WILLKIE FARR & GALLAGHER LLP

1875 K Street, NW
Washington, DC 20006

Tel: 202 303 1000
Fax: 202 303 2000

November 21, 2006 ***Ex Parte Notice***

Marlene H. Dortch
Office of the Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: In the Matter of Amendment of Parts 2 and 25 of the Commission's Rules to Allocate Spectrum in the Ku- and Extended Ku-Bands to the Vehicle Mounted Earth Station Satellite Service ("VMES") on a Shared Primary Basis and to Adopt Licensing and Service Rules for VMES Operations in the Ku- and Extended Ku-Bands, RM-11336

Dear Ms. Dortch:

On November 13, 2006, Tim Shroyer, Chief Technical Officer, General Dynamics C4 Systems, along with Jennifer McCarthy and the undersigned, counsel for General Dynamics Corporation (collectively, "General Dynamics"), met with Lisa Cacciatore, Ron Chase, Kate Collins, Howard Griboff, Scott Kotler, Paul Locke, John Martin, James Miller, and Salomon Satche to discuss the factual and legal issues, as well as the various technical parameters, described in the above-captioned Petition for Rulemaking filed by General Dynamics on May 24, 2006. Attached are the questions that were distributed by the FCC's Staff and discussed at the meeting, and General Dynamics' responses thereto. As noted, General Dynamics will provide a response to question number one separately.

Should you have any questions regarding this matter, please do not hesitate to contact the undersigned.

Respectfully submitted,

/s/

McLean Sieverding
Counsel for General Dynamics Corporation

cc: John Giusti;
Jim Ball;
Lisa Cacciatore;
Ron Chase;
Kate Collins;
Howard Griboff;
Francis Gutierrez;
Scott Kotler;
Paul Locke;
John Martin;
James Miller; and
Salomon Satche

Questions for meeting with General Dynamics
November 13, 2006

1. Pointing and Tracking Mechanism. An earth station on a vehicle might be expected to undergo more rapid motion, changes of direction and vibration than similar earth stations on vessels (ESVs). These changes would appear to demand a larger reliance on the antenna pointing and tracking mechanism to maintain the proper pointing in VMES compared with ESVs. We'd like to understand better the technical aspects of this mechanism to ensure that it will maintain the required tolerance over the long term, and to understand better the conditions that military operational testing will require. This material currently is not a part of the petition. For example:

- *What are the parameters the VMES tracker is tested under and under what parameters is it operated?*
- *At what point does it fail (deg/sec in which axis) and what is the typical and extreme environments in which it would be used (deg/sec in which axis)?*
- *What is the typical failure rate of the antenna tracker and what are its principal failure modes?*

2. Aggregate Power Control. Our understanding is that the operator can increase the transmit power fed to the antenna potentially causing interference to near-by satellites. Additionally, we understand that the General Dynamics system, unlike the similar proposed aeronautical mobile satellite service (AMSS), does not have a central Network Operations Center (NOC) from which the aggregate power at the GSO from multiple transmitting vehicles can be controlled to protect nearby satellites.

- *We would like to understand how the operator would know if he were causing interference if he compensates for mispointing or blockage by attempting to operate at increased power, and how he might be contacted to shut off the unit?*

Additionally, the ESV systems based upon AMSS systems, such as Boeing Connexion, use dynamically controlled CDMA to increase the efficiency of transponder use. These system operators and others have argued that the EIRP-density limits should be an aggregate limit that applies to all cofrequency terminals.

- *What would General Dynamics' reaction be if the Commission rules insisted that there be a central NOC to ensure the EIRP-density limits are maintained either as individual or aggregate limits?*
- *Does General Dynamics have any comment on the current "10*Log(N)" rule applied to CDMA systems?*

3. International Recognition. As a regulatory matter, ESVs obtained international recognition by working within the ITU prior to petitioning for a Commission rulemaking. As a consequence of gaining this recognition, certain international constraints were placed on ESVs which are, generally, reflected in the ESV service rules. Without international recognition, ESVs would be restricted to operating only in the U.S.

territorial waters. Vehicle-mounted earth station proponents have not obtained international recognition through the ITU. As such, restricting vehicle-mounted earth stations to U.S. territory would appear to significantly reduce the utility of this application for the military. We would like to discuss the international aspects of earth stations on vehicles with General Dynamics. For example:

General Dynamics says that the FSS would allows for a "surge capacity" for military anywhere in the world (Petition Page 6) and [This is] "the best option to support U.S. forces in the Middle East" (Petition Page 8) and, further, the Petition (on Page 1) wants to ensure that the US military are able to adequately test and train with mission-critical VMES satellite communications.

- *Does "Mission critical" imply operational usage, thereby suggesting use on foreign soil?*
- *How will the military use VMES in or near administrations that treat ESVs as secondary MMSS (See, for example FN 5.457B, including several Middle East countries)?*
- *How will they do joint training (military exercises) in countries that don't recognize ESVs, much less VMES (see ITU-FNs 5.505, 5.506B, 5.508 and 5.509)?*
- *Does* General Dynamics *envision any efforts in the ITU to gain recognition for VMESs? If so, how long do you think this effort will take to bear fruit?*

4. Scope of VMES Technology. The General Dynamics Petition (Page ii/iii) says "...limited authority has generally only permitted to test and demonstrate Satellite on the Move (SOTM) technologies and is insufficient to meet the military's requirements to widespread domestic training with SOTM and other VMES technologies as are required."

- *What other VMES technologies are being referred to?*

5. Spectrum Efficiency. The Petition (Page 1) says that VMES will yield a more efficient use of spectrum.

- *We would like to better understand how this will happen. Is this solely by creating more users to the Ku-band FSS?*

6. Comparability with ESV, AMSS. The Petition (Page 1) says that licensing VMESs will improve access to spectrum by services with mutually compatible technical characteristics.

- *We see VMES as very different technically, i.e., motion different on VMES vs. ESVs; AMSS are centrally controlled, VMES are not proposed to be. Please explain further how does* General Dynamics *expects VMES to be similar to Ku-Band ESVs and AMSS, and how will they differ?*

7. Rules For Commercial Use. The Petition (Page 1) says that VMESs will result in broader market driven deployment of broadband technologies, although the application is directed to only military test and training.

> - *Does this statement "market driven" imply multiple vendors and commercial use?*
> - *If* General Dynamics *envisions commercial use of VMESs, what rules would they change to provide protection to the neighboring FSS systems?*

8. Data Logging. General Dynamics asserts that there should be no detailed location data-logging rules applied to VMESs because of a lack of interference experienced from ESVs and VMESs and because of the existing capabilities of FSS operators to geolocate interference sources.

> - *Noting Qualcomm's comment that existing FSS geolocation is only capable of locating fixed interferers to within a few 10's of kilometers, can General Dynamics identify another potential method that could be used to identify which mobile VMES terminal was acting as an interference source, if things should go wrong?*

9. Other questions from current record:

> How would General Dynamics react if we limited the development of the antenna-size to larger than a minimum value?
>
> How would General Dynamics react to using a pointing restriction based on the beam-width of the antenna instead of the current, fixed 2 degrees.
>
> Does General Dynamics have any alternatives to minimum antenna size & peak pointing error?

Questions for Meeting with General Dynamics
November 13, 2006

1. Pointing and Tracking Mechanism. An earth station on a vehicle might be expected to undergo more rapid motion, changes of direction and vibration than similar earth stations on vessels (ESVs). These changes would appear to demand a larger reliance on the antenna pointing and tracking mechanism to maintain the proper pointing in VMES compared with ESVs. We'd like to understand better the technical aspects of this mechanism to ensure that it will maintain the required tolerance over the long term, and to understand better the conditions that military operational testing will require. This material currently is not a part of the petition. For example:

- *What are the parameters the VMES tracker is tested under and under what parameters is it operated?*

- *At what point does it fail (deg/sec in which axis) and what is the typical and extreme environments in which it would be used (deg/sec in which axis)?*

- *What is the typical failure rate of the antenna tracker and what are its principal failure modes?*

Response: General Dynamics will provide a separate response to this question.

---

2. Aggregate Power Control. Our understanding is that the operator can increase the transmit power fed to the antenna potentially causing interference to near-by satellites. Additionally, we understand that the General Dynamics system, unlike the similar proposed aeronautical mobile satellite service (AMSS), does not have a central Network Operations Center (NOC) from which the aggregate power at the GSO from multiple transmitting vehicles can be controlled to protect nearby satellites.

- *We would like to understand how the operator would know if he were causing interference if he compensates for mispointing or blockage by attempting to operate at increased power, and how he might be contacted to shut off the unit?*

Response: General Dynamics' overall approach in preparing our Petition for Rulemaking was to envision a system of satellite earth terminals that could be seamlessly integrated with other existing FSS Ku-Band user terminals, such as VSATs and all classes of fixed terminals. To accomplish this, our methodology was to closely follow the Commission's recent ESV rules and technical standards. In the simplest case, which we have extensively tested under our experimental authorization, a VMES can operate with a single FDMA modem providing full-duplex satellite communications links on the order of more than 2 MBPS with a simple 2.4 meter fixed terminal on the distant end. In

such a simple network, an automatic network control system could potentially be more complex than the VMES network itself. This lack of complexity, however, does not relieve the operator of such a terminal of its responsibility to comply with all pertinent technical requirements for licensing of FSS Ku-Band uplink terminals, including control of uplink EIRP, EIRP Density, and antenna pointing accuracy. Even in the case of fixed FSS Ku-Band terminals today, while there is no specific antenna pointing requirement in the Commission's regulations, such a requirement can be easily inferred from the combination of antenna radiation pattern requirements and input power density limits, as well as individual license EIRP limits. As proposed, the VMES rules would include an additional regulatory requirement to ensure compliance with the antenna pointing accuracy, in addition to the normal power control methods which should be employed by all FSS Ku-Band terminals.

The end result of faults in antenna pointing or raising output power levels above those proposed for VMES operations would be exactly the same as in other FSS Ku-Band terminals. Specifically, a need to transmit at a higher than predicted EIRP is indicative of a problem in the uplink system—either an antenna pointing error, antenna damage, or antenna feed or feedline problem. Additionally, an antenna pointing error would usually result in an inability to demodulate the intended downlink signal, which again would typically lead to standard troubleshooting techniques used today on larger antennas to investigate antenna pointing, antenna or feed damage, or other equipment faults.

If a VMES was to bypass the normal indications of link problems and simply transmit an inordinately high EIRP, the terminal operator would be notified by the satellite network operator to cease operations. This is precisely the same mode of operation currently utilized by the hundred of FSS Ku-Band Satellite Newsgathering terminals in use throughout the United States every day; however, those SNG terminals typically operate with (on the order of more than 20 dB) higher EIRP levels than anticipated for VMES operation. In this regard, General Dynamics believes our proposed VMES terminals would be no better but also no worse than larger FSS Ku-Band Earth Stations in operation.

Additionally, the ESV systems based upon AMSS systems, such as Boeing Connexion, use dynamically controlled CDMA to increase the efficiency of transponder use. These system operators and others have argued that the EIRP-density limits should be an aggregate limit that applies to all cofrequency terminals.

- *What would General Dynamics' reaction be if the Commission rules insisted that there be a central NOC to ensure the EIRP-density limits are maintained either as individual or aggregate limits?*

Response: General Dynamics' proposal was intended to encompass as broadly as possible several different operating scenarios, from a simple SCPC two-terminal network to fully integrated multi-station network installations. In the case of the smallest

networks, an interconnected NOC with overall network control authority might actually make operation of such networks impractical—setting a de facto lower bound for network operation by requiring the added cost of the NOC infrastructure.

General Dynamics believes the situation is somewhat similar to the current regulations permitting a licensee to secure an FSS Earth Station license, permitting (i) simple operation with a limited number of terminals and local control, or (ii) a full FSS Ku-Band VSAT Network license with far greater network communications capacity and correspondingly larger investment in network control. If the Commission elects to require a central NOC for power control and other purposes for all VMES operation, we anticipate there will be requests for waiver by small networks for operation of very few terminals in at least the early days of operation.

It should be understood by all that, in no case, with or without centralized NOC control, is the earth station operator relieved of its responsibility to ensure compliance with all operating requirements and limitations, including geographic exclusion zones, antenna pointing, and power control.

- *Does General Dynamics have any comment on the current "10*Log(N)" rule applied to CDMA systems?*

Response: As the Commission has likely observed, there are actually very few systems that truly use CDMA for FSS Ku-Band operation. However, systems built by Qualcomm and ViaSat are excellent examples of such systems that have been successfully deployed. General Dynamics' proposal was intended to encompass as broadly as possible several different potential modulation schemes known today, as well as to set the stage for full compliance of future systems as they are developed. We based our recommendation on what we believe to be the Commission's wise choice in the ESV regulations to decline to require a specific modulation or signal structure, leaving the maximum possible freedom for system developers and operators. General Dynamics' operations to date have all utilized FDMA or TDMA modulation schemes, even when sometimes using PN-modulated spectrum spreading to comply with power density limits. Such modulation schemes always provide a one-to-one correlation to individual station transmitted power density with that experienced at the GSO. For systems operating in true CDMA modes, with multiple uplinks simultaneously occupying the same spectrum, we concur that a "10*Log(N)" rule should apply.

---

3. <u>International Recognition</u>. As a regulatory matter, ESVs obtained international recognition by working within the ITU prior to petitioning for a Commission rulemaking. As a consequence of gaining this recognition, certain international constraints were placed on ESVs which are, generally, reflected in the ESV service rules. Without international recognition, ESVs would be restricted to operating only in the U.S. territorial waters. Vehicle-mounted earth station proponents have not obtained

international recognition through the ITU. As such, restricting vehicle-mounted earth stations to U.S. territory would appear to significantly reduce the utility of this application for the military. We would like to discuss the international aspects of earth stations on vehicles with General Dynamics. For example:

General Dynamics says that the FSS would allow for a "surge capacity" for military anywhere in the world (Petition Page 6) and [This is] "the best option to support U.S. forces in the Middle East" (Petition Page 8) and, further, the Petition (on Page 1) wants to ensure that the U.S. military are able to adequately test and train with mission-critical VMES satellite communications.

- *Does "Mission critical" imply operational usage, thereby suggesting use on foreign soil?*

Response: While many satellite communications users—the U.S. Military included—would prefer to have some form of global operating license, General Dynamics realizes that this is impractical for applications such as EVS, FSS, or VMES. We believe the closest service model to VMES operation on FSS Ku-Band satellites is FSS Ku-Band VSAT service. In the case of FSS VSAT service, there are satellites that utilize fairly broad coverage beams but in all cases the individual earth stations have to be licensed by the administrations actually charged with regulating communications within their territories. Unlike ESVs, which when licensed by the United States, operate on the high seas under the auspices of licenses issued by the Commission, we anticipate that VMES operation will require a form of licensing pertinent to the administration under which they will actually transmit. General Dynamics therefore anticipates that VMES terminals will be utilized on foreign soil under the auspices of the regulations issued by the relevant jurisdiction.

- *How will the military use VMES in or near administrations that treat ESVs as secondary MMSS (See, for example FN 5.457B, including several Middle East countries)?*

Response: General Dynamics anticipates that military users of VMES terminals will be required to negotiate local frequency coordination within the range of potential terrestrial interference, just as they do today with other frequencies regulated by the Commission and the NTIA. This is the existing situation for all RF communications systems, both satellite and terrestrial-based, whether they operate on frequencies that have been reserved for government or civil use. An excellent example is the use of FSS C-Band satellite frequencies, which are also assigned on a global basis to terrestrial microwave communications applications. The U.S. Military already makes use of these FSS C-Band frequencies both for ESV and Fixed operation, so such coordination with administrations responsible for regulating frequency assignments in other territories is already required.

- *How will they do joint training (military exercises) in countries that don't recognize ESVs, much less VMES (see ITU-FNs 5.505, 5.506B, 5.508 and 5.509)?*

Response: General Dynamics anticipates that users of VMES terminals in joint military exercises will be required to coordinate frequency assignments just as they do today with other frequencies regulated for both government and civil use. There exist today certain U.S. military communications systems which operate on the same frequency as others used by foreign governments and military organizations. In some cases these systems are mutually compatible, in others they are disruptive. When the Commission adopted the service and licensing rules for ESVs, it acknowledged the potential for interference to radio operation in other countries and, thus, placed the burden on operators to "ascertain whether the relevant administration may have operations that could be affected by ESVs, and determine whether those administrations have adopted specific requirements concerning ESV operations." The Commission further instructed that "[o]nce the vessel enters foreign waters, the ESV must operate under our technical rules, or those of the foreign administration, which ever is more constraining." (*ESV Report and Order*, FCC 04-286, at ¶ 121 (2004)) The same precautions can be expected in the context of VMESs operating in foreign jurisdictions.

One example of international operation of VMES terminals is currently in place in Germany. General Dynamics has supplied SOTM terminals to ND-Satcom, a leading German satellite communications modem and system manufacturer and integrator, who has supplied these systems to the German Bundeswehr (the German Army). Currently these SOTM terminals are in operation in Germany by the Bundeswehr, licensed by the German administration. Thus, the issues of coordination for VMES frequency use should be no more onerous than that required for other RF uses, including not only communications, but RADAR as well.

- *Does General Dynamics envision any efforts in the ITU to gain recognition for VMESs? If so, how long to you think this effort will take to bear fruit?*

Response: General Dynamics does not believe it is practical to gain ITU recognition for VMES operation before operating such terminals under the Commission's regulations. Indeed, we believe the Commission's recent experience with ESVs and the current state of ITU recognition of those systems is probably a good example of what might be expected from efforts to gain recognition for VMES terminals under the ITU. Such an effort would likely require several years, and even then, many administrations would simply retain footnotes to preclude operation of VMES terminals.

General Dynamics' proposal was intended to urge the Commission to provide a regularized licensing mechanism and service rules for VMES operations within the

territory regulated by the Commission through technical standards that render the transmissions of VMES terminals no different than those of ESVs, VSATs, and other FSS Ku-Band terminals. This results in identical homologation issues, even if serving a somewhat different user community.

In this way, there is no need for a separate VMES frequency assignment, and VMES transmissions would be fully compatible with all other FSS Ku-Band communications systems, both domestically and internationally. General Dynamics' testing conducted under our experimental authorization has conclusively demonstrated that this is easily achievable. This has been shown through our testing of several standard commercial VSAT systems and FDMA modems with VMES terminals showing excellent results. We believe that after other administrations recognize the compatibility of VMES operation with other existing FSS Ku-Band users, the implementation of broader VMES rules on an international basis and ultimately through the ITU should be more easily accomplished.

---

4. Scope of VMES Technology. The General Dynamics Petition (Page ii/iii) says "… limited authority has generally only permitted to test and demonstrate Satellite on the Move (SOTM) technologies and is insufficient to meet the military's requirements to widespread domestic training with SOTM and other VMES technologies as are required."

- *What other VMES technologies are being referred to?*

Response: General Dynamics has developed a family of Satcom-On-the-Move$_{TM}$ (SOTM$_{TM}$) terminals as our specific implementation of the more generic class of Vehicle Mounted Earth Stations (VMES). Our principal point in the statements quoted above was to suggest to the commission that the licensing mechanisms currently employed to test and demonstrate these earth stations, specifically through the use of Special Temporary Authorizations and Experimental Licenses, has been sufficient to test and demonstrate representative VMESs, but it is insufficient for expanded, long-term operational use. Specifically, widespread domestic training with VMESs—either with General Dynamics' specific SOTM$_{TM}$ implementation or that of another provider—would more readily be conducted through regularized licensing procedures in which the technical and regulatory requirements are certain.

General Dynamics believes that in the recent ESV rulings, the Commission has wisely chosen to set technical standards describing the required antenna pointing accuracy and Effective Isotropic Radiated Power Density limits, rather than describing how these characteristics are achieved. We believe this same approach is the best solution to defining the technical requirements for VMES operations. General Dynamics has developed an implementation of a class of VMESs we call Satcom-On-The-Move$_{TM}$ that utilizes high-end mechanical and electronic components that permit exceptionally accurate antenna pointing and careful power density control even in the demanding military off-road environment. We envision that following the issuance of VMES

regulations General Dynamics and other manufacturers will then be able to develop new versions of VMES terminals able to satisfy those same regulations with systems designed for use in less demanding environments, produced in a more cost-effective manner. One of the most significant issues with designing and producing VMES terminals today is simply the lack of specificity and certainty regarding the ultimate technical and regulatory requirements that such terminals must satisfy. Once such regulations are issued, General Dynamics anticipates a broader range of VMES terminals will be produced that are strictly comply with the VMES regulations and are suitable for different environments or conditions.

---

5. Spectrum Efficiency. The Petition (Page 1) says that the VMES will yield a more efficient use of spectrum.

- *We would like to better understand how this will happen. Is this solely by creating more users to the Ku-Band FSS?*

Response: The Commission has previously licensed systems for use on Land Mobile and Air Mobile platforms using FSS Ku-Band spectrum by ensuring that the individual and aggregate Power Spectral Density produced by a network of such users was in all cases substantially lower than that which might result from a typical FSS Ku-Band VSAT network. With the relatively small antennas such platforms could support, this rightfully required some conservatism in the permissible Power Spectral Density Limits. Such limitations helped ensure that the resultant EIRP Density would always be acceptable to adjacent satellite users, even in the presence of exceptionally wide uplink antenna beams impinging on adjacent satellites as well as the intended satellite, and in the presence of limited effectiveness in antenna pointing and tracking. Such systems, even if using CDMA techniques to increase spectral efficiency, will always result in somewhat reduced overall efficiency due to the link degradation resulting from lower effective gain on the uplink and the downlink, and the correspondingly lower Signal-to-Noise ratio.

The proposed VMES implementation permits increased efficiency in the use of FSS Ku-Band spectrum because it would encourage the use of somewhat larger antennas, and mandate that they be pointed and tracked effectively. With these requirements, the maximum possible link efficiency can be achieved for the actual antenna size employed. We were pleased to see the Commission's almost identical technical requirements in the ESV rulings, and we believe the increased space segment efficiency thus derived was at least part of the justification the Commission used in selecting that particular set of technical conditions for ESV operation.

Consider as an example, the potential easing of the antenna pointing accuracy requirement. The requirement currently proposed, as included in existing ESV regulations, requires a pointing accuracy of at most 0.2 Degrees. For a typical parabolic antenna on the order of 40 cm in size, such as might be employed in a VMES, the main beam of the antenna radiation pattern extends beyond 1 Degree from boresight, and thus has a potentially significant impact on EIRP Density towards adjacent satellites. If the

pointing accuracy requirement was increased from 0.2 Degrees to 2 Degrees, for example, the VMES antenna could operate pointed directly at an adjacent satellite. Such operation could technically be supported, but only by carefully limiting the uplink EIRP Density both on boresight and towards adjacent satellites, and through the use of much more satellite downlink EIRP to close the link. Such prospective VMES systems with lesser antenna pointing accuracy and a corresponding requirement for significant spectral spreading, have been designed and are currently being tested, under Special Temporary Authorizations or Experimental Licenses, by their manufacturers. Thus, by making the antenna pointing accuracy significantly broader, the spectrum and satellite power efficiency which could be achieved would be greatly reduced.

The proposed VMES implementation describes the EIRP Density limits towards adjacent satellites but does not mandate a methodology to achieve them, with either antenna radiation pattern or signal structure, other than imposing an antenna pointing accuracy requirement. Thus, the VMES designer is able to trade-off VMES terminal cost and complexity for overall system efficiency. If maximum efficiency is desired, the VMES terminal can be designed with a relatively large antenna and excellent antenna pointing performance. If minimum antenna height above the mobile platform is the principal objective, a VMES system designer could select a much smaller antenna, increase signal spreading to satisfy EIRP Density limits, and accept a lower overall spectral efficiency. Thus, the proposed VMES rules maximize overall spectrum efficiency by setting a standard through which maximum performance can be achieved through as small an antenna aperture as desired.

---

6. Comparability with ESV, AMSS. The Petition (Page 1) says that licensing VMESs will improve access to spectrum by services with mutually compatible technical characteristics.

- *We see VMES as a very different technically, i.e., motion different on VMES vs. ESVs; AMSS are centrally controlled, VMES are not proposed to be. Please explain further how does General Dynamics expect VMES to be similar to Ku-Band ESVs and AMSS, and how will they differ?*

Response: General Dynamics believes that under the proposed VMES rules, several different classes of existing and future FSS Ku-Band earth stations will actually be capable of interoperation. Our testing conducted to date under our experimental authority has provided excellent proof of this over the last several months. Specifically, General Dynamics has undertaken a series of tests using standard commercial FSS Ku-Band VSAT modem systems operating through our VMES antennas with excellent results. VSAT systems tested to date include those manufactured by Hughes Network Systems, ND-Satcom, Vipersat/Comtech EF Data, and iDirect, as well as FDMA modems produced by Radyne and Comtech EF Data. In each case, General Dynamics was able to demonstrate an operating mode that provided excellent performance in terms of link BER and spectral efficiency while satisfying the proposed VMES technical standards. Each of

the systems tested operated in conjunction with a Fixed FSS Ku-Band earth station in approximately the 2.4 meter class, so operation with other FSS Ku-Band earth stations is assured. In each of the VSAT system tests conducted to date, General Dynamics has been able to identify an operating mode already being used in FSS Ku-Band VSAT services that is also compatible with VMES operation—thus demonstrating that VMES terminals can technically interoperate with existing FSS Ku-Band VSAT networks if permitted through regulation.

Interoperability of VMESs and ESVs is even more straightforward. Since the antenna pointing requirements and EIRP Density limits proposed for VMES use are identical to ESV regulations, it is very likely that they will make use of the same type of modem systems and RF equipment. General Dynamics' testing to date under our experimental authorization demonstrates that the Doppler frequency shifts induced by the vehicle motion are in most cases less than the Doppler shifts already experienced by inclined or slightly-inclined geostationary satellites. Thus, typical satellite modem systems already readily accommodate the level of Doppler shift experienced in VMES operation. Perhaps a more significant propagation characteristic, which is more unique in the VMES context, is signal blockage. Since VMES operations are anticipated to be conducted in urban and rural topography, signal blockage due to buildings, telephone poles, freeway underpasses, etc. are a normal occurrence. General Dynamics testing with FSS VSAT systems, which nearly all use some form of TDMA access techniques, are mostly immune to signal blockage effects. Signal blockage stops transmission during the actual period of the outage, as one might expect, but since they are high speed TDMA modems, they quickly reacquire the desired signal very shortly after the blockage is restored. Our tests demonstrate that this is often on the order of less than 2 seconds. The use of IP data formats as well as other packetized information protocols actually enhances VMES operation because they are all essentially designed to cope with interruptions of data transmission. (Alternatively, ESVs should not normally incur significant signal blockage conditions other than during in-port operations or when ESV terminals are less than optimally mounted on ships superstructures and thus might be subject to mast or superstructure signal blockage.)

VMES interoperability with AMSS terminals is conceptually a bit different. From a technical standpoint, AMSS terminals are not required to demonstrate a high precision of antenna pointing and tracking, as are ESVs and as proposed for VMESs. In aircraft-mounted antenna installations, this is reasonable because the antenna structure typically is much smaller, and thus lower in gain and wider in Beamwidth, than the antennas anticipated for use in VMES operation. This mandates a higher degree of spectral spreading in the signal structure utilized with AMSS terminals than with ESV or VMES terminals. This additional level of signal spreading typically means that modem systems designed for AMSS operation will likely perform well in a VMES terminal, but a modem and signal structure intended for VMES operation may not satisfy the reduced EIRP Density levels required for AMSS operation. There are some manufacturers of AMSS modem systems, such as Boeing and ViaSat, who are currently testing such systems with land vehicles. These systems tend to operate with lower EIRP Density levels and do not impose as stringent requirements on their antennas as do the proposed VMES terminals.

Additionally, the signal structure used for such operations is primarily intended to operate in the absence of obstructions or signal blockage. Thus, some such modem systems have significant difficulty in resynchronization following the types of signal blockage common in VMES operation. It is General Dynamics' experience that these terminals adapted for such operation are thus less efficient than the proposed VMES standards. Because of these factors, General Dynamics anticipates that terminals intended for AMSS operation could potentially be utilized in VMES operation because they will meet the required EIRP Density limits. (It may be necessary, however, to utilize a different antenna on the VMES terminal than that intended for AMSS operation simply due to the insufficient antenna pointing accuracy.) In this situation VMES and AMSS terminals may well be able to interoperate, but interoperability is by no means assured.

---

7. Rules for Commercial Use. The Petition (Page 1) says that VMESs will result in broader market driven deployment of broadband technologies, although the application is directed to only military test and training.

- *Does the statement "market driven" imply multiple vendors and commercial use?*

Response: Yes. General Dynamics requests that the Commission establish VMES regulations that are not simply achievable by us, but that form the framework for a new class of satellite communications services that would be supported by several different manufacturers and users. The family of VMES terminals currently produced by General Dynamics are very high-performance, highly specialized units optimized for the military off-road environment. We chose that difficult operating environment mostly because U.S. military satellite communications users continue to have a pressing need for such systems. Additionally, this is among the most demanding of all physical operating environments. Systems designed to operate at these incredibly high levels of antenna velocity and acceleration could easily satisfy the proposed VMES technical requirements in all less-demanding environments.

In this regard, we believe the Commission set an excellent example in the ESV regulations. Clearly the environment experienced by a small boat traversing inland waterways is much different than that experienced by a small freighter in a high sea state. The Commission declined to set different standards in the ESV regulations for different types of ships or different classes of satellite communications services. Instead, the Commission rightly chose to specify the EIRP Density and antenna pointing performance that must be maintained, under all operating conditions, on all platforms, and for all types of supported communications services. That is exactly the approach General Dynamics encourages the Commission to take with the proposed VMES regulations. Setting the baseline technical requirements at the time of issuing the VMES regulations will clearly define the operating characteristics VMESs have to achieve, under all conditions and on all platforms. This will permit future optimization by system designers and users to efficiently meet the emerging requirements of the U.S. military and otherwise.

Additionally, since the proposed VMES rules would set a high performance standard currently achievable only on high-end military-level systems, development of future system should provide a natural period of evolution. During the early periods of VMES operation, designers and users will have an opportunity to characterize both terminal hardware and system operation, which will permit further refinements in both. This should result in operational enhancements for VMES systems by the time commercial operation is practical.

- *If General Dynamics envisions commercial use of VMESs, what rules would they change to provide protection to the neighboring FSS systems?*

Response: General Dynamics does not believe that additional rules would be required for protection of neighboring FSS systems any more than they were required for ESVs. The proposed VMES rules should result in VMES signals appearing on their own and adjacent satellites exactly the same as existing FSS Ku-Band VSAT, ESV, and other signals. Whether the VMES user is a military operator or disaster recovery communications technician, the proposed VMES rules should ensure that the maximum EIRP Density towards adjacent satellites would never be higher than that currently experienced.

It should also be noted that the proposed antenna pointing requirements are non-trivial. Currently, they can only be achieved by a somewhat sophisticated pointing and tracking system designed for a very demanding environment. As long as these requirements are maintained for VMES operation, regardless of the environment, the specific vehicle dynamics, etc., the VMES system designer would have to include adequate design margin to ensure compliance in the intended operating environment. This will mandate an additional level of design and production complexity that will likely keep VMES terminals above the range of "consumer" products. They will likely satisfy applications like Satellite Newsgathering, disaster recovery communications, cellular base station interconnect restoral, etc., but their necessary complexity is unlikely to ever result in VMESs that approach the cost of even the most expensive VSAT terminals.

---

8. <u>Data Logging</u>. General Dynamics asserts that there should be no detailed location data-logging rules applied to VMESs because of a lack of interference experienced from ESVs and VMESs and because of the existing capabilities of FSS operators to geolocate interference sources.

- *Noting Qualcomm's comment that existing FSS geolocation is only capable of locating fixed interferers to within a few 10's of kilometers, can General Dynamics identify another potential method that could be used to identify which mobile VMES terminal was acting as an interference source, if things should go wrong?*

Response: General Dynamics suggests that VMES operation poses no greater probability of causing interference than other classes of FSS Ku-Band earth stations, if designed and operated properly. Indeed, current Satellite Newsgathering vehicles probably pose a much greater probability of causing interference than do VMESs. SNG terminals typically use manually-pointed antenna positioners, whereas VMES terminals will all require auto-acquisition Antenna Control Units as there is simply no other possible way to meet the tight antenna pointing accuracy requirements of the VMES regulations. Additionally, SNG earth stations transmit significantly higher EIRP signals than will VMESs. Thus, not only is an SNG terminal much more likely to be pointed at the wrong satellite, its high EIRP transmissions ensure that any interference it causes will be significant. SNG terminals are not currently required to provide position logs, but they are required to eliminate interference sources, and to mitigate any interference events observed. It can be demonstrated that SNG terminals have been providing satisfactory performance on FSS Ku-Band satellites from within the United States for many years. General Dynamics believes the same mechanism that has worked so well for SNG terminals, which is evidenced by the fact that the level of interference complaints currently being experienced is rather low, should be applied to VMES operations.

General Dynamics has contacted some of the most prominent manufacturers of Satellite Monitoring Systems with associated geolocation capabilities supplied to FSS Ku-Band satellite operators. Glowlink Communications Technology, Inc. is one such manufacturer. Jeffry Chu, the President of Glowlink, reports that they are currently producing geolocation systems, such as the Glowlink Model 8000. This system is specifically designed for FSS satellites and can typically geolocate down to about 5 to 7 miles. With good ephemeris data on satellite position, it can be as accurate as sub-mile. Such geolocation accuracy is now possible and will be fielded more broadly by satellite operators as requirements dictate. This should permit the determination of VMES location to within an accuracy that permits terrestrial search and interference resolution in even the most extreme cases. The foregoing is not intended as an endorsement of any particular proprietary technology or service provider, but rather, is offered as an example to illustrate that promising options exist in terms of interference resolution and geolocation solutions.

Further, VMESs will typically have GPS receivers because accurate location information will be required for the calculation of predicted satellite pointing angles based on ephemeris. Thus, it would be technically feasible to store position logging information in the VMES terminal for retrieval as an aid in resolution of interference events. However, many users, but especially military users, would find the continuous transmission of position information from the VMES absolutely unacceptable from an operational security standpoint, and waiver requests would be likely should such a requirement be imposed. Other methods, such as somehow modulating every VMES uplink signal with a unique identification code are probably impractical and have been demonstrated to be ineffective in other geostationary satellite communications systems.

---

9. Other questions from current record:

How would General Dynamics react if we limited the development of the antenna-size to larger than a minimum value?

Response: Many potential VMES users really don't understand the impact of antenna size on satellite link performance. As part of our VMES development activities, General Dynamics has conducted significant research on user preference for antenna size and terminal configuration. What we have found is that regardless of what minimum size one proposes for such operation, some additional group of users will likely request an even smaller antenna. As stated above, this can actually be accommodated in some cases, at least at the expense of additional satellite power and additional spectral spreading. We believe the Commission acted wisely in preparing the ESV Ku-Band rules by declining to specify a minimum antenna size. We believe the same approach is warranted in establishing VMES rules. Declining to specify a minimum antenna size and gain permits system designers and operators to trade VMES size and complexity for increased satellite power and bandwidth efficiency. In anticipated VMES operation, General Dynamics does not believe there will be a "one size fits all solution" so this flexibility will permit the best optimization of available resources.

General Dynamics has recently observed most military customers select VMES antennas on the order of 50 cm or larger in size to permit operation on FSS Ku-Band satellites with most modems without having to resort to spectrum spreading to reduce EIRP Density. Our experience demonstrates that with smaller antennas there are virtually no conditions under which a VMES might operate in the United States without resorting to spectrum spreading in order to satisfy EIRP Density limits. If a particular antenna size is established as a minimum, it is quite likely that the Commission will receive requests for waiver, regardless of the minimum size selected.

How would General Dynamics react to using a pointing restriction based on the beam-width of the antenna instead of the current, fixed 2 degrees?

Response: In general, pointing restrictions based on the beam-width of the antenna instead of the current, fixed 2 degrees spacing is probably easier to achieve from a manufacturing standpoint, assuming that for smaller antennas the pointing restriction would be wider. In practice, tighter antenna pointing restrictions permit more efficient use of satellite power and bandwidth resources. Thus there is an inherent system/operational motivation to keep the antenna pointing as tight as possible. The downside of this increased pointing accuracy is higher cost for the VMES antenna pointing and tracking mechanism. On the other hand, smaller antennas will already require at least some level of spectrum spreading to meet EIRP Density limits, so

additional spreading could be utilized, on both the uplink and downlink, to offset the antenna gain degradation resulting from less accurate pointing.

In principal, General Dynamics believes the Commission struck the right balance in the ESV rules. We believe we are able to continue to satisfy those requirements and thus provide a relatively high level of link efficiency. However, if the Commission were to relax the antenna pointing requirement while still retaining the proposed EIRP Density limitation mask, system designers could trade antenna performance for EIRP Density. We would very much prefer not to see the Commission reduce the antenna pointing accuracy requirements and compensate with reducing the permitted EIRP Density levels, because we believe the end result of decreased antenna pointing accuracy would certainly have to be a corresponding reduction in permissible EIRP Density. Above all, we would much prefer the permitted EIRP Density levels to be at least as high as those currently included in the ESV regulations.

Does General Dynamics have any alternatives to minimum antenna size & peak pointing error?

Response: As stated above, General Dynamics believes the Commission struck the right balance in the ESV rules. This provides the ability to interoperate with other FSS Ku-Band earth stations and trade off spectral efficiency for VMES size, cost, and complexity. Setting a specific antenna minimum size or a less-stringent antenna pointing requirement simply changes the trade-off options available to the system designer. Smaller antennas and less-stringent pointing accuracy both tend to make VMES terminals utilize “special” modulation formats with a high degree of spectral spreading, making them less efficient and less likely to be interoperable with other FSS Ku-Band Earth Stations.