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SATELLITE RADIO BRANCH
DOMESTIC FACILITIES DIVISION
SATELLITE RADIO BRANCH

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

In the Matter of Amended Application of

ORBITAL COMMUNICATIONS CORPORATION )
)
For Authority to ) File No.
Construct a Low-Orbit Mobile ) 22-DSS-MP-90(20)
Satellite System )

## Comments

### I. BACKGROUND AND STATEMENT OF INTEREST

Torrey Science & Technology Corporation (hereinafter referred to as the company) consists of a group of executives, scientists and engineers with many years of experience in government and commercial research, development and system implementation. The company is dedicated to applying the highest quality research and design capability to the development of affordable communication, navigation, and digital audio products for both the government and commercial marketplace. While the company's 1991 revenues are expected to be just under $1,000,000, several new communication and audio products currently in development will substantially boost revenue in coming years. Several of these new products are based on the availability of the Orbital Communication Corporation (hereinafter "ORBCOMM") low-orbit, mobile satellite system described in the amended ORBCOMM filing now before the Commission.

Specifically, the company has submitted proposals to the U.S. Coast Guard to design, develop and manufacture monitoring and position location equipment for installation on navigation buoys. This remote buoy monitoring equipment will utilize both the position location and message reporting features of the ORBCOMM satellite service. The ORBCOMM service will permit a buoy status reporting system to meet the low cost, low power consumption, and high reliability requirements necessary to make the position determination and status reporting functions economically feasible for installation on the hundreds of critical navigation buoys in the coastal waters and harbors of the United States. Based on the projected cost and other technical information contained in the ORBCOMM filing, no other available position location and radio reporting technology was competitive with the ORBCOMM system for this application.

Another current Coast Guard requirement involves search and rescue at sea. An effective search and rescue operation requires a determination of the original search datum and the movement of that datum under the influence of sea surface current. In addition, in order to plan an effective search, the search team needs real time, accurate sea surface current information. Currently this aspect of the search and rescue process is accomplished by use of marker buoys which drift with the ocean current but which require hours of valuable aircraft time in locating the buoys with VHF direction finding techniques. To address these shortcomings and greatly improve the search and rescue operation, the Coast Guard desires an air deployable surface drifting buoy design which is low cost (since

buoys are not recovered), self powered for up to 45 days of life, self-locating with position determination ability, and with the capability of reporting sea surface temperature, its own location and other parameters via a data link. Considering these requirements, the company developed such a buoy based on the ORBCOMM system and submitted a proposal to the Coast Guard for design and demonstration of prototype hardware. Again based on the economic and technical data in the ORBCOMM filing, no other available technology can provide the low cost performance to make the self-locating and reporting surface drifting buoy a reality.

These Coast Guard applications which will improve navigation safety and the effectiveness of search and rescue operations are illustrative of the potential uses for the ORBCOMM system which are not now being served by other available systems. By designing and manufacturing these products for the Coast Guard, the Navy and/or other agencies, the company will generate many manufacturing and engineering jobs for its employees as well as providing valuable products to its customers and serving the public interest in improved waterway safety and increased effectiveness of at-sea search and rescue operations.

## II. COMMENTS

Torrey Science & Technology Corporation strongly supports ORBCOMM's request for authority to construct the system and we urge the Commission to act to expedite the rulemaking and licensing processes so that innovative and potentially lifesaving services (as we described above, for example) can be available without delay.

We further urge the Commission to authorize construction immediately and without the delays associated with unnecessary and time consuming comparative processes that would postpone, and possibly jeopardize, the availability of this valuable service to the specific Coast Guard application described above and to the American people in general. Since the ORBCOMM system is capable of world wide service, the company's products as well as the ORBCOMM based products of other US companies, could enjoy wide export abroad with attendant benefit to the US balance of payments.

In addition to the Coast Guard applications described above, the Company has potential applications for the ORBCOMM system to provide low cost data acquisition and position determination in the areas of emergency services, environmental and remote asset monitoring, tracking, and messaging.

The ORBCOMM system is a great improvement over current and planned systems since it provides a low cost solution to the position determination and report back requirements of the areas listed above. It is noted that the ORBCOMM system is a pioneering system with applications in the above and many other areas.

A major advantage of the ORBCOMM approach is the proposed use of the VHF frequency spectrum. The use of VHF offers the opportunity for very low equipment cost due to a widespread technology and manufacturing base. However, any satellite communications system which is to provide useful capacity at VHF

must be designed to operate properly in the presence of the earth-space propagation characteristics and the interference characteristics of that band. Specifically, the modulation system must be selected to provide reliable service in the real VHF environment.

The ORBCOMM approach is to utilize a frequency division multiple access (FDMA) approach, with real time variable channel assignments based on measured activity from other users of the same portion of the spectrum. In effect, the ORBCOMM approach adaptively selects those channels in the spectrum which are not already being used at that time, thereby minimizing the possibility of mutual interference and maximizing the effective use of scarce spectrum resources.

In a competing application, STARSYS has proposed a system intended to provide many of the same services, but through the use of spread spectrum techniques. Although many current applications have shown spread spectrum to be practical, effective against certain levels of interference, and efficient in their use of the spectrum in those applications, spread spectrum as proposed by STARSYS is not an effective method for communications via spacecraft at VHF, in contrast to the use of FDMA. The reason arises from the nature of the interference generated by the existing users of VHF, as illustrated in the following brief technical discussion.

We compare the average number of simultaneously supported uplink small user terminals for CDMA and FDMA at a given instant, using the parameters presented by STARSYS and ORBCOMM. We

assume a variable number M of interfering emitters in the 1 MHz uplink bandwidth, each of 10 watts radiated power. Denote the average number of small users as N. Let the power received at the satellite on the uplink from one small user terminal be S watts. The total equivalent interference density at the input to the receiver consists of:

$N_o$ watts/Hz from the equivalent receiver noise,

(N-1)*S/W watts/Hz from the other N-1 small users,

5*M*S/W watts/Hz from the M interferers[1],

2*4*S/W watts/Hz from the 4 forward channel links[2],

all of which are assumed to be spread uniformly over the spreading bandwidth W = 1 MHz. In order for successful communications for the small user, the equivalent signal to noise density ratio must exceed the minimum required for successful communications. This minimum signal to noise density is $R(E_b/N_o)_{reqd}$ where R is the end-end data rate in bps and $(E_b/N_o)_{reqd}$ is the energy per bit to noise density ratio characteristic of the end-end modulation and coding system. Therefore successful communications is provided to the small user only if the available signal to noise density ratio exceeds the required signal to noise density ratio. This requirement is expressed as:

$$R\left(\frac{E_b}{N_o}\right)_{reqd} \leq \frac{S}{N_o + [5MS + (N-1)S + 8S]/W}$$

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[1] The 10 watt interferers each have 5 times the radiated power of the individual small user. This analysis assumes that any larger interferer can be reduced to no more effect than a 10 watt interferer.

[2] Each STARSYS forward uplink channel has twice the effective radiated power of an individual small user terminal.

This expression can be manipulated to give the upper limit on the number of small users that can achieve simultaneous access in the presence of M interferers as:

$$5\,M + N \leq \left[\frac{W}{R(E_b/N_o)_{reqd}}\right] - \left[\frac{N_o W}{S}\right] - 7$$

The second bracketed term is the loss on the uplink to receiver noise and is customarily ignored. The first bracketed term is evaluated using the STARSYS parameters: W = 1 MHz, R = 4167 bps, and $(E_b/N_o)_{reqd}$ = 2.3 dB. The upper limit on the number of small users that can achieve simultaneous access in the presence of M interferers is then: $5\,M + N \leq 134$.

Now consider the interference environment. Assuming a uniform distribution of the 173 assigned channels in the 148 MHz to 149.9 MHz band, there are 91 channels in the 1 MHz bandwidth. If only one third of these channels are active, so M = 30, substitution into the above inequality shows that no small users are supported.

By contrast, consider the FDMA system which uses a maximum of 20 channels. With only one third of the channels active, an FDMA system can support 13 simultaneously active small users. By locating the FDMA channels between the currently assigned channels, the FDMA system may experience no degradation.

The actual disadvantage of the CDMA system compared to the FDMA system is even greater than the above simplified analysis shows, for the following reasons. First, the CDMA limiting factor of 134 in the above idealized equation will be reduced by a variety of effects, including a loss in correlation due to filtering to constrain the

transmitted signal to the 1 MHz bandwidth, a loss in correlation and generation of self noise due to non-linearities in the spacecraft payload, downlink noise which further reduces the available signal to noise ratio, and a variation among the received signal levels from the different user terminals. The latter effect alone can exceed 3 dB (a factor of 2) just due to the effect upon the aggregate terminal pattern of the nearby ground, so that the value of 134 would be more realistically less than 67, and the CDMA system would be disabled if only 14 of the 91 channels in the band were active.

Second, the assumption that an onboard processor can reduce all interferers to individually have no greater effect than a 10 watt emitter is quite optimistic. If in fact half the emitters have an effective radiated power of 50 watts, only 5 such emitters will disable the CDMA system.

By contrast, the performance of the FDMA system does not depend upon the detailed specific assumptions of the power levels of the other users of the uplink band, but exploits the narrow bandwidth of those channels. The FDMA approach will operate successfully in the presence of the existing interference environment.

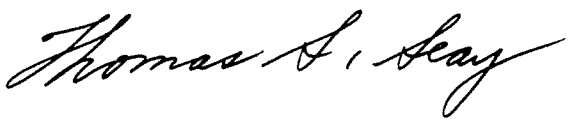
## III. SUMMARY

A low altitude mobile satellite system providing two-way data communications and position determination services at low cost will have many life-saving and quality-of-life benefits. The use of VHF is a key to achieving low costs. Although in many cases CDMA is a suitable approach, the strength and amount of potential interference

to the system from other users of the VHF spectrum lead to the conclusion that only an FDMA system has the potential to offer reliable service for small, low-cost user equipment.

Accordingly, Torrey Science & Technology Corporation strongly supports ORBCOMM's request for authority to construct the low-orbit, mobile satellite system described in the amended ORBCOMM filing now before the Commission. We urge the Commission to act to expedite the rulemaking and licensing processes so that innovative and potentially lifesaving services can be available without delay. We further urge the Commission to authorize construction immediately and without the delays associated with unnecessary and time consuming comparative processes that would postpone, and possibly jeopardize, the availability of this valuable service to the specific Coast Guard application described above and to the American people in general. Since the ORBCOMM system is capable of world wide service, the company's products as well as the ORBCOMM based products of other US companies, could enjoy wide export abroad with attendant benefit to the US balance of payments.

Respectively submitted,



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