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April 22, 1994

Mr. William F. Caton, Secretary
Federal Communications Commission
1919 M Street, N.W., Room 222
Washington, D.C. 20554

Re: Gen. Docket No. 90-314; Jackson/Pickholtz Overview of PCS Spectrum Needs

Dear Mr. Caton:

In the wake of the PCS panels last week, Dr. Charles Jackson and Professor Raymond Pickholtz have prepared the attached "Overview of PCS Spectrum Needs," which summarizes their views with respect to two central issues regarding the current PCS channel plan: 1) the difficulty of engineering around incumbent microwave systems and 2) the question of the most efficient PCS channel plan. The paper re-affirms the beliefs by Dr. Jackson and Professor Pickholtz that microwave sharing problems appear to be vastly overstated by the proponents of fewer, less competitive licenses; that 20 MHz spectrum allocations are efficient standalone PCS spectrum allocations that will serve most markets in the United States, but will also consolidate easily to 40 MHz if more bandwidth is required; and that the most efficient PCS channel plan consists of six uniform 20 MHz allocations.

We hope that the Commission finds this summary useful as it continues its reconsideration of the PCS service rules and channel plan. Please contact us if you have any questions regarding this submission.

Very truly yours,

Gary M. Epstein
James H. Barker
of LATHAM & WATKINS

Counsel for Bell Atlantic Personal Communications, Inc.

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Overview of PCS Spectrum Needs

by

Dr. Charles Jackson

Professor Raymond Pickholtz

April 22, 1994

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Overview of PCS Spectrum Needs

by

Dr. Charles Jackson
Professor Raymond Pickholtz

April 22, 1994

I. Introduction

This presentation summarizes our views regarding two key issues in PCS spectrum planning — (1) the difficulty of engineering around the incumbent microwave systems and (2) the question of the most efficient channel plan. As we have stated in previous filings,[1] we believe that the calculations and models used by proponents of 40 MHz PCS licenses to estimate the potential interference from PCS to existing microwave systems are excessively conservative. We believe (1) that the problem of engineering around the incumbents has been overstated by other parties and (2) that six 20 MHz channels are the most efficient channel plan for the 120 megahertz of spectrum that the FCC has allocated to licensed PCS.

II. Microwave Incumbents

Unlike the situation when the FCC authorized cellular in 1982, PCS cannot be accommodated in nearly empty spectrum. Rather, the FCC must deal with the difficult policy issues posed by the existence of microwave systems operating in the 1850-1990 MHz band. In the short run, these incumbent systems are to be protected from interference and the PCS operators must work around them. In the long run, PCS operators will be able to require the relocation

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[1] *Maximally Efficient PCS Channel Plans*, December 7, 1993. *A Critique of LCC's Preliminary Analysis of the Differences between 800 MHz and 1800 MHz Wireless Telecommunications Systems*, September 13, 1993. *Sharing Spectrum Between PCS and Microwave Systems*, August 1993.

of incumbent, providing that the PCS operator picks up the cost of this relocation. This includes the public safety users, which the FCC, on its own motion, has decided to transition out of the PCS band.

Key questions for the Commission in designing a comprehensive regulatory scheme for PCS are the extent to which pre-existing microwave operations will limit PCS operations and the cost to PCS operators of freeing up sufficient spectrum to begin operations.

Other potential PCS licensees have offered studies to the Commission analyzing and discussing the relative ease or difficulty of accommodating PCS operations in the 1850-1990 MHz band. The Commission, with reasoning based in part on these studies, determined that PCS could be accommodated in the 1850-1990 MHz band. These studies continue to be used to justify the notion that PCS licenses must have relatively wide bandwidth, perhaps 30 to 40 MHz, in order to easily accommodate immediate PCS operations.[2]

We disagree. We believe that PCS can be accommodated with 20 MHz licenses. These previous studies were based upon highly conservative assumptions and calculated "exclusion zones" based upon those conservative assumptions. Even with these conservative assumptions, the studies showed that there was substantial spectrum immediately available for PCS operations in the 1850-1990 MHz band. The so-called "exclusion zones" in these studies did not identify geographic regions where microwave operations precluded PCS operations. Rather, they identified regions where attention must be paid to engineering in the PCS operations — regions where one can't just take a PCS system out of the box and turn it on.

These studies included the following excessively conservative assumptions:

- higher power levels than required for PCS,
- partially or completely ignored the directivity of microwave receive antennas,
- ignored the effects of obstructions in blocking interfering signals, and

[2] PCS Action, Inc., "White Paper on PCS Spectrum Issues," July 21, 1993, Ex Parte presentation to Brian Fontes, FCC Chief of Staff.

- did not consider the huge fade margins built into many microwave systems.

They also failed to note that, in any sharing environment, one can *engineer* the location of base stations and can work to control interference.

These analysts are persistent. For example, American Personal Communications (APC) responded to our study on microwave sharing with an "Engineering Statement of J. Barclay Jones."[3] In that engineering statement, Mr. Jones stated at the end of his analysis of our study: "No amount of 'careful engineering' will magically allow PCS transmitters to use microwave frequencies in the vicinity of the incumbent receivers. Despite Bell Atlantic's claims, there are no easy 'fixes' or free lunches." But, we never claimed the existence of the mythical free lunch. Rather, our claim was that previous studies on PCS/microwave spectrum sharing were conservative — they required overprotection of microwave systems — and that the reader should take this conservatism into account when thinking through the policy issues of PCS licensing. As we observe below, APC has now adopted our view of this conservatism — at least when the issue is the operation of their proposed system in the Washington, D.C. region.

One example of the view that larger licenses are the best way to engineer around microwave incumbents was given at the FCC PCS Task Force Open Meeting on April 12, 1994 when Jeff Rosenblatt of Comsearch stated that "The ability of PCS to co-exist with microwave is better served with larger spectrum blocks."[4] In support of this claim, he observed that the receive filter bandwidths are wider than the microwave channels and hence would block an entire channel or more. He presents, in Figure 1 of his prepared statement, information on the IF filter bandwidth of common analog microwave radios. That table shows no radio with an IF bandwidth less than 10 MHz and many radios with larger bandwidth including radios with IF bandwidths of 18, 22 and 28 MHz. He argues that wider PCS bands ease the task of engineering around the microwave incumbents.

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[3] See letter from Wayne N. Schelle and Martin Cohen to Commissioners Quello, Dugan and Barrett, September 9, 1993.

[4] Prepared statement of Mr. Jeff Rosenblatt, p. 1.

We observe that wider PCS block bandwidth offers no guarantee that PCS operators will be able to "engineer around" the microwave radios.[5] Consider PCS channel block A under the FCC's current rules. Channel Block A consists of the frequencies from 1850-1865 MHz paired with the frequencies 1930-1945 MHz. The incumbent microwave channelization is 1850-1860 paired with 1930-1940. Suppose one of the wideband receivers operating in the 1850-1860 band today uses a receiver with an IF bandwidth of 22 MHz. Such a receiver would normally be tuned to the center frequency (1855 MHz) and with 22 MHz IF bandwidth it would be (roughly speaking) susceptible to interference over the entire range of 1855-11 MHz to 1855+11 MHz or 1844 MHz to 1866 MHz. In other words, all of one end of the 30 MHz wide Block A frequencies are blocked by such a receiver. Moving to 30 or even to 40 MHz blocks does not solve the problems observed by Mr. Rosenblatt.[6]

We believe that 20 MHz spectrum allocations can serve most markets in the country as standalone allocations. Mr. Rosenblatt's firm also concluded last summer that "a PCS allocation of 20 MHz can permit deployment of PCS" in one of the country's densest urban markets.[7] Moreover, such blocks can consolidate efficiently and rapidly if more bandwidth is indeed needed. Ultimately, however, tying bandwidth to the incumbent problem is a red herring.

Rosenblatt concludes that spectrum sharing between PCS and microwave is only a stopgap — ultimately relocation of the microwave systems will occur. We agree and suggest that the

---

[5] One way to preserve a large number of licenses while reducing the chance that a licensee would be blocked by a single microwave receiver would be to assign PCS licenses using non-contiguous portions of the 1850-1890 and 1930-1970 MHz frequencies. For example, one 20 MHz license could consist of the ranges of 1850-1855, 1870-1875, 1930-1935, and 1950-1955 MHz. We do not believe that such an alternative need be considered since we do not believe that the problem of the microwave incumbents is intractable. But this appears to offer most of the incumbent avoidance advantages of 30 or 40 MHz licenses with out the negative effects on industry structure.

[6] Note that even moving to 40 MHz blocks does not assure that a single microwave system will not block a PCS system. If the PCS low band were divided into two 40 MHz bands, one natural channelization would be 1850-1870 MHz paired with 1930-1950 MHz and 1870-1890 MHz paired with 1950-1970 MHz. Note that a receiver with an 28 MHz IF operating on a center frequency of 1865 MHz would block operations from 1851-1879 MHz. Such a receiver would effectively "block" operations on the 1850-1870 MHz region.

[7] "Analysis of a 20 MHz PCS Spectrum Allocation for Detroit," Comsearch, August 1993.

focus should be on finding ways to speed that relocation rather than on channel plans that may reduce the need for a speedy relocation at the cost of a permanent reduction in industry competition.

III. A "40 MHz" Proponent's Views

One of the first studies on PCS spectrum issues was prepared by APC.[8] It issued a second study a year later.[9] The 1992 APC study used a relatively simple and clearly described methodology to identify what the report called "exclusion zones" around microwave transmitters where PCS operations needed to be prohibited in order to permit interference free operation of the microwave systems. This methodology was then applied in 11 major cities to determine the extent of the microwave blockage of PCS operations.

The primary conclusion of the 1991 APC study was:

> . . . As a result of the analysis of the existing use of the 1850-1990 MHz band in the top eleven U.S. markets, APC is able to conclude that adequate spectrum exists for start-up PCS operations.
>
> APC, 1991 study, p. 23

APC's conservative model was good enough to support this conclusion. Even though APC's assumptions overstated the protection required for microwave systems, the study nevertheless established the availability of spectrum for PCS in the major urban areas. Indeed, the conservatism of the model probably speeded acceptance of its conclusions.

The 1992 APC report used the same conservative assumptions but now offered conclusions on the difficulty of sharing the limited PCS spectrum among multiple PCS operators. The

---

[8] "Frequency Agile Sharing Technology ("FAST") Report on Spectrum Sharing in the 1850-1990 MHz Band Between Personal Communications Services and Private Operational Fixed Microwave Service," APC, July 1991, Volumes I and II.

[9] "Report on Spectrum Availability for Personal Communications Services Sharing the 1850-1990 MHz band with the Private Operational Fixed Microwave Service," APC, November 1992.

1992 report offered three broad conclusions on the negative consequences of dividing the PCS spectrum among more licensees.

Yet, that same report offered a caveat on its methodology. In their 1992 report, APC stated:

> APC does not advocate that operating PCS systems use simple exclusion zones to provide interference protection to OFS microwave licensees. Exclusion zones are a useful device for obtaining valuable information on spectrum sharing which can be used for policy decisions. The exclusion zones utilized in the July 1991 Report are not flexible enough to be utilized for actual PCS system design nor were they intended to be put to this type of use.
>
> APC, 1992 report, p. 13, footnote omitted

Note that the effect of APC's conservative assumptions was reversed between the 1991 and 1992 studies. In 1991, its conservative assumptions *overestimated* the protection that microwave systems would require, and hence gave the FCC and microwave interests reassurance that the policy goal of PCS/OFS sharing was reasonable. In 1992, these assumptions *underestimated* the spectrum that would be available to multiple PCS operators and thereby supported arguments against smaller PCS bands. Such overprotective analysis does not provide sound information for informed decisionmaking on the required bandwidth of PCS licenses.

The key to understanding both the strengths and limitations of the APC studies is to look at the APC definition of "exclusion zone." APC's analysis relied on simplified assumptions for propagation, antenna selectivity and the geographical distribution of interfering power and, in conjunction with the severe rules in EIA TSB-10E, concluded that PCS operations were impossible within a specific geographic region around each microwave site. For example, APC effectively assumed that co-channel PCS operations were impossible within four miles of a microwave receiver even if the PCS system operated at low power and behind the microwave receiver. (*See* the 1992 APC report, p. 13.)

Such simplified interference calculations and rules could be appropriate in many circumstances. They reduce the computing task and are useful in getting a first cut at the dimensions

of the problem. They were perfectly appropriate for the first task APC set itself, showing the possibilities of PCS sharing with private microwave. However, the definition by APC of these regions as "exclusion zones" and the combining of such regions to provide estimates of the "Areas with No Spectrum Available for PCS" might be misleading. A better name for these regions might have been "Areas where PCS System Engineering will be Required to Protect Incumbent Microwave Systems."

In a recent filing APC offered an analysis of the short comings of traditional analysis of PCS interference into microwave systems which is strikingly similar to our analysis. On January 18, 1994, APC filed an "Application for an Initial Authorization in the Personal Communications Service" pursuant to its Pioneer's Preference grant. In that Application, APC stated:

> Theoretical interference prediction methods must be conservative to ensure interference-free operation for incumbents. APC has found that often buildings or other obstructions, unaccounted for in theoretical predictions, can provide sufficient isolation to allow PCS frequencies to be used without interference, after coordination with the affected microwave incumbent, where theoretical methods might predict interference.[10]

This is exactly our point. We couldn't have said it much better ourselves.

IV. A "50 MHz" Proponent's View

Time Warner Telecom on September 9, 1993 filed a report by Guy Jouannelle and Arun Jalan of LCC, Incorporated that purported to show that PCS systems require 50 MHz of spectrum in order for those PCS systems to provide service comparable to cellular service.

The LCC study is flawed. Key assumptions of the LCC study are incorrect — they do not reflect the characteristics of modern radio technology. Consequently, the consequences of the

[10] APC PCS Application, FCC Form 401, Schedule B, Exhibit 6, *Engineering Exhibit*, p. 9.

study lack any foundation and cannot be depended upon in reasoned policy making. Further, we believe that the conclusions are incorrect.[11]

A. The Power Budget

The heart of the LCC study is the observation that a PCS system operating at 1800 MHz will have a 6 dB lower power budget. Based on this assumption, the authors purport to show that, all other things being equal, the PCS system will need more base stations or more frequencies to obtain coverage equal to a cellular system.

Two questions immediately come to mind. Are the calculations of power budget correct? We think not. Second, and perhaps more important, assuming for the sake of argument that the LCC power budget is correct, does that power budget imply the differences in coverage or performance the authors calculate? Again, we think not.

We considered their power budget and showed that, with reasonable assumptions, the disparity could be reduced to only 1 dB. What does such a 1 dB difference mean? If we use the inverse fourth power propagation model LCC used in their analysis, then the 1 dB difference corresponds to a 6 percent greater coverage range for cellular when the cell size is limited by coverage, rather than the 40 percent coverage range LCC calculated.

LCC's results and the authors' conclusion that 50 MHz is needed by PCS licensees flows from their one finding on power budgets and their exclusive focus on noise-limited rather than interference-limited cells. Any analysis that considers maximum cell sizes assumes that usage is low enough that cell splitting is not yet required. In an interference-limited world, as would be expected in a mature PCS or cellular system, cell diameters are determined by the placement of other cells — not by the performance of the power budget against thermal noise.

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[11] We do not address the question of whether the comparability of PCS and cellular license regions is a useful policy exercise. Time Warner and LCC posed this issue. We merely show that their conclusions on the relative competitiveness of 50 MHz PCS licenses are wrong.

The authors of the LCC study quickly dismiss the easy ways to fix their estimated 6 dB difference between PCS and cellular by claiming that such technical fixes are available to both PCS and cellular and that they therefore cancel out. This is not correct. Cellular system designs are a consequence of weighing many factors and trading them off, one against another, to design the best possible system. A PCS operator, faced with slightly different tradeoffs, should be expected to choose a slightly different system design.

B. Critique of the LCC "City Case Study"

The LCC study contains a "City Case Study" that used an LCC-proprietary cellular analysis tool to compare the coverage of two hypothetical networks — one cellular, one PCS, each serving the Washington, D.C. region inside the beltway. The two systems are assumed to be quite similar, except the radio coverage of the PCS system is based on a 6 dB poorer coverage threshold. Clearly the LCC report needed analysis similar to the city case study. As the LCC authors themselves observed "it is at least theoretically possible that most cells in practical 1800 MHz systems would be capacity limited, not coverage limited, and *thus little parity benefit would result from creating PCS assignments larger than 800 MHz cellular*" [LCC, p. 16, emphasis added]. In other words, in any region where reuse is extensive and where cells are less than the maximum diameter, PCS and cellular parity result from equal bandwidths.

The burden on LCC is then to show that reasonable PCS systems need the extra bandwidth to gain comparability. To do this the authors consider their hypothetical cellular system that consists of 20 cells with three sectors each. The authors did not discuss the actual channel plan used or the degree of cellular reuse permitted and they did not include maps. But, they gave us enough information to understand the general outline of their system. First, they assume a penetration of 3 percent. Low penetration is needed to get the results Time Warner and LCC wanted to show. Higher penetration would mean more traffic and cells would become capacity limited.

There is a second problem with the LCC study. It did not take into account the capacity increase made possible by digital wireless technology. Tables 3 and 4 of the LCC report tabulated the number of channels required at each cell site for each sector. The total of 60 sectors use a combined total of 920 channels for the cellular model (15.3 channels/sector) and 926 channels for the PCS model (15.4 channels/sector). The LCC report offers no description of the reuse model. Indeed, there appears to be no need for reuse if a technology only slightly more spectrally efficient than cellular is used.

Anyone who follows mobile radio technology is well aware of the enormous expansion of capacity that has been made possible by the modern digital systems. Claims for the expansion of capacity over the old AMPS technology range from six-fold to twenty-fold. Even a technology with but a six-fold capacity increase would permit a cellular system to support the equivalent of 2400 channels without reuse or to tradeoff bandwidth against range.[12]

To sum up, there are two major problems with the LCC "City Case Study." First, the authors studied an artificially low penetration level. Second, they did not take into account the properties of modern digital wireless systems. If they had, they would have observed that there was plenty of spectrum available in the low-density cells for the PCS carrier to trade-off bandwidth against range.

C. Practical Implications

What happens if the FCC adopts a policy reflecting the Time Warner-LCC conclusions and those conclusions are incorrect? The answer is: There will be a lot less competition in PCS. One hundred megahertz will support five 20 MHz licenses but only two 50 MHz licenses.

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[12] We note that Time Warner's Alex Felker has stated ". . . in digital systems some substitution between bandwidth, capacity and coverage is both possible and practical. For example, the QUALCOMM CDMA digital systems being developed for PCS and cellular permits coverage and capacity to be traded off against each other more-or-less continuously." (Prepared Statement of Alex D. Felker, Vice President, Technology Time Warner Telecommunications, to the FCC's PCS Task Force, April 12, 1994, pp. 10-11, footnote omitted.)

What happens if the FCC rejects the Time Warner-LCC conclusion and those conclusions are correct? The answer is: Time Warner will buy two licenses in the auction if the Commission issues 20 MHz blocks. If the FCC's PCS license rules permit aggregation to 40 or 50 MHz and that is the efficient outcome, as Time Warner argues, then an auction of smaller bandwidth license permits that outcome to be achieved rapidly. If, as we believe, PCS licenses of around 20 MHz are efficient, then auctioning wider bandwidths probably prevents our society from achieving those efficiencies.

D. Conclusion

The Time Warner-LCC study is fatally flawed. Its conclusions lack any reasoned foundation. But, even if its conclusions were true, one could not then go on to conclude that the proper bandwidth for the PCS spectrum units in the PCS auction was 50 MHz. Rather, all one could conclude was that bidders should not be precluded from bidding on more than one block in a single geographic area.

V. Maximally Efficient PCS Channel Plans

The FCC's channel plan which splits the PCS spectrum into seven blocks (two 30 MHz blocks and one 20 MHz block in the low band (1850-1970 MHz) and four 10 MHz blocks in the high band (2130-2200 MHz) is less efficient, judged solely on engineering terms,[13] than a plan which divides the spectrum into six 20 MHz blocks (four in the low band, two in the high band).[14]

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[13] The emphasis here is on engineering efficiency. We believe that the plan is also economically inefficient as Professor Jerry Hausman has shown. See Affidavit of Professor Jerry A. Hausman, Gen. Docket 90-314, filed April 11, 1994.

[14] A word on terminology. In order to avoid confusion we will refer to the licensing regions for individual PCS licenses as "blocks" and will refer to the two separate regions of PCS spectrum as "bands."

A. Channel Plan Efficiency

The PCS spectrum was made available in two moderately separated regions of the spectrum and was divided into seven blocks of three different sizes. We believe that the FCC rules will lead to inefficient spectrum use and will thereby make PCS service more expensive and the PCS industry less competitive. The repacking or consolidation that is likely to occur under the current rules will lead to inefficient license packages and may "strand" some of the 10 MHz blocks. A substantially more efficient initial division would be into six equal-sized (20 MHz) blocks. Our alternative channel plan permits consolidation to efficient packages that do not cross the PCS bands.

B. The FCC's Channel Plan

The FCC's PCS rules (47 CFR 99) authorize licensed PCS operations in seven blocks. Among the notable features of this band plan and the FCC's PCS rules are:

- Three different block sizes (with the largest 300 percent bigger than the smallest), and
- PCS operates in two, significantly separated PCS bands.

We believe that the band plan and FCC rules harm the public interest for the following reasons:

- Consolidation inside the 1850-1990 band appears prohibited, and
- Consolidation across the high band/low band boundary appears inefficient and practically unworkable.

Consequently, we believe that the practical effect of the FCC channel plan and rules will be to effectively "waste" 20 to 40 MHz of spectrum.

We reach these conclusions from a few simple statements which we believe to be true. We believe that a 30 MHz license has only slight operating efficiencies over a 20 MHz license,

but has substantial advantages over a 10 MHz license. We also believe that today there is a significant cost premium to build a portable or mobile unit for operation on both of the PCS bands rather than on just one band. Given these facts, if one considers the possible patterns of consolidation under the PCS rules, one will find that it is highly unlikely that consolidation of PCS licenses will lead to maximally efficient spectrum use. An alternate PCS channel plan, one composed of six 20 MHz license is highly likely to result in more efficient spectrum use than the current plan.

C. Technology: Costs of the FCC Plan

The FCC's channel plan raises three technical issues that lead to an increase in the cost of equipment. First, the PCS spectrum is divided into two bands — 1850-1990 MHz and 2130-2200 MHz. The relative bandwidth inside each of these regions is small, but the relative bandwidth spanning both regions is bigger. Second, the transmit receive separation for three of the PCS blocks is 80 MHz, while in the other four blocks it is 50 MHz. Finally, the PCS blocks come in three widely varying sizes.

The cost of a radio transmitter or receiver depends, in part, upon the width of the band of frequencies it must tune. More correctly the cost usually depends upon the relative bandwidth it must tune across. A PCS radio restricted to either blocks A, B and C, or blocks D, E, F and G, need tune only a very small fraction of the channel bandwidth. In contrast, a radio that must tune the full range from block A to block F needs be able to tune across a significant fraction of the bandwidth. This additional bandwidth requirement has several implications for the design of radio system. In particular, it makes receiver design more complicated. Instead of permitting use of a narrow-band antenna system, the system requires an antenna which is efficient across a range of frequencies. Front-end amplification and filtering become more difficult. The demands on the local oscillator frequency synthesizer and control logic are increased.

Similarly, the burden on transmitters is increased. In many cases the difficulties parallel the difficulties in receivers. Additionally, it may be difficult, at least for a few years, to obtain output amplifiers for portable units that operate in both the PCS bands.

Given the technical realities and manufacturers' statements, we believe it likely that products will be developed for the lower PCS band first and that dual-band equipment will appear later and at higher cost.

1. Uneven Transmit/Receive Separation

The forward and reverse frequencies in the lower PCS band are separated by 80 MHz while those in the upper PCS band are separated by only 50 MHz. The smaller separation places a greater burden on the receive filters required to give the same transmit signal rejection.

2. Uneven Channel Bandwidths

The seven PCS blocks offer three different channel bandwidths. Additionally, given the possibility of consolidation under the PCS rules a fourth channel bandwidth, 40 MHz, could be observed in some PCS systems. While this heterogeneity complicates system design and installation it should not pose significant long-run problems for manufacturers and installers.

3. Consumer Impact

These factors all combine to make it harder to build dual-band PCS radio equipment — portable, mobile or base. Manufacturers we have talked with indicate that they expect that a PCS unit operating on both PCS bands will have a cost premium of 10 to 30 percent over single-band units. Additionally, it may be bulkier or have shorter battery life. A PCS service operator with authorizations in both bands will also face difficult infrastructure decisions. The need for dual-band mobile units could be eliminated if every base station had the capability to operate on both bands. But, putting such dual-band capacity in place would roughly double the cost of the electronics in lightly loaded cells. The FCC's build-out requirements

may also force any operator with dual-band authorizations to put in place radio infrastructure that is not justified on economic grounds.

D. PCS Consolidation - Background and Constraints

The FCC has not restricted PCS firms to operating on only a single license in each service area. Rather, the rules permit firms to obtain, either in the initial auction or in the after-market, multiple PCS licenses serving the same geographic area. Such combination or consolidation of PCS licenses are subject to certain constraints. The Commission's PCS rules allow PCS licensees not affiliated with a local cellular carrier to control up to 40 MHz of PCS spectrum. PCS licensees affiliated with one of the local cellular carriers are permitted access to only 10 MHz. And, there is no provision for "splitting" a license. In particular, the rules do not contemplate that the holder of the 20 MHz block C license could sell half the block to the block A licensee and the other half to the block B licensee.

The FCC's PCS channel plan appears to waste spectrum and other resources. If consolidation to 40 MHz is necessary for efficiency (a claim we strongly doubt) the FCC plan forces inefficient consolidation across bands. The combination of the dual bands and the uneven division of the spectrum in the FCC plan will most likely result in the virtual waste of a significant block of spectrum for many years to come.

A more efficient PCS channel plan is the following:

Block A	1850-1860 paired with 1930-1940 MHz,
Block B	1860-1870 paired with 1940-1950 MHz,
Block C	1870-1880 paired with 1950-1960 MHz,
Block D	1880-1890 paired with 1960-1970 MHz,
Block E	2130-2140 paired with 2180-2190 MHz, and
Block F	2140-2150 paired with 2190-2200 MHz.

This plan permits consolidation to 40 MHz (should that be economically efficient) without crossing band boundaries. It avoids the waste of spectrum implicit in the FCC's current plan.

VI. Conclusion

Microwave sharing problems appear to be vastly overstated by the proponents of fewer, less competitive licenses. Indeed, one of those proponents, APC, essentially agrees with this proposition in their PCS license application.

The LCC study purporting to show that 50 MHz was required for PCS to be comparable with cellular appears to be profoundly flawed and should not be relied upon.

The most efficient PCS channel plan appears to be that consisting of six 20 MHz licenses. This would allow robust competition in personal radio services offered in the 2 GHz range.