Incidental Paper

Cellular Phones: Is There Really Competition?

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Program on Information Resources Policy

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Cellular Phones: Is There Really Competition?

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Executive Summary

This paper describes the cellular radiotelephone industry in the United States and points out several relevant policy issues. In 1993, ten years after its birth, cellular radio, which may lead the wireless revolution of the 1990s, reached a size and level of dynamic maturity sufficient to provide guidance—if not lessons—for the future.

The complex and not always transparent structure of the cellular service industry and the dissatisfaction some parties (for example, several major states) have expressed are rooted largely in decisions of the 1980s, which federal authorities made either consciously or by default.

The analysis presented in this report of cellular service provision in the U.S. indicates the following:

- Only modest price decreases occurred over most of the decade, in spite of the competitive scheme implemented by the FCC and of subscriber levels well in excess of expectations;

- Cellular service provision is controlled by a small number of big operators mainly and increasingly in the hands of traditional telephone companies, although this probably was not the intent of the regulator;

- The great geographic fragmentation of the service offering makes satisfying the needs of truly mobile users both difficult and costly; and

- The technological evolution of the cellular infrastructure, particularly implementation of digital radio communication with its inherent benefits, is hampered by diverging standards, whose multiplicity handicaps the technological leadership worldwide of the U.S. cellular industry.

Plans as of early 1994 for the introduction of personal communications services—a natural extension of cellular—including the license auctions to be held in 1994 and 1995, appear to address these issues only partially.

Note

The database for this report closed early in 1994, and the principal research was completed by that date.

Contents

Illustrations

Figures

Tables

Chapter One

Overview

In the early 1990s wireless[1] became a major driver in the transformation of the telecommunications industry, as optic fiber had been for some time.[2] The most visible dimension of wireless as such a force to the general public and business alike is cellular radiotelephony.[3]

Cellular[4] is generally viewed as a great American success story[5]: by July 1993, less than ten years after its birth—the first cellular system was activated in Chicago in October 1983—there were more than thirteen million cellular subscribers in the U.S. By that time cellular carriers had invested $13 billion and were employing 36,500 people; in 1992 they collected $7.8.billion in service revenues.[6] This impressive growth pattern, illustrated in **Figure 1-1**, appears largely recession-proof and unlikely to change dramatically soon: between mid-1992 and mid-1993, the subscriber population continued to grow by 47.0 percent. Actually the U.S. penetration (mid-1993) was only 5.0 percent of population; this is substantially less than the most penetrated—albeit much smaller—countries in the world.[7]

This achievement owes a great deal to the ingenuity of the American engineering, business, and regulatory communities. This report analyzes several current questions and

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[1]The now generally accepted term "wireless" covers the technologies and services that for the user eliminate dependency on physical lines, cables, and sockets to place or receive telephone calls or to exchange data, facsimiles (faxes), images, or other types of messages. Basically, wireless means radio (electromagnetic waves on the air) and remains strongly associated with mobile communication.

[2]For an introduction to the discussion of wireless and policy, see Derrick C. Huang, *Up in the Air—New Wireless Communications* (Cambridge, Mass.: Harvard University Program in Information Resources Policy, August 1992, P-92-3).

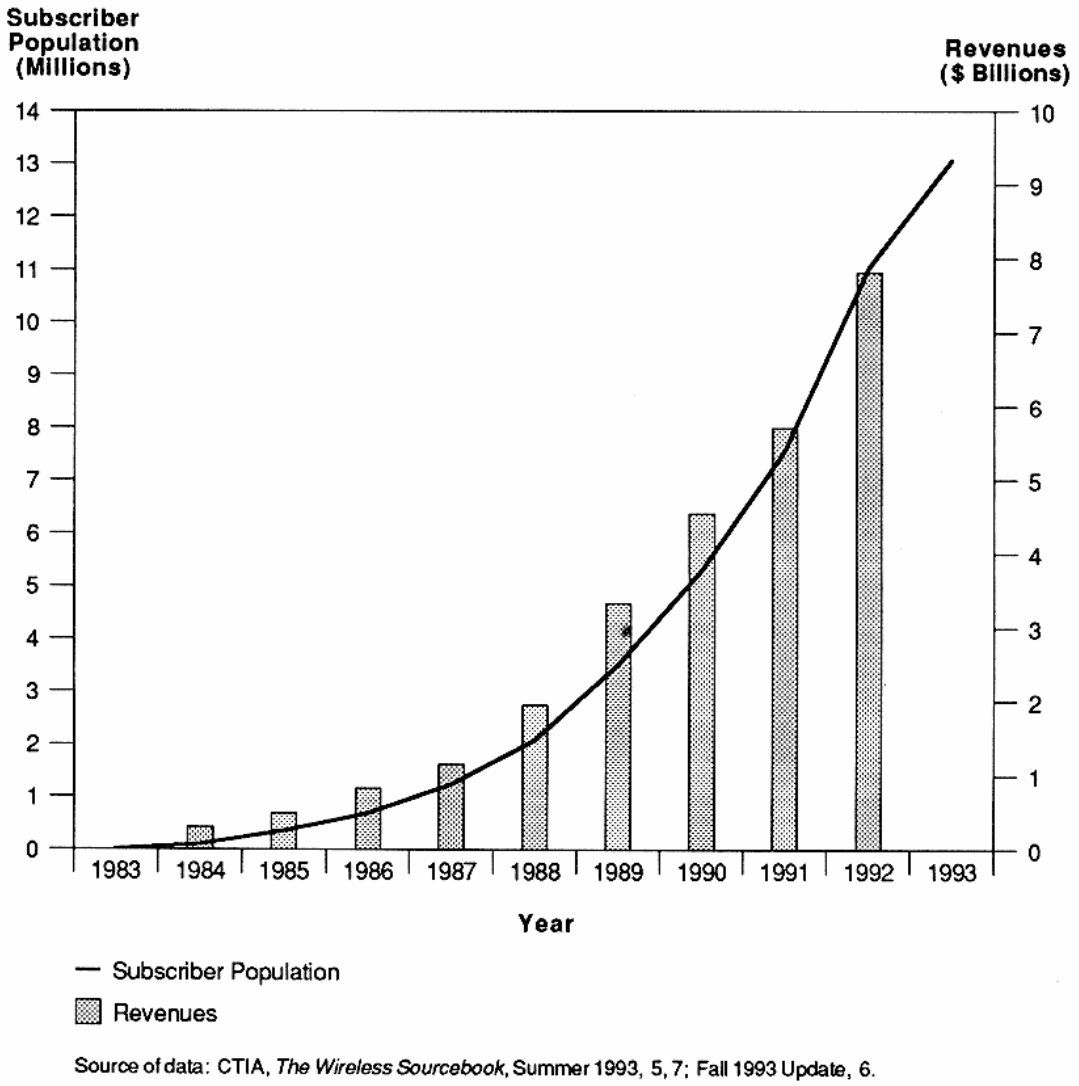
[3]Some basic concepts in cellular radio are summarized in the Appendix.

[4]In this report the generic *cellular* is used to designate technologies and services associated with mobile cellular radiotelephony.

[5]Cellular Telecommunications Industry Association (CTIA), "What a Fabulous American Success Story!" *The Wireless Sourcebook*, Summer 1993, 1.

[6]Ibid. Data made public by CTIA.

[7]Sweden, Finland, and Norway had cellular penetrations of 9.0, 8.7, and 8.0 percent, respectively, by August 1993, according to the newsletter *European Mobile Communications* (August 1993).



Source of data: CTIA, *The Wireless Sourcebook*, Summer 1993, 5, 7; Fall 1993 Update, 6.

Figure 1-1

Growth of Cellular Subscriber Population and Revenues

problems that appear important when developing wireless policies and regulatory provisions for the future. Four specific issues are addressed here:

(*i*) **Competition**: How well does competition work for cellular, in the interest of the users? This question has been debated significantly, because it affects the need for more competitors to offer cellular-like services or a need for other measures that would make competition work better.

(*ii*) **Concentration**: Is the cellular services industry becoming too concentrated, particularly in the hands of the conventional telephone industry? Such an evolution, which is clearly taking place, is probably not in the spirit of the original regulatory framework and may have unfortunate side effects.

(*iii*) **Fragmentation**: Is the cellular services industry, as perceived by the mobile user, too fragmented? The geographic fragmentation of U.S. cellular service provision is striking: a large number of independent systems have been set up just to serve local needs, whereas many users' mobility extends beyond their local area, often region-wide and nationwide.

(*iv*) **Technological Evolution**: Is the cellular services industry following the pace of technology, specifically in relation to digitization? Digital technologies applied to cellular allow better use of the radio spectrum and provide a number of advantages to the end-user. But the withdrawal of the Federal Communications Commission (FCC) from its historic standard-setting role followed by the industry's inability to achieve consensus contribute to delaying digitization and may later introduce further complexity and inconvenience for the subscribers. Concern has been expressed within the industry that this situation is detrimental overall to the worldwide leadership of the U.S. in mobile communications.

There are other policy or regulatory issues related to cellular, for example, interconnection: how dependent should cellular carriers be on landline carriers and to what extent can cellular carriers be their own landline carriers? How do the interconnection provisions—for interconnection between cellular and landline—allow for fair competition between classes of cellular carriers? Or the matter of security, in the sense of confidentiality: what legal provisions against eavesdropping should be in place, and what are the cellular carriers' obligations and the users' rights regarding privacy? Or the implications for policy and standards of serving international travellers? These questions receive only incidental mention in this report.

This analysis is limited to the four issues outlined above. The focus is on the cellular services industry, its customers, and the regulator in the broadest sense. The discussion of these more or less controversial subjects is preceded by a description of the cellular scene, its background, regulatory framework, and industry structure.

Chapter Two

Background

2.1 The Original Regulatory Framework and Its Evolution

Cellular radiotelephony, a novel way of using a limited amount of radio spectrum to put mobile telephone at the disposal of many (see **Appendix**), is no doubt an American invention. The way to cellular service in the U.S., however, was long, as has been well documented by Calhoun and others.[1] It can be seen as the evolution from small-capacity, more or less specialized radio communication systems to large-capacity mobile telephone services that took place against the will of the established telephone industry, which wanted to develop cellular as a natural extension to the monolithic public telephone network.

Some two decades after AT&T had made several technical proposals—as early as 1947—the FCC opened a cellular rulemaking docket in 1968. Two years later cellular was allotted forty MHz[2], which constituted a very close win against the TV industry with its voracious spectrum demands. Political wrangling among the various players essentially explains why another twelve years elapsed before commercial cellular service was opened in October 1983.

Since the 1940s, the Radio Common Carriers (RCCs) sector[3] had been open to competition, which made it difficult for AT&T to push through for cellular a monopoly similar to the one prevailing for conventional telephony (in which AT&T was then the dominant player). The long, complex battle among Motorola, the RCCs, the FCC, the judiciary, and AT&T bought time, allowing the initially weaker RCC industry to strengthen its arguments and position (for example, in light of the newer switching technologies[4]). Thus,

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[1]George Calhoun, *Digital Cellular Radio* (Norwood, Mass.: Artech House, 1988); hereafter referred to as Calhoun with a page number. See also, Christopher J. Mines, *Policy Development for Cellular Telephone Service in the United States and the United Kingdom* (Cambridge, Mass.: Harvard University Program on Information Resources Policy, P-93-3, September 1993).

[2]Extended in 1986 to fifty MHz.

[3]In the early 1980s there were more than five hundred RCCs.

[4]"New digital switching systems were emerging and becoming cheaper and more 'turnkey'. . . . Much of this technology was [finally] coming from outside the Bell system. By the end of the 1970s, it was clear that AT&T no longer had the monopoly on switching technology and know-how it had enjoyed in 1971. In short, it began to

in January 1980 the FCC started a new cellular rulemaking proceeding focussed on licensing. It concluded in its May 1981 Report and Order that two licenses had to be awarded in each of the thirty major cities (called top markets): one to the local telephone company and one to any other most qualified entity that the FCC would choose from among applicants. Competition was introduced into the cellular world and was there to stay.

The aggressiveness of the RCCs in pursuit of the cellular opportunity and the heavy workload generated by the Comparative Hearings led the Commission to switch to a lottery system for the selection of licensees beyond the thirty top markets. The way lotteries developed (see section **3.3**) has led the process to be named, as late as 1988, a "licensing disaster."[5]

Most people would agree, however, that the ten years from 1984 to 1993 have seen a striking—and largely unexpected—cellular explosion. Perhaps because cellular took so long to emerge and demand for it had built up, it was adopted by the marketplace more quickly than any other new end-user communications technology: it took less than nine years to reach ten million subscribers in the U.S., whereas reaching the same penetration for the basic wired telephone and for fax took thirty-eight and twenty-two years, respectively. More important, for the majority of Americans[6] cellular service is available where they live and work.

Notwithstanding the political and regulatory developments of since 1990 under the label personal communications services (PCS) (which make use of wireless technologies and actually are an extension of cellular), the original regulatory framework described above was little changed. Two modifications are noteworthy.

First, in 1988 the FCC relaxed the rule linking cellular licenses to use of a unique technical analog standard, the American Mobile Phone System (AMPS). Relaxation opened the door for implementation, in the same frequencies originally allocated to analog cellular, of new, more spectrum-efficient—particularly digital—technologies. Further, these frequencies were no longer restricted to mobile telephony: data and fax transmission also could be offered. Second, in 1991 the FCC, noticing that cellular licensees did not cover some

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dawn on people that an RCC could actually set up and operate a cellular system" (Calhoun, 53).

[5]Calhoun, 134.

[6]By year-end 1992, 96.5 percent, according to CTIA.

nonnegligible areas within the markets they were licensed to serve, decided to award new licenses aimed at the unserved areas.

2.2 The Cellular Industry at Large

Within the U.S. cellular arena there are five key categories of players with more or less conflicting stakes.

(*i*) Government in the broadest sense and other referees (including Congress, the individual states, and the judiciary), all with regulatory and spectrum management prerogatives;

(*ii*) Cellular carriers, which operate cellular systems and offer cellular services, in contact with end-users, either directly or through separate marketing channels such as mobile communications dealers or resellers;

(*iii*) Landline carriers, which extend calls to and from fixed telephone network subscribers;

(*iv*) Manufacturers of cellular network equipment and cellular phones[7] and their distribution channels; and

(*v*) End-users or subscribers.

The dominant role of cellular carriers within the industry is not reflected by visibility in the market (the subscriber generally is more familiar with the brand name on the phone than with the name of the carrier). It stems, rather, from the carriers' financial weight: over the few years during which a typical end-user will make use of the cellular phone acquired at a genuine or carrier-subsidized price, the end-user normally will spend several times that amount in service charges.

The cellular infrastructure equipment manufacturing sector is also much smaller than the cellular carriers' business, because the manufactured elements a carrier needs represent only a modest fraction of the total costs. According to one estimate (clearly on the low side), "The global market for cellular services is valued at $10-15 billion. The global market for cellular network equipment and cellular phones is valued at $1-2 billion."[8]

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[7]Hereafter referred to simply as *phones*.

[8]U.S. International Trade Commission, *Global Competitiveness of the U.S. Advanced Technology Industries: Cellular Communications*, June 1993, ix.

Chapter Three

The Cellular Services Industry

3.1 Local Cellular Carriers and Systems

The concept of the 734 markets that constitute the basic framework of cellular in the U.S. is based partly on work carried out (since the 1950s) at the Bureau of the Census and the Office of Management and Budget (OMB). This work showed that trade-related and other interactions take place to a large extent within 306 urban areas labelled metropolitan statistical areas (MSAs). Because MSAs are a good representation of the connections urban areas provide within the U.S., they were originally chosen to become cellular markets. Subsequently, the grid was completed with 428 rural service areas (RSAs). The MSAs encompass 75 percent of the nation's population, while the RSAs encompass the remaining 25 percent but represent 80 percent of the land mass.[1]

The geographic pattern of the MSAs and RSAs does not match the way the conventional telephone network is segmented for business or for regulatory purposes, namely, into the regions serviced by the seven regional Bell operating companies (RBOCs) and their 164 local access and transport areas (LATAs). Nor does this pattern match any political or administrative subdivision, except that in each state there are a number of MSAs and RSAs and that each MSA or RSA encompasses a number of counties.

In each cellular market[2] there is a wireline (also called B block[3]) carrier, namely, the local telephone company, which competes against the nonwireline (or A block) carrier. Each carrier, wireline or nonwireline, at that local level operates a single cellular system comprising base stations and one or more mobile telephone switches tied into the local telephone network. The layout of the cells, hence the deployment of the base stations, insures radio coverage of the service area corresponding to the market with which the system is associated.

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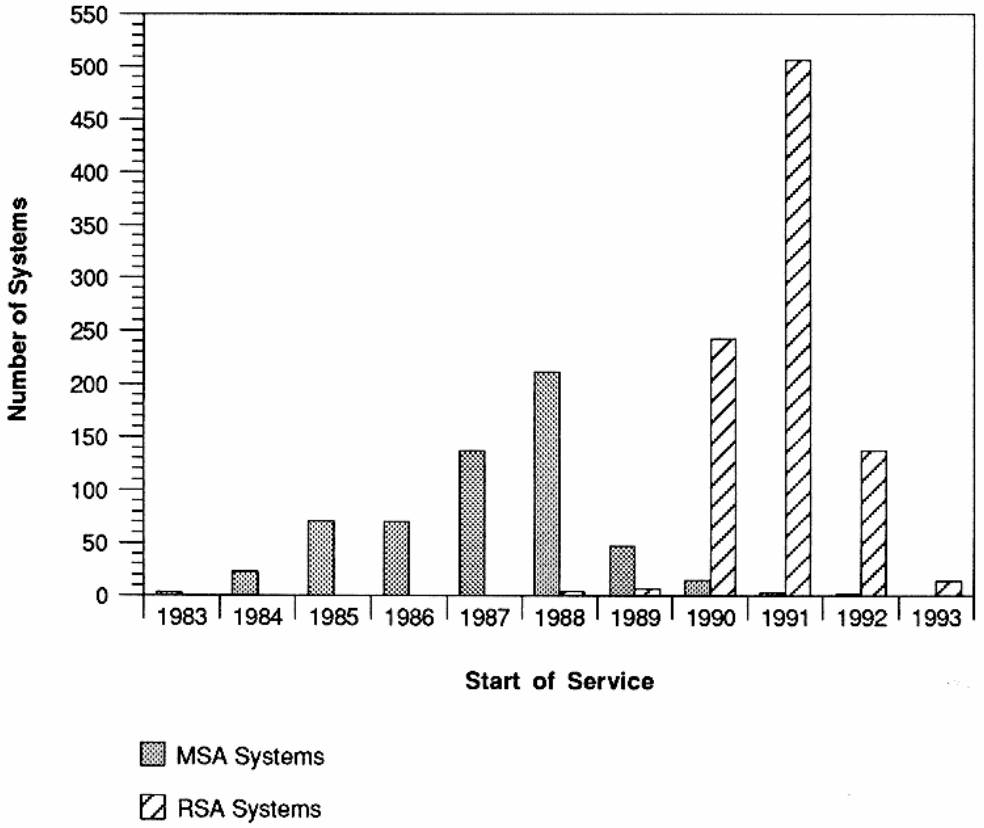
[1]*The Wireless Sourcebook*, Summer 1993, 22.

[2]Markets are numbered from 1 to 734 and for easy reference the RSAs in each state also are numbered. The MSAs are commonly referred to by the associated major city.

[3]Blocks of radio spectrum allocated to the respective carriers: A block: 824-835, 845-846.5, 869-880 and 890-891.5 MHz; B block: 835-845, 846.5-849, 880-890 and 891.5-894 MHZ.



Source of data: CTIA, *The Wireless Sourcebook*, Summer 1993, 108-176.

Figure 3-1

Distribution of Cellular Systems by Year of Start of Service

Markets differ widely in geographic size (ranging from less than a hundred to ten thousand square miles) and demographic characteristics. The Los Angeles market, for instance, with a population of fourteen million, approached one million cellular subscribers at year-end 1993.[4] In contrast, the population of the Modesto, California, MSA for example, is less than 100,000; the wireline system there has a single base station serving a couple of

[4]The Los Angeles market had 854,000 subscribers in March 1993, according to "RCR Top 20 Cellular Markets, 1-20," *RCR*, June 21, 1993, 10.

thousand subscribers. Hence, the 1,523[5] cellular systems deployed as of mid-1993 are quite diverse in scope and layout.

Start-up of so many systems took place gradually over the 1984—1993 period, paced by the licensing process. Analysis of the dates of the opening of commercial service[6] indicates that 50 percent of the 306 MSA systems were operational by the end of 1987, but not until mid-1991 were 50 percent of the 428 RSA systems operational (see **Figure 3-1**). This history largely contributed to the lower penetration achieved in rural areas: the number of RSA subscribers by year-end 1992 is estimated to represent less than 10 percent of the total cellular subscribers, an estimate that supports the assumption that RSAs constitute a privileged growth potential for the coming years.

3.2 Other Regulatory Provisions

Cellular may not appear a heavily regulated area: carriers generally do not need to file tariffs,[7] but they must comply with specific federal rules and regulations. From the start, the FCC "asserted federal primacy over the areas of technical standards and competitive market structure for cellular services,"[8] consequently minimizing the role states can play. Key to the regulatory framework is the Cellular Geographic Service Area (CGSA) of a cellular system, i.e., the area in which the licensee is committed to provide service: it must, from initial operation onward, serve at least 75 percent of the CGSA and has five years (from the date of the license) to "fill in" that CGSA. Parts of the CGSA then not covered—the unserved areas—are subject to new licensing[9]; this procedure stimulates established carriers to "build out" their markets. The FCC received a large number of fill-in applications, but had not defined an appropriate selection procedure—auction or other—as of end 1993.

Construction of facilities, such as base stations, must be authorized by the FCC (though since November 1991, a simple notification to the FCC will do). The carrier, however, is not

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[5]*The Wireless Sourcebook*, Fall 1993 Update, 5.

[6]Data derived from *The Wireless Sourcebook*, Summer 1993, 108-176.

[7]This point is controverted: in 1992 a Court of Appeals ruled in the opposite direction, and a rectifying bill was introduced in the House in 1993.

[8]"Amendment of Rules Relative to Cellular Communications Systems," Final Rule published May 21, 1981, *Federal Register*, 27669.

[9]See "Rules for Unserved Areas," FCC Rcd 6185 (1991).

relieved of the need to secure local approval to set up towers in compliance with local zoning laws; such approval is increasingly difficult to obtain.

To deter practices incompatible with fair competition, cellular services are to be rendered by separate entities—corporations—with their own account books, personnel, and facilities.[10] This provision is largely aimed at the wireline carrier, because it is affiliated with the local telephone company that essentially has a monopoly on conventional local voice services. According to another regulatory constraint imposed from the very start, cellular carriers are not allowed to offer "fleet call dispatch" services.[11] The reason invoked is the inefficient use of spectrum that would result from the many short calls such services entail, if handled by cellular systems; another reason may be the wish to protect the dispatch sector from competition from cellular. As it turned out, the ambitions of the (noncellular) mobile radio industry—which includes companies specializing in dispatch—with its current wave of mergers and acquisitions,[12] represent a competitive threat to the cellular carriers.

Until 1993 cellular and paging were categorized as *common carrier radio services*, as opposed to *private radio services*, which include specialized mobile radio (SMR) operators.[13] This categorization is changing: in line with legislation enacted by Congress in 1993,[14] mobile services will be labelled either *commercial* or *private*. To determine the relevant criteria for these two classes, in October 1993 the FCC issued a Notice of Proposed Rulemaking.[15] Cellular is to become a commercial mobile service, because it is rendered to the public against payment and to a large extent complements the public switched telephone network. This change means that future licensing of cellular is likely to be by auction.

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[10]"Amendment of Rules Relative to Cellular Communications Systems," Final Rule published May 21, 1981, *Federal Register*, 27656.

[11]Ibid., 27672: "Fleet call dispatch service is a variety of dispatch service in which a dispatcher is able to establish simultaneous communication with multiple mobile units."

[12]Nextel (previously known as Fleetcall, a major specialized mobile radio operator, is in the process of deploying, with the assistance of Motorola, a nationwide digital mobile communications network that will offer cellular-like services.

[13]Because SMRs offer services for profit, not to the public but to specific business sectors, they were considered private.

[14]Amendment to the 1934 Communications Act by Title VI, section 6002(b), of the Omnibus Budget Reconciliation Act of 1993.

[15]"Regulatory Treatment of Mobile Services," Proposed FCC Rule published in the *Federal Register*, Oct. 14, 1993, 53169-53172.

3.3 The Change of Hands and the Current Structure

Already in 1982, at the outset of cellular licensing, interest in this business was considerable: for the thirty largest cellular markets (i.e., the largest cities) there were more than two hundred candidates for a nonwireline license, many of them large companies experienced in aspects of communications, such as cable TV operators or long-distance exchange carriers. The Comparative Hearings allowed licenses to be granted to the candidates most qualified and able to make the necessary financial investments. The lotteries used subsequently for the hundreds of other markets and the purely speculative goals of many applicants led to awarding licenses to individuals neither qualified nor interested in setting up and operating a mobile telephone system. Calhoun gives some satirical but apparently real examples:

> The Nashua, New Hampshire, franchise was won by an octogenarian, a disabled truck driver and a highway engineer, all from California. . . . The three Californians barely know each other, know even less about car phones and haven't ever driven through Nashua. . . . The Little Rock, Arkansas, license was won by an Odenton, Maryland, housewife and her husband, a switchboard repairman. Melbourne, Florida, went to a San Jose, California, dentist and his wife, an artist.[16]

As might be expected, a vast change of hands followed. Research for this report did not discover a relevant detailed analysis, but the FCC (which must be advised of all modifications regarding licensee ownership) asserts that "as of March 1993, 70% of all cellular licenses and 85% of the nonwireline licenses had been the subject of at least one non-proforma transfer of control."[17]

The current industry structure results from this complex reshuffling of the deck, fairly continuous since 1984. First, on the wireline side of the business, the two percentages quoted above indicate[18] that 55 percent of wireline carriers were subject to change of control, a surprisingly volatile pattern for the local telephone company world. More important, nonwireline carriers were extensively bought up by wireline carriers active in other markets,

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[16]Calhoun, 134, citing the *Wall Street Journal.*

[17]*FCC Notice of Proposed Rulemaking in the Matter of Competitive Bidding (Auction Law)*, Oct. 12, 1993, 13.

[18]Because there are as many wireline as nonwireline licenses.

or, rather, by the telephone groups those wireline carriers belong to. Illustrating this point, **Table 3-1** lists the most important known transfers and acquisitions from 1987 to 1992.

Table 3-1

Major Cellular Operator Acquisitions and Transfers, 1989–92

Acquiring Operator or Buyer	Acquired Operator or Seller	Date	Scope of Acquisition
British Telecom	McCaw	1/89	22%
Lin Broadcasting	Metromedia	9/89	New York City
Century Communications	Providence Journal	1/90	1 market
Contel	McCaw	2/90	13 markets
Time Warner	Price Communications	3/90	25%
McCaw	Lin Broadcasting	3/90	New York, Los Angeles, Philadelphia, Houston, Dallas
GTE	Providence Journal	4/90	8 markets
Metromedia	Lin Broadcasting	5/90	Philadelphia
GTE	Contel	7/90	174 markets
Pactel	Cellular Communications	7/90	15 markets
Southwestern Bell	Crowley Communications	10/90	4 markets
BellSouth	GTE/Contel	3/91	Atlanta
BellSouth	McCaw	4/91	3 markets
Comcast	Metromedia	5/91	Philadelphia
Ameritech	Cybertel	5/91	8 markets
Pactel/McCaw	Associated Communications	8/91	6% of San Francisco
Bell Atlantic	Metromobile	9/91	21 markets
Sprint	Centel	5/92	125 markets
AT&T	McCaw	11/92	33%

Source: MTA/EMCI, *Cellular Marketplace*, Washington, D.C., 1993. Data based on reports from *Mobile Phone News*, *Telocator Bulletin*, *The Media Quarterly Review*, *RCR*, and *The Cellular Investor*.

A noteworthy feature is the pattern of multiple ownership of cellular carriers, wireline and nonwireline alike. This pattern is illustrated, for example, by the list of cellular subsidiaries of the BellSouth Corporation (**Table 3-2**), the largest RBOC and also probably

Table 3-2

Holdings of BellSouth Corporation in U.S. Cellular Carriers (Through BellSouth Enterprises and BellSouth Mobile Systems)

	Percentage Ownership*
BELLSOUTH CELLULAR CORPORATION	—
American Cellular Communications	**100**
ACC of Rockford, Inc.	100
National Cellular Communications Inc.	99.9
Anniston-Westel Company, Inc.	100
Gulf Coast Cellular Telephone Co.	98.7
Bakersfield Holdings, Inc.	100
Bakersfield Cellular Telephone Co.	100
Charisma Communications Corp. of Southwest	50
Galveston Mobile Corporation	100
Galveston Mobile Partnership	43.7
Galveston Cellular Partnership	56
Galveston Cellular Telephone Co.	100
Gary Cellular Corporation	100
Gary Cellular Telephone Co.	33
Hawaii Cellular Corporation	100
Honolulu Cellular Telephone Co.	51
Houston Cellular Corporation	100
Houston Mobile Cellular Communications Co.	42
Cellular Systems	50
Houston Cellular Telephone Co.	75
Jackson Holdings, Inc.	100
Jackson Cellular Corporation	100
MCTA	50
Los Angeles RCCS, Inc.	85
Los Angeles Cellular	51
Los Angeles Cellular Telephone Co.	65
ACC Cellular	100
Westel–Indianapolis	**100**
Bloomington Cellular Telephone Co.	92
Muncie Cellular Telephone Company, Inc.	93
Terre-Haute Cellular Telephone Company, Inc.	93
Kokomo Celltelco Partnership	9
Westel–Los Angeles Co.	**100**
Westel–Milwaukee Company, Inc.	**100**
Green Bay Cellular Telephone Co.	99.1
Janesville Cellular Telephone Co., Inc.	79.9
Madison Cellular Telephone Co.	92.5
Racine Cellular Telephone Co.	88.2
Sheboygan Cellular Telephone Co., Inc.	86.3
Westel Richmond, Inc.	**100**
RCTC Wholesale Co.	72.7
Richmond Cellular Telephone Co.	100
Westel–Tampa Company	**85**

*Indentation left and sequence down express hierarchy of ownership from primary company through subsidiaries. Percentages indicate portion of a subsidiary owned by another company, usually another subsidiary.

Table 3-2, continued

	Percentage Ownership
BELLSOUTH MOBILITY INC.	**100**
Acadiana Cellular General Partnership	35
Alabama Cellular Service, Inc.	100
Huntsville MSA L.P.	40
Centel Cellular Company of Hickory	3.4
Centel Cellular Company of North Carolina	11
Centel Cellular Company of Tallahassee	10
Centel Cellular Company of North Louisiana Cellular L.P.	9
Chatanooga CGSA, Inc.	100
Chatanooga MSA L.P.	62.7
Chatanooga CGSA, Inc.	100
Decatur RSA L.P. 80	
Florida Cellular Service Inc.	100
Jacksonville MSA L.P.	85.8
Florida RSA No. 1 L.P. 30	
Florida RSA #2B (Indian River) L.P.	71.5
GEORGIA CELLULAR SERVICE, INC.	**100**
Atlanta Athens MSA L.P.	99.9
Georgia Cellular Holdings, Inc.	100
Georgia RSA No. 1 L.P.	40
Georgia RSA No. 2 L.P.	45
Georgia RSA No. 3 L.P.	75
Kentucky CGSA Inc. 100	
Baton Rouge MSA L.P.	48
Lafayette MSA L.P.	48
Louisiana RSA No. 7 Cellular General Partnership	66.7
Louisiana RSA No. 8 L.P.	50
Memphis CGSA, Inc. 100	
Memphis SMSA L.P.	75
M-T Cellular, Inc.	100
Nashville/Clarksville CGSA, Inc.	100
Nashville/Clarksville MSA L.P.	5.5
North Carolina RSA 15 North Sector L.P.	11
Northeastern Georgia RSA L.P.	34
Northeast Mississippi Cellular Inc.	100
Orlando CGSA, Inc. 100	
Orlando SMSA L.P.	85
South Carolina Cellular Service, Inc.	100
Columbia MSA L.P.	5.5
South Carolina RSA No. 4 Cellular General Partnership	50
South Carolina RSA No. 5 Cellular General Partnership	50
South Carolina RSA No. 6 Cellular General Partnership	50
Cellular Mobile Services of California, Inc.	100
Cellular Mobile Services of Illinois, Inc.	100

Table 3-2, continued

	Percentage Ownership
GEORGIA CELLULAR SERVICE, INC., cont.	
Cellular Mobile Services of Indiana, Inc.	100
Cellular Mobile Services of Michigan, Inc.	100
Cellular Mobile Services of Missouri, Inc.	100
Cellular Mobile Services of Texas, Inc.	100
Graphic Cellular Properties, Inc.	100

Source: BellSouth Corporation, records and public filings.

the operator with most cellular holdings. Over 60 percent of the ninety-two cellular subsidiaries are partially (i.e., not wholly) owned by Bell South. Multiple ownership pushed to this degree implies that the *number of subscribers a cellular operator has*[19] is an ambiguous notion as well as often considered confidential information.

The industry publication *RCR* (*Radiocommunications Report*) estimated for each major operator the aggregate number of subscribers it serves on cellular systems in which it has a majority ownership. **Table 3-3** presents these data for the eighteen major operators ranked by number of subscribers. To the extent that this information can, at least approximately, be relied upon, it shows that taken together these eighteen serve 92 percent of the total U.S. subscriber population[20]; this percentage would be even higher if it included minority interests. On the other hand, the cellular business community—such as CTIA or securities analysts—often chooses to calibrate an operator in "pops" i.e., population in markets it serves, prorated according to the percentages of ownership. As shown in **Table 3-3**, this measure would lead to a substantially different ranking, because penetrations in various markets differ. In total, though, the same eighteen operators own 74 percent of the U.S. pops.

[19]Throughout this report, the term local carrier—or just carrier—is used to mean the entity that operates a cellular system in a given market (MSA or RSA); operator is used to signify the broader entity that controls a number of such cellular carriers, either directly or indirectly through one or more subsidiaries. To illustrate this point, in Table 3-1 Jacksonville MSA L.P., the cellular wireline carrier serving Jacksonville, is owned 85.8 percent by Florida Cellular, Inc., which is owned by BellSouth Mobility, Inc. It competes with the nonwireline carrier Cellular One of Jacksonville, owned by McCaw Cellular Communications. The name Cellular One is a trade name and does not indicate ownership. Which entity (local carrier, operator, or trade name) is visible to the subscriber varies from case to case.

[20]By March 1993, 11.1 out of 12.05 million.

Table 3-3

Eighteen Major U.S. Cellular Operators

Cellular Operators	Subscribers[1] (000s by 3Q93)	POPs[2] (000,000s)	Ratio[3] (Percent)
BellSouth Cellular Corporation	1,524	39.1	3.90
Southwestern Bell Mobile Systems	1,513	32.5	4.65
McCaw Cellular Communications	1,192	61.0	3.81
Lin Broadcasting	682		
GTE Mobilnet *(with Contel)*	1,156	54.2	2.18
PacTel Cellular	774	33.0	2.34
Bell Atlantic Mobile	753	34.7	2.17
Ameritech Mobile Communications	650	21.4	3.04
Sprint Cellular	428	15.9	2.69
US West Newvector Group	426	17.6	2.42
NYNEX Mobile Communications	410	19.5	2.10
Cellular Communications	370	7.8	4.74
Contel Cellular	(328)	*(see GTE)*	*(see GTE)*
Comcast Cellular	199	7.2	2.76
Alltel Mobile Communications	185	7.6	2.43
US Cellular Corporation	182	19.5	0.93
Vanguard Cellular Systems	99	6.0	1.65
Century Cellunet	86	5.6	1.53
Total	**11,094**	**382.6**	**2.90%**

[1] Source: *RCR*, May 24, 1993, 10, and *The Cellular Communications Industry*, Spring 1993, Donaldson, Lufkin & Jenrette, 12.
[2] Source: CTIA, *The Wireless Sourcebook*, Summer 1993, 56.
[3] Subscriber per 1000 "pops" (population in markets).

A simplified view of the complex cellular world is provided by focussing on the main urban (including suburban) areas, where, as **Figure 3-1** shows, cellular service generally was first available. The higher, though diverse, penetrations the large cities enjoy vs. other areas (as shown in **Table 3-4**) are presumably related to many factors, such as higher per capita

income,[21] prevalence of traffic jams, and higher density of executives and other real-time information dependent professionals. The eighteen largest cities provided about 47 percent of all U.S. cellular subscribers, though they represent less than 32 percent of the U.S.

Table 3-4

Cellular Penetration in the Eighteen Top U.S. Urban Areas

Urban Areas	Population[1] (000,000s, 1990)	Subscribers[2] (000s, 3/93)	1990 Population[3] (Percent)
Los Angeles	13.86	854	6.16
New York	13.70	678	4.95
Chicago	7.26	526	7.23
Washington/Baltimore	6.30	433	6.90
Detroit	4.53	360	7.95
Dallas/Fort Worth	3.95	350	8.86
Miami/Fort Lauderdale	3.19	328	10.28
Philadelphia	4.46	324	6.67
San Francisco/San Jose	3.69	260	7.05
Houston	3.49	238	6.81
Boston	4.03	233	5.78
Atlanta	2.70	214	7.92
Seattle/Everett	1.97	197	10.00
Cleveland	1.83	177	9.67
Tampa	1.97	151	7.66
San Diego	2.50	150	6.00
St. Louis	2.42	130	5.37
Minneapolis	2.44	128	5.24
Total	**84.43**	**5,731**	**6.79**
Share in National Total	**31.7%**	**47.6%**	

[1]Source: CTIA, *The Wireless Sourcebook*, Summer 1992, 28-29.
[2]Source: *RCR*, June 21, 1993, 10; July 26, 1993, 10.
[3]Subscribers per 100 inhabitants.

[21]Herschel Shosteck Associates has analyzed effective buying income (EBI) as a significant factor in cellular penetration. In 1992, EBI in the top ten cellular markets ($47,885) was 20 percent above the average U.S. EBI ($39,806) (*Herschel Shosteck Associates' Data Flash-Cellular Market Quarterly Review*, June 1993).

population. Matching them with the eighteen major operators (**Table 3-5**), confirms the fragmented ownership pattern previously mentioned, for both wireline and nonwireline operations: up to six operators may be involved in the ownership of the pair of carriers (as in Chicago, Houston, or Cleveland). Smaller operators, beyond the eighteenth rank, intervene only in five of these cities and then only marginally.

For most practical purposes, these eighteen operators constitute the cellular services industry. The seven RBOCs, GTE (which owns 90 percent of Contel), and McCaw (which owns 52 percent of Lin Broadcasting) are dominant. With AT&T's intended acquisition of McCaw[22] and PacTel's buy-out option on Cellular Communications, Inc.,[23] the industry is now largely in the hands of conventional telephone carriers. The few true outsiders remaining in the game with significant multistate presence—Vanguard, Comcast, and Associated Communications—comprise at best a few percent of the total, and by year-end 1993 their continued independence was precarious.

Thus, the macroscopic business reality of mobile telephony hardly mirrors the original wireline-nonwireline scheme conceived by the FCC (see section **3.1**), but that scheme is the only regulatory reference point and remains the mechanism through which the government expects competition to take place, on whatever geographic scale.

3.4 The Investor's Picture

The phenomenal growth of mobile communications understandably has attracted many investors, even well after the original "gold rush" generated by the lotteries. A yardstick commonly used to evaluate cellular transactions, the "price per pop"—the price of the transaction divided by the "pops" of the cellular properties that changed hands—has drawn substantial public attention. An analysis by the communications consultants MTA/EMCI[24] of forty-three transactions spanning more than five years (September 1988—February 1993) showed that the price per pop varied widely ($40 to $235) with no clear upward or downward

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[22]As of year-end 1993, not yet finalized and vigorously opposed by some RBOCs.

[23]The ties of Cellular Communications, Inc. to PacTel, of McCaw to Lin Broadcasting and to AT&T, and of Contel to GTE are discussed, from the vantage point of the securities industry, in *Industry Strategies: Wireless Communications Industry*, a report prepared by Suzan Passoni for Cowen & Co., Boston, September 1993.

[24]*Cellular Marketplace*, MTA/EMCI, Inc., Washington, D.C., 1993. Data based on reports from *Mobile Phone News*, *Telocator Bulletin*, *The Media Quarterly Review*, *RCR*, and *The Cellular Investor*.

Table 3-5

Cellular Ownership by Major Operators in Major U.S. Cities

18 Leading Cellular Operators	Percentage Ownership of Wireline (W) and Non-Wireline (N) Operators in Major Urban Areas								
	Los Angeles	New York	Chicago	Washington D.C.	Detroit	Dallas	Miami	Phila-delphia	San Francisco
BellSouth	60.03 N						100 W		
Southwestern Bell			100 N	100 N		72.56 W			
McCaw						22.56 N	100 N		50 N
GTE	1.1 W				4.85 W	27 W			85.40 W
PacTel	82.3 W				50 N	17 N			47 N
Bell Atlantic		36 W		64.75 W				100 W	
Lin Broadcasting	39.97 N	93.08 N				60.44 N		49.99 N	
Ameritech			95 W		90.73 W				
Sprint		10 W	5 W						
U S West									
NYNEX		54 W							
Cellular Comm.					50 N				
Contel	11.2 W			35.27 W					11.19 W
Comcast								50.01 N	
ALLTEL									
US Cellular	5.5 W								
Vanguard									
Century Cellular					3.04 W				
Wireline	100	100	100	100	99*	99*	100	99*	97*
Nonwireline	100	93*	100	100	100	100	100	100	97*

*Complement to 100% is owned by operators not listed. Totals are rounded off.

Table 3-5, continued

18 Leading Cellular Operators	Percentage Ownership of Wireline (W) and Non-Wireline (N) Operators in Major Urban Areas								
	Houston	Boston	Atlanta	Seattle	Cleveland	Tampa	San Diego	St. Louis	Minneapolis
BellSouth	43.75 N		100 W						
Southwestern Bell		100 N						98 W	
McCaw				100 N		100 N		15 N	100 N
GTE	79.17 W			18.28 W	92.3 W	100 W			
PacTel			100 N		50 N		100 W		
Bell Atlantic									
Lin Broadcasting	56.25 N								
Ameritech					4.20 W			85 N	
Sprint	8.77 W				3.50 W				
U S West				74.69 W			100 N		69 W
NYNEX		100 W							
Cellular Comm.					50 N				
Contel	4.40 W								30 W
Comcast									
ALLTEL	2.34 W							2 W	
US Cellular				6.25 W					
Vanguard									
Century Cellular									
Wireline	97*	100	100	99*	100	100	100	100	99*
Nonwireline	100	100	100	100	100	100	100	100	100

*Complement to 100% is owned by operators not listed. Totals are rounded off.

Source: Data for this table are taken from CTIA, *The Wireless Sourcebook*, Fall Update 1993.

trend. The variation confirmed that other factors, as important as population, determine the profit expectations for a given cellular market.

Within the total activities of the RBOCs and other telephone groups, cellular still plays only a modest role, and no separate accounts are generally published.[25] Financial analysis in some depth of what the investment community sees as the cellular industry is therefore commonly limited to only a fraction of this sector, namely, those more or less independent companies devoted (substantially) to cellular and publicly traded. Half a dozen operators[26] fall into this category, permitting an analysis of financial health and business performance related to cellular. These companies clearly show,[27] in addition to steep year-to-year revenue increases, attractive cash flows with cash-flow margins[28] up to 40 percent. The margins are generally forecast to improve still further: a typical RSA financial model[29] leads to a cash-flow margin of 52 percent after ten years of operation.

An analysis by MTA/EMCI[30] of the stock performance of six cellular stocks during the period from December 1988 to March 1993 again reveals no clear trend; in the spring of 1993 the market seemed to recover from the 1989 highs that dropped to the 1990 lows.

All in all, the cellular services industry is still too young—and the financial burden of its debt still too high—to allow it to display the extravagant profitability of which it is sometimes accused. By now the basic investments are in place and, given that neither genuine market potential nor technical feasibility can reasonably be questioned, more than average medium-term profitability is generally expected. Competition with existing cellular operators will develop from various directions: mobile radio operators, cellular-like personal communications services, and satellite-based systems. These competitors, however, appear unlikely at

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[25]This situation can be expected to change in the case of PacTel, which, following its request, in October 1993 was authorized to spin off its cellular operations. Whether other RBOCs will follow this step remains an open question.

[26]These operators—sometimes referred to as "pure-plays"—are mainly McCaw, Contel Cellular, U.S. Cellular, Vanguard, Associated Communications, and Comcast.

[27]In their K-10s and other reports to the Securities and Exchange Commission (SEC).

[28]Cash flow divided by revenue.

[29]MTA/EMCI, *Cellular Marketplace*, 150. According to a table titled "Valuation Model of a Typical Cellular Company" in *The Cellular Communications Industry*, a report prepared for Donaldson, Lufkin, and Jenrette, Spring 1993, impressive cash-flow increases are also forecast.

[30]Ibid.

least for some years to have a dramatic impact on an industry with a 13 million customer-base that is currently growing at a rate of more than 40 percent per year.

3.5 The Resellers

Marketing cellular—often including the mobile phone equipment—takes place through a variety of channels, from operator-owned stores, operator-controlled agents, specialized distributors and installers to department stores and car dealers. One channel, which deals specifically with cellular service, is the reseller sector, which, because it has raised important policy questions, deserves attention here. A reseller is a business entity that purchases telephone numbers and cellular service at wholesale or discounted rates from one or both cellular carriers in a market and then resells it at retail rates.[31]

According to a report by the Florida Senate Committee on Commerce,[32] "Resellers are perceived by the FCC to play an active role as a competitor in the cellular radiotelephone market." Already in the early 1980s the FCC, when setting the original rules for cellular, wanted to give a separate retail sector, the reseller sector, a chance. In its basic 1981 ruling the FCC said:

> We are not certain that the resale of cellular service will develop. We continue to believe, however, that restriction of cellular resale is contrary to the public interest for reasons similar to those set forth [for the public network services].[33]

Aiming at a truly competitive market, in the same ruling the FCC required that:

> AT&T[34] and its underlying cellular affiliates provide system capacity to non-affiliated retailers or resellers on a non-discriminatory basis and on the same terms and conditions as its own distribution arm.

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[31] "The Mouse That Roared," *Cellular Marketing*, January 1993, 34.

[32] *A Report on the Cellular Radiotelephone Industry*, prepared by the Staff of the Florida Senate Committee on Commerce, chaired by Senator W.D. Wild, January 1992. Hereafter referred to as *A Report on the Cellular Radiotelephone Industry* (Florida Senate Committee).

[33] "Amendment of FCC Rules Relative to Cellular Communications Systems," Federal Register, May 21, 1981, 27671.

[34] In 1981, at time of this ruling, there were no RBOCs, and AT&T owned the vast majority of local telephone networks, hence also the cellular wireline carriers.

The reseller sector has not lived up to expectations; to say the least, it is not thriving. The National Cellular Reseller Association (NCRA), which represents seven firms with an aggregate of 240,000 subscribers, estimates that only 5 percent of cellular business goes through the fewer than a hundred reselling companies nationwide. A number of resellers have sold out,[35] and in May 1993 one of the key players[36] applied for Chapter Eleven protection. As a result of the concurrent concentration, there was at least one apparently healthy reseller of significant size left in 1993.[37]

The feeling prevalent among resellers is that they are being squeezed out of business by the cellular carriers and by what they consider a lax regulatory regime.[38] They complain that the discounted rates they are charged are at the carriers' discretion, the only regulatory requirement being that the rates cannot exceed those the carrier charges its best or largest customers. This situation appears to disregard the relief from such costly tasks as marketing, billing, and debt collection (including associated financial risks) that the reseller offers the carrier (see section **5.1**).

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[35]Including well-backed entities such as GTE Mobile Communications.

[36]Cellcom Corp., which had 53,000 subscribers.

[37]Nationwide Cellular Services, Inc., which had 145,000 subscribers in October 1992.

[38]In the United Kingdom, one of the leading cellular markets in the world, cellular operators are not authorized to sell their services directly to users: business must go through resellers, called "service providers." The resulting highly competitive secondary market—more than the operator duopoly—is often considered a key contributor to the impressively fast expansion of cellular in that country.

Chapter Four

The Cellular Manufacturing Industry

A basic understanding of the cellular industry, mainly of the infrastructure providers, is helpful, however, in order to grasp the more technical aspects that are addressed in sections **5.3** and **5.4**.

4.1 Cellular Network Equipment Providers

Interconnected by landlines or microwave links, network equipment within cellular systems consists, on one hand, of base stations, each in radio contact with almost any point in a cell, and, on the other hand, of switching gear, also called mobile telecommunications switching offices (MTSOs) or cellular switches, in charge of routing calls. To the carrier the investment in the procurement of base stations, site preparation, and installation is most important, if for no other reason than their number[1]: a high percentage of the cell-site cost is spent on the real estate where the facility sits and on administrative and procedural costs, largely to accommodate objections by neighbors or environmental protection groups. MTSOs constitute the element of high and technical value, because—with associated computers, databases, and complex software—they encompass most of the intelligence and features.[2]

The vast majority of cellular systems already set up are homogeneous, that is, within a system a single manufacturer provides both base stations and MTSO(s).[3] Because some manufacturers are stronger in radio technology (i.e., the base station) and others in switching, a number of alliances were forged in the late 1980s and early 1990s.

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[1]According to CTIA, by mid-1993 in the U.S there were 11,550 active cell sites, each with one base station (or several in the case of sectorized cells). For the carrier the total cost of a base station ranges from $.5 to $1 million. But because the major part of this amount is for site costs, electronic equipment provided by the manufacturer represents only a fraction of this amount.

[2]The cost of a cellular switch can be millions of dollars, with a smaller share for installation.

[3]This pattern of homogeneity, which obviously limits competition in the cellular network equipment market and deters potential new entrants, is likely to change with the emergence in 1993 of an MTSO-base station interface standard (the A+ standard proposed by Motorola).

Information available from various sources[4] indicates that cellular network equipment provision is a fairly concentrated activity, with a strong international dimension. Of the five main manufacturers—Motorola, Ericsson, Northern Telecom, Nokia, and NEC[5]—that have been successful in providing cellular systems around the globe since the mid-1980s, the first three are in the forefront in the U.S., with AT&T, which has no meaningful international presence in this sector. Other significant providers to U.S. cellular carriers have been Novatel,[6] Canada-based, and Astronet, a U.S.-based but largely non-U.S. driven joint venture.[7]

Advanced radio technology and telephone-switching skills are the major ingredients that allowed this small group of manufacturers to hold on to this thriving business. With the focus on digital (vs. analog) systems growing, newcomers—such as Hughes Network Systems (associated with Alcatel)— are emerging, which will undoubtedly further increase the competition in this market.

Although these companies have the technological lead in cellular, innovation can come from elsewhere, for example, from small firms (e.g., Qualcom[8]) or from other industries (e.g., IBM[9]). The same pattern applies to the lead in standardization, which in the U.S.[10] takes place within the Telecommunications Industry Association (TIA),[11] albeit with close monitoring by CTIA.

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[4]"Global competitiveness of U.S. advanced technology industries: cellular communications," U.S. International Trade Commission, June 1993.

[5]Motorola is based in the U.S., Ericsson in Sweden, Northern Telecom in Canada, Nokia in Finland and NEC in Japan.

[6]Northern Telecom acquired 63 percent of Novatel in 1992, after a long business relationship with Motorola.

[7]Astronet is owned by Siemens Stromberg-Carlsson (51 percent) and Mitsubishi (49 percent).

[8]Qualcom originated an important digital cellular technology and standard; see section 5.4.

[9]IBM conceived an ingenuous spectrum-efficient mechanism known as cellular digital packet data to transmit portable computer data over existing cellular networks, which is being implemented by several major operators that plan to offer the service in 1994 or 1995.

[10]Global standardization of cellular takes place within the CCIR and CCITT, two organizations dependent on the United Nations through its agency, the International Telecommunications Union. For reasons largely related to spectrum management, no true global cellular standard is likely to be in significant use before the turn of the century.

[11]The more than five hundred members of TIA are U.S. manufacturers and distributors of telecommunications equipment (including several foreign-based companies).

4.2 Cellular Phone Providers

Though largely overlapping with the network equipment sector, mobile phone manufacturing is to some extent a separate industry, with a larger but diminishing number of players and a different customer base: the ultimate buyer of the product is the subscriber, rather than the carrier.

Strength in highly integrated components (microprocessors, digital-signal processors, random-access and read-only memory chips, displays, low-power technologies) represents an important, though not indispensable, asset for success. This factor and the orientation toward consumer electronics[12] of cellular phones have allowed Motorola and Japanese manufacturers to dominate the U.S. market, followed closely by Finland-based Nokia.

In view of the further decline in prices resulting from cutthroat competition and from manufacturing techniques oriented toward very large volumes, phones can be expected to play a smaller and smaller role in the economics and balance of forces in mobile communications. On the other hand, the increasing features of the phones (e.g., data-oriented features[13]) and their future ability to support multiple standards may shape the evolution of the cellular industry.

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[12]The increasing share of handheld vs. car phones underscores these points, because it makes small size, light weight, and low power consumption of utmost importance. According to CTIA, by 1993 more than 50 percent of the cellular units sold in the U.S. are for use outside the car.

[13]In November 1993, BellSouth introduced under the name of SIMON, a powerful "personal communicator," i.e., a hand-held cellular phone with PC-like functions, such as the ability to access electronic mail, send and receive faxes, or update an integrated agenda. SIMON was designed and is manufactured by IBM. Other companies have introduced what are called personal digital assistants (PDAs), for example, Apple's Newton, that have cellular communications functions.

Chapter Five

Four Major Issues

5.1 Did Customers Benefit from Competition?

As the FCC's 1981–82 rulemaking proceeding made clear, cellular radio services have the potential to be offered on a competitive basis: the natural monopoly considerations prevailing for conventional local telephony (e.g., digging to lay wires or setting up many poles) did not apply; allocation of the cellular spectrum could be shared among several carriers without excessive system overhead resulting; the market appeared very large (and later proved even larger than anticipated), and many candidates wanted to offer such services (section **3.3**). For the thirty largest markets, the FCC accepted 194 applications; for the next thirty, it accepted almost four hundred![1] In spite of the Department of Justice's reservations about whether a duopoly would ensure competition, the FCC decided in favor of a duopoly, mainly out of concern for efficient allocation of spectrum and economy of scale.

When later the real market size became apparent, those concerns lost some pertinence, and attention was focused more on the possible benefits of the right level of competition: lower prices (in theory, as low as marginal cost) and lower production costs.

It is common economic doctrine that a duopoly structure is unlikely to result in perfect—or even near-perfect—competition. But how far from acceptable cellular is (and the implications thereof) has proved a major issue in the early 1990s on which interested parties have taken a variety of positions, some extreme.

5.1.1 Main Parties' Positions

The question of the competitiveness of the cellular services marketplace remains of strategic importance in view of the federal government's expressed intent[2] to allow and foster the introduction of new, to some extent equivalent, superior, or cheaper mobile

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[1]"The Competitive Potential of Cellular Mobile Telecommunications," *IEEE Comm.* (November 1983), 16.

[2]With the FCC Report and Order of October 1993, the PCS plan is in place; the IRIDIUM (LEO satellite system) project received strong international backing from the U.S. State Department, and Nextel (formerly Fleetcall) was authorized to build a digital mobile radio network with cellular-like capability.

communications services. The position of the cellular carriers according to its industry association is clear:

> Those who. . .allege that the cellular industry does not have adequate competition today. . .could not be further from truth. Cellular companies are competing with each other for the consumer, cutting costs, meeting customer needs and preferences, promoting technological and service innovations and, above all, offering competitive pricing packages.
>
> Competition has produced a decline in the effective monthly cost of cellular, down 29% from 1985 to 1992. At the beginning of 1993, the average monthly bill had fallen to $68.68. . . . The success of cellular competition can be found. . .also in the number of cellular subscribers who shift from one provider to another. Analysts estimate that 21.6% of cellular subscribers switch to the competing cellular carrier annually, inspired by price and service competition. . . .
>
> Detroit is a. . .clear example of this competitive rivalry. Industry analyst Herschel Shosteck estimates that the respective market shares of PacTel and Ameritech in Detroit changed as follows:

	1987	1991
PacTel	51.2%	40.5%
Ameritech	49.8%	59.5%[.][3]

The FCC has generally been perceived as supportive of CTIA's position: "The FCC has determined and now assumes that because two carriers are licensed in the market, competition exists," according to a report by the Florida Senate Committee on Commerce.[4] Some see in this support a "hangover" from history, as in Hazlett's study of the topic:

> As the FCC split the difference between competition and monopoly in 1981, belatedly allowing some competition in cellular but steadfastly resisting the encouragement of the Department of Justice to offer an "open entry" solution, it may have gone as far as politics would allow.[5]

In 1992, when setting preliminary rules for PCS, the FCC implied it had made the right choice for cellular:

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[3]CTIA, *A Competitive Cellular Industry (Today); A Frenzy of Wireless Competition (Tomorrow)*, White Paper, No. 4, Aug. 26, 1993, 4.

[4]*A Report on the Cellular Radiotelephone Industry* (Florida Senate Committee), 39.

[5]Thomas W. Hazlett, *Market Power in the Cellular Telephone Duopoly*, a report prepared for Time Warner Telecommunications, August 1993, 2. Hereafter referred to as Hazlett with a page number.

> In licensing mobile services, the Commission has squarely placed its faith in competitive markets and service flexibility. . .a faith amply justified by the nationwide availability of cellular service, the competition among cellular providers for customers; the diverse array of service and equipment options; and the aggressive behavior of cellular providers in implementing new technologies.[6]

The matter of price is not mentioned.

Some major state regulatory commissions (in California or Florida) have voiced strong doubts about the reality of competition in the cellular duopoly markets. The California Public Utilities Commission (PUC) wrote in 1988:

> We are concerned that the facilities based utilities ([cellular] carriers) enter into meaningful price competition. For example, no overall price reductions have occurred despite actual subscriber levels outstripping most initial projections. Further, several recent price increase applications were withdrawn after a substantial public protest and controversy. The extent of competition, or lack of it, between carriers has a direct bearing on the degree of regulatory intervention we deem necessary to protect consumers.[7]

The concern expressed by California[8] supports the attitude of the dozen states that exercise rate-base regulation of cellular as well as that of others that imposed a less constraining tariff-filing obligation. By 1991, however, eleven out of the twenty-five state jurisdictions that partially regulate cellular were investigating the possibility of deregulation.[9] This move, some say, is directly related to effective lobbying at the state level on behalf of cellular operators strongly opposed to regulation of their business. Rates in states that regulate them have not been found to be inferior to those in states that do not.[10]

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[6]*FCC Notice of Proposed Rulemaking and Tentative Decision*, July 16, 1992, 3.

[7]Investigation on the Commission's Own Motion into the Regulation of Cellular Radiotelephone Utilities, Order Instituting Investigation, PUC, State of California, Nov. 23, 1988, 1.

[8]The state with the highest cellular population: according to a 1988 estimate, at least 20 percent of all U.S. cellular subscribers were in California.

[9]*A Report on the Cellular Radiotelephone Industry* (Florida Senate Committee), 21.

[10]Ibid., Appendix 13.

5.1.2 Findings by Some Outsiders

In 1992 the nonpartisan General Accounting Office (GAO) investigated the question of competition in cellular.[11] Its report is largely inconclusive, demonstrating the difficulty of the issue. In relation to rate decreases over time—a likely although not necessary symptom of true competition in a new technology market—the GAO established that between 1985 and 1991 the lowest rates available declined by 27 percent in real terms (i.e., after adjustment for inflation), which is only a few percent in nominal terms.[12] Regarding relationships between competitors' rates, the GAO found that in about twenty out of the thirty major markets, the best prices differed by less than 10 percent between wireline and nonwireline carriers and sometimes were identical; in the remaining markets, the differences averaged 22.4 percent.

A key factor mentioned by the GAO probably affecting competitive behavior was the pattern of split ownership (see section **3.2**), which often leads to an operator's competitor in one market being a partner in another; this situation may affect their pricing decisions for markets in which the two compete. Do crossed ownerships impede the competitive impetus in management decisionmaking, in a web so complex that no one seems to have a clear overview of them?

In 1992 the GAO also stressed the lack of basic information needed to analyze the reality of effective competition:

> The FCC. . .has not received evidence showing that cellular telephone companies are engaging in anti-competitive activities or charging excessive prices. The FCC does not collect revenue, cost and other data from cellular carrier licensees. Without such data, the FCC has acknowledged that it would be difficult to conclude that the cellular telephone service market is fully competitive.[13]

Hazlett's apparently conclusive assessment focused on market power:

> The evidence that the current cellular telephone operators possess a high degree of market power. . .is simply overwhelming. Rates in typical

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[11]*Concerns About Competition in the Cellular Telephone Service Industry*, a report to the Honorable Harry Reid, U.S. Senate, by the General Accounting Office, 1992.

[12]Ibid., 24.

[13]*Concerns about Competition in the Cellular Telephone Service Industry* (GAO report), 4.

> cellular markets are at least twice those needed to cover costs (both operating and capital).[14]

The claimed market power and the ability to set high rates are reflected, according to him, in the exceptionally high ratio "Capital value/Asset replacement cost" pertaining to cellular (capital value is the price at which a firm can be bought on the market). For competitive U.S. industries this ratio is generally around 1, while for cellular it lies in range of 6 to 12. What clearly biases cellular is the value of the license—typically much higher than the aggregate physical investment after a few years—which the current operator may have acquired almost free of charge at the outset, either through public hearing or lottery or at a high price from the previous operator or lucky speculator. Valuation of the license is at the heart of the excessive profitability debate, and so, to a lesser extent, are the depreciation period (which Hazlett assumes to be ten years, implying a fairly slow technological evolution) and the cost of borrowed capital.

The consolidated operations of McCaw,[15] for instance, illustrate this point. McCaw, in the cellular business practically since the beginning, nonetheless revealed huge losses in 1991 and 1992 (25.7 and 21.0 percent of revenue, respectively) due essentially to the cost of its debt. Interest expenses in those years amounted to 42.3 and 28.1 percent of revenues, respectively. They are also several times higher than depreciation!

5.1.3 Other Benefits to Customers from Competition

The customer has definitely not benefited from decreases in cellular service charges which would be expected in a competitive explosive new market built on technologies the intrinsic costs of which have been dropping. Paradoxically, the customer may be suffering from competition, namely, from the rivalry for licenses. Again, looking at McCaw, licenses bought at hundreds of dollars "per pop" years later generate high capital costs to be paid off by the end-user one way or another (unless they continue to be borne by stockholders or other debt holders).

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[14]Hazlett, 1.

[15]Consolidated statements of operations in the 1992 Annual Report of McCaw, the largest cellular operator still independent of the telephone companies as of year-end 1993. Three-quarters of McCaw's revenues are from cellular.

Competition has certainly provided other benefits, such as quality of service, diversity of features and service options, and speed of geographic deployment leading to more appropriate coverage. No true measurements of such elements are available, but certain related aspects of the cellular business are disturbing. The first is *churn*, the proportion of subscribers that cancel subscriptions either because they can get what they consider a better deal from the other carrier or because they no longer want service. In the U.S. cellular churn is surprisingly high, 3 to 4 percent per month,[16] which means that every year about one-third of the subscribers change sides or quit! Even if those that quit represent less than half of the total, the share of subscribers not pleased with the service is significant—perhaps their expectations were too high or the charges were higher than estimated.

A second disturbing aspect is the high marketing costs associated with cellular: on average carriers are said to spend $500 to $700 (including a retail commission of at least half that amount) to gain and activate a new subscriber. If this cost is combined with the amount of churn, two natural business goals appear to remain largely unachieved in spite of—or because of—competition: on one hand, stabilizing customers by keeping them satisfied with the quality of service, the price-performance, and the expectation of improvements to come and, on the other, easing new subscriptions by stimulating a buyer's market with a positive reputation spread by many satisfied users.[17]

5.1.4 On Ways to Improve Competition

Some states made major efforts toward improving competition in cellular services aimed at a better deal for the end-user. In November 1988, the California PUC launched an investigation "into the regulation of cellular radio telephone utilities."[18] After lengthy

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[16]"The Impact of Churn on the Cellular Industry," *Business Strategy Monitor*, BIS Cap International, December 1990.

[17]In the U.K., Official Telecommunications (OFTEL), the regulatory body, has for several years carried out measurements of service quality of the two cellular operators; the results, which are made public, show substantial differences, depending on the area examined. Measurements made in the second half of 1993 in Scotland, for instance, showed that calls made on one system were on average four to five times more likely to be dropped than those made on the competing system. *Vodafone News Release*, Dec. 9, 1993.

[18]*Opinion and Order—Before the Public Utilities Commission of the State of California, Investigation on the Commission's Own Motion into the Regulation of Cellular Radio Telephone Utilities*, Oct. 6, 1992.

proceedings, in October 1992 a decision[19] was issued "to increase competitive forces for cellular services"[20] the key points of which were the following:

> (*i*) Cellular carriers would implement a cost allocation system to "segregate retail activities from wholesale" and other activities;
>
> (*ii*) They would unbundle their wholesale tariff into specific and explicit subcomponents; and
>
> (*iii*) Resellers would be allowed to "perform switching functions currently provided by the facilities-based carriers."[21]

Clearly, the resellers were behind this move aimed at allowing them to become a significant competitive force.

The PUC decision of October 1992 was very shortly strongly opposed by the major cellular operators active in California[22] and, pending further action in federal court, its execution was stayed. The resellers' claim to switching rights would seem to have substantial technical implications—which the proceedings did not fully clarify—for the basic role of the cellular carrier and the structure of a cellular system. The system switch is virtually its brain, and how the reseller could either replace or complement that function and how its doing so could be in the public interest are both difficult to see. The provision regarding switching may have weakened the cases of the reseller and the PUC. Resellers should be perceived as a key marketing channel with the potential to enhance competition and therefore need to be given a place; according to the head of NCRA, "Reselling is only a viable business in states where either the state PUC regulates wholesale rates or the carriers want to do business with resellers."[23]

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[19]Ibid.

[20]"The Mouse That Roared," 44.

[21]*Opinion and Order—Before the Public Utilities Commission of the State of California*, 1992.

[22]Filings to the California PUC by GTE Mobilnet, McCaw, PacTel, LATC, separately, Oct. 26, 1992.

[23]"The Mouse That Roared," 34.

5.2 Is the Cellular Services Industry Too Concentrated into a Few Old Hands?

As shown in section **3.3**, 92 percent of all U.S. cellular subscribers (by March 1993) were served by systems that belong[24] to the eighteen largest operators. Further, only a few of those—rather small entities—are not directly controlled by large conventional telephone groups (if the acquisition of McCaw by AT&T is assumed to go through). This may seem naturally to be the case: is not radiotelephony a subset of telephony?

In other parts of the world, however, the emergence of cellular was seen as an opportunity not only to introduce competition but also to generate a new industry with strong novel players.[25] Breaking the (local) telephone monopoly can represent a chance for some powerful but slower growth sectors to take an active part in the communications revolution.

Historically, new entrants have a key role in the evolution of the U.S. telecommunications scene. A quarter of a century ago, tiny Carterfone was the first authorized provider of customer premises equipment (CPE). Born at about the same time, MCI became the first alternate long-distance carrier to the Bell System. The two new companies triggered the emergence of what have become two huge diversified industry sectors: CPE and interexchange carrier (IXC) service,[26] but not without strenuous fights and under gradually acquired regulatory protection.

The concept of new entrants and entrepreneurs was inherently part of the basic U.S. cellular duopoly framework, and, as shown in section **3.3**, many outsiders joined in. Some major ones from the cable TV and broadcasting business (e.g., McCaw, Lin Broadcasting, Comcast) have been doing well. The effect of the process of reshuffling and concentration that occurred—and continues—however, has been to put an ever increasing fraction of cellular activity into the hands of conventional telephone companies: the RBOCs and others, and soon

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[24]In the sense of majority ownership.

[25]In Europe, for example, competitors to wireline carriers come from a variety of sectors: steel (Mannesmann or Thyssen in Germany), electrical manufacturing (Racal in the U.K.), water utilities (Compagnie Générale des Eaux in France), mining (Kinnevik in Sweden), or energy (Veba in Germany). In addition, in several cases the new entrant performs substantially better than its telephone-utility controlled competitor.

[26]Competing with AT&T, by year-end 1993 the IXCs had 60 percent of the long-distance telephone business, a share still on the rise; competition apparently contributed largely to the decrease in long-distance rates during the past twenty-five years.

AT&T. Concern about adherence to the logic of separating wireline and nonwireline was expressed as early as 1988 by the California PUC:

> [The] wireline/non-wireline separation. . .has not been maintained; in 1986 the FCC ruled that the non-wireline license could be purchased by a landline telephone company affiliate. This has resulted in substantial purchase of non-wireline cellular company interests by local telephone exchange company affiliates resulting in their dominance of the cellular radiotelephone industry.

On one hand, such a concentration biased toward wire-based telephony was probably not the intent—certainly not the expressed intent—of the regulator (i.e., neither the FCC nor the Department of Justice). On the other, this evolution could ease, for cellular wireline and cellular nonwireline, some level of integration between mobile and fixed telephony and thus provide new functions and features of value to end-users. From the viewpoint of AT&T, "The wired and wireless networks must join forces to share network capabilities and intelligence, but this integration cannot happen in a flash. A phased integration is more likely."[27]

Irrespective of competitiveness, acquisitions of nonwireline cellular carriers by wireline operator groups such as the RBOCs has disturbing side effects probably unforeseen when the FCC decided to authorize them.

Having cellular carriers of various areas join efforts is a natural evolution that has marketing and other advantages. In February 1993, fourteen wireline operators banded "together to form a North American brand and service identity to be called Mobilink."[28] They agreed to develop uniform service standards (e.g., level of quality and feature codes). The grouping might have played an important role in solving the roaming problem (section **5.3**), but, unfortunately, Mobilink proved a weak partnership, and its cohesion is at risk: ownership of a nonwireline license by, say, member A, in the wireline territory of member B obviously generates conflicts of interest.

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[27]A.T. Kripalani, "A Seamless and Smart Network Is the Key to Great PCS," *AT&T Bell Labs. Telephony*, March 8, 1993, 28.

[28]*Telephony*, Feb. 22 1993, 8. The founding members of Mobilink are: Alltel, Ameritech, Bell Atlantic, Bellsouth, Centel, GTE, Nynex, PacTel, Rochester Telephone, SNET, U S West (rather, their cellular subsidiaries), plus Cellular, Inc. and Century Cellunet, as well as a Canadian operator, Mobility Canada.

As of year-end 1993, one noteworthy move away from concentration may be the spin-off by Pacific Telesys of its PacTel Cellular arm.[29] The motives behind this move are assumed to be essentially financial, and PacTel is probably an exception to the general rule, i.e., for the telephone companies, cellular is both a strategic opportunity and a threat, hence their goal, soon achieved, is to get it under their control.

5.3 Is Cellular Service Provision Too Fragmented?

Although fragmentation may at first glance seem inconsistent with concentration, in this context it is not: the focus here is on fragmentation in terms of markets and systems.

Cellular is associated with mobility and, to a large extent, with automotive mobility. Yet the service is essentially offered *within* hundreds of individual markets or service areas, notwithstanding increasingly contiguous coverage. The boundaries of these service areas are routinely crossed by subscribers travelling for business or leisure: such *roamers* require cellular service in areas outside their home areas and may be even more critically dependent on it when far from home base. The difficulties associated with roaming—both to initiate and to receive calls—constitute a key factor in the dissatisfaction of a significant portion of subscribers.

5.3.1 Current Problems Related to Fragmentation

Cellular service outside the home service area assumes a reciprocal agreement between two wireless carriers—the home carrier and the one serving the roamer's location—as well as a suitable link between the systems.[30] Considering the number of service areas (734) and systems (about twice as many), the number of reciprocal agreements potentially required is enormous. The insufficiency of such agreements, in number, scope, and degree of implementation, explains the many burdens roaming subscribers are subjected to, such as the following:

(*i*) complexity of basic procedures (e.g., looking up and keying special codes);

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[29]After ten months of deliberation, in November 1993 the California PUC approved this spin-off, which encompasses, in addition to cellular, paging and vehicle location operations. See *Wall Street Journal*, Nov. 3, 1993; and *Mobile Phone News*, Dec. 20, 1993, 8.

[30]When placing a call, the roaming subscriber has to be recognized as a valid subscriber and identified for billing purposes. To receive a call, the subscriber must be known and located.

(*ii*) the need to register in advance, as well as delays in implementation that may extend from hours to days;

(*iii*) the need to plan ahead and to advise potential calling parties of special procedures particular to the area the roamer will be in;

(*iv*) significant daily roaming charges, irrespective of calls actually made or received;

(*v*) high charges for roamer calls (up to five times the charge for cellular calls in the home area), in addition to charges for landline;

(*vi*) different billing cycle for roamer calls from that for calls placed in home area; and,

(*vii*) in some cases, charging roamer calls only on commercial credit cards (instead of inclusion in basic bill).

The most blatant evidence of the maze of roaming procedures and charges is the *Official Cellular Roaming Handbook*, published twice yearly by Cellular Directions, Inc., as a guide for North American roamers, with 430 pages of fine print (and maps). The *Handbook* lists 413 cellular carriers involved in reciprocal roaming agreements. In principle, if all these carriers had reciprocal agreements, the agreements would exceed 85,000! Fewer are required, however, because of substantial *clustering* and other groupings; reciprocal agreements are reportedly between four and five thousand.[31] To add to the complexity, some agreements are one-way, that is, they apply to only a subset of the systems a carrier operates. The roaming landscape is constantly evolving, with new agreements added and others dropped.

In spite of the inadequacies mentioned, roaming traffic is significant. In 1993, roaming revenues represented more than 12 percent of total cellular service revenues, a percentage continually on the increase (it was 8.5 percent in 1988).[32] But the potential of the true roaming business may be much higher, even with the current cellular subscriber population.

Another increasingly critical related problem the cellular industry faces is fraud. Fraud has been estimated to amount to $100-$300 million per year.[33] Insufficient real-time

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[31]A large RBOC may have about one thousand roaming agreements, with terms that often need to be renegotiated.

[32]Both percentages from CTIA data.

[33]CTIA, *Fast Facts: Cellular Telephone Fraud*, August 4, 1993.

procedures for validating and authorizing roaming calls and callers have led to fraud. Proper communication between cellular systems, it is believed, would prevent the most common fraud, cloning a valid subscriber's phone and charging fraudulent calls to that bill.

As of early 1993, intersystem communication is implemented technically in the form of direct interconnections between MTSO's—cellular switches—of the same manufacturer through proprietary protocols. An alternative is third-party services (such as those offered by GTE's Telecommunications Services Division) which adapt to the specific characteristics of systems they serve and carry out necessary protocol conversions.

5.3.2 Seamless Roaming

The cellular industry is aware of the importance for its future development of the shortcomings discussed above and puts increasing emphasis on an ambitious objective: *seamless roaming*. Commonly defined "as the concept of people using their cellular phones anywhere at any time, using all their features as if they were at home,"[34] seamless roaming will render boundaries between markets or carriers almost transparent to the user.

According to the president of a major cellular operator, U S West New Vector, early in 1993, "From a customer perspective, the lack of seamless roaming is perhaps the most significant negative in our industry. . . . . It is a roadblock to our vision of instant effortless personal communications."[35] Similarly, according to Craig McCaw, chairman of McCaw Cellular:

> Roaming is still confusing and annoying and remains the biggest gripe of cellular customers who bought their phones and service to increase their productivity and to be easily reached. . . . The people who want wireless services need seamless roaming. That implies fair pricing, ease of use and a host of other things which at this point in time have not yet occurred both because of the selfishness of certain carriers but also, perhaps, of a lack of proper leadership on all our parts.[36]

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[34]"Reaching New IS-41 Levels," *Cellular Business*, February 1993, 50.

[35]John DeFeo, president of U S West New Vector, quoted in "The Cellular Industry Inches Closer to Seamless Roaming," *Telephony*, Feb. 15, 1993, 19.

[36]Ibid.

Seamless roaming is not an easy matter, again mainly because of the fragmented structure of the industry. "The cellular systems have grown up ad hoc. . . . It has certainly made our task difficult," said CTIA's vice president for technology.[37]

Seamless roaming between systems controlled by the same operator has made considerable progress, though. McCaw has set up the North American Cellular Network (NACN), "a service which links together separate cellular coverage areas, so that to the customer, all of the coverage areas seem to be a gigantic cellular system."[38] In autumn 1993 NACN reportedly was available in thirty states and five hundred cities and served 3.5 million subscribers.[39] Similarly, Vanguard has established Nationlink, and Bell Atlantic Mobile Systems (BAMS) has implemented easy roaming capability for its customers in the New York–Washington, D.C., corridor (and to some extent beyond, through agreements with NYNEX). Because such service is not compatible with the provisions of the Modified Final Judgement, BAMS had to secure approval of the Justice Department.[40]

A leading cellular industry representative considers, however, that "there are many technical and logistical issues to work through before customers will realize seamless interoperator roaming."[41] Adherence to industrywide technical standards is only one aspect: Interim Standard-41 (IS-41), a standard mechanism for cellular intersystem communication has been in development since 1984 (and is still being refined) under the auspices of TIA and CTIA. The most advanced versions of IS-41 will allow:

> (*i*) a roaming subscriber to place calls when outside the home area, without dialing special codes;
>
> (*ii*) a wireless caller to reach a roamer without knowing the service area the roamer is in;
>
> (*iii*) uniform procedures for features, regardless of the serving switch; and

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[37]Ibid., quoting Michael Hirsch.

[38]"Letter to Our Stockholders," McCaw Cellular 1992 Annual Report.

[39]"McCaw Cellular Communications," *Wall Street Journal*, Nov. 10, 1993.

[40]The Modified Final Judgement executed by Judge Harold Greene of the Federal District Court of the District of Columbia in 1984 established a framework for deregulation and for divestiture by AT&T of its Bell Operating Companies, later the RBOCs. Under its provisions the RBOCs cannot provide interstate services (or other inter-LATA services). Waivers may be issued by the Department of Justice on a case-by-case basis.

[41]John DeFeo, quoted in *Telephony*, Feb. 15, 1993, 22.

(*iv*) reduction of fraud by requiring the caller's home switch to verify the caller is a valid subscriber and authorized to roam.

Implementation of IS-41[42] by cellular carriers throughout the U.S. is a costly proposition and is taking place gradually, in steps, because of the multiple versions of the standard. To ease the evolution toward seamless roaming, mainly for the smaller cellular operators, CTIA decided to establish a national backbone signalling network. In July 1993 a supplier was selected[43] to provide appropriate interconnection service to cellular carriers that decide to join.

5.3.3 Broad Implications of Fragmentation

A U.S. industry observer made a striking comparison between U.S. and Canadian cellular[44]:

> The cellular industry in the United States should try taking a look at its neighbor to the North for advice. Canadian carriers definitely have some strengths. Both the wireline and non-wireline carriers offer hassle-free roaming. . . . One reason is because Canada has the only national cellular carrier in North America. Rogers Cantel Mobile Communications is the only non-wireline carrier which is licensed to provide national cellular coverage across Canada. . . . Although Canadian cellular systems operate on the same frequencies as the U.S., they are licensed differently. When it comes to roaming, having a nationwide service seems to solve numerous problems. It gives customers the ability to have Cantel service follow them when they travel within the Cantel network. It also means the caller does not need to know where the customer is. . .the call automatically follows. . . .[45]

Roaming capability and fraud control in the U.S. imply intersystem communication. Among systems belonging to the same operator, this is relatively easy to achieve. Communication among systems belonging to different operators is more arduous and more than a technical problem. Primarily two approaches are being pursued: use of a third-party network (such as the backbone network sponsored by CTIA) or direct interconnection via the

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[42]Underlying IS-41 is a transport mechanism that uses one of two standards, either X.25 or SS7 (Signalling System 7), an international standard that eventually will be implemented in all telephone switching systems, including cellular switches.

[43]"Cellular-Phone Pact Is Set by Independent Telecommunications," *Wall Street Journal*, July 28, 1993, B8.

[44]Total levels of penetration are of the same order in the two countries.

[45]Sue Marek, "Canada—Cellular's Thriving Frontier," *Cellular Marketing*, January 1993, 48-49.

IS-41 standard. In the absence of such capability, a clearinghouse will be necessary, although that will offer fewer functions and less protection.

A suitable and secure level of seamless roaming requires many complex interactions among a many cellular carriers. The technical and commercial cost of the corresponding inter-entity transactions generated by these mechanisms will not be offset by the resulting benefits—or those expected to result—from the fragmentation the regulator imposed on the industry at the outset of cellular.

The reason the FCC decided to define 734 independent markets in the first place remains unclear. Certainly, there was an urban logic to start with, and the OMB's existing 306 MSAs provided a convenient federal reference. The factors that triggered the subsequent decision in favor of 428 RSAs, that is, an average of eight per state (Texas has twenty-one), are not apparent.

Was speed of deployment an implicitly expected benefit? Getting cellular service to nearly every U.S. county at more or less the same time is a worthwhile objective.[46] This is what generally happened in rural areas (see **Figure 3-1**), but only about eight years after the birth of the industry. Many cities began to be served only some five years after Chicago, Baltimore, and Washington. This speed of deployment might have been achieved by regulatory provision[47] had much larger geographic markets been defined instead of the MSAs and RSAs.

Although the degree of competition to be introduced and the amount of spectrum to be allocated were debated considerably in the history of cellular, and in the early 1990s for PCS,[48] the question of the extent of geographic fragmentation of the market has received little attention. In spite of clustering, the MSA–RSA-based duopoly will burden the U.S. cellular service industry as it tries to satisfy the requirements of mobile Americans. In the long run this weakness can make cellular vulnerable to less fragmented alternatives.

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[46]The reasoning (confirmed by experience, for example in Europe, is that an operator given a large area will first deploy service in the most attractive places—in practice, the largest cities—giving more remote areas only a very low priority.

[47]Similar to the FCC coverage obligation (section 3.1).

[48]*Notice of Inquiry, Amendment of the Commission's Rules to Establish New Personal Communications Services, Summary of Reply Comments, Bellcore*, FCC docket 90-134, Feb. 4, 1991.

5.4 Does the Cellular Industry Follow the Pace of the Technological Evolution?

5.4.1 Digitization

The information world has gone, is going, or will go digital: computers, telephony, information storage (audio CD, digital audio tape [DAT], CD-ROM[49]), as well as pubic electronic media (radio and TV broadcasting and cable). The National Information Infrastructure (NII), the technological priority project of superhighways proposed by the Clinton Administration in mid-1993, is assumed to be digital. Digitization is the cornerstone of the current dominant convergence phenomenon (telephone-cable TV-computer) and other multimedia trends strongly affecting the information industries.

Beyond the reasons why the information world as a whole is going digital, digitization has special implications for cellular. The majority of cellular systems in operation around the globe in 1994 still use analog technologies, particularly over the weakest link, radio over the air:

> No communication channel is more variable or more uncontrollable than the radio link to and from a moving vehicle. . . . It is quite normal for a mobile radio channel to experience fades—sudden decreases in signal strength—[by a] factor of 10,000 to 100,000 in a fraction of a second.[50]

Recognized since the early 1980s as particularly suitable to such a hostile environment, digital technologies (applied to voice coding, signal processing, error correction, channel equalization, and echo control) would dramatically enhance cellular in at least four ways:

> (*i*) higher spectrum efficiency, i.e., the amount of traffic or number of subscribers accommodated within a given spectrum allocation[51];
>
> (*ii*) for the user, better quality of voice transmission[52] and fewer dropped calls;

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[49]CD-ROM: compact-disk read-only memory.

[50]Calhoun, 199.

[51]Spectrum efficiency is a complex matter. Calhoun labels it "a notorious portmanteau concept" (394) that can mean half a dozen different things. For a broad understanding of spectrum issues, see Derrick C. Huang, *Managing the Spectrum: Win, Lose, or Share* (Cambridge, Mass.: Harvard University Program on Information Resources Policy, P-93-1, February 1993).

[52]Perceived voice quality is controversial. Some users react negatively to "vocoder" speech. Other problems are related to its use with the public telephone network.

(*iii*) extended talk-time and standby-time, implying less dependence for users of portable phones on recharging batteries; and

(*iv*) greater security of calls, i.e., privacy and protection against eavesdropping.[53]

5.4.2 Background for U.S. Digital Cellular Standardization

From the outset it was clear that in the U.S. digital would represent a technological alternative to analog (AMPS) within the same radio spectrum that the FCC originally allocated to cellular (see section **2.1**).[54] In 1988, following a request from CTIA, TIA initiated work on a North American digital standard. The FCC, which in 1981 claimed federal authority over technical standards for cellular, withdrew from this role in 1988 and was no longer formally involved; the matter was left completely to the industry. According to CTIA's request, seven objectives (in relation to AMPS) were to be pursued:

(*i*) ten times the capacity (i.e., a tenfold spectrum efficiency);

(*ii*) significantly reduced fixed costs;

(*iii*) equal or better quality, with a special focus on resistance to fading and interference;

(*iv*) analog fallback, i.e., dual-mode cellular phones (analog-digital);

(*v*) advanced features (encryption, sending and receiving text messages, access to information services);

(*vi*) multivendor support through intrasystem interface standards; and

(*vii*) minimization of technical risk.

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[53]Regulations prohibit the manufacture, sale, and use of scanners capable of eavesdropping on cellular phone conversations. In spite of them, given the substantial amount of such equipment still around, eavesdropping is said to be common.

[54]The situation in the U.S. is different from that in Europe, where a dedicated spectrum allocation was formalized by a European Commission directive for the digital cellular system called the Global System for Mobiles (GSM).

The standard that emerged after some three years uses time-division multiple access (TDMA)[55] technology and comes close to meeting the objectives set. The improvement in capacity generally observed, however, is only threefold.[56]

As the TDMA standard specification came to fruition, a still more advanced alternative technology, code-division multiple access (CDMA),[57] caught attention; it was even more difficult to implement and offered much higher capacity, allowing still better use of the available radio spectrum. Instead of an improvement by a factor of 3, CDMA publicly claimed twenty times the capacity of AMPS![58] Because no strong majority within CTIA stood behind either TDMA or CDMA, since July 1993 both are accepted U.S. standards (known as interim IS-54 and IS-95, respectively).

Data transmission warrants at least an aside in a discussion of the migration to digital. In theory, both digital cellular standards have attractive potential for data transmission, but very little if any effort is being exerted in this direction.[59] In the opposite direction, cellular carriers are making considerable investments in cellular digital packet data (CDPD)—which misleadingly incorporates the word digital—an efficient data transmission scheme associated with AMPS, i.e., analog cellular.[60]

5.4.3 Positions and Plans

In an effort to put as good a face on the situation as possible, CTIA states:

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[55]In TDMA, each frequency is divided into time slots, and each time slot constitutes an independent telephone circuit.

[56]The factor of 3 is with respect to the 1993 AMPS capacity. Since CTIA set the objectives listed here, AMPS has considerably improved.

[57]CDMA uses spread spectrum technology (still largely confined to the defense sector), in which a code associated with the signals of different users distinguishes one signal from another.

[58]Presentation by Qualcom, WirelessWorld Conference, Orlando, Florida, November 1993.

[59]The history of digital landline systems is instructive in this respect: for many years, even decades, the industry claimed that an important benefit of the migration to digital would be effective data transmission. Sending data via digital transmission and switching systems designed primarily for voice, however, proved very difficult, and its acceptance was therefore delayed (e.g., data over ISDN).

[60]For a description of CDPD, see James E. DeRose, *The Wireless Data Handbook* (Mendocino, Calif.: Quantum, 1994), 46-47.

> The duality of standards will not result in incompatibility, since both systems are designed to default to analog operation when digital channels are not available.[61]

The statement confirms the important assumption that in the foreseeable future digital cellular telephones in the U.S. will also have analog capability: the manufacturer of a U.S. digital cellular phone has to incorporate into the equipment both digital (TDMA or CDMA) and analog (AMPS) technologies. When the subscriber happens to be in an area lacking digital coverage,[62] the phone falls back into analog mode, in which case neither the user nor any carriers involved will benefit from the features and other advantages of digital.

The conflict continues to rage. In the fall of 1993, according to *Cellular Business* magazine, "The fight between the digital technologies is only becoming more heated, more divided and more complicated."[63] Very rapidly, variants and further improvements to the two basic systems are being proposed that spur escalating claims for capacity and other performance characteristics.

In view of the advantages of digital and to alleviate the capacity problem in major U.S. cities, some operators, including several heavyweights on either side of the fence,[64] considered they needed to move forward and make a choice. Because TDMA is significantly ahead of CDMA in implementation, choosing CDMA implies a delay of another two years or so in digital investments and service offerings. As a result, some consider that the real choice for carriers is to go or not to go digital. According to an article titled "Digital Cellular in the U.S.: What's the Rush?":

> Although digital eventually will offer significant advantages, there are few benefits today which means that the U.S. cellular carriers have little

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[61]CTIA, *Fast Facts: Digital Cellular in North America*, Aug. 12, 1993 (Revised), 1.

[62]More precisely, digital coverage in the digital mode of the phone used (TDMA or CDMA), either by the home carrier or the carrier that would ordinarily serve the user when roaming at this location. Triple standard phones (TDMA/CDMA/AMPS) are likely to appear at some point but, at least initially, will be heavier and more expensive.

[63]Julie M. Anthony, "Family Feud," *Cellular Business*, October 1993, 30.

[64]By year-end 1993, McCaw, Southwestern Bell, and BellSouth were clearly in the TDMA camp, while U S West, Bell Atlantic, PacTel, and NYNEX were proponents of CDMA.

reason to deploy it quickly, according to a comprehensive economic comparison study.[65]

Although some operators that committed early to the originally unique digital standard offer TDMA service in a few areas, others appear to want to put things off: PacTel Cellular announced that it "has decided to wait until CDMA technology is available in 1995 before deploying digital cellular,"[66] a position shared with Bell Atlantic. In Chicago because both TDMA and CDMA systems are in service (CDMA on a trial basis only), customers, if informed fairly, will not easily invest in one or another type of digital phone.

5.4.4 Is There an Issue?

The success story of American cellular is often attributed to the existence from the start of a single nationwide spectrum allocation and a single standard, AMPS. This situation allowed large volumes at the manufacturing end—primarily for phones—and made all the players confident.[67] A single digital standard, not necessarily optimal, might have eased the migration from analog, in the interest of users, carriers, and manufacturers alike.

The value to users of the advantages generally attributed to digital is unquestioned. For carriers, which continue to make heavy investments in the networks,[68] better use of the spectrum and lower cost of infrastructure equipment[69] are important considerations. But in face of the standards situation, there are clearly hesitations—especially among the smaller carriers, the distribution channels, and the customers—that are not alleviated by announcements of turn-abouts, changes of camp, by one or another large operator. Customers

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[65]Charles F. Mason, *Telephony*, October 1993, 7. The comparison study referred to is "Digital/Next Generation Cellular Technologies," by Herschel Shosteck and Associates, issued as a report (the main author of which is recognized industrywide as an authority in the cellular business) to subscribers, December 1993; hereafter cited as "Digital/Next Generation Cellular Technologies," Herschel Shosteck and Associates.

[66]*TR Wireless News*, Nov. 18, 1993, 12.

[67]Unlike Europe, for instance (until the recent emergence of digital GSM), where different national spectrum allocations and half a dozen standards have considerably fragmented the market and contributed to very low penetrations in countries as important as Germany and France. In total, in mid-1993 Western Europe, notwithstanding the Scandinavian "stars," had an analog cellular penetration of only 18 per 1,000 inhabitants against 50 in the U.S. (Inclusion of digital would affect the comparison only marginally.)

[68]"Since 1983, cellular carriers have spent about $12.7 B in infrastructure. . .their investment is expected to reach $18.8 B by 1995." Calvin Sims, "Hughes Gets Big Contract At BellSouth," *New York Times*, Nov. 30, 1993, D4.

[69]"A large number of subscribers in the same RF [radio frequency] channels reduces cost per subscriber by 30 to 60% compared to analog." *Cellular Facts*, Hughes Network Systems, Germantown, Maryland, 1992.

can be expected, for instance, to find the security advantage of digital less convincing—to benefit from it in many geographic areas digitally covered, the customer would need a three-mode phone (TDMA-CDMA-AMPS). All this clearly adds a new dimension of complexity to roaming.

For such reasons, digitization in the U.S. will be slow. As of year-end 1993, less than 1 percent of subscribers are said to be served by digital. In three scenarios recently developed by a leading information technology (IT) consultancy, the share of digital subscribers forecast by 1998 remains in the range of 27 to 32 percent.[70] Another authoritative estimate is dramatically lower: between 5 percent and 10 percent by 1998.[71]

Embarking on digital with two different standards has implications for the long term, because it is unlikely that TDMA will wipe out CDMA or vice versa: fragmentation of the marketplace and confusion of the mobile user (contrary to claims, users will not "remain outside of this," because they like to know what functions and features they can get and where they can use them). Ironically, though technologies evolve quickly, their lifetime in the networks is very long. Herschel Shosteck illustrates this by a caricature:

> In 1947, the Bell Laboratories originated the concept of cellular radio . . . . Thus, AMPS and TACS[72]—the dominant cellular radio analog networks—are based on technology more than 50 years old. Yet, these networks still being rolled out today have a remaining 15-20 years life expectancy.[73]

AMPS phones will be sold in the U.S. for many years, and the market will make the difference.

In summary, on the negative side, in the U.S. digital will come in slowly and divide the marketplace. On the positive side, a very advanced scheme, namely, CDMA, is being tested in the real world, where it will gain experience and find its place; in the late 1990s it may

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[70] *1993 U.S. Cellular Market Forecast—Analog & Digital*, BIS Strategic Decisions, 1993.

[71] "Digital/Next Generation Cellular Technologies," Herschel Shosteck and Associates.

[72] TACS, a standard the U.K. derived from AMPS, is implemented in several European countries.

[73] "Digital/Next Generation Cellular Technologies," Herschel Shosteck and Associates.

allow the U.S. to leapfrog competing European and Japanese digital standards[74] rolled out abroad.

As in many other areas, technological evolution—that is, large-scale penetration of new technologies—is intertwined with standards. Some influential parties in the U.S. communications industry strive to keep government out of standards, but the digital cellular story shows that in a highly competitive and rapidly evolving context, the industry left to itself is more likely to enter a divergent rather than consensual mode. For that reason, opposite views are being expressed. For example, in its comment to the FCC's "second report and order" on PCS, Motorola requested "the FCC [to] take a more active leadership role in PCS standards."[75]

[74]GSM and Japanese Digital Cellular (JDC) are TDMA-based.

[75]*Telecommunications Reports*, Dec. 13, 1993, 18.

Chapter Six

Outlook

Developments on the U.S. wireless scene during the latter part of 1993 address the issues discussed in this report, but only in part.

On one hand, mobile radio operators are getting ready to deploy networks with large, multistate coverage, which will offer services deemed equivalent to those offered by cellular. Nextel in particular, formerly Fleetcall, received approval from the FCC to deploy a nation-wide digital cellular-like network, a far cry from the geographic fragmentation of cellular discussed here (section **5.3**). Nextel has acquired several other mobile operators as well as licenses held by Motorola (against 20 percent of Nextel's equity).[1]

On the other hand, and probably more important, in September 1993 the FCC issued its PCS ruling:

> (*i*) The ruling introduces a much higher level of competition at the local level: five licenses will be auctioned for every Basic Trading Area (there are 492 BTAs);
>
> (*ii*) it establishes a duopoly scheme in each Major Trading Area, i.e., at a much larger geographic level (there are 49 MTAs); and
>
> (*iii*) it offers existing cellular operators the possibility of bidding for the licenses mentioned above, with limitations, however, in areas where these operators already offer cellular service.

Some concerns put forth—too late?—about the FCC's PCS decision mirror views on fragmentation expressed in this paper. The decision was voted 2:1,[2] the dissenting vote

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[1]"Nextel has the right to provide wireless services to a potential audience of 180 million people, considerably higher than the potential customer base of McCaw Cellular Communications, Inc., the largest cellular company." "Nextel Gets Motorola's SMR Licenses, Forms Strategic Alliance with NTT," *Wall Street Journal*, Nov. 10, 1993, B4. "When [Motorola] and other others recently announced transactions are completed, Nextel will have a stake—directly or indirectly—in 45 of the nation's top SMR markets." Gautman Naik, "Nextel's Deal With Motorola Advances," *TR Wireless News*, Nov. 18, 1993, 14.

[2]Only three FCC Commissioners were available.

motivated by "concerns that some of the 2 GHz licensed PCS spectrum blocks and service areas are too small to be economically viable."[3]

MCI, which plans to build a nationwide PCS network, commented that "PCS needs a technical standard or [it] will face start-up delays since there could be 2,562 licenses issued and 72 variations on technical standards."[4]

The split affecting digital cellular and the lack of readiness of a U.S. PCS standard, even though PCS spectrum auctions are scheduled for late 1994, offer a foreign standard the opportunity to be introduced into the U.S. According to a San Francisco-based analyst:

> GSM is favored right now because it can be implemented immediately . . . . Since many of the PCS networks will be GSM based, GSM has the opportunity to become the de facto standard.[5]

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[3]"Barrett's Dissent Signaled Problems Behind PCS Ruling," *RCR*, Oct. 11, 1993, 1, 8.

[4]Ibid.

[5]"PCS Services Opening Door to GSM," *Communications International*, Nov. 8, 1993, 36.

Appendix

Some Basic Concepts in Cellular Radio

Cellular radiotelephony is one way to extend the capability of the *public switched telephone network* (PSTN) to mobile subscribers, that is, telephone subscribers not physically connected, by using radio communications at the mobile end. Cellular is specifically characterized by one factor: it can be implemented with a limited amount of radio spectrum, even if the number of mobile users and the traffic generated grows very large.

Because of propagation of electromagnetic waves and other technical constraints, in practice only certain radio frequency bands are suitable for radiotelephony. But these also serve many other purposes (e.g., radio and TV broadcasting, public safety and other vehicle dispatch, national defense, air traffic control, etc.), leading many to conclude that "spectrum is a scarce resource."[1]

The basis of cellular is the carving up of a geographic area to be served into small contiguous *cells*. Radio frequencies—or radio channels—used in one cell at a given moment can simultaneously be used in other noncontiguous cells.[2] Hence, cellular is often described as a smart *frequency reuse* mechanism.

The size of cells typically ranges from a fraction of a mile to up to twenty miles in diameter, depending on traffic capacity required and on terrain. Normally, the base station, namely, the antenna and associated electronic equipment, is at the center of each cell. The base station provides the link to the mobile phones located in a given cell at a given time: the speech link to phones in active conversation and, using a separate control channel, the control link to other phones in standby mode (i.e., power on).

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[1]For an overall understanding of radio spectrum issues, see Huang, *Managing the Spectrum: Win, Lose, or Share*.

[2]This arrangement implies that the signals carried within a cell are at a low enough power that they do not interfere with those carried at the same frequency a few cells away. The low power of cellular technology (a fraction of a watt to several watts) makes hand-held cellular phones, with their minimal battery requirements, feasible.

All base stations of a cellular system are connected to the *mobile telephone switching office* (MTSO), or mobile switch, by high-speed landlines or microwave links, and the MTSO is connected to the PSTN. One cellular system may include several MTSOs, each serving a subarea—a fraction of the total service area—with its connected base stations.

An important related concept is *hand-off* (sometimes *hand-over*): as a mobile subscriber converses while driving or walking from one cell to another, the computerized MTSO monitors the subscriber's progress and transfers the call from the radio channel in one cell to a one in the next cell. This hand-off takes place so quickly that it is transparent to the user.

Another related concept is *roaming*, i.e., geographic mobility between cells (and MTSO subareas) and between independent systems, typically operated by separate entities. To deliver a call to a mobile subscriber, the system must know in which cell the subscriber is located. This knowledge is an intrinsic function of any cellular system, as long as the roamer remains within the area(s) covered by that system. The situation grows more complex when the roamer moves from the home system to another system (with contiguous coverage or remotely located). In this case, information needs to be exchanged (in more or less real time) between the two systems, so that the roaming subscriber (*i*) can be authorized to make calls on the remote system and be billed at home and (*ii*) can be located on the remote system and receive incoming calls. Roaming ordinarily refers to roaming between different (noncollocated) systems.

To meet the needs of a growing subscriber population within the area it serves, a cellular carrier may need to increase the (traffic) capacity of its system without authorization to use spectrum beyond its original allocation. This is often accomplished through *cell-splitting*, i.e., increasing the number of cells and base stations (in the zones with the heaviest traffic); *sectorizing* is another way to split cells. Cell-splitting is generally costly: clearly, if more frequencies become available, spectrum could be traded against investment into cell sites. That puts the focus again on spectrum efficiency and technologies to improve it.

Similarly, to accommodate heavy traffic at specific locations (dense business centers or airports, for example), *microcells* may be implemented; imbedded in existing cells, microcells load existing cells off and adapt the traffic capacity and service quality to specific local

requirements. Cellular operators have implemented microcells in their systems without using additional spectrum.

The simple concepts just summarized here provide the underpinnings of the emerging *personal communications services* (PCS). The major difference is that cellular systems operate in the 800–900 MHz band while PCS will operate in the 1.8–2.2 GHz band, i.e., at radio frequencies about twice those of cellular.

Compared with cellular, PCS[3] is generally seen as a broader concept: cellular implies contiguous coverage (including hand-over and roaming) and is likely to remain strongly tied to the PSTN, and adhering to its telephone usage practices. PCS, in contrast, may include wireless variants, for instance, with only *spot coverage* or other modified telephone services, e.g., data and image. The trend, though, since 1990 has been for PCS to look increasingly functionally equivalent to cellular.[4]

Finally, continued growth of cellular and the emergence of PCS both suggest that in the long run users will be less and less dependent on the PSTN, as more and more traffic flows directly from mobile to mobile, because a larger fraction of the population will be on wireless. Traffic may then transit less through the facilities of the conventional telephone carriers and more through cable TV and satellite facilities.

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[3]In its licensed versions. Unlicensed PCS is also covered by the FCC decision of September 1993.

[4]In *public access* or *telepoint* systems, the service the mobile user gets is similar to that provided by public telephone booths: both allow users to initiate calls.

Acronyms

BAMS	Bell Atlantic Mobile Systems
BTA	Basic Trading Area
CDPD	cellular digital packet data
CGSA	Cellular Geographic Service Area
CPE	customer premises equipment
CTIA	Cellular Telecommunications Industry Association
DAT	digital audio tape
FCC	Federal Communications Commission
GAO	General Accounting Office
IT	information technology
IXC	interexchange carrier
IS-41	Interim Standard-41
LATA	local access and transport area
MTA	major trading area
MSA	metropolitan statistical area
MTSO	mobile telecommunications switching office
NII	National Information Infrastructure
NCRA	National Cellular Reseller Association
NACN	North American Cellular Network
OMB	Office of Management and Budget
PSTN	public switched telephone network
PUC	Public Utilities Commission
RBOC	regional Bell operating company
RCC	radio common carrier
RSA	rural service area
SMR	specialized mobile radio
TIA	Telecommunications Industry Association

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