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Federal Communications Commission
Office of Secretary

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

In the Matter of FINAL ANALYSIS COMMUNICATION SERVICES, INC. For Authorization to Construct, Launch and Operate a Non-Voice, Non-Geostationary Mobile Satellite System in the 148-150.05 MHz, 400.15-401 MHz, and 137-138 MHz bands	)	File Nos. 25-SAT-P/LA-95 76-SAT-AMEND-95 79-SAT-AMEND-96 15-SAT-AMEND-96 7-SAT-AMEND-98

JUN 1998

Satellite Policy Branch

To: The Commission

REPLY

Final Analysis Communication Services, Inc. ("Final Analysis"), by its attorneys, hereby replies to the Comments filed by Orbital Communications Corp., ("ORBCOMM") on May 18, 1998, in response to Final Analysis's Application for Clarification and Review of the International Bureau decision (the "*Bureau Order*")[1] granting Final Analysis its above-captioned Little LEO authorization. As demonstrated in Final Analysis's Application for Review and further confirmed below, and in the attached Consolidated Engineering Statement and independent engineering analyses of W.L. Pritchard & Co., Inc. ("Pritchard"), Lockheed Martin Management & Data Systems ("Lockheed Martin") and ITT Corporation ("ITT Corp,"), Final Analysis's amended system proposals will not cause any increase in potential adjacent channel interference to ORBCOMM from Final Analysis's 137 MHz downlink operations or co-channel interference to ORBCOMM in the shared 148 MHz uplink band. Furthermore, in the attached joint letter, Final Analysis and ORBCOMM both agree that all downlink issues are resolvable

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[1] *See Final Analysis Communication Services, Inc.*, Order and Authorization, DA 98-616 (rel. Apr. 1, 1998).

through post-licensing coordination. Accordingly, the Commission should grant Final Analysis's Application for Review and reject ORBCOMM's Comments.[2]

Final Analysis's proposed increase in downlink EIRP from 12.8 dBW to 17.8 dBW will not result in any increase in potential adjacent channel interference, contrary to ORBCOMM's claims at ¶¶ 1-3 of its Comments. As shown in Final Analysis's Application for Review at p.14, increasing Final Analysis's downlink EIRP to 17.8 dBW will not increase adjacent channel interference to ORBCOMM because of Final Analysis's use of GMSK. In its attached comments, ITT Corp. states that the Final Analysis out-of-band emission will result in "the signal power in the adjacent channel . . . . [being] below the detectable limits of the receiver." The conclusion that increased EIRP will not increase potential adjacent channel interference to ORBCOMM is also supported by the attached analyses of Pritchard.. Moreover, as Pritchard and ITT state, the resulting pfd with Final Analysis's EIRP increase in the 137 MHz band shared with NOAA, ORBCOMM, Leo One and E-SAT is in fact decreased. Thus, ORBCOMM has no justifiable concern regarding the efficacy of Final Analysis's use of GMSK to suppress out-of-band emissions from the 137 MHz band. Furthermore, as Pritchard independently confirms with regard to Final Analysis's use of GMSK as compared to ORBCOMM's and Leo One's use of O-QPSK to suppress out-of-band emissions, "Final Analysis will cause less out-of-band interference to ORBCOMM and Leo One than they will cause to Final Analysis."

[2] ORBCOMM's procedural objection at pp. 2-3 of its Comments is without merit. Final Analysis properly invoked its right to Commission review without rejecting the license. The *Bureau Order* at ¶ 80 obligated Final Analysis to accept the grant as made as a condition of its license. The Bureau clarified that Final Analysis's acceptance of the license would not affect its right to seek administrative or judicial review. *See Final Analysis Communication Services, Inc.*, DA 98-881 at ¶ 6 (Int'l Bur. Rel. May 8, 1998) (clarifying that by filing requested certification, "Final Analysis does not waive its right to Commission or judicial review" of the *Bureau Order*). In certifying that it accepted the license as granted, Final Analysis thus acted in compliance with the principle in *Capitol Telephone v. FCC*, 498 F.2d 734, 740 (D.C. Cir. 1987), that a licensee comply with the conditions upon which its license is granted.

Final Analysis also has previously shown, contrary to ORBCOMM's Comments at ¶ 4, that there will be no increase in potential interference to users sharing the 148 MHz uplink band from Final Analysis's amendments with regard to its subscriber uplink channels and increase in the number of satellites from 26 to 32. ORBCOMM incorrectly claims at ¶ 4 of its Comments that Final Analysis proposed an increase its subscriber uplink channels from "12 or 14 to 40" and that this alleged increase would increase potential uplink interference to ORBCOMM. As demonstrated in the attached Consolidated Engineering Statement and as shown in Final Analysis's October 1997 Amendment at p.25 n.28, and its Application for Review at pp. 16-18, there has been no increase in the total number of active receivers for uplink transmissions on the 148 MHz band from the total of 14 active VHF receivers specified in Final Analysis's original 1994 application, and thus no increase in potential interference.[3] As Final Analysis has not asked for authority for current use beyond the total of 14 active VHF receivers specified in its Original Application, there is no potential for increased interference in the 148 MHz uplink band. Moreover, specification of additional uplink channels for future spectrum allocation is consistent with Commission rules for Little LEOs.[4]

There also is no potential for increased interference in the 148 MHz uplink band due to the increase in the number of Final Analysis satellites from 26 to 32. As shown in the attached

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[3] Final Analysis's February 1996 Amendment specified 14 additional receivers per satellite (for a total of 28) for future use only in case of domestic allocation of the WRC-95 spectrum. The October 1997 Amendment proposed an additional 12 receivers, also reserved for use in the event of domestic allocation of WRC-97, L-Band, or other future spectrum to the Little LEO service. The total number of 14 active VHF receivers for use in the currently allocated 148 MHz band has not changed.

[4] *See First Round Report and Order*, CC Docket No. 92-76, 8 FCC Rcd 8450 at n.38 (1993). Part of the System 2 agreement reached in the Joint Proposal is that Final Analysis migrate its portion of the 149.9-150.05 MHz TRANSIT band to future unknown spectrum and allow ORBCOMM to use Final Analysis's allocated channels in this band. This was a significant compromise by Final Analysis. Without building in receiver capability to use the unknown future spectrum, Final Analysis cannot migrate. If ORBCOMM really intends that Final Analysis not be allowed to build in the necessary receiver capability to effectuate future migration, then it is only fair that ORBCOMM retract its migration request and allow Final Analysis to remain in the TRANSIT band.

Consolidated Engineering Statement, uplink usage is a function of data throughput, and the actual uplink usage in Final Analysis's 32 satellite system is *less* than the 26 satellite system because a lower data rate (9.6 kbps) is used with the 32-satellite system than the 26-satellite system (19.2 kbps). Furthermore, ORBCOMM fails in its attempt to distinguish the rule adopted in the *ORBCOMM Second Round Authorization Order*, DA 98-617 at ¶ 24 (rel. Mar. 31, 1998), that an increase in the number of satellites will not result in increased uplink usage where the capacity of downlink spectrum available limits use of uplink spectrum to the same amount. As discussed in Final Analysis's Application for Review at pp.10-11 and confirmed by Pritchard, "utilization of uplink is clearly limited by the amount of downlink capacity, which is directly related to the total downlink bandwidth assigned to System 2." Thus, in both the cases of the ORBCOMM's increase in satellites and Final Analysis's increase in satellites, the combined effect of the increase in satellites with the reduction in service downlink channel spectrum is a net decrease in potential interference.[5]

ORBCOMM also has not shown that the increase in uplink power from 10W to 20W will increase potential interference to ORBCOMM, or that the 20W uplink power is not necessary to close a communications link in view of actual noise levels in the 148 MHz environment. Uplink transmission at 20W is not nearly enough power to overpower a simultaneous co-channel transmission in the 148 MHz band.[6] ORBCOMM's Comments at ¶ 7 also incorrectly suggest

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[5] The *ORBCOMM Second Round Authorization Order* at ¶ 25 evaluated and approved its altitude increase under Section 25.116's major amendment standard and is binding here.

[6] As confirmed in Final Analysis's Application for Review at p.19, at least 150W to 300W power at a minimum – not 20W – would be required to overpower a simultaneous co-channel uplink transmission. In any case, Final Analysis's proprietary STARS channel assignment system will prevent an uplink channel from being assigned for uplink transmission to a Final Analysis satellite if the channel is in use at the same time by an ORBCOMM subscriber. The operation of STARS in preventing simultaneous uplink transmission can and should be addressed through coordination. As discussed in the attached letter jointly submitted to the FCC by ORBCOMM and Final

(continued...)

that Final Analysis did not take enough relevant scans of noise levels in the 148 MHz band in reaching the conclusion that uplink power of 20W is the minimum necessary to overcome noise levels in the 148 MHz band. In fact, Appendix II to Final Analysis's Application for Review at Table I merely provides examples of these scans, and does not consist of the entire scan data set. Furthermore, the Lockheed Martin letter states "for a handheld transceiver incorporating omnidirectional antenna, RF link analysis has shown that the links are interference limited due to the large amounts of man-made interference in these bands."[7]

WHEREFORE, the Commission should expeditiously grant the relief requested in Final Analysis's Application for Review and reject ORBCOMM's Comments.

Respectfully submitted,

FINAL ANALYSIS COMMUNICATION SERVICES, INC.

By: ______________________

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Its Attorneys

Dated: June 2, 1998

(...continued)
Analysis, the companies agreed at a May 29, 1998, coordination meeting to independent third-party review of the functionality of the companies' respective proprietary DCAAS and STARS channel polling algorithms.

[7] Final Analysis agrees that market considerations argue in favor of the minimum possible power usage for user terminals. However, 20W is necessary for reliable communications in certain high noise environments.

ATTACHMENT

CONSOLIDATED ENGINEERING STATEMENT

CONSOLIDATED ENGINEERING STATEMENT

The Oppositions filed on May 18, 1998 by Leo One USA Corporation ("Leo One") and Orbital Communications Corporation ("ORBCOMM") to the Final Analysis Communication Services, Inc. ("Final Analysis") May 1, 1998 Application for Clarification and Review of its license raise new technical issues and present new technical analyses. This Consolidated Engineering Statement is provided in support of the responses to these new technical issues provided in Final Analysis's Replies to ORBCOMM and Leo One, filed contemporaneously herewith. This Consolidated Engineering Statement is also supported by independent technical analyses by three separate, well-respected firms in the aerospace and telecommunications industry, as well as by a joint letter to Regina Keeney, Chief of the International Bureau, by counsel for ORBCOMM and Final Analysis, provided in the following exhibits:

Exhibit 1 - Lockheed Martin Management and Data Systems ("Lockheed Martin")

Exhibit 2 - ITT Corporation

Exhibit 3 - W.L. Pritchard & Co.("Pritchard")

Exhibit 4 – Letter dated June 2, 1998, by Aileen A. Pisciotta, counsel for Final Analysis and Stephen L. Goodman, counsel for ORBCOMM ("Joint ORBCOMM/Final Analysis Letter")

I. FINAL ANALYSIS'S PROPOSED DOWNLINK CHANGES DO NOT INCREASE POTENTIAL INTERFERENCE

Leo One provides new technical arguments to attempt to demonstrate that Final Analysis's proposed increase in downlink power is not required to achieve an acceptable margin. Leo One also asserts that an increase in Final Analysis downlink power will degrade other systems. Orbcomm raises new concerns regarding potential out-of-band interference and the need to evaluate the impact of Final Analysis's proposed use of GMSK modulation. The analysis below addresses these issues.

A. Increased EIRP is necessary for an operational system

Final Analysis has previously demonstrated in itsOctober 1997 Conforming Amendment, as well as in its December 15, 1997 Opposition to the Leo One Petition to Deny, that the increase in downlink EIRP proposed in the Conforming Amendment is necessary to enable it to have a technically operable system. This conclusion is supported by Pritchard and Lockheed Martin.

Lockheed Martin states that "the link will not close under the reasonable assumptions stated in the letter, using the licensed power." They further say "...downlink EIRP of 12.8 dBW produces a negative margin assuming all other link analysis parameters are left unchanged. Our link analysis shows closure is achieved when using the Final Analysis requested EIRP value."

Lockheed Martin also states that "...the 600 bits per second data rate used in the link analysis is significantly lower than the original and amended data rates proposed by Final Analysis. The lowering of the bit rates was done to ensure reliable link closure."

B. Increased EIRP meets ITU/NTIA limits for pfd coordination requirements

Final Analysis has stated that its requested increased EIRP will not increase the potential for interference to other users. Its pfd remains well within the established ITU and NTIA limits of -125 $dBw/m^2/4kHz$. This conclusion is supported by both Pritchard, ITT and Lockheed Martin. Lockheed Martin concludes that the pfd resulting from the increased EIRP is well within ITU limits. Furthermore, as stated by Pritchard and ITT, the pfd of the Final Analysis system operating in the band timeshared with NOAA has actually decreased.

ITT states "analysis of the revised submission shows that the revised power spectral density on the ground will actually decrease." They further state, "the potential for interference with other receivers listening on the same frequency is actually reduced from the initial submission."

C. Out of band interference has not increased

Final Analysis has previously demonstrated that its use of GMSK modulation will protect users of adjacent bands from out-of-band emissions to a level acceptable to the voice-sensitive cellular industry. ORBCOMM acknowledges that GMSK modulation tends to reduce out-of-band interference. This efficacy of GMSK modulation is also supported by the independent Pritchard and ITT analyses.

Pritchard states "on this basis, Final Analysis will cause less out-of-band interference to ORBCOMM and Leo One than they will cause to Final Analysis." Pritchard concludes that the Final Analysis system performs better than the other modulation regimes used by ORBCOMM and Leo One.

ITT reports:

> For the adjacent channel analysis, the modulation waveform used is GMSK, a waveform specifically designed for reducing potential interference in adjacent communication channels. The waveform has rapid reduction in spectral emissions away from the occupied bandwidth of the signal. Our analysis shows that the emission in the adjacent channel is significantly reduced from the peak signal level and at the power levels contemplated, the signal power in the adjacent channel will be below the detectable limits of the receiver.

Although theoretically there is always some adjacent channel signal, realistically the energy is below thermal noise and not discernable.

D. There is no harmful impact to other licensees

1. Leo One

There is no demonstrated increased potential interference to Leo One. Leo One does not offer any specific argument that it is harmed by Final Analysis's proposed increase in downlink EIRP. Indeed, since no downlink spectrum is shared with Leo One, the only potential for interference would come from out-of-band interference into the adjacent channel. As shown above, the out-of-band emissions into the adjacent channel will be below "thermal noise" and hence undetectable by Leo One's receivers.

2. ORBCOMM

There is no demonstrated increased potential interference to ORBCOMM. In the ORBCOMM/Final Analysis Joint Letter, the parties agree that out of band emissions from downlink operations can be addressed through post-licensing coordination. As is true with Leo One, no downlink spectrum is shared with ORBCOMM, and thus the only potential for interference would come from out-of-band interference into the adjacent channel. Again out-of-band emissions into the adjacent channel will be below "thermal noise" and hence undetectable by ORBCOMM's receivers.

3. E-SAT

Final Analysis's pfd in the VHF band has actually decreased. Therefore, the impact of Final Analysis operations on the CDMA system (E-SAT) is less, not more, than before. The Report & Order requires Final Analysis to coordinate operations with E-SAT in the 137-138 MHz band in the same way as would have been required for coordination with GE-Starsys. With regard to Starsys, ORBCOMM was required to reduce its power to a certain limit only when operating in the Starsys ground station antenna's main beam, and not all the time. Final Analysis will coordinate its operations in the same manner as it relates to E-SAT's system.

E. Final Analysis's change in pfd is less than that approved for Leo One

Leo One's increase in downlink EIRP approved by the Commission results in a larger increase in pfd than the increase requested by Final Analysis and denied by the Commission. The analysis presented in Leo One's Opposition is misleading. Leo One's comparison of "service link pfd" to "service link pfd" and "feeder link pfd" to "feeder link pfd" is inappropriate because it does not take into consideration changes in frequency bands. Pfd comparisons must be for a particular spectrum band. Therefore, Leo One's argument that "its downlink power increase results in the same or lower pfd" is inaccurate.

The following chart illustrates the impact on pfd per band of Final Analysis's and Leo One's EIRP changes:

Company	Band	Pending Application Pfd (dBw/m2/4kHz)	1997 Amendment Pfd (dBw/m2/4kHz)	Change/Impact
Leo One	137-138 MHz	-125.7	-125.2	Increase + 0.2 dB
	400-401 MHz	-135.9	-125.1	Increase +10.8 dB
Final Analysis	137-138 MHz	-130.8	-131.6[1]	Decrease – 0.8 dB
	400-401 MHz	-136.2	-127.8	Increase + 8.4 dB

As the chart indicates, Leo One significantly increased (by 10.8 dB) its pfd in the band it timeshares with the Air Force DMSP system (400-401 MHz), while Final Analysis decreased its pfd in the band it timeshares with NOAA (137-138 MHz). Furthermore, Leo One's increased EIRP resulted in increased pfd in both bands.

II. FINAL ANALYSIS'S PROPOSED UPLINK CHANGES DO NOT CAUSE ADDITIONAL POTENTIAL INTERFERENCE

Leo One raises the single argument that an increase in use of uplinks by the Final Analysis system will reduce the ability of Leo One to find clear channels to nearly zero. Additionally, Leo One's position on this issue in its challenges to Final Analysis's license contradicts its earlier representations in support of its own A/B Plan in Appendix B to its December 20, 1996 Comments in IB Docket No. 96-220.

Both of the Leo One and ORBCOMM positions are based upon incorrect factual assumptions regarding the number of proposed active VHF receivers and uplink throughput of Final Analysis's proposed system. Final Analysis's conclusions that no additional potential interference will be created are confirmed by the independent experts.

ORBCOMM's further argument that Final Analysis's proposed increase in uplink power may cause additional potential interference should be addressed in post-licensing coordination of their respective proprietary DCAAS and STARS channel polling algorithms. See ORBCOMM/Final Analysis Joint Letter.

A. Increase in satellites will not cause increased use of uplinks

Little LEO systems operate uplinks and downlinks interdependently, as is required by STARS/DCAAS operating methods. Uplinks are not activated unless and until they are

[1] The pfd value differs from that shown in the Conforming Amendment because it was calculated using the values for data rate and bandwidth listed in the November 12, 1997 letter from Peter Batacan, counsel to Final Analysis, to Magalie R. Salas, Secretary of the FCC. This letter supersedes the information in the Conforming Amendment. The Pritchard analysis likewise uses this value.

signaled by a downlink The FCC has previously acknowledged this in the first round ORBCOMM license where it held that the use of uplinks is constrained by limits on available downlinks -- what cannot come down will not be sent up.

Pritchard supports this view, concluding that the Final Analysis proposed uplink configuration will not cause degradation to other systems, and furthermore that Leo One has the potential to use uplink channels more than Final Analysis. Pritchard states "

> The utilization of the uplink is clearly limited by the amount of downlink capacity, which is directly related to the total downlink bandwidth assigned to System 2.

Leo One itself has previously offered this same view. In its December 20, 1996 Comments in IB Docket 96-220, Leo One proposed, in its Appendix B, two narrowband systems A and B. Leo One calculated the uplink capacity of systems A and B as a function of Orbcomm's downlink capacity. Apparently concluding that good engineering practice requires a balance of uplink and downlink capacity, Leo One stated, in Appendix B at p. 2, "since ORBCOMM had the opportunity to engineer its spectrum requirements, it is assumed that ORBCOMM's system is balanced, i.e., that the 940 kHz of shared 149 MHz uplink spectrum supports the same 1,160 mbits per day:"

B. Increased receivers on-board will not increase Final Analysis's use of shared uplinks

Leo One's argument that Final Analysis's proposed increase in uplink receivers on board to 40 will cause, by itself, increased interference in shared uplink channels is based upon factual errors.

As identified in the following chart, Final Analysis has consistently proposed 14 active receivers in the shared VHF band. Additional inactive receivers are proposed to be included in the satellite design to operate in frequency bands not yet allocated internationally or by the FCC to Little LEOs. In any event, these additional frequency bands will not involve uplink sharing with Leo One and therefore cannot increase potential uplink interference:

Receivers by Band	When Proposed	Allocation Status
14 VHF	Original Application	WRC-92 (allocated and assigned)
14 UHF	February 1996 Amendment	WRC-95 (Region 2 allocation pending)
12 (UHF & L Band)[2]	Conforming Amendment	WRC-97 and future (not allocated)

Final Analysis's proposed VHF uplinks in its Conforming Amendment remain unchanged from its pending Application.

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[2] Some of these receivers would allow Final Analysis to migrate its use of the transit band to some future allocation, vacating it for ORBCOMM as required by the *Second Round Report and Order*.

C. Uplink usage must be measured by total system throughput

Total potential uplink usage must be measured in terms of total throughput, calculated by reference to total number of satellites, receivers in the relevant uplink band, and applicable data rates on the uplink channels. An appropriate analysis of these factors demonstrates that Final Analysis's amended constellation has a lower total data throughput than its originally proposed constellation.

The originally proposed constellation had 26 satellites, each with 14 VHF receivers, operating up to 19.2 kbps. The amended constellation has 32 satellites with 14 VHF receivers operating at a lower data rate of 9.6 kbps Data throughput, as a function of these variables, is as follows:

Uplink Use Per Satellite (receivers x data rate = throughput):

Constellation	VHF Receivers	Data Rate	Throughput
Original	14	19.2 kbps	269 kbps
Amended	14	9.6 kbps	134 kbps

Uplink Use Per System (receivers x data rate x satellites = throughput):

Constellation	VHF Receivers	Data Rate	Satellites	Throughput
Original	14	19.2 kbps	26	6,989 kbps
Amended	14	9.6 kbps	32	4,301 kbps

D. Leo One's availability analysis is incorrect

Leo One refers to analyses purporting to show that Final Analysis's additional satellites and proposed uplink configuration will reduce its ability to find clear channels from 99% of the time to 1% of the time. There is no data or source given for the initial assumptions. Nonetheless, an examination of relevant factors on the record shows that there is no support for such a conclusion.

As described above, the number of uplink receivers in shared spectrum has not changed and total throughput, due to a decrease in associated data rate, has declined. The only other relevant consideration is whether the proposed increased number of satellites results in an increased number of satellites in view such that uplink availability to Leo One will be reduced.

Leo One's argument that its uplink availability will be reduced is based upon its assumption that Final Analysis's Conforming Amendment results in 1.25 Final Analysis satellites in view and that 40 receivers will be used in the 148 MHz band. However, based upon Leo One's assumptions stated in the record, this number of satellites in view is less than the number of satellites in view that affords it 98% availability.

Specifically, in connection with its proposed A/B Plan, in Appendix B at pp. 8-10, Leo One stated that competing uplink usage from ORBCOMM's system– assumed to have 1.4 satellites in view -- would provide 98% uplink capacity equal to both systems, A and B. It must be presumed that the Final Analysis 32 satellite system -- which Leo One calculates will have 1.25 satellites in view at all times – will offer less degradation than a system with 1.4 satellites in view.

In any event, using the throughput analysis outlined above, it is clear that, even taking an increase in satellites in view into account, using Leo One's own analysis factors, overall uplink usage by Final Analysis declines under the Conforming Amendment. Thus, there can be no adverse impact on uplink availability for Leo One.

Uplink Use Per Satellites in View (receivers x data rate x satellites in view = throughput):

Constellation	VHF Receivers	Data Rate	Satellites in View	Throughput
Original	14	19.2 kbps	0.67[3]	180 kbps
Amended	14	9.6 kbps	1.25	168 kbps

In all cases -- a satellite by satellite comparison, a system by system comparison, or a comparison using satellites in view --- the modified Final Analysis constellation uses less uplink in shared bands than the originally proposed constellation.

III. THE AMENDED CONSTELLATION REDUCES PROBABILITY OF FAILURE AND POTENTIAL FOR INTERFERENCE TO NOAA

A. Concerns related to footprint overlaps are unfounded

1. The possibility of interference is due to transmitters rather than footprint overlaps.

Arguments on the record that Final Analysis's constellation changes would cause interference to NOAA, particularly by Leo One, rely upon a superficial association between increased "satellites in view" and "footprint overlaps" to conclude that additional satellites in the Final Analysis constellation will increase the potential for interference. In fact, however, the potential for interference comes, not from footprint overlaps per se, but from overlaps including transmitters operating in the same band. For example, the Teledesic 288 satellite system would have many more footprint overlaps with NOAA than Final Analysis's 32 satellites but has zero potential for interference to NOAA because it has no transmitters operating in the 137-138 MHz band. Thus, an increase in footprint overlaps alone will not cause increased potential

[3] These factors of 0.67 for the original constellation is taken from Leo One's own availability analysis in its December 4, 1997 Petition to Deny Final Analysis's Conforming Amendment, at Appendix A, p. 7.

interference. Increased interference can occur only with an increase in malfunctioning transmitters operating in the same frequency as NOAA.

2. The number of transmitters was reduced

In its Application for Clarification and Review, Final Analysis showed that the reduction in the number of transmitters per satellite reduced the potential for interference. Specifically, the Original Application proposed three VHF transmitters on each of 26 satellites, for a total of 78 transmitters operating in the 137-138 MHz band. The Conforming Amendment proposes one VHF transmitter on each of 32 satellites, a reduction of 66%. Since interference only occurs if transmitters fail to operate as designed, fewer transmitters means lower possibility of failure.

B. The probability of interference has been reduced

1. NOAA's concerns were based on the possibility of failure

In the December 1997 emails from NOAA contractor Frank Eng relied upon in the Bureau Order, Mr. Eng points out that the possibility of interference due to the increased number of satellites is a function of the probability of operational failure: "If all FAI systems operated perfectly as planned there would be no grounds for concern, however, in the real world there is always a finite chance of faulty operations." In connection with Final Analysis's proposed system, however, Mr. Eng failed to note at that time that the number of transmitters in the system had been reduced from 78 to 32. This reduction in transmitters reduces the potential for failure (i.e., there are fewer transmitters to fail), which reduces the potential for interference.

2. Independent analysis verifies reduced probability of failure

Pritchard has undertaken an independent analysis of the probability of failure for Final Analysis's original and amended constellations. Pritchard concludes that the probability of failure, and consequently the potential for interference, is lower for the amended constellation compared to the original constellation. This is due to the fact that transmitters in the 137 band are reduced. Therefore, there is a reduced potential for interference, and no increased potential interference, from the additional satellites.

EXHIBIT 1

LOCKHEED MARTIN

May 29, 1998

Final Analysis, Inc.
Attn: Nader Modanlo, President
9701 E. Philadelphia Court
Lanham, Maryland 20706-4400

Dear Mr. Modanlo:

We are pleased to provide the letter that you requested, regarding the link analysis for the Final Analysis' System. We used a reasonable approach to the link analysis because we want the links to be reliable in the real environments that users will operate the service.

We specifically addressed the need for additional power, showing that the link would not close under the reasonable assumptions stated in the letter, using the licensed power. We also point that given the increased power the power flux density will stay within NTIA limits.

We believe that this provides the information that you requested, and if we can be of further assistance, please let us know.

Sincerely,

Lawrence Wharton
Program Manager, Final Analysis Program

In summary, we find that the interference potential for the Final Analysis conforming submission is not significantly different for both the in-channel and adjacent channel users. We also find that the impact on the payload architecture and design will be minimal.

Very truly yours,

William F. Perry
Director
Communications and Navigation Space Systems

Introduction - We at Lockheed Martin Management and Data Systems have analyzed the radio links proposed by Final Analysis. We have determined that the Satellite Service Downlink power level (EIRP) as specified in the License[i] is insufficient to support the associated air interface to a subscriber, when operating in an Urban Man-made noise environment.

Summary of Analysis - Your proposed system will provide narrowband digital data services to subscribers using a constellation of Low Earth Orbit (LEO) satellites. The RF links between the subscriber terminals and the satellites are in the VHF and UHF bands. For a hand-held transceiver incorporating an omni-directional antenna, RF link analysis has shown that the links are interference limited due to the large amounts of man-made interference in these bands. (Ref. ITU-R, Rec 372-6). Due to this interference, low link margins are predicted, even at low channel bit rates (<1000 bits per second). Note that the 600 bits per second data rate used in the link analysis is significantly lower than the original and amended data rates proposed by Final Analysis. The lowering of the bit rates was done to insure reliable link closure.

As shown in Table 1, your licensed (ref. FCC Order and Authorization DA 98-616 par. 66-67) downlink EIRP of 12.8 dBW produces a negative link margin assuming all other link analysis parameters are left unchanged. Our Link Analysis shows link closure is achieved when using the Final Analysis requested EIRP value. To improve link performance, more EIRP is better.

	Service Link Downlink per FA Request	Service Link Downlink per FCC License
Bit Rate(s) bps	600	600
Modulation	GMSK (BT=0.3)	GMSK (BT=0.3)
Transmitted Power (Watts)	32	10
EIRP (dBW) with respect to receiver	16.5 *	12.8
Man-Made Noise	Urban	Urban
FEC Decoder Output Bit Error Rate	1×10^{-4}	1×10^{-4}
FEC Coding	Rate 1/3, k=7, soft-decision, conv.	Rate 1/3, k=7, soft-decision, conv.
Elevation Mask (degrees)	16	16
Required E_B/N_O (dB)	5.5	5.5
Link Margin (dB)	3.33	-0.37

* 16.5 dB (vs. 17.8 dBW) was used in the Link Analysis to account for additional expected losses in the transmit path

Table 1 Licensed vs. Requested EIRP Performance

The link analysis addressed the amount of satellite EIRP required to produce a 1 dB link margin for a hypothetical Earth Station viewing a satellite from horizon to horizon. The results are plotted as required EIRP (dBW) versus Earth Station elevation angle (degrees) in Figure 1. This graph indicates that

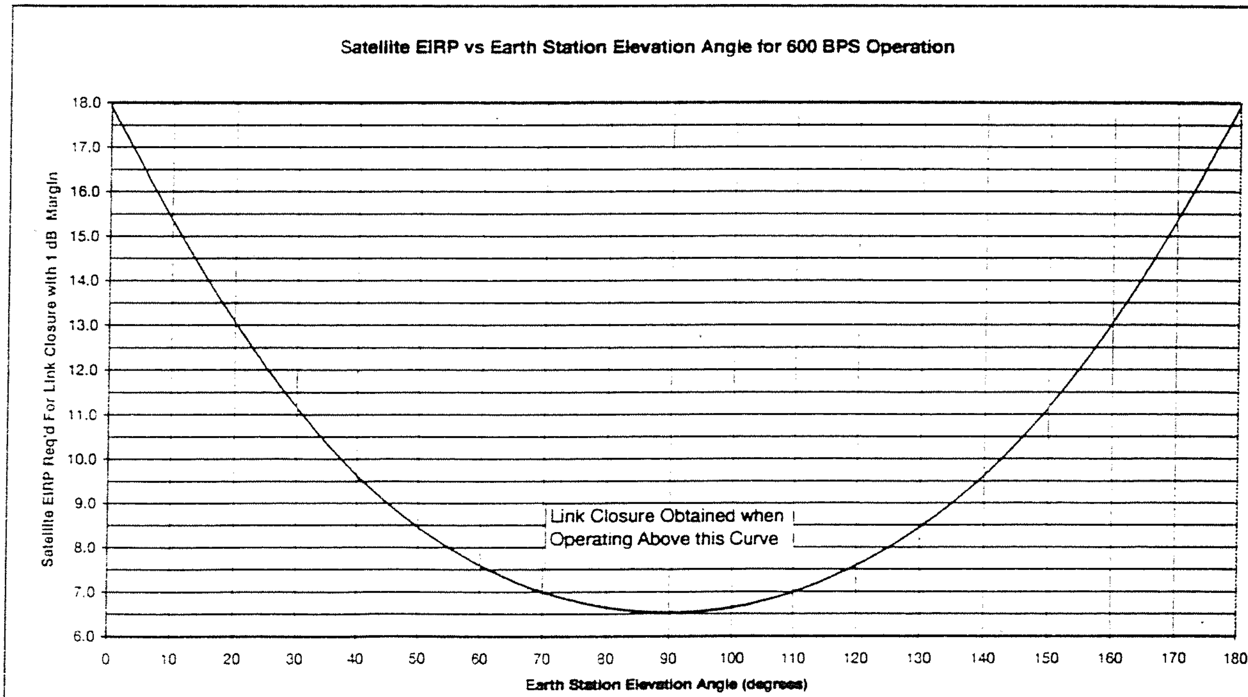

Figure 1

with 12.8 dBW EIRP, only users with elevation angles greater than 25 degrees can obtain reliable link closure. This high elevation angle severely limits coverage. Whereas, with 16.5 dBW EIRP, users can obtain reliable link closure with a more reasonable 5 degree elevation angle. When comparing 5 and 25 degree elevation angles, figure 2 indicates a reduction in satellite coverage of approximately 50 % for the 25 degree minimum elevation angle.

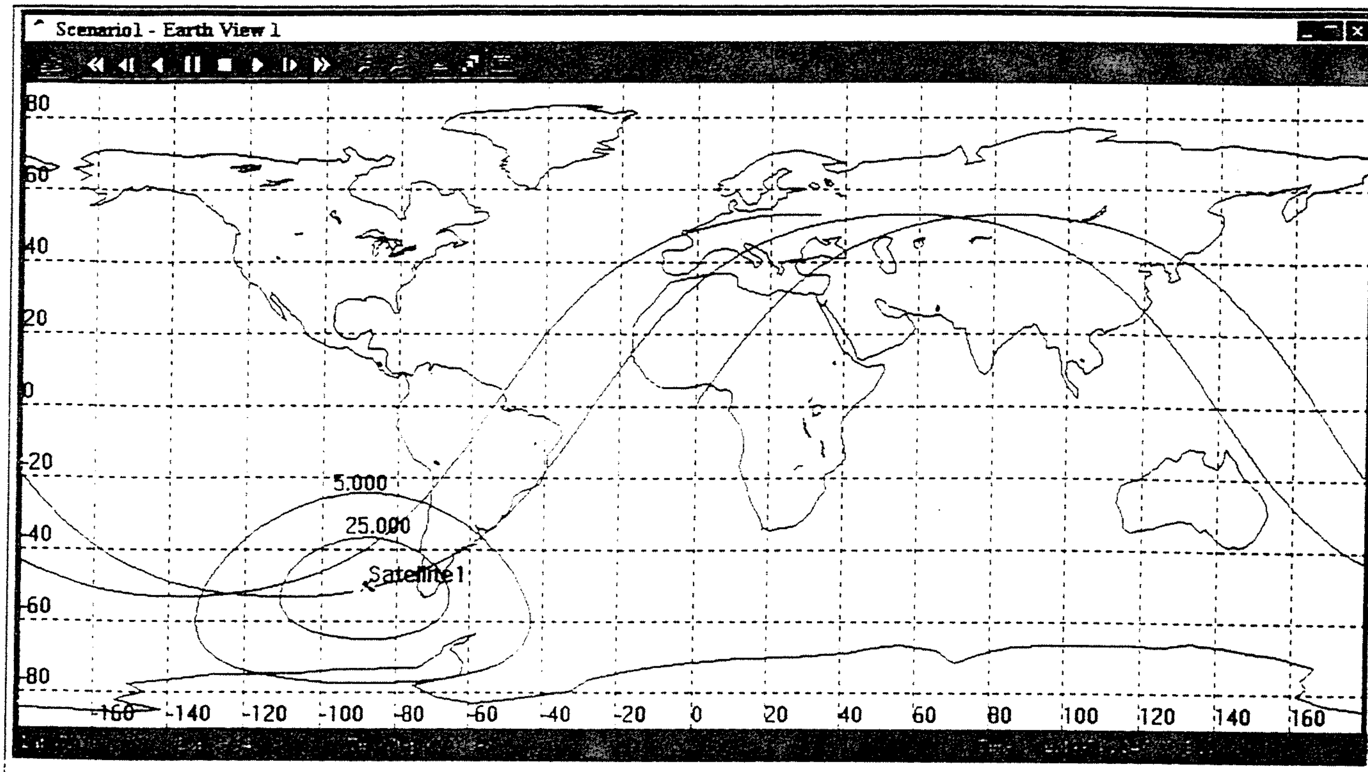

Figure 2

The link analysis also addressed compliance with the NTIA regulations 647B and 599A:

647B—The use of the band 400.15-401 MHz by the mobile satellite service is subject to the application of the coordination and notification procedures set forth in Resolution 46. However, coordination of a space station of a mobile satellite service with respect to terrestrial services is required only if the power flux density exceeds -125 dB-(W/m^2/4 kHz) at the Earth's surface. The above power flux-density limit shall apply until such time as a competent world administrative radio conference revises it. In making assignments to the space stations in the mobile satellite service in the above band, administrations shall take all practical steps to protect the radio astronomy service in the band 406.1-410 MHz from harmful interference from unwanted emissions.

599A—The use of the band 137-138 MHz by the mobile satellite service is subject to the application of the coordination and notification procedures set forth in Resolution 46. However, coordination of a space station of a mobile satellite service with respect to terrestrial services is required only if the power flux density exceeds -125 dB-(W/m^2/4 kHz) at the Earth's surface. The above power flux-density limit shall apply until such time as a competent world administrative radio conference revises it. In making assignments to the space stations in the mobile satellite service in the above band, administrations shall take all practical steps to protect the radio astronomy service in the band 150.05-153 MHz from harmful interference from unwanted emissions.

The last phase of the analysis determines the satellite EIRP required to produce the flux density limit as set forth in the regulation and compares it to the Final Analysis satellite design EIRP. The Final Analysis transmitted signal uses source data encoding techniques in conjunction with an antenna that incorporates an isoflux taper (ref. Figure II-6b of the Final Analysis

EXHIBIT 3

W. L. PRITCHARD & CO., INC.
CONSULTING ENGINEERS IN SATELLITE COMMUNICATIONS
7315 WISCONSIN AVENUE, BETHESDA, MARYLAND 20814

TEL: (301) 654-1144
FAX: (301) 654-1814
E-MAIL: wlpco@ix.netcom.com

1 June 1998

Mr. Nader Modanlo
President
Final Analysis Communication Services
9701-E Philadelphia Court
Lanham, MD 20706-4400

Dear Mr. Modanlo,

A brochure summarizing W.L.Pritchard & Co., Inc.'s engineering qualifications and extensive experience in satellite telecommunications is attached.

You had asked us several questions in connection with the application of Final Analysis Communication Services, Inc. to construct, launch and operate a non-voice, nongeostationary mobile satellite system in the 148 -150.05, 400.15-401 and 137-138 MHz frequency bands. The questions and our answers are set forth below.

Power Flux Density in the VHF Band
for the Final Analysis 26-satellite versus 32-satellite Constellations

You asked us to calculate the power flux density [PFD] in dBW/m2/4kHz of the two constellations. We found that the PFD for the smallest occupied bandwidth transmission was -130.8 dBW/m2/4kHz in the 26-satellite constellation, and -131.6 dBW/m2/4kHz in the 32- satellite constellation, a reduction of 0.8 dBW/m2/4 kHz. This improvement occurs for the smallest occupied bandwidth transmission. Larger occupied bandwidths for services through the new constellation would result in even lower PFD levels than the -131.6 value.

The calculations used a standard methodology and the following data:

	26 Satellite Constellation	32 Satellite Constellation
Transmitted Power	10W	32W
Occupancy Factor	1.5	1.5
Slant range at θ	3194.4 km	3194.4 km
Smallest occupied bandwidth	7.2 kHz	27.0 kHz
Gain at θ	+3 dB	+3 dB
Elevation angle θ	5°	5°

The input values for the 26-satellite constellation were obtained from the original Application as amended 23 February 1996.

Values for the 32-satellite constellation were obtained from the Conforming Amendment of October 1997 and smallest bandwidth as stated in the 12 November 1997 letter to Ms Magalie Roman Salas of the FCC, p. 2.

Probability of Failure

No interference would be caused to NOAA operations if the Final Analysis satellite were working as planned as its footprint entered the NOAA satellite footprint. Interference would only occur if the Final Analysis satellite failed to work as planned when its footprint intersected a NOAA satellite footprint. We were asked to consider the probability that such failed operation would occur. Final Analysis has stated that for either constellation, there is one on-board control system (computer and memory) for each satellite. The system is radiation hardened but not redundant. The control system and operating method are such that the transmitter default mode is off. That is, the transmitter will only be turned on in the VHF band by the on-board computer when the computer checks its time chart of NOAA transmissions and determines that a Final Analysis signal will not cause interference to NOAA signals. We estimate the expectation of harmful interference to NOAA VHF operation from a signal of the same frequency transmitted from either the 26-satellite or 32-satellite constellation as follows.

Let p = probability of a single failure of computer control or memory

$P(k)$ = probability of exactly k failures in n independent events.

Alternatively, the transmitter could fail in the ON mode, and cause interference if in the VHF NOAA bands.

Let q = probability of failure of a transmitter in the "ON" mode,

b = bandwidth of each transmitter in 3 transmitter/satellite case,

B = bandwidth of full transmitter in single transmitter case,

r = ratio of VHF bands to total downlink band available to FACS,
(Note that r is the same for both constellations.)

$E(\omega)$ = expected loss to NOAA of bandwidth ω.

It is reasonable to assume that all failures are independent, whether computer or transmitter.

In the 26-satellite constellation each satellite has 3 transmitters. We understand from Final Analysis that each transmitter radiates a single channel, and that when the three transmitters operate simultaneously, each uses a different portion of the downlink bandwidth. Each satellite therefore has the following expectation of lost bandwidth to NOAA:

$$E_3(\omega) = brP(1) + 2brP(2) + 3brP(3)$$
$$= 3brq(1-q)^2 + 2br(3q^2)(1-q) + 3q^2$$

After routine algebraic reduction we have:

$$E_3(\omega) = 3brq$$

where 3q is the probability of losing bandwidth br as a result of transmitter failure.

Each satellite has a single control system with its associated probability of failure p and of no failure (1-p). The original system of 26 satellites with 3(26) = 78 transmitters has a probability P_{26} of harmful interference equal to the probability of either a computer OR a transmitter failure. Since the joint probabilities of these events is negligibly small, the result is simply given by:

$$P_{26} = \text{P(any computer failure)} + \text{P(any transponder failure)}$$
$$P_{26} = [1 - \text{P(no comp failure)}] + [1 - \text{P(no lost bandwidth)}]$$
$$P_{26} = [1-(1-p)^{26}] + [1-(1-3q)^{26}]$$
$$P_{26} = 26 \cdot p + 13 \cdot 25 \cdot p^2 + \cdots + 26 \cdot 3 \cdot q + 13 \cdot 25 \cdot 3q^2 + \cdots$$

If we ignore terms in higher powers of p and q

$$P_{26} = 26p + 78q$$

We note the increased probability of interference due to 78 transmitters, but any single transmitter failure has only about b/B as much effect on lost bandwidth to NOAA when compared to a single wide band transmitter.

In the 32-satellite constellation, each satellite has one transmitter. For a total bandwidth of B, the expectation of lost bandwidth is

$$E_1(\omega) = Br \cdot P(1 \text{ failure}) = Brq \approx 3brq.$$

This is identical to the three transmitter case.

For each satellite, the probability of any failure causing interference is

$$P_1 = 1 - P(\textit{no failures})$$

$$P_1 = 1 - (1-p)\cdot(1-q) = p + q - pq.$$

For 32 satellites with only 32 transmitters we have the following probability of harmful interference:

$$P_{32} = 1 - (1-p)^{32}(1-q)^{32}$$

Ignoring higher powers we have, to a very good approximation,

$$P_{32} = 32p + 32q.$$

Considering only the effect of transmitter failure, the 32-satellite constellation has 32/78 ≈ 0.43 less likelihood of causing interference due to failure. However, since p is not zero, there is a small increase in computer failure probability, since there are 32 rather than 26 computers in this larger constellation. The combined effect is a lower probability of failure, and therefore a reduced potential for interference, for the modified constellation of 32 satellites compared to the original constellation of 26 satellites.

Increased Use of Uplink

Without onboard storage there would be no increased use of uplinks, and no increased potential for interference on the uplinks nor downlinks. What is uplinked must be immediately downlinked. The utilization of the uplink is clearly limited by the amount of downlink capacity, which is directly related to the total downlink bandwidth assigned to System 2.

With onboard storage, there is the possibility of storing some traffic information for relay later at an appropriate time and location. Such operation improves the utilization of the spectrum and orbits. We note that onboard storage capability of Leo One is larger than that of Final Analysis and as a result Leo One's use of uplink could be greater than that of Final Analysis.

Out-of-Band Emission

Only Generalized MSK signals are used in System 2. These signals have lower out-of-band emissions, with a 12 dB per octave roll off.

The Leo One and Orbcomm systems use only O-QPSK which has only 6 dB per octave roll off. They have higher likelihood of causing interference to adjacent channels.

On this basis, Final Analysis will cause less out-of-band interference to Orbcomm and Leo One than they will cause to Final Analysis.

This completes our summary of technical analyses of the FACS system.

Sincerely yours,

Wilbur Pritchard
President

OUR CLIENTS INCLUDE:

INTERNATIONAL
Alenia Spazio
Canadian Space Agency
European Space Agency (ESA)
Inmarsat
ITU
Putnam, Hayes & Bartlett, Inc.
Telespazio S.P.A.

MANUFACTURERS
Raytheon Company
Space Systems/Loral
Westinghouse

W.L. PRITCHARD & CO. INC.

NEW SYSTEMS:
AfriSpace/WorldSpace, Inc.
CD Radio, Inc.
Loral/Globalstar
Orion Network Systems Inc.
Rimsat, Ltd.
[illegible], Inc.
Tongasat
Unicom/SatTime, Inc.
USA Channel Systems

OPERATIONAL SYSTEMS
Two Way Systems
[illegible] Networks Group

LAW FIRMS
[illegible]
Venable, Baetjer & Howard

W.L. Pritchard & Co., Inc. provides technical, economic, and market analysis for new and established telecommunications ventures.

Our company focus is on innovative problem solving for the complex demands and opportunities in telecommunications now and into the 21st century. In an era of dynamic change, W.L. Pritchard & Co. Inc. provides its clients a competitive advantage through its business and engineering experts who have extensive experience in systems design and operations. Its core staff is supplemented with allied experts as required. This diversified expertise ensures a cost-effective and unbiased approach to client needs and requirements in:

- Systems Design and Engineering
- Economic and Technical Analysis
- Market Research and Demand Forecasting
- Technology Engineering Assistance and Expert Witness Testimony in Satellite Communication Litigation
- Regulatory Submissions, Satellite Coordination, and Global Satellite Communications Interference Studies
- Analysis and Recommendations of Strategies for Entrepreneurial Satellite Ventures
- Appraisal of Fair Market Value of Satellites, Transponders, and Earth Stations
- Analysis of Small Satellite Technology and Applications

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W.L. PRITCHARD & CO. INC

ENGINEERING SOLUTIONS FOR TELECOMMUNICATIONS CHALLENGES

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W.L.Pritchard & Co., Inc. provides independent and highly qualified studies in the design and operation of satellites and satellite systems, earth stations and tracking/telemetry systems, terrestrial telecommunications networks, broadcasting and cable television networks, VSAT networks, and other space and terrestrial telecommunication systems. Services include requirements analysis, technical feasibility studies, preparation of design specifications, RFP development, evaluation of vendor technical proposals, negotiations with manufacturers, construction monitoring, implementation and operation.

Economic Analysis and Appraisals
W.L.Pritchard & Co., Inc. uses its own sophisticated mathematical models and extensive business experience to evaluate costs and benefits, identify and compare investment opportunities and risks, and identify cost saving and long-term cost control.

Market Research and Demand Forecasting
The combined business and engineering expertise of W.L.Pritchard & Co., Inc. brings over 150 man-years of experience to its market research and demand forecasting. For manufacturers, operators and users of satellite and telecommunications systems, the company has conducted domestic and international market studies designed to gauge demand and competition, and has estimated potential market share. The company also constructs mathematical models to forecast satellite and terrestrial telecommunications traffic.

Technology Assessment & Expert Witness
The experienced, independent engineering team of W.L. Pritchard & Co., Inc. is ideally suited to evaluate new and competing technologies on merit and without bias, to assist entrepreneurs and venture capitalists and to resolve patent infringement issues. Recommendations are made relating to system expansion, equipment integration, upgrade reliability, and improved cost efficiency. The firm has also provided expert witness testimony and technical expertise for litigations.

Regulatory Submissions & Satellite Coordination
W.L.Pritchard & Co., Inc., as active participants in the international satellite and telecommunications community, has performed engineering studies that include interference, frequency coordination, and site surveys necessary for FCC applications. Studies, which have included work for the ITU, have been completed for communications satellite systems, cellular mobile radio telephone systems, FM radio stations, low power TV stations, and terrestrial microwave facilities.

Innovative problem solving for the complex demands and opportunities in telecommunications now and into the 21st century

W.L. PRITCHARD & CO. INC

DR. WILBUR PRITCHARD
President

WILBUR PRITCHARD is an internationally recognized telecommunications engineer. He has directed major corporations, as well as his own companies. He was an early advocate of the use of direct broadcast satellites. He established W.L. Pritchard & Company, Inc., in 1989 to provide innovative consulting and systems engineering for telecommunications systems, particularly for satellites, as an outgrowth of Satellite Systems Engineering, Inc., which he founded 21 years ago, and its successor, SSE Telecom, Inc.

Dr. Pritchard was the first Director of Comsat Labs and at the same time the United States' Delegate to the Technical Subcommittee of INTELSAT's Managing board. He came to Comsat from the Aerospace Corporation where he had led the development of military satellite communications.

Dr. Pritchard has served on task forces such as the National Academy of Sciences Space Applications Study (Chairman of the Panel on Broadcast Satellites), and NASA's Space and Earth Sciences Advisory Committee on the Scientific Uses of the Space Station.

Honors for Dr. Pritchard include memberships in the National Academy of Engineering and the International Academy of Astronautics, awards from the U.S. Air Force, AIAA, and AAS, and election as a Fellow of the IEEE and AIAA. He was inducted into the Society of Satellite Professionals International (SSPI) Hall of Fame in 1997. He is a licensed professional engineer in Maryland and Massachusetts.

W.L. PRITCHARD & CO. INC

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tel (301) 654-1144 fax (301) 654-1814

DR. PETER P. NUSPL
Senior Staff Engineer

DR. NUSPL joined W.L. Pritchard & Co. with 32 years in digital communications by satellite, primarily in program formulation and budgeting, project monitoring. He has lectured and published extensively to international engineers and management.

At INTELSAT from 1981 to 1994, he was Senior Scientific Advisor and managed and directed research on many topics related to advanced satellite communications. From 1964 to 1981 he was a Research Scientist at the Communications Research Centre, Canada.

As technical manager of numerous projects dealing with signal processing, co-author and guest editor of many papers, Dr. Nuspl has a broad overview of global preparations for processing in advanced telecommunications satellites, which includes regenerative scenarios and switching for several services.

Dr. Nuspl is an active Member of IEEE and its Committees; he serves on the Committee on Communications and Information Policy of the US Activities Board. He is an active editor of the *Int'l Journal of Satellite Communications*.

Dr. Nuspl is a co-author of the textbook *Digital Communications by Satellite, Modulation, Multiple Access and Coding* (Wiley, 1981; Keiser, 1991: also published in Japanese; JATEC, 1983).

Dr. Nuspl has a Ph.D. degree (Information Engineering) from the University of Michigan, and also holds M.A., M.S. and B.A.Sc. degrees.

W.L. PRITCHARD & CO. INC

JACK DICKS
Vice President, Engineering

MR. DICKS has over 35 years of experience in the telecommunications industry. Since joining W.L. Pritchard & Co. in 1994 he has directed communications performance, co-ordination and satellite planning efforts, and intersystem coordination under ITU procedures. In his 25 years with Comsat and INTELSAT, he supervised a wide range of communications systems designs and satellite configuration planning, and led preparation of new services and earth station specifications. He actively represented INTELSAT at ITU meetings such as the CCIR, CCITT, WARC 85/88 and WARC 92.

As INTELSAT Director of Communications Engineering and Research, he led satellite communication system design, and developed technical specifications for the INTELSAT digital services and the INTELSAT VI payload, working closely with manufacturers and users. He established INTELSAT's Technical Laboratories, and directed advanced studies and system computer models.

Mr. Dicks' ten years at Comsat included responsibility for INTELSAT IV, V and VI payload technical specifications, and a major role in introducing the Standard B and smaller antennas into the INTELSAT system. He spent twelve years with Canadian Marconi Co., COTC and Systems Sciences Corp., installing submarine cables, tropospheric scatter systems, and the Mill Village earth station.

Mr. Dicks holds a B.S. degree (Math, Physics) from Concordia University, Montreal.

W.L. PRITCHARD & CO. INC

ELLEN D. HOFF
Executive Vice President

MS. HOFF provides extensive experience and expertise in international telecommunications policy and operations, corporate planning, service demand studies, and market strategies.

In over twenty years experience at Comsat, Ms. Hoff's responsibilities included those of Vice President and General Manager of International Satellite Services, where she developed new services in consultation with the Company's customers and international partners, achieved growth in new and established services, and restructured operations to focus on customers and service quality. Ms. Hoff represented the United States on the INTELSAT Board, Budget, Charging Policy and Planning Committees. She was for two terms Chairman of the INTELSAT Advisory Committee on Planning. Her corporate development projects included assisting business units to penetrate competitive markets, and directing international demand/supply analyses. As Vice President for International Operations, she was responsible for international policy, engineering and operations, and led the development and implementation of new digital services on the INTELSAT system.

Consulting projects for U.S. and foreign clients included options to restructure a nation's international carriers, strategies for new services for an earth station manufacturer, and analyses of international private line services and carriers. Ms. Hoff has a BA from Harvard College, and an MA from George Washington University. She is currently Mid Atlantic Board President of the Society for Satellite Professionals International.

W.L. PRITCHARD & CO. INC

RODNEY A. MOORE
Staff Engineer

MR. RODNEY A. MOORE specializes in wireless broadcasting technologies, applications and manages FCC Affairs for W.L. Pritchard & Co. Inc. He is responsible for the firm's design work on wireless services, including: Multipoint Multichannel Distribution Services, Interactive Video Data Services, Low Power Television, Cellular Telephony and Paging Services.

As W.L. Pritchard & Co. Inc.'s principal in terrestrial broadcasting, Mr. Moore conducts the link analyses, prepares interference studies, designs contour coverages, determines available markets and oversees the firm's terrain studies. He is charged with the responsibility to guarantee the firm's conformance with all relevant FCC rules and regulations for these applications. Mr. Moore conducts negotiations with tower owners, equipment manufacturers, competing communications entities, and Federal Communications Commission officials. Mr. Moore has been successful in filing over one thousand telecommunications applications with the Federal Communications Commission.

Prior to joining W.L. Pritchard & Co. Inc., Mr. Moore was technical consultant to Abacus Communications Company, specialists in low power television and wireless cable.

Mr. Moore was educated at Howard University and Capital College. He holds the license for LPTV station K14IE, New Orleans, LA.

WLPRITCHARD & CO. INC

DR. ASHOK K. SINHA
Senior Staff Engineer

At W.L. Pritchard & Co., Inc. DR. SINHA has contributed to a variety of programs and projects involving domestic and international communications satellite systems and has participated in intersystem coordination and R&D activities. He is also an adjunct professor at the University of Maryland at College Park.

At INTELSAT, Dr. Sinha contributed for over 12 years to the introduction and development of new service applications for the INTELSAT global satellite system, and to its R&D and communications systems engineering programs. Previously, at COMSAT, Dr. Sinha performed modeling and analysis of several aspects of satellite communications applied to the INTELSAT system, including implementation of TDMA and SS-TDMA, and also contributed in the systems planning and analysis for the Arabsat, Satcol, Aussat, and INMARSAT systems.

Formerly, at Computer Sciences Corp., Dr. Sinha led work on theoretical modeling and enhancements applied to satellite orbit analysis methodology, reference geomagnetic field, and ionospheric scintillation. He conducted research in information theory, atomic physics and atmospheric and ionospheric modeling at University of Maryland and Goddard (NASA).

Dr. Sinha is a member of IEEE, and a recipient of the First Piero Fanti International Award from Telespazio (Italy) and INTELSAT. He has published over 50 technical reports and papers. He received an M.Sc. degree in Physics from Patna University (India) and a Ph.D. degree in Physics from University of Maryland.

WLPRITCHARD & CO. INC

JAMES R. OWENS
Senior Staff Engineer

MR. OWENS joined W.L. Pritchard and Co., Inc. with 35 years in the satellite industry, particularly in satellite proposal evaluations, contract negotiations, construction monitoring, launch readiness reviews, launches and spacecraft operation. He is Professorial Lecturer at George Washington University.

In the last of 16 years at INTELSAT, Mr. Owens led the team defining new technologies required for next-generation satellites. As Manager of Research and Development for 5 years, he formulated and ran the R&D program, and was personally active in propulsion, attitude determination and control, thermal design, power systems and mission planning. He also participated in satellite proposal evaluation and construction monitoring. Mr. Owens was Manager of Satellite Operations for 10 years, operating the 15-18 satellite in-orbit fleet, and serving as mission director for 13 INTELSAT Vs.

At Comsat Laboratories he managed the Positioning and Orientation Department for 10 years, developed attitude control and on-board propulsion systems, and participated in satellite specification, proposal evaluation and construction monitoring. From 1956 to 1965 Mr. Owens was with RCA Astro as Manager of the thermal design department.

Mr. Owens is a senior member of the AIAA and for many years was a member of the Spacecraft Systems and the Electric Propulsion Technical Committees. He holds a BSME from George Washington University and an MSME from the University of Pennsylvania.

WLPRITCHARD & CO. INC

EXHIBIT 4

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Stephen L. Goodman
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June 2, 1998

Hand Delivery

Regina M. Keeney
Chief, International Bureau
Federal Communications Commission
2000 M Street, N.W.
Washington, D.C. 20554

Re: **Final Analysis Communication Services, Inc.**, Order and Authorization to Construct, Launch and Operate Non-Voice Non-Geostationary Mobile Satellite System (File No. 7 –SAT-AMEND-98) DA 98-616 (rel. April 1, 1998)

Orbital Communications Corporation , Order and Authorization for Modification Of Authorization to Construct Launch and Operate Non-Voice Non-Geostationary Mobile Satellite System (File No. 8-SAT-AMEND-98) DA 98-617 (rel. March 31, 1998)

Dear Ms. Keeney:

This letter is jointly filed on behalf of Final Analysis Communication Services, Inc. (Final Analysis" and Orbital Communications Corporation ("ORBCOMM") (referred to collectively as the "Parties") with respect to the above captioned Little LEO licenses. Specifically, this letter is to notify you that, on Friday, May 29, 1998, representatives of Final Analysis and ORBCOMM met to continue discussions on the coordination of their two systems. Particularly with reference to ORBCOMM's May 18, 1998 Comments ("ORBCOMM Comments") on Final Analysis's May 1, 1998 Application for Clarification and Review of its license ("Final Analysis Request"), the following points were agreed upon:

- **Downlinks**: Both Parties anticipate that coordination between the two systems on downlink operations can be resolved through the sharing of information with respect to operational parameters acceptable to ORBCOMM under international standards and specification of Final Analysis's proposed downlink operations, including out-of-band emissions. The Parties have agreed to exchange the necessary information over the next few weeks with the expectation that coordination on downlink issues will be resolved as soon as possible.

- **Uplinks**: The Parties acknowledge that coordination of uplink operations in the 148-149.9 MHz band will require substantial effort over an extended period of time, and will require the review of certain proprietary information, including DCAAS and STARS algorithms and frequency scanning data from real-world observations.

  - To begin the process, the Parties have agreed to engage an independent third party expert to perform the necessary technical analyses on a proprietary basis. The Parties will, over the course of the next couple of weeks, suggest names of companies that may be invited to bid on this work.

  - The Parties also have agreed to coordinate on a statement of work that will guide the independent coordination analysis and to provide their respective proprietary algorithms and data, on a confidential basis, to the independent contractor.

In addition to the coordination steps agreed upon as outlined above, the Parties shared the following observations about comments that have been placed in the record with respect to Final Analysis's Request as well as ORBCOMM's March 16, 1998 Application for Review of the NVNG MSS license granted to Leo One USA Corporation ("Leo One"), DA-98-238 (rel. February 15, 1998) and Leo One's April 30, 1998 Application for Review of ORBCOMM's license:

- Effective uplink coordination is dependent upon resolution by the Commission of the issues raised by ORBCOMM concerning its rights, under Section 25.142(a) of the Commission's Rules, 47 C.F.R.§ 25.142(a), to interference protection as a first round licensee.

- The coordination steps outlined by the Parties above ultimately must involve Leo One as well. Contemporaneously with the submission of this letter, the Parties are inviting Leo One to participate in these coordination activities.

Respectfully,

Aileen A. Pisciotta
Counsel for Final Analysis Communication Services, Inc.

Stephen L. Goodman
Counsel for Orbital Communications Corporation

cc: Attached Service List

CERTIFICATION OF ENGINEER

I, David W. Grimes, Chief Engineer, Final Analysis, Inc., by my signature affixed below, hereby certify, pursuant to Section 1.16 of the Commission's rules, 47 C.F.R. § 1.16, that:

(1) I am the technically qualified person responsible for preparation of the engineering information contained in the foregoing Consolidated Engineering Statement;

(2) I am familiar with the Commission's rules set forth in Part 25 of Title 47 of the Code of Federal Regulations;

(3) I have either prepared or reviewed the engineering information submitted in the foregoing Consolidated Engineering Statement; and

(4) I certify under penalty of perjury that the foregoing is true and correct to the best of my knowledge.

David W. Grimes, Chief Engineer
Final Analysis Inc.

CERTIFICATE OF SERVICE

I, Beatriz Viera, hereby certify that a true and correct copy of the foregoing "**Reply**" to Orbital Communications Corp. on behalf of Final Analysis Communication Services, Inc. was delivered by hand or regular mail this 2nd day of June 1998, to each of the following:

Chairman William E. Kennard*
Federal Communications Commission
1919 M Street, N.W., Room 814
Washington, D.C. 20554

Commissioner Gloria Tristani*
Federal Communications Commission
1919 M Street, N.W., Room 826
Washington, D.C. 20554

Commissioner Harold W. Furchtgott-Roth*
Federal Communications Commission
1919 M Street, N.W., Room 802
Washington, D.C. 20554

Commissioner Susan Ness*
Federal Communications Commission
1919 M Street, N.W., Room 832
Washington, D.C. 20554

Commissioner Michael K. Powell*
Federal Communications Commission
1919 M Street, N.W. Room 844
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Mr. Thomas Tycz*
Chief Satellite Division
Federal Communications Commission
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Ms. Cassandra Thomas*
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Office of Radio Frequency Management
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Mr. William T. Hatch
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U.S. Department of Commerce
National Telecommunications and Information Administration
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Office of General Counsel
National Atmospheric and Oceanic Adm.
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B. Viera

Beatriz Viera

* Hand Delivered