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Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of Petitions for Rulemaking filed by DIAL PAGE, INC., et al.	CONSOLIDATED ET DOCKET NO. 92-100 RM-7977, et al.

In the Matter of Request for Pioneer's Preference of ECHO GROUP L.P.	PP-36

CONSOLIDATED REPLY COMMENTS OF ECHO GROUP L.P.

Echo Group L.P. ("Echo"), by its attorneys, hereby submits this Reply to the comments filed by various parties regarding both the petitions for rule making ("Petitions") and Echo's Request for Pioneer's Preference ("Request") captioned above. Because the issues to be addressed are interrelated, and in the interest of efficiency, Echo hereby files one Consolidated Reply to the comments regarding the Petitions and its Request.

I. Introduction

As Echo has already made clear, it does not object to an allocation of frequencies in the 930-931 MHz band that would include services in addition to its pro-

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posed mobile data radio service ("MDRS"). In fact, Echo's proposed six MDRS licensees would occupy only 300 KHz of the available spectrum, leaving the remaining 700 KHz for other services. Moreover, Echo generally supports the principles proposed by Mobile Telecommunication Technologies Corp. ("Mtel") for allocating and licensing the 930-931 MHz band, including its proposed primary 50 KHz per licensee channeling plan.

Echo submits, however, that certain aspects of Mtel's proposal are unnecessarily restrictive. For example, Mtel would have the Commission adopt a strict construction schedule for nationwide licensees requiring specific markets to be operational within specified time periods. Such a strict schedule, however, would not enable licensees to account for variations in demand, site availability, or other factors. The Commission should afford licensees more flexibility in selecting the priority of markets to be constructed, provided that licensees adhere to general construction requirements designed to deter speculation.

II. PageMart and PageNet Have Untimely and Inartfully Challenged the Economic and Technical Viability of MDRS

Contrary to the assertions of PageMart, Inc. ("PageMart") and Paging Network, Inc. ("PageNet"), Echo's MDRS technology is truly innovative and will provide an

advanced two-way terrestrial mobile data radio service on only 300 KHz within the 930-931 MHz band. The low cost, efficient and versatile service that Echo proposes is based on a unique technology and cannot be comparably provided by other existing or proposed two-way services. Unlike other petitioners in this docket, Echo will not be simply replicating existing paging operations.*

To begin with, Echo notes that the comments filed by PageNet and PageMart regarding Echo's Petition for Rule Making (RM-7782) are untimely in that they were filed nine months after the period for filing comments had expired and were not accompanied by a motion for leave to late-file comments.** In any event, Echo filed with the Commission a detailed technical MDRS Progress Report on June 1, 1992. This report outlines the MDRS

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* MDRS was developed in conjunction with Echo by Dr. Bruce Lusignan. Dr. Lusignan is well-known in the industry and to the Commission for his pioneering work in satellites and mobile radio at Stanford University. He developed the concept of direct broadcast satellite television in the 1970s and worked with the Commission, NASA, the State of Alaska, and industry to bring it into reality. In the 1980s, under contract to the Commission's UHF Task Force on spectrum utilization, Dr. Lusignan developed Amplitude Companded Side Band ("ACSB") radio, which is able to deliver voice services on 5 KHz channel spacing. The ACSB technique has led to Commission allowance of 5 KHz channel splitting in mobile radio bands and to the allocation of the 5 KHz assignments in the 220-222 MHz band.

** Echo's Petition for Rule Making appeared on Public Notice August 26, 1991, and comments were due 30 days thereafter. See Report No. 1858.

system characteristics and refutes in detail the arguments raised by PageMart and PageNet. Here, Echo more summarily addresses these parties' comments.

A. PageMart Grossly Mischaracterizes MDRS

1. Cost Effectiveness of MDRS

PageMart contends that Echo's MDRS "would employ virtually the same technical capabilities as conventional cellular radios, with the attendant hardware complexities and costs." PageMart Comments at 41. This is not true. Unlike cellular radios, MDRS user equipment is not frequency synthesized. Moreover, it incorporates all data processing, tuning, synchronizing, error checking, and data flow management into one custom gate array chip and a simple microprocessor (Model No. 8051), all with a combined cost of under $10. The radio is simplified by inexpensive direct-conversion design and balanced gain and filter functions. Its design also eliminates costly tuning requirements inherent in cellular CPE.

Further, to reduce user radio costs, MDRS will employ continuous base station transmissions with a high-stability crystal for frequency reference. Unlike in cellular, however, this high-stability, higher-cost crystal will be located only at base stations.* In contrast, the user units will use inexpensive crystals for frequen-

* The crystal is included in the base station cost estimate.

cy reference. Through use of a digital software program in the microprocessor, a "varicap" will correct the end user crystal to the frequency designated by the base station. This digital automatic frequency control ("AFC") was specifically developed to reduce user unit costs and has been thoroughly and successfully tested in the field.

Moreover, contrary to PageMart's claim, MDRS radios do not require "much more stringent front end filter[s]" for the proposed 5 KHz channel spacings. PageMart Comments at 42. With the user unit locking into the base station crystals, the "front end" filters are not different from the comparable low-cost cellular components. The radio's 5 KHz channel filters are located at the base band amplification filter section. In the base band, 5 KHz widths are no harder to implement than 30 KHz widths: if the ratio of bandwidth-to-channel spacing is the same, the number of filter components and the required precision are the same.

PageMart also expected that Echo had not developed sufficient new technology to overcome co-channel interference problems. PageMart Comments at 43-44. As described more fully in Echo's June 1 report, the spectrum efficiency of MDRS results from combining (1) narrow

channels, (2) spectrum reuse,* (3) elimination of the extra data transmission associated with less efficient protocols (commonly known as "overhead"), (4) data management that efficiently combines different classes of data, and (5) continuous one-bit "Status Requests" from the transmitter to handle "bursty" data.**

In short, MDRS would provide more capacity than PageMart's proposal or the other pending 930-931 MHz proposals. For instance, in the June 1 report Echo demonstrated MDRS capacity for providing various services proposed by others for the 930-931 MHz band. For the mix of services assumed therein, 285,000 customers could be accommodated in Phase I of MDRS construction in a typical MSA.*** In Phase II, the same mix would increase the total to 855,000 users. If the messaging services were restricted to one-way paging (with confirmation), the MSA customer capacity on the MDRS system would be 1.73 million in Phase I and 5.18 million in Phase II. These numbers illustrate the enhanced capacity of MDRS, to support both simple paging services and the more advanced two-way messaging services proposed by Echo.

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* A four-fold frequency reuse will be used in the typical MSA in Phase I system construction. As demand increases, a 12-fold reuse in Phase II will be accomplished by sectoring base stations.

** See June 1 MDRS Progress Report, Section 3.

*** See June 1 MDRS Progress Report, Section 4.

2. Service Pricing

PageMart's comments on service pricing reflect a broad misunderstanding of the MDRS frequency reuse strategy and the system's true capacity. Indeed, PageMart incorrectly assumes MDRS will have the same equipment and service costs as current cellular technology. PageMart Comments at 44.

Initially, 15 to 20 MDRS base stations would provide coverage to most MSAs.* As illustrated in Echo's June 1 report, these stations would have capacity to serve from 200,000 to 300,000 customers in each urban area, which is much larger than cellular's capacity. When these "Phase I" capacities are approached, base station division can be used to increase system capacity. Typical MSAs with relatively flat terrain can divide base stations three-fold (i.e., up to 60 stations), resulting in a capacity increase to between 600,000 and 900,000 customers.**

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* Certain large area MSAs, such as Los Angeles or New York, will require more than 20 base stations, whereas smaller area MSAs will require fewer than 15 base stations.

** In hilly areas such as Los Angeles, shielding will occur to enable the carrier to use base stations with smaller coverage areas and to reuse frequencies more often. In fact, in Los Angeles, Echo estimates that a 10-fold reuse pattern can be used, if necessary. If customer density required, 10-fold frequency reuse could result in capacities of 2,000,000 to 3,000,000 customers.

Moreover, PageMart suggests that the "proprietary design" of MDRS equipment will restrict the mass market appeal of end user and base station equipment. PageMart Comments at 44. This is not true. MDRS is a patented technique that will be available to other service providers. In any event, even if Echo were the only equipment user, the capacity and appeal of its low-cost two-way data transmission system would itself provide the high volume needed to ensure low-cost manufacturing. In Phase I the top 30 MSAs will have as many as 600 base stations with capacity to serve six million to nine million customers. After Phase II expansion of the top 30 MSAs, a system (demand warranting) would entail up to approximately 1,800 base stations with capacity to serve an added 12 million to 18 million customers.* This production volume would lead to the lowest production costs, which would put the technology way out on what PageMart refers to as the "learning curves."

Finally, in the June 1 report, Echo demonstrates that the capital investment of one base station can be recovered in only two years with less than a

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* The millions of user units constitute high volume; the number of base stations are medium volume. To reduce costs, base station hardware consists of more than 80% OEM equipment supplied by manufacturers with larger market bases.

$0.002 charge per message delivered and with the base station operating at only one-quarter capacity.* These calculations account for peak and non-peak calling rates and are conservative in that long messages are assumed to cost the same as short messages. Additionally, monthly access charges are not included. The illustration shows that MDRS will be a profitable service while cutting costs to consumers far below the costs available today. These reductions enable many new applications unattainable with today's high-priced messaging services.

3. In-Building Penetration

PageMart claims that 220-222 MHz frequencies have as good building penetration as 930-931 MHz frequencies. PageMart Comments at 45. PageMart's claim, however, contradicts years of industry experience. In fact, PageMart claims that "it is almost inconceivable" that MDRS communications can be reliably established with a mobile unit within a building (i.e., 2400 Baud at 20 dBM)." Id. Nevertheless, MDRS uses the same power margins as are used by the cellular industry for hand-held phones to achieve in-building penetration.**

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* See June 1 MDRS Progress Report, at Section 4.

** For instance, MDRS employs user radios with 100 mw transmitter power and a radio bandwidth of 3.5 KHz to carry the 2.4 Kb/sec. signal. The "cell" sizes are generally the same size as a typical cellular radio cell sizes. Hand-held cellular telephones use

(Footnote continued)

Far from being "almost inconceivable," MDRS has essentially the same building penetration as cellular telephones. This performance has been thoroughly verified by field tests in San Diego, San Rafael and Mountain View, California.* Contrary to Pagemart's contentions, Echo is not "attempting to 'port' technology intended for use at 220 MHz frequencies to 930 MHz." Id. On the contrary, the technology has been specifically developed and tested at the 800 MHz and 900 MHz bands.**

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a power of 600 mw maximum and have a receiver bandwidth of 18 KHz. The sensitivity of a radio system is proportional to its power divided by the bandwidth of the radio receiver. For the same margins as cellular hand-held radios, the MDRS radios would need only 3,500/18,000 as much power, i.e., 116 mw. In fact, MDRS uses 100 mw of power, which is essentially the same. In addition, the automatic error correction system ("ARQ") makes MDRS less dependent on signal-to-noise ratios, which further improves in-building services.

* See June 1 MDRS Progress Report, Appendices I and II.

** Similarly, PageNet questions Echo's comparison of radio propagation at the 220-222 MHz and 930-931 MHz bands. PageNet Comments at 10. As the Commission is well aware, radio waves pass readily through nonmetallic substances such as glass, plastic, wood and wall board, yet they are reflected or deflected by metals such as aluminum, iron, steel and copper. If a grid of metal has holes about the size of the radio wavelength (equal to the speed of light divided by the radio frequency), much of the energy will pass through the open "spaces" in the metal. If the grid is smaller than the wavelength, most of the radio waves will be reflected. At 220-222 MHz, the radio wavelength is about four feet, much greater than spacing between steel rods used in reinforced
(Footnote continued)

B. PageNet Similarly Mischaracterizes MDRS and Inaccurately Compares it to Other Services

1. The Role of Voice Paging

PageNet's argument that an innovation in voice paging technology represents a broad new offering to the public is not accurate. PageNet Comments at 7. Voice paging, voice mail and automatic answering machines all provide similar services to the consumer: receiving a called-in voice message. As cellular and PCN telephones become more widespread, the need to transmit a message to the customer via voice paging will diminish because the "paging" party will have the option to call directly to the cellular customer's telephone or voice mail.

Furthermore, the "breakthrough" in PageNet's system is based on efficient voice encoders (Vocoders) to reduce the data rate and voice activation (VOX) to eliminate time gaps. These techniques reduce the length (in data bytes) of the message to be transmitted. This com-

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concrete walls or the steel wall joists used in modern buildings. Accordingly, 220-222 MHz radio signals do not penetrate buildings well. The wavelength at 930-931 MHz, however, is about one foot, less than the typical spacings of metal in such structures. These radio signals penetrate buildings much better, typically 20 dB (i.e., 100 times greater than 220-222 MHz radio signals at the center of a building). In fact, this phenomenon is one important reason why the Commission allocated cellular service frequencies in the 800 MHz band.

pressed data, however, is equivalent to an E-mail data message and can be transmitted by an E-mail system with little added complexity. Similarly, the MDRS system can deliver compressed voice through an E-mail option, as can many of the other messaging systems proposed in the captioned Petitions.

2. Existing Message Services

PageNet argues that the Petitions proposing improved two-way messaging services should be denied because they are similar to existing or recently announced messaging services, namely ARDIS, the United Cellular Group, and low-Earth orbit ("LEO") satellites. PageNet Comments at 8-9. To deny Echo's Petition on the basis that data services are already offered or proposed by these entities, however, would be equivalent to having blocked the internal combustion engine because horses were already serving the personal transportation market.

The ARDIS System is more expensive than MDRS both in terms of base station equipment and user equipment. In addition, it has data protocols that make transmission of short messages, which characterize many of the most important MDRS applications, more burdensome. In fact, the ARDIS "overhead" and "hand shaking" protocols require more data transmission than the message itself. Moreover, the "bursty" nature of user-originated data offers further problems for ARDIS. For example,

ARDIS uses a random access technique, i.e., user units transmit when the user hits the transmit key. If two users happen to transmit at the same time, their messages collide and each user must try again. When channel loading reaches 15-30%, less than one-half of the messages sent will be successfully received. To compensate, the system can attempt to follow a polling strategy whereby the base stations call each user in sequence. For most services requiring real time responses, however, "polling" spends much more of the channel capacity in checking the user radios than in retrieving their data. In short, ARDIS is a service better suited for a high end user market and reflects a higher cost, less efficient approach.

In contrast, MDRS uses a digital design for low-cost user radios, a miniature low-cost base station, and a patented single-bit Status Request to solve the "bursty data" problem cited above. Accordingly, even when MDRS channel loading reaches 80%-90%, virtually all messages sent will be successfully received due to the use of simplified protocols, automatic error correction (ARQ), and priority queuing.* Spectrum shaping, "cell" splitting, and small base station cost allow for maximum frequency reuse. In comparison with ARDIS, MDRS is ap-

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* See June 1 MDRS Progress Report, at Section 4.

proximately less than one-fifth of the cost for user radios and approximately less than one-fifteenth the cost for base stations. Moreover, MDRS's frequency utilization (based on transmitted data, not overhead) is from five to 10 times more efficient than ARDIS, depending on cell size and message length.

As stated above, the capital investment of an MDRS network in a typical large MSA could be recovered in two years with a per-message cost of less than $0.002 even if the system operates at only one-fourth capacity. Even $0.01 per message would be far below current rates.* Because of these reduced costs, MDRS will more efficiently provide two-way radio messaging services currently prohibited by the high costs of the ARDIS and other similar systems.

Similarly, the mobile data service proposed by "United Cellular Group" is also far more expensive than MDRS and appears aimed at large volume users.** Nor does this system have the MDRS flexibility to provide a mix of services with spectrum and cost efficiency. Also, like

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* Current rates approach $0.25 per 200-byte message.

** The United Cellular approach apparently will be based on modifications to Motorola's central switching equipment using time from idle cellular voice channels to provide interactive data services. It apparently will first use normal dial-up data lines and later extract the data to be routed to central switching machines and then to the consumers.

ARDIS, it does not appear to have an efficient solution to the "bursty" data problem.

Finally, PageNet suggests that interactive wireless data services may be provided by LEO satellites. This "iridium" system would seek to provide service to ground radios from a ring of 77 satellites orbiting the Earth every one and one-half or two hours. The distance between end user radios on the ground and orbiting satellites in the sky, and the complexity of routing data among various satellites, results in data radios that are very expensive compared to radios communicating with base stations only a few miles away. Accordingly, the LEO system will be cost competitive only for consumers in sparsely populated and little-travelled areas. It does not promise to be a viable system for the 90% of the U.S. population that lives in more populated cities and towns.

III. CONCLUSION

As Echo's June 1 MDRS Progress Report and the above responses indicate, Echo's proposed MDRS will dramatically increase the capacity and efficiency of current paging and data messaging systems. It will increase spectral efficiency while at the same time greatly reduce the cost of base station and user radio units. Increased equipment capacity and reduced equipment cost will result in the ability to offer a two-way data messaging service at a fraction of the cost of other systems.

Not having reviewed the detailed design parameters of the Echo system, PageMart and PageNet questioned whether the capacity improvements and the cost reductions stated earlier by Echo could be achieved. MDRS, however, introduces five major improvements simultaneously to achieve these goals. The first three factors combine to improve the system capacity and the spectrum utilization dramatically; the last two similarly combine to reduce system costs. The five factors together produce the low per-message costs that MDRS can offer. In conclusion, these are:

1. Frequency reuse: Although not new to mobile radio or cellular, frequency reuse is a dramatic change for the data delivery industry. For instance, the paging industry commonly uses simulcasting techniques in which the same message is transmitted over a large urban area. The MDRS frequency reuse significantly improves spectral efficiency.

2. Base Station Synchronous Protocol: The base station transmits an error-checked, addressed packet to the user, commanding the data return in a specified time slot. Automatic correction methods (ARQ) are used to eliminate errors. This fully synchronous, centrally controlled technique eliminates multiple layers of protocols and synchronizing overhead common to other systems. Only the data bits actually needed for the radio trans-

mission are sent through the scarce spectrum. For short messages, the efficiency (data bits ÷ [data bits + control bits]) is two to three times better than other message protocols.

3. Single Bit Response for Bursty Data: Random origination of messages from user radios becomes unstable at a channel capacity of 15% or 30%, depending on whether variable message or time-slotted messages are used. Reservation systems (which use random access messages to reserve the actual data transmission) give an improvement, but only if data messages are long. Base station polling systems (asking user radios if service is required) use excessive overhead for "bursty" data. Yet, the patented single-bit Status Request of the Echo system solves the problem, increasing throughput at least two times on typical bursty messages.

4. Base Station Beacon for AFC: The cost of the user radio is reduced by digitally locking its low cost crystal to the base station reference frequency. Other innovative radio design also reduces the cost of the user radios.

5. OEM Base Station Design: The base station uses common, off-the-shelf subsystems to achieve low cost and high reliability. In addition, it is miniaturized to minimize facility space and cost.

In sum, Echo's technology is such that it can provide not only advanced two-way, real time data transmissions, it can economically provide at the same time one-way paging or provide for the transmission of simple acknowledgments to the calling party. This versatility, which is not present in existing technologies, and the fact that Echo's MDRS may be developed at more than one frequency band for different applications, should be viewed as a testament to the flexibility and versatility of the technology and not grounds to disqualify MDRS from a frequency allocation or Echo from a Pioneer's Preference. Indeed, the Commission's goal in allocating spectrum and awarding licensing preferences is not to reward

rigid proposals, but to encourage innovative technological development that best utilizes available spectrum in an efficient and versatile manner.

Respectfully submitted,

ECHO GROUP, L.P.

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Dated: June 16, 1992

Declaration of Dr. Bruce Lusignan

I, Bruce Lusignan, declare under penalty of perjury that I am Chairman of TransTech International and Director of Stanford University's Communications Satellite Planning Center and a member of Stanford University's Center for Telecommunications; I developed MDRS in conjunction with Echo Group L.P. ("Echo") and prepared for Echo the MDRS Progress Report Echo filed with the Federal Communications Commission on June 1, 1992; I have read the foregoing Consolidated Reply Comments prepared on behalf of Echo and the facts stated therein are true and correct.

Bruce Lusignan

Bruce Lusignan

Dated: June 16, 1992

CERTIFICATE OF SERVICE

I, Simone Wu, do hereby certify that on this 16th day of June, 1992, a copy of the foregoing Comments of Echo Group L.P. was mailed by first class U.S. Mail, postage prepaid, to the following persons:

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