EXHIBIT I

FCC Submittal for Consideration of a Experimental OmniTRACS C-Band Operation in USA:

Introduction

This document presents an interference assessment of OmniTRACS C-Band systems for foreign applications. These analyses are prepared for the purpose of obtaining type approval or blanket license approval of as many as 20,000 terminals, or more depending on satellite capacity, in the host country. A corresponding document for Ku-Band was submitted by Eutelsat to the CEPT (European Conference of Posts and Telecommunications) in **OMNITRACS MOBILE COMMUNICATION TERMINAL, TECHNICAL DEFINITION FOR THE EUTELTRACS SYSTEM,** Volume I Technical Definition, Section 5 Interference Assessment, EMC, EMI, 12-Dec-1990. In preparation for a C-Band system in Brazil, and elsewhere, a similar analysis is provided for consideration of an experimental license in the USA for development and testing locally in San Diego CA. Since the OmniTRACS C-Band is identical in form and function to the Ku-Band system, this analysis addresses only the mobile transmit issues of the FCC application that change for the C-Band system. The discussion addresses interference analysis for the proposed C-Band transmit bandwidth, earth mobile terminal to space, covering 5.9 GHz to 6.4 GHz.

In this document, the analysis addresses a 2° satellite spacing allowed for domestic satellites. The analysis is also correct for a 3° satellite spacing anticipated for use with mobiles operating in foreign territories with foreign satellites. Performance to a 3° spacing can be seen by referring to Figure 9 where the OmniTRACS power density profile clearly shows that it exceeds the FCC guideline mask used at Ku-Band for interference at 2° and 3° satellite spacing. In this analysis, QUALCOMM demonstrates that the OmniTRACS C-Band power density falls below all relevant interference masks, especially at 2° required for experimental trials in the USA. It should be noted that the C-Band peak power density is -3 dBW/4kHz whereas the corresponding domestic OmniTRACS Ku-Band peak power density (see OmniTRACS FCC License Application) is 3 dB higher at 0.2 dBW/4kHz[1]. Hence, QUALCOMM is confident that the potential interference from the C-Band experimental system will be half the level of the Ku-Band OmniTRACS system. Also note that the Reference Bandwidth used within this document is 4 kHz rather than the 40 kHz bandwidth used by international requirements and the CCIR.

Antenna patterns of the patch array antenna for the mobile terminal are given on the following page for reference. The antenna pattern is similar to the fan beam shape as in the OmniTRACS Ku-Band. The elevation beam width is wide and elongated relative to the azimuth beam width to accommodate the wide variety of elevation directions from the various mobile locations in the network toward the satellite. The azimuth pattern is made as narrow as possible to provide adequate gain for the links and to provide directivity for tracking and pointing functions. The first figure shows the receive (solid) and the transmit (dashed) for the elongated elevation beam pattern. These two beams have different beam width.

---

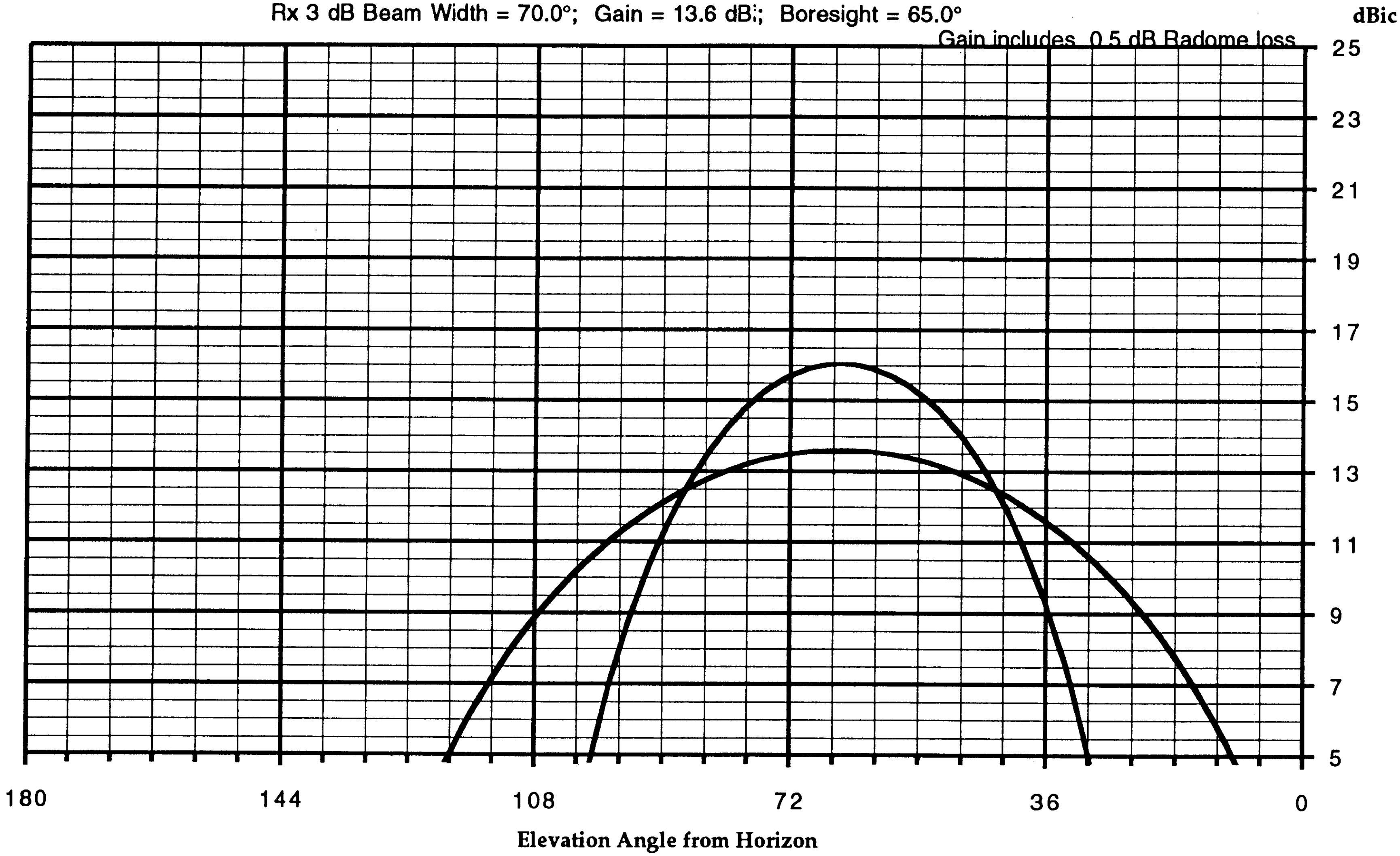
[1]See Attachment 4 of the OmniTRACS FCC Application, Technical Exhibit for Technically Identical Remote Small Antennas in VSAT Networks; pages 2-3.

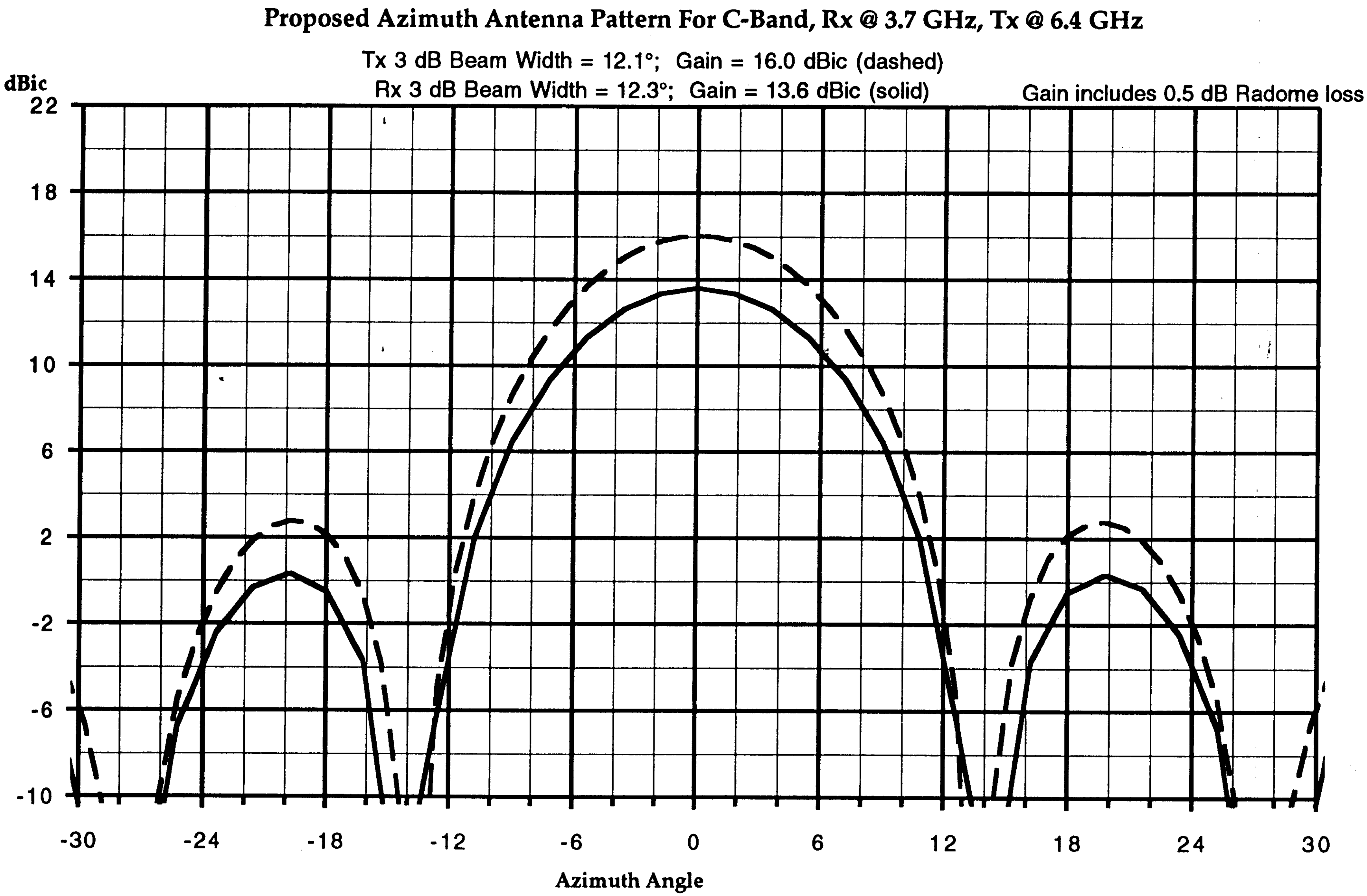
In azimuth, the antenna design will match both receive and transmit beam widths so that the tracking functions will track on a similarly shaped receive pattern as is transmitted. Typical passive antennas (reflector type) are difficult to tune in this way for both receive and transmit bands considered (3.7 - 4.2 GHz Rx, 5.9 - 6.4 GHz Tx) and results in a receive azimuth pattern nearly twice the width as the transmit pattern. QUALCOMM has incorporated state-of-the-art patch array technology to achieve a more controlled design and maintain a small size for the mobile application.

Elevation Antenna Pattern For C-Band, Rx @ 3.7 GHz, Tx @ 6.4 GHz

Tx 3 dB Beam Width = 40.5°; Gain = 16.0 dBi; Boresight = 65.0°

Rx 3 dB Beam Width = 70.0°; Gain = 13.6 dBi; Boresight = 65.0°




Proposed Azimuth Antenna Pattern For C-Band, Rx @ 3.7 GHz, Tx @ 6.4 GHz
Tx 3 dB Beam Width = 12.1°; Gain = 16.0 dBic (dashed)
Rx 3 dB Beam Width = 12.3°; Gain = 13.6 dBic (solid)
Gain includes 0.5 dB Radome loss
dBic
22
18
14
10
6
2
-2
-6
-10
-30
-24
-18
-12
-6
0
6
12
18
24
30
Azimuth Angle

Research Program

A. Maximum Power Spectral Density

The mobile stations to be used in the C-Band system are equipped with a 3 dBW nominal transmitter and a steerable patch array antenna of 16 dBic gain (RHCP) in the direction of maximum radiation. The gain profile of the antenna used for the C-Band system can be modeled as simple sin(x)/(x) patterns with antenna transmit beamwidths and beam center according to (also see introductory antenna patterns):

Elevation: Beamwidth = 40°, Boresight = 65°

Azimuth: Beamwidth = 12°,

This results in a practical maximum EIRP of 17 dBW toward a linear polarized satellite receive antenna for any r.f. channel (20 dBW for RHCP satellite antenna).[2] For any single mobile transmission, a practical maximum power of 4 dBW at the antenna input and 16 dBi effective peak antenna gain (RHCP) yields an EIRP in any 4 kHz band in the direction of maximum antenna gain not exceeding -7 dBW for transmission to a linear-polarized satellite receive antenna from a single mobile terminal (-4 dBW a RHCP satellite antenna).

Following a similar analysis as was used in the original application for the Ku-Band OmniTRACS system, a calculation of maximum aggregate power spectral density at boresight for an entire C-Band network operating in a 36 MHz transponder is given by:

Tx Power of 1 spread carrier	4.0	dBW	(2.5 watt typical max Tx power)
Antenna Gain	16.0	dBic	(boresight at 65° elevation)
Polarization Loss	-3.0	dB	(cp-to-linear)
Occupied BW	-75.6	dB/Hz	(36 MHz)
# of Channel Slots in Occupied BW	22.6	dB	(180 simultaneously)
FCC Reference BW	36.0	dB Hz/4kHz	(4 kHz)
Tx Duty Cycle	-3.0	dB	(50% duty cycle)
Aggregate EIRP Density	-3.0	dBW/4 kHz	

The aggregate power spectral density is -3 dBW/4kHz on boresight. This is 4 dB higher than a single channel power density (-7 dBW/4kHz) mentioned above because of power summation from neighboring r.f. channels spaced at 400 kHz intervals within the 36 MHz bandwidth. The Hub Station controls all simultaneous transmissions and frequencies used by each active mobile station such that the combined power density from all transmissions remains below 2.5 times that produced by any one mobile transmission. Note that the C-Band system power density is about 1/2 the power density of the current live Ku-Band OmniTRACS system operating at a maximum aggregate EIRP density of 0.2 dBW/4 kHz.

---

[2] World Satellite Almanac, by Mark Long, shows that all satellites in the domestic geosynchronous arc use linear receive and transmit antennas for C-Band operation in the 5.9 to 6.4 GHz band.

B. Maximum Level of Interference

In order to assess all potential interference created by the OmniTRACS C-Band system, one needs to distinguish the two modes of access on the Return Link used in the network: deterministic transmissions and probabilistic transmissions .

i. Interference to Adjacent Satellites

As shown in the above Section A, deterministic transmissions cause a worst case power density level at boresight and at any frequency within the total 36 MHz occupied bandwidth equal to -3 dBW/4 kHz. A deterministic transmission is one in which the mobile unit is instructed to use a particular Return Link channel for a particular length of time and no other mobile unit is allowed the same access.

For the purpose of meeting transmission power densities within specified bandwidths at angular separations along the orbital arc toward other satellites, Figure 3 provides a comparison of various mask specifications relative to a common bandwidth of 4 kHz. (In that figure, the CCIR FSS (Fixed Satellite Service) guideline shown has been modified from a 40 kHz reference bandwidth specification to the 4 kHz bandwidth used in this document.)

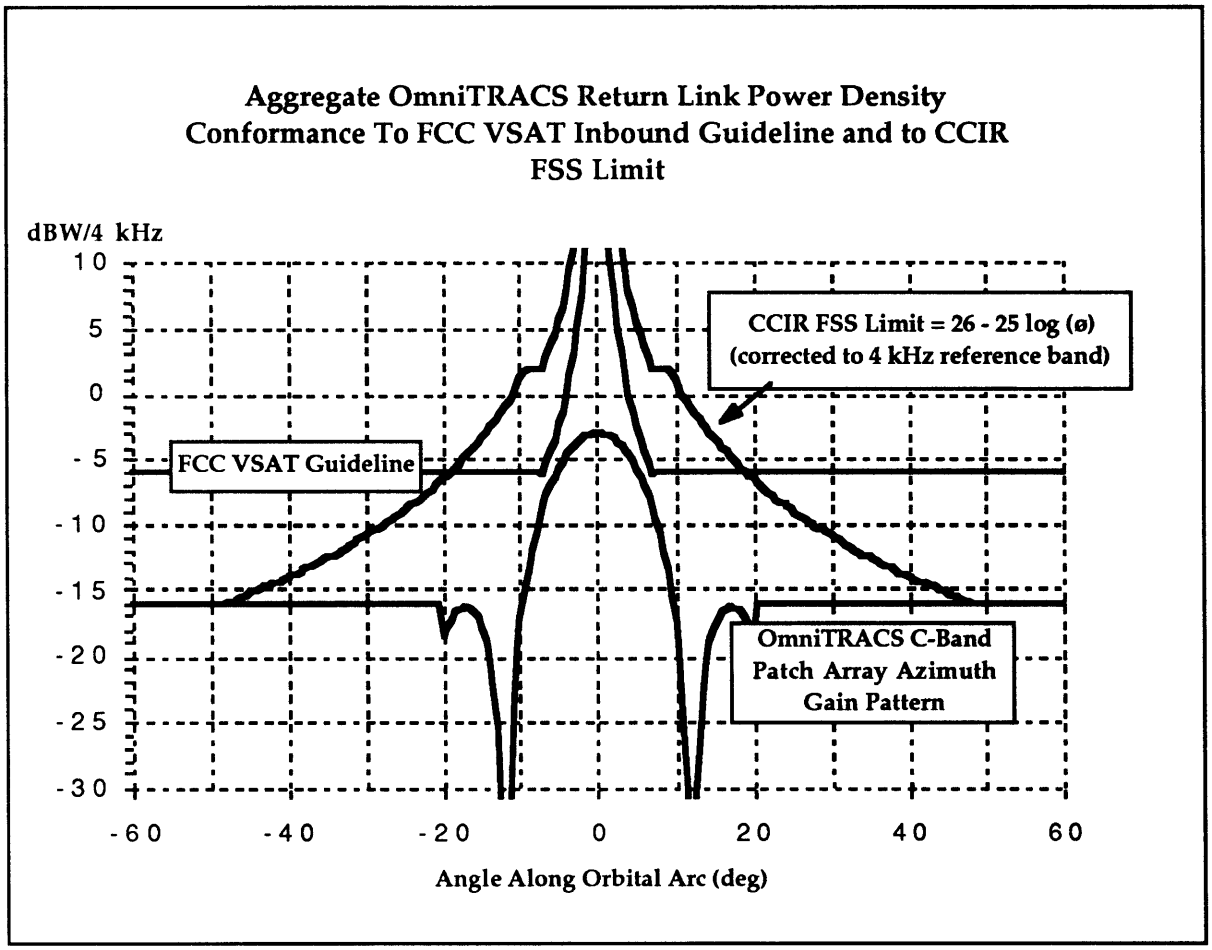


Figure 3 - Aggregate Transmitted Power Density Profile

As is demonstrated in Figure 3, interference due to the total power density resulting from all mobile transmissions that can be received by an adjacent satellite located in that portion of the orbit will never exceed a level of -3 dBW/4 kHz for linear satellite antennas. Note that this worst-case interference level corresponds to the rather theoretical situation where all the transmitting mobile stations, by chance, mispoint their antenna in the direction of the adjacent satellite considered.[3]

For an adjacent satellite located 2° away from the host satellite, an EIRP density of -3.0 dBW per 4 kHz corresponds to a FCC mask limit of the form $4.5 - 25 \log \theta$ dBW/4kHz, when compared to the pattern used typically for 1.2 meter earth stations operating in the fixed satellite service. This is 10.5 dB below the limit of off-axis EIRP density needed to dispense with a waiver request on transmissions for which the applicable pattern is given by $15 - 25 \log \theta$ dBW/4 kHz. Hence, when viewed in light of Footnote 35 referenced below, the OmniTRACS C-Band system meets the adjacent satellite interference requirements in similar fashion to the Ku-Band application. Of course, meeting this type of requirement by a whole group or network of mobile terminals that behave identically lends itself well to an effective methodology for blanket licenses on multitudes of identical mobile platforms.

> ***Footnote 35 of FCC April 9 1986 Declaratory Order states:***
>
> ***(35) Specifically , a waiver request will be unnecessary where the power density into the antenna is set at a level to assure that the radiated EIRP density does not exceed $15 - 25 \log \theta$ dBW/4 kHz for off axis angles between 1° and 7° and does not exceed -6 dBW /4 kHz for off-axis angles between 7° and 9.2°, in the 14.0 to 14.5 GHz band.***

ii. Probabilistic And Deterministic Transmissions

The OmniTRACS C-Band system uses identical network management control to that used by the Ku-Band system. Hence the same arguments and discussion used in the original OmniTRACS Ku-Band application apply here with respect to deterministic transmissions from the mobile terminals as well as the unsolicited, probabilistic transmissions from mobile terminals.

The deterministic transmissions are controlled by direct commands on the outbound Forward Link for the use of inbound deterministic channel resources on the Return Link. Probabilistic transmissions are controlled by a similar command that contains a "throttle" (persistence) which limits the probability of a transmission from any particular mobile terminal based on a closed loop observation by the Network Management Computer ("NMC") of the current activity of unsolicited inbound messages in the probabilistic channels. As discussed in the Ku-Band application, the probability "throttle" limits transmissions to one mobile unit per inbound r.f. channel and at the same time, the r.f. channel spacing is widened to

---

[3] Note that in the actual system, the variety of elevation gain values and G/T footprint of the satellite further limits the magnitude of the total interference.

twice the deterministic, 400 kHz, width to account for the less frequent case of two mobiles attempting the use of the same r.f. channel. A summary discussion of probabilistic transmissions, revised for C-Band, is given below.

iii. Probabilistic Transmissions

During probabilistic transmissions, each terminal in a group or class is given the opportunity to transmit with probability p_{tx}, if it has a priority return message queued. The only transmissions in this case are priority return messages. The NMC will use the p_{tx} factor along with frequency channel assignments to tightly control interference levels.

A conservative algorithm is used to tightly track the priority return message generation rate and the number of outstanding queued priority return messages.[4] The p_{tx} factor is then determined for these two factors and the time since the last poll for priority return messages.

This mechanism provides the control of the mean number of MCTs (Mobile Communication Terminals) per Return Link frequency channel. The worst case of this mean determines the worse case probability distribution used for interference analysis.

Because of the large number of terminals generating messages in a fully loaded system, a Poisson model for the distribution is used. The Poisson Distribution that is created for a single Return Link frequency channel with the worst case mean of 1.33 MCTs transmitting on this frequency channel may be formulated as:

$$p_k = m^k/k!\ \exp(-m)$$
$$k = 1, 2, 3, \ldots\ldots, n$$
$$m = 1.33$$

Confidence levels are determined from this distribution. For example, with a confidence level of 95%, there will be 3 or fewer transmissions because:

$$\sum_{i=4}^{\infty} p_i \leq 5\%$$

The maximum uplink interference EIRP levels due to a fully loaded OmniTRACS C-Band system that will be generated for stated fractions of time (confidence levels) in the bandwidth listed are shown in the following table (in dBW).

[4] The Return Link Receivers located at the Hub Terminal Facility have the ability to determine the total number of responses to a poll for probabilistic transmissions even though collisions may occur that prevent demodulation. Polls will normally occur every few seconds. These two facts allow both rapid and stable tracking by the NMC of very rapid increases in message generation rate that might occur. In the event of a prolonged system outage that would cause a large backlog of queued messages, the NMC will start with a very low value of the persistence parameter.

Table 1 Maximum Uplink Interfering EIRP Due to Full Capacity OmniTRACS C -Band Return Link at 2° Spacing at Stated Confidence Levels and Bandwidths .
(dBW)

Bandwidth	99%	99.5%	99.8%	99.9%	99.95%	99.99%	99.999%
0.1 MHz	13.5	13.5	14.5	14.5	15.0	15.5	16.0
1.0 MHz	23.5	23.5	24.5	24.5	25.0	25.5	26.0
10 MHz	31.0	31.0	31.0	31.0	31.5	31.5	31.5
36 MHz	36.5	36.5	36.5	36.5	36.5	36.5	36.5

These limits apply during worst case conditions of system operations and with any mix of deterministic and probabilistic traffic. One will notice that in comparison to similar tables for the OmniTRACS Ku-Band system, these levels are approximately 3 dB lower due to the lower power density levels for OmniTRACS operations in the C-Band.

c. Interference Into Terrestrial Services:

With regards to terrestrial interference: Part 25.204 of the Commission's Rules[5] states that for elevation angles greater than 5° the power radiation limits are not constrained. Below 5 degrees, there are maximum power radiation limits of 40 dBW in the 1 to 15 GHz bands and 64 dBW limits above the 15 GHz band. The OmniTRACS C-Band system would fall under restrictions for the 1 to 15 GHz band and meets these constraints by a very wide margin (> 40 dB) since the maximum power radiated by the whole return link is bounded by -3.0 dBW in any 4 kHz bandwidth. The OmniTRACS C-Band system will easily satisfy this terrestrial interference regulation. Part 25.204 states:

> *§ 25.204 Power limits.*
>
> ***(a) In bands shared coequally with terrestrial radio communication services, the equivalent isotropically radiated power transmitted in any direction towards the horizon by an earth station operating in frequency bands between 1 and 15 GHz, shall not exceed the following limits except as provided for in paragraph (c) of this section:***
>
> *+40 dBW in any 4 kHz band for $ø \leq 0°$*
>
> *+40+3 ø dBW in any 4 kHz band for $ø < 0° \leq 5°$*
>
> *(b)* [This paragraph refers to frequency bands above 15 GHz.]
>
> ***(c) For angles of elevation of the horizon greater than 5° there shall be no restriction as to the equivalent isotropically radiated power transmitted by an earth station towards the horizon.***

---

[5] 47 C.F.R. § 25.204.

Although it is not apparent from the introductory antenna gain patterns provided above, the antenna design calls for a null at the horizon with -20 dB gain relative to boresight. At present, prototype antennas are performing to better than -30 dB for the transmit band, 5.9 to 6.4 GHz. This null is intended for added protection.

Objectives

QUALCOMM seeks this authorization in order to finalize the design of the C-Band system. Live testing of the system will permit QUALCOMM to assess performance characteristics and make any necessary adjustments.

Benefits of Experiment

This experiment will contribute to the development and expansion of mobile satellite communications by permitting QUALCOMM to develop a C-Band system which can be implemented abroad in areas without Ku-Band capacity. QUALCOMM has received a favorable response to its efforts and looks forward to development of this new stage of the OMNITRACS system.

<u>EXHIBIT 2 TO FCC FORM 442</u>

Applicant QUALCOMM Incorporated, Inc. hereby states that the operation of earth stations pursuant to the license requested herein will not constitute a major action within the meaning of the National Environmental Policy Act, as set out in 47 C.F.R. § 1.1301 <u>et seg</u>., and the operation of these earth stations will have no adverse environmental impact. Facilities will not be of the type listed in Section 1.1307(a) of the Commission's rules. Moreover, all facilities will be in compliance with the environmental radiation health standards referenced in Section 1.1307(b) of the rules. Thus, an Environmental Assessment meeting per 47 C.F.R. § 1.1307 requirements is not applicable.

QUALCOMM Incorporated

By: ______________________

Thomas R. Lafleur
Director, Engineering
Qualcomm Incorporated

EXHIBIT 3 TO FCC FORM 442

OmniTRACS C-Band equipment will be provided to a private corporation for use in Brazil.