

True Wirelessness: A Whole New Ball Game

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By the year 2000, ubiquitous wireless personal communications services will change the ways that individuals, businesses, and other institutions in North America and Europe manage their affairs. Already, people are becoming increasingly mobile in their personal and professional lives. More and more, they want to use rapidly emerging wireless technologies to communicate directly with other individuals – not merely with other telephone instruments – anytime and any place throughout the world.

Services permitting this kind of fluid connectivity will have enormous impact, both for their users and for their providers. We forecast added revenues of \$35-40 billion per year by the year 2010 in the United States alone, and at least an equal amount throughout the rest of the world.

However, before these services can become reality, a number of issues need to be addressed and a variety of technical and regulatory barriers removed. In this article, we describe the services that will become available and outline the issues that must be resolved over the next several years.

Wireless Personal Communications Defined

Wireless Personal Communications Networks (PCNs), in conjunction with lightweight hand-held radio units, will permit users to establish two-way voice, message, and data communication with other communicating parties simply, easily instantly and at any time. In addition, wireless PCNs will support or facilitate a wide range of activities, including:

- Receiving or making a call unobtrusively, anywhere, anytime
- Knowing who the caller is by name and knowing the nature of the call
- Sending or receiving brief messages when talking is impractical or impossible
- Invoking specialized call-handling functions, such as call forwarding, call screening, or voice mail
- Storing low-priority calls and messages for attention later

Wireless PCNs will also offer separate billing for business and personal calls and a location-independent user identification system. Implementing PCNs will require substantial enhancements of the existing tele-communications infrastructure, including new numbering systems, location and routing intelligence, message store/forward/paging capabilities, ubiquity of coverage, and a host of other infrastructure functions and services.

One significant innovation is that phone numbers will be issued to users rather than to their wireless access or cellular instruments. As the users move from one area to another, the network will track their movements and route calls accordingly. This new network places users at its center, rather than at a fixed point of termination, such as a desk in an office or a room in a house.

Given the appropriate infrastructure and enabling technologies, wireless PCNs will allow users to employ a single handset in a wide variety of environments, providing a seamless, ubiquitous, and function-rich suite of communications services.

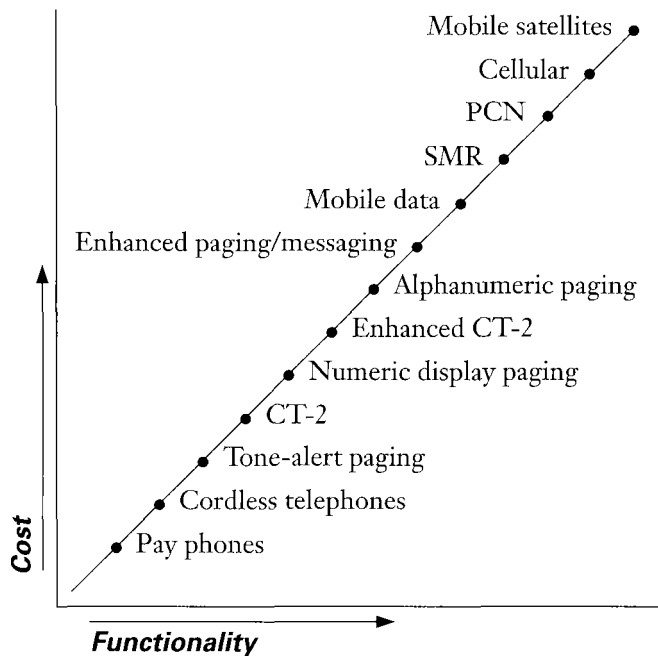
We believe that wireless personal communications will be provided not by a single, ubiquitous service, but rather by a continuum of complementary services that will meet the varying needs of many different, sizeable market niches in North American, Europe, and elsewhere. The services that we foresee (Exhibit 1) include:

- Next-generation digital microcellular radiotelephone service for both personal and in-vehicle use
- Telepoint: one-way public calling (wireless pay phone), sometimes referred to as CT-2 or second-generation cordless telephone, whereby a caller can originate a call, but cannot be called
- Enhanced telepoint: two-way calling from „islands“ of coverage, with limited local „hand-off“ from cell to cell as users move throughout a coverage area, and with a paging feature to alert users about inbound messages
- Advanced cordless telephone: two-way calling for business and residential users
- Wireless PBXs (in-building, in-office private systems)
- PCN service: cellular-like service with slow-speed hand-off
- Enhanced paging/messaging with limited message-back capability
- Mobile data services: public stand-alone services or services integrated into portable computers

- Mobile satellite services

Exhibit 1

PCN Product Positioning



The positioning of each service with respect to relative cost and functionality is illustrated in Exhibit 1. It is interesting to note that the difference between next-generation digital microcellular radiotelephone service and PCN service may disappear in the long run; the cellular industry argues that PCN will be a natural evolution of cellular service.

We estimate that within 10 years of these services being fully available, demand for them will approach 50 to 60 million new users in North America and a similar number in Europe, over and above today's cellular and paging users. Individual services will grow at varying rates, with enhancements of today's cellular and radio paging services continuing to serve well over half the projected market demand (Exhibit 2).

Exhibit 2

North American Demand for Selected Wireless PCNs to 2002

(millions of units)

	<i>Estimated 2002</i>			
	<i>Stage I by 1995</i>	<i>Stage II by 1998</i>	<i>Stage III by 2002</i>	<i>Penetration of Total Population</i>
CT-2/Telepoint	0.8	7.1	9.4	4.0%
CT-2 with paging	1.5	11.6	16.3	6.5%
New PCN	–	2.1	17.1	7.0%
Cellular (analog and digital)	15.2	28.6	30.0	12.0%
Enhanced paging/messaging	15.0	17.5	21.3	8.5%
Total	32.5	66.9	94.1	37.5%

The Societal Impact of PCNs

A number of wireless personal communications services – including radio pagers and other messaging terminals, cellular phones, and cordless telephones for both residential and business applications – have already won widespread acceptance in major North American and European countries (Exhibits 3 and 4). The differences among countries in terms of wider market penetration are striking. They reflect principally the time when mobile cellular services were first authorized (Scandinavia got a head start with the Nordic Mobile Telephone or NMT service), and the decision to introduce competition. France and Germany have only recently authorized additional cellular operators in their national markets (to compete with their respective telephone companies, France Telecom and Deutsche Bundespost Telekom), while the two United Kingdom cellular operators, Vodafone and Cellnet, have been in operation since 1985.

Exhibit 3

Growth of Mobile Telephones versus Telephone Main Lines, 1991

	<i>New Fixed Main Lines (OOOs)</i>	<i>New Mobile Phones 1000s)</i>	<i>New Mobile as a % of New Fixed</i>
Sweden	115	133	115%
United States	3,850	1,978	51%
United Kingdom	840	323	38%
Italy	1,070	147	14%
France	950	108	11%
Germany	1,400	101	7%

Exhibit 4

Cellular Radiotelephone Subscriber Penetration, 1991

	<i>Subscribers</i>	<i>Population (millions)</i>	<i>Penetration per 1,000</i>
Sweden	585,180	8.4	69.66
United States	7,500,000	250.0	30.00
United Kingdom	1,235,000	56.6	21.82
Italy	567,540	57.2	9.92
France	375,000	55.5	6.76
Germany	532,250	62.0	8.58
Japan	1,089,160	122.0	8.93

It is noteworthy that Japan has not been among the leaders in terms of the development of mobile telephone services, although rapid growth is now predicted, with expectations of 8 million subscribers by the year 2000. The Japanese telephone carrier, NTT, began its cellular service in 1979, but as in the United Kingdom and the United States, competition, first introduced in 1988, has given a significant boost to the growth of the market.

For the past 40 years, the vast majority of wireless communications users have been business and professional people who have needed mobile communications in their jobs. Today, however, new users entering the marketplace are employing these services in both their private and their professional lives. This trend is made possible by the availability of smaller, more convenient portable radio units and the ubiquity of mobile services throughout North America and Europe, as well as by the decline in terminal equipment prices and service usage charges.

Generally, in their private lives, users choose these wireless services for the convenience and personal security they offer, while in their professional lives, users are attracted by increased convenience and higher levels of personal productivity or reduction in „down time“ when they are on the move. Happily for commercial service providers and equipment vendors, these are benefits to which subscribers attach great value, and for which they are prepared to pay a premium over and above their fixed telephone charges.

We are frequently asked in the business world, „When will the truly mobile office actually appear?“ Our response is that much of it is here and available today. Wireless handsets are already operating in office environments behind local switches or private branch exchanges (PBXs), and radio technology has been incorporated in laptop and palmtop computers and in electronic diaries – e.g., the Sharp Wizard. The list of portable computer manufacturers that have incorporated radio technology in some of their professional products includes Hewlett-Packard, AT&T Safari, Toshiba, GRid Systems, Compaq, Poqet, Sony, Matsushita, and Apple.

One phenomenon fueling the growth of wireless communications activity is that, as subscribers begin to use these new products, services, and technologies, they quickly find new applications for them. These in turn broaden the market for wireless products and services and create demand for new ancillary services (which produce additional revenue opportunities to the vendor community), including caller identification, incoming call screening, and full storage, rerouting, and forwarding of text and voice messages. Bell Atlantic is currently testing such a radio-based intelligent network offering in the Pittsburgh area.

Impact on Existing Infrastructures

Clearly, the institutions that will feel the greatest impact from the introduction of these new services are the well-established wireline telephone and cellular networks. Will the new services enrich them or pass them by? We expect the former. Basically, these new services are extensions or enhancements of the fixed telephone and cellular telephone networks, whose enormous in-place investments will provide the necessary backbone links. At the same time, the established networks will capture only a portion of the market for the new services – and that portion is unlikely to be as large as the markets for their current core businesses.

While there may be some cannibalization of telephone company revenues by new wireless personal communications – e.g., substitution for traditional wireline pay phones, second lines into residences, or even the principal telephone line in single-adult households – we feel that the overall lost revenue will be relatively minor and outweighed by the opportunities. Not only should telephone companies be able to reserve some of these new revenues directly for themselves, but they will also find sizeable additional sources of revenue in providing a range of network-related and other support services to the wide variety of wireless service providers that will operate in these markets. These support services – which should produce enormous new revenues for wireline telephone companies in both North America and Europe – will include:

- Local loop and long-distance transport
- Subscriber location and tracking
- Multiple-provider service billing and revenue sharing
- Multiple grades of on-demand service provisioning based on multiple subscriber profiles
- Multicarrier network management

To perform all these functions, wireline operators will need to accelerate and enhance their network upgrade plans beyond those currently envisaged to support their own fixed telephone operations. In fact, in our view, these wireless operations will drive telco capital investment plans to provide full Advanced Intelligent Network (AIN) functionality as much as five years sooner than would otherwise have been the case in telco fixed plant modernization. The call-processing power and complexity of the software required to provide the support services mentioned are daunting, and can very likely be provided only by organizations with major network facilities in place, skills in managing very large projects for software and systems development and implementation, and access to sizeable capital investment resources.

In our view, wireless mobile communications traffic imposes far more challenging requirements on the fixed telephone network than is the case with conventional wireline telephone traffic. Not only does basic handling of a mobile call generate up to seven times the signaling traffic and three times the processing load of a fixed call, but the features demanded by mobile users require much more sophisticated network functions. For example, mobile users are much more frequent and demanding users of services such as directory inquiries and voice messaging than their fixed network counterparts.

We estimate that some \$10 billion to \$15 billion will need to be invested in network facilities over the next 10 years in the United States alone (with approximately the same amount needed in Europe) merely to support future wireless operations. These investment projections are based on current industry estimates that average investment per subscriber will total \$200 to \$300 and that networks must be configured to handle upwards of 60 million subscribers in North America. Offsetting these investment levels, we believe that there will be incremental annual revenues of about \$35-40 billion by 2010, when all these services are in place and 60 million subscribers are being served. (Average monthly revenue per subscriber in the United States is expected to be approximately \$50.)

We believe that the wireless personal communications market will attract many new players beyond today's telephone companies and providers of cellular and radio paging service. Other radio service entrepreneurs are appearing with the competitive encouragement of the Federal Communications Commission (FCC) in the United States and other government bodies overseas. Large multinational consortia are forming to address some major new overseas cellular and PCN opportunities. Cable TV companies are positioning themselves to provide wireless operators with local loop transport services (in competition with local telephone companies), and new third parties from the system integration and computer industries are approaching these markets to provide third-party, operational, and customer-support services. Included in this latter group on an international scale are such firms as Electronic Data Systems (EDS), Digital Equipment Corporation, Hewlett-Packard, Tandem Computers, and Stratus Computers.

In our view, the key factors for success in this marketplace will be:

- The ability to obtain government franchises and adequate radio spectrum
- The ability to gain access to adequate levels of capital investment
- The ability to develop complementary strategic alliances and partnerships to satisfy the full range of needs and political influences in the marketplace
- The ability to develop effective distribution channels and pricing strategies to meet the widely varying needs of different market segments

Enabling Technologies for PCNs

In order for all the above forecasts to become realities, further equipment developments must occur in a timely fashion to permit introduction of the new services. These developments fall into three major categories:

- Intelligent network hardware and software
- Radio transmission standards
- Multimode portable radios

Intelligent Network Hardware and Software.

Of the three categories, upgrading the telecommunications networks to meet all the functional requirements described above will probably present the greatest challenge. Full AIN functionality will require thousands of person-years of hardware and software development to enable North American, European, Japanese, and other networks to meet the comprehensive needs of the wireless marketplace. Many network vendors are currently engaged in early engineering design work to bring about the desired results. But much development, testing, and manufacturing still lies ahead before these capabilities will be widely available on a proven commercial basis.

Radio Transmission Standards. Service providers and equipment vendors must reach agreement on Common Air Interface (CAI) radio transmission standards to permit easy, user-friendly approaches to system interoperability, so that subscribers can move freely from one operating environment to another without having to go through complicated disconnect and reconnect procedures. The lack of interoperability may have been one of the most critical shortcomings in the United Kingdom's recent – and largely unsuccessful – attempt to introduce so-called CT-2 wireless pay phone service. At present, discussions are proceeding to develop the necessary CAI agreements among potential system operators and equipment vendors. However, these are not easy negotiations. Company policies and strategies concerning proprietary designs and intellectual property make the development of satisfactory arrangements very delicate. However, once these agreements are made, equipment design becomes relatively straightforward.

Multimode Portable Radios. The need for multimode subscriber radios poses a set of very challenging equipment design problems for worldwide radio manufacturers in North America, Europe, and Asia. In this instance, we are referring to very small, hand-held radios, weighing 7 to 10 ounces, that meet several criteria:

- Operation in voice, data, and text messaging modes (and perhaps in a video mode in the future)
- Operation in different radio frequency bands when the radio may be required to operate over a number of different licensed services
- Operation with different RF modulation schemes to permit interoperability among systems in different regions

With regard to the last point, a number of viable choices are being considered in the United States, Europe, and Japan. In the United States, modulation schemes that will very likely be employed in various regions include: analog advanced mobile phone service (AMPS); narrow-band versions of the same; enhanced time-division multiple-access digital transmission technology (E-TDMA); and code-division multiple access (CDMA) using spread-spectrum technology for very high capacity and broadband requirements. We expect to see all of these schemes deployed to one degree or another in various parts of the United States, posing very difficult design challenges to the multi-mode radio manufacturers, who will want to offer radios that can roam and operate in a variety of locations. Furthermore, if the radios are to function worldwide, they will need additional variations in digital cellular specifications, for example, with respect to voice compression schemes, the European GSM (Groupe Speciale Mobile), and Japanese systems.

Barriers to Rapid PCN Deployment

In our view, while a wide range of wireless personal communication services will ultimately be offered in the U.S., European, and Japanese markets, it is going to take several years for the regulatory and technological issues to be resolved. Even though government agencies in North America, Europe, and Japan are favoring competition in wireless services, many very practical questions need to be answered before real progress can take place. For example:

Where will adequate radio spectrum come from? Most government bodies are beginning to identify under-utilized RF spectrum that may be reassigned for these wireless PCN services. However, this process is paced by the identification of specific, sizeable needs and adequate channels to meet these needs. It may take many years to reassign channel licenses from existing holders, such as utilities or the military, to wireless PCN service providers.

What technical standards will apply? The process described above involves very long and difficult industry negotiations. Future services may be delayed by having to await decisions on which radio frequencies they are to operate on and which technical specifications are to be implemented.

Which classes of operations will be permitted to hold licenses? Deciding who will be eligible to hold licenses and who will be excluded will be a very difficult political issue for government licensing bodies to resolve. Candidates for licensing include:

- Cellular telephone operators
- Radio paging companies
- Local exchange telephone companies
- Long distance telephone companies
- New, entrepreneurial radio service providers
- Mobile satellite system operators
- Cable TV service providers

Should key decisions wait for tests? In the United States alone, as of early 1992, more than 100 engineering and marketing tests have been authorized by the FCC to test and evaluate a wide variety of possible new PCN service concepts. Two or more years will pass before any significant results from these tests are known. Should key decisions on licensing, frequency, and standards await the outcomes of these tests? In our view, the answer to this question is „yes,“ in order for regulatory decisions to be made in a pragmatic, implementable way.

Another significant barrier to the implementation of new PCN services is financial. As noted above, building the networks necessary to offer these services will require significant capital investments. Unfortunately, the U.S. investment community is somewhat skeptical about major investments in competitive radio services following its sometimes painful experiences with the U.S. cellular radio industry. Consequently, only organizations with deep cash or investment pockets will be likely to play in this game. Alternatively, well-heeled consortium (joint venture) partners from outside the industry may be invited to join, in exchange for major ownership shares.

Participation by outsiders may have financial and political benefits, but it carries certain risks as well. Outsiders' lack of operating knowledge and experience could lead to unrealistic expectations for investment requirements and market opportunities (as was apparent in some of the early plans of several of the U.K. PCN consortia, which have since been substantially curtailed and consolidated).

Conclusions

We believe that wireless communications services will develop rapidly once the barriers of regulation, investment, and network infrastructure are overcome, and will serve millions of people throughout North America, Europe, Japan, and elsewhere well into the next century. There is significant pent-up demand for these services, so that there should be ample room for a number of complementary services to satisfy diverse user needs.

While today's cellular and paging industries will be early beneficiaries of this explosive market growth, there will be substantial demand for other specialized services, which will provide ample opportunity for additional market entrants.

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