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CALIFORNIA MICROWAVE

July 6, 1992

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FCC MAIL BRANCH

Ms. Donna R. Searcy, Secretary
Federal Communications Commission
Washington, DC 20554

Re: ET Docket 92-9

Dear Ms. Searcy:

Enclosed please find the original and four copies of the reply comments of California Microwave, Inc. in the matter of ET Docket 92-9.

Sincerely,

CALIFORNIA MICROWAVE, INC.

David B Leeson

Dr. David B. Leeson
Chairman

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

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In the Matter of	)	
	)	
Redevelopment of Spectrum to	)	
Encourage Innovation in the	)	ET Docket No. 92-9
Use of New Telecommunications	)	
Technologies	)	

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To: The Commission

REPLY COMMENTS OF CALIFORNIA MICROWAVE, INC.

California Microwave, Inc. offers the following reply comments in support of the Commission's interest in providing frequency spectrum for the application of emerging technologies to personal communications services.

USERS REQUIRE A SINGLE UNLICENSED DEVICE FOR VOICE AND DATA, USABLE FIRST WITH PRIVATE, THEN PUBLIC NETWORK GATEWAYS Page 2

LEAST-COST LOW-POWER USER DEVICE DICTATES CLEAR SPECTRUM, VERY SHORT RANGE, WIDELY DISPERSED INFRASTRUCTURE Page 3

MINIMAL FCC REGULATIONS: MULTIPLE ACCESS, MULTIPATH AND ERROR MITIGATION PROVIDED THROUGH INDUSTRY STANDARDS Page 4

PUBLIC POLICY: FAVOR PORTABLE OVER FIXED SERVICES IN 2-GHZ FREQUENCY BANDS, RELOCATE TIMELY BUT FAIRLY Page 5

RELOCATION POLICY: RECOGNIZE PCS IS AN URBAN CONCEPT, 2-GHZ FIXED AND GOVERNMENT SERVICES ARE MAINLY RURAL Page 6

COMPENSATION SOURCE: LICENSED PUBLIC SERVICE PROVIDERS, BUT NOT PRIVATE ACCESS POINTS OR USER DEVICES Page 7

FAIR COMPENSATION BASIS: REMAINING UNDEPRECIATED BOOK VALUE, NOT REPLACEMENT COST, OF INCUMBENTS' OBSOLETED ASSETS Page 7

Integrated from the broad range of diverse comments submitted, some possible concepts for a workable investment-worthy personal communications service are detailed in following sections.

USERS REQUIRE A SINGLE UNLICENSED DEVICE FOR VOICE AND DATA, USABLE FIRST WITH PRIVATE, THEN PUBLIC NETWORK GATEWAYS

Many commenters envision a universal personal communications service, with voice, paging, electronic messaging, and interactive computing ranging from personal digital organizers to networks of individual computers. Market sizes for this type of service, if successful, are quantified at some 60 million individual users and $195 billion.[1] This application has the promise of going far beyond the usefulness of merely replacing wires or augmenting cellular telephony in existing applications, and will ultimately impact energy and economic policy world-wide.

A user will choose from a family of personal devices ranging from a "Dick Tracy Wrist Radio" telephone (perhaps with timekeeping and paging or messaging), through a pocket-size interactive personal organizer (with calculator, news dissemination and wrist-radio functions), to a miniature palm- or lap-top computer work station that incorporates all of these wireless communications functions. Individual type-approved devices will offer both voice and data services, and will be able to roam among private gateways within premises[2] as well as among licensed public gateways offering network carrier-PCS services for a fee.[3]

In order that this service be accepted widely enough to be truly economical, it is thought necessary that, having made a choice of device, the user will be able to use that one device to access both the type-approved private and public network gateways, as well as to accomplish local peer-to-peer communications independent of infrastructure interaction. The concept of a single identification number permitting service to an individual anywhere in the country has received widespread publicity. Separate short-range and long-range pocket telephones, pagers and computers will create the same consumer confusion seen in the proliferation of appliance remote controls.

Because private access points will be owned and operated within an individual premise by its owners or lessees, any requirement for control or intervention by a regional authority such as a public licensee will represent a serious deterrent to widespread acceptance. At the same time, requiring a potential user to own and carry multiple devices in order to access the full range of PCS services will also greatly limit acceptance and will compromise the economies of scale of a truly universal user device.

Advances in computer networking, if applied to wireless telephony service, will permit the same spectrum and technology to be used for both voice and data services. Some technical characteristics resulting from this opportunity will be explored in later sections of this document. We agree with the need to establish spectrum for emerging portable telecommunications technologies, and that the 1850-1990 MHz band is suitable. We believe the public interest will be best served by unbundling non-licensed private voice[4] and data services for immediate operation in lightly-loaded frequencies that are lightly loaded in urban areas.

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[1] American Personal Communications, June 5, 1992 at pg 2, referring to A. D. Little and Motorola

[2] EDS Corporation, June 8, 1992 at pg 2; Hewlett-Packard Company, June 8, 1992 at pg 1, Apple Computer, Inc. June 8, 1992 at pg 5; Rolm, June 8, 1992 at pg 8; Wireless Information Networks Forum, June 5, 1992 at pg 2

[3] American Personal Communications, June 5, 1992 at pg 2, defining PCS as carrier-PCS; Telocator, June 8, 1992 at pg 6

[4] Rose Communications Inc., June 5, 1992 at pg 2

LEAST-COST LOW-POWER USER DEVICE DICTATES CLEAR SPECTRUM, VERY SHORT RANGE, WIDELY DISPERSED INFRASTRUCTURE

In order that the user devices be as small and inexpensive as possible so as to promote user acceptance, it is viewed as a precondition to widespread success of PCS that a suitable frequency band be provided free of a requirement to share spectrum with incompatible signals. While a number of commenters have suggested the possibility of approaches to permit sharing[5], there is substantial doubt that compromise devices that share with unlike services will find any broader acceptance than existing Part 15 ISM-band services.[6]

Additionally, in order to create user devices with comparable economics to, say, digital watches, appliance remote controls or garage-door openers, demands strongly restrictive limitations on size, battery power and complexity. These technical considerations dictate a communications device with very short range, which in turn suggests the requirement for a widely-dispersed access-point infrastructure that bears the burden of hardware and software complexity. A PCS concept that requires that the high-volume user product include the types of complexity imposed on, for example, current cellular telephone products (*e.g.*, cooperative power control, separate control channel, range and multipath requiring substantial power level and battery size) will be severely economically disadvantaged.

The requirement for infrastructure carpeting the service area extends from the in-building context, where this is more readily visualized, to the public-service territory as well. This implies requirement for moderate-data-rate (to carry message and data as well as voice traffic), very-short-range access points distributed along major thoroughfares and throughout public pedestrian and transportation areas. This carpet infrastructure concept also encompasses the seamless access to wireless in-building private branch exchange (PBX) services by users entering, leaving and passing by the premise served by the private gateway infrastructure. It is widely recognized that some isolation is afforded by the reflection or transmission loss of building walls. Separate but compatible provisions may be required to accommodate very high-data-rate peer-to-peer communications as between a lap-top computer and desk-top docking port.

While the specification of the low radiated user and gateway power levels that permit only very short range communications provides for acceptable levels of mutual interference among multiple PCS users, both user and gateway receivers will need to operate at full sensitivity. This gives rise to the requirement that the frequency band be clear of noncompatible (*e.g.*, high-power, long-range, narrower-bandwidth) signals.

In all system concepts there is a broad optimum choice between user-device and infrastructure complexity. The optimum point depends on the quantities and economics of scale of user devices, and in the case of wireless communications also on the realities of radio propagation and interference. In almost every widely attractive economic network case, the concepts of hierarchical concentration of longer-range traffic (*e.g.*, trunking in telephony, bridging and routing in local area networks, superhighways in automotive transportation) come to dominate purely peer-to-peer implementations. Also, for systems with a user population comparable to the entire population, complexity, regulation and expense are best concentrated in the infrastructure sector (*e.g.*, telephones and the switching network, household appliances and electric power distribution).

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[5] American Personal Communications, *ibid.*; Telocator, June 8, 1992 at pg 6

[6] IEEE 802 Local Area Network Standards Committee, June 5, 1992 at pg 8; Motorola, June 8, 1992 at pg 17; Apple, June 8, 1992 at pg 5

The interconnection of infrastructure devices, such as private access points networked to PBX or LAN functions within a premise or public devices interconnected to the public switched telephone or data networks, is technically within reach and not at issue in the establishment of clear frequency spectrum for the user wireless interconnection. Existing licensed and unlicensed radio services, as well as the full range of cable and optical fiber media, can serve to interconnect the carpet infrastructure that will emerge to serve PCS.

MINIMAL FCC REGULATIONS; MULTIPLE ACCESS, MULTIPATH AND ERROR MITIGATION PROVIDED THROUGH INDUSTRY STANDARDS

Even with the simplifications resulting from strongly limited power and range, PCS wireless systems must be able to provide fair multiple access in the presence of multipath propagation and interference from other identical devices. A number of concepts can be assembled to point the way to the implementation of PCS services.

First, multipath is a fact of life for all radio services, both in-building and outdoors. For conventional microwave systems, multipath effects resulting from variations in the atmosphere increase with range. Thus shorter-range systems will suffer less from this source. Both outdoor and, particularly, indoor radio systems also experience multipath signal cancellation from reflections off natural and structural elements of the environment.

Today's conventional systems are designed with 30 to 40 dB of fade margin to provide acceptable availability in the presence of multipath fades. To accommodate multipath, such a system transmits 250 to 5000 times more power, and creates 250 to 5000 times more interference potential, than would be required for a system that employs a sufficient combination of frequency, space and polarization diversity and antenna directionality to reduce fade margin requirements to the range of 3 to 6 dB.

One identified means of accomplishing this multipath mitigation is through application of spread-spectrum techniques broad enough to provide adequate bandwidth to reduce fade margin requirements.[7] This concept also supports the application of code-division multiple access (CDMA) for PCS. Direct-sequence spread-spectrum is thought by some to be potentially the simplest and most economical technique, but certain technical limitations must be recognized.

In simplest form, the ability of spread-spectrum signals to overcome potential interference from other spectrum users is measured by the ratio of radio-frequency (RF) bandwidth to data bandwidth. This ratio is termed the processing gain, which is significantly also the upper limit on the system jamming margin, the ratio of interference to signal that can be accommodated without transmission failure. Thus, direct-sequence systems in radio bandwidths of tens of MHz can provide substantial processing gain for low data rate signals such as individual digitized voice channels, but are limited as to the highest data rate that can be accommodated within a given bandwidth and jamming margin requirement. The limitation on the number of simultaneous users in an otherwise interference free environment is also related to the processing gain/jamming margin parameter.

Direct-sequence systems are particularly vulnerable to jamming from narrow-band interferers, which has directed attention of some to frequency-hopping systems in Part 15

[7] C. A. Rypinski, June 4, 1992 at pgs 3-5

applications. If a frequency band can be provided that is clear of incompatible interfering signals, then the required dynamic range of signal levels is determined solely by the ratio of minimum to maximum operating range. A choice of very small maximum range and a compatible minimum range results in a jamming margin requirement for direct-sequence spread spectrum systems that can be met for useful computer data rates and attractive numbers of simultaneous voice users in radio bandwidths envisioned in ET Docket 92-9.

Separate from the multipath and interference improvements available through the use of spread-spectrum technology, computer local area networks (LANs) have proven the powerful advantages of packet techniques for logical addressing as well as error detection and correction. It is suggested that the very techniques that have proven so successful in LANs can be applied to wireless voice and data networking to provide multiple access and error-free transmission even in the presence of contention for transmission resource by multiple users.[8] It is this technology that make possible the concept of error-free unlicensed use of the radio spectrum. Standards efforts are underway to adapt the successful concepts of computer networking to wireless networks.

These efforts could result in the feasibility of including all PCS services up to a certain data rate (determined by RF bandwidth and ratio of maximum-to-minimum range) in a single frequency band. It is possible, of course, to provide additional segmentation among narrow- and wide-band users on a sub-band basis, but any additional requirements of this type may translate into additional user cost that could compromise the economic effectiveness of the PCS concept. If the concept of a single user device with carpet infrastructure for private and public access is accepted, it may not be necessary to separate applications on a sub-band basis. If separate sub-bands are deemed advisable, as for high data rate user-PCS, the sub-bands should be contiguous to preserve economies of scale.

The Commission should consider the technical feasibility of the allocation of a single frequency band by multiple voice and data users through the single minimal regulatory requirement that radiated power spectral density not exceed a single specified level determined necessary for reliable operation at a range derived from user-infrastructure tradeoffs acceptable to private and public users. Industry standards such as those being developed by IEEE 802.11 can provide the protocols and operating concepts for the realization of a universally useful outcome in the public interest, convenience and necessity.

PUBLIC POLICY: FAVOR PORTABLE OVER FIXED SERVICES IN 2-GHZ FREQUENCY BANDS, RELOCATE TIMELY BUT FAIRLY

Public policy world-wide favoring portable over fixed operation below 3 GHz has a sound technical base, and results in operationally and economically attractive user and gateway devices. In addition to the desirable omnidirectional antenna characteristics that permit operation in any physical attitude, operation at frequencies below 2.3 GHz offers the promise of all-silicon realization of the radio circuits.[9] This represents a substantial economic advantage over the gallium arsenide devices required for the higher-frequency microwave bands.

Additionally, a frequency allocation in the 2-GHz range will conform U.S. policy and practice with that of other countries now leading the way in personal communications

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[8] C. A. Rypinski, *ibid.*

[9] National Semiconductor Corporation, comments at *En Banc* Hearing, November, 1991

services.[10] This provides the opportunity for U.S. manufacturers to serve a home market, without which export efforts are at a considerable disadvantage.

It is most understandable that incumbents in the 2-GHz band would prefer the *status quo*, and they have organized a comprehensive campaign to bring attention to their viewpoint. No one would wish other than completely fair treatment of incumbents, and the Commission's sensitivity to this issue is noted.[11]

In determining the appropriate and fair disposition of incumbents who have made effective use of the 2-GHz band for many years, the Commission should give special recognition to the relative timing requirements of private- as compared to carrier-PCS, and of urban as compared with rural spectrum. Also, technical facts about the reliability of other frequency bands can be confirmed quickly[12], and retrofit concepts can introduce more effective digital technology, as well as the emerging technologies developed for PCS[13], into service for incumbents.

RELOCATION POLICY: RECOGNIZE PCS IS AN URBAN CONCEPT, 2-GHZ FIXED AND GOVERNMENT SERVICES ARE MAINLY RURAL

The urban nature of PCS service and the rural nature of existing 2-GHz private and government microwave services should be recognized as an important factor in gauging the magnitude of the relocation issue and in resolving the disposition of incumbents[14].

Personal communication services are required where the population is most dense. Rural services can be provided to PCS users on a secondary basis during the transition period without compromising the economic basis of the service. Also, rural users more naturally seek satellite-based services, and the Commission should preserve mobile satellite services (MSS) clear allocations at 2 Ghz[15] and 11 GHz[16].

The Commission should give consideration to suggestions that early relocation is required only for the 2-GHz operational-fixed service (OFS) paths that cross urban areas. These are the very paths that would be most amenable to replacement with non-radio media, and the sites are the most accessible for the activity associated with relocation.

Additionally, the Commission should give strong consideration to the suggestions that government services in the 1710-1850 MHz band are also primarily rural, so that existing urban OFS paths might be relocated to this government band with minimal impact on both government and OFS users[17].

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10 Northern Telecom Inc., June 5, 1992 at pg 7
11 Telocator, ibid., at pg 2
12 COMSEARCH, June 5, 1992 at pg 17
13 C. A. Rypinski, June 4, 1992 at pg 6; California Microwave, Inc., June 5, 1992 at pg 1
14 Tel/Logic Inc., June 8, 1992 at pg 6; Citizens Utilities Company, June 5, 1992 at pg 3
15 AMSC, June 8, 1992 at pg 2; Communications Satellite Corporation, June 5, 1992 at pg 4
16 Hughes Network Systems, June 5, 1992 at pg 2
17 NTIA, June 8, 1992 at pg ii

COMPENSATION SOURCE: LICENSED PUBLIC SERVICE PROVIDERS, BUT NOT PRIVATE ACCESS POINTS OR USER DEVICES

Given the concept of a single personal device that could roam nationwide, and the attendant carpet infrastructure requirement, it is anticipated that premise owners or lessees would own and operate their own private type-approved access points without accounting for fees for that portion of the communications link. This type of service can be viewed as a multiple-access extension, for voice and data, of the Part 15 cordless telephone systems now coming on the market for wireless PBX implementation.

Additional access points for public service can be provided by, for example, local wireline-telephone or cable-television companies. These public network operators will provide mobile and portable network access in a given geographic area under a permit and license structure similar to the current cellular structure. In view of the fact that these franchises can have substantial economic value, it is expected that resolving the details of establishment of this type of service will take more time than establishing the framework for private infrastructure and personal devices. The complexities of the public network regulation should not stand in the way of timely establishment by the Commission of the regulatory and frequency allocation framework for private or user PCS.

If the Commission determines that compensation is due incumbents, it can come from licensed public service providers. While it is possible to imagine fees imposed on private access point users, this could be a substantial economic damper on services that will not themselves generate fees and will not be accounted. Certainly, the imposition of fees on user devices or use will represent a brake on the efforts to establish a truly inexpensive, very widespread service.

FAIR COMPENSATION BASIS: REMAINING UNDEPRECIATED BOOK VALUE, NOT REPLACEMENT COST, OF INCUMBENTS' OBSOLETED ASSETS

As a final comment, it is noted that the determination of fair compensation basis for the remaining usefulness of 2-GHz assets to incumbents is an accounting question for which a rigorous answer exists. Incumbents should expect, at a maximum, to be compensated for remaining undepreciated book value of assets rendered obsolete by relocation.

It has been pointed out by a number of commenters that the bulk of incumbent equipment in the 2-GHz band employs older analog rather than newer digital technology, so there is available to the incumbents a more efficient and cost-effective service. Also, the reliability of other, higher frequency bands has been made clear by calculation and by example of widespread TVA and FAA use.[18] These new frequency bands can be employed by incumbents, using much of their existing installations (*e.g.*, baseband, multiplex and power equipment, cables, towers, structures, real estate), but it is inappropriate to make light of the magnitude of the effort involved.

Opposing claims have been advanced about the costs of relocation, but these will be clarified as issues of timing, rural vs. urban and the potential of adjacent government bands are resolved. Much of the cost of existing systems has already been paid for by ratepayers and customers in the form of depreciation, and the accounting basis for the remaining value in an incumbent's microwave system already exists in the books of that user.

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[18] American Personal Communications, *ibid.*, at pg 2

To summarize this point, any compensation should not be replacement cost, but should be defined by the remaining undepreciated book value, as carried in incumbents' own accounts, of assets rendered obsolete.

CONCLUSIONS

Personal communications service will succeed if voice and data users can access private and public services with a single device. This will require clear spectrum for short range access to widely dispersed infrastructure, and sharing of the band among private and public users. Sub-bands for specific services, if deemed appropriate, should be contiguous.

The Commission can facilitate the timely development of PCS by minimal regulation, perhaps limited only to power spectral density appropriate to very short range, of a new allocation; multiple access, multipath and error mitigation can be required to be provided by industry standards based on existing computer network practice. Conforming to worldwide adoption of 2-GHz bands for portable service has a sound technical and economic basis. Unbundling private PCS services for immediate clear allocation and operation will provide timely service now awaited by users.

Required bandwidth for PCS, determined by multiple-access user density, cell size (maximum range), multipath mitigation means and maximum data rate, is in the range of 70 to 140 MHz. Development of minimal regulations for peer-to-peer and private PCS service can proceed timely, recognizing that PCS will initially be primarily an urban service while existing uses of the 2-GHz bands are largely rural.

Regulations for public carrier-PCS, expected to be more complex, can follow, with provision from this service for relocation compensation of incumbents. The remaining undepreciated book value, not the replacement cost, of incumbents' obsoleted assets is a fair basis for compensation.

California Microwave is a long-standing supplier to the microwave and satellite communications businesses, and actively supports the efforts of the Wireless Information Networks Forum (WINForum) and the IEEE 802 Local Area Network Standards Committee.

Respectfully submitted

CALIFORNIA MICROWAVE, INC.

by David B. Leeson

Dr. David B. Leeson
Chairman

Date: July 6, 1992