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

NARRATIVE STATEMENT OF THE BOEING COMPANY TO ITS APPLICATION FOR NEW EXPERIMENTAL RADIO STATIONS IN THE 81-86 GHz BAND FCC FORM 442, EXHIBIT 1

Robert Catania, Esq.
Counsel
Boeing Satellite Systems, Inc.
2260 E. Imperial Highway
El Segundo, CA 90245-0902

David A. Nall
Mark D. Johnson
Squire, Sanders & Dempsey L.L.P.
1201 Pennsylvania Avenue, N.W.
P.O. Box 407
Washington, D.C. 20044-0407
(202) 626-6600

Its Attorneys

March 29, 2002

The Boeing Company ("Boeing"), by its attorneys and pursuant to Section 5.63 of the Commission's Rules (47 C.F.R. § 5.63), hereby presents its narrative statement to the Application for New Radio Stations Under Part 5 of the FCC Rules - Experimental Radio Service (Other Than Broadcast) ("*Application*"). For the reasons set forth herein, Boeing respectfully requests the Commission grant Boeing as soon as possible an experimental license for an innovative, fixed wireless, gigabit, point-to-point technology using nonutilized and underutilized commercially-available upper millimeter-wave frequencies above 70 GHz[1]. The license will allow this high-speed digital data communications technology, which can complement and compete with fiber, to be expeditiously developed, validated, and ultimately deployed, particularly in rural and suburban areas.

I. OBJECTIVES

Boeing plans to use the experimental license to conduct the following: technical demonstrations of equipment or techniques (47 C.F.R. § 5.3(d)); demonstration of equipment to prospective purchasers by persons engaged in the business of selling radio equipment (47 C.F.R. § 5.3(f)); testing of equipment in connection with production or regulatory approval of such equipment (47 C.F.R. § 5.3(g)); development of radio technique, equipment, operational data or engineering data related to an existing or proposed radio service (47 C.F.R. § 5.3(i)), and limited market studies (47 C.F.R. § 5.3(j)). Specifically, Boeing first intends to demonstrate the performance of its recently developed and refined fixed wireless high data rate systems to potential customers at various venues including trade shows. Second, Boeing plans to provide the results of its nationwide experiments to the FCC and industry in a joint effort to develop and establish

[1] Boeing has concurrently submitted three companion Limited Market Study applications, each in a different upper millimeter-wave frequency band (the first at 71-76 GHz, the second at 81-86 GHz, and the

service rules for the fixed services in the upper millimeter-wave frequencies,[2] and additionally, to pursue permanent FCC authorizations for the operation of its innovative systems. Third, Boeing expects to gain invaluable operational and engineering data from the experiments that will help Boeing to further improve its research in fiber-like, fixed service communications systems. And, finally, through a limited market study, Boeing hopes to learn insights on customer requirements and demand for these novel gigabit point-to-point upper millimeter-wave systems.

II. EXPERIMENTATION PROGRAM

To achieve these objectives and for the technical and customer reasons as described below, Boeing respectfully requests a two-year, nationwide blanket license for 100 experimental units. Under the blanket license, in accordance with Section 5.75 of the Commission's Rules (47 C.F.R. § 5.75), Boeing will facilitate any necessary frequency coordination by notifying the Commission, and as appropriate the National Radio Astronomy Observatory in accordance with Section 5.91 (47 C.F.R. § 5.91), of specific details of individual experiments.[3] Also, to facilitate any coordination issues pertaining to this specific application with the National Telecommunications and Information Administration ("NTIA") regarding potential operational government systems in the 81-86 GHz frequency band, Boeing may perform experiments, if necessary, outside a buffer zone around certain military bases or other government properties as specified by the

---

last at 92-100 GHz).

[2] *In the Matter of Service Rules for the Point-to-Point Use of the 71.0-76.0 GHz and 81.0-86.0 GHz Bands*, Petition for Rulemaking, Loea Communications Corporation, RM-10288 (rel. September 27, 2001).

[3] If there are any Radio Astronomy ("RA") activities in the requested spectrum at the following fourteen RA sites, Boeing will actively engage the RA community to work out any sharing arrangement prior to performing experiments that will interfere with the operations of those sites. The fourteen RA sites are as follows: Goldstone, CA; Green Bank, WV; Socorro, NM; St. Croix, VI; Hancock, NH; North Liberty, IO; Ft. Davis, TX; Los Alamos, NM; Pie Town, NM; Kitt Peak, AZ; Owens Valley, CA; Brewster, WA; Mauna Kea, HI; and Westford, MA.

FCC or NTIA.[4] However, at the request of authorized government users, Boeing would also perform its experiments inside the buffer zone or directly on government properties.

Boeing intends to perform real-world experiments with business, commercial, industrial, scientific, medical, government, and other entities by deploying systems at a variety of locations. Moreover, Boeing believes a two-year nationwide license is the simplest regulatory mechanism for this type of experiment because, as testing progresses, Boeing expects its equipment to evolve and transform as valuable information on performance and customer acceptability in different rain regions and other circumstances is collected and assessed.

Boeing is in discussions with a number of entities who have shown interest in participating in fixed wireless upper millimeter-wave experiments to validate immediately a number of currently available applications that can potentially benefit from such innovative high-speed digital data communication technology in rural, suburban, and urban environments. Boeing and possible participants are also interested in real-world equipment performance and reliability in different rain regions at various rain rates. As experimental opportunities present themselves, and to the extent practical, Boeing plans to perform experiments in Crane rain regions A, B1, B2, C, D1, D2, D3, E, F, and H, covering all of the United States. Boeing anticipates encountering different precipitation conditions, including rain rates ranging from 0.25, 1.25, 5, 25, 50, 100 to 150 mm/hr as well as snow and sleet.

---

[4] The buffer zone can be up to a distance of 20 km from a specified boundary within or from the perimeter of a government property as defined by the FCC or NTIA. The concept of buffer zone or the 20 km distance should not be construed as de facto sharing criteria between or among government and commercial systems. Boeing is presently developing sharing techniques and criteria for intra-service and inter-service sharing situations in the requested spectrum, and would like to work with the FCC, NTIA, and other government and commercial entities to develop the most appropriate sharing mechanisms for the upper millimeter-wave frequencies above 70 GHz.

Another reason for testing in as many rain zones and different rain rates as possible is that Boeing has recently received from the Radio Communications Research Unit at Rutherford Appleton Laboratory in the United Kingdom data on upper millimeter-wave propagation loss due to precipitation effects,[5] which do not preliminarily align with the results from existing FCC and ITU predictive models.[6] As a result, Boeing believes that authorization of 100 experimental units is crucial for collecting sufficient data about its systems' propagation characteristics. Boeing plans to make available the real-world statistics collected from its communications experiments in multiple rain regions to appropriate technical bodies so that propagation experts can examine the assembled data, validate existing models, and, if necessary, recommend appropriate changes.

III. SYSTEM DESCRIPTION

Boeing's experimental systems will operate various digital signals in the 81-86 GHz frequency band. The data rates will typically range from OC-24 (1.244 Gbps) to OC-192 (10 Gbps). The transmitted signals will be phase modulated with effective radiated powers ranging from approximately 25 dBW to 57 dBW depending on antenna sizes, which range from 15 cm (6 in) to 90 cm (36 in). The systems' transmitted power will be in full compliance with the Commission's rules on radiofrequency radiation exposure limits: 5.0 mW/cm^2 power density for occupational/controlled exposures and

---

[5] *Report on Analysis of 500 m Range Data*, Project Report D28-3, K. S. Paulson and C. J. Gibbins, Radio Communications Research Unit, Rutherford Appleton Laboratory, United Kingdom, (June 2001) ("At all the millimeter-wave frequencies, the ITU-R model underestimated attenuation due to rainfall despite the excellent agreement between the rain rate model in ITU-R Recommendation P.837-2 and rain rate measurements made by the distrometer and rain gauge. This suggest that the ITU-R rain attenuation model may not be adequate at these frequencies."), pp. 9-10.

[6] *Millimeter Wave Propagation: Spectrum Management Implications*, Bulletin Number 70, Office of Engineering and Technology, Federal Communications Commission (July 1997); *Specific Attenuation Model for Rain for Use in Prediction Methods*, ITU-R Recommendation P.838-1 (October 1999); *Propagation Data and Prediction Methods Required for the Design of Terrestrial Line-of-Sight Systems*, ITU-R Recommendation P.530-9 (February 2001).

1.0 mW/cm^2 power density for general population/uncontrolled exposures, as specified in Section 1.1310 of the FCC's Rules (47 C.F.R. § 1.1310). Figure 1 below illustrates graphically how some of Boeing systems will comply with the Commission's human exposure limits based on preliminary OET Bulletin 65 calculations.[7]

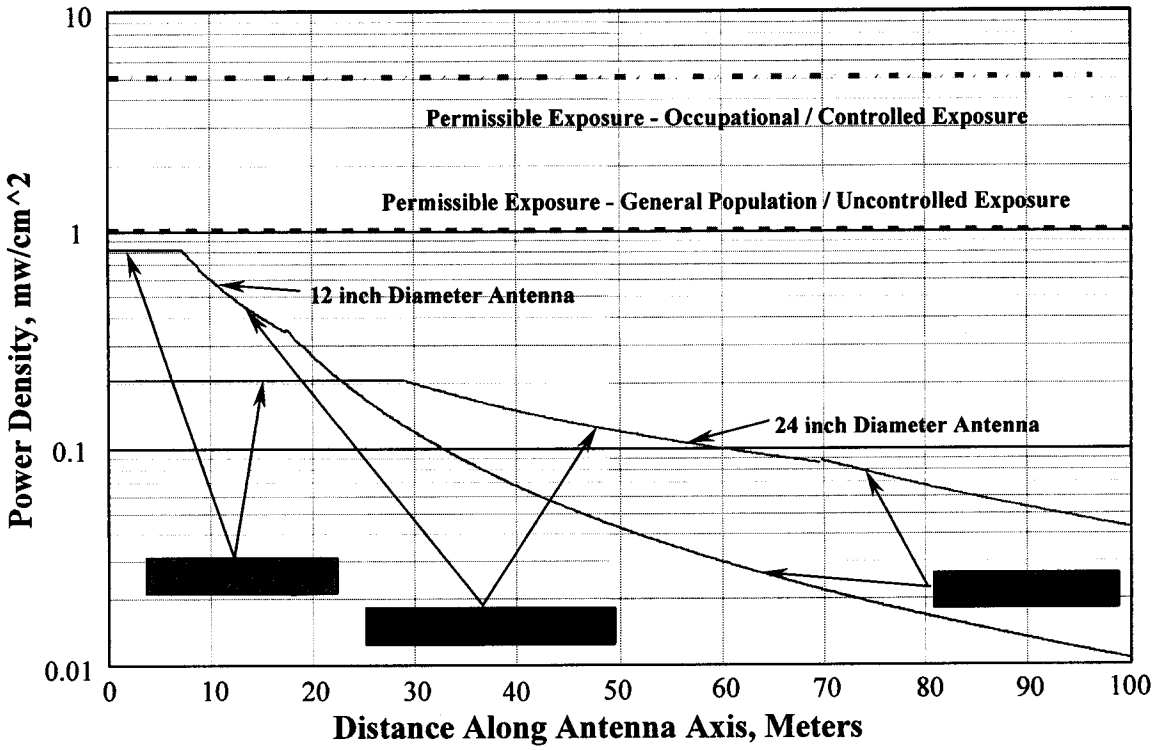

Figure 1. Preliminary Data on Human Exposure Limit Compliance.

A summary of the technical specifications of Boeing's equipment is as follows:

Frequency:	81-86 GHz
Effective Radiated Power:	25 - 57 dBW
Emission Designator:	G1D

[7] *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields*, OET Bulletin 65, Edition 97-01, Office of Engineering and Technology, Federal Communications

Necessary Bandwidths:	0.3 - 4.5 GHz
Modulation:	Phase modulated
Antennas:	15 - 90 cm

Upper millimeter-wave antennas occupy very narrow beamwidths, approximately on the order of 1.77° for a 15 cm antenna and 0.29° for a 90 cm antenna, which characteristics would facilitate co-frequency sharing between systems that are designed for limited distance, point-to-point communications. As various experimental opportunities arise based on different customer requirements and in diverse weather conditions, Boeing will be able to examine a variety of sharing situations not just among similar fixed service systems, but also between the Boeing systems and systems in other services.

Detailed analysis preliminarily suggests that co-frequency sharing can be achieved through simple spatial and angular separation. Although more study is needed, under certain conditions collocated transmitters only need as few as five to 10 degrees of angular separation to avoid interference. The planned experiments will enable Boeing to validate these preliminary analytical results with real-world data. Consequently, Boeing believes a greatly improved understanding of compatibility issues will be developed and will also result in practical recommendations on sharing rules for the upper millimeter-wave frequencies between and among different user groups.

Of course, Boeing will clearly inform participants in the experiments that all equipment operations must not cause harmful interference to any authorized, non-experimental systems, and must accept any interference from the same systems. Should

---

Commission (August 1997).

interference occur to another system, Boeing would immediately take steps to mitigate any interference, or if necessary, cease operation.

IV. LIMITED MARKET STUDY

In conjunction with the experiments and pursuant to Sections 5.3 (j) and 5.93 of the Commission's Rules (47 C.F.R. §§ 5.3(j) and 5.93), Boeing hereby requests the Commission's authorization to conduct a limited market study ("LMS") to determine customer demand for and acceptability of this innovative fiber-like technology in various deployment scenarios. Based on current market research, Boeing believes there could be over a $1 billion global market for fixed wireless gigabit point-to-point communications systems. To justify the substantial investment required to pursue this opportunity, it is critically important to validate customer demand and acceptability. Boeing expects factual findings from the experimental study will provide guidance on the efficient usage, including frequency sharing and spectrum reuse, of the precious upper millimeter-wave spectrum not just to Boeing, but also to third parties, including customers, service providers, and equipment manufacturers who may have an interest in using the upper millimeter-wave frequencies.

Boeing will conduct the LMS with the assistance and voluntary participation of a number of prominent telecommunications service providers, as well as new entrepreneurial companies with their own novel applications. Working together, Boeing and these companies will choose deployment options, collect data, and evaluate experimental results. As different users approach the market with unique and diverse applications ranging from alternative solutions to fiber access to backhaul solutions for remote broadband access, the need for a comprehensive and thorough market study is

further underscored. Without doubt, Boeing believes an LMS will provide important insights on the value of the vital upper millimeter-wave spectrum that has the sufficient bandwidth to provide gigabit fiber-like communications to commercial and government users in rural, suburban, and urban areas. Last, Boeing believes the results from an LMS will provide great assistance in any FCC rulemaking on what should be the most appropriate regulatory approaches for the upper millimeter-wave frequencies.

Boeing will not profit from the LMS; however, because of the scientific and research necessity to set up and maintain a number of transmit and receive sites in various rain regions over a period of time, Boeing and other participants will share the cost of the real-world experiments.[8] After considerable investigation, Boeing believes 100 units will be sufficient to collect the necessary technical data, validate market demand and requirements, and to allow for some economies of scale during initial equipment and system fabrication.[9] While it is not Boeing's intention to begin mass production of these units until service rules have been established and the market validated, achieving some initial economies of scale will enable the recurring costs of each deployment to be kept sufficiently low to attract the participation of a minimum number of users and to allow the study to collect comprehensive and accurate data. As the Commission understands, companies can no longer afford to make large financial investments in telecommunications infrastructure based on untested assumptions of actual costs and/or customer demand. However, it will be expressly understood by all participants that the prototype communications equipment used in the experiments will remain the property of Boeing during and after the experiments. Boeing will further

[8] A business case for cost sharing is included with this application.

inform all participants that equipment operation is for experimental purposes only under an FCC experimental license, which can be cancelled at any time.

V. CONCLUSION

By authorizing the experimental license, the FCC will allow upper millimeter wave spectrum systems to be evaluated on the same basis as fiber and free space optical (i.e., lasercom) systems, which are not similarly regulated. Boeing believes a two-year license covering a limited number of 100 units without the sale of any equipment is sufficiently restricted so that the limited market study goals can be achieved, all without setting a major precedence and without limiting future use of the underutilized upper millimeter-wave spectrum. In short, by granting Boeing the requested experimental license, the Commission will permit Boeing to contribute significantly to the development, extension, expansion, and utilization of the radio art in the public interest.

Respectfully submitted,

THE BOEING COMPANY

By: 

Robert Catania, Esq.
Counsel
Boeing Satellite Systems, Inc.
2260 E. Imperial Highway
El Segundo, CA 90245-0902

David A. Nall
Mark D. Johnson
Squire, Sanders & Dempsey L.L.P.
1201 Pennsylvania Avenue, N.W.
P.O. Box 407
Washington, D.C. 20044-0407
(202) 626-6600

Its Attorneys

March 29, 2002

[9] The combined limit on the number of experimental units will be 100 units for all three LMS applications at the bands: 71-76 GHz, 81-86 GHz, and 92-100 GHz.

Bravo Limited Market Study in 81- 86 GHz Demonstration Parameters	
Nature of Service	Experimental
Class of Station	XD FX
Call Signs	
File Number	
Authorization Period	From **6/1/02** through **5/31/04**
Purpose of Operation	Demonstration of wide bandwidth data r.f. link performance and evaluation of market interest
Station Locations	Nationwide
Typical Site Characteristics	Seal Beach (ORANGE), CA - NL 33-45-24; WL 118-05-03 (NAD 27)
	2201 Seal Beach Blvd, Seal Beach, CA 90740 (Bldg. 80)
	Height to tower tip - 2 m
General Site Requirements	Range of Site Characteristics
	Any geolocation site completing satisfactory screening and coordination
	</= 6 meters above ground, or roof top, and no high antenna structures

Limited Market Study Parameters 1 (81-86 GHz).xls

Station Frequency Information	
Antenna Beam Width	0.29 degrees (3 ft. diameter @ 81 GHz)
Lower Frequency	81 GHz
Upper Frequency	86 GHz
Station Class	FX
Freq./Emission Designator	266MG1D, 366MG1D, 733MG1D, 442MG1D, 1G07G1D, 1G29G1D, 2G14G1D, 2G26G1D, 4G53G1D
Modulating Signal	Phase modulation
Polarization	Dual circular
Authorized Power (ERP)	</= 451666 W
Frequency Tolerance (+/-)	0.06%
Antenna Beam Width	0.44 degrees (3 ft. diameter @ 81 GHz)
Lower Frequency	81 GHz
Upper Frequency	86 GHz
Station Class	FX
Freq./Emission Designator	266MG1D, 366MG1D, 733MG1D, 442MG1D, 1G07G1D, 1G29G1D, 2G14G1D, 2G26G1D, 4G53G1D
Modulating Signal	Phase modulation
Polarization	Dual circular
Authorized Power (ERP)	</= 89218 W
Frequency Tolerance (+/-)	0.06%
Antenna Beam Width	0.88 degrees (3 ft. diameter @ 81 GHz)
Lower Frequency	81 GHz
Upper Frequency	86 GHz
Station Class	FX
Freq./Emission Designator	266MG1D, 366MG1D, 733MG1D, 442MG1D, 1G07G1D, 1G29G1D, 2G14G1D, 2G26G1D, 4G53G1D
Modulating Signal	Phase modulation
Polarization	Dual circular
Authorized Power (ERP)	</= 5576 W
Frequency Tolerance (+/-)	0.06%
Antenna Beam Width	1.77 degrees (3 ft. diameter @ 81 GHz)
Lower Frequency	81 GHz
Upper Frequency	86 GHz
Station Class	FX
Freq./Emission Designator	266MG1D, 366MG1D, 733MG1D, 442MG1D, 1G07G1D, 1G29G1D, 2G14G1D, 2G26G1D, 4G53G1D
Modulating Signal	Phase modulation
Polarization	Dual circular
Authorized Power (ERP)	</= 348 W
Frequency Tolerance (+/-)	0.06%

Carrier Frequency GHz.	Bandwidth MHz.	Data Rate MBps	Data Mode	Signal Designator
81	266	155.52	OC-3 Coded BPSK	266MG1D
Minimum	266	311.04	OC-6 Coded QPSK	266MG1D
	366	1244.16	OC-24 Coded 16QAM	366MG1D
	733	2488.32	OC-48 Coded 16QAM	733MG1D
	442	1500	HDTV Coded 16QAM	442MG1D
	1066	1244.16	OC-24 Coded QPSK	1G07G1D
	1285	1500	HDTV Coded QPSK	1G29G1D
	2132	2488.32	OC-48 Coded QPSK	2G14G1D
Maximum	2266	4976.64	OC-96 Anlog Coded 16QAM	2G26G1D
86	4530	9953.28	OC-192 Anlog Coded 16QAM	4G53G1D

Table of Gain, Maximum Power, and ERP for Different Antenna Sizes and Frequencies

freq GHz	w-length meters	D meters	Gmax	Gmaxdb db	BeamW deg	Pmax Watts	Pactual Watts	ERPmax Watts	ERPfiled Watts
100	0.00300	0.9144	687686.03	58.37	0.24	2.19	1.64	917882.41	688411.81
100	0.00300	0.6096	305638.23	54.85	0.36	0.97	0.73	181310.11	135982.58
100	0.00300	0.3048	76409.56	48.83	0.72	0.24	0.18	11331.88	8498.91
100	0.00300	0.1524	19102.39	42.81	1.43	0.06	0.05	708.24	531.18
92	0.00326	0.9144	582057.45	57.65	0.26	2.19	1.64	776895.67	582671.75
92	0.00326	0.6096	258692.20	54.13	0.39	0.97	0.73	153460.87	115095.66
92	0.00326	0.3048	64673.05	48.11	0.78	0.24	0.18	9591.30	7193.48
92	0.00326	0.1524	16168.26	42.09	1.56	0.06	0.05	599.46	449.59
86	0.00349	0.9144	508612.59	57.06	0.28	2.19	1.64	678865.83	509149.37
86	0.00349	0.6096	226050.04	53.54	0.42	0.97	0.73	134096.95	100572.72
86	0.00349	0.3048	56512.51	47.52	0.83	0.24	0.18	8381.06	6285.79
86	0.00349	0.1524	14128.13	41.50	1.67	0.06	0.05	523.82	392.86
81	0.00370	0.9144	451190.80	56.54	0.29	2.19	1.64	602222.65	451666.99
81	0.00370	0.6096	200529.25	53.02	0.44	0.97	0.73	118957.56	89218.17
81	0.00370	0.3048	50132.31	47.00	0.88	0.24	0.18	7434.85	5576.14
81	0.00370	0.1524	12533.08	40.98	1.77	0.06	0.05	464.68	348.51
76	0.00395	0.9144	397207.45	55.99	0.31	2.19	1.64	530168.88	397626.66
76	0.00395	0.6096	176536.64	52.47	0.47	0.97	0.73	104724.72	78543.54
76	0.00395	0.3048	44134.16	46.45	0.94	0.24	0.18	6545.29	4908.97
76	0.00395	0.1524	11033.54	40.43	1.88	0.06	0.05	409.08	306.81
71	0.00423	0.9144	346662.53	55.40	0.34	2.19	1.64	462704.52	347028.39
71	0.00423	0.6096	154072.23	51.88	0.50	0.97	0.73	91398.42	68548.82
71	0.00423	0.3048	38518.06	45.86	1.01	0.24	0.18	5712.40	4284.30
71	0.00423	0.1524	9629.51	39.84	2.02	0.06	0.05	357.03	267.77