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Worldwide Personal Communications Activities

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Executive Summary

1.0 Introduction

Mobile communications such as cellular telephone has been growing at a high percentage rate over the last few years. Personal communications systems which make telecommunications services portable represent the next major advancement in the evolution of the communications network and are seen as a future growth area. The momentum for personal communications is driven by the desire for mobile communications as evidenced by the demand for terrestrial cellular telephone. There are projected to be 500,000 cellular subscribers in Canada by the end of 1990. In 1989 there were 5 billion worldwide subscribers. This is forecasted to be 19 billion by 1995.

Over the last two years personal communications has emerged as the newest concept in communications. It promises to bring fully personal communications to the individual, not to a place.

The objective of this paper is to summarize worldwide developments in personal communications. The paper will define what personal communications has to offer and discuss major areas of R&D technology development. It will also summarize worldwide activities, standards, market demand and spectrum considerations as well as the major players involved in the development of personal communication services.

2.0 Types of Personal Communications

PCS, (personal communication service) in the U.S., is defined as a set of services that allow a customer to personally control the origination, termination, associated features of calls, messages, or other applications regardless of geographic location or method of access.

PCN (personal communications network) is defined as a wireless access network using microcell technology. PCN does not include any form of cordless telephony or DECT (Digital European Cordless Telephones).

CT2 which is seen as a primitive form of personal communications, is the second generation of cordless telephone service in the UK. CT2 is being used in a wide variety of public locations and could also be used in the home and office.

Other cordless technologies are being tested around the world such as CT2+ and CT3. Europe is moving towards one common standard known as DECT.

3.0 Standards and Spectrum Considerations

Standards are crucial for the implementation of personal communications. The public needs uniform standards in order to have seamless access to personal communications. To have a number of different standards would fragment the market.

Around the world different countries are forming consortia or working groups to specify standards. International standards working groups have also been set up through the CCIR (International Radio Consultative Committee).

Worldwide R&D and testing in access technologies has been emerging in the areas of modulation, coding, and access technology such as CDMA (code division multiple access), TDMA (time division multiple access) and FDMA (frequency division multiple access))

WARC (World Administrative Radio Conference) is to be held in the first quarter of 1992 and will, amongst other things, address allocations in the band width 0.5-3 GHz for the land mobile (includes personal communications), mobile satellite, direct broadcasting satellite, space research and exploration services. Canada is proposing 60 MHz for personal communications (1870-1930 MHz).

4.0 Activities by Country

In the United Kingdom three consortia have been licensed by the DTI (Department of Trade & Industry) for PCN. They have a plan to establish a PCN by late 1992. Prior to the PCN licensing four CT2 operators were granted licenses in January of 1989.

A research project under EURO-COST (European Cooperation in the Field of Scientific & Technical Research) entitled the COST 231 program has been set up by a number of European countries to undertake R&D in the area of personal communications.

In the United States in 1988 the FCC (Federal Communications Commission) circulated a notice of inquiry seeking comments on personal communications. In its inquiry, the FCC sought comments on the amount of spectrum needed for PCS, the types of technologies that should be given priority, the technical standards that should govern PCS and the degree to which providers should be regulated. The FCC has granted over 20 experimental licenses for PCS.

Japan's Ministry of Post and Telecommunications has been recommending development of a second generation cordless phone system called a Personal Handy Phone (PHP). NTT (Nippon Telegraph and Telephone) indicated it wanted to start procurement of the PHP type, with possible uses for home, business and public telepoint. NTT favors the latter two applications.

In Canada eleven companies have been granted experimental licenses for a public cordless telephone service.

5.0 Strategic Alliances in Personal Communications

In the UK three consortia have been licensed to establish a PCN. They are Mercury PCN, Unitel and Microtel. The same kind of set up was done for CT2. There are four consortia that were granted licenses in January of 1989. They are Phonepoint, Ferranti, Mercury Callpoint and BYPS.

In the US a number of partnerships or alliances have been formed over the last three to six months: Millicom & SCS; PCN Amercia & Northern Telecom; AT&T, Qualcomm, Nynex & Ameritech; Bell South Enterprises & Sony Corp.

Partnerships have not yet begun to form in Japan in personal communications. There really is only one major player involved in personal communications services, NTT.

In Canada a consortium called Vision 2000 consisting of 32 communications and information technology organisations including users is conducting R&D and testing in advanced personal communications.

6.0 Market Demand & Opportunities for Personal Communications

As with all new technologies, estimates of market demand vary widely and are often incorrect. According to Gartner Group worldwide revenues for personal communications in 1995 are projected to be \$284 million US. By the year 2000 this is projected to be \$2 billion US. The breakdown worldwide in 1995 is the following: \$124 million in the UK, \$94 million in the US and Canada, and \$65 million in Europe. This includes cordless telephones and personal communication services.

According to Arthur D. Little the demand for PCS offerings will reach 60 million subscribers in 10 years (in the U.S. alone) after start up, assuming monthly charges of \$110, declining to \$50. Revenues will reach \$30-\$40 billion.

7.0 Cellular Versus Personal Communications

The cellular industry has had tremendous growth throughout the eighties. In 1989-1990 there was an annual growth rate of 30.9% in revenues. This is expected to continue from 1990-1995 with a compound annual growth rate average of 21.2% in each year according to Gartner Group. This growth rate will be supported by the advent of digital cellular and the eventual development of Motorola's Iridium System.

Personal communications faces a difficult challenge if it competes against cellular. The crucial difference between cellular and personal communications will be the cost of the service and the terminal. Early consulting reports by A.D. Little say that a personal communication service (with reduced functionality compared to cellular) could be anywhere between \$10-40

US a month which is much less than current cellular. Also the handsets (ranging between \$100-\$250) will be much less expensive than portable cellular.

Worldwide Personal Communications Activities

1.0 Introduction

1.1 Objective of the Report

Mobile communications such as cellular telephony has been growing at a high percentage rate over the last few years. Personal communications systems which make telecommunicatons services portable represent the next major advancement in the evolution of the communications network and are seen as a future growth area. The momentum for personal communications is driven by the desire for mobile communications as evidenced by the demand for terrestrial cellular telephone. There are projected to be 500,000 cellular subscribers in Canada by the end of 1990. In 1989 there were 5 billion worldwide subscribers. This is forecasted to be 19 billion by 1995.

Over the last two years personal communications has emerged as the newest concept in communications. It promises to bring fully personal communications to the individual, not to a place.

The objective of this paper is to summarize worldwide developments in personal communications.

1.2 Scope of the Report

The paper will define what personal communications has to offer and discuss major areas of R&D technology development. It will also summarize worldwide activities, standards, market demand and spectrum considerations as well as the major players involved in the development of personal communication services.

1.3 Methodology

A wide variety of sources were used to produce this paper. Four consulting reports were used to assist in the paper: Arthur D. Little, Evans Research, BIS Mackintosh and Gartner Group. Also proceedings from conferences on personal communications held in Dallas and Chicago were used to assist in the development of this paper.

2.0 Types of Personal Communications

Over the last two years personal communications has emerged as the newest and most talked about concept in communications. Personal communications has become the focal point for the emerging wireless revolution. It promises to bring fully personal communications to the individual, not to a place.

In the U.S. the FCC (Federal Communications Commission) in 1988 put out a notice of inquiry entitled DOKET 90-314 asking for comments and information on personal communications. In the notice of inquiry they used the terminology PCS (personal communications services). PCS is defined as a set of services that allow a customer to personally control the origination, termination, associated features of calls, messages, or other applications regardless of geographic location or method of access.

2.1 Basic Services Offered by PCS:

Voice Service

PCS shall offer voice service with quality grade of service, privacy, billing reliability and connectivity equivalent to that of current wireline voice service.

Data Service

Customers subscribing to PCS data service will be able to transmit and receive data messages to and from portable terminals that these customers carry, or that are stationary in a home, office, or vehicle.

Centrex Service

Wireless Centrex service enables the local exchange carriers to offer business customers a Centrex-based set of features that centers around the use of wireless terminals.

911 Service

Wireless 911 service provides an automatic call for help when 911 is dialed, or when a "call for help" button is pressed. The system furnishes the location of the port on which the call was initiated to locate the person who needs help.

Supplementary Services

Medical Alert Service

Medical Alert is essentially a reverse paging service. The subscriber carries a pager-like device that enables the subscriber to signal someone in the event of a medical crisis. The location of the customer is identified by the network.

Child Location Service

This combines several aspects of traditional paging services and the unique aspects of PCS. When interrogated, a Child Locator Service unit identifies its wearer's location in terms of proximity to the nearest radio port or group of radio ports.

Electronic Mail Service

The PCS has the ability to provide for the display of brief messages in a scroll format on the small liquid crystal display of a partial unit.

Other Supplementary Services

- Calling Number Identification
- Call Tracing
- Call Forwarding
- Call Transfer
- Three Way Calling
- Conference Calling
- Advertisement of Charges
- Additional Levels of Security

2.2 Personal Communications Network (PCN)

PCN (personal communications network) can be defined as a wireless access network using microcell technology. PCN does not include any form of CT2 (second generation of cordless telephones) or DECT (Digital European Cordless Telephones). It does include what is occurring in the UK with the licensing of 3 PCN operators and perhaps in North America with the development of CDMA (code division multiple access) or spread spectrum to enhance the development of personal communications.

2.3 Public Cordless Telephones

Telepoint first introduced in the UK, is based on the cordless base/handset configuration which can be used in the home and office, and also within 100 metres of any public base station, which can be installed in a wide variety of public locations. The sets are also PBX compatible, a feature which will enable them to be used in business locations as mobile extensions. Each base set can support a number of handsets at the same time.

Current CT2 handsets weigh around 270 grammes, much lighter than the analogue cellular hand portable. An important reason for this is because the low power budget provides for a significantly longer battery life than hand portable cellular batteries, and therefore batteries are much lighter.

CT2 as first implemented in the UK was only one way. The user is not able to receive calls only originate calls. However CT2+ and CT3 technologies which are being tested in Canada and the U.S. are two way. CT2+ is the standard developed by Northern Telecom

while CT3 is the standard developed by Ericsson.

2.4 DECT (Digital European Cordless Telephone)

DECT is a major development in the field of mobile communications in Europe. DECT is generally understood as the European standard for the next generation of cordless telephone service. Handsets will be small light weight handheld portable radio transceivers, capable of communicating with a base station over short distances.

It is envisioned that the first application will be office buildings with wireless communications, including data transfer. The last ten years in Europe were characterized by the fact that no common market existed for cordless products. Several standards existed and most countries allowed in their legislation only one of these. Examples like the UK CT1, CEPT CT1, the French 41-26, CEPT CT1+, the UK CT2 and the Swedish DCT-900 are well known. DECT will therefore be an attempt at a common European Standard by mid 1992. DECT will operate in the frequency band 1880-1900 MHz.

There are two camps in Europe's burgeoning world of low-powered personal communication services. Those who favor CT2/Telepoint, mainly because of its simplicity and low cost; and those who embrace DECT. DECT's advocates laud its improved operational capabilities over CT2 in four key areas:

1. Two way signalling
2. Support for roaming
3. The potential for incorporating incall handoff, though this is not expected in the initial DECT system.
4. Support for higher density deployment.

3.0 Standards

The standardization of technologies in the short term is crucial for the development of personal communications. The TIA (Telecommunications Industry Association) has specified a new digital cellular standard to replace the AMPS analogue one used throughout North America today. It will involve the use of a narrowband (30 KHz) TDMA (time division multiple access). However this standard is being challenged by Qualcomm who have developed digital CDMA (code division multiple access). Qualcomm is backed by two other major players in mobile communications, AT&T and Nynex.

Trials of several spread spectrum CDMA wireless access have been taking place in North America. Preliminary results from Qualcomm and PacTel would indicate that CDMA will be a strong contender for personal communications and cellular in North America.

In Europe a Pan-European digital cellular system is being developed called GSM. GSM will adopt a TDMA 200 KHz standard for digital cellular. GSM is expected to be fully implemented by 1992 which will allow a speedier implementation for PCN. GSM with TDMA is being proposed in the UK for the implementation of PCN at a higher frequency than digital cellular (1800 MHz rather than 900MHz).

In Japan the ministries with greatest influence on the standardization of telecommunications technology are the Ministry of Posts and Telecommunications (MPT) and the Ministry of International Trade and Industry (MITI). MPT is basically in charge of network-based standards, while MITI is responsible for the technical associations for standardization, including standards for customer equipment.

MPT will determine the standards for the Japanese mobile telephone service, and MITI will not have any immediate influence in the standardization process. However, because of its industrial clout, MITI will have a considerable influence in the shape of the regulatory regime. In Japan a Japanese digital cellular system is set to begin operation in the early 1990's also using the TDMA standard.

3.1 International Standards Activities

The International Telecommunications Union (ITU), which is responsible for telecommunications standards and spectrum management world-wide, has both regulatory and technical organizations.

The International Telegraph & Telephone Consultative Committee (CCITT) advises the ITU on "wired" telecommunications requirements, and the International Radio Consultative Committees (CCIR) advises on radio related, i.e. "wireless" requirements.

In late 1985, CCIR Study Group 8, which is responsible for all mobile services, formed a special international group to identify the requirements for Future Public Land Mobile Telecommunications Systems (FPLMTS).

Twenty nine administrations and ten international organizations presently participate in the

work of this group, which was called Interim Working Party 8/13 and is now known as Task Group 8/1.

In April, 1988 a new Interim Working Party (IWP8/14) was formed to deal with Mobile Satellite requirements for land, sea and air services.

A Joint CCIR/CCITT Experts Working Meeting on personal telecommunications was held in Vancouver B.C., Canada, June 4-8, 1990, bringing together experts Task Group 8/1 and most affected CCITT Study Groups. This unique meeting was held to help coordinate the various wired and wireless standards activities needed to provide seamless personal telecommunications.

In Europe the ETSI (European Telecommunications Standards Institute) is working on standards for personal communications and has set up working groups as well. Under the RACE program there is a project entitled UMTS (Universal Mobile Telecommunications Service). The goal of UMTS is a standard flexible air interface for all classes of service (e.g. cordless telephony, cordless PABX, cellular radio, PCN, etc.)

The UMTS concept is an approach within RACE which is expected to evolve during the course of the program. The key elements of the UMTS are:

- a common standard for public cellular systems and private cordless telephones (domestic and business) with full inter-working;
- very low cost personal terminals, i.e. mass market pocket telephone;
- an infrastructure comprising a mixture of public and private cells connected to the IBCN (Integrated Broadband Communications Network) so as to allow growth constrained only by economics;
- high bit-rate radio channels designed to carry a wide range of data services including video and graphics, short messages, large data files.

Standards are crucial for the implementation of personal communications. The public needs uniform standards in order to have seamless access to personal communications. To have a number of different standards would fragment the market.

4.0 Activities by Country

4.1 Europe

In 1989 the DTI (Department of Trade and Industry) in the United Kingdom circulated an article entitled "Phones on the Move", which proposed the introduction of a whole new generation of mobile telephony. Soon after the DTI accepted applications for PCN licenses. Eight applications were received comprising mainly consortia groups, of which three were accepted.

<u>Licensed Consortia</u>	<u>Members</u>	<u>% Share</u>
1) Mercury PCN	Mercury	60
	Motorola	20
	Telefonica	10
2) Unitel	STC	30
	US West	30
	Thorn EMI	25
	Deutsche Bundespost	15
3) Microtel	British Aerospace	35
	Pacific Telesis	20
	Millicom	15
	Matra	10

Prior to the licensing of three PCN consortia the DTI had licensed four CT2 or Telepoint operators in January of 1989.

<u>Successful Applicants</u>	<u>Launch Date</u>	<u>% Share</u>
1) Phonepoint	August 89	BT (45%), STC (25%) Nynex (10%), France Telecom (10%), Deutsche Bun.(10%)
2) Ferranti Creditphone	Oct. 89	Ferranti (60%), Telephone Rentals, British Technolog., Fleming Inv., British Linen

Note: Northern Telecom is in the process of acquiring STC

3) Mercury Callpoint	Dec. 89	Mercury (33%), Motorola (33%), Shaye (33%)
4) BYPS	Spring 90	Phillips (33.3%), Barclays (33.3%) Shell (33.3%)

Including the three PCN licenses, four CT2 Operators and two Cellular Operators there will be nine operators within the UK industry structure competing for market share. Upon speaking to several analysts and attending a number of sessions on PCN there was a general feeling that there will be a shakeout in the UK. Possibly that CT2 will be the one to give in the long run with the advent of DECT in 1992. However Adam Quinton who is an analyst of the investment bank UBS Phillips & Drew stated that it would be easy to envisage a disaster scenario in which a losing PCN network cuts prices to win customers and volume given high fixed but low marginal costs. He predicts that it is conceivable that one of the PCNs will go spectacularly bust in the late 1990's.

EURO-COST (European Cooperation in the Field of Scientific & Technical Research)

The COST 231 Project

The COST 231 research program covers a wide field of land mobile communications aspects, with a major emphasis on personal communications systems which in the near future will provide voice and data communications through small, cheap, handportable radio terminals.

The project has a nominal duration of four years and is therefore scheduled to terminate by 1993. Three working groups were set up: WG1 (Radio Subsystem Aspects) for studies on narrowband and widespread systems operating in the UHF frequency bands, WG2 (UHF Propagation) for the relevant propagation studies and WG3 (Broadband Communications) for dealing with system aspects and propagation studies on broadband systems operating at frequencies above the UHF bands.

As of May 1990 thirteen countries had signed the Memorandum of Understanding (MOU): Austria, Denmark, Federal Republic of Germany, Finland, France, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden, Switzerland, UK and four others have expressed their interest to join.

The major goals for COST 231 are to identify the characteristics of radio systems suitable for personal communications service and provide design methods and coverage models for their implementation. This involves studies on digital transmission techniques and propagation.

Cooperation between COST 231 and GSM is maintained mainly in the propagation field, where COST 231 experts can provide data for the specification of the propagation models for the DCS 1800 which is going to be standardized by GSM.

Liaisons with ETSI bodies dealing with DECT have been maintained through correspondence among Chairman, exchange of documents and a presentation to COST 231 Management Committee of the DECT system from ETSI.

Very useful information has been exchanged with the RACE (Research for Advanced Communications in Europe) Mobile Project Manager. A number of documents describing the UMTS (Universal Mobile Telecommunications System) under study by the RACE Project R1043 have been received and discussed.

The goal of the UMTS is a standard flexible air interface for all classes of service (e.g. cordless telephony, cordless PABX, cellular radio etc.). The UMTS concept is an approach within RACE which is expected to evolve during the course of the programme. The key elements of the UMTS are:

- a common standard for public cellular systems and private cordless telephones with full interworking;
- very low cost personal terminals, i.e mass-market pocket telephone;
- high bit-rate channels designed to carry a wide variety of data services including video and graphics, short messages, large data files.

The technical work carried out so far within COST 231 Project is a very low percentage of what is needed for studying the problems related to the evolution of land mobile radio systems towards personal communications networks, but COST 231 Management Committee meetings are attended by a large number of experts from many institutions with capabilities to contribute in many fields, so it is expected that the ambitious goals of the presented work plan will be reached.

4.2 United States

In 1988 the FCC (Federal Communications Commission) put out a notice of inquiry entitled DOKET 90-314. In its inquiry, the FCC sought comments on the amount of spectrum needed for PCS, the types of technologies that should be given priority, the technical standards that should govern PCS and the degree to which providers should be regulated.

The FCC also proposed excluding telephone companies and cellular mobile radio licensees from providing PCS in areas they already serve, to ensure the market is open to entrepreneurs.

The FCC's DOKET 90-314 proceeding on PCS technologies has drawn comments from

virtually every corner of the industry but no consensus on how PCS systems should be developed; how they should be treated by regulators; where they should be located in the spectrum; and how much spectrum should be allocated to them.

The FCC has granted over 20 experimental licenses for PCS. Attached is a map of the locations and who has been granted experimental licenses.

4.3 Canada

In Canada eleven companies have been granted experimental licenses for a public cordless telephone service, an enhancement of the CT2 technology referred to as CT2+ and CT3. CT2+ in Canada and the U.S. refers to an enhanced version of CT2, using twice the bandwidth and offering more features and efficiency than CT2. The term CT3 applied by Ericsson Radio Paging to the technology of its line of cordless PABX uses TDMA and operates in the 800 and 900 MHz frequency bands. CT3 is an early, proprietary version of DECT. Trials are to be held across Canada during the next 12 months (September 90-September 91) and licenses to offer the service to the public could be issued in early 1992. The trial period will allow manufacturers and service providers to gain a better understanding of this new radio technology and help assess economic feasibility, regulatory and licensing issues. The companies granted the experimental licenses are BCE Mobile, Rogers Cantel, Telesat Mobile, the Beeper People, BC Mobile, Bell Canada, Bell Northern Research, Glenayre Electronics, Motorola, Novatel and Sasktel.

BCE Mobile is the first of the eleven license holders off the mark. The company has already begun trials in Montreal and will soon begin trials in Toronto, Regina, Edmonton and Halifax where it has agreements with local telephone companies.

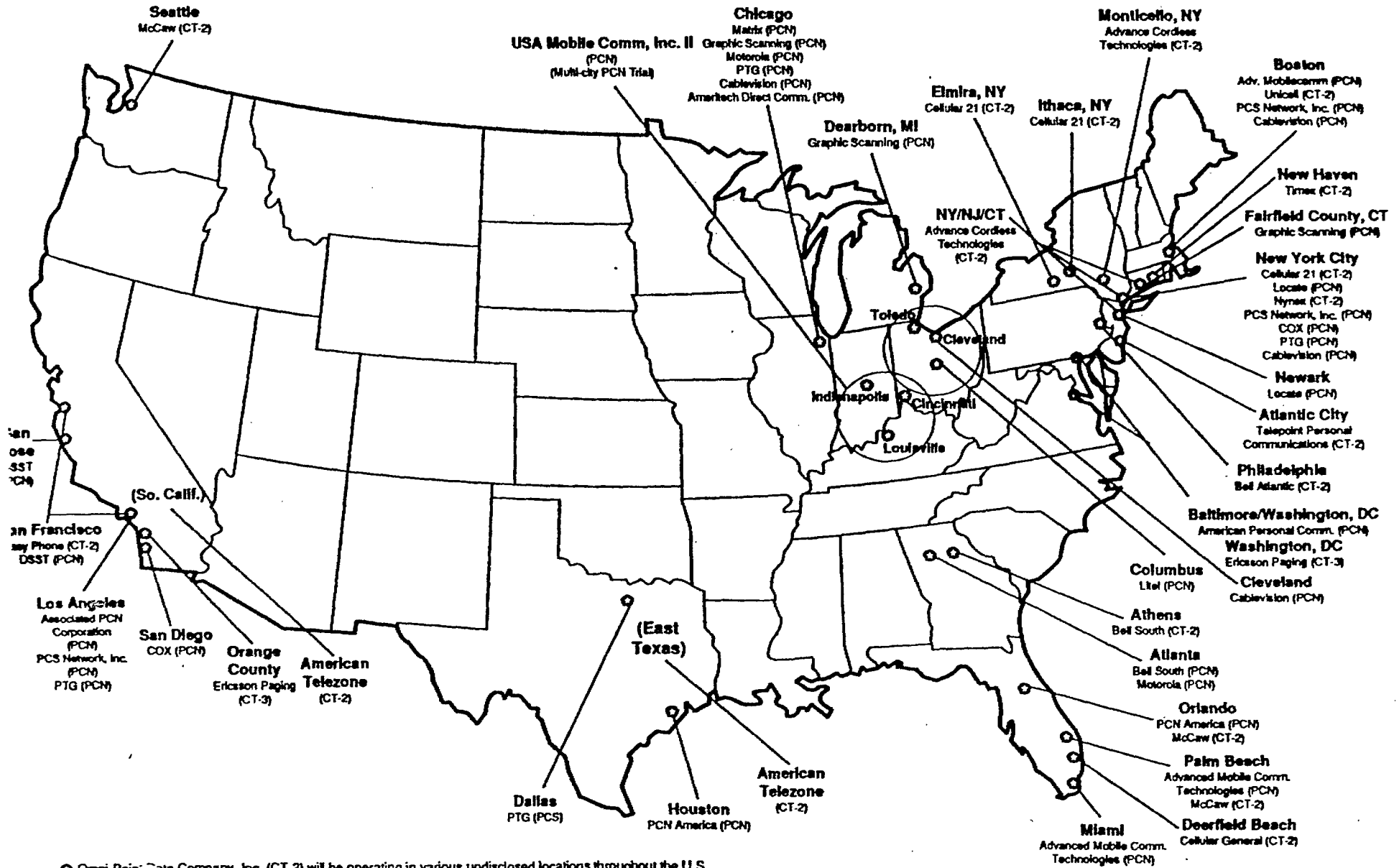
Two of the country's largest makers of telephone are sparring over which technical standard will anchor the next generation of cordless telephones in Canada. Northern Telecom and Novatel Communications are backing differing versions. Northern Telecom is backing the CT2+ standard (being used in BCE Mobiles testing) while Novatel is backing the CT3 standard developed by Ericsson and being proposed for DECT.

Also in Canada a consortium referred to as Vision 2000 has been formed. Vision 2000 Inc. is a consortium of communications and information technology organizations to facilitate the development and accelerate the use of advanced personal communications in order to enhance the competitiveness of the Canadian communications industry, increase productivity and improve the quality of life in Canada. Although this is industry driven the Department of Communications has taken an active role in Vision 2000. There are a total of 32 members in Vision 2000 comprising organizations from industry, academia and government.

4.4 Japan

Japan's Ministry of Post and Telecommunications has been recommending development of a second generation cordless phone system called a Personal Handy Phone (PHP). NTT

Geographic Locations of PCS Experiments



○ Omni-Point Data Company, Inc. (CT-2) will be operating in various undisclosed locations throughout the U.S.

(Nippon Telegraph and Telephone) indicated it wanted to start procurement of the PHP type, with possible uses for home, business and public telepoint. NTT favors the latter two applications.

5.0 Strategic Alliances in Personal Communications

Over the past year, especially the last three to six months a number of partnerships or strategic alliances have formed in order to develop the technologies needed to implement a personal communications network.

5.1 The United Kingdom

The United Kingdom became the first country to license three consortia in the development of a personal communications network. As mentioned earlier the names of the consortia are Mercury PCN, Unitel and Microtel. Each of these three consortia promise to commit \$2 billion CDN towards the development of a personal communications network. In all three consortia each company has different but complementary skills to produce a personal communications network. Let's consider the consortia Unitel for example:

In the consortia Unitel, STC has a worldwide reputation for advanced communications and information systems development and is Europe's second largest manufacturer of telephones. As the world's leading international consumer and rental and retail company THORN EMI has an unrivalled knowledge of the consumer with over 1500 outlets in the UK. Deutsche Bundespost Telekom is a major European Telecommunications network operator, playing an active role in the development of Pan-European standards and U.S. West provides telecommunications services to nearly 12 million customers in 14 states in the USA, also operating 29 cellular and 51 paging systems in 15 states throughout Western America. The combined skills within this consortia will attempt to implement an effective and efficient personal communications network by late 1992 in the UK.

The three consortia have formulated an Association of European Operators to further develop a personal communications network. The association was formed after signing a cooperative agreement in support of the "DCS 1800" (digital cellular system) standard for PCN systems. The 1800 is associated with frequencies of operation in MHz. The actual band will be from 1710-1880 MHz, providing 75 MHz duplex bands with a 20 MHz spacing. The DCS 1800 will use GSM network interfaces and architecture, and the main modifications are expected to facilitate low power hand held portables operating over relatively small cells.

Prior to the licensing of PCN four consortia were also granted licenses to operate a CT2 service. Each company in each consortia also brings a number of differing skills to try and develop a successful CT2 service. The four consortia are listed in the prior section under Activities by Country.

5.2 The United States

The first company in the U.S. to be granted an experimental license in 1990 in personal communications was Millicom Inc. Since that time Millicom which is a major player in the cellular industry has formed partnerships with SCS and Northern Telecom.

- 1) Millcom Technologies Corporation a subsidiary of Millicom Inc. has formed a joint venture with SCS to develop and hold intellectual property rights for PCNs specifically in the area of spread spectrum technology.

The Millcom SCS joint venture will utilize a combination of state of the art technologies including broadband, Direct Sequence Spread Spectrum (DSSS); Code Division Multiple Access (CDMA); Adaptive Power control (APC) and low-power handsets to create what the joint venture believes to be the perfect radio based communications system for the U.S.

- 2) PCN America, another subsidiary of Millicom has formed a joint venture with Northern Telecom which is one of the largest suppliers of fully digital telecommunications switching systems in the world. Northern Telecom will support Millicom in the design and conduct of the trials, the analysis of the results of these trials, and the specification of equipment that may be required to support the future operational PCNs.

PCN America's request was one of the first experimental licenses granted. The first phase of the test will take place in the first quarter of 1991, and it will study the propagation and interference characteristics of spread spectrum. In 1992, the companies plan to be looking at switching and handoff capabilities. The third phase will entail building out the complete system in the cities.

- 3) Perhaps the biggest partnership formed was between AT&T (manufacturer and carrier in telecommunications), Qualcomm (manufacturer of terminals for cellular), Nynex (carrier) and Ameritech (carrier).

AT&T has signed an agreement with Qualcomm Inc., a San Diego company that pioneered the code division multiple access technology, for use in cellular radio systems, Nynex Corporation, and Chicago based Ameritech plan to install the systems in their networks.

The plan by three of the industry's biggest players to develop and use the CDMA technology is significant because their approval could help make it a standard for the cellular industry and so-called personal communications of the future.

CDMA systems are said to offer up to twenty times more call-handling capacity than the conventional cellular systems. The CDMA systems assign a special electronic code to each call signal, allowing a number of calls to occupy the same space and be spread over an entire frequency band. By contrast, the current standard for future digital systems, time division multiple access, or TDMA, offer three to seven times the capacity of existing systems and works by placing each call signal into a time slot and transmitting it within a single frequency channel.

Nynex Mobile Communications, which has the more ambitious plan of the two regional phone companies, said that late next year in New York city it will roll out the nation's first wireless personal telephone service using the CDMA technology. Nynex announced a multimillion dollar agreement to buy the switching gear from AT&T. Nynex also said it agreed to buy \$3 million digital telephone sets from Qualcomm to sell to its customers. The phones are expected to be smaller, lighter and cheaper than most existing cellular phones.

Ameritech Mobile Communications said it will be studying the benefits of CDMA technology but during the evaluation period still supports the current TDMA standard.

4) APC (American Personal Communications), a cellular service provider, has formed a partnership with the Washington Post. The Post owns a large cable division with 420,000 subscribers and 4 television stations. The partners predict that the experimental system will be up and running by the end of 1991. The system will service not only Washington, but will also provide service to suburban Maryland and northern Virginia. In 1983 the two partners formed the first experimental cellular system.

APC plan to experiment with CDMA and TDMA so the service will be able to share spectrum with other users.

5) Bell South Enterprises (carrier) and Sony Corp. of America formed a partnership to conduct a three month trial of one and two way wireless communications using Sony's equipment. The trial will involve 35 volunteers using handsets, base stations and pagers in several combinations. This is a form of CT2 being experimented with by the two companies.

5.3 Japan

In Japan consortia or strategic alliances have not yet been formed. NTT is principally the major player in Japan in PCS.

NTT plans to solicit bids from domestic and foreign manufacturers for the joint development and procurement of digital cordless telephone systems. A formal "Track III" procurement notice was issued on December 12, 1990, with a closing date for bids set at March 4, 1991. NTT said the product required will be a compact, lightweight and economically-designed system consisting of a base station control unit, base stations, multiplexers and portable handsets, suggesting use as premises equipment or for public access services akin to telepoint.

5.4 Canada

In Canada there is a consortium of 32 companies called Vision 2000 whose aim is to do collaborative R&D in advanced personal communications. All the members have the same goal of developing the use of advanced personal communication in order to enhance the competitiveness of the Canadian communications industry, increase productivity and improve the quality of life in Canada.

In the coming months more and more strategic alliances will formulate between companies in order to situate themselves in a position to capture market share when a personal communication service is implemented. Each company will bring different but complementary skills to the partnership. The most common form of alliance is where there is a manufacturer or supplier of telecommunications equipment linked up with a carrier or provider of telecommunications services.

6.0 Spectrum Considerations

Before discussing spectrum considerations in the U.K., the U.S., Japan and Canada, a few concepts that are important to spectral efficiency are described below.

Frequency division multiple access (FDMA) - a modulation and multiple access scheme in which each channel is assigned a specific frequency band in the total signal.

Code Division Multiple Access (CDMA) - a digital multiple-access technology whereby each signal has its own unique binary sequence and all signals share the same frequency band also known as direct sequence spread spectrum.

Time Division Multiple Access (TDMA) - a system in which each user is assigned a given time slot and transmission typically takes place in a radio frequency claimed to be wider than in the case of TDMA.

6.1 The United Kingdom

Personal communications in the U.K. will utilize a frequency of 1800 to 1900MHz compared to the existing 900MHz for cellular. This means that there are different characteristics in the radio waves. In effect they don't travel as far, so more and smaller radio cells (micro cells) are needed to support the system. The smaller radio cells enable larger capacity to be supported and in this sense PCN technology is ideally suited to serving areas of high traffic density due to high customer demand - the mass market. It also enables lower power and, hence, smaller hand-portables to be offered.

6.2 The U.S.

Within the U.S. many of the companies filing first round comments in the FCC's inquiry into personal communications services backed the allocation of spectrum for the operation of advanced personal communications. Support came from a diverse group of Bell Operating Companies, independent telephone companies, equipment manufacturers and would be personal communications operators.

The FCC had requested public comment on whether and how PCS should be introduced into the U.S. Specifically, it asked whether there is a market; whether spectrum should be allocated, and if so how much and from where; and what regulatory and technical

standards should be adopted. The attached table indicates PCS technical characteristics for CT2, DECT and PCN.

In the U.K. the GSM technology also proposed for PCN uses TDMA. In the U.S. the FCC is looking for a standard that is spectral efficient. There has been considerable testing with spread spectrum CDMA. A Qualcomm representative (Qualcomm pioneered CDMA technology) used an expression to sum up his presentation on CDMA. "Spectrum is like real estate. They're not making anymore of it. CDMA is to spectral efficiency as skyscrapers are to real estate.

CDMA has several advantages over TDMA according to Qualcomm:

1. Qualcomm claims that its CDMA based solution could provide a twenty fold increase on existing analogue capacity. The TDMA approach is expected to bring about more modest capacity gains, approximately 8-10 times present analogue capacity.
2. Qualcomm can accommodate a digital transmission for a carrier using as little as 10% of the present spectrum allocation. With the TDMA approach, carriers will be unable to convert to digital without making 40% of the spectrum available to digital switching.
3. The cost of infrastructure with CDMA may be as little as one fifth of that associated with TDMA.
4. Portable terminals will be available from the outset with CDMA while a delay of two years is expected for TDMA.
5. The TIA (Telecommunications Information Association) TDMA standard will at first omit any standards for data transmission. CDMA will support data from day one.
6. The low power requirement of mobile and portable units will be approximately one tenth of that anticipated with TDMA terminals.
7. Privacy will be enhanced beyond that capable with TDMA terminals.

Nynex Mobile which has bought digital handsets from Qualcomm and is using CDMA will use frequencies already assigned to it for cellular telephone transmissions for testing of PCS. Nynex conducted a trial of the new technology from February to June, and was enthusiastic.

The CDMA or "spread spectrum" technology shares frequency with other users over a broad range of frequencies but with lower energy content, to minimise noise and interference with other radio devices.

6.3 Japan

Japan will adopt their version of the TDMA standard for digital cellular which is expected to be out by 1992.

PCS Technical Characteristics

	CT-2	DECT (Note 1)	PCN (Note 2)
Signalling Scheme			
Duplex Method	TDD	TDD	FDD
Access Method	FDMA	TDMA	TDMA
Channel Width	100 kHz	1.728 MHz	200 kHz
Frequencies	864-868 MHz	800-1000 MHz	1800-1900 MHz
Range	50-200 m	Up to 500 m	0.4-6 km cells
Call Receiving	No	Yes	Yes
Handoff	No	No	No
Applications:			
Cordless fone	Yes	Possibly	Possibly
Wireless PBX	Yes	Yes	Yes
Public	Telepoint	Telepoint possible	Port.; mob. w/adapter
Time Frame	Now (in UK)	Late 1991-92	Late 1992

- Notes: 1. Pre-DECT systems (dubbed "CT-3") also being evaluated in Europe.
 2. PCN description based on GSM specs now being considered in Europe. CDMA/SS systems also being studied in the U.S.

NTT plans to solicit bids from domestic and foreign manufacturers for the joint development and procurement of digital cordless telephone systems. The announcement was released by the company's London-based European subsidiary. A hint perhaps that NTT would welcome competitive bids from the champions of the various European interim standards and help to create a more global standard.

6.4 Canada

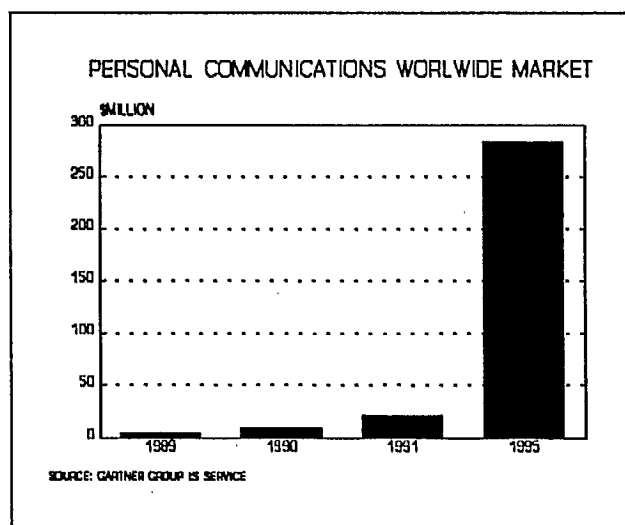
In Canada experimental licenses have been granted by the Department of Communications for public cordless telephony. Novatel and Northern Telecom are battling over which standard will be adopted. Novatel has been licensed by Ericsson to make products based on the CT3 standard. Northern Telecom offers an improved version of CT2, dubbed CT2+.

CT2+ must operate in the 900MHz range in limited spectrum allocation. CT3 operates in the 800-900MHz range. Both rank moderate in terms of spectral efficiency.

In Canada an 8 MHz block (944-952 MHz) of spectrum has been made available for the commercial debut of cordless telephone service.

7.0 Market Demand & Opportunities for Personal Communications

As with all new technologies, estimates of market demand vary widely and are often incorrect. Worldwide projections of revenue for personal communications for 1995 are projected to be \$284 US million by Gartner Group. By the year 2000 Gartner Group predicts revenues for personal communications to be \$2 billion US. This projection by Gartner Group includes PCN, CT2 (CT2+,CT3) and DECT.



In 1989 the UK accounted for the entire \$4 million with the CT2 operators. In 1990 again all the revenues will come from CT2 in the UK. In 1991 \$5 million will come from the U.S. and \$16 million from the UK for a total of \$21 million. Again this will mainly be CT2. In 1995 we see a huge rise of \$284 million. This is for all personal communication revenues. The U.S. and Canada will account for \$95 million, Europe \$65 million and the UK \$124 million.

According to Arthur D. Little the demand for PCS offerings will reach 60 million subscribers in 10 years (in the U.S. alone) after start-up, assuming monthly charges of \$110, declining to \$50. Revenues will reach \$30-\$40 billion annually.

7.1 The United Kingdom

Personal Communication Networks

According to Adam Quinton of UBS Phillips & Drew, PCNs will have significantly less favourable economic characteristics than those seen so far for the two UK cellular radio operators. After peak pre-tax losses of as much as 100 million pounds per annum, a PCN might break even by 1996 making a cumulative profit by 1999/2000. Revenues for the three PCN networks will be in the region of \$4 billion CDN by the year 2000. PCN operators would be wise not to threaten a price war. It is easy to envisage a disaster scenario in which a losing network cuts prices to win customers and volume given high fixed but low marginal costs. It is conceivable that one of the PCNs will go spectacularly bust in the late 1990s. UBS Phillips projects a subscriber market of 4 million by the year 2000 for PCN in the UK.

CT2 or Telepoint

The four Telepoint networks (based on the CT2 cordless telephone standard) licensed by the British government have so far not met the expectations of their advocates. The first year of operation has shown that the public is not yet ready for telepoint. There are three networks now in operation: Mercury Callpoint; Phonepoint and Zonephone. They are very secretive about their sales, but the best estimates from telecommunications analysts is that between them they have not sold more than 5000 handsets. Their territorial coverage is also less than the promoters had predicted for this time, and only 5000 base stations have been installed, mostly in central London and along motorways. According to Gartner Group IS Service the telepoint operators in the UK in 1989 had \$4 million US in revenues with only 5000 subscribers. For 1990 this is projected to be \$9 million US in the UK.

Some of the reasons for failure are:

1. Not well marketed to the end user, consumers do not understand what they are buying.
2. The three operators rushed into operation long before they had enough base stations in place to assure that handsets could actually be used where the subscriber wanted to use them.

3. The stringent government requirement that base stations comply with the Common Air Interface standard by the end of 1991 and that intersystem roaming be available by June 1991.
4. The high price of the handsets has also contributed to the slow pace. The three operating networks have offered handsets at approximately 200 pounds each.
5. Another drawback hampering Telepoint is that the technology used prohibited the operators from providing inbound calling service, which de facto protects the two wire phone companies. However, this will be changing as new technologies are being developed.

In the public arena, telepoint operators are working on solutions to increase subscriberships, establish an early base of business customers, and improve telepoint's overall market appeal.

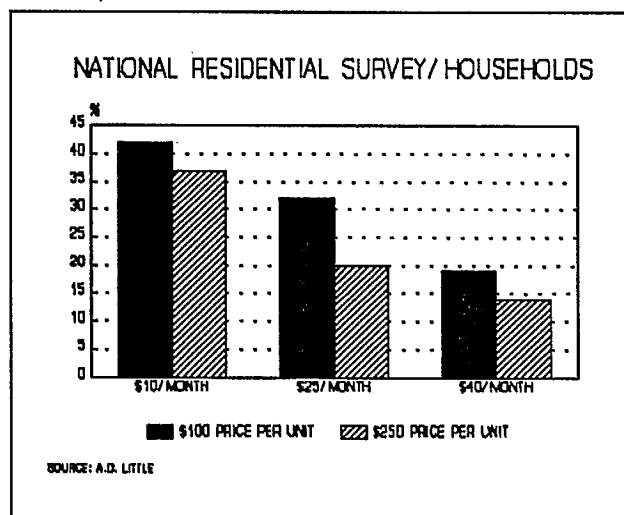
Users should be able to access all telepoints by the middle of 1991 when a common air interface is implemented. Also all operators are focussing on broader coverage as well as more cooperation amongst them.

7.2 The US.

Personal Communication Networks

PCN America commissioned a study by Arthur D. Little which surveyed 600 households and 400 businesses nationwide from August 1 - September 15, 1990. Additionally the firm interviewed 100 households in both Houston and Orlando, Florida, where PCN America will construct its experimental networks.

Nationally, 40 percent of all households indicated they are likely to subscribe to PCS, according to the study. Potential customer interest declines as the cost over existing telephone service increases from \$10 to \$40 a month. At a price of \$40 a month, however, 14 percent of the households said they are likely to subscribe to PCS. The potential subscriber group of 40% at the lowest price combination is equivalent to 37.3 million residential telephone access lines. The core buyer group of 14% at the highest price combination is equivalent to 12.75 million residential access lines and nearly three times existing penetration of cellular. The level of interest is much less sensitive to an increase in the initial purchase cost of the access device set from \$100-\$250 than a rise in the monthly service cost.

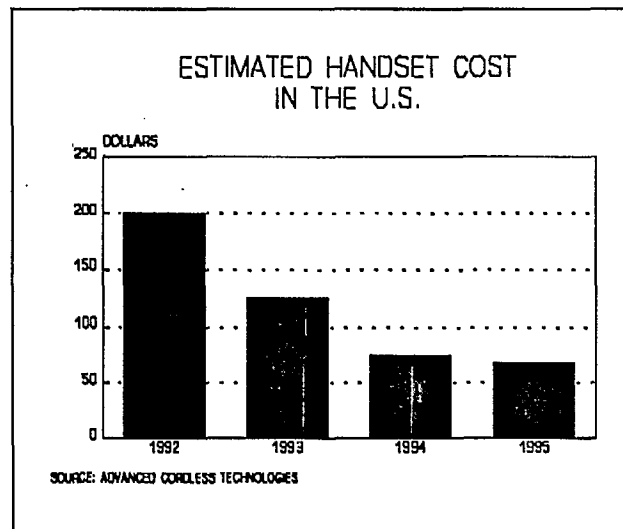
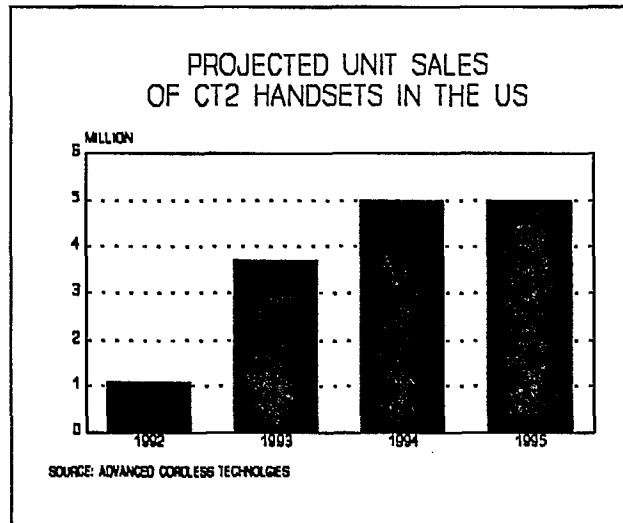


The Arthur D. Little survey found that business users were somewhat less interested than residential users in subscribing to PCS. More than one firm in three will buy PCS at the lowest level of monthly premium and one in four will buy PCS at the highest level. A large share of business users, about 68% of the likely business users, would subscribe to the service within one year after it became available.

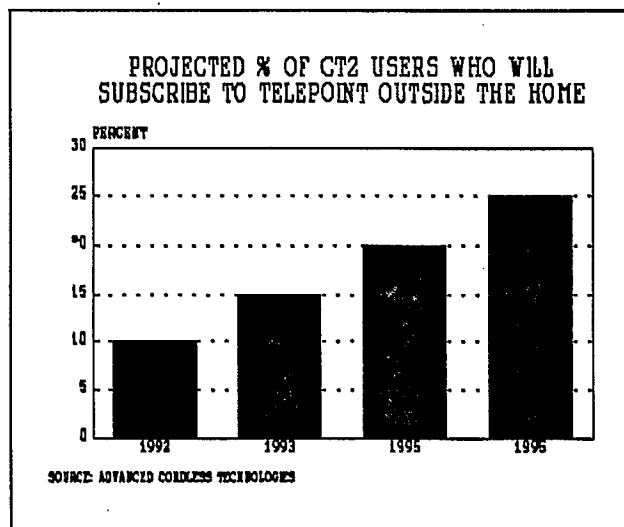
Nearly 30% of the potential business users said they would replace regular telephone service when they subscribe to PCS, and nearly 40% would drop their existing cellular service. Of course, what the actual practise might be remains to be seen.

Public Cordless Telephones

In the U.S. a survey performed by Advance Cordless Technologies projects that by 1995 up to five million CT2 handsets could be sold for an enhanced public cordless telephone service. The estimated cost for the handset in 1995 would be \$68.



The projected percentage of CT2 users who will subscribe to the telepoint service for use outside the home is 25% in 1995, the remaining 75% using CT2 handsets as a residential cordless telephone.



7.3 Canada

Public Cordless Telephones

In Canada the Industrial Advisory Committee made estimates of the potential market for digital cordless telephony. They view the business market (composed of wireless PBX's, etc.) as the initial market because it fills a need in the office today and because that market is less price sensitive. The residential market, which is much more price sensitive, will develop when prices drops.

A five year consolidated view of the Canadian wireless product and public communications service industries indicated a \$3.2 billion opportunity in Canada alone. Of this total, \$2 billion is in equipment sales and \$1.2 billion reflects public communications service revenue. These estimates include sales of 6 million handsets and 2.5 million public, business and residential base stations.

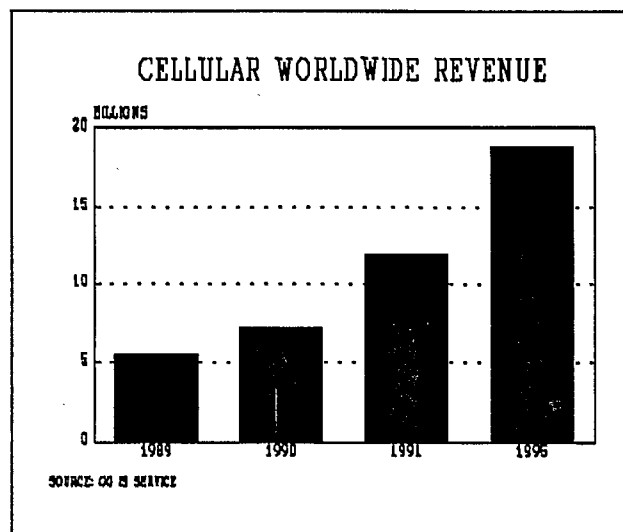
7.4 Japan

MPT's published forecasts of the growth of mobile communications distinguish between three categories: cellular, telepoint and PCN. NTT has disclosed long term forecasts which are close to those done by MPT. However, NTT forecasts do not cover cellular services which do differentiate between public cordless telephone and PCN services. Demand for PCNs is expected to run two to three times as high as demand for telepoints. MPT forecasts of demand in Japan by the year 2000 for next-generation mobile telephone services, in millions of subscribers, are as follows:

	Low	High
Telepoint	6.5	13.0
PCN	9.0	18.0
Cellular, car phones	6.0	6.9
Cellular, portables	2.2	1.6
Total MPT forecasts	23.7	39.5
Total NTT forecasts	20.0	n/a

8.0 Cellular Versus Personal Communications

The cellular industry has seen remarkable growth since its inception in the early to mid 80's. The demand for cellular has consistently been underestimated each year by a number of consultants. Cellular will continue to grow in the 90's. Worldwide revenue for cellular was \$5.5 billion US in 1989. It is projected to rise to \$18.8 billion US by 1995 according to Gartner Group IS Service.



The latest and most talked about development in cellular besides the conversion to digital, was the announcement of the Iridium System. Motorola's Iridium concept proposes to launch a network of 77 low orbiting communications satellites. These would be, in essence, skyborne cellular base stations that would provide cellular type service to locations around the world where traditional cellular service is unavailable or impractical.

The Iridium network, which an early estimate put in the range of \$2 billion, will provide global communications directly from a hand-held telephone to the satellite system and then to a designated phone system, using inter-satellite links when necessary to provide full network interconnectivity.

For Iridium to succeed it has to overcome massive political and regulatory obstacles. In order for Iridium to have the 800,000 subscribers that it needs for economic viability, telecom administrations around the world must grant Motorola various approvals. It is always difficult to get worldwide agreement on new communications standards and services; not only is Iridium no exception, it requires that countries give up an increasingly scarce resource: frequency spectrum.

Personal communication networks can be seen as an evolution from existing cellular technologies, using microcell technology. The crucial difference between the two will be the cost of the service and the difference in functionality. As mentioned earlier the cost per month of a personal communication service will be between \$10-40 while the terminal itself will range from \$100-250 in the US. Existing cellular is seen as much more expensive. Anywhere between \$80-120 a month for the service and \$800-1200 US for a handheld portable depending on which country it is purchased in. However, in recent months the cost of cellular has dropped dramatically which leaves some analysts skeptical about the potential market for PCN.

In the U.S. it would seem that CDMA will be the probable standard which offers three times the current TDMA standard. In Europe PCN will operate at a higher frequency than cellular. The smaller radio cells enable larger capacity to be supported.

A third difference is PCN will allow for smaller terminals than cellular. Less power will be needed therefore smaller batteries allow for pocket sized terminals.

PCN will not only be competing against an established cellular industry but also against the available cordless telephone services using CT2, CT2+, CT3, and DECT. By the time PCN evolves these new services will already be implemented. Standards will play a crucial role in bringing PCN to the market quickly but only efficient and effective research and development by the industrial sector will determine the role of PCN in the future. These technologies and markets are in the embryonic stage and the next ten years will see a major transformation in portable telecommunications with impacts on users, regulators, manufacturers and service providers.

In the future we could see these different services complement one another or even the integration of these services. For example a mobile satellite working with cellular telephony or a personal communications network, or a PCN handset working on a cellular network and vice-versa. This would mean one seamless network for users. Each particular service would address a different market niche (i.e. cellular, the mobile market, PCN the mass market, cordless service in the office and residential market).

