kHz of spectrum and offers similar functionality.[36] The prevention of automobile theft and related crimes is certainly a worthy objective, but the devotion of two exclusive 8 MHz blocks of spectrum in addition to the Lo-Jack allocation raises serious cost/benefit questions. Put differently, PacTel would have the Commission accord it exclusivity in the nation's major markets for nearly three times more spectrum than will be allotted for new narrow-band personal communications services.[37] At a time when the Commission is considering many different communications systems that would employ spread spectrum techniques to increase capacity and to minimize interference, PacTel's performance problems hardly provide a basis for a grant of exclusivity.[38]

In contrast to the exclusive regime PacTel asked the Commission to mandate, spectrum sharing demands that users design more robust equipment. This offers an incentive for the development of technology that can lead to the highest utilization of a mixed use band such as 902-928 MHz. Pinpoint is making the most of these incentives and submits that PacTel would not need exclusivity were its AVM system far less fragile. Accordingly, the FCC should not reward a fragile system -- ill-conceived for a shared band -- with 8 MHz of exclusive spectrum.

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[36] Stolen Vehicle Recovery Systems, 4 F.C.C. Rcd 7558 (1989).

[37] New Personal Communications Services Proposed, F.C.C. News Report No. DC-2175 (July 16, 1992). Of course, in addition to its 8 MHz spread spectrum channel, Pactel seeks 250 kHz for paging.

[38] Although PacTel ultimately may conclude that it must improve the Teletrac technology to meet market demands for other communications services, the incentives will be those of a duopolist that can exclude most direct competition.

2. PacTel's Proposed "Forward Link" also Wastes Spectrum

PacTel's system requires a separate "forward link" that is not part of its wideband HML channel. Essentially, PacTel would use the forward link as a paging channel to activate the wideband transmitter in vehicles. Its request for 250 kHz would appear designed to accommodate ten conventional 25 kHz channels.[39] Because PacTel would have the Commission grandfather its existing system, this would be tantamount to authorizing PacTel ten exclusive 25 kHz paging channels on a virtually nationwide basis.[40]

Pinpoint agrees with the need for some sort of forward channel. One of the chief limitations of GPS, dead reckoning and Loran C is that none of these afford any inherent communications path to facilitate the transmission of messages relating to the vehicle being located. Pinpoint, however, solved this dilemma through technology that uses signaling in the same channel employed for vehicle location. Unlike PacTel's Teletrac system, therefore, Pinpoint does not need to employ separate spectrum for this purpose.

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[39] Ameritech's METS system description actually specifies ten 25 kHz channels as opposed to a single 250 kHz channel.

[40] As the Commission's records reflect, Pactel holds authorizations for more than 700 locations for the 925 MHz "forward link" channels it seeks to have authorized as part of the proposed changes. See Attachment A. While Pinpoint recognizes the flexibility that has been inherent in the Commission's application of § 90.239, it can find no basis for the authorization of such forward links absent a wholesale waiver of the Commission's rules.

There are already up to forty channels available for private carrier paging at 929 MHz. Forty additional channels are also available at 931 MHz for common carrier paging. PacTel is a major licensee in both the private carrier and the common carrier paging services. Moreover, PacTel has been urging the Commission to make available 25 kHz channels at 930 MHz for advanced messaging services.[41] PacTel provides no explanation why, if separate spectrum is needed, such allocations will not suffice.

Indeed, even if separate outbound channels were found consistent with the public interest, PacTel's design is inefficient. By placing high-powered emitters clustered around two points in the band (e.g., 904 and 925), PacTel's proposal may have the undesired effect of making it more difficult for other systems to be engineered into the band.[42] Before proceeding with any changes in the rules that would specifically authorize a "forward link" such as that proposed by PacTel, the Commission should examine whether such a system makes efficient use of spectrum.

Although of questionable utility from a spectrum efficiency standpoint, PacTel's proposed forward channels might offer great commercial advantages unrelated to AVM, particularly where PacTel's system may preclude the further development of

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[41] Inconsistently, however, Pactel has opposed according applicants more than 25 kHz for a single channel at 930 MHz. Reply of PacTel Paging, ET Docket 92-100 at 6 (filed June 16, 1992). At the same time, it seeks to obtain up to ten such channels grouped together at 924.890 - 925.140 MHz in this proceeding.

[42] The stations on these narrowband "forward link" channels appear to be conventional paging-like facilities, with similar ERP and antenna gains and elevations. As such their signals (as "jammers") enjoy significant gain advantages over the desired mobile's signals. Since one of these "jammers" would be present in each 8 MHz band, other systems would, of necessity, expend great effort in eliminating these jamming signals from their desired signals. Of course, concern for other systems would not be as great, if, as PacTel proposes, the Commission allows it exclusivity.

existing AVM technologies and competition. PacTel should not be allowed, however, to piggyback its paging needs onto the important public interest in AVM. Pinpoint has formulated a design not requiring a separate forward link. PacTel should be required to as well.

C. PacTel's Plan Amounts to Little More than Spectrum Speculation

In its Petition, PacTel admits that it is now offering service only at a few locations. PacTel also asks the Commission to extend its exclusivity request to cover all of its existing licenses, whether built or not. This would give it, essentially, exclusive use of an 8 MHz band nationwide.

PacTel's own materials -- its Appendix 2 sharing analysis -- also support this plea through the following syllogism:

> (1) for some time Teletrac has been seeking and obtaining licenses in most major markets pursuant a slow-growth implementation schedule (which was never placed on public notice nor subject to public comment);
>
> (2) Teletrac systems are now in operation in five of the major markets, but have licenses in several more;
>
> (3) because the system is fragile and exclusivity is the only way to solve the problems caused by interference, Teletrac should be granted exclusivity everywhere in which it has obtained a license even though it may not have constructed.

Pinpoint has no objection to extended implementation schedules in a shared spectrum environment. However, PacTel's approach has been to file for hundreds of new sites

and then petition for exclusivity rather than refining its AVM technology to survive within a shared band. PacTel's strategy has been aided by the five-year extended implementation schedule it was accorded. PacTel thus misused FCC flexibility to speculate in spectrum, a plan that will be realized if its request for exclusivity and five additional years is granted.

More than $ 3.2 million over three years in cash and services have been invested for Pinpoint to develop a robust AVM technology designed to operate in a shared environment. Over a similar period, by deferring the construction requirements, then obtaining exclusivity, PacTel could file and lock-up dozens of markets unfairly. So long as the spectrum sought by PacTel was shared, the public interest was not prejudiced by the extended implementation schedule, and Pinpoint did not object. Now that it has its authorizations, however, PacTel urges the Commission retroactively to accord it exclusivity and "cut-off" license applications for hundreds of cities.

Attachment A quantifies PacTel's spectrum speculation. As the first two pages show, PacTel already holds 750 transmitter licenses, with 86 pending authorizations. Grant of its Petition, therefore, would permit PacTel to lock-up an 8 MHz exclusive allocation in each of these locations. For its part, Ameritech's METS/Mobilevision has licenses in 330 locations, with 95 additional pending applications. PacTel's plan, therefore, would preclude AVM entry throughout large regions of the nation.

Not only would PacTel's proposal be unfair to other potential providers of AVM, it would also rob most of the public of access to important AVM services. The extended implementation schedule, followed by exclusivity, would give PacTel and Ameritech -- the likely sole AVM licensees and beneficiaries of any exclusive duopoly -- up to ten years to construct AVM facilities in their remaining licensed cities. Under PacTel's scheme, therefore, the vast majority of Americans would be required to forgo the benefits of AVM until PacTel and Ameritech decide the time is ripe, something that could not occur if sharing, and competition, were preserved.[43]

As noted above, sharing provides for a multiplicity of services and service providers to thrive thereby furthering the goals of competition and new technology development. In contrast, adoption of PacTel's proposals would result in a duopolistic environment for HML AVM. PacTel has argued vociferously that the AVM market is very broad with readily substitutable alternative technologies.[44] The fact remains, however, that HML is a key methodology for AVM that does not compete very directly with Loran C, GPS and dead reckoning. While there is a place for all of these methods in the AVM constellation, PacTel's plan would foreclose other alternatives before the market has even begun.

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[43] Although an extended implementation schedule may be appropriate for any given entity in a competitive environment, it has very different consequences in the context of exclusivity.

[44] See Request of Pacific Telesis Group for Waiver of Section II(D)(1) to Provide Radiolocation Services, United States v. AT&T, Civ. Act. No. 82-0192 (D.D.C. filed Aug. 14, 1989).

In sum, PacTel's answer to its system fragility is regulatory endowments rather than technical solutions. After obtaining licenses for hundreds of sites that it did not intend to construct promptly, PacTel now seeks to freeze out competition such as Pinpoint and others and obtain an exclusive allocation throughout most of the United States.[45] The same effect would occur with respect to Ameritech's subsidiary METS, which has also aggressively pursued a licensing strategy but thus far appears not to be offering much, if anything, in the way of service. The Commission should not countenance such speculation in scarce spectrum resources.

IV. THE COMMISSION SHOULD ADOPT POLICIES AND RULES THAT ALLOW PINPOINT AND OTHERS TO DEVELOP AND MARKET AVM TECHNOLOGY

The current regulations have fostered the development of many different systems to serve a multiplicity of requirements within the 902-928 MHz band. Rather than adopt the regressive regulations proposed by PacTel, Pinpoint urges the Commission to consider refinements of the rules that would maintain a flexible band plan for licensing many different types of AVM systems with differing spectrum needs.

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[45] Curiously, PacTel's proposed standards for achieving exclusivity would mandate 110 miles separation and a 50 mile radius protected zone. The standard, however, as proposed by PacTel would allow only a 10 mile buffer between neighboring systems. If the Commission were writing on a clean slate, even this standard would pose interference problems for systems such as PacTel. See, e.g., Appendix 2 to the PacTel Petition (300 watt facility 40 miles from Chicago at a height of 250 feet would eradicate coverage within 20 miles of the interfering transmitter and reduce the overall area covered from 2,332 square miles to 593 square miles). Of course, if PacTel is granted exclusivity in most major markets, then it would be poised to coordinate with itself. This demonstrates, however, that PacTel's plan, if it is to work, presupposes nationwide use of 904-912 MHz.

If there are to be changes in the manner in which HML systems operate and are licensed, the Commission should move forward to establish a regulatory framework that will not cast in stone the inadequate technologies of the past. According to industry sources, PacTel serves fewer than 6,000 customers currently.[46] A technical innovation in Pinpoint's ARRAY™ allows it to provide 3.24 million position fixes per hour within a version of the system operating in 8 MHz.

However, accuracy could improve still further were the Commission to open the entire 902-928 MHz band for AVM. In such an environment, HML systems could spread over a wider bandwidth than 8 MHz. For bandwidths around 8 MHz or less, the performance of the system increases approximately proportionally, to the bandwidth. At bandwidths of between 12 and 25 MHz, the resolving power of narrow-pulse ranging systems begins to overcome the features of the urban scattering environment (individual building, street/lane widths, etc.).[47] As a result, low-cost equipment can be built that is capable of performing accurate, rapid high-resolution position fixing thereby yielding high throughput.

Moreover, increased bandwidth allows designs to move from phase-difference measuring systems (capable of low speed, high resolution location, but suffering from the vagaries of multipath perturbation of the received phase) to narrow pulse multilateration, with the capability of significantly minimizing the effects of multipath.

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[46] Published accounts state that the number of stolen vehicle recovery customer units fielded by PacTel in its largest market, Los Angeles, is about 3,000. Inside IVHS at 7 (May 11, 1992).

[47] Resolving power is the ability to distinguish one multipath echo pulse from another.

This is because in such wider bandwidth systems, the resolving capability of the pulses reaches the same order of magnitude as the size of the scattering objects, namely the range of 25 to 200 feet. The proprietary techniques developed by Pinpoint are capable of producing these resolutions in equipment suitable for the mass AVM market.

With simple circuitry capable of resolving one multipath echo from another, the resolving power of the ranging function of the pulses becomes high enough for a small number of pulses to provide a position fix within the desired resolution (typically tens of feet) in a short time, hence larger position-fixing throughput. The throughput then begins to be limited by propagation rather than by processing. Thus, the "throughput versus bandwidth" rises exponentially, rather than linearly, with a doubling of bandwidth producing 10 to 100 fold increases in fixing rates.

Accordingly, with Pinpoint's proposed technology -- operating throughout the AVM band -- much more accurate ranging, and higher capacity, is available. For example, Teletrac's phase-difference system using 8 MHz produces 70 fixes per second to within a published 100-foot accuracy. By contrast, considering only half of the capacity of an ARRAY™ system using 16 MHz, the comparable figures are 1,500 to 15,000 fixes per second accurate to within 20 to 50 feet.[48] Expansion across the band

[48] Thus, ARRAY™ could offer 3,000 to 30,000 in 16 MHz depending on the geographic size of the system (a large system would have multiple simultaneously operating "clusters").

also would facilitate the development of more robust technologies that are also more compatible with other non-HML systems including various tag technologies.[49]

While ARRAY's™ capacity may seem large, it is important to recognize that HML systems can play a major role in the implementation of the intelligent vehicle highway system. As noted above, the HML methodology would allow for the location of vehicles at relatively long distances from the fixed radio facilities. Indeed, IVHS will likely require a variety of communications systems designed to meet many different needs. If real time location tracking is to occur over wide areas, as may be necessary to implement traffic management in certain major urban markets, capacity far in excess of that proposed by Teletrac will be needed.

Attachment B illustrates the IVHS application of HML technology to monitor traffic flow over a wide area. As shown therein, the Baltimore/Washington area, for example, would require more than 1.6 million position fixes per hour if only 2.5% of the vehicles were equipped with AVM HML technology. Pinpoint's technology would

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[49] The ARRAY™ system is already compatible with modulated backscatter tag technologies such as current deployed with Amtech's TollTags. Compatibility is achieved at two different levels.

The first level flows from the ARRAY's network protocol level. Since position determination is accomplished with positive status acknowledgement, an occasional lost position fix or message acknowledgement (as for example might occur as the vehicle were passing in front of the tag illuminator). The loss would be detected at the protocol level and a retry process would be initiated, until movement of the vehicle through the station allowed the message and/or position fix to be accomplished.

The second level follows from the statistical nature of the communications process and the fact that it is being applied to moving vehicles on a tollway. In this case, the fraction of the time that the mobile ARRAY™ receiver may be overwhelmed or "blinded" by the tag illuminator would be small, (since the field of illumination is specifically designed to be confined to the region in front of the toll booth) and ensures that the retry-on-error mechanisms would not create a significant burden for the system.

permit several time that number at position fixes per hour. PacTel, however, claims that it can offer only 240,000 position fixes per hour, making it unsuitable for IVHS. Only the continuation of a shared spectrum environment, with opportunities for entities such as Pinpoint, can ensure adequate technology to meet important needs such as those of IVHS.

Given the enormous potential of other approaches to AVM, the Commission should promote a solution that allows market driven technology to propel the development of systems that serve marketplace demand. Adoption of PacTel's proposal would have exactly opposite effect. It would lock in, at most, two separate systems.[50] At the same time, there will be little incentive to put additional resources on the development of systems that can operate at a more efficient manner and can better tolerate interference.

Finally, Pinpoint urges the Commission to revise the definition of AVM to allow the location of any moving non-aeronautical based item. Most importantly, however, the regulations should clarify that all licensees are required to cooperate mutually in the shared use of the spectrum.

Pinpoint recognizes that not all systems are inherently compatible and that there may be limits to the number of HML systems that can be accommodated in the band. Pinpoint is willing to explore these issues. PacTel's proposed solution, however, would have the Commission authorize such a system regardless of its inefficiency and

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[50] Indeed, it appears that PacTel specifically designed its frequency plan to accommodate it and METS. See PacTel Petition at 22 & n.32.

the opportunity cost the public would incur by foregoing the benefits of genuine competition in the provision of HML based AVM services. Pinpoint submits that is a price the public should not have to pay.

V. CONCLUSION

Under Section 7 of the Communications Act, any party petitioning the Commission to change its rules where the effect would be to foreclose the development of new technology in a competitive fashion faces a high burden.[51] PacTel fails to measure up to that standard and seeks exclusivity on the basis of its system's inherent fragility. PacTel urges protection from competition in the guise of fostering

[51] 47 U.S.C. § 157(a).

innovation. Both themes run counter to long-held Commission policies and the overall public interest. Accordingly, PacTel's Petition should be dismissed or denied.

Respectfully submitted,

PINPOINT COMMUNICATIONS, INC.

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TAB

LIST OF ATTACHMENTS

Attachment

PacTel Teletrac & METS/Ameritech and Mobilevision:
902-928 MHz AVM Licenses and Applications . . . . . A

Vehicle Location Capacity Required to Implement
Intelligent Vehicle Highway Systems in Selected U.S.
Metropolitan Areas . . . . . B

ATTACHMENT A

PACTEL TELETRAC
&
METS/AMERITECH AND MOBILEVISION:

902-928 MHz AVM LICENSES AND APPLICATIONS

NOTE: The data presented in this attachment are current as of May 29, 1992, and are based on records obtained from the Commission's data base contractor. The totals represent the number of separate land station locations licensed to, or applied for by, PacTel Teletrac or Mets/Ameritech. For purposes of this attachment, the totals allocated to PacTel Teletrac includes licenses and applications of North American Teletrac and other subsidiaries or related companies; METS/Ameritech includes Mobilevision and other subsidiaries or related companies.

PacTel Teletrac

State	Licenses	Non-Carrier	Total
Alabama	17	0	17
Alaska	0	0	0
Arizona	12	1	13
Arkansas	6	0	6
California	77	6	83
Colorado	11	1	12
Connecticut	20	0	20
Delaware	0	0	0
District of Columbia	3	0	3
Florida	55	14	69
Georgia	15	0	15
Hawaii	6	0	6
Idaho	0	0	0
Illinois	20	11	31
Indiana	18	1	19
Iowa	8	0	8
Kansas	6	0	6
Kentucky	14	0	14
Louisiana	16	1	17
Maine	0	0	0
Maryland	4	0	4
Massachusetts	25	1	26
Michigan	33	6	39
Minnesota	6	1	7
Mississippi	6	0	6
Missouri	12	1	13

PacTel Teletrac

State	Licenses	Applications	Total
Montana	0	0	0
Nebraska	6	0	6
Nevada	6	0	6
New Hampshire	12	0	12
New Jersey	18	1	19
New Mexico	6	0	6
New York	30	2	32
North Carolina	15	1	16
North Dakota	0	0	0
Ohio	40	3	43
Oklahoma	11	0	11
Oregon	6	1	7
Pennsylvania	51	1	52
Rhode Island	6	1	7
South Carolina	20	0	20
South Dakota	0	0	0
Tennessee	28	0	28
Texas	51	29	80
Utah	7	0	7
Vermont	0	0	0
Virginia	12	1	13
Washington	12	1	13
West Virginia	7	0	7
Wisconsin	16	1	17
Wyoming	0	0	0
GRAND TOTAL	750	86	836

METS/AMERITECH and Mobilevision

State	Licenses	Applications	Total
Alabama	6	0	6
Alaska	0	0	0
Arizona	6	3	9
Arkansas	3	2	5
California	33	2	35
Colorado	5	7	12
Connecticut	9	0	9
Delaware	3	0	3
District of Columbia	0	0	0
Florida	20	2	22
Georgia	3	0	3
Hawaii	3	0	3
Idaho	0	3	3
Illinois	3	4	7
Indiana	16	0	16
Iowa	4	3	7
Kansas	3	3	6
Kentucky	1	3	4
Louisiana	11	3	14
Maine	0	0	0
Maryland	5	0	5
Massachusetts	13	0	13
Michigan	15	0	15
Minnesota	3	1	4
Mississippi	1	1	2
Missouri	6	3	9

METS/AMERITECH and Mobilevision

State	Licenses	Applications	Total
Montana	0	3	3
Nebraska	2	2	4
Nevada	3	3	6
New Hampshire	0	0	0
New Jersey	11	0	11
New Mexico	3	2	5
New York	14	0	14
North Carolina	9	0	9
North Dakota	0	0	0
Ohio	27	0	27
Oklahoma	7	2	9
Oregon	4	1	5
Pennsylvania	17	0	17
Rhode Island	2	0	2
South Carolina	8	0	8
South Dakota	0	4	4
Tennessee	17	0	17
Texas	15	27	42
Utah	3	1	4
Vermont	0	0	0
Virginia	7	0	7
Washington	6	1	7
West Virginia	0	3	3
Wisconsin	3	2	5
Wyoming	0	4	4
GRAND TOTAL	330	95	425

TAB

Vehicle Location Capacity Required to Implement Intelligent Vehicle Highway Systems in Selected U.S. Metropolitan Areas

Registered Vehicles Per Million Population	770,000
Percentage of Vehicles to Be Used with IVHS	2.50%
Vehicles Equipped with Location Technology	19,250
Equipped Vehicles on the Road During Peak Hours[1]	11,550
Number of Polls/Location Fixes Required Per Peak Hour[2]	277,200

Metropolitan Areas	Population	Vehicles	Peak Hourly Location Fixes Required
Dallas/Fort Worth	3,750,000	2,887,500	1,039,500
Washington/Baltimore	6,000,000	4,620,000	1,663,200
Los Angeles	13,000,000	10,010,000	3,603,600
Chicago	8,000,000	6,160,000	2,217,600
Denver	2,000,000	1,540,000	554,400
San Antonio	1,000,000	770,000	277,200

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1 It is assumed that 60% of vehicles will be on the road during peak hours.

2 This assumes that, every five minutes, a vehicle will be polled/located twice in the course of a 10 second interval to determine speed and direction.

ATTACHMENT B

ENGINEERING CERTIFICATE

My name is Louis H.M. Jandrell. I have a Bachelor of Science degree in Electrical Engineering.

I am currently Vice President of Design and Development of Pinpoint Communications, Inc., which I co-founded in 1990. I am also the President of Idea Matrix, Inc., which I founded as The Matrix Company in 1984. Idea Matrix, Inc. provides consulting services in many areas of radio communications and electronic product design and development. Before 1984, I had served as Product Development Manager of Astec Electronics for a year, as New Product Development Manager at Sunflex company for two years, and as an electrical engineer for several other companies from 1965 to 1981.

I hereby certify that I am technically qualified to be responsible for the technical information submitted in the attached Opposition of Pinpoint Communications, Inc. The information presented in the attached Opposition is complete and accurate to the best of my knowledge.

Dated this 23rd day of July, 1992

By: Louis H.M. Jandrell

By: Jane R. Brannigan-Jones
Notary Public

Jane R. Brannigan-Jones
Notary Public, District of Columbia
My Commission Expires Jan. 14, 1997

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