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

ORIGINAL FILE

In the Matter of:	)	
	)	
PAGEMART, INC.	)	ET Docket No. 92-100
	)	PP-40
Request for a Pioneer's Preference	)	
Regarding its Petition for Rulemaking	)	
to Allocate 800 MHz in the 930-931 MHz Band	)	
and to Establish Rules and Policies for a New	)	
Nationwide & Local Personal Information	)	
Messaging Service	)	

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PAGEMART's REPLY TO FORMAL OPPOSITION

Pagemart, Inc. ("PageMart"), by its attorneys and pursuant to Sections 1.405(b) and 1.402(e) of the Commission's Rules, 47 C.F.R. §§ 1.405(b) and 1.402(e), hereby replies to the so-called "formal opposition" (the "Opposition") submitted in this proceeding by Mobile Telecommunication Technologies Corporation ("MTel").[1]

INTRODUCTION

As demonstrated in PageMart's Motion to Strike filed contemporaneously herewith,[2] the MTel Opposition is a blatant violation of the Commission's procedural rules which should be summarily stricken from the record.[3] In this Reply,

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1 Formal Opposition and Reply Comments of Mobile Telecommunication Technologies Corporation, ET Docket No. 92-100, PP-40 (filed June 16, 1992)("MTel Opposition").

2 PageMart's Motion to Strike Formal Opposition and Reply Comments, ET Docket No. 92-100, PP-40 (filed July 1, 1992)("PageMart Motion").

3 Among other things, the Opposition was submitted in violation of the long-standing rule that oppositions to petitions for rulemaking are due no later than 30 days after filing (Section 1.405(a)), a time deadline expressly incorporated into the pioneer's preference rules (Section 1.4021(e)). See PageMart Motion, Section I. Furthermore, although captioned as "Reply Comments," the MTel Opposition does not "reply" to the comments of PageMart or any other party in ET Docket No. 92-100, but rather consists solely of comments on PageMart's original petition for rulemaking, filed February

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List A B C D E

PageMart responds to the substantive arguments presented by MTel—none of which has any merit whatsoever—without conceding the validity of MTel's procedural ploy. For the reasons that follow, MTel's assertions that PageMart's proposal for Personal Information Messaging Service ("PIMS") lacks technical feasibility or otherwise fails for satisfy the Commission's standards for grant of a pioneer's preference in the licensing process are entirely makeweight and divorced from any good faith attempt at engineering or legal analysis. In short, MTel's Opposition is a sham, unworthy of any respect and a transparent attempt to thwart objective consideration of the merits of competing proposals for the 930-931 MHz paging reserve band.[4]

PageMart's PIMS proposal represents a classic instance of entrepreneurial vision which more than meets the minimum standards for consideration of a pioneer's preference award. By combining existing communications technologies in an entirely new network design—centered on radiolocation and massive frequency re-use—PIMS offers startling service advantages with essentially "off-the-shelf" components. MTel's Opposition finds itself caught on the horns of its own dilemma, as MTel argues, first, that PIMS is not technical "feasible," and second, that PIMS is not technologically "innovative" because its elements have already been

28, 1992, See PageMart Motion, Section II.

4 For instance, MTel filed, virtually simultaneously, oppositions to all of the other advanced messaging services proposed in ET Docket No. 92-100, most of which have been submitted by firms far smaller than—and with far more modest legal resources than—Mtel itself. In addition, MTel waited months after submission of PageMart's pioneer's preference request to submit its Opposition, during which its engineering consultants reviewed PageMart's technical materials in detail, and filed a document of extraordinary length on the last day scheduled for reply comments. The clear implication from MTel's tactics is that it desired to preclude meaningful response to its arguments and to swamp its smaller competitors with an ever-increasing volume of legal pleadings, without regard to merit.

employed elsewhere. MTel cannot have it both ways; PIMS simply cannot be both infeasible and at the same time a mere replica of existing services. Consequently, MTel's Opposition represents the scurrilous and disingenuous misrepresentations of a party whose own proposal cannot withstand scrutiny, filed not based on any recognized telecommunications principle but rather for the sole purpose of precluding consideration of the merits of proposals other than its own.[5] PageMart's PIMS proposal meets all of the criteria established by the Commission for award of a pioneer's preference. While the Commission may ultimately determine after analysis that no party, or some other party, merits a pioneer's preference, it cannot dismiss PageMart's request on the hypertechnical, inconsistent and fundamentally untrue procedural grounds pressed by MTel.

ARGUMENT

I. PAGEMART's PIMS PROPOSAL MORE THAN MEETS THE COMMISSION'S STANDARD FOR "TECHNICAL FEASIBILITY"

MTel argues that PageMart "has failed to demonstrate technical feasibility." Opposition at 2. MTel is grossly incorrect for three reasons. First, the PIMS service proposed by PageMart—unlike 24,000 kbps transmission speed and complex TDD modulation schemes such as proposed by MTel—is fully feasible with current technology. Second, MTel's purported "engineering" objections to PIMs feasibility are entirely makeweight, ignoring communications literature and commercial realities which support PIMS and based on an incorrect and distorted

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[5] See Public Notice, ET Docket No. 92-100 (June 15, 1992)(formal opposition converts preference proceeding into restrictred proceeding, precluding ex parte presentations).

characterization of the PIMS network proposal. Third, MTel's Opposition is premised on a standard for technical "feasibility" which is not only far in excess of that articulated by this Commission, but one which MTel's own proposal in this docket cannot meet.

A. PIMS is Technically (and Commercially) Feasible Today Using Currently Available, Off-the-Shelf Technology

The centerpiece of the MTel Opposition is its claim that the "basic theory" of PIMS is suspect because "PageMart elected not to file a technical feasibility demonstration." Opposition at 2. Not only is there not requirement in the Commission's rules that a party separately file a document captioned "technical feasibility demonstration," but no such filing is needed for PIMS. From its initial rulemaking petition in February 1992, PageMart has made clear that the technical advancement in PIMS lies in its "innovative combination" of existing technologies.[6] Since the key elements of PIMS—radiolocation, frequency reuse and miniaturized subscriber RF capabilities—are already in use in different sectors of the communications industry, there is by definition a reality-proven feasibility to PIMS that cannot be controverted.

As PageMart has emphasized previously, the essence of PIMS is massive frequency reuse, obtainable by bringing to the paging industry the frequency management techniques used and refined by cellular mobile radio systems. Radiolocation techniques have been developed and refined in numerous satellite

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[6] E.g., Petition for Rulemaking, RM-7980, at 6-9 (Feb. 28, 1992); Request for Pioneer's Preference, PP-40, at 13-14 (March 19, 1992); PageMart Comments,ET Docket No. 92-100, at 1-9 and Exh. 1 (June 1, 1992); Reply Comments of PageMart, ET Docket No. 92-100, at 6, 8-10 & n.9 (June 16, 1992).

and other Commission-authorized services. Miniaturized RF devices are already commercially available—such as MTel's own credit-card sized paging equipment—and what PageMart and its cooperating equipment manufacturers have added is the revolutionary concept of incorporating the radio into a PCMCIA-standard computer card, thus permitting the novel and unparalleled convenience of "device-independent" messaging.

The brilliance of the PIMS concept stems precisely form this liberal adaptation of existing technology in a manner no one—certainly not MTel—has previously conceived. PageMart's June 16 Reply Comments in this docket, in fact, made clear that PIMS is not only technically feasible, but commercially feasible as well.[7] All of the individual network components have been selected from available equipment, and the PCMCIA-standard RF card is in prototype form with several manufacturers committed to its manufacture. Thus, while MTel labors to prove theoretical feasibility for simulcast transmission speeds almost four times faster than the 6,250 ERMES european paging standard, PageMart has devised a reuse-based system operating at 4,800 bps which offers a ten-fold increase in message throughput capacity.

B. MTel's Engineering Consultants Have Produced a Biased, Illusory and Entirely Makeweight Set of Purported "Deficiencies" in PIMS System Design

MTel's Opposition includes two sizeable appendices prepared by MPR Teletech, Ltd. ("MPR"), its engineering consultants, which purport to demonstrate

[7] PageMart Reply Comments, at 8-10 & n.9 (June 16, 1992).

that PIMS's four-cell reuse design and related system elements are infeasible. Despite having almost four months to analyze and evaluate PageMart's PIMS proposal, MTel's so-called "experts" offer a sorry collection of distortions, half-truths and engineering misrepresentations. MPR's analysis is nothing more than a hatchet job for which even an inexperienced engineer should be embarrassed.

Given the 15-day time limit on replies to oppositions (15 C.F.R. §§ 1.402(e), 1.405(b)), PageMart has not had sufficient time to develop a response to each of the technical points raised by MPR or to retain an independent engineering firm to respond to MPR's "analysis." We have prepared an initial technical response to MPR, however, which is annexed to this Reply as Appendix A. PageMart reserves the right to file further and additional technical responses once it has had adequate time to prepare them, should the Commission not grant PageMart's Motion to Strike MTel's Opposition.

The salient points in response to MPR, as detailed in Appendix A, are simple:

• **Four-Cell Reuse**. Three and four cell reuse plans are demonstrated in operable in current cellular systems, such as PacTel. Dr. Lee of PacTel has received a patents (No. 4,932,049) for 3 cell reuse and DB Products currently manufactures the antennas required for 3 and four cell reuse architecture. MPR analysis is based on hexagonal cell pattern, which is very simplistic and informative but is not useful as a design tool. Lee's book refers to this design as a "fictitious cell pattern", useful in theory but not in practice.

• **Number of Receiver Sites.** MPR's analysis is again based on the simplistic hexagonal cell pattern which does not take into account terrain and antenna properties, or performance of receivers, antennas, and combiners. Had MPR's analysis accurately reflected reality or looked to existing cellular systems, it would have concluded that no such problem exists. If MPR's analysis was accurate, however, it is Mtel and not PageMart that would require a significant increase in the number of receiver sites. The available power for NWM architecture in-building is two-watt, whereas PIMS is 10 watts. In addition, the data rate in the return link is twice what PIMS requires. From inside a building they have one fifth the power and are running at twice the speed, and so will require substantially more receivers than are necessary for PIMS.

• **Cochannel and Adjacent Channel Interference.** MPR incorrectly states that PIMS assumes that building walls offers high levels of signal attenuation to mitigate the problem of out of building cochannel and adjacent channel interference. PIMS minimizes these problems through careful RF management, rather than relying on attenuation. PageMart recognizes, as MPR apparently does not, that a building structure allows for greater flexibility in antenna placement and that radiation can be directed inward only, rather both inward and outward. In fact, a key element of Lee's patent on 3 or 4 cell reuse relies on placing the transmitter on exterior wall and radiating inward. For these reasons, outward radiation is minimized, and the need to rely on building walls for attenuation is limited. Because there is less radiation outward from the building, the adjacent channel interference problem

mentioned by MPR is greatly reduced. In addition, the cochannel interference problem raised by MPR does not exist because geo cells do not transmit on the same frequency as the in-building cells.

- **Adjacent Channel Interference.** PIMS has control over, and therefore manages, its ten consecutive channels, whereas NWMN manages only a single channel and has no control over any adjacent channel. Therefore, PIMS can manage the usage on adjacent channels to avoid any problems associated with adjacent channel interference. On the other hand, NWMN, which has not control over adjacent channels, will have to cooperate with the adjacent channel users to overcome their interference problems. While Mtel is at the mercy of its adjacent users for its entire bandwidth, PIMS faces adjacent interference only in the first and last bandwidths.

- **Power Efficiency of Pager.** MPR misrepresents how the PIMS transceiver works. PIMS RF transmission follows the POCSAG TDM protocol, which only requires the receiver to be on less than 18 percent of the time prior to data reception. POCSAG breaks time into 8 slots that are preceded by a start or "synch" pulse. Since each receiver can only be addressed in its preassigned time slot, it need only be turned on for "1/8 plus the synch pulse" of the time.

- **Time Division Duplex.** The adjacent channel problems raised by MPR do not exist for PIMS, but for the reasons stated above, are a serious problem for NWN. Because NWN has no control over adjacent channels and their use, as PIMS does, NWN is vulnerable to interference caused by independent users on adjacent

channels. NWN requires TDD to overcome this problem. Since PIMS is designed to minimize the adjacent interference problems, TDD is not necessary.

- **Cost of Subscriber Devices**. Contrary to MPR's assertions, the device cited by PageMart is a simple phase lock loop solution using standard Integrated Circuits components that were available in 1982. The 16,000 bps data rate in a 25 kHz channel meets current FCC requirements using a PSK modulator. This device is definitely not state of the art, but rather has been commercially available since 1982. This design actually exceeds PIMS requirements without a DSP chip, but using instead by using the simple phase lock loop IC.

- **BPS Limit.** MRP's analysis incorrectly imposes on PIMS the same data rate limitation that it has imposed on itself because of its own system architecture, but is inapplicable to PIMS. In fact, PacTel analysis states significantly higher rates are achievable based on its own experiments. MPR's conclusions signals that differ by fifteen miles in distance are of equal power is not valid.

- **Mobitex Comparison**. PIMS and Mobitex are designed to achieve different objectives and are, therefore, not truly comparable. Mobitex architecture is constructed primarily for mobile communications, whereas PIMS architecture is configured for personal communications such as in-building coverage. MPR's comparison is like comparing a cellular phone to a cordless phone, which are totally different markets, and is not a valid comparison.

C. MTel Has Misconstrued the Commission's Standard for Technical Feasibility in Pioneer's Preference Cases

MTel's Opposition is premised on the assumption that to demonstrate "technical feasibility," a pioneer's preference applicant must offer a detailed technical analysis, replete with equations and experimental test results, for each and every technical characteristic of a proposed network or service. This test is not only impossible—the paper burden on the Commission alone makes it unworkable—but silly. Communications engineering is a well-established process of system design and network implementation; although numerous technical details remain to be worked out in any system, "feasibility" does not turn on developing each precise network " criterion up front. As a simple example, database-oriented and SS7 services in landline telephony are undoubtedly "feasible," even though many of them have yet to be implemented and exist today only in protocol form.

The essential test of "feasibility" is just that: can a proposal work? Instead of future possibilities which may be developed if some assumptions are borne out and new capabilities produced in the lab, the Commission needs to know that an innovation can succeed in reality. As the Reconsideration Order makes clear, the question of feasibility is whether "a proposed new service or technology is viable."[8] Where, as here, a new service is based on combinations of existing technologies in a form not previously anticipated, the issue of "viability" is a simple one. There is no reason to suspect—and certainly MTel has supplied none—that the technological

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[8] 7 FCC Rcd. 1809, ¶ 12 (1992).

capabilities marshalled by PageMart cannot be "ported" to the paging environment. In short, the innovativeness of PIMS lies not in its technical developments as much as in its service enhancements, thus making the issues of "technical feasibility" entirely irrelevant.

The issue of feasibility is, finally, a very curious one for MTel to raise. MTel's NWN service is premised on transmission speeds of 24,0000 kbps, which no existing technology is capable of supporting. NWN is likewise premised on a coding and modulation scheme which has never been tested in connection with any service. All that MTel offers are analytical theories that it may be able, eventually, to develop technologies to support baud rates six times that of the most-advanced paging standards known to the industry. If MTel succeeds, it will certainly have made a technical improvement, perhaps even worth of a patent. But "theoretical" feasibility, based on the mathematical equations offered by MTel, is plainly not sufficient prima facie evidence of the technical "viability" required for a tentative preference award. Thus, it is MTel's NWN which, in fact, has completely failed to meet the Commission's feasibility standard for a pioneer's preference award.

II. MTEL's POSITION ON "INNOVATIVENESS" IS INTERNALLY INCONSISTENT AND CONFUSES TECHNICAL INNOVATIONS WITH THE SERVICE INNOVATIONS OFFERED BY PAGEMART

MTel argues that PageMart's PIMS proposal is not innovative because its individual technical elements, standing alone, are "variations of existing industry technology."[9] This argument is not only absurd—and in direct contradiction to the

[9] Opposition at ii.

Commission's declarations that its is the development of new communications services that warrants a pioneer's preference—but silly. As noted above, MTel claims on the one hand that PIMS is so technically complex that it is not feasible to implement the service, but on the other hand claims that PIMS technology isn't innovative because its components already exist. A service may be either technically infeasible or a non-innovative use of existing technologies, but obviously not both.

Equally significantly, the Commission's pioneer preference policies are not designed to reward mere technical developments—properly the role of the Patent Office—because "the Commission is a licensing agency" concerned with encouraging design of a "licensable service."[10] A pioneer's preference is not awardable for technical genius, but for innovative services. Thus, pioneer's preferences are designed to promote parties which propose "allocation of spectrum for a new service" or improvements in existing services. 47 C.F.R. § 1.402(a). Since the focus of MTel's Opposition is that each of the individual elements of PIMS, standing alone, is not sufficiently "innovative" from a technical standpoint, its argument is clearly wide of the mark. MTel has not—and cannot—allege that PIMS as a service is not innovative, since no existing paging or communications service supports either the same broad range of functionalities or the same spectrum efficiency.

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[10] 6 FCC Rcd. 3488, ¶ 37 (1991).

In fact, PageMart's use of existing technolgies is not a deficiency, but a benefit. By relying on proven equipment—already detailed in PageMart's June 16, 1992 reply comments—PageMart's PIMS eliminates the "speculation" involved in proposals, like MTel's, which have yet to be tested because there is no network or subscriber equipment available to support the proposed service. When the entire combination of developments involved in PIMS is considered, the service is plainly innovative, and certainly innovative enough to meet the Commission's necessarily fliexible standard for tentative award of pioneer's preferences. (E.g., Reconsideration Order, ¶ 7.)

CONCLUSION

Unlike MTel's NWN—which has established mere theoretical feasibility—PageMart's PIMS proposal is more than adequate to meet all of the standards for award of a pioneer's preference, including both technical feasibility and

innovativeness. The Commission should summarily deny MTel's "Formal Opposition" on the merits.

Respectfully submitted,

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Dated: July 1, 1992.

Appendix A

RESPONSE TO MPR TELTECH, LTD.

Prepared for Submission to the
Federal Communications Commission
in Connection with
PageMart, Inc. Request for Pioneer's Preference for Its
Personal Information Messaging Service (PIMS)

ET Docket No. 92-100
PP-40

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1. United States Patent No. 4,932,049
2. MicroLite Fiber Optic advertisement
3. Preliminary Specifications, Decibel Products
4. Efficiency of a New Microcell System, by W.C. Lee
5. Transmission Loss Over Smooth Earth
6. Motorola SilverLink 2000 advertisement
7. MicroFill advertisement
8. PCMCIA "Pager Card" Prototype

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Reply Comments to MTel Opposition Petition June 16, 1992

The MTel formal opposition paper to PageMart's request for Pioneers Preference has enclosed technical review material by MPR Teltech, Ltd. that attempt to critique PageMart's PIMS proposal. Each comment by two MPR reviewers will be addressed and will be shown to be without any technical foundation. MPR personnel have either misunderstood, misinterpreted or re-engineered the PIMS system to arrive at their conclusions.

A. Comments on the physical layer aspects of the (PageMart) Petition in Rulemaking.

Accordingly, we shall deal with each point and demonstrate that all of MPR's points are without merit.

MPR concludes 12 cell reuse pattern required

> "It is quite unlikely that a 4-cell reuse pattern could be used in the cellular system design. Calculations indicate that a 12-cell reuse pattern is required."

Both 3 and 4 cell reuse plans confirmed for use in cellular systems. First, MPR concludes, after using Dr. Lee's textbook on cellular system design, that a 12-cell reuse plan[1] is needed. This is in direct conflict with the existing cellular telephone industry which has been able to (1) operate under the 7 cell reuse scheme commonly used today, and (2) install as small as a 3 cell reuse "micro-cell" plan with equal to, or better performance than conventional 7 cell plans.

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[1] "From this analysis, the 4 cell reuse strategy proposed by PageMart does not appear to achieve the spectrum efficiencies claimed. A 12 cell reuse strategy using 12 data channels, one polling channel, and one return link channel appear to be the minimum requirement."

Dr. Lee's book, and many others, represent a starting point in cellular system design that doesn't represent (1) current state of the art, or (2) actual experimental data from the massive amount of experimental work done to fine tune theoretical analysis. Specifically, MPR primarily cites the references to Dr. Lee's books and articles that, on the surface, supports their argument and omits the articles that clearly support the four cell reuse plan incorporated in PageMart's design, such as Dr. Lee's article in "Smaller Cells for Greater Performance.[2] " Dr. Lee's paper clearly states that even a 3 cell reuse plan can be designed to be 2 dB superior to a 7 cell reuse design (i.e., 2 dB greater than the standard 18 dB C/I ratio):

Three Cell Reuse

$$\frac{C}{I} = \frac{R_k^{-\beta}}{\sum_{k=1} D_k^{-\beta}} = 105 \ (=) \quad 20 \text{ dB}$$

The above equation that defines the carrier-to-interference ratio (C/I) is used to estimate cochannel interference from all neighboring cells broadcasting on the same channel at the same time. Normal analog cellular practice is to specify C/I to be 18 dB or higher.

Furthermore, MPR never provides the results of Dr. Lee's digital system design analysis, namely a C/I ratio of 18 dB for an analog voice system which corresponds to a 5 dB reduced requirement for a given digital voice system, resulting in a C/I ratio requirement of 13 dB (in the "Digital Systems" chapter of the same book that MPR uses[3]) for a 4 cell reuse system. Therefore, because

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[2] IEEE Communications Magazine, November 1991, Smaller Cells for Greater Performance; Dr. W.C.Y. Lee.

[3] Mobile Cellular Telecommunications System, William C.Y. Lee, McGraw Hill, 1989.

MPR did not cover digital cellular system design, they overlooked the fact that, "The digital unit performance can be reduced by 5 dB to obtain the same performance as an analog unit" (page 428[4]):

Digital Cellular System

> "Swerup and Uddenfeldt compared a narrowband coherent digital modulation with gaussian MSK to an analog FM system. Two 16-kbps voice coders were used. Residual excited linear predicted codes and subband codes were tested. The digital unit performance can be reduced by 5 dB to obtain the same performance as an analog unit. This 5-dB reduction advantage means a large coverage area and a closed frequency-reuse distance for each cell can be served in a cellular system. This is, in turn, an example of high spectral efficiency usage (described in Sec. 13.4). Consider the following calculations.
>
> In a omnidirectional-cell system, assume that C/I = 13 dB, i.e.,
>
> $$\frac{C}{I} = \frac{q^4}{6} > 10^{1.3} = 20$$
>
> Solving for q and using Eq. (2.4-5), we obtain
>
> $$q = 3.31 = \sqrt{3K}$$
>
> $$\underline{K \approx 4 \text{ (frequency-reuse pattern)}}$$
>
> In this case the total number of channels is 333; then
>
> $$m \approx \frac{333}{4} = 83 \text{ channels/cell}$$
>
> which is higher than the 47 channels per cell for $C/I \geq 18$ dB.

MPR appears to ignore published literature that would provide technical arguments and commercial equipment that implement microcell reuse all the way to 3 cell reuse plans, such as (1) Dr. Lee's recent Microcell system patent 4,932,049 available for commercial use through Decibel Products, its licensed manufacturer (Exhibit 1), Micro Lite products (Exhibit 2), Smart System (Exhibit

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[4] Ibid.

3), and (2) Dr. Lee's article on "Efficiency of a New Microcell System.[5] " The article in footnote 5 concludes that not only can a 3 cell reuse pattern be achieved through a very simple design, but that a 4 cell reuse pattern using this technology may be more suitable (Dr. Lee's article on "Efficiency of a New Microcell System", page 3, Exhibit 4):

Four Cell Reuse

> "In edge-excited zone cells, the D_1/R_1 has to be 4.6 in order to maintain the voice quality. Where D_1 is the cochannel zone separation and R_1 is the distance from the zone transmitter to the zone boundary, R_1 is also equal to the cell radius. Then new q ($q = D/R_1$) becomes 3.6 as shown in Fig. 5. Then the frequency reuse factor K becomes
>
> $$K = \frac{(q)^2}{3} = \frac{(3.6)^2}{3} = 4.32 \sim 4 \quad \textbf{(Frequent reuse factor)}$$
>
> which proves that the edge-excited approach can increase the ratio capacity by 7/4 = 1.75 times."
>
> There are situations when all of the zones have to turned on. We call this a non-selective edge-excited zone configuration. In a non-selective edge-excited zone configuration, all of the cells are treated as omni-cells because all zone's sites are transmitting concurrently. In an analog system, the regular center-excited omni-cells require the co-channel interference reduction factor which is equivalent to 1 = D/R = 4.6 as mentioned previously."

Since there is no restriction on cell size, the aforementioned microcell approach is equally suitable for macrocell design.

Another factor that is not considered in MPR's analysis, is antenna pattern design which in many cases can effectively use "down tilt" (accomplished in antenna design to significantly reduce the main lobe energy at the horizon in both omni and sectorized antenna design (see Exhibit 5). Furthermore, factors such as terrain cannot be addressed in any real system design by a terrain propagation

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[5] PacTel Corporation's Pioneer's Request for PCS Technology dated May 4, 1992 (p.62).

factor as used by MPR, but is a fact of life in many systems designs that use natural terrain features (e.g., mountains, canyons, etc.) to even further increase frequency reuse in certain MSA's (e.g., major west coast cities).

It is interesting also that MPR compares C/I ratios specified to be 18 dB or higher (for analog cellular systems) and not 13 dB for digital systems (see Mobile Cellular Telecommunications System by Dr. Lee, page 428) and assert the unsubstantiated figure of 22 dB for binary digital FM systems (no indication by MPR author as to the details of his own work[6]). Moreover, no consideration is given by MPR that address what is currently done in wireless digital data systems to achieve high performance, namely:

- Signal interleaving, for example at the application level versus at the link level
- Forward-Error control (i.e., POCSAG or other protocols).
- Signal diversity through multiple antennas
- Antenna pattern control through down tilt and using narrow beam antennas.

Either collectively or separately, the above signal enhancement approaches are used in many wireless applications.

> MPR: "Normal analog cellular design practice is to specify the C/I to be 18 dB or higher, with this figure requiring the classic seven cell reuse pattern. To achieve a C/I protection ratio of 22 dB[7] requires the use of a 12-cell reuse pattern."

Digital Cellular Systems out performs Analog Cellular Systems on (C/I).

The commercial reality is that even today's data modems that now operate at 9,600 bps and above (IBM's CelluPlan II is contemplating 19.2K bps on conventional AMPs-type cellular systems with C/I = 18 dB) work well in vehicles

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6 (Page 8) Normal analog cellular design practice is to specify the C/I to be 18 db or higher, with this figure requiring the classic seven cell reuse pattern. Previous work by the author has found that the 10^{-2} BER capture ratio for binary digital FM in a 25 kHz channel spacing with a 4.0 kHz peak deviation and a data rate of 4,800 bps was on the order of 22 db in the fading channel environment.

7 Ibid.

with the only typical complaint being dropped connections at hand-off points. Furthermore, it is incorrect to refer to a section in Dr. Lee's book on page 190[8] for analog cellular systems and ignore the relevant equivalent calculations for C/I on digital cellular systems in the same book (page 428).

In summary,

- MPR's own referenced authority, Dr. Lee, has shown that a 3-cell reuse is not only feasible, but it is a commercial reality. Also, a unique 4-cell reuse design is shown to have more design flexibility in Dr. Lee's papers.

- Existing voice analog cellular systems (with C/I = 18) are using commercially available modem equipment to run at rates at or well above 9,600 bps with excellent results except for hand-offs (which PIMS does not require because messages are typically between 10 and 100 seconds).

- MPR unnecessarily limits the scope of their investigation.

  - Many technical papers and books have been published on C/I, signal propagation's losses (including the significant non-linearity of path loses even in the log-log plane of signal versus distance - Dr. Lee assumes a linear log-log extrapolation independent of distance for estimation purposes). Other researchers have done considerable work on transmission path loss[9] and the linear log - log approximation of MPR is only a crude approximation that unduly penalizes short to medium range path loss (see Exhibit 5).

  - Modulation, interleaving and signal diversity techniques for signal enhancement for digital FM systems that support traditional 10^{-2} BER (for paging systems) have been omitted in the MPR discussion.

MPR states that a massive number of receiver sites are needed.

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[8] MRP statement on page 9: "The use of 120 degree sectoring within each cell of a 4-cell reuse pattern is shown by Dr. Lee [7, p. 190] to yield a co-channel interference ratio of 14 db, which again is unacceptable. This would also require 12 data channels instead of 8. If 60 degree sectoring within each cell of a 4-cell reuse pattern is adopted, a 21 db co-channel interference ratio is obtained. This is a reasonable value for digital RF packet communications.

[9] The PIMS' return link approach is simple: (1) in "free space" (or near free space conditions such as vehicle) approximately 0.1 Watt is sufficient and (2) in buildings up to 10 Watts using a "power module" plugged into line ac voltage, to augment the low power subscriber transceiver is appropriate.

> "The PageMart system will need far more than twice the number of dedicated receivers as there are base stations. Calculations indicate that for a 0.1 watt subscriber device, between 25 and 169 dedicated receivers per base station cell site would be required."

PIMS' low power return link in free space and high power "Power Module" approach in buildings is superior to the NWN approach. First, MPR misquotes the PIMS rulemaking document by asserting that (page 10):

> "Our understanding of this is that the Effective RF Power (ERP) of the portable device is limited to less than 1.0 Watt, which is consistent with the low powered (0.10 Watt) transceiver that is integrated into a hand-held personal computer product. (p. 8). Yet on p. A13, PageMart proposes To achieve two-way operation in a high insertion loss building, the unit would be coupled with a separate power module, as depicted in Exhibit XII, which would be capable of generating up to 10 Watts as a transmitter. This is also mentioned on page 9. This is inconsistent with their previous statement of limiting the maximum ERP to 1 Watts, and in fact proposes to use the 10 Watts of power in the very area where they wish to use low power to ensure minimum interference with other computer and communication equipment."

PageMart's approach is very straightforward: if the subscriber is outside or riding in a vehicle 100 mw (or up to 1 watt) is adequate return link power to communicate with receiver sites. On the other hand, advanced messaging services are expected to have its major impact on business or "white collar" applications and, therefore, <u>must work especially well</u> in buildings. For inbuilding applications, a "power module" is provided for that mode of operation and could operate at up to 10 watts ERP when plugged into AC line voltage. The "power module" could be configured to operate as either a wired or wireless "repeater" to the subscriber transceiver module.

Thus, when a PIMS subscriber is in a building with even 20 dB or more insertion loss, the return link will function reliably (see table below). The entire theoretical analysis of MPR is aimed at discrediting PIMS free space, 100 mw return link.

However, if MPR would have only stopped to consider, MTel's NWN has even a greater dilemma than PageMart in their return link for acknowledgment.

Available Power for Transmission (Return Link)

System	Location	Total Power	Building Penetration Loss*	Available Power in dBm
PIMS	Outside building	100 mw (20 dBm)	None	**20 dBm**
NWN	Inside building	2 w (33 dBm)	15 dBm	**18 dBm**
Cellular	Inside building	600 mw (27.8 dBm)	15 dBm	12.8 dBm
PIMS	Inside building	10 w (40 dBm)	15 dBm	**25 dBm**

* MPR's assumption

Therefore, if we compare a PIMS subscriber standing outside a high rise office building with a building penetration loss of 15 dB to an NWN subscriber standing inside the building, and a cellular telephone subscriber standing inside, NWN has 2 dBm lower return link power than PIMS, and a cellular subscriber is over 7 dBm lower. Fortunately, their analysis is absolutely disproved by the "real world" experience of portable, hand held cellular phones that work in many high rise office buildings (on the ground floor where the building penetration loss is at least 15 dB).

MPR's analysis is significantly flawed for a number of reasons that could increase power available up to 40 dB:

- The return link must be increased to take into account actual receiver sensitivity (10 dB).

- Return link antenna gain (10 dB).
- No shadowing (8 dB)
- Diversity (+12 dB) – note more than one receiver or antenna.

However, a significant assumption used by MPR in performing their "absolute analysis" prediction of signal power level requires ranging information that many researchers have performed, some of which have measured results that predict distances that deviate by a factor of two or more with regard to short-to-medium distance (see references Bullington (6) and Harley (21)). More importantly, because urban, suburban, with and without significant foliage, short range less than 1Kw, medium range less than 10 kilometers or greater than 10 kilometers, all have an influence on transmission loss prediction because range is highly non-linear (log-log coordinates), one linear log - log equation for 0 to 30 kilometers is only a very crude predictor[10] (see Exhibit 5).

Also, these predictors were not used to evaluate MTel's NWN system return link performance in the NWN technical feasibility report of June 16, 1992.

Cellular telephone systems such as in the case of the non-wireline operator in San Diego (which Communication Industries constructed and PacTel later operated) initiated service with 12 cells (in a difficult terrain environment) and provided reasonable inbuilding performance. As the system, cell-subdivided, to approximately 24 cells, a very good degree of inbuilding performance was achieved. PageMart's San Diego paging services today operate with 12 transmitter base stations and provides very good coverage. A similarly constructed PIMS system in the initial stages would probably have a similar base station deployment with approximately two times that number for receiver sites

[10] Dr. Lee uses $38.4 \log_{10} d_1$ independently of distance (i.e. short, medium or long distances as Bullington discusses.