

spectrum up to the licensee, but would not preclude the licensee from pairing the bands if it chose to do so.<sup>93/</sup>

Reasons why the Commission may wish to consider allocating contiguous rather than paired spectrum blocks include:

- **Multipath rejection**

Echoes or "ghosts" create major limitations to the operation of land-mobile communications systems. The technical term for the multiple reflected signals that cause ghosts is "multipath." CDMA technology can reduce the harmful effects of multipath. The ability of CDMA to reject multipath increases with increasing bandwidth. A system operating in twice the bandwidth has the ability to reject multipath for paths differing by half the distance. A CDMA-TDD system operating, for example, in 24 MHz of contiguous spectrum should have roughly the same cost and capacity as a CDMA-FDD system operating in two 12 MHz blocks, but it should perform better.<sup>94/</sup>

- **Support of Asymmetric Services**

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<sup>93/</sup> Adequate transmit and receive separation, for example, is possible within a 24 MHz contiguous block if a licensee chose to adopt a conventional paired frequency block approach. Historically, the pairing of bands for Frequency Division Duplexing made it easier to filter the transmit/receive signals with lumped parameter filters for analog signals. Modern digital signal processing and the transmission/reception of digital modulation makes FDD filtering easier and less costly even without a very large frequency separation. Furthermore, digital transmission/reception makes Time Division Duplexing ("TDD") very attractive for inexpensive handsets, and is currently being used for spread spectrum, TDMA and many other techniques which are viable candidates for the PCS radio link.

<sup>94/</sup> In TDD, the base stations would be synchronized to avoid adjacent channel interference. The guard time between the in-bound and out-bound traffic in the TDMA frame is small since the guard time needs only to be the maximum cell propagation delay. For example, in microcells of 1000 ft radius, this delay is approximately 1  $\mu$ s (microsecond). A common TDMA frame is at least 2 ms (millisecond) so that the guard time contributes only a very small overhead.

Paired bands developed in mobile radio and microwave to support voice telephone service. In voice telephony, however, the traffic is symmetric and conversations flow in each direction equally. Not all communications traffic flows have such balance. Paging systems, for example, are currently one hundred percent outbound. In addition, many personal data uses (LANs, database access) are quite asymmetric; a person typing at a keyboard may generate few communications, but can demand vast amounts of data from a central computer or server.

It is reasonable to assume that the use and development of asymmetric services -- driven by applications such as electronic mail, software loading, and database access -- will increase in the future. A contiguous spectrum allocation can be dynamically divided between inbound and outbound channels to support asymmetric services efficiently.<sup>95/</sup> Doing something similar with two equal but paired sub-bands is much more difficult and costly.

■ **Contiguous Bands Can Support Internal Sub-bands with T/R Separation**

As mentioned, the allocation of contiguous spectrum blocks permits the blocks to be subdivided if a provider wishes to do so. A 24 MHz band can be divided into three sub-bands 9.5 for A, a 5 MHz buffer band, and 9.5 for A' (the sub-band paired with A'). 5 MHz should be sufficient separation to support traditional land-

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<sup>95/</sup> For example, one can pair the symmetrical services equally and the asymmetrical services unequally, or one can divide the band into three portions thus:



The data portion might even be shared among several voice users since data is "bursty" and generates fewer Erlangs.

mobile system architectures (although there may be a cost penalty associated with such a small separation). The PCS operator would be able to use the guard band for other PCS services or activities that would not interfere with the operation of the mobiles e.g., wideband data signals, in-building communications, or point-to-point links.

■ **Contiguous Spectrum Allocations Will Enhance Future Flexibility**

Consider a possible future move to a new modulation technology. If that new technology requires either 1) a large contiguous block of spectrum or 2) substantial setbacks (in frequency) from the band edge to prevent out-of-band interference, a PCS operator with a single contiguous allocation of say, 24 MHz will be much better positioned to adopt this new technology than will an operator with two separate allocations of 12 MHz.

A channel plan that seeks to maximize the benefits of five PCS providers and the benefits of contiguous 24 MHz bands could be configured as follows:

**PLAN B**

<b>Spectrum Region (MHz)</b>	<b>Channel Use</b>	<b>Comments</b>
1850-1874	PCS Block A	
1874-1898	PCS Block B	
1898-1910	PCS Block E	paired with E'
1910-1930	Unlicensed	
1930-1942	PCS Block E'	paired with E
1942-1966	PCS Block C	
1966-1990	PCS Block D	some overlap with MSS

As shown above, Plan B yields one paired spectrum block (E and E') and four contiguous blocks. Each of the five blocks are equal to 24 MHz. The plan provides for unlicensed spectrum at 1910-1930 MHz as proposed in the NPRM. The contiguous blocks permit licensees to pair the contiguous spectrum if the licensee desires. It is even possible for two licensees having contiguous spectrum separated by 80 MHz to negotiate or barter so that paired spectrum blocks are created as is the practice in current mobile cellular.<sup>96/</sup>

## V. TECHNICAL STANDARDS

### A. 2 GHz LICENSED OPERATION

#### 1. Protection of Fixed Microwave Operations

It is clear that technical standards are necessary to protect the fixed microwave operators in the 2 GHz band as well as the new PCS users of the spectrum.<sup>97/</sup> The proposal to use EIA's TSB10-E, however, is unduly restrictive and inappropriate for use in the PCS context.

The TSB10-E methods and procedures were developed primarily to protect microwave receivers from interference and evolved from an earlier era of analog transmission. TSB10-E spells out the particulars for measuring degradation caused by external interference to both analog and digital microwave links.

For analog links, TSB10-E defines degradation as introducing a 1 dB loss in signal-to-noise ratio (SNR) -- say, for example, from 30 dB to 29 dB -- in a nominal top-

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<sup>96/</sup> Note that in this plan there is some overlap of block D with a possible MSS band (as indeed there is even with the NPRM channel plan). It may be that block D is best suited for broadband CDMA, which can be used as an overlay, especially if the MSS is used as a thin-route system.

<sup>97/</sup> See NPRM at 43, ¶ 109.

of-the band Frequency Division Multiplexed (FDM) voice channel. This number of 1 dB loss does not actually mean that the degradation is perceptible most of the time since many, if not most, microwave links are designed with a margin of as much as 45 dB for fade protection. Fading in a line of sight microwave link is predominantly caused by variations in the atmospheric refractive index. This can cause the microwave beam to "bend" out of the reception angle of the receive antenna or to develop multipath signals which could cancel at the receive antenna. The outage, or unavailability, is defined as the probability that the received signal falls below a usable level. Empirical methods have been developed and accepted by the engineering community for calculating the unavailability<sup>98/</sup> as:

$$U = 2.5 abfD^3 \times 10^{-F/10}$$

where a = Terrain Factor  
b = Humidity Factor  
f = Frequency (MHz)  
D = Path Length (mi)  
F = Fade Margin (dB)

Note that this formula does not include the considerable reduction in unavailability that is afforded by the use of antenna diversity which many line of sight microwave systems employ.

At 2 GHz, with path lengths as large as 20 mi, and with a fade margin of 40 dB, this formula gives an annual outage of about 15 seconds in Houston and less than 2 seconds in Orlando. The numbers are even smaller in less humid locations. For average terrain and climate with 40 foot spacing antenna diversity, the unavailability is of

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<sup>98/</sup> "Engineering Considerations for Microwave Communications Systems," AG Communications Systems, at 59-63 (1989). Model based on work of Barnett and Vigants, Bell Laboratories, Reported at ICC '70, San Francisco.

the order of  $3.3 \times 10^{-999/}$  or about one hundredth of a second per year! For shorter spans this number is further reduced. The 1 dB figure is therefore "buried" in the excess margin designed into existing fixed microwave links.

For digital systems, the TSB10-E specification defines unacceptable interference to be any signal which causes the Bit Error Rate (BER) to increase above  $10^{-6}$  (technically to increase from  $10^{-6}$  to  $10^{-5}$ ). This degradation from  $10^{-6}$  to  $10^{-5}$  BER is equivalent to having an (additional equivalent noise) interference increase of no more than 1 dB into the microwave receiver. This is an extremely harsh requirement since  $1 \text{ dB} = 1.25$ ; thus, this requirement means that the additional interference can be no more than 0.25 of the noise level or 6 dB below the noise when operating at  $10^{-6}$  BER. As in the analog case, fade margin is designed into the system so that very rarely is the reception at the "threshold" of  $10^{-6}$  BER. Furthermore, digital systems take advantage not only of antenna diversity, but of the significantly greater tolerance to interference. In addition, the use of inexpensively available error correcting coding (which can be used as an add-on if not predesigned) reduces the deleterious effect of interference even further.

It is plain that EIA TSB10-E is a useful guideline, but it should not be imposed by the Commission on PCS providers, lest it be used as an unreasonably high "wall" to keep perceived PCS "intruders" out of the 2 GHz band and thus defeat dramatically more efficient use of the spectrum. Any proposed interference standard should take into account that current microwave users of the proposed PCS spectrum have over-designed links. This luxury of over-design may have been appropriate when

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<sup>99/</sup> Id. at 63.

spectrum in this band was not shared (except with other microwave users), but it is unduly restrictive in the current proposed shared environment.<sup>100/</sup>

## **2. 2 GHz Power and Antenna Height Limits**

The proposal to limit the power levels to that similar to current cellular mobile (7 watts mobile ERP and up to 500 watts base station power) appears reasonable. Bell Atlantic does not believe that the power limits should be set higher than this in the rules, but the rules should include the mechanism of either (1) variance appeal to the Commission for any licensee who can demonstrate a need to exceed ERP and antenna height limits, e.g., for large cells in rural areas, provided that the interference specifications (to be determined) are not exceeded, or (2) a rule which would allow a licensee to negotiate with neighbors up to the coordination distance, the use of more power and/or antenna heights up to a maximum power at the base station and antenna heights specified in table 1 of the NPRM at ¶ 119. In any event the rules should require that no more than the minimum power necessary to operate with an error rate of say,  $10^{-6}$  raw BER.

## **3. Coordination Distance**

The coordination distance specified in TSB10-E is somewhat less objectionable than the fixed microwave interference standards. Here again, however, Bell Atlantic would point out that TSB10-E was established for fixed microwave-to-

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<sup>100/</sup> Bell Atlantic acknowledges that there may be circumstances where a more relaxed interference standard may be exceeded in the projected crowd of PCS operators and users. Using today's technology, however, allows units operating near the line of sight of microwave links to automatically power down, or avoid interfering frequencies. Further, the use of smaller cells will reduce power or more futuristically one can fix antenna nulls against interference. The global objective is to allow greater spectrum utilization efficiency while providing acceptable performance and interference levels.

microwave interference. Because microwave radio antennas have high gain and directivity, the coordination concerns in that context are greater than for PCS for microwave to microwave, since the potential exists for considerable effective radiated power (ERP) to be delivered even over long range if the co-channel or adjacent channel antennas happen to be pointed towards each other. For PCS systems, by design, neither the base station antennas nor the customer units will have high gain (most likely on the order of 0 dB). The coordination distance could be therefore smaller than that specified in TSB10-E.

#### 4. 2 GHz PCS-to-PCS Interference Standards

The proposed PCS-to-PCS interference standard appears to be based on the analog AMPS. The calculation in the NPRM presumes the need for 35 dBu minimum field-strength for "good quality service" and adds  $1.28 \times 9.4$  dB for location variability based on a lognormal shadowing model with 9.4 dB standard deviation (Okamura). This yields 47 dBu of coverage up to a licensee's boundary. It may not be necessary, however, to have 35 dBu to achieve "good quality service." Digital systems are much more tolerant to interference and can operate with signal-to-interference ratios significantly (e.g., by 10 dB or more) lower than analog systems.

In Bell Atlantic's view, therefore, it may be appropriate to lower the objective signal levels at the PCS licensee's boundaries so that the licensee's own unit operates at  $10^{-5}$  raw BER at the boundaries and does not cause any degradation beyond  $10^{-5}$  raw BER in the adjacent or co-channel users. The advantage of tightening the permissible boundary signal strength at the boundary is that it would provide an incentive for introducing innovations such as error control coding, diversity, and adaptive power

control. The result could be a reduction in the net interference level, and in some instances, an increase in total capacity.

#### **B. POWER LIMITS FOR 2 GHZ UNLICENSED DEVICES**

The proposed power limits for 2 GHz unlicensed services will probably not protect the fixed microwave users, especially if TSB10-E is the defined standard of protection. This is especially true for the 1 watt/10 MHz channel bandwidth option. Because most of the fixed microwave systems actually operate over 10 MHz, they would have no filter rejection of any power received from wideband data PCS operating over a full 10 MHz. This is especially true of outdoor use of unlicensed devices near the main lobe of the microwave receive antenna pattern.<sup>101/</sup>

#### **VI. CONCLUSION**

PCS represents perhaps the most important radio development of this century and the beginning of the next. Its potential is limitless -- it can create multiple new information and knowledge networks readily accessible by almost everyone. Using ether and electrons, coupled with terminal microcomputers, fiber optic glass, digital switches, and network intelligence, PCS can truly make each person a "knowledge worker." Considering what is at stake, the Commission should act with vision and resolve in assuring all companies the opportunity to offer competitive services to consumers. In so doing, the Commission should authorize at least two nationwide licenses.

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<sup>101/</sup> This observation may be mitigated by the fact that the 1910 to 1930 MHz band is relatively unpopulated. See NPRM at 19 n.31.

**Bell Atlantic urges the Commission to act promptly to expedite provision of a diversity of nationwide PCS service networks, in accordance with the recommendations contained herein.**

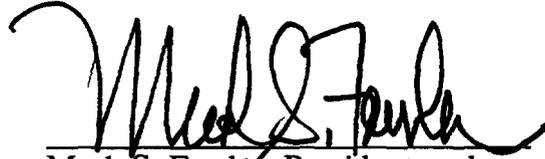
Respectfully submitted,

BELL ATLANTIC PERSONAL  
COMMUNICATIONS, INC.

Of Counsel:

James R. Young  
William L. Roughton

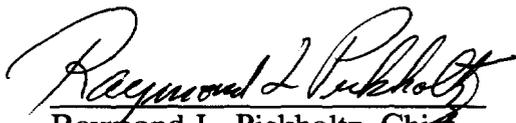
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Its Attorneys





Before the  
FEDERAL COMMUNICATIONS COMMISSION  
Washington, D.C. 20554

	)	GEN Docket No. 90-314
	)	ET Docket No. 92-100
In the Matter of	)	
	)	RM-7140, RM-7175, RM-7617,
	)	RM-7618, RM-7760, RM-7782,
Amendment of the Commission's	)	RM-7860, RM-7977, RM-7978,
Rules to Establish New Personal	)	RM-7979, RM-7980
Communications Services	)	
	)	PP-35 through PP-40
	)	PP-79 through PP-85

AFFIDAVIT OF ALFRED E. KAHN

STATE OF NEW YORK	)	
	)	: ss:
COUNTY OF TOMPKINS	)	

I. INTRODUCTION AND SUMMARY

1. My name is Alfred E. Kahn. I am Robert Julius Thorne Professor of Political Economy, Emeritus, at Cornell University, where I have been on the faculty since 1947, and successively Chairman of the Department of Economics and Dean of the College of Arts and Sciences. My business address is 308 North Cayuga Street, Ithaca, New York 14850.

2. The experience of mine most pertinent to the present proceeding is that in addition to having been Chairman of the New York Public Service Commission during the period 1974-77 and of the U.S. Civil Aeronautics Board in 1977-78, I have for almost my entire professional career specialized in the economics and policies of competition and economic regulation. My most pertinent writings on these subjects are my book, Fair Competition, the Law and Economics of Antitrust Policy, written in collaboration with J.B. Dirlam, and my two-volume The Economics of Regulation, published originally in 1970-71 and reprinted by MIT Press in 1988--along with some 70 professional articles. I have taught courses in both these areas in the Cornell Department of

## BIOGRAPHY

### GEORGE GILDER

George Gilder is senior fellow at the Discovery Institute in Seattle. A graduate of Harvard University, he majored in government, studied under Henry Kissinger, and later taught as a fellow at the Kennedy Institute of Politics. He is author of nine books, including *Life After Television*, *Microcosm*, *The Spirit of Enterprise* (just reissued in an updated edition as *Recapturing the Spirit of Enterprise*), *Wealth and Poverty*, *Visible Man*, *Men and Marriage*, and *The Party That Lost Its Head* (with Bruce Chapman).

Gilder is a contributing editor of *Forbes* and *Forbes ASAP* and a frequent contributor to a wide range of publications, including *The Wall Street Journal*, *American Spectator*, *National Review*, and a variety of electronic business publications. He is currently working on a new book on computers and telecommunications, to be entitled *Telecosm*. A first draft of one of the chapters appeared in the March-April 1991 issue of *Harvard Business Review* under the title *Into the Telecosm* and a further chapter will be featured in *ASAP*, *Forbes'* new technology supplement.

Mr. Gilder pioneered in the formulation of supply-side economics when he served as chairman of the Lehrman Institute's Economic Roundtable, as Program Director for the Manhattan Institute, and as a frequent contributor to A.B. Laffer economic reports. Since the publication of *Wealth and Poverty*, he has consulted regularly with key government and high technology leaders.

Gilder's *Life After Television*, a prophecy of the future of computers and telecommunications, was published by Whittle Communications in 1990 and republished in June 1992 by W.W. Norton in an updated edition.

His major work, *Microcosm*, explains the quantum roots of the new electronic and communications technologies and maintains that the law of the microcosm requires decentralization of both business and government, in data processing, manufacturing, telecommunications, and even defense. Long expected to favor large capital intensive bureaucracies, the new technology in fact impels a global revival of entrepreneurship. Gilder also shows that the new technology will not only transform the office and the factory but also consumer electronics.

Mr. Gilder has been chairman of a small business himself and serves on the board of directors of several high technology companies. He is the recipient of a White House Award for Entrepreneurial Excellence. Mr. Gilder has given several hundred speeches around the world to major corporations and to conferences on business, technology and telecommunications issues.

Economics and in the Cornell and New York University Schools of Law. During the administration of President Eisenhower, I served as a member of the Attorney General's National Committee to Study the Antitrust Laws and, under President Carter, on the National Commission on Antitrust Laws and Procedures. I attach a full copy of my resumé as an appendix.

3. The purpose of my affidavit is, on the basis of my experience both as an economist and as a former regulator, to comment on certain issues raised by the Commission in its Notice of Proposed Rulemaking ("NPRM"). These include: the amount of spectrum and number of licenses to be allocated to new radio-based personal communications services ("PCS"); eligibility requirements for PCS licenses; and the geographic scope of those licenses.

4. My approach to these issues is grounded in the proposition that the competitive market is by far the best mechanism for producing the efficient utilization of scarce resources; and that is precisely the task confronting the Commission in these proceedings. This conviction translates into recommendations that the Commission set aside the largest possible portion of the spectrum for PCS, with as many as five licenses for each locality; that, to the greatest extent possible, it leave to a free after-market in operating rights the determination of the best uses and users of that portion of the spectrum; and that the Commission bar no particular categories of applicants from these licenses. In my judgment, finally, there are strong reasons for making at least two of the licenses nationwide in their scope.

## **II. FIRST PRINCIPLES**

5. As one who played a substantial role in getting the government out of the business of defining valuable operating licenses and choosing among competing applicants in the airline industry, I experience a certain awkwardness in undertaking to advise the Commission on how to perform these very tasks in the present proceeding. I begin with the presumption that the way in which to get the maximum social benefit from a scarce resource like the electromagnetic spectrum is to require competing applicants to bid for such portions of it as they wish to use, with the right subsequently to buy and sell those operating rights subject only to the considerations and restraints

embodied in our antitrust policies.<sup>1</sup> These market processes, ideally, would determine not only how particular portions of the spectrum should be distributed among competing applicants but also how all of it is to be allotted among the various and constantly changing alternative services in the provision of which it is an input.

6. Awarding licenses through auctions or competitive bids would accomplish two separate purposes. First, it would extract the rental value of this scarce resource for the benefit of the general public, rather than confer it free of charge on the successful private applicants. Second, and entirely separately, it would ensure the most efficient use of that resource, under the presumption that the best available measures of efficiency are the respective prices for which private owners are willing to sell and bidders or purchasers are willing to buy.

7. As I understand it, however, the Commission does not have the statutory authority to allocate the spectrum through the use of auctions. On the other hand, it does contemplate giving licensees broad discretion in the uses to which they put their allotments and freedom to buy and sell them subsequently, and these approximations to a free after-market are surely to be applauded.<sup>2</sup> Making the rights, however initially bestowed, freely salable and purchasable should achieve the same efficient results as an initial bidding process, subject to the possibly important qualification that the transactions cost and time entailed in ensuring that ultimate most efficient allocation may be much larger when the rights are not distributed through market mechanisms in the first instance.

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<sup>1</sup> This presumption is of course subject to contradiction in situations of market failure or prohibitively high transactions costs. For example, while it might be logical, in principle, to rely on individual bidding for small individual pieces of the spectrum in order to be able to use cordless telephones (or the streets in residential neighborhoods) to produce the efficient outcome, manifestly the transactions costs would almost certainly be prohibitive, and the Commission's proposal in this proceeding simply to make 20 MHz available for such low-power operations on an unlicensed basis represents the more efficient way of achieving that result.

<sup>2</sup> To this approval I would attach two qualifications: 1) to the extent the Commission bestows the licenses initially on the basis of undertakings by the applicants to meet certain performance criteria, such as minimum rates of exploiting the rights they convey, successors should generally be bound by those understandings; and 2) subsequent combinations of operating rights must be subject to review in terms of whether they are likely to impair competition--preferably, I will suggest, by the agencies responsible for enforcing the antitrust laws.

8. Precluded from employing auctions, the Commission has no alternative but to decide itself, at least initially, what portion of the spectrum should be set aside for PCS and how many separate licenses to carve out of that allotment, what kinds of entities may be permitted to apply and how they are to be selected--by methods ranging from lotteries to comparative hearings and judgments of qualifications, application by application.

9. I have no particular qualifications to advise the Commission about many of the technical judgments involved in trying to determine the optimum allocation of the spectrum among alternative uses and users. What I can do, on the basis of my experience as an economist and former regulator, is suggest such general principles as seem to me to apply to its making of these initial judgments--in the context of an understanding of the extent to which the discretion of licensees in their choice of technologies and target markets and a free market in licenses, from that point onward, may be relied upon to improve upon the efficiency of the initial decisions.

### III. THE SIZE OF THE SPECTRUM ALLOCATION AND NUMBER OF LICENSES

10. So long as the Commission is, inescapably, in the business of apportioning the spectrum among its various possible uses, it has no choice but to try to make its allocations in such a way as to maximize the expected total social value extracted from it. Such choices among alternative uses are difficult. They require detailed knowledge of technologies and markets--both present and prospective--that the Commission can possess or acquire only very imperfectly, at best.

11. Several reasons lead me to believe that the "personal" voice and data services encompassed under the broad mantle of PCS deserve a large allotment.

12. First, we have the example of the enormous success and growth of cellular to show how valuable these services are. Cellular properties are currently valued at many times the replacement value of their tangible assets.<sup>3</sup> A high ratio of market value to replacement cost means

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<sup>3</sup> See, "U.S. Spectrum Management Policy: An Agenda for the Future," U.S. Department of Commerce, NTIA Special Publication 91-23, February 1991. See especially Appendix D, "Estimating the Value of Cellular Licenses."

that additional investment in the industry in question is likely to generate correspondingly large improvements in economic efficiency. Allocating more spectrum to cellular-like PCS service would permit exactly such a remedy.

13. Second, the Commission has decided to use market-like mechanisms in effect to choose between the contemplated new and present uses of the microwave band in question. By requiring PCS licensees to make incumbent fixed-microwave operators whole if they displace them-- either through negotiated agreements or by constructing equivalent telecommunications systems<sup>4</sup>-- it not only protects the incumbents; it also ensures that they will be displaced by PCS only if the latter constitutes a more valuable use of that particular part of spectrum (in the opinion of the purchaser, who bears the risk of being mistaken).

14. The third and most important consideration that seems to me to argue in favor of generosity in the size of this overall allotment to PCS is that it will permit the certification of a larger rather than a smaller number of initial separate licensees of minimum efficient size and, by so doing, ensure the maximum feasible amount of competition in the exploitation of this potentially large, variegated market. This will have the incidental and in my opinion desirable effect--paradoxically-- of minimizing the size of the give-away of valuable rights to a scarce resource, since presumably the value of that gift will vary inversely with the expected intensity of competition to which the successful applicants will be subject.<sup>5</sup>

15. Indeed, the foregoing considerations, and especially a full appreciation of the effectiveness of a competitive market in making the most efficient use of the spectrum, suggests the

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<sup>4</sup> See *Redevelopment of Spectrum to Encourage Innovation in the Use of New Telecommunication's Technologies*, ET Dkt No. 92-9, First Report and Order and Third NPRM (released October 16, 1992) (allocating 220 MHz of spectrum for emerging technologies and adopting a framework for the transition).

<sup>5</sup> It might appear that this beneficent effect would be offset by the effect on other uses: the wider the band allotted to PCS, the greater the scarcity value of the licenses for all those other uses. As I have already suggested, however, the fact that most of those incumbent uses can be accommodated elsewhere at relatively low cost and would in any event have to be compensated by the aspiring provider of PCS services would seem to tip the balance on the side of a large initial allocation to PCS.

even more radical conclusion that the Commission should seriously consider releasing the entire 220 MHz band that it has reserved for emerging technologies. That such a broadscale opening would most fully serve the purposes I have already described--maximizing the potential public benefit, offering the greatest possible opportunity and stimulus for competitive innovation and minimizing the scarcity rents bestowed on individual recipients--should be obvious.

16. A free after market--including, necessarily, freedom of licensees to make whatever uses of their allotment seems to them most profitable--should fully satisfy the one apparent counter consideration--that by so doing the Commission might preclude access in the future of such other even more valuable uses as emerge. If such other, superior uses of the spectrum band or any part of it emerge, they would prevail: it would either be in the interest of the initial licensees to undertake them, or other providers should be able to offer a purchase price higher than the value of the licenses to their incumbent users--provided only that there are a sufficient number of competitive licenses initially issued so that no single holder could refuse to sell in order to protect a monopoly position.

17. The decisions about the optimum number of licenses to be issued and the size of the total spectrum allocation to PCS are, of course, interdependent. The choice of the number of licenses to be squeezed into whatever total band it sets aside for this purpose, like many of the other decisions confronting the Commission in this case, will necessarily involve a balancing of two offsetting considerations--the desirability of maximizing diversity of providers and the likelihood of effective competition, on the one side, and the economies of scale and scope, on the other. The first consideration alone, other things being equal, argues on the side of maximizing the number of licensees. The second requires an assessment of such efficiency penalties as may be associated with a narrower allotment--that is to say, sacrifices of such efficiencies as could be achieved if each licensee could mount a larger scale of operations and offer a wider range of services.

18. As for the former consideration, no one can assert unequivocally that the five licenses that are the upper limit of the number suggested by the Commission are absolutely necessary for effective competition. The PCS licensees would be competing not only with one another but also,

to an extent about which it is not possible as yet to be certain, with the two cellular licensees and the cellular-like specialized mobile radio services ("SMRS"). Depending on how PCS develops, its licensees might be competing also with the wire-based telephone services of the LECs and with other radio-based services. On the other hand, if the Commission were to conclude, as I have, that there are persuasive reasons for permitting one or two of the new licenses to go to the incumbent LECs or cellular operators, the number of PCS licenses could determine the total number of competitors, including the incumbents.

19. As the Commission prepares to evaluate this tradeoff, it is important for it to bear in mind that its initial decision about the number of licenses to issue and their average band widths is effectively only a provisional one, provided the licenses permit alternative uses and can subsequently be purchased and sold.<sup>6</sup> This is especially desirable since those initial decisions will inevitably be based, implicitly or explicitly, on little better than guesses about the nature and dimensions of the future market for these services and the evolution of technology and must therefore always be thought of as only tentative and subject to alteration as information and experience accumulates.

20. In these circumstances, it would seem the prudent policy would be to run the risk of erring on the side of too many licensees each with too small an allocation, in the interest of maximizing the likely effectiveness of competition. If, then, the initial allocations involved an excessive sacrifice of the economies of operating on a larger scale, correction of that error could safely be left to the market, through subsequent purchases and sales.<sup>7</sup>

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<sup>6</sup>If there were to be any doubt about the ability to buy and sell fractions of licensees, I suggest it would be desirable--and conducive to efficiency--for the Commission to make that right explicit.

<sup>7</sup>As a matter of arithmetic, it would appear subsequent sales of partial allocations of band widths could equally well be counted on to correct errors of the opposite kind; but if the consequence of the Commission's initially issuing too few licenses is insufficiently effective competition, the problem would be much more difficult to correct. Since the likelihood of the initial recipients being willing to sell off some of their rights to potential competitors will almost certainly be less than of companies with licenses insufficiently broad to sell them off to others who could make better use of them, the Commission would in this event have to identify the problem in particular localities itself and revoke all or part of the offending licenses in order to correct it.

21. The transfer of rights in a free after-market must, of course, as in the case of purchases and sales of all other business assets, be subject to the antitrust laws. There is always the danger that a purchaser may be able to offer a potential seller sufficient inducement because their merger will produce an increase not in efficiency but in monopoly power. As a general proposition, I believe the antitrust agencies have the greater competence to make such assessments: antitrust jurisprudence provides as much guidance as is available, for example, about how to deal with acquisitions that promise to produce both results.

#### IV. ELIGIBILITY REQUIREMENTS

22. The Commission asks for comments on what kinds of applicants should be eligible for these PCS licenses--specifically, whether LECs and cellular operators should be barred from acquiring them. Once again, the decision calls for a balancing of the benefits of a multiplicity of service providers against the benefits of integration--i.e., economies of scope and scale.

##### Categorical exclusions

23. My strong recommendation would be that no incumbent service providers be excluded, precisely because of those economies of integration. As the Commission fully recognizes, it would surely be inefficient to exclude the telephone companies from using the radio spectrum for hooking up customers in situations where that medium promised to be less costly than laying additional cable. Moreover, since the incumbent companies are already in the business of offering communications services to their subscribers, it would seem highly inefficient to deny them the opportunity to expand the range, variety and diversity of their offerings in these new ways, making fuller use of their already considerable managerial, technical and commercial capabilities.

24. The counterconsideration is, of course, that the new services are potentially competitive as well as complementary with those of the incumbent providers. Manifestly, the greater the number of licenses to be issued in each locality, the less the tension between these two considerations. If the Commission were to see its way clear to issuing five PCS licenses in each locality, there need be less concern about the possible attenuation of what we might term intermodal

competition consequent on permitting acquisition of one of them each by the local wireline and non-wireline incumbents--thereby reducing the number of potential competitors from seven to five--than if it were to issue only three--which in that same event would have the effect of increasing the total number of competitors only from two to three. But even if the Commission were to settle upon only three PCS licenses, there would still be the strong reasons I have previously cited not to exclude the LECs and non-wireline cellular operators; to put it more positively, there would remain powerful reasons for permitting each of them to acquire a license.

25. Similar concerns might have been expressed about permitting telephone companies to provide cellular service. I am unaware of any evidence or convincing argument, however, that telephone company participation in the cellular business has stifled its growth. On the contrary, there has been a dramatic increase in the number of cellular subscribers, from less than 100,000 in 1984 to approximately 10 million today, while at the same time prices have declined.

26. The other reason for concern stemming from the competitiveness of the new services with the existing ones is that if the LECs, in particular, are permitted to offer PCS, they may deny their non-integrated PCS competitors interconnection with their wired local networks on terms that give the latter a fair opportunity to compete on the basis of their relative efficiency. So far as I am aware, the experience in the cellular field demonstrates that it is not necessary to exclude the LECs from offering that service to ensure non-wireline competitors interconnection on fair terms.

27. In expressing these preferences, I reflect my own philosophical reservations about structural restrictions, which, whatever their merits as guarantors of competitive fairness, are also inherently anti-competitive. As a general proposition, I have severe reservations, on competitive grounds such as I have expressed in other contexts, to flat governmental restrictions on the permissible scope of companies' operations, and prefer non-structural safeguards of competition--such as equal access, ONA, CEI and other such obligations to serve competitors on equal and non-discriminatory terms, full accounting separations or even, if absolutely necessary and the sacrifice

of benefits of integration not excessive, fully separated subsidiaries--even where the safeguards that these provide may be less than perfect.<sup>8</sup>

Encouraging the maximum amount of diversity

28. If the Commission does decide that both the LECs and cellular operators should be eligible to receive PCS licenses, there are still methods by which it could attempt to preserve the maximum amount of diversity in each market.

(1) The first and most obvious is, as I have already suggested, to issue a large number of licenses, at least initially--at the upper end of the three to five range that the Commission has suggested.

(2) The Commission apparently contemplates making cable companies and other local access and exchange providers eligible. This would further promote diversity and competition. Indeed, the arguments for including (or excluding) LECs seem to me to apply with almost equal force to these other companies. The wired distribution networks of the cable companies and alternative local carriers are potential competitors for a wide range of local distribution services. Cable companies have entered the local telephone business in the United Kingdom and, by press accounts,<sup>9</sup> appear to be succeeding. Thus, granting a PCS license to one of them diminishes by one the number of potential local competitors. On the other hand, PCS systems may be natural complements to the wired networks of the cable companies and other local transporters. They have the wire and fiber necessary to interconnect PCS base stations with switching centers. People will use mobile communications not when they are sitting in front of the television set but when they are in the yard, walking down the street or on their way to the office: wireless service would let the cable firm extend its network to those points. Thus, permitting a cable company to have a PCS license would enable it to exploit the economies of scope between its network and PCS, and by so

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<sup>8</sup> See, e.g., my Reply Affidavit in *USA v. Western Electric Co. et al*, Civil Action No. 82-0192, on relaxation of the MFJ restrictions on the ability of the Bell Companies to offer information services, January 8, 1991.

<sup>9</sup> E.g., Gary Kim, "TeleWest Unites U.K. telephone and cable tv," *Lightwave*, Oct. 1992, p. 1.

doing make it a more effective competitor. And the presence of such strong competitors provides additional reason in turn to make LECs and cellular carriers likewise eligible for PCS licenses.

(3) If a LEC or cellular company owned or participated in one of the regional or national licensees, the Commission rules could provide that neither it nor any affiliate would be entitled also to one of the local licenses. Such a provision would have the additional positive attraction of ensuring that to the extent a LEC or cellular provider obtained operating rights over and above those conveyed by a license for its own local market it could exercise them only by invading the markets of other LECs or cellular companies. As the experience in airlines has demonstrated, mutual market interpenetrations by carriers, extending their operations nationally and internationally, can be one of the most powerful forms of competition. In the same way, we have already seen instances of LECs invading one another's markets and competing vigorously in the offer of yellow pages and cellular services.

## V. THE GEOGRAPHIC SCOPE OF THE LICENSES

29. The Commission asks for guidance on whether and in what proportions the licenses should be nationwide, regional (by one definition or another) or local. Here again its task is to try to strike the best possible balance between the economies of scale, on the one side, and the advantages of a multiplicity of entrepreneurs, on the other--subject to subsequent correction by a free market in operating rights.

### The case for national licenses

30. I have already explained why I believe it would be desirable for the Commission to tilt its balancing of these offsetting considerations, in the first instance, on the side of as large a number of licenses in each locality as seems feasible. Similarly, when it turns to the question of the geographic scope of each license, the same goal of multiplicity and diversity of entrepreneurship calls for different kinds of licenses--national as well as regional or local. This means, to come directly to the point, that if, for example, the Commission settles on five licenses for each locality, at least two and in my judgment preferably several of these should go to entities authorized to operate on