Mar. 31, 1996	$116.5	$79.4
International Datacasting Corp.	Jan. 31, 1996	$ 10.1	$6.0
i-Star Internet Inc.	May 31, 1996	$19.4	$ 26.3
JDS Fitel	Mar. 31, 1996	$74.8	$ 85.9
JetForm Corporation	Apr. 30, 1996	$43.4	$45.9
Linmor Information Systems	Mar. 31, 1996	$1.0	$ 0.6
Lumonics	Dec. 31, 1996	$209.1	$186.1
Microstar Software Ltd.	Jan. 31, 1996	$2.7	$6.3
Milkyway Networks Corp.	Apr. 30, 1996	$4.3	$4.3
Mitel	Mar. 31, 1996	$576.4	$517.1
MOSAID Technologies Inc.	Apr. 30, 1996	$37.7	$44.3
Newbridge Networks Corp.	Apr. 30, 1996	$921.2	$1,093.4
Nortel Technologies (US$)	Dec. 31, 1996	$12,889.0	$10,672.1
Plaintree Systems Inc.	Mar. 31, 1996	$31.4	$28.1
Spar Aerospace	Dec 31, 1995	$544.5	$320.5
SHL Systemhouse (US$, traded MCI)	Dec. 31, 1996	$1,500.0	$1,000.0
Simware Inc.	Apr. 30, 1996	$17.7	$27.9
SR Telecom	Dec. 31, 1995	$143.1	$140.3

* *Latest fiscal year*
Source: Annual Reports

2.5 Initial Public Offerings

There has been an increasing number of Initial Public Offerings (IPOs) by companies in our Region. In fact, one of the key discussion subjects among local business leaders is the possible development of a local public stock exchange to meet the increasing capital needs of technology companies. Some of the recent IPOs included the share offerings of the following telecommunications and computing firms:

- JDS Fitel
- Linmor Information Systems
- Milkyway Networks
- Fulcrum Technologies
- JetForm
- i-Star Internet

2.6 The Entrepreneurial Spirit and Start-Up Activity

The Region's pride is the entrepreneurial spirit of our technology people. Over the last thirty years several top Canadian technology companies have emerged in our Region. In fact, many of the companies have their roots either in the National Research Council (NRC) or Bell Northern Research, the research subsidiary of Bell Canada and Northern Telecom. Examples of these top Canadian technology firms include Mitel Corporation, Newbridge Networks, Corel Corporation, and Plaintree Systems.

The presence of organizations like the NRC, with its resident world-class researchers, facilities, and services, has resulted in many spin-off companies in the Region. Since its inception in 1946, the NRC has generated or contributed to about 66 spin-off companies. Fifty-nine of these companies are still operational! A recent example is SiGe Microsystems specializing in Silicon Germanium based semiconductor and integrated circuitry design and development.

Other major sources of technology spin-offs have been Newbridge Networks and Nortel Technologies. Newbridge has spun-off or financed close to fifteen companies in our Region since the early 1990s, including CrossKeys Systems, TimeStep, WestEnd Systems, Elcombe Systems, and most recently Tundra and Televitesse. Nortel Technologies has also spun out several key product or technology groups into separate companies, including TTS Meridian and Entrust Technologies. A most recent announcement by Corel Corporation has launched Corel's spin-off activities. Corel announced that it is in the process of establishing a subsidiary corporation named Corel Computer Systems to focus on the development and marketing of Corel's current and future hardware products.

As well, several organizations in our Region aid the development of start-up companies. There are two key incubator programs for start-up companies in the telecommunications and computing industries, available at the National Research Council of Canada and the Communications Research Center. These organizations provide incubator facilities, assistance with technology development, assistance with intellectual property protection, access to facilities, technology experts, access to technologies and intellectual property.

Additional assistance is available from the Ottawa-Carleton Research Institute (OCRI), NRC Industrial Research Assistance Program and the Ottawa-Carleton Economic Development Corporation (OCEDCO). As an example, OCEDCO assists entrepreneurs through the Entrepreneurship Center and the Specific Investment Opportunity (SIO) program.

2.7 Venture Capital Investments

Information and telecommunications technologies remain in the top spot for venture capital investments. Several venture capital companies from across Canada and the U.S. have become increasingly interested in investing in Ottawa-Carleton based technology companies and as a result, Silicon Valley North has become a hub of venture capital over the last two to three years. The key venture capital firms located in the Region include:

- Capital Alliance Ventures
- Working Ventures
- Royal Bank Venture Capital Division
- Business Development Bank, Venture Capital Division

The following table highlights some of the technology companies in the telecommunications and computing sectors that obtained venture capital financing in 1995 and 1996.

Key Venture Capital Investments in Ottawa-Carleton in 95/96

Company	S*	Investment (000's)	Business
1996			
Accelerix	U	$4,000	Semiconductors
Advanced Laser & Fusion Technology	U	$400	Semiconductor fabrication equipment
Cadabra Design Libraries Inc.	X	$2,000	Software
Caravelle Networks Corp. 1995	U U	$510 $1,263	Internet watching/ network management software
Chrysalis Information Technology Security	E	$2,235	Data security (encryption)
CrossKeys Systems Corp.	X	$2,118	Network & service management products
Dipix Technologies 1995 1995	T X X	$1,000 $150 $600	Digital imaging boards and vision systems
Enterprise Planning Systems, Inc. 1995	X T	$1,020 $1,000	Intranet manufacturing groupware
Fuse Works	U	$500	Internet game platforms
Hegyi GeoTechnologies Int'l 1995	E E	$250 $500	Developer of integrated GIS/GPS systems
Linmor Technologies	X	$2,283	Network management applications
Milkyway Networks 1995	X E	$130 $2,500	Internet security software
Neuma Technology Corp.	X	$500 $250	Software- configuration management tools
New Edge Technologies Inc.	X X	$250 $500	Internet software provider
PSC Group Int'l Corp.	X	$7,200	Internetworking training
RMX Technologies Inc.	E	$2,000	Graphics publishing protocol for Internet
Showbasemedia Inc.	U	$558	Extranet database e-commerce
SFi Sylvain Paust Inc.	X	$750	Programming tools & utilities
Toi-Kinnoir Inc.	E	$1,000	Medical informatics (software & database)
West End Systems Corp.	X	$3,550	Data/telecommunications product
1995			
Cary Peripherals Inc.	X E	$500 $900	Computer peripherals
Tundra Semiconductor Corp.	X	$10,500	Development and marketing of semiconductors
Fulcrum Technologies	X	$1,281	Retrieval software for client/server applications
i-Star Internet Inc.	E	$500	Internet access

*S = Stage (U-Start-up, E- Early Stage, T-Turnaround, X-Expansion)
Source: Who's getting Venture Capital Funds, Financial Post

2.8 Research and Development

Approximately $1,088 per citizen is being spent on research and development (R&D) in the Ottawa-Carleton Region, compared to $295 in Toronto and $250 in Montreal. The Region generates $2 billion in R&D related work in telecommunications alone, which amounts to 75% of Canada's total R&D expenditure in that industry. An additional $1 billion is being spent in the Region by the other high-tech sectors on research and development.

Companies

Research and development is the engine of competitiveness for high-technology companies in the Ottawa-Carleton Region. Some of the key R&D strategies have been to achieve a critical mass, capitalize on market and technology niches, integrate R&D teams with product development, and provide direct interaction with clients. Some of the companies have also implemented either spin-off or acquisition strategies to complement their research and development and new product portfolio.

Many of the high-tech firms in the Ottawa-Carleton Region are the top Canadian R&D innovators, based on their annual R&D spending. The following highlights those companies that are among the top 100 R&D innovators in Canada.

Top Canadian R&D Companies In The Ottawa-Carleton Region

(Amounts In 000's)

1995 Rank	1994 Rank	Company	R&D $ 1995	R&D $ 1994	Change (%)	Revenue 1995	R&D as a % of Revenue
1	1	Nortel Technologies	$2,332,050	$1,727,360	35.01	$14,648,000	15.92
11	17	Newbridge Networks	$91,397	$58,550	56.1	$800,523	11.42
19	9	Bell Canada	$58,000	$102,700	-43.52	$8,183,400	0.71
27	22	Mitel Corp.	$42,500	$37,300	13.94	$588,800	7.22
29	26	Spar Aerospace Ltd.	$40,100	$35,300	13.6	$594,485	6.75
32	57	Corel Corporation	$37,375	$17,243	116.75	$269,550	13.87
43	29	Canadian Marconi Co.	$27,009	$32,070	-15.78	$261,676	10.32
51	49	Cognos Inc.	$23,058	$20,363	13.23	$168,100	13.71
69	54	Gandalf Technologies	$13,900	$18,650	-25.47	$164,600	8.44
79	83	SR Telecom	$11.500	$9.900	16.5	$143,100	8
88	N/A	Lumonics Inc.	$10,200	$7,800	30.5	$171,900	5.9

Source: Research Money Exclusive Report, Canadian Corporate R&D Directory Database, Canada's Top 100 Corporate R&D Spenders

Typically, the larger high-technology firms in our Region spend on average 8-12% of their revenues on R&D, while some of the more R&D intensive companies spend a somewhat higher portion of their sales revenues on research and development. As an example, Nortel Technologies spends between 13 and 14 per cent of sales revenue on research and development.

Research Organizations

Several world renowned research organizations aid the development of new technologies in our Region. These leading research organizations, laboratories, and consortiums in the computing and the telecommunications sectors in the Region include the following organizations.

Educational Institutions	
Algonquin College	The College is dedicated to be the 'trainer of choice' through the Centres of Excellence such as the Media Centre and the Telecommunications Centre.
Carleton University	The University is actively involved with the Region's telecom and computing companies in areas such as wireless communications, parallel computing applications, electronics, and software development.
University of Ottawa	The University is committed to being the leading edge for computer training through the School of Information Technology and Engineering (SITE).
Laboratories	
Communications Research Centre	The Centre is conducting leading edge R&D to develop the Canadian Communications infrastructure and to support Canadian telecommunications firms in their efforts to remain globally competitive. Supported by a professional staff of 250 with an operating budget of $ 91.4 M (95-96).
Defence Research Establishment Ottawa	The Establishments carries out various technological thrusts related to the needs, present and future, of the Canadian Armed Forces, supported by a professional staff of 120 with an operating budget of $ 24.2 M (96-97).
NRC Institute for Information Technology	NRC IIT is dedicated to the R&D development in software and systems technologies, supported by an operating budget of $ 8.3 M (96-97) and a professional staff of 75.
NRC Institute for Microstructural Sciences	NRC IMS' goal is to help keep Canada at the leading edge of the technologies that enable the information revolution, supported by an operating budget of $ 12.1 M (96-97) and a professional staff of 125.
Facilitators Of R&D	
Canadian Foundation for Innovation	The Foundation was created February 1997 to provide integrated, accessible pathways to information and services relevant to small and medium size enterprises using technology. An $ 800 M endowment distributed over the next five years geared to bolstering the research infrastructure.
CANARIE Inc.	The Canadian Network for the Advancement of Research, Industry and Education is an industry led and managed consortium created in 1993 by the federal government and private sector to collaborate in stimulating the development of the information highway. Over its full seven year program CANARIE could generate over $ 1 B in economic benefits.
OPCOM	The Optical Processing and Computing Consortium of Canada is an alliance between Canadian industry and government research laboratories to accelerate the development of competitive applications in optoelectronic systems, supported by a $ 20 M budget over five years.
Ottawa-Carleton Research Institute (OCRI)	OCRI's mission is to foster interaction among people from educational institutions, government and industry to enhance the effectiveness of R&D, increase the resources available for R&D, and promote the development of the regions' high technology sector. Supported by a professional staff of 12 with an operating budget of $ 2.8 M (96-97).
PRECARN Associates	PRECARN is a 35 member owned industrial consortium conducting R&D in intelligent systems and robotics supported by a. professional staff of 12 with an operating budget of $ 1.85 M (96-97).
Strategic Microelectronics Consortium	SMC is a national industry association dedicated to accelerating the sustainable growth and development of microelectronics in Canada.
Telecommunications Research Institute of Ontario	TRIO is a telecommunications leader in identifying and communicating business opportunities and future trends to enhance the technological competitiveness of Canadian companies through university partnerships in focused and shared research programs. Annual funded research reaches $ 5 M.

In this volume over 60 company and R&D organization profiles have been compiled to highlight their products, services, technologies, and research and development activities taking place in the Region.

The following pages of the report highlight the 19 key technology segments of the Ottawa-Carleton Region's telecommunications and computing industries

3.0 Industry Technology Segments

3.1 Key Technology Segments in the Ottawa-Carleton Region

This study has identified 19 technology segments with significant presence in the Ottawa-Carleton Region. This segmentation was prepared based on publicly available information on the companies and research organizations in our Region, including corporate profiles, annual reports, directory listing, and other relevant articles and materials.

In order to organize the technology segments into a manageable number, segments have been grouped according to related technologies. Although some may disagree with the grouping of these segments or may have defined the segments differently, the decision to have a finite number of key technology segments has a number of benefits. These benefits include the following:

- companies may look at the complementary nature of their businesses and develop further business and technology linkages;
- companies and R&D organizations may review the level of activity in a particular segment and implement strategies for future technology development, such as the creation of R&D consortiums;
- economic development organizations and government agencies may promote our Region to technology specific industry groups abroad;
- industry and government may implement technology specific economic development strategies and investments;
- educational institutions may develop technology specific training programs that meet the human resource requirements of industry.

This study is the first of its kind in the Ottawa-Carleton Region and therefore, it is limited to a preliminary survey. It is the goal of the authors, the NRC Regional Innovation Office for the National Capital Region in cooperation with OCEDCO, to solicit feedback on this study and to implement a more comprehensive data collection in the future that will allow for an enhanced in-depth analysis of the segments. Consequently, this study is best viewed from the perspective of being the 'first step' in the analysis presenting an inventory of the Region's technology segments and their strengths.

For each of the 19 segments, the report provides a general overview of the segment, identifies the key companies, products and technologies, and describes the research and development areas. At this stage there has been no attempt to provide a more in-depth analysis of these segments, such as industry/market growth rates, overall size of the local industry, etc. As indicated above, this type of analysis may be implemented at a later stage after an in-depth survey of the organizations.

We are, however, providing a first level analysis on the relative importance of these segments. This analysis involved judgements that were based on the background research as opposed to detailed, homogenous survey data. This analysis is offered to the reader with the understanding of its limitations, and is intended to provide a point of departure for any future strategic analysis of these industries. The following are the key technology segments identified in this study.

Key Technology Segments in the Ottawa-Carleton Region in Telecommunications & Computing

I. Technology Building Blocks

1? Fiber Optics and Optoelectronics
2? Integrated Circuits, Boards and Components
3? Broadcasting Equipment and Services
4? Computer and Peripherals Manufacturing
5? Telecommunications Equipment

II. Systems Development and Management

1? Land-based Wireless Communication Systems
2? Fixed and Mobile Satellite Systems
3? Telecommunication and Network Management Systems
4? Defence Command and Control Systems
5? Enterprise/End User Communication Systems
6? Network Security Products
7? Robotics and Intelligent Systems
8? Visual Information Systems
9? Systems Integrators and Technology Consulting Services
10? Internet/Intranet Service Providers

III. Systems and Development Tools

1? Internet/Intranet Software Tools and Products
2? Software Application Development Tools and Databases

IV. Applications

1? Multimedia Products and Services
2? Corporate Software Applications

Sections 4,5,6 and 7 of this report describe these technology segments in more detail. It must be noted here that two additional technology segments are not covered in detail in this report, since research have only showed one or two organizations in these segments. These segments are the following:

- Operating Systems – the only company in this segment is QNX Software Systems that develops the QNX Operating Systems, and

- Telecommunications Service Providers – with two leading Canadian organizations Bell Canada and Stentor Network Management.

3.2 The Relative Importance Of Each Technology Segment [1]

Perhaps the most interesting question, once the technology segments are identified, is the relative importance of each segment. We have selected the following variables to analyze the importance of the technology segments.

- Local Industry Strengths
- Local Industry Growth
- Local R&D Investments
- Global Industry Growth
- Global Industry Size

Since there was limited data available for these variables, only a comparative ranking is presented in graphical format in the following pages. While this ranking does not provide information on the relative distances of the industry segments from each other, it does classify the various technology segments and positions them in the four quadrants of each graph. The following three graphs show the results of this analysis.

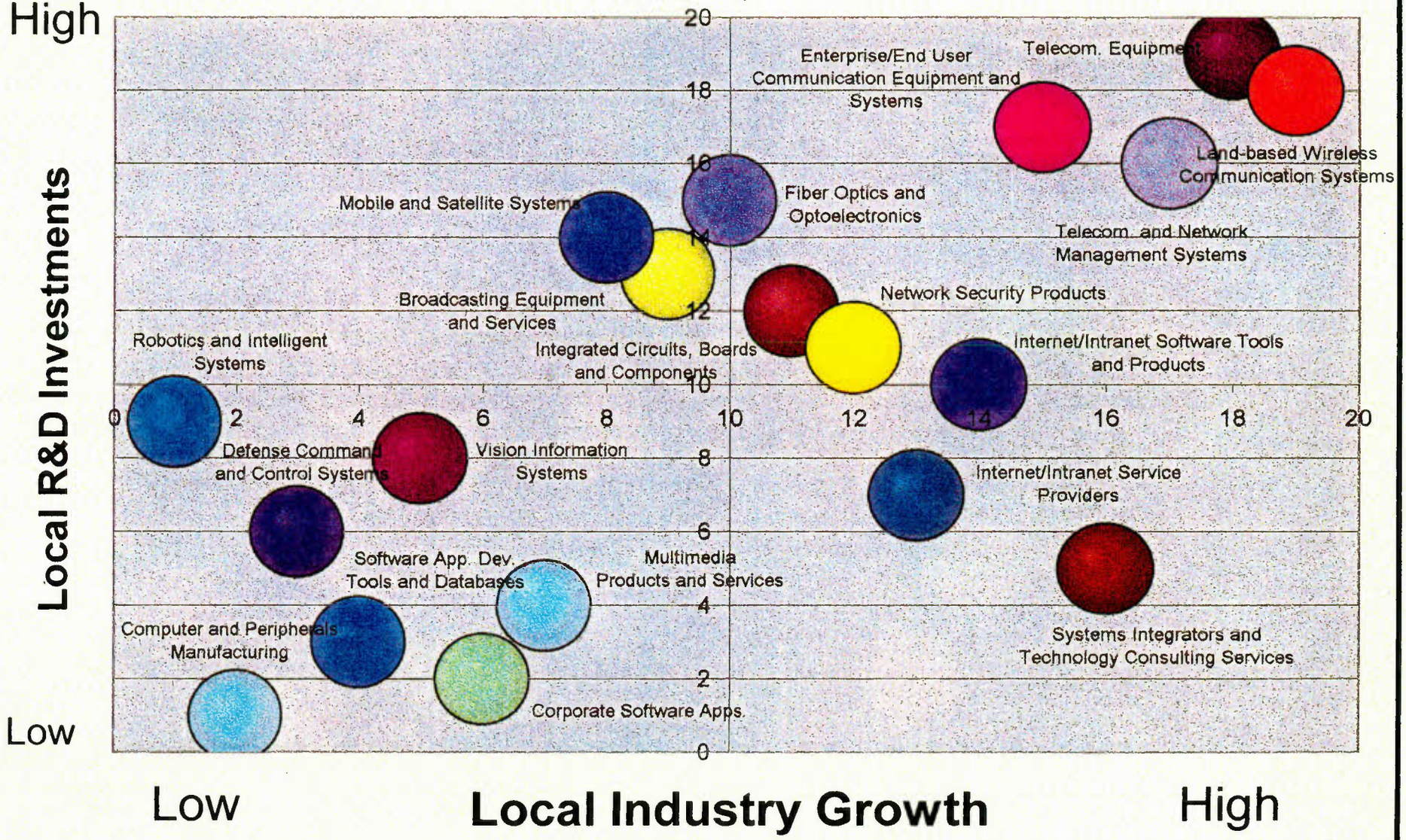
Decision-makers in technology companies and research organizations may use this preliminary information as a framework for making strategic decisions on corporate and research and development investments.

Note 1

As mentioned in the introduction to this chapter the following analysis involved certain judgements, since appropriate and consistent data was not available for each of the defined technology segments and to a certain extent represents CMG's view on the technology segments. Therefore, this analysis is offered as a framework for future analysis of the strengths of the telecommunications and software industries in the Ottawa-Carleton Region. It is the goal of the authors and the NRC Regional Innovation Office for the National Capital Region that this analysis be further refined through additional data collection.

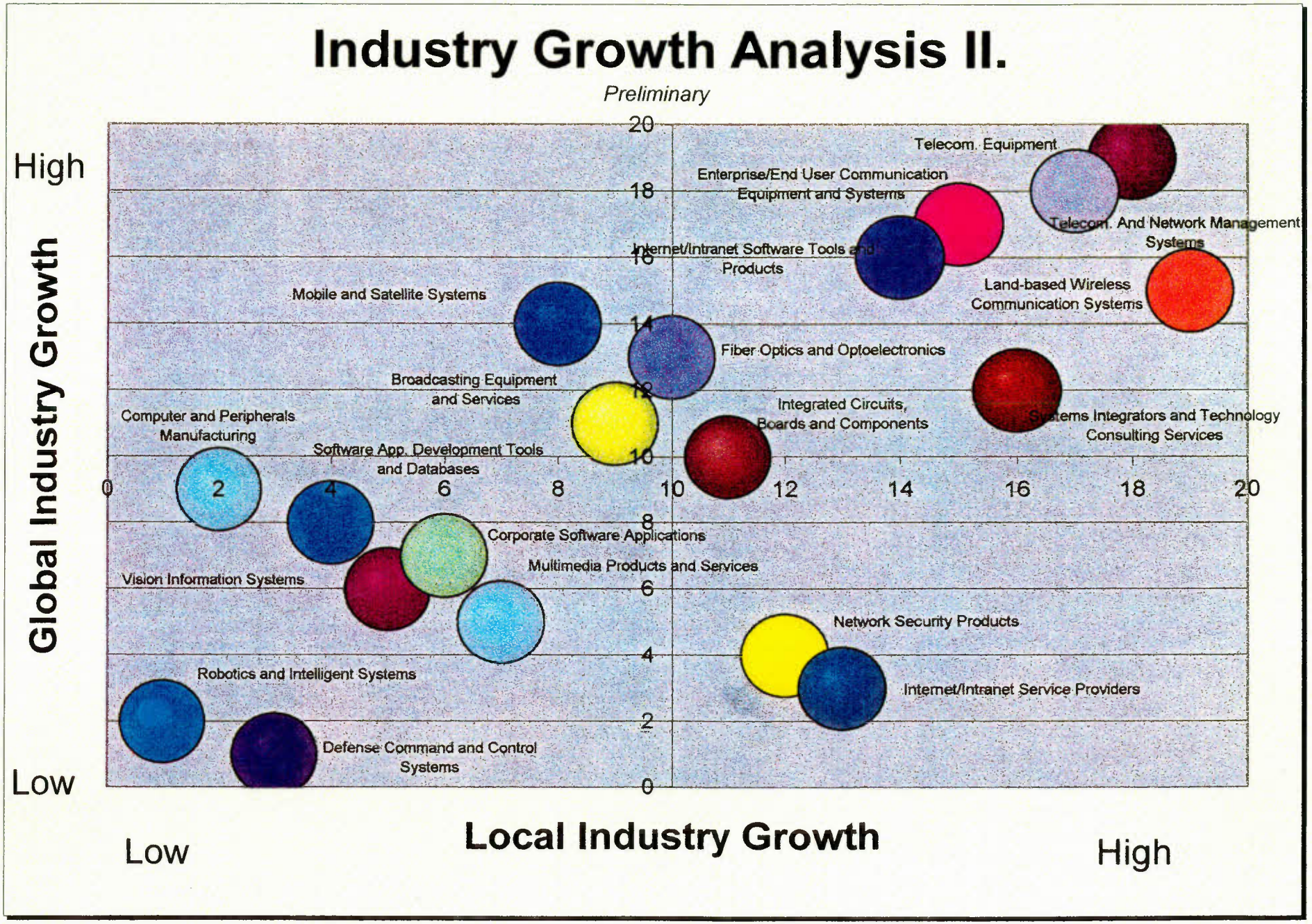
Industry Growth Analysis I.

Preliminary



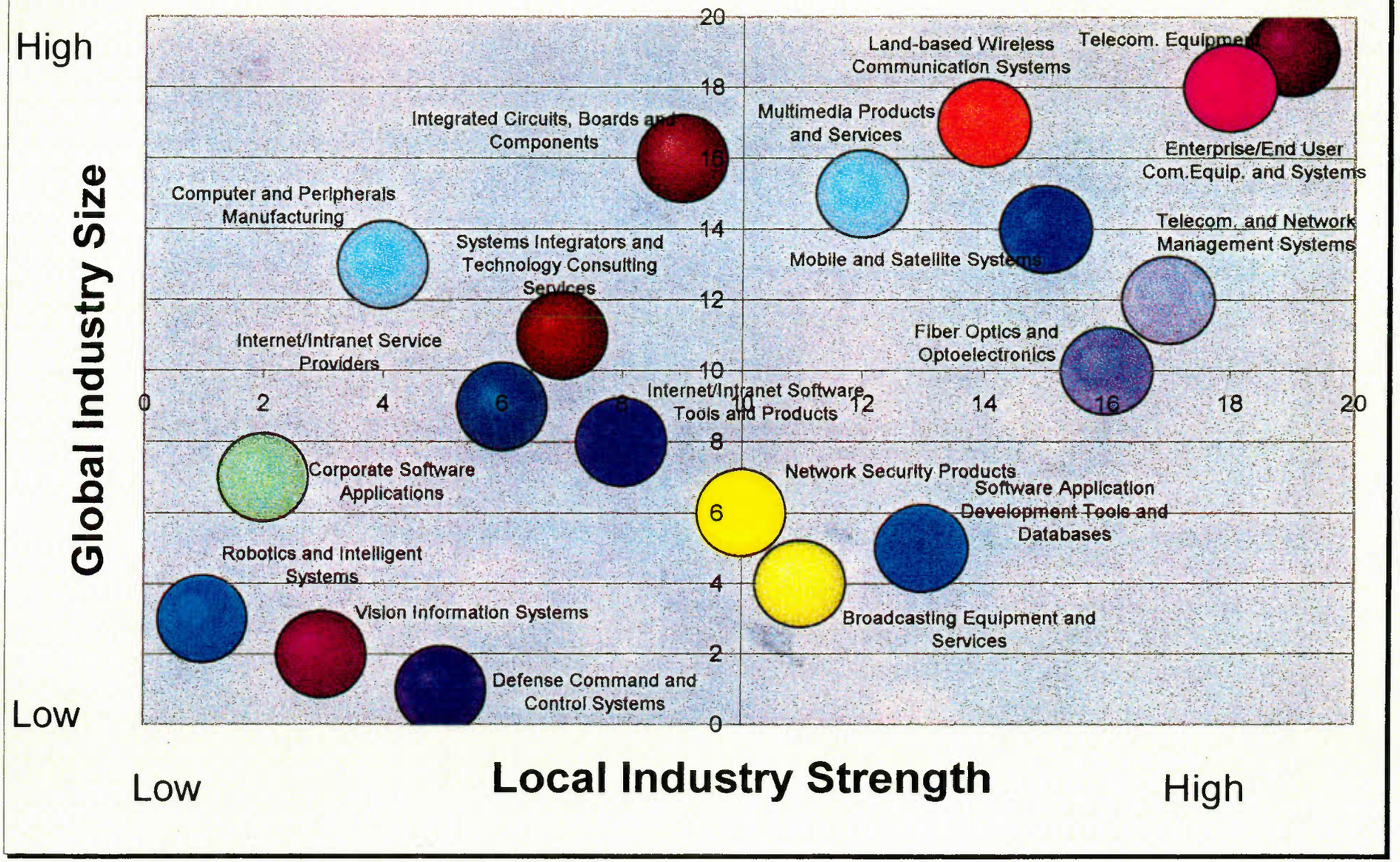
Industry Growth Analysis II.

Preliminary



Industry Strength-Size Analysis

Preliminary



4.0 Technology Building Blocks

Most technology-based products are composed of subsystems and components that are combined and assembled to make up a final product that, in turn, meets an end-user need. These components include semiconductors, integrated circuits, fiber optic devices, etc. and each one is a technological product in its own right.

This first segment group includes all the technology segments whose products and services act as building blocks for other, more complex products. Each technology segment which has built a significant presence in the Ottawa-Carleton Region is highlighted in a separate section in this chapter. The segments identified as building blocks are fiber optics and optoelectronics, integrated circuits, boards and components, broadcasting equipment and services, computers and peripherals, and telecommunications equipment.

4.1 Fiber Optics and Optoelectronics

Overview

Fiber optic transmission is having a major impact on every area of communications technology. Fiber optics can handle voice and data traffic at many gigabits per second, whereas its traditional copper-pair counterpart can transmit just a few megabits per second. It has revolutionized long distance telephony and is assuming a wider role in applications as diverse as local area networks and television transmission. Many high technology companies depend on fiber optic and optoelectronic products for the connection of networks and telecommunication systems. Deregulation of the telecommunication services industry and demand for new services has created a need for more network carrying capacity or bandwidth. In response, fiber optics is a technology that is being introduced and improved to satisfy this need.

Similar demand is also seen in the optoelectronic industry. Optoelectronic products have been in demand over the last few years with the increased development of fiber optic transmission, switching in control and measurement systems, laser-based technologies in manufacturing, and space programs. An estimated 16 million miles of fiber is currently installed in the US. This number is expected to grow rapidly in response to customer demands for faster networks, which incorporate a combination of fiber optic and optoelectronic components.

Most telecommunication companies expect to complete the conversion from copper to fully fiber optic systems by the year 2015. The market for telecommunication systems that make more effective use of fiber optics, e.g. Synchronous Optical Network (SONET) and Wavelength Division Multiplexing (WDM), is expected to reach $10 billion by the year 2005. Most of the production of fiber optic and opto-electronic products in the Ottawa-Carleton region comes from the following companies.

Key Companies

Company Name	Employees	Sales M $	Main Product /Service
Consolidated Communications Inc.	80	$18.0	Provides fiber optic cabling services
Fitel-Photomatrix	75		Develops unique optical systems, which allows additional channels to be added to fully used fiber cables.
JDS Fitel	720	$74.8	Designs, manufactures and supports fiber optic components
Lumonics Inc.	200	$209.1	Designs, manufactures and markets laser-based advanced manufacturing systems
Mitel Corporation	1,500	$576.4	Designs, manufactures and markets optoelectronic devices
Nortel Technologies (US$)	5,500	$12,889.0	Designs and develops fiber optic networks, multiplexers and optoelectronic solutions
Optotek Ltd.	20		Designs and manufactures opto-electronic components and subsystems
Oz Optics Limited	25	$5.0	Manufactures fiber optic components and educational kits for training purposes
Prestec Electronics Limited	90		Manufactures fiber optic and data patch cords
Spar Aerospace Limited	329	$544.5	Designs and manufactures electro-optic systems

Technology and Product Highlight

The key companies in the production of fiber optic products and components are Nortel, JDS Fitel and Oz Optics Limited. Nortel and JDS offer a complete line of over 100 different products and components. The key companies in optoelectronics are Spar Aerospace and Optotek. Fiber optic products and services include: fiber optic components manufacturing (e.g. laser diode drivers, controllers, polarizers, and reflectors), high speed data and fiber optic patch cords and PCB assembly, optical connector assemblies and polishing equipment, and fiber optic cable design, testing, installation and maintenance services.

Opto\electronic systems include: opto\electronic components (e.g. LED displays and associated drive electronics), laser-based manufacturing systems (e.g. marking, cutting, drilling, and packaging opto\electronic devices), and robotic applications to image and accurately map in 3D in unstructured environments. Other products manufactured by companies in this technology segment include: fiber optics components and test instrumentation, optical switches, wavelength division multiplexers, and environmental test systems for fiber optic devices, passive optical components for telecommunications and CATV industry, optical return loss measurement test equipment, and optical connectors.

Research and Development

Research and development activities from these companies include the development of higher precision fiber optic technology at a lower manufacturing cost and better quality.

In addition, the following key research organizations are involved in the research and development of fiber optic and opto-electronic technologies: Algonquin College, Carleton University, Communications Research Center, Information Technology Research Center, NRC Institute for Information Technology, NRC Institute for Microstructural Sciences, Optical Processing and Computing Consortium of Canada, Strategic Microelectronics Consortium, Telecommunications Research Institute of Ontario.

Research and development projects include: A 50 GHz analog microwave fiber optic link, artificial retina, optical correlators, and optical storage systems, design, modeling, fabrication and simulation of optoelectronic devices, high-frequency optoelectronic receiver for wireless LANs, high-performance optoelectronic integrated circuits, modeling and system simulation for fiber optic communication networks, multi-wave length optical networks, optical back-plane technology based on laser and detector arrays, parallel optical links, photosensitivity phenomena in optical fibers, rare-earth-doped fiber amplifiers and lasers, and telecommunications cabling.

4.2 Integrated Circuits, Boards and Components

Overview

Semiconductors, including microprocessors, micro-controllers, memory and specialized logic chips, are the building blocks of all electronics. Fueled by the demand of personal computer and telecommunications growth, the semiconductor industry has grown steadily since 1985 and particularly fast since 1992, with annual growth exceeding 30 percent. Today's market is about $200 billion. The global semiconductor industry growth is projected to be $350 billion by the year 2000.

Since about 80% of semiconductor and components used by Canadian companies are imported, the potential growth for Canadian companies in this segment is very high.

The products and services provided by companies in this technology segment can be grouped into three categories: design and manufacturing of circuits, design and manufacturing of components, and consulting services. The following table presents the key companies involved in this industry technology segment.

Key Companies

Company Name	Employees	Sales M $	Main Product /Service
Chipworks Inc.	50	$1.7	Consulting services including technical analysis of semiconductors
Chrysalis-ITS	20		Manufactures integrated circuit cards
Circtronics (Division of Gandalf)	28		Manufactures double-sided and multi-layer circuit boards
CompAS-Epitek Microelectronic Division	74		Designs and manufactures hybrid circuits and multi-chip modules
Filtran Microcircuits Inc.	42	$2.8	Designs and manufactures high resolution circuits
LSI Logic Corporation of Canada Inc.	16		Manufactures application and customer-specific integrated circuits
Mitel Corporation Semiconductor Division	116		Designs and manufactures integrated circuits and microelectronic components
Mosaid Technologies Inc.	162	$37.7	Designs and manufactures advanced memory integrated circuits and memory test systems
MPC Circuits Inc.	40	$6.0	Manufactures multi-side and multi-layer circuit boards
Nortel North America Components & Supply Operations	1000		Develops semiconductor production processes and uses these processes for the fabrication of custom microchips to be used In Nortel products.
Optotek Ltd.	20		Designs and manufactures semiconductor components
Prism Printed Circuits Inc.	20		Manufactures multi-side and multi-layer circuit boards
Quadrillion Corporation	7		Designed and developed a software package that identifies the causes of yield problems in semiconductor fabrication
Semiconductor Insights Inc.	95		Consulting and lab services for circuit, process and structural analysis of state-of-the-art semiconductor devices
SiGe Microsystems Inc.	10	$0.5	Designs and manufactures enhanced integrated circuits
Tundra Semiconductor Corporation	50		Designs, develops and supports bus-bridging semiconductors for embedded systems
Unicad Inc.	37	$6.0	Designs and develops software tools to shorten the design cycle of printed circuit boards

Technology and Product Highlight

These companies develop products for different applications including, telecommunications, military, enterprise-wide network security, embedded systems, satellite, aerospace, personal communication systems (PCS), automotive, navigation and air traffic control. In the category of manufacturers of circuit boards the key products include multi-sided and multi-layered circuit boards, and the key companies are Nortel, Filtran, Mitel, CompAS-Epitek and MPC. In the category of silicon components manufacturing the key products are memory chips, application specific integrated circuits (ASIC) and bus-bridge semiconductors. The key companies in this category are Mosaid and Tundra. Lastly, in the category of consulting products and services, the key service is the design of software tools that help to shorten circuit board design. The key companies are Semiconductor Insights and Unicad. Other services offered by companies in this technology segment include plating, blind hole sputtering, high-precision photolithography, and circuit assembly.

Research and Development

The above mentioned organizations' research and development activities include the development of automated tools that will quickly and clearly image sub-micron features in an integrated circuit, speeding the extraction of the circuit design information and the microstructural and process information, development of integrated circuits utilizing SiGe wafer technologies for RF and wireless communications markets. Key organizations in research and development area are Filtran, Mitel, Nortel, and Tundra.

The Ottawa-Carleton Region has been traditionally strong in microelectronics related research and development. The key research organizations in this area include Algonquin College, Carleton University, the Communications Research Center, the Information Technology Research Center, NRC Institute for Microstructural Sciences, Ottawa Carleton Research Institute and the Strategic Microelectronics Consortium. These organizations' R&D activities focus include advanced large-scale optimization approaches to solve VLSI circuit layout problems, high speed integrated circuits, micropower CMOS circuits for personal communications applications, modeling and design of advanced bipolar transistor devices and chips, parallel computing, and surface mount technology of silicon components and processor technology.

4.2 Broadcasting Equipment and Services

Overview

As more information becomes readily available within industry specific databases, the demand for faster, real-time data distribution grows. High-speed, point-to-multipoint, satellite data and audio broadcasting are in growing demand. Although data network broadcasting systems can work with either cable or satellite systems, satellite-based applications will experience increased demand in the next few years due mainly to deregulation and advances in satellite technology.

With the introduction of the CD format of music reproduction and distribution in the late 1980s, a significant demand emerged for the upgrade of radio broadcasting to the use of digital technology. This segment is formed by six companies that provide radio, data and TV broadcast products and services. The broadcasting products and services are grouped into products and services for music and data. Buyers of these products and services are mainly music, weather and news network operators around the world.

Key Companies

Company Name	Employees	Sales M $	Main Product /Service
Artech	65		Designs a real time internet broadcast software product
International Datacasting Corporation	54	$10.1	Designs, manufactures and markets digital transmission networks & services for the radio/data broadcast industries
Norpak Corporation	25		Designs, manufactures and markets TV data broadcast products, systems and software for data transmission
Nortel (US$)	5,500	$12,889.0	Designs and manufactures broadband technology products and systems
Rohde & Schwarz Canada Inc.	30		Designs, manufactures and markets FM and TV broadcasting equipment
Televitesse Systems Incorporated	55		Designs and develops intelligent, digital news alerting software

Technology and Product Highlight

The key products belong to International Datacasting Corporation (IDC), and Norpak. IDC's products focus on digital audio, multimedia, and data broadcasting products and software. They include multi-port satellite receivers and multimedia specialized systems. Norpak's products focus on TV data encoders, receivers, bridges, and system-level applications software. They include a system that enables the scheduled gathering and distribution of Internet content allowing users to access and browse the content at any time using any standard Internet browser without tying up a phone line. Other products manufactured by companies in this technology segment include: real time Internet broadcast software, RF modems, digital circuits, embedded firmware, and TV data encoders, receivers, bridges, software and internet distribution systems.

Research and Development

The key company involved in research and development is IDC. It focuses on the development of products such as data network broadcast software products and single-board designed data receivers. Additionally, the Communications Research Center is involved in the research and development of broadcasting technology. Research and development projects include the development of broadcast technologies, digital radio broadcast standards, digital television system standards development, and the standardization of a digital audio radio system.

4.4 Computer and Peripherals Manufacturing

Overview

Computer hardware production revolves around the assembly of components imported from the US and Southeast Asian countries. A lack of a significant native semiconductor manufacturing industry (as opposed to semiconductor design) in Canada will continue to limit the services and products the companies can offer to value-added product and service areas in this technology segment.

Computer manufacturing and assembly is a saturated and low margin market. Competing in export markets is difficult, particularly when competing against low cost personal computer manufacturers from Taiwan and Thailand. Therefore, many Canadian manufacturers have focused their activities towards the fast-growing peripherals and component technologies, such as imaging and data communications, rather than on computer hardware assembly.

There is a significant regional market for companies in this technology segment. This demand is driven mainly by the Federal Government Departments' requirements for advanced microcomputer and computer servers. Sales of servers, particularly Unix-based units, will strengthen as Federal government organizations continue to migrate away from mainframe and continue to invest in greater connectivity and Internet access.

The following table highlights those few key companies that manufacture computer systems and peripherals in the Ottawa Carleton Region.

Key Companies

Company Name	Emplo-yees	Sales M $	Main Product /Service
Cemtech Ltd.	30	$50.0	Large scale computers and storage devices
Digital Equipment of Canada	2400	$14,563.0	Designs and manufactures computer systems and peripherals
DY 4 Systems Inc.	185	$52.0	Designs and manufactures high-end VME open architecture ruggedized computer systems for military and aerospace applications
Eurocom Ltd.	20		Manufactures and markets high-end laptop computers
Hardware Canada Computing	30	$8.0	Manufactures computers
Imapro Corporation	25		Research and engineering of high-resolution digital color scanners, workstations and output devices
Northern Micro Inc.	60		Manufactures personal computers and servers
ProComputer Systems	24		Manufactures microcomputers

Technology and Product Highlight

The key products include personal computers and servers, peripherals, and scanners. The most significant company in this segment is Digital Equipment. Digital is the largest Canadian personal computer manufacturer with $2 billion in annual exports from its Kanata plant. Its main products are client/server solutions, including its 64-bit Alpha microchip based workstations and servers. Imapro has several world-class peripheral products including high-end scanners and PC based image recorders. Eurocom, a relatively small manufacturer of laptop computers, has received considerable international recognition for its leading, high-end 200MHz laptop computer.

Research and Development

Research and development activities in this segment focus on enhancing PC and server designs. This is led by Digital Canada. Its activities revolve around building partnerships with other industry leaders and the continuous development of fast and reliable computer systems. Internet servers are among one of the latest results of Digital's research and development activities. Additional R&D activities focus on the design and development of image input hardware by Imapro.

4.5 Telecommunication Equipment

Overview

Telecommunications equipment manufacturers develop products that enable telecommunications service providers to transport voice, data and image over the telephone lines. In addition to the traditional telecommunications services and networks, more and more organizations are building their own private enterprise-wide networks consisting of PCs, workstations and servers communicating via local-area networks (LAN), metropolitan-area networks (MAN) and wide-area networks (WAN). Similarly to service providers' networks these Networks have a variety of components including, transmission equipment, bridges, switches and routers that are assembled to provide seamless connection.

Current market estimates show that the telecommunications service providers plan to spend approximately $275 billion on telecommunications equipment worldwide in 1998. This market is currently growing at a 5% rate, which is expected to accelerate to approximately 15% beyond the Year 2000. Led by Nortel, Mitel and Newbridge, the telecommunication equipment segment is highly competitive and has established a strong presence in international markets.

Market estimates show that sales of networking products will continue to increase during the next few years as more companies require information to be shared between geographically separated users. It is anticipated that this growth will be fueled by telecommunications service providers in the U.S. and in countries in Eastern Europe, Asia and Latin America as the state-owned and recently privatized service providers invest in upgrading their communications infrastructures. In terms of corporate networking markets, it is anticipated that switching will become a more common method of building enterprise networks, and routing will be integrated into other devices. The following table highlights those key companies that make up this technology segment in the Ottawa-Carleton Region.

Key Companies

Company Name	Employees	Sales M $	Main Product /Service
Gandalf Technologies Inc. (US$)	362	$116.5	Supplies remote access products, data switches, modems (ISDN solutions)
Mitel Corporation	1,500	$576.4	Supplier of public switching equipment
Newbridge Networks Corporation	1,800	$921.2	Designs, manufactures and markets ATM, Frame Relay switches, transmission equipment
Nortel Technologies (US$)	5,500	$12,889.0	Designs and manufactures digital switching products and transmission equipment
Plaintree Systems Inc.	135	$31.4	Develops and manufactures LAN Ethernet switches

Technology and Product Highlight

This segment includes multiple hardware products including Asynchronous Transfer Mode (ATM), Frame Relay, X.25, Statistical Multiplexers, Time Division Multiplexers, Ethernet, Fast Ethernet, Gigabit Ethernet, switched Ethernet, Fiber Distributed Data Interface (FDDI) Token Ring and switched Token Ring.

The hottest telecommunications technologies include Asynchronous Transfer Mode (ATM), Frame Relay, Fast Ethernet, and Fiber Distributed Data Interface (FDDI). The leading companies in these areas are Newbridge Networks and Nortel Technologies, which are also recognized among the top telecommunications equipment companies worldwide. A smaller niche player with cutting edge technology is Plaintree Systems. Plaintree's products serve primarily the LAN Fast Ethernet switching and connectivity markets. Ethernet accounts for almost 80% of the LAN connectivity market today.

Research and Development

World leading research and development activities are taking place in this area in our Region led by Nortel Technologies and Newbridge Networks. Both of these companies conduct wide ranging R&D activities, including the development of switching equipment that targets the unprecedented terabit speed, new generation of ATM switches and new transmission technologies. As one of the most recent developments, Siemens AG of Germany and Newbridge Networks have signed an R&D collaboration agreement for the joint development of the above mentioned new generation of ATM switches, which has resulted in Siemens opening its Siemens Telecom Innovation Center in the Ottawa-Carleton Region.

Several research organizations conduct research and development that support the development of new generations of telecommunications and networking equipment. These include Information Technology Research, Telecommunications Research Institute of Ontario, Canadian Telecommunications Research Institute, the Communications Research Center and the Ottawa-Carleton Research Institute. Research activities of these organizations include broadband communications, broadband networking infrastructure, ATM network resources management architecture and interconnection of wireless and wired ATM-based networks.

5.0 Systems Development and Management

This segment group includes computing and communications network architectures, network development and network management highlighting those system development activities that have built up significant presence in the Ottawa-Carleton Region. These technology segments include a number of 'generic' telecommunications systems technologies and a set of 'specialized' systems technology segments.

The generic technology segments include land-based wireless communications systems, fixed and mobile satellite systems, telecommunications and network management, enterprise/end user communications systems, network security, robotics and intelligent systems, systems integrators and technology consulting segment and the Internetlintranet service providers' segment.

The specialized systems development and management segments include the visual information systems segment and the defence command and control systems technology segment.

As mentioned earlier, there are two additional technology segments that are not covered in detail in this report that would belong to this chapter. In these two technology segments the research have only showed one or two organizations. Therefore, no separate sections have been established for these two technology segments. These segments are the following:

- Operating Systems – the only company in this segment is QNX Software Systems that develops the QNX Operating Systems, and
- Telecommunications Service Providers – two leading Canadian organizations Bell Canada and Stentor Network Management form this segment.

5.1 Land-based Wireless Communication Systems

Overview

This technology segment includes radar, radio, paging and cellular-based wireless communication systems.

Today, most wireless communication needs are served by cellular, land-based equipment. Demand for wireless communications services is accelerating worldwide. As an example, by the end of 1997, Canada's total cellular subscriber base is expected to top four million users. This means that very sixth person is equipped with cellular phone. The majority of North American cellular systems use an analog technology known as the Advanced Mobile Phone System (AMPS). As analog (AMPS) cellular systems approaching capacity, cellular operators plan to migrate to digital systems using Time Division Multiple Access (TDMA). This represents a

significant market worldwide for digital wireless telecommunications equipment and technologies. It is estimated that the TDMA market can reach $100 billion dollars in the next 5 years.

With respect to radio, the market for Expanded Specialized Mobile Radio (ESMR) is expected to grow steadily. ESMR completely remodels the old concepts or radio-dispatch systems in use since the 1970s. The applications of radar and radio revolve around surface transportation, air, marine traffic control communications systems and supervisory control and data acquisition for the natural resources industries.

Key Companies

Company Name	Employees	Sales M $	Main Product /Service
Atlantis Scientific Systems Group Inc.	35		Provision of radar signal simulation and analysis, and microwave hardware and data acquisition
Audor Communications Inc.	25	$4.0	Manufactures radio/telephone patching, radio/antenna switching systems and VHF direction finders
CAL Corporation	185		Designs and manufactures antennas and microwave systems
Canadian Marconi Company	250	$251.5	Manufacturing of tactical radios, antenna signal processing and airborne radar products
Galdalf Technologies (US$)	362	$116.5	Manufactures wireless PBXs
Nortel Technologies (US$)	5,500	$12,889.0	Designs and manufactures digital cellular, fixed radio technology and wireless access networks
SR Telecom		$143.1	Point to Multi-point, Time Division Multiple Access (TDMA) digital microwave systems
TTS Meridian Systems			Provides wireless solutions based on Nortel products.
Rohde & Schwarz Canada Inc.	30		Manufactures radio communication systems and direction finders

Technology and Product Highlight

The key companies in this segment are Nortel Technologies, Canadian Marconi, SR Telecom and TTS Meridian Systems. Their products are designed to support various applications in avionics, communications and surface transportation. Products include radar systems, microwave rapid systems, radar and surveillance systems through "smart antennas" and other radio communication systems. Other products manufactured by companies in this technology segment include digital radio, analog and digital cellular networks and antennas systems (phased array, helical, wave-guide, deployable space-qualified, fixed and steered).

Research and Development

Research and development activities of these key companies include airborne voice/data communications, wireless measurement systems, environmental remote sensing and the next generation of personal communications system (PCS).

Additionally, several research organizations are involved in the research and development of radio, radar, microwave and wireless technologies. These organizations include Carleton University, Communications Research Center, Defence Research Establishment Ottawa, Information Technology Research Center, NRC Institute for Microstructural Sciences, and the Telecommunications Research Institute of Ontario. These organizations' research activities focus on adaptive antenna designs for interference cancellation, microwave, millimeter-wave and high speed digital circuits and antennas, radio modem technology, system software development for wireless communications systems and mobile agents, self-configuring CDMA wireless data networks, oversampled techniques in mobile communications, advanced digital personal communications (PCS) technologies and specialized integrated circuit development for PCS.

5.2 Fixed and Mobile Satellite Systems

Overview

There are two types of satellite communications networks. Fixed satellite systems allow organizations to access and use modern communication services such as voice, data, broadcasting, paging, and facsimile in a fixed location at a high speed and significant loading capacity without geographical limitations. The more recent development of mobile satellite systems made it possible for both organizations and individuals to access the above mentioned services on land, at sea or in the air while in motion.

Three types of companies are part of this growth segment. The first group of companies (Telesat Canada and TMI Communications) own and operate a satellite-based fixed or mobile communications network. The second group (CAL Corporation, Calian Communications and Canadian Marconi Company) consists of companies which design and manufacture products that make use of satellite-based networks. The third group of companies (Telesat, Lapp-Hancock and MPR) provides consulting and supporting products for the satellite and telecommunications industry in Canada and worldwide.

Key Companies

Company Name	Employees	Sales M $	Main Product /Service
CAL Corporation	185		Designs and manufactures mobile satellite based terminals, antennas and systems
Calian Communications Systems Ltd.	35	$47.9	Designs, manufactures and markets mobile satellite end user products and electronic systems
Canadian Marconi Company	250	$251.5	Designs, manufactures and markets global position system products
Lapp-Hancock Associates Ltd.	25		Consulting services for the planning, implementation and auditing of satellite and mobile communications systems
MPR Teltech Ltd.	35		Develops multimedia systems in the area of satellite communications
Spar Aerospace	329	$544.5	Supplies flight safety and communication systems
Telesat Canada	416	$244.0	Operates the Anik series of satellites. Provides consulting, and orbit and satellite operation services and products
TMI Communications & Company	171		Owns and operates a mobile satellite-based communications network (MSAT Network).

Technology and Product Highlight

Telesat Canada and TMI Communications are world leaders in the design and development of satellite based communications systems. Telesat operates Anik satellites, while TMI Communications operates the mobile satellite called MSAT. These two companies have worked with several local technology partners on the development of satellite communications systems elements and the development of communications applications.

Telesat's products and services include TV signal broadcasting, satellite based private business networks, transfer orbit services to other satellite operators, consulting, and it provides a flight-dynamic software used by satellite operators for mission and station-keeping operations. Satellite signals are received and transmitted through Very Small Aperture Terminals (VSATs), which are small, inexpensive satellite dishes (1.8 meters in diameter) with associated electronics and software for providing voice, facsimile, and data transmission/reception capabilities. VSATs are used for such applications as video-conferencing, interactive distance learning, wide-area network (WAN) interconnection, real-time inventory management, point-of-sale data gathering, and other services. TMI's products and services include voice, voice mail, circuit-switched data, one-way messaging, facsimile, aeronautical and marine.

CAL Corporation's products focus on terrestrial, aeronautical applications as well as it provides technologies for satellite space segments. Safety and surveillance solutions provide accurate and rapid detection or emergency distress alerts to national and regional search and rescue agencies. Space applications, such as those involving Spar Aerospace and the Anik Satellites, include orbit control sensors, inter-satellite communication links, and fuel monitoring devices. Calian Communication's products include global paging terminals for mobile satellite communications. CAL and Calian's network-related equipment are designed to work with TMI's MSAT network.

Research and Development

The key players in research and development are Telesat Canada, TMI Communication and CAL Corporation in the Ottawa-Carleton Region. Telesat's research and development activities include development work on Direct Broadcast Satellite System (DBS) design, ATM for tele-health and distance learning applications, and participation in the development of multimedia satellite communication systems. TMI's activities include the development of new products and services including packet-data, differential global position system and dispatch radio. TMI also supports its partners in new application development for the MSAT network.

CAL Corporation's research and development activities include the enhancement and development of vehicle mounted satellite based telephone products, antennas for the delivery of interactive multimedia services, satellite-aided search and rescue products, and optical instruments for space-borne remote sensing and meteorological applications.

Additionally, there have been several research organizations involved in the research and development of satellite communication systems, including the Communications Research Center, Defence Research Establishment, NRC Institute for Microstructural Sciences, and the Telecommunications Research Institute of Ontario. These organizations' research and development activities focus on development of advanced compression techniques, new antenna designs, and they provide development facilities such as satellite communication systems test-beds.

5.3 Telecommunications and Network Management Systems

Overview

Telecommunications and network management systems allow telecommunications service providers and operators of large private networks to manage their computer and telecom resources. Companies in this technology segment produce network management products and systems.

The proliferation of powerful workstations and PCs, together with a vast installed base of minicomputers and mainframes, has produced immense pressure to link these resources. Local and Wide Area Networks (LANs, WANs) allow the sharing of programs, data and peripherals by providing common access to local and remote resources.

Increasingly, these private networks are interconnected to public telephone and data networks or the Internet. As new services added network traffic changes at the various network levels. This may require the routing of traffic, the addition of new network channels, new equipment to meet the changing day-to-day operating requirements or the changing long-term demand. Network management services, therefore, must be performed at the various network levels including LANs, WANs, enterprise communications networks and public communications networks.

It is estimated that the overall worldwide network management market will reach $100 billion dollars in 1998. Hardware connectivity products expected to capture 39% of this market followed by network management software products (22%). The remaining will be spent on such cost items as network connectivity charges, systems design, implementation and consulting. Total market growth is estimated between 255 and 30%.

The following companies are well positioned to capture a sizable part of this high growth segment.

Key Companies

Company Name	Emplo-yees	Sales M $	Main Product /Service
CrossKeys Systems Corporation	180		Supplier of network management software
Impath Networks Inc.	35		Supplies PC-based network management software
Lanvista Corporation	55	$11.0	Designs and markets network management software tools and consulting services
Linmor Information Systems		$1.0	Supplies network management software
Newbridge Networks Corporation	1,800	$610.0	Designs and manufactures network management products
Nortel (US$)	5,500	$12,889.0	Designs and manufactures a wide variety of network products and systems
Simware Inc.	130	$17.7	Designs and markets software products to automate network management tasks
Stentor Network Management			Provides national telecommunication network management services to the provincial telephone co.-s
West End Systems Corporation	130		Develops and markets network access and transmission products, and provides sophisticated network management systems

Technology and Product Highlight

The leading companies in this technology segment include Newbridge Networks, Nortel Technologies, CrossKeys Systems and West-End Systems. Public communications and enterprise level network management tools include a wide variety of functions, such as setting-up backup systems, storage, capacity planning, configuration management, event management, fault management, network monitoring, performance management, network security and accounting.

Research and Development

R&D activities focus on the development of vendor-independent network management systems based on open concepts. These open concept communications network management systems provide telecommunications service providers with the freedom to choose among the various telecommunications equipment suppliers and integrate their communications equipment into the network solution.

Several research organizations are involved in the research and development of communication network management systems, including the Communications Research Center, Defence Research Establishment Ottawa, Information Technology

Research Center and the Telecommunications Research Institute of Ontario. Their research focus on ATM network resources management architecture, interconnection of wireless and wired ATM-based networks, communication algorithms, enterprise, local and wide area networking, and multi-network technology.

Significant expertise in this area resides in Bell Canada, the largest telecommunications service provider in Canada and in Stentor, which provides national network management services to the provincial telecommunication service providers in Canada.

5.4 Defence Command and Control Systems

Overview

High-technology products that combine sophisticated hardware and software elements characterize the defence industry. Typical products and services in this technology segment include command, control and communication (C3) products, electronic warfare systems, military radar systems, space systems and related design, implementation and support services.

The main markets for these technologies are the national security agencies in Canada and various countries around the world. The current priority markets for the defence industry are the United States and Asia. Emerging growth markets include South Korea, Malaysia, Indonesia and China. There are a number of growth technology niches. As an example, sales forecasts for defence systems in the aerospace market alone are estimated at $10 billion. There is also growing recognition that lighter, more mobile modern conventional forces are required for national and international security commitments, which may create additional markets for new communications and computing related equipment.

Key Companies

Company Name	Employees	Sales M$	Main Product /Service
Amtek Engineering Services Ltd.	70		Engineering, technical, support and R&D services for land, air, and marine material management/logistics and communications
Canadian Marconi Company	250	$251.5	Integrated logistic support services
Computing Devices Canada Limited	650		Designs and produces electronic equipment for defence applications
DY 4 Systems Inc.	215	$52.0	Designs and produces open architecture computer systems for military applications
Electronic Warfare Associates Canada Ltd.	26		Supplies monitoring and weapon system electronics.
Excalibur Systems Limited	25	$4.5	Designs and manufactures electronic warfare threat simulators and video output training systems
Lockheed Martin Canada	220		Supply of turnkey systems for naval, airborne and land applications
Lockheed Martin Electronic Systems	30		Design, development, and supply of complex computer-based electronic systems
Promaxis Systems Inc.	70		Provides engineering and logistic support services and products to Department of National Defence
Thomson-CSF Systems Canada Inc.	80	$6.0	Systems integration that provides command, control, communications, and landmine detection systems.

Technology and Product Highlight

These companies are involved in the provision of the following products and services: military training and computer simulation, material management, logistics and communications applications, advanced signal processing applications, integrated logistics support, avionics systems, tactical radios, defence vehicle electronic systems, surveillance systems for land, sea and air, monitoring and weapon system electronics, communications security, project management, military command and control real-time systems, flight safety systems, countermines systems, and electronic warfare simulators. The key companies for these products are Canadian Marconi, Lockheed Martin, and Computing Devices. Computing Devices is being recognized for supplying military technology products, Lockheed is an important player in the provision of the integrated systems and Canadian Marconi is one of the leading military communications technology solutions providers.

Research and Development

The research and development activities of organizations in this technology segment include product improvement of command, control and communications (C3) systems, electronic warfare systems, military radar systems, and space systems.

In addition, the following research organizations are involved in the research and development of defence systems and technologies: Communications Research Center, National Research Council, and the Defence Research Establishment Ottawa. Their research activities focus on the following important technologies: aircraft combat survivability, defence communications (broadband, earth-space radio, and antenna techniques), detection and identification of agents, information warfare,

maritime integrated above water warfare, military information processing, missile approach warning systems, national level command and surveillance, space systems and target tracking.

5.5 Enterprise/End User Communication Systems

Overview

The enterprise and end user communications systems technology segment encompass technologies that have been traditionally located at the enterprise level, such as telephone terminals, Private Branch Exchange systems (PBX), and voice-mail systems.

These traditional technologies are in the process of integrating with other levels of communication network management systems and personal computers through Computer Telephony Integration or CTI.

Several new emerging technology applications in this segment include providing voice and video communication functionality to personal computers, providing small business enterprises with PBX functions and services and call center management. In fact, it is anticipated that PBXs will be evolving to become 'voice servers' and become part of the total networking solution.

Another interesting technology area is mobile inter-office communications systems utilizing low frequency radio-communications technologies. These mobile inter-office communications systems allow employees to respond to calls through a mobile receiver regardless of their location within an office or a building.

It is estimated that CTI market is a $500 million to $2.3 billion overlap between the worlds of telecommunication, networking and computers. This market is still in its infancy, but a rapid process of growth is to begin. As an example, current PBX sales are often bolstered by sales of CTI application software such as call center products. PBX sales teams at firms like Nortel and Mitel are already marketing software packages to tie PBXs and servers together in the aforementioned call center applications. The companies that provide telecommunication hardware, computer software, and integrated systems and represent this segment are highlighted in the following table.

Key Companies

Company Name	Employees	Sales M $	Main Product /Service
Castletron Network System Corporation			Supplies network access products to allow voice, data and fax services over frame relay, ATM and internet networks
Centerpoint Technologies Inc.	15	$2.5	Small enterprise or home based business telephone switches (micro-PBX)
Corel Corporation (US$)	972	$334.2	Developed desktop video conferencing equipment and software
Mitel Corporation	1,500	$496	Designs, manufactures and markets CTI systems including voice communication systems
Nortel (US$)	5,500	$12,889.0	Designs, manufactures and markets intelligent data, voice and fax communication systems
Pika Technologies Inc.	17		Manufactures voice cards offering voice and telephony resources
T-Base Research and Development Inc.	11	$3.0	Research and development of touch memory technology including interactive voice response systems
Time ICR	21	$4.5	Provides voice mail, fax mail, and automated attendant service and equipment
TTS Meridian Systems Inc.	32		Manufactures voice communication systems including voice response systems
Vienna Systems Corporation	22		Designs and manufactures server-based hardware and software products to handle voice, data and video calls

Technology and Product Highlight

These companies are involved in the provision of the following products and services: LAN and host based email systems, voice, data and video conferencing, messaging, interactive voice response systems, electronic mail systems, voice response and speech recognition platforms, touch memory technology for interactive voice response systems, and fax mail. Some of the system components in this technology segment include: gateways for switching voice and data calls between networks and the public telephone network, audio-text (bulletin boards), automated attendant services, interactive voice response, voice-mail, fax broadcast, personal fax-mail, and never busy fax.

Research and Development

The research and development activities of the above mentioned organizations include: computer telephony integration at the network management and desktop computer levels, enhanced business communications with a single network infrastructure to merge and manage effectively voice, video and data communications. Research organizations active in this area include Algonquin College, Communication Research Center, and NRC Institute for Information Technology. Their research and development activities focus on transmission and compression techniques applied to video, seamless messaging, voicemail, email and fax systems.

5.6 Network Security Products

Overview

Network security concerns represent the greatest barrier to increased usage of public networks. As an example, security limitations have been cited as a major barrier to using the Internet for mission-critical activities. Organizations today are linking their systems across enterprise-wide networks as well as increasing their exposure to customers, competitors, browsers and hackers on the Internet. Each connection magnifies the vulnerability to attack.

With the increased connectivity to the Internet and the wide availability of automated cracking tools, organizations can no longer simply rely on their basic operating system security protection to protect their valuable corporate information. Several new technology niches have been emerging to improve network security such as the development of firewalls, encryption technologies, public/private key systems to prevent unauthorized access.

Key Companies

Company Name	Emplo-yees	Sales M $	Main Product /Service
Chrysalis-ITS	20		Develops encryption hardware and software and IC card technology for enterprise-wide network security
Datamex Technologies Inc.	30	$10.0	Supplier of network security equipment
Entrust Technologies Inc.			Designs and provides software products for privacy and authenticity of data communications
Milkyway Networks Corporation	67	$4.3	Development of network security products for networks connected to the internet or which utilize internet tools
TimeStep Corporation	60		Designs and provides network security systems that secure network communications

Technology and Product Highlight

Several leading edge network security firms are located in the Ottawa-Carleton Region. These include TimeStep Corporation, a Newbridge Networks Affiliate, Entrust Technologies a spin-off of Nortel and Milkyway Networks. These companies focus on the development of several important technologies and products that will improve network security, such as network security and auditing tools, secure remote access, encryption techniques, digital signatures and web-based certification authority, and integrated cryptographic engines to allow desktop and laptop to automatically and transparently encrypt files.

Research and Development

The above mentioned organizations' research and development activities include development of security products, public-key infrastructures that span multiple security domains, design of cryptographic algorithms, public-key mechanisms, security protocols in the area of authentication, key management architectures for protection of information objects such as files or messages, centrally managed secure network management systems, porting firewall technology, and security hardware.

Additionally, several public research organizations are involved in conducting research and development in the area of network security in the Ottawa-Carleton Region. These organizations include Canarie Inc., the Communications Research Center, and the Information Technology Research Center. These organizations' research and development activities are aligned with the previously mentioned research and development areas and activities of the companies.

5.7 Robotics and Intelligent Systems

Overview

Perhaps, the most prominent Canadian project in the area of robotics and intelligent systems that demonstrates Canada's leadership in this area, was the Canadarm for the U.S. Space Shuttle Program.

While robotics have traditionally focused on the automation of repetitive tasks, or using robots in environments unfriendly to humans, many aspects of robotics will require intelligent decision-making in the future. Intelligent systems and artificial intelligence are expected to play an important role to facilitate decision-making in complex, dynamic environments. Such environments may require the reconciliation of large quantities of information in diverse forms with knowledge embodied in humans, documents, operating practices and software.

While our region is the intellectual hub for robotics and intelligent systems, we have only found a few companies whose primary activities lie in the development of such technologies. These companies' activities are highlighted in the following table.

Key Companies

Company Name	Employees	Sales M $	Main Product /Service
Applied AI Systems Inc.	17		Develops and sells intelligent mobile robots using neural-networks and real-time artificial intelligence
Compris Inc.	12		Designs, develops and consults in artificial intelligence based computerized education and training
RES International	40	$4.0	Consulting services in knowledge-based systems
SIRMA International Corporation	5		Provider of R&D and consulting services in expert systems, intelligent support systems and knowledge engineering

Technology and Product Highlight

These companies develop a wide variety of products and technologies including artificial intelligence, robotics, neural networks, real-time artificial intelligence, artificial intelligence based education and training, object oriented technology, vision systems, yield problems detection software in the semiconductor fabrication process, electromechanical devices manufacturing, expert systems, intelligent decision support systems, intelligent geographical information systems (GIS), and intelligent computer aided design and manufacturing (CAD/CAM).

Research and Development

Several outstanding research and development organizations are involved in robotics and intelligent systems related research and development activities in the Ottawa-Carleton Region.

In fact, Precarn Associates manages the funding program for private and public partnerships in this area and also manages the activities of the university based research program called Institute for Robotics and Intelligent Systems or IRIS. IRIS brings together over 400 researchers from 23 Canadian Universities and has significant funding commitment to this technology segment nationally. IRIS' research focus includes human-machine interfaces, intelligent computation, intelligent supervisory systems, and machine sensing and actuation.

In addition, significant research activities are taking place at Carleton University, where research activities focus on robotics, at the Information Technology Research Center, where research activities focus on hierarchical control architecture for robotics, and at the NRC Institute for Information Technology, where research activities focus on integrated reasoning.

5.8 Visual Information Systems

Overview

Visual information systems technologies have been applied in a wide variety industries for the acquisition, recognition, storage, distribution and processing of information related to two and three dimensional (2D, 3D) objects.

While traditional video and scanning technologies can acquire, store, distribute 2D and 3D images, the emphasis in this technology segment is on object recognition and the related information processing. This technology segments builds on a number of components such as video technology, video transmission, digital signal processing, real-time software and a variety of sensor technologies.

The most common applications of these technologies have been security systems, machine vision systems for manufacturing, identification systems and more recently

biomedical imaging. While initial applications of these technologies focused on information acquisition in two dimensions, there has been a growing interest in applications that can accurately acquire, recognize and process information in 3D format.

Several companies focus on the development of visual information systems in the Ottawa-Carleton Region. These companies' activities are highlighted in the following table.

Key Companies

Company Name	Employees	Sales M $	Main Product /Service
AIT Advanced Information Technology	185	$16.3	Designs and markets identification and security systems based on surveillance technology
Dipix Technologies Inc.	50		Designs and manufactures a line of imaging products for the vision market
Hymarc Ltd.	22	$2.0	Manufactures 3D laser based vision systems
Infographic Systems Inc.	30		Develops access control/monitoring systems
Prologic Systems Ltd.	80		Develops multimedia, 3D data visualization, and pattern recognition products
Senstar Corporation	58	$11.0	Designs and manufactures outdoor perimeter intrusion detection and alarm monitoring systems
Telexis Corporation	80	$6.5	Designs and markets video systems for remote monitoring
United Marine Division of Cansim Simulators	25		Manufactures systems for centrally monitored intrusion alarm systems for high security

Technology and Product Highlight

We have several industry leaders in this segment, namely AIT Advanced Information Technology, Senstar Corporation and Telexis Corporation. Companies in this segment provide the following products and services: recording and video surveillance technology, chemical, explosives and narcotics detection systems, imaging boards for machine vision and industrial inspection, 3D laser based vision systems for inspection, access control/monitoring systems for building safety, machine vision and image processing hardware and software, fingerprint scanners, image compression and matching, 3D data visualization and pattern recognition, global positioning, outdoor perimeter intrusion detection and alarm monitoring systems for high security applications, and remote video and imaging systems.

Research and Development

The above mentioned organizations' research and development activities include the development of new sensor technologies, high speed digital signal processing (DSP) and application specific integrated circuit (ASIC) design, digital signal processing, real-time software development, and remote sensing.

In addition, there are several research organizations that conduct research and development in this area. These research organizations include Algonquin College, Information Technology Research Center, NRC Institute for Information Technology, and the Optical Processing and Computing Consortium of Canada. The

activities of these research organizations include the development of advanced algorithms to acquire and process 3D visual information, new sensor technologies to acquire the geometry of objects (including full color), 3D navigation, 3D imaging, 3D modeling, accelerated realistic image synthesis for virtual environments, digital audio-video editing, real-time signals, spatial cognition, and spoken image.

5.9 Systems Integrators and Technology Consulting Services

Overview

System integrators and technology consulting firms provide systems design, development and implementation services. Over one hundred companies are involved in the provision of such services for telecommunication and computing technologies in the Ottawa-Carleton Region.

The creation of system integration and technology companies was fueled to a large extent by the information and telecommunication systems requirements of the Federal Government organizations and departments, most of which are located in the Ottawa-Carleton Region. The following table shows the top six systems integrator and consulting firms in the Ottawa-Carleton Region.

Key Companies

Company Name	Employees	Sales M $	Main Product /Service
ADGA Group	250		Systems Engineering, Software Engineering, Information Security, Multimedia and Project Support
Andersen Consulting	500	$146.0	Management and international consulting
DMR Group	350		Information technology planning, enterprise architecture, knowledge transfer, system development and integration
EDS Canada	250		Technology consulting
ISM Information Systems Management	600		Systems integration, consulting, facilities management, data processing and data capture services
SHL Systemhouse (US$)	550	$1,500.0	System integration, software development and facilities management

Technology and Product Highlight

These companies provide systems engineering, software engineering, information security, multimedia, project support services, Internet web design, network design, computer communications network design and data processing services.

Research and Development

Research and development activities are limited in this technology segment due to the nature of the business. These activities mainly focus on the development of new approaches, methodologies for systems design, development and implementation.

5.10 Internet/Intranet Service Providers

Overview

Over half of the organizations worldwide have direct connections to the Internet. The Internet is most often used more for e-mail than any other purpose. In most cases organizations maintain web sites to be able to provide basic company and product information to their clients.

Due to security concerns, only less than five percent of the organizations currently use the Internet to conduct business transactions. Until recently, due to the lack of proven business benefits, many organizations have adopted a wait-and-see approach. With the introduction of new network security products this is expected to change. Electronic commerce is the area where significant growth is anticipated in the near future as it becomes the driving force behind Internet services.

For many of the smaller service companies, the Internet has presented significant opportunities. As an example, dozens of companies have emerged in the Ottawa-Carleton Region to provide Internet connection and related services. The large telecommunications companies followed suite, once they recognized the size and growth of this market segment. The following table highlights a few of the key service providers.

Key Companies

Company Name	Emplo-yees	Sales M $	Main Product /Service
Bell Canada	40,000	$8,183.4	Provides Internet access and services
CM Whittaker & Associates Ltd.	2		Provides Internet access and services
Comnet Communications			Provides Internet access and services
Craig Technologies Inc.	26		Provides Internet access and services
Cyberus Online			Provides Internet access and services
Global-X-Change Communications	17		Provides Internet business solutions through access to the Internet
Hookup Communications			Provides Internet access and services
i-Star Internet Inc.	80	$19.4	Provides high-speed direct internet access and services
Magi Data Consulting Inc.	25		Provides Internet access and services
Magma Communications Ltd.	15		Provides Internet access and services

Technology and Product Highlight

These companies are involved in the provision of Internet access services including access, website development, training and consulting services. The key companies in our Region in this technology segment are Bell Canada with its 'Sympatico' Internet service, and i-Star Internet, a pioneer of electronic commerce applications. In addition, there are several public network service providers, including the Ottawa Carleton Research Institute's OCRINet and Carleton University's FreeNet services.

Research and Development

The research and development activities of the corporate service providers are focusing on the development of advanced network infrastructure, customer service and account management software, and content development. Public research organizations' R&D activities have been focusing on the development and the expansion of the public network infrastructure. Important public research organizations that have been involved in the development of network technologies and infrastructure in the Region include Canarie Inc., Communications Research Center, and the Information Technology Research Center.

6.0 System Development Tools

The segment group described in Chapter 6 of this report covers systems development tools. In general, system development tools help enhance or simplify the development of systems, software applications or the creation, analysis and development of information.

Those system development tool areas, where there are significant research and development activities and products in the Ottawa-Carleton Region, were classified into two technology segments. These two technology segments are the software application development tools and databases and the Internet/Intranet development tools and products.

6.1 Software Application Development Tools and Databases

Overview

Development tools and languages are enabling technologies used to construct the software applications that help automate business processes and make people more productive. These tools are often based on the precepts of rapid application development, intensive user involvement, and joint application development to facilitate the interaction of programming teams. Database query, management and analytical systems are enabling knowledge workers to compile and analyze data from a variety of sources, and use it to make more effective business decisions.

Globally, the most often expected benefit from the use of software development tools is reduced development time, followed by enhanced systems quality.

It is estimated that the global market for development tools and databases is over $20 billion annually. Overall revenues are expected to reach more than $35 billion by the year 2000.

This segment includes a number of internationally recognized companies with leading edge technology tools such as object oriented technology for real time applications in client/server environments. The following table highlights those firms in the Ottawa-Carleton Region that compete in this market.

Key Companies

Company Name	Employees	Sales M $	Main Product /Service
Cognos Inc.	659	$207.5	Develops and markets client/server tools for reporting, analysis, and application development, 4GL application development tool
Fulcrum Technologies Inc.	250	$60.2	Designs and markets information-retrieval software that can be used on networks, internet and web sites
Gallium Software	45	$4.7	Develops human computer interface software products for real time applications
JetForm Corporation	300	$43.4	Designs and markets electronics forms packages and related software tools
Microstar Software Limited	35	$2.7	Provides SGML based document analysis, design and authoring tools used for document management systems
Neuma Technology Corporation	24		Develops software tool-set for managing complex software and engineering projects
Object Technology International Inc.	60		Provides object-oriented tools and development environments to support the development of object-oriented systems and products
ObjecTime Limited	41		Markets a tool-set that automates real-time software development
Sterling Software	34		Markets a 4GL application development tools

Technology and Product Highlight

The leading companies in the Region are Cognos, JetForm, Object Technology International, Fulcrum and Microstar in this technology segment. The companies in this segment have developed a wide variety of tools and databases including advanced client/server tools for application development, hypertext programming language based on SGML, font facilities for UNIX software developers, object-oriented language and development environment, real-time software development tool, and advanced 4GL application development tools and environments. Additional interesting development products also include data mining, query and reporting and ad hoc data analysis tools.

Research and Development

In addition to the research and development activities of the above companies there are several research organizations that are active in this technology segment. These organizations include Carleton University, Information Technology Research Center, NRC Institute for Information Technology, and the University of Ottawa.

These organizations' research and development activities focus on application software frameworks to support end user programming of large-scale systems, real-time and embedded systems, software design technology, software engineering methodologies, software requirements engineering and design based on message sequence charts and static embedded object oriented language for real-time applications.

6.2 Internet/Intranet Software Tools and Products

Overview

This technology segment includes those companies that develop specific end user software tools and products to access and manage information on the Internet or Intranets. With the explosion of Internet use by the business community, government organizations and the general public there is an increasing need for providing a wide variety of tools.

There has been a tremendous demand for simplified, programming tools like JAVA, e-mail interconnections, web page design and authoring tools. Additional tools that have just entered the market include Internet databases, Internet telephony, electronic commerce application tools, Internet audio and video application development tools, 3D interactive virtual reality development tools (VRML), etc.

There have been significant developments in the range of applications of the Internet. Commercial and business applications include retailing (cybermalls or virtual stores), shipping (see Fedex's site), banking, insurance and investment services. Developments also extend to entertainment and education including distance education, travel and virtual reality. Information service companies provide access to on-line daily papers, magazines and specialized news. All these developments show the increased importance of Internet related systems and application development tools.

Market estimates suggest that the worldwide corporate spending on Internet server and communications software will reach $3 billion in 1998, and expect to grow to $4 billion in 1999.

The following table highlights those key companies in the Ottawa-Carleton Region that are involved in the development of Internet development tools and related products.

Key Companies

Company Name	Employees	Sales M $	Main Product /Service
Artech	65		Designs a real-time internet broadcast software product
Corel Corporation(US$)	972	$334.2	Designs and markets products to create and manage web sites
Dataware Technologies	49	$7.0	Specializes in full text retrieval and structured information retrieval for internet
Fulcrum Technologies Inc.	250	$60.2	Designs and markets information-retrieval software that can be used on networks, internet and web sites
Ingenia Communications Corp.	65	$3.6	Designs and implement internet applications and web databases
Simware Inc.	130	$17.6	Have developed an Internet server management software for managing corporate servers
Nortel Technologies (US$)	5,500	$12,889.0	Designs and manufactures internet traffic management and dial-up access products and systems

Technology and Product Highlight

Several leading technology companies are involved in the development of Internet software tools and products. As an example Corel Corporation has been in the forefront of developing web-authoring software for the home and business software markets. Fulcrum Technologies have been active in information retrieval technologies that may be applied in Internet browsers. Simware has developed an Internet server management software that helps manage corporate Internet servers including selected security features. Dataware Technologies' products include tools to develop and manage applications and databases in the Internet/Intranet and real time Internet broadcast software.

On the network management side, Nortel Technologies have developed several interesting products that allow telecommunications service providers to improve network management in response to the increased demand Internet users are placing on the local telephone network infrastructure.

Research and Development

Research and development in this segment focuses on developing Java applications, Internet order desk system, and integration of Intranet and groupware technologies.

Several research organizations have been involved in research and development of technologies related to the Internet. In addition to the implementation of the public infrastructure initiatives such as the 'Information Highway Initiative', Canarie Inc., the Communications Research Center, and the Information Technology Research Center have been active in research and development focusing on Internet development tools and Internet related communication and software technologies. Some of the most recent projects included the study of high-performance global search architecture, information access technologies and interpersonal communications on the Internet.

7.0 Applications

This chapter covers software applications with significant presence in the Ottawa-Carleton Region. Two major technology segments in this group have a significant industrial base in the Region. These two technology segments are multimedia and corporate software applications.

Multimedia refers to a variety of products and technologies that typically combine image and sound. Examples for the many applications of multimedia include animation, motion pictures, presentations, and tele-medicine.

Under corporate software applications we have grouped those companies and products that sell off-the-shelf software products for business users to assist with various business functions.

7.1 Multimedia Products and Services

Overview

The Ottawa-Carleton Region has a thriving multi-media business community. In fact, some of the worldwide industry's origins may be traced back to the National Research Council, where researchers first pioneered a simple version of the animation software technology. After close to twenty years, most recently these researchers and the NRC have been given international recognition for this pioneering work.

Over the years the local multimedia industry has become known as *'Media North'* and has become a major supplier of the US and international multimedia industries. A significant portion of this industry's activity is directly related to the computer software and telecommunications industries of the Region.

Interactive multimedia is a skyrocketing industry segment with a worldwide market approaching $1-trillion in annual sales. While it was not possible to list all the companies involved in the multimedia technology segment, a few of the key companies are highlighted in the following table.

Key Companies

Company Name	Employees	Sales M $	Main Product /Service
Animatics Multimedia Corp.	22		Designs and markets multimedia software products
Artech	65		Designs multimedia and animation software products
Corel Corporation(US$)	972	$334.2	Designs and markets sophisticated graphics, illustration, desktop publishing software packages and multimedia titles and desktop video conferencing
DVS Communications Inc.	38	$2.0	Analysis, design, development, delivery and evaluation of multimedia technology assisted learning solutions
Fifth Dimension CAD/CAM Systems	75		Designs and integrates solutions for imaging, multimedia and document storage and retrieval
Future Endeavors Inc.	22		Develops multimedia software products
Impath Networks Inc.	35		Develops multimedia applications
Libraxus Inc.	24		Provides solutions for electronic dissemination of textual and multi-media documents

Technology and Product Highlight

Several companies lead this technology segment including: Corel Corporation in the graphics, desktop publishing and CD-ROM publishing; Artech in the area of animation software titles; Future Endeavors in CD-ROM publishing; and DVS Communications in the technology assisted learning area.

Companies in this technology segment provide a wide variety of technologies, products and services. Some of the primary applications and uses of multimedia include software animation, entertainment software development, development of CD-ROM based multimedia image galleries, CD-ROM based educational titles, CD-ROM based databases, multimedia employee training programs, information kiosks, and Internet based graphics and multimedia presentations.

Research and Development

Research and development activities in this technology segment focus on interactive TV, online gaming products and toy controllers, multimedia communications, Java based graphics, multimedia and desktop publishing applications.

Several key public research organizations have been involved in the development of multimedia related technologies. These organizations include Algonquin College Multimedia Center, Telecommunications Research Institute of Ontario (TRIO), Canadian Strategic Software Consortium, Canarie Inc., Information Technology Research Center, NRC Institute for Information Technology, the Ottawa-Carleton Research Institute and the Multimedia Communications Research Laboratory at the University of Ottawa.

These organizations' research and development efforts have focused on 3D imaging, 3D modeling, classification hierarchies, color image applications to graphic arts and motion pictures, digital animation, digital audio-video editing, electronic publishing,

interactive multimedia, multimedia in medicine, multimedia mail, Java enabled tele-learning and real-time multimedia distributed database systems.

7.2 Corporate Software Applications

Overview

In today's market place with the increasing sophistication of software packages, many organizations elect to purchase off-the-shelf software products instead of undertaking costly internal developments.

Horizontal integration of functionality is an important selection criterion for commercial software packages. Most of the major vendors of corporate applications have migrated their offerings to integrated suites using client/server architecture. The global market for corporate software applications is estimated to grow to $5 billion in annual sales by the Year 2000 with an annual growth of approximately 60%.

Our Region has a strong and thriving presence in this technology segment as it may be seen in the following table.

Key Companies

Company Name	Employees	Sales M $	Main Product /Service
Amtek Software Information Systems	65		Designs and markets off-the-shelf management tools to assist in materiel management
ASI Corporation	57		Markets enterprise-wide asset management software combining all life-cycle management features
Byte Ltd.	20		Develops integrated solutions for multilingual document and image management applications
Cognos Inc.	659	$207.5	Develops and markets client/server products for data mining, data analysis and reporting tools and a 4GL application development tool.
Corel Corporation	560	$269.0	Designs and markets graphic, word processing, spreadsheet, database packages
Domus Software Limited	85		Produces a correspondence control manager software product
Enterprise Planning Systems Inc.	42		Provides an advanced collaborative planning and scheduling software
Fulcrum Technologies Inc.	200	$60.2	Designs and markets information-retrieval software that can be applied to document and information management
Ivation Datasystems Inc.	20		Develops a software to analyze historical trends, geographic distributions and statistical data
JetForm Corporation	300	$43.4	Designs and markets leading an electronic form package and a workflow package.
KOM Inc.	22	$3.0	Manufactures of connectivity software for optical storage systems
Linktek Corporation	35	$3.2	Designs and develops client/server financial and material management systems
Microstar Software Limited	35	$2.7	Provides develops document management tools and provides solution based on SGML
Provenance Systems Inc.	13		Develops and markets software for managing electronic and paper records
PSSoftware	25		Develop recorded information management systems for the control of paper and electronic based records
Promira Software (Fastman Software)	26		Develops manufacturing management systems.
Tydac Technologies Inc.	24		Develops spatial and modeling software products

Technology and Product Highlight

A significant portion of the above companies develops document management related software packages. The leading companies in this area are JetForm Corporation, Fulcrum Technologies, Microstar Software, Provenance Systems and PSSoftware. Key products of these companies include information storage and retrieval systems, correspondence tracking system, Recorded Information Management System (RIMS), document and imaging Standard Generalized Markup Language (SGML) solutions, tools for SGML document analysis, design and authoring, document imaging, data warehousing, document management and electronic form management software.

Other company products include asset management software, data access and analysis software, advanced collaborative planning groupware software, statistical data processing, financial software systems, manufacturing systems, material management software and human resources systems. In these categories the leading companies include Cognos Inc., Enterprise Planning Systems, Linktek Corporation and Amtek Software.

In the business productivity and graphics software area the leading company is Corel Corporation. Its products include the leading drawing package Corel Draw and the Corel WordPerfect Office Suites for word-processing, database and spreadsheet applications.

Research and Development

Due to the nature of the software development business these companies mostly focus on product development and less so on carrying out research. Product development efforts of these companies include development of workflow packages, report writers, full text search engine development, advanced C-language document management application development, development of new records management tools and techniques, and other windows-based records management software applications. Additional areas of development also include community-based information retrieval, exploiting structured text searches in digital libraries, multi-database system supporting text and relational, keyword extraction, multi-agent information systems

Additional research organizations that focus on improving software development methodologies include Carleton University, Information Technology Research Center, NRC Institute for Information Technology, and University of Ottawa. Studies at these organizations focus on real time software development, software engineering and software requirements engineering and design based on message sequence charts, and real-time applications.

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