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Converging Industries Research Foundation

Practical Solutions for Communications Policy

PCS Supplement to Cellular to PCS: A Wireless Primer

June 14, 1997

*Presentation at the July 1997 NARUC Meeting
San Francisco, CA*

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Telecommunications Industries Analysis Project:

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The Telecommunications Industries Analysis Project is associated with the Public Utility Research Center at the University of Florida College of Business Administration.

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Graphics were produced by Erika Jobson, Cedar Designs.

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Table of Contents

| | |
|---|-----|
| List of Figures and Diagrams | i |
| List of Acronyms | ii |
| Project Information | iii |
| List of Participants in the Telecommunications Industries Analysis Project, 1997..... | iii |
| Background on the Telecommunications Industries Analysis Project | iv |
| I. Introduction | 1 |
| II. PCS Basics | 4 |
| What is PCS? | 4 |
| Is anyone providing broadband PCS service? | 4 |
| What broadband PCS services are currently being offered? | 4 |
| III. Spectrum Allocation | 5 |
| What's the difference between narrowband and broadband PCS? | 5 |
| Where in the world is PCS? | 5 |
| IV. Is There Life after Auctions? | 8 |
| What's going on with PCS technical standards? | 8 |
| What's happened with the PCS auctions?..... | 8 |
| Who qualifies as an entrepreneur? | 8 |
| What if someone already occupies a place in the PCS spectrum? | 11 |
| What's going on with the build-out of PCS systems? | 11 |
| How does wireless handle emergency 911 calls?..... | 12 |
| What is cloning? | 13 |
| What's going on with area codes?..... | 13 |
| What is "calling party pays"? | 14 |
| What's happened to the price of wireless services? | 14 |
| V. Additional Policy Issues | 16 |
| VI. Notes | 17 |

List of Figures and Diagrams

List of Figures

| | | |
|-----------------|---|---|
| Figure 1 | U.S. Mobile Services Time Line..... | 2 |
| Figure 2 | U.S. Radio Spectrum: Location of Commercial Services..... | 7 |
| Figure 3 | PCS Auctions | 9 |

List of Acronyms

List of Acronyms

| | |
|-------|--|
| ALI | Automatic Location Information |
| AM | Amplitude Modulation |
| APC | American Personal Communications |
| BB | Broadband |
| BOC | Bell Operating Company |
| BTA | Basic Trading Area |
| CBO | Congressional Budget Office |
| CDMA | Code Division Multiple Access |
| CMS | Commercial Mobile Services |
| CMRS | Commercial Mobile Radio Services |
| CTIA | Cellular Telecommunications Industry Association |
| DBS | Direct Broadcast Satellite |
| DCS | Digital Cellular Service |
| E911 | Enhanced 911 services |
| ESMR | Enhanced Specialized Mobile Radio |
| ESN | Electronic Serial Number |
| FCC | Federal Communications Commission |
| FDMA | Frequency Division Multiple Access |
| FM | Frequency Modulation |
| GHz | Gigahertz (billion cycles per second) |
| GSM | Global System for Mobile communications |
| Hz | Hertz (cycles per second) |
| kHz | Kilohertz (thousand cycles per second) |
| LEC | Local Exchange Carrier |
| LMDS | Local Multipoint Distribution Service |
| MIN | Mobile Identification Number |
| MHz | Megahertz (million cycles per second) |
| MTA | Major Trading Area |
| NARUC | National Association of Regulatory Utility Commissioners |
| NB | Narrowband |
| NTIA | National Telecommunications and Information Administration |
| PCS | Personal Communications Services |
| PHS | Personal Handy-phone Service |
| PSAP | Public Safety Answering Point |
| SMR | Specialized Mobile Radio |
| STP | Signal Transfer Point |
| TDMA | Time Division Multiple Access |
| TRS | Telephone Relay Service |
| TV | Television |
| U.S. | United States |

Project Information

List of Participants in the Telecommunications Industries Analysis Project

July 1997

State Regulators

NARUC Representatives from:
California Public Utilities Commission
Florida Public Service Commission
Illinois Commerce Commission
Iowa Utilities Board
Massachusetts Department of Public
Utilities

Companies and Governments

AT&T
Bell Atlantic
BellSouth
Corning
France
France Telecom
GTE
Kalona Cooperative Telephone
Nortel
NTT America
NYNEX
Pacific Bell
SBC Communications
Sprint
Sprint Local Telecom Division
360° Communications
U S WEST

Sponsors:

Corporation for Public Broadcasting

Assisting with *public* data:

Bellcore
Federal Communications Commission
National Exchange Carrier Association
National Telecommunications and Information Administration

Project Information, cont.

Background on the Telecommunications Industries Analysis Project

The Telecommunications Industries Analysis Project (TIAP), a six-year-old research consortium, conducts and reports impartial research in the areas where network planning, business financials, and public policy (regulation and legislation) intersect. The participants actively work together to develop new options for telecommunications policies to meet the needs of consumers, governments, and companies in a changing, competitive environment. Participants include regulators, domestic and foreign telecommunications companies, materials and equipment manufacturers, and other communications-based organizations.

The purpose of the Project is to produce research and analysis that will assist policy makers in making informed decisions.

TIAP incorporates the following features:

- **Neutral setting**
The Project provides a neutral setting, free of partiality, thereby ensuring objective and independent research.
- **Multiple viewpoints**
Participants play an active role in the research and analysis, represent their own interests, and understand and assist in developing others' perspectives.
- **Analysis and results of alternatives**
The Project provides research data, tools, and models for critical decision making.
- **Public distribution of research**
Data used by this Project are publicly available. Research products become public domain information.

I. Introduction

Introduction

This supplement updates the *Cellular to PCS: A Wireless Primer* (December 1995) and provides a current snapshot of the personal communications services (PCS) industry.¹ As with the earlier *Wireless Primer*, many of the technology and regulatory issues discussed are still evolving and may not be resolved for some time. Since the current market philosophy is moving toward competition, new regulatory approaches, instead of traditional ones, are being used to resolve PCS issues.² Furthermore, the sweeping changes in the wireline local and long distance traditional regulatory rules will affect the regulatory treatment of most wireless services.

Figure 1 provides a time-line indicating the major events in the evolution of mobile communications services. The *Telecommunications Act of 1996* (hereinafter referred to as the *Act of 1996*) made major changes in the following areas that affect commercial mobile radio services (CMRS), which include PCS, cellular, paging, and other wireless services:³

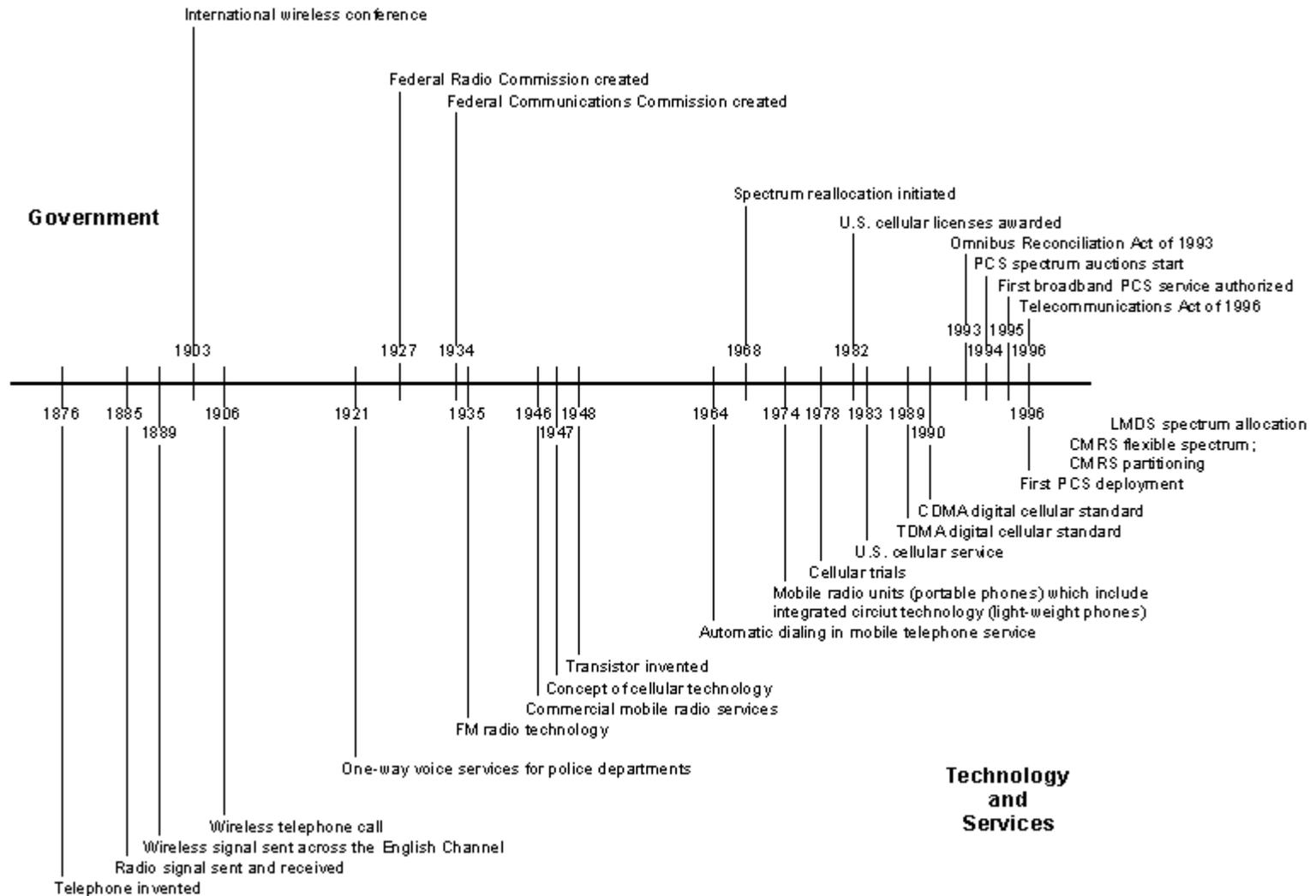
- **Marketing: Allows the Bell Operating Companies (BOCs) to jointly market and sell wireless services with traditional wireline local and toll services.**⁴
- **Interconnection and Reciprocal Compensation: Includes CMRS providers.**⁵ **Reciprocal compensation means that wireless companies are compensated for terminating wireline traffic. Prior to the Federal Communications Commission's (FCC's) *Interconnection Order*, only wireless carriers paid terminating access charges.**⁶ **The reciprocal interconnection rates vary by individual companies and states; therefore, there is no common, nationwide rate structure.**⁷
- **Shared Infrastructure (Technology, Facilities, and Functions): Includes PCS providers with the overall requirement that local exchange carriers (LECs) share "public switched network [PSN] infrastructure, technology, information, and telecommunications facilities and functions" upon request by qualifying carriers.**⁸
- **State and Local Regulatory Preemption: Sets limits on state and local governments with respect to regulation of placement, construction, and modification of facilities (including cell sites). These limits also include compliance with the FCC's rules on the environmental effects of radio frequency emissions and the availability of property, rights-of-way, and easements. The FCC is instructed by the *Act of 1996* to resolve conflicts arising in this area.**⁹

The sections in this paper cover the following items:

- **Section II, PCS Basics: Answers the questions: What is PCS? Is anyone providing broadband PCS service? And what broadband PCS services are currently being offered?**
- **Section III, Spectrum Allocation: Defines the difference between narrowband and broadband PCS and provides some international background.**
- **Section IV, Is There Life after Auctions?: Updates auction statistics and explains the issues associated with the build-out of PCS systems (including partitioning and disaggregation), emergency 911 services, cloning, area code exhaust, calling party pays, and wireless prices**

I. Introduction, cont.

Figure 1: U.S. Mobile Services Time Line



I. Introduction, cont.

- Section V, Additional Policy Issues: **Lists PCS policy issues that will need to be resolved in the future.**
- Section VI, Notes: **Provides sources and additional technical background.**

II. PCS Basics

What is PCS?

The FCC defines PCS as "radio communications that encompass mobile and ancillary fixed communications that provide services to individuals and businesses and can be integrated with a variety of competing networks."¹⁰ Within the past two years, after the initial spectrum auctions, PCS has already brought new entrants to the mobile communications markets, has expanded competition, and is helping to change the concept of what a service could be.

To better understand where PCS came from, its location in the spectrum, and technical standards, see the *Wireless Primer*.¹¹

Is anyone providing broadband PCS service?

Yes, there are many PCS providers currently operating. As of May 1997, more than 50 major United States (U.S.) cities had at least one broadband PCS company in operation.¹² **Figure 1** shows that the first PCS services were instituted on November 1995 by American Personal Communications (APC) in the Washington, DC/Baltimore major trading area (MTA) under the Sprint Spectrum brand.¹³

What broadband PCS services are currently being offered?

To differentiate themselves from other service providers, PCS companies have introduced a variety of services designed to provide customers with new choices. For example, a PCS provider may package together mobile telephone, voice mail, and paging services. In addition, customers can choose unlimited accounts or specific time-limited packages for each service to accommodate their needs and their budgets. Some PCS companies have included Internet connections in their packages.

III. Spectrum Allocation

What's the difference between narrowband and broadband PCS?

Figure 2 shows the location of the most common commercial communications services on the radio spectrum and their assigned frequencies. Broadband services are located at 1850-1910 and 1930-1990 MHz, and narrowband services are located at 901-902, 930-931, 940-941 MHz. The terms "broadband" and "narrowband" were adopted to indicate that only broadband could accommodate spread spectrum emissions. (An example of spread spectrum is the CDMA protocol¹⁴ where the signal is sent in short bursts and occupies a given frequency only for a short period of time.) Narrowband can provide paging, data transfer, and digital voice messaging, while broadband can provide these services as well as high-quality voice.

Narrowband PCS was designed for advanced paging services (both one-way and two-way) and new wireless messaging services. For example, with one particular response paging service, customers are notified when a message has been sent and may select a preprogrammed response or some other response.¹⁵ Another example is a campus narrowband PCS system that provides data transfer services (such as security systems, bookkeeping, and inventory control) and confirmation of message delivery along with traditional services such as roaming and one-way paging.

Where in the world is PCS?

The United States placed Broadband PCS services in the 1850-1990 MHz range of the spectrum to align it with the international range for worldwide mobile services (2 GHz range). Other countries deployed cellular and PCS-like services before the U.S. This advanced deployment provided information on what succeeded, what failed, what limitations applied, how a particular technology performed, and what government policies hindered or helped deployment of new services. For example, Japan deployed the world's first cellular system in 1979. Also, Japan and European countries already had PCS-like commercial services before the U.S.¹⁶ For example, Japan and Hong Kong used a different cordless technology, *Personal Handy-phone Service (PHS)*.¹⁷ In parts of some countries, such as in China or in Eastern European countries, cellular was the only telephone service available for the ordinary consumer.

Before the late 1980's in Western Europe, each country had analog networks for cellular services. Each country had mandatory protocols and many of these protocols (standards) were incompatible with other countries' protocols. In the late 1980's, the European Commission selected protocols for voice mobile services in two different bands (also called ranges) in the radio spectrum.¹⁸ This facilitated roaming between countries. The European Commission also created a duopoly in both bands, setting a limit of two competing companies for each band in each country. France and Germany promoted the migration of voice mobile services to a new digital protocol, while Italy and England continued to support the combination of analog and digital protocols. The success of PCS in Europe can be seen in the penetration rates of the following countries:¹⁹

III. Spectrum Allocation, cont.

European Digital Subscribers/Networks:

| | Number of Networks | Number of Subscribers | | | Digital Penetration* |
|----------------|--------------------|-----------------------|-----------|---------------|----------------------|
| | | GSM | DCS | Total Digital | |
| France | 3 | 2,362,720 | 108,300 | 2,471,020 | 4.26% |
| Germany | 3 | 4,875,000 | 585,000 | 5,460,000 | 6.74% |
| Italy | 2 | 3,116,500 | 0 | 3,116,500 | 5.40% |
| Norway | 2 | 850,000 | 0 | 850,000 | 19.77% |
| Spain | 2 | 2,018,000 | 0 | 2,018,000 | 5.17% |
| Sweden | 3 | 1,631,000 | 0 | 1,631,000 | 18.75% |
| United Kingdom | 4 | 2,436,200 | 1,452,600 | 3,888,800 | 8.42% |

*Errors in totals due to rounding.

European Analog Subscribers/Networks:

| | Number of Networks | Number of Analog Subscribers | Analog Penetration* |
|----------------|--------------------|------------------------------|---------------------|
| France | 2 | 277,270 | 0.48% |
| Germany | 1 | 550,000 | 0.68% |
| Italy | 2 | 3,769,500 | 6.53% |
| Norway | 2 | 437,000 | 10.16% |
| Spain | 2 | 12,117,000 | 3.12% |
| Sweden | 2 | 909,340 | 10.45% |
| United Kingdom | 2 | 3,099,800 | 6.71% |

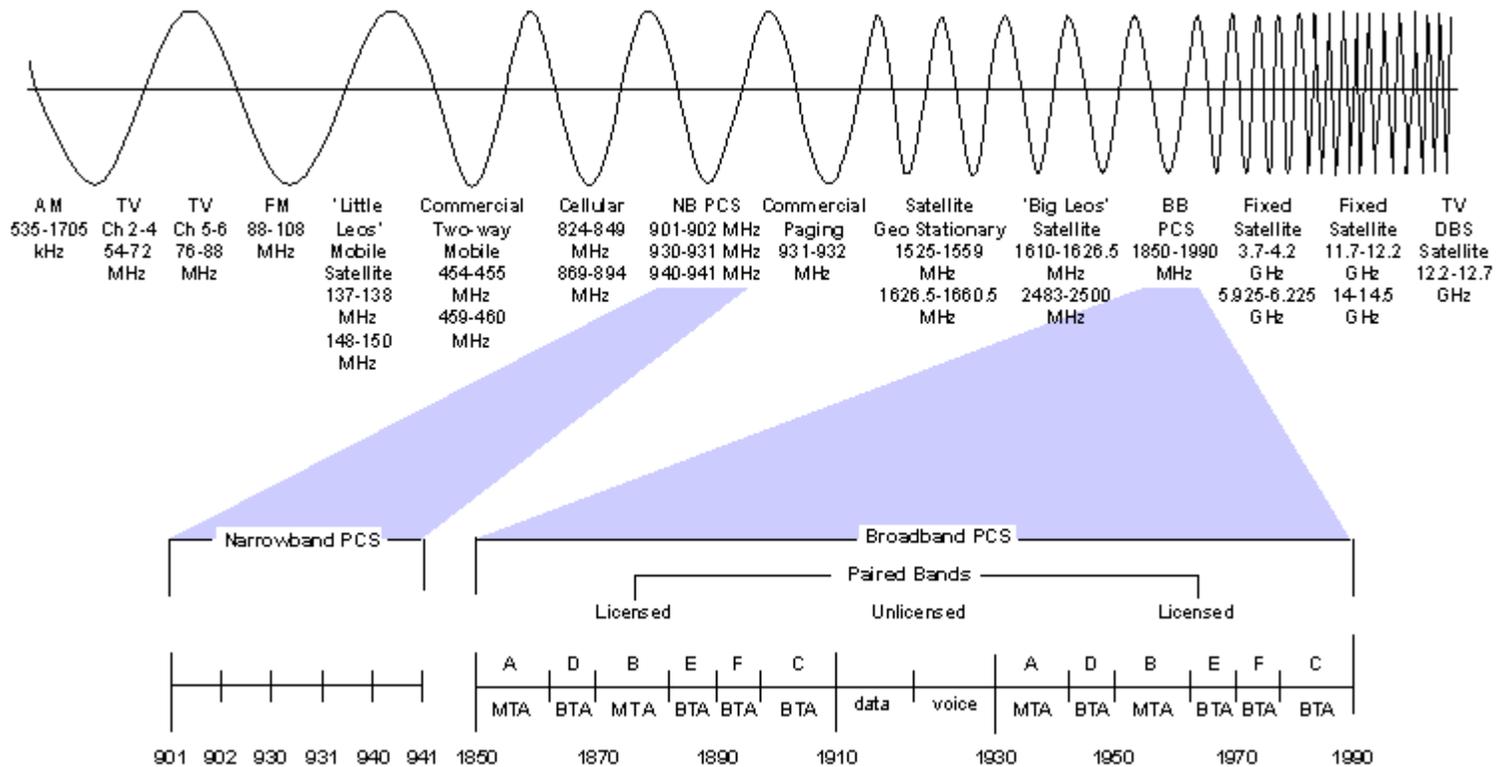
*Errors in totals due to rounding.

Total Digital and Analog:

| Total Digital and Analog Subscribers | Total Penetration* |
|--------------------------------------|--------------------|
| 2,748,290 | 4.74% |
| 6,010,000 | 7.42% |
| 6,886,000 | 11.93% |
| 1,287,000 | 29.93% |
| 3,235,000 | 8.29% |
| 2,540,340 | 29.20% |
| 6,988,600 | 15.14% |

III. Spectrum Allocation

Figure 2: U.S. Radio Spectrum: Location of Commercial Services



IV. Is There Life after Auctions?

What's going on with PCS technical standards?

In the area of PCS technical standards, the U.S. market has been allowed to develop the technology with government oversight only in limited areas. The FCC adopted a flexible approach to technical standards to "encourage the development of the broadest range of PCS services and devices; foster the most economic and efficient use of the spectrum; and ensure that existing services and PCS operations are protected from interference."²⁰

For example, currently there are a variety of broadband PCS standards: some companies are using Global Systems for Mobile communications (GSM), some are using Code Division Multiple Access (CDMA), and some are using Time Division Multiple Access (TDMA). PCS providers selected digital standards because of its quality, security, privacy, and capacity.²¹ The FCC has allowed companies to select standards that best fit each company's needs. The FCC policy is to refrain from mandating a standard, encourage innovation (through the pioneer's preference licenses),²² and require that PCS license holders build facilities.

Initially the FCC had planned to establish a PCS advisory committee to help resolve technical issues. However, the successful work of several industry standards bodies and the results of the experimental licenses led the FCC to conclude that an advisory committee was unnecessary.²³

The FCC did institute technical regulations that were necessary to resolve interference between different wireless systems. For example, the FCC instituted technical restrictions to protect fixed microwave companies from interference. The FCC also set limits on antenna height, radiated power, and out-of-band emissions.²⁴

What's happened with the PCS auctions?

As of June 1997, the total amount raised by the PCS auctions was \$21.5 billion with \$20.4 billion from the broadband PCS auctions and \$1.1 billion²⁵ from the narrowband PCS auctions (**Figure 3**). Of this total, \$10.0 billion was for standard licenses, \$0.7 billion was for pioneer's preference licenses, and \$10.8 billion was for entrepreneur's licenses.²⁶

Who qualifies as an entrepreneur?

The FCC created entrepreneur's licenses to fulfill the Congressional mandate to "encourage small businesses, rural telephone companies, and businesses owned by members of minority groups and women (collectively known as 'designated entities')" to provide wireless services.²⁷ In response to a Supreme Court decision, the FCC modified its rules regarding entrepreneur's licenses, making them race- and gender-neutral in order "to promote the rapid deployment of new services to the public without judicial delays."²⁸

Entrepreneur's licenses are for the C and F blocks for broadband PCS (**Figures 2 and 3**). Small businesses may pay for their licenses through installment payment plans²⁹ and are eligible for a 25-percent bidding credit (a 25-percent reduction in the price of the winning bid).³⁰ The rules for cross-ownership of PCS licenses by cellular and CMRS providers are relaxed for entrepreneur companies, allowing a greater percent to be owned (40% instead of 20%).³¹

IV. Is There Life after Auctions?, cont.

Figure 3: PCS Auction

Broadband PCS

| Channel Block: | Channel Size: | Spectrum Frequency: | Markets: | Number and Type of Licenses: | Auction Period: | Dollars Raised: |
|----------------|---------------|---|----------|---------------------------------------|--|-----------------------------------|
| A, B | 30 MHz | 1850 - 1865 and 1930 - 1945 MHz 1870 - 1885 and 1950 - 1965 MHz | 51 MTAs | 99 Standard 3 Pioneer's Preference | Dec. 5, 1994- Mar. 13, 1995 | \$7,034,240,010 \$701,780,374 |
| C | 30 MHz | 1895 - 1910 and 1975 - 1990 MHz | 493 BTAs | 493 Entrepreneur | Dec. 18, 1995- May 6, 1996; July 3, 1996- July 16, 1996 | \$9,269,147,315* \$904,607,467 |
| D, E, F | 10 MHz | 1865 - 1870 and 1945 - 1950 MHz 1885 - 1890 and 1965 - 1970 MHz 1890 - 1895 and 1970 - 1975 MHz | 493 BTAs | 986 Standard 493 Entrepreneur | Aug. 26, 1996- Jan. 14, 1997 | \$1,875,090,669 \$642,553,896* |
| Total | | 1850 - 1990 MHz | | | | \$20,427,419,731 |

Narrowband PCS

| | | | | | | |
|------------------|--------------------------------|---|--------------|--------------|---------------------------------|---|
| 1, 2, 3, 4, 5 | 50 kHz paired with 50 kHz | 940.00 - 940.05 and 901.00 - 901.05 MHz 940.05 - 940.10 and 901.05 - 901.10 MHz 940.10 - 940.15 and 901.10 - 901.15 MHz 940.15 - 940.20 and 901.15 - 901.20 MHz 940.20 - 940.25 and 901.20 - 901.25 MHz | 5 Nationwide | 5 Standard | Jul. 25, 1994- Jul. 29, 1994 | \$400,000,000 (\$80,000,000 for each license) |
| 12, 13 | 50 kHz paired with 50kHz | 940.25 - 940.30 and 901.25 - 901.30 MHz 940.30 - 940.35 and 901.30 - 901.35 MHz | 5 Regions | 10 Standard | Oct. 26, 1994- Nov. 8, 1994 | \$92,599,020 \$151,544,001 |
| 18, 19 | 50 kHz paired with 50 kHz | 940.35 - 940.40 and 901.35 - 901.40 MHz 940.40 - 940.45 and 901.40 - 901.45 MHz | 51 MTAs | 102 Standard | | |
| 6, 7, 8 | 50 kHz paired with 12.5 kHz | 930.40 - 930.45 and 901.7500 - 901.7625 MHz 930.45 - 930.50 and 901.7625 - 901.7750 MHz 930.50 - 930.55 and 901.7750 - 901.7875 MHz | 3 Nationwide | 3 Standard | Jul. 25, 1994- Jul. 19, 1994 | \$47,001,001 \$47,505,673 \$47,500,000 |

IV. Is There Life after Auctions?, cont.

Figure 3: PCS Auction, cont.

| | | | | | | |
|-------------------|--------------------------------|--|--------------|-------------------------|---------------------------------|---|
| 14, 15, 16, 17 | 50 kHz paired with 12.5 kHz | 930.55 - 930.60 and 901.7875 - 901.8000 MHz 930.60 - 930.65 and 901.8000 - 901.8125 MHz 930.65 - 930.70 and 901.8125 - 901.8250 MHz 930.70 - 930.75 and 901.8250 - 901.8375 MHz | 5 Regions | 20 Standard | Oct. 26, 1994- Nov. 8, 1994 | \$53,699,092 \$53, 621,666 \$48,718,014 \$88,621,007 |
| 20, 21, 22 | 50 kHz paired with 12.5 kHz | 930.75 - 930.80 and 901.8375 - 901.8500 MHz 930.80 - 930.85 and 901.8500 - 901.8625 MHz 930.85 - 930.90 and 901.8625 - 901.8750 MHz | 51 MTAs | 153 Standard | | |
| 25, 26 | 50 kHz paired with 12.5 kHz | 930.90 - 930.95 and 901.8750 - 901.8875 MHz 930.95 - 931.00 and 901.8875 - 901.9000 MHz | 493 BTAs | 986 Standard | | |
| 9, 10, 11 | Unpaired 50 kHz | 940.75 - 940.80 MHz 940.80 - 940.85 MHz 940.85 - 940.90 MHz | 3 Nationwide | 2 Standard 1 Pioneer | Jul. 25, 1994- Jul. 29, 1994 | \$37,000,000 \$38,000,000 \$33,300,000 |
| 23, 24 | Unpaired 50 kHz | 940.90 - 940.80 MHz 940.95 - 941.00 MHz | 51 MTAs | 102 Standard | | |
| Total | | | | | | \$1,139,109,474 |

Unlicensed PCS

| | | | | | | |
|------------------------|----------|-----------------|--|--|--|------------------|
| | 1.25 MHz | 1910 - 1930 MHz | | | | |
| Total for PCS Auctions | | | | | | |
| | | | | | | \$21,566,529,205 |

In the first C Block auction, two bidders defaulted. The initial amount raised was \$10, 216, 496, 324. In the F Block auction, withdrawal payments raised the amount by \$205, 000 (from \$642, 348, 896 to \$642, 553, 896).

Sources: Personal communications with the FCC. Also, FCC, *In the Matter of Amendment of the Commission's Rules to Establish New Personal Communications Services* (hereinafter referred to as the PCS Docket), GEN Docket No. 90-314, *Notice of Proposed Rule Making and Tentative Decision*, FCC No. 92-333, August 14, 1992, footnote 42, page 25; *Memorandum Opinion and Order*, FCC No. 94-144, June 13, 1994, ¶ 17b, page 7, and ¶ 75-76, page 31; *First Report and Order*, FCC No. 93-329, July 23, 1993, ¶ 77, pages 32-33; and *Third Report and Order*, FCC No. 93-550, February 3, 1994, ¶ 36, pages 16 - 17; ¶ 51, page 21; and ¶ 74, page 28; and *FCC Broadband PCS Auction Submission Round Results*, March 13, 1995.

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IV. Is There Life after Auctions?, cont.

What if someone already occupies a place in the PCS spectrum?

Some of the spectrum licensed to PCS companies is currently being used by other companies for point-to-point communications. While these current occupants are required to vacate the PCS frequencies, the PCS carrier must pay for the occupant's relocation to new frequencies. In a small number of cases, this situation has created the opportunity for delay and significant expense for PCS companies who are required to build out their systems and provide services within a specified time. However, as of May 1997, these delays have not been significant or widespread in most of the markets.³²

What's going on with the build-out of PCS systems?

At the time of the auctions, the FCC required that within five years after the granting of broadband PCS licenses, the service providers must reach specific benchmarks for availability of service.³³ The build-out of some PCS systems has met with delays for a variety of reasons. These reasons may include an inability to attract funding from the capital markets. Also, in a few cases, existing occupants created delays (as described above).

Yet another reason for delays in build-outs is zoning battles over cell site locations. The *Act of 1996* sets limits on state and local governments with respect to regulation of placement and construction of cell sites.³⁴ However, some companies have faced highly publicized battles with local communities. Customers want the services but don't want the towers in their back yards. The issues for the communities are both environmental and aesthetic. While some companies have obtained leases for sites on federal property (and therefore technically are not subject to state or local zoning regulations), in reality the federal government works with local zoning boards anyway and the issue remains.³⁵

In order to expedite the build-out of broadband PCS in some areas, the FCC initiated a proceeding on partitioning and spectrum disaggregation.³⁶ These rules would allow the PCS license holders to sell portions of their license by either or both of the following methods:

- **Partitioning:** Dividing a portion of the license for the company's service area along geographical, political, or other boundaries, and selling it to another company.

Partitioning would be extended to all license holders, eliminating the current restriction that permits only small telephone companies to sell parts of their PCS broadband territory. After the first five years, companies holding entrepreneur's licenses would be able to partition their territory as well.

- **Disaggregation:** Assigning discrete channels or blocks of the spectrum licensed by one company and selling the license for this portion to another company.

Disaggregation would be allowed for any amount of the spectrum. Before the first five years, entrepreneur's license holders would only be able to disaggregate to another company with an entrepreneur's license. After five years, the entrepreneur companies could sell portions of their spectrum as long as the Federal government were compensated with an "unjust enrichment" payment.³⁷

IV. Is There Life after Auctions?, cont.

The *Partitioning and Disaggregation Proceeding* also would change the build-out requirements. With partitioning there would be two construction options for the partitioned area.³⁸ Disaggregation would be allowed before the build-out requirements for the first five years were met. Specific construction requirements would be tied to whether the spectrum was originally licensed as a 30 MHz block or a 10 MHz block.³⁹

In addition, the FCC has initiated a proceeding to allow wireless carriers greater flexibility in use of their existing spectrum. This proceeding would allow these carriers to "offer any form of wireless local loop service, whether mobile, fixed, or a combination."⁴⁰ Fixed wireless services use a radio transmission between two fixed points (generally the cell site to the customer's stationary location, such as a home or office telephone).⁴¹

Disaggregation, partitioning, and flexible spectrum allocation are intended to increase the number of options available to both companies and customers; along with this comes the reduction of the predictability of the current spectrum licensing system. The result is that companies no longer know who their future competitors might be.

How does wireless handle emergency 911 calls?

The 911 emergency number has been in effect since the late 1960s for customers using wireline telephone services. Today the enhanced 911 (E911) system is available to 89% of all wireline telephones.⁴² When a customer dials 911, the call and coding (which identifies the phone number and the street address of the call) is sent to a public safety answering point (PSAP). Operators at the PSAP provide assistance, often routing the call to police departments, fire departments, or ambulance services.

As the wireless market grows, customers want E911 services available on their cellular or PCS phones also. In fact, a large percentage of customers cite safety as their main reason for purchasing a mobile phone.⁴³ However, unlike wireline services, where each line terminates in a fixed location, a mobile service customer may be anywhere. Knowing the location of the cell site, the diameter of which ranges from 600 feet to 10 miles, is not the same as knowing the precise location of the caller, especially in an emergency situation.⁴⁴

Therefore, new administrative and operating systems need to be installed so that mobile customers can have E911 services. The FCC adopted rules requiring cellular, PCS, and specialized mobile radio (SMR) companies to provide E911 service by the end of an eighteen-month period starting October 1, 1996. The FCC set the following requirements for wireless E911 services:

- **Code Identification:** Must send calls along with a code (the mobile identification number, or MIN) to the appropriate PSAP.⁴⁵ The connections are to be made automatically to the PSAP, with no verification needed from the caller. These rules also apply to calls made by customers roaming outside the home territory of their company. Regardless of whether or not the handset has the capability of transmitting the code, the company must still provide E911 if requested by the PSAP.⁴⁶
- **911 Call Back:** Must initiate system changes that allow the PSAP operator to call back if the 911 call is disconnected.

IV. Is There Life after Auctions?, cont.

- **Identification by Latitude and Longitude:** Must be able to identify the latitude and longitude of a mobile unit making a 911 call within a radius of no more than 125 meters in 67% of all cases.⁴⁷ This feature is called automatic location information (ALI).
- **Interface with Devices for Customers with Disabilities:** Must be capable of transmitting calls to local 911 service by individuals with speech or hearing disabilities.⁴⁸
- **Conditions for Serving a PSAP:** Must provide a PSAP with service if: (1) the PSAP has requested that the number and location information be forwarded with wireless calls; (2) the PSAP is capable of receiving and using this information; and (3) there is a mechanism for the recovery of the costs related to providing this information.

What is cloning?

When a wireless phone is on, it sends out an embedded message several times per minute. This message includes the electronic serial number (ESN) and the wireless telephone number, and it notifies the wireless cell site that the phone is in a particular location. This allows the wireless customer to be located for incoming calls, for roaming, and for other purposes. The overhead message has customer information. Criminals use electronic scanner equipment, often near highways and airports, to capture these signals. They then take a specific ESN and its associated telephone number and apply them to one or more phones, producing clones of the original wireless phone. The cloned phone is then used illegally and fraudulently to sell wireless service. Some companies have restricted international calls because it can take up to 30 days for the bill to arrive. New technology is being developed to eliminate this problem. For example, digital systems currently make it harder to clone a phone. However, this area will always be a target for "hackers." It's a race, with each side pushing for better technical solutions, only to be overridden by the other side.

What's going on with area codes?

Even without the rapid increase in the number of wireless customers,⁴⁹ the number of telephone numbers available in some area codes has already been used up, or "exhausted." There are two technical solutions⁵⁰ to this issue with wireline carriers falling into both camps:

- **Overlay:** In this case, a new area code is stacked, or overlaid, over the existing area codes. Customers who already have phone numbers retain their current area codes; new customers receive phone numbers with a new area code. However, instead of the current 7 digits, customers would have to dial 10 digits for all local calls.
- **Split:** In this case, the territory covered by an existing area code is split into two or more areas. One area retains the existing code, and the other areas receive new codes. Some local calls require only 7 digits and other local calls now require 10 digits.

Most wireline carriers tend to favor a split since renumbering is done at the switch. However, if an area is experiencing rapid growth, then the company may favor an overlay rather than repeatedly reprogramming its switches and its billing systems.

IV. Is There Life after Auctions?, cont.

Similarly, wireless carriers may fall into either of the two camps. With wireless technology, the renumbering is done to the mobile handset. The customer has to bring the handset to a company representative. Many of the new PCS companies don't care about the overlay since they are just starting operations and don't have many customers. However, other existing cellular companies and some of the PCS companies prefer a split. With a split, only some of the customers have to bring in their handsets for reprogramming.

In addition, consumers and businesses would prefer to avoid the inconvenience, the additional costs, and potential loss of customers associated with number changes. However, if an area experiencing rapid growth has already gone through several splits in a relatively short time, then the customers are more likely to favor an overlay.

While a number of industry and government groups are working on the long-term plans for numbering nationwide, in the short-term, the treatment of area code exhaustion remains an issue.⁵¹

What is "calling party pays"?

Under a "calling party pays" plan, the person who calls the wireless customer pays for the call. The advantage to this plan is that people will hand out their wireless numbers because they are not charged for incoming calls. With "calling party pays," there is a technology that could be used to alert the person originating the call that there will be a specific charge for his or her call to the wireless customer. Another approach is that wireline and wireless technologies will be transparent to the customers; the same rates would be used regardless of whether it's wireline or wireless.

What's happened to the price of wireless services?

Over the past ten years, the average local monthly wireless bill has decreased from \$96.83 to \$47.70.⁵² A number of factors contributed to this decrease. One factor is that the initial startup costs for installing new facilities are reflected in the prices charged to the customers.⁵³ In a competitive market, after these costs have been recovered, companies providing services often lower their prices. For example, the price of a wireless handset has dropped from \$179 in 1994⁵⁴ to as low as about \$50 in 1997.⁵⁵

A second factor contributing to the decrease in prices is the introduction of competition into the former cellular duopoly (a limit of two cellular companies per market). Many PCS providers are already competing in the major cellular markets. In some areas, wireless service is already becoming a substitute for local wireline service.

A third factor contributing to wireless price reductions is new pricing structures. Unlike traditional local telephone services, where prices vary city by city, some new wireless services have the same price regardless of the location. For example, when the customer roams from one city to another, the price for local calls stays the same. This is a local equivalent of a single nationwide long distance rate offered by some long distance companies.

From the customer's viewpoint, service features (such as mobility, access to emergency

IV. Is There Life after Auctions?, cont.

services, ability to reach people or databases through the network, and price) are more important than specific technologies. Advances in technology have created more than one technical solution for transmitting data between the local telephone company switch and the customer's location, such as a house or office. For example, a wireless technology, called "fixed wireless," permits replacement of the traditional industry's copper wire, coaxial cable, or fiber optic cable with a wireless link. Traditional telephone services, such as voice calls, data transmissions, and Internet access, can all be carried over fixed wireless links. Fixed wireless technologies and services are part of a wireless evolution. This evolution and its wireline counterparts will be the focus of a future paper by the Telecommunications Industries Analysis Project.

V. Additional Policy Issues

Additional Policy Issues

1. Interconnection
 - a. Appropriate technology, including standards
 - b. Economically efficient pricing
 - c. Appropriate rules regarding the provision of resold services and interconnection of networks
2. Defaults on build-outs of PCS facilities
3. Fraud
 - a. Licensing applications
 - b. Consumer fraud
4. Security/Privacy
5. Number portability and roaming
6. Billing structures, including payments and administration systems
7. Jurisdiction
 - a. Federal
 - b. State
 1. States preempted with regard to market entry and rate regulation
 2. Consumer protection/quality of service
 3. Facilities siting (towers/zoning)
 4. Bundling of PCS services with wireline
 5. Operator/emergency services/Telephone Relay Service (TRS)
 6. Impact of MTAs/BTAs overlapping state boundaries on preemption issue
 - c. Municipal
 1. Environmental/tower siting
 2. Taxation (such as per customer or by percent of total revenues)
 3. Construction/right-of-way
8. Site acquisition
 - a. Impact on communities
 - b. Real estate availability and cost
9. Universal service role
10. Unlicensed services
11. Potential competitors
12. Resale

VI. Notes

Notes

- ¹ Carol Weinhaus, Charlene Lagerwerff, Bob Lock, et al., *Cellular to PCS: A Wireless Primer* (hereinafter referred to as *Wireless Primer*), presentation at the February 1996 National Association of Regulatory Utility Commissioners (NARUC) Meeting, Washington, DC, Telecommunications Industries Analysis Project, Boston, MA, December 21, 1995.
- ² In the telecommunications industry, the prevailing market philosophies (monopoly, competition, and regulation) affect legal and regulatory rules. For an overview, see Carol Weinhaus, Bob Lock, John Bosley, et al., *A Snapshot in Time: LEC Switch Investment and Price Structures for Connections to the Switch Just before the Telecommunications Act of 1996* (hereinafter referred to as *A Snapshot in Time*), presentation at the July 1996 NARUC Meeting, Los Angeles, CA, Telecommunications Industries Analysis Project, May 10, 1996, page 2, and Figure 1, page 3. See also, Carol L. Weinhaus and Anthony G. Oettinger, *Behind the Telephone Debates*, Ablex Publishing Corporation, Norwood, New Jersey, 1988, pages 5 through 13.
- ³ *Telecommunications Act of 1996*, Pub. L. No. 104-104, February 8, 1996 (hereinafter cited as the *Act of 1996*). For more details, see U.S. Congress, House of Representatives, 104th Congress, 2d Session, Report 104-458, *Telecommunications Act of 1996, Conference Report to Accompany S. 652* (hereinafter referred to as the *Conference Report*). The *Act of 1996*, Sec. 3(a)(44) uses the term "Commercial Mobile Service (CMS) Provider," while the FCC uses the term CMRS.
- ⁴ *Act of 1996*, Sec. 601(d), Commercial Mobile Service Joint Marketing, "Notwithstanding section 22.903 of the Commission's regulations (47 C.F.R. 22.903) or any other Commission regulation, a Bell operating company or any other company may, except as provided in sections 271(e)(1) and 272 of the Communications Act of 1934 as amended by this Act as they relate to wireline service, jointly market and sell commercial mobile services in conjunction with telephone exchange service, exchange access, intraLATA telecommunications service, interLATA telecommunications service, and information services."
- ⁵ *Act of 1996*, Section 251(b)(5), Interconnection, Obligations of All Local Exchange Carriers, "Reciprocal compensation: The duty to establish reciprocal compensation arrangements for the transport and termination of telecommunications."
- ⁶ The FCC's *First Report and Order* on the implementation of local competition required wireline telephone companies to enter into reciprocal compensation agreements with CMRS providers, effective thirty days after the *Order's* appearance in the *Federal Register*, August 29, 1996. (*Implementation of the Local Competition Provisions of the Telecommunications Act of 1996*, CC Docket No. 96-98, *First Report and Order*, FCC 96-325, August 8, 1996, hereinafter referred to as the *Interconnection Order*.) However, the U.S. Court of Appeals stay of the *Interconnection Order* gave rise to questions about what was the effective date. [*Iowa Utilities Board v. Federal Communications Commission*, No. 96-3321 (8th Circuit, 1996)] Some carriers contended that the effective date was November 1, 1996 (the date the court-ordered stay was lifted). As part of their interconnection negotiations, many companies have settled on using the November 1 date as the starting date for reciprocal compensation.
- ⁷ There are three major categories of interconnection: with the LECs at a local switch, at a tandem switch, or at the signal transfer point (STP). For a description of the types of wireless interconnection with a local telephone company network, see *A Snapshot in Time*, Appendix D, pages 55 and 56. Before the reciprocal compensation agreements, the average per-minute access rate was between .024 cents to .051 cents. Harry Young, Vice President of Telecommunications Strategies, Strategis Group, "Wireless Interconnection Competition Seminar," Chicago, IL, May 1997.
- ⁸ *Act of 1996*, Sec. 259(a). Infrastructure sharing regulations are required "within one year after the date of enactment."
- ⁹ Section 704(c) facilities siting; availability of property: The *Act of 1996* states "The regulation of the placement, construction, and modification of personal wireless service facilities by any State or local government or instrumentality thereof — (l) shall not unreasonably discriminate among providers of

VI. Notes, cont.

functionally equivalent services; and (II) shall not prohibit or have the effect of prohibiting the provision of personal wireless services," Sec. 704(a)(7)(B). The definition of "personal wireless services" in this section "means commercial mobile services, unlicensed wireless services, and common carrier wireless exchange access services," Sec. 704(a)(7)(C). The *Act of 1996* also states that the "Commission shall provide technical support to States to encourage them to make property, rights-of-way, and easements under their jurisdiction available for such purposes. For details on radio frequency emissions, see Sec. 704(a)(7)(B)(iv) and Sec. 704(b). For details on the availability of property, see Sec. 704(c).

In the *Conference Report* that accompanied the *Act of 1996*, there is further discussion on the issue of FCC preemption of local and state land-use decisions. The preemption only covers certain areas of zoning. "It is the intent of this section that bans or policies that have the effect of banning personal wireless services or facilities not be allowed and that decisions be made on a case-by-case basis." Another intent "is to ensure that a State or local government does not ... favor one competitor over another." On the other hand, the *Conference Report* states that local and State governments have flexibility. "For example, the conferees do not intend that if a State or local government grants a permit in a commercial district, it must also grant a permit for a competitor's 50-foot tower in a residential district." *Conference Report*, pages 207-208.

- ¹⁰ 47 CFR Ch I (10-1-96 Edition), § 24.5, page 224. The FCC originally defined PCS "as a family of mobile or portable radio communications services which could provide services to individuals and businesses, and be integrated with a variety of competing networks." FCC, *In the Matter of Amendment of the Commission's Rules to Establish new Personal Communications Services* (hereinafter referred to as the *PCS Docket*), GEN Docket No. 90-314, *Notice of Proposed Rule Making and Tentative Decision*, FCC No. 92-333, August 14, 1992, ¶ 29, page 14. Also, *Memorandum Opinion and Order*, FCC No. 94-144, June 13, 1994, ¶ 2, page 3.
- ¹¹ *Wireless Primer*.
- ¹² *Wireless Week*, "Competitors Affect Price," May 19, 1997, page 30.
- ¹³ FCC, *In the Matter of Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993; Annual Report and Analysis of Competitive Market Conditions with Respect to Commercial Mobile Services, Second Report*, (hereinafter referred to as the *Second Annual CMRS Competition Report*), FCC 97-75, March 25, 1997, page 20.
- ¹⁴ For a definition of CDMA, see *Wireless Primer*, page 21 and Figure 10, page 26.
- ¹⁵ FCC, *In the Matter of Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993; and Annual Report and Analysis of Competitive Market Conditions with Respect to Commercial Mobile Services, Second Report*, FCC No. 97-75, March 25, 1997, pages 30 and 31.
- ¹⁶ The first analog cellular services were in the 900 MHz range. See **Figure 2** of this supplement and see *Wireless Primer*, Section III, pages 13-16, for a description of the radio spectrum and the frequencies for wireless services.
- ¹⁷ This technology allowed customers to use a single piece of equipment indoors as a cordless phone and outdoors as a PHS handset. "MPT Announces Final Policy on PHS Business," *New Area of Telecommunications in Japan*, November 15, 1994, No. 220, page 1.
- ¹⁸ In the 900 MHz range, the standard was Global Systems for Mobile communications (GSM), and in the 1800 MHz range the standard was Digital Cellular Service, or DCS (which is GSM modified for 1800 MHz use). See **Section IV** for a description of various standards.
- ¹⁹ Personal communication with France Telecom.
- ²⁰ FCC, *In the Matter of Amendment of the Commission's Rules to Establish New Personal Communications Services* (hereinafter referred to as *PCS Rules*), GEN Docket No. 90-314; ET Docket No. 92-100, *Notice of Proposed Rule Making and Tentative Decision*, FCC 92-333, August 14, 1992, ¶ 105, page 42.

VI. Notes, cont.

- ²¹ Most cellular providers are also converting their systems from analog to digital. For a discussion of standards, see *Wireless Primer*, Section IV, pages 20-26. For definitions of analog and digital systems, see *Wireless Primer*, Section II, page 11.
- ²² For a discussion on pioneer's preference licenses, see *Wireless Primer*, Section V, pages 27 and 30.
- ²³ These technical issues include "transmission standards, interference control, inter and intra industry protocols, and roaming." *PCS Rules*, ¶ 106, page 42.
- ²⁴ *ibid.*, ¶ 107, page 42.
- ²⁵ Slight differences in numbers from those in **Figure 3** are due to rounding.
- ²⁶ For background on auction proposals, see U.S. Congress, Congressional Budget Office (CBO), *Auctioning Radio Spectrum Licenses*, Washington, DC, March 1992. See also, U.S. Dept. of Commerce, *U.S. Spectrum Management Policy*. For details on the auctions, including the award of pioneer's preferences and the reasons for initiating spectrum auctions, see *Wireless Primer*, Section V, pages 27-31.
- ²⁷ *Omnibus Budget Reconciliation Act*; and *In the matter of Implementation of Section 309(j) of the Communications Act — Competitive Bidding*, PP Docket No. 93-253; *Implementation of Sections 3(n) and 332 of the Communications Act Regulatory Treatment of Mobile Services*, GN Docket No. 93-252; and the *PCS Docket; Sixth Report and Order*, FCC No. 95-301, ¶ 2, page 3.
- ²⁸ *Adarand*, 115 S. Ct. at 2113. In the FCC's *Report and Order* revising the rules, the FCC states, "The Supreme Court held ... that any federal program that makes distinctions on the basis of race must satisfy the strict scrutiny standard of judicial review." FCC, *In the Matter of Amendment of Parts 20 and 24 of the Commission's Rules — Broadband PCS Competitive Bidding and the Commercial Mobile Radio Service Spectrum Cap, Amendment of the Commission's Cellular/PCS Cross-Ownership Rule*, WT Docket No. 96-59 and GN Docket No. 90-314, *Report and Order*, June 24, 1996, page 3, ¶ 2 and 3.
- ²⁹ *PCS Docket; Sixth Report and Order*, ¶ 39 and 40, pages 23 and 24. See also, *Further Notice*.
- ³⁰ *PCS Docket*, ¶ 47, page 26.
- ³¹ *ibid.*, ¶ 49-52, pages 27-29.
- ³² For details on involuntary relocation, see FCC, *Amendment to the Commission's Rules Regarding a Plan for Sharing the Costs of Microwave Relocation*, WT Docket No. 95-157; RM-8643, *First Report and Order and Further Notice of Proposed Rule Making*, FCC No. 96-196, April 30, 1996, ¶ 23 to 34.
- ³³ One-third of the population in a 30 MHz license area and one-fourth of the population in a 10 MHz license area must have services available. Providers with 10 MHz blocks have an alternative — they can demonstrate to the FCC "that they are providing substantial service." There is also a ten-year benchmark: two-thirds of the population must have broadband services available in this time frame. *PCS Docket, Memorandum Opinion and Order*, ¶ 155-156, page 63.
- ³⁴ See **Section I** for details.
- ³⁵ In the San Francisco area, some communities have resisted the placement of antennas in neighborhoods, near schools, or near churches. *Wireless Week*, "Bill to Promote Sites; Wiretap Law Funding Considered," pages 1 and 4; and "PBMS Launches in San Francisco; Carrier's Bay Area Buildout Marked by Siting Battles," May 19, 1997, page 32. A.J. Schneider, *Daily News Coverage, Indianapolis Business Journal*, "Towers Result in Catch-22; Customers Like Service, but Fight Infrastructure," May 12, 1997, Vol. 18, No. 8, page 17A. For earlier history on local zoning issues, see also, *Wireless Primer*, Section VII, Note 49, page 38.
- ³⁶ The intent of this proceeding was to provide flexibility to "(1) facilitate the efficient use of spectrum by providing licensees with the flexibility to make offerings directly responsive to market demands for particular types of service; (2) increase competition by allowing market entry by new entrants; and (3)

VI. Notes, cont.

- expedite the provision of service to areas that otherwise may not receive broadband PCS service in the near term." FCC, *In the Matter of Geographic Partitioning and Spectrum Disaggregation by Commercial Mobile Radio Services Licensees*, WT Docket No. 96-148; and *Implementation of Section 257 of the Communications Act — Elimination of Market Entry Barriers*, GN Docket No. 96-113; *Report and Order and Further Notice of Proposed Rulemaking*, December 20, 1996, ¶ 1, page 3, (hereinafter referred to as *Partitioning and Disaggregation Proceeding*).
- ³⁷ *Partitioning and Disaggregation Proceeding*, ¶ 2, page 5.
- ³⁸ In one option, the company buying the territory would meet the same five- and ten-year service requirements mandated for the company selling the territory (for 10 MHz or 30 MHz licenses). In the other option, the company selling a portion of its territory would certify that it had met or will meet the five- and ten-year construction requirements for the entire area. In this case, the company buying a portion of this territory would only have to fulfill the substantial service requirements at the end of this ten-year period; *Partitioning and Disaggregation Proceeding*, page 4.
- ³⁹ "The January 1, 2000 benchmark and five-year build-out requirements for disaggregation are eliminated," *Partitioning and Disaggregation Proceeding*, ¶ 2, pages 4 and 5. Section 24.229(c) of the FCC's rules [47 C.F.R. § 224.229(c)] already permitted "a broadband PCS licensee that [had] met its five-year construction requirement to disaggregate its licensed PCS spectrum after January 1, 2000," ¶ 4, page 8.
- ⁴⁰ FCC, June 27 Agenda, WTB/CWD — July 1996, "CMRS Flexible Service Report and Order: Background, Proposed Rule Changes," page 1. This "rule change is intended to eliminate industry uncertainty on this point." FCC, *In the Matter of Amendment of the Commission's Rules to Permit Flexible Service Offerings in the Commercial Mobile Radio Services* (hereinafter referred to as *Flexible Service Proceeding*), WT Docket No. 96-6, *Notice of Proposed Rule Making*, FCC No. 96-17, January 25, 1996.
- ⁴¹ On June 27, 1996, the FCC reported that its flexible spectrum rules "replace rules that limited certain CMRS providers to offering fixed services on an 'ancillary,' 'auxiliary,' or 'incidental' basis to mobile services. The Commission concluded that these regulatory limitations had caused uncertainty among wireless carriers as to the scope of fixed services that were allowed under our [sic.] rules, and could potentially inhibit development of wireless local loop and other fixed services." FCC, "Action in Docket Case: FCC Votes to Permit Flexible Service Offerings in the Commercial Mobile Radio Services (WT Docket No. 96-6)," *NEWSReport* No. DC 96-61, June 27, 1996.
- ⁴² Bob Rutkowski, Technical Planning Engineer, 360° Communications, May 1997.
- ⁴³ In 1996, 58% of PCS, cellular, and emergency specialized mobile radio subscribers gave personal safety (12%) and emergency communications (46%) as the most important reasons to purchase a mobile phone. CTIA, *Wireless Statistics*, "United States Wireless Demographics: Most Important Reason to Purchase a Phone," <http://www.wow-com.com/professional/reference/usdemog.cfm>, May 27, 1997.
- ⁴⁴ Personal conversation with Corning, Inc., May 1997.
- ⁴⁵ FCC, *In the Matter of Revision of the Commission's Rules to Ensure Compatibility with Enhanced 911 Emergency Calling Systems*, CC Docket No. 94-102; RM-8143, *Report and Order and Further Notice of Proposed Rulemaking*, September 10, 1996; Federal Register, August 2, 1996, effective October 1, 1996; ¶ 10, page 8.
- ⁴⁶ This must be completed by October 1, 1997. *ibid.*, ¶ 11, page 9.
- ⁴⁷ This must be completed by October 1, 2001. *ibid.*, ¶ 18, page 12 and ¶ 139, page 69.
- ⁴⁸ No later than October 1, 1997. *ibid.*, ¶ 50, page 26.
- ⁴⁹ The number of wireless subscribers has nearly doubled in the past two years (from 24 million subscribers in 1994 to 44 million in 1996). CTIA, "CTIA's Semi-Annual Data Survey Results,"

VI. Notes, cont.

<http://www.wow-com.com/professional/index.cfm>, May 12, 1997.

- ⁵⁰ There is also an interim solution that pools unused area code numbers. This is a short-term fix for the inevitable area code revamping. See "Ameritech backs 847 plan," *Chicago Tribune*, May 15, 1997, pages 1 and 4. See also, "CUB offers way out of area code nightmare," *Daily Herald*, May 15, 1997.
- ⁵¹ State regulators in North Carolina are currently facing this issue. On one side are eight cellular companies and one local telephone company favoring an overlay. On the other side are twenty-two local and long-distance companies favoring a split. *Daily News Coverage*, Associated Press, "Coalition Presents New Area Code Plan," AP-NY, May 17, 1997.
- ⁵² CTIA, "CTIA's Semi-Annual Data Survey Results," <http://www.wow-com.com/professional/index.cfm>, May 12, 1997. The data are for December 1987 and December 1997.
- ⁵³ When technologies are new, the equipment is often more expensive in the early stages of deployment. In this stage, the companies producing the equipment need to recover their research, development, and production costs. They pass these costs on to the companies that build the facilities, who, in turn, pass these costs on to their customers.
- ⁵⁴ "AT&T will deliver," *Television Digest*, Vol. 34, No. 38, September 19, 1994, page 19.
- ⁵⁵ Price reported is that of a portable handset, not that of a mobile car phone. "Cellular Phones," *Consumer Reports Buying Guide 1997*, Vol. 61, No. 13, December 15, 1996, page 175.