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April 19, 2005

Mr. Donald Abelson, Chief
International Bureau
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

IB Docket No. 05-220
IB Docket No. 05-221

Dear Mr. Abelson:

TMI Communications and Company Limited Partnership ("TMI") and its affiliate, TerreStar Networks Inc. ("TerreStar")[1] hereby request that the Bureau finalize the redistribution of available 2 GHz spectrum to TMI so that TMI and TerreStar can be certain that they will have sufficient spectrum to establish a fully competitive Mobile Satellite Service ("MSS") with an integrated Ancillary Terrestrial Component ("ATC") and thus recognize the Commission's decade-long promise for next-generation MSS systems.

Specifically, TMI and TerreStar request that the Bureau amend TMI's existing Letter of Intent ("LOI") authorization for 2 GHz MSS by redistributing to TMI an additional 3.34 MHz of the recently surrendered spectrum in both the uplink (2000-2020 MHz) and downlink (2180-2200 MHz) 2 GHz MSS bands. This spectrum redistribution, which would provide TMI with 10 MHz of spectrum in each direction, is consistent with the Commission's competition policies and, indeed, is essential to facilitate the deployment of an ubiquitous, fully interoperable (satellite/terrestrial) voice and broadband data service that will benefit the public safety community as well as rural and urban consumers alike. Grant of TMI/TerreStar's request consequently will serve the public interest and – given the state-of-the art design of TMI/TerreStar's satellite system – will provide extraordinarily large, cognizable and non-speculative efficiencies by enabling the satellite to optimize the signal strength and channel capacity available to mobile handsets.

Indeed, less than two years ago, the Commission stated that "[t]he amount of spectrum a particular satellite operator would need to provide a particular service depends on the satellite operator's system design itself and the operator's business assessment of the service to be provided."[2] Thus, given the "innovative designs, unique niche markets targeted by each operator, and cutting edge technology," going forward, the Commission said that it would not "attempt[] to evaluate each licensees' spectrum

1 TerreStar is the prospective assignee of TMI's 2 GHz MSS authorization and has contracted with Space Systems/Loral Inc. for a satellite that will operate in this band.

2 *Amendment of the Commission's Space Station Licensing Rules*, IB Docket 02-34, 18 FCC Rcd. 10760, 10776 ¶ 29 (2003) ("*Licensing Reform Order*").

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needs"[3] but to rely on market forces to the extent possible. The Bureau should be guided by this policy here, especially given the unique demands of designing a competitive MSS system.

As the Bureau is aware, TMI/TerreStar is moving forward rapidly to construct and deploy a sophisticated 2 GHz MSS system that will deliver ubiquitous and redundant voice and high-speed packet data communications services throughout North America. On April 11, 2005, TMI submitted a certification to the Commission stating that, as of March 31, 2005, it had timely met the "begin physical construction" milestone for its GSO satellite. TMI/TerreStar plans to file an application with the Commission seeking authority to provide an ancillary terrestrial component immediately upon meeting the Commission's gating criteria.[4] In light of these developments, it is critically important for TMI/TerreStar to resolve as soon as possible the current uncertainty that exists regarding the amount of 2 GHz MSS spectrum that will be available to their MSS network and, correspondingly, to consumers.

The ultimate success of any mobile satellite service depends on a licensees' ability to access sufficient spectrum. As the industry moves closer to commercial launch, the business and technical requirements of a viable hybrid satellite/terrestrial system – and the spectrum necessitated by those requirements – have become clear. Now, it is evident that MSS licensees operating in the 2 GHz band will need at least a 2 x 10 MHz spectrum block to create a viable hybrid satellite/terrestrial system that can deliver critical benefits to first responders, homeland security agencies, and rural America.

I.

Background

Under the Commission's rules, TMI/TerreStar and ICO Global Communications (Holdings) Limited ("ICO") will soon have a *pro rata* 2 x 6.67 MHz share of the total 2 x 20 MHz spectrum block allocated to the 2 GHz MSS service.[5] The

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3 *Id.*

4 *See Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, the L-Band, and the 1.6/2.4 GHz Bands*, Memorandum Opinion and Order, IB Docket No. 01-185, FCC 05-30, at ¶ 89 (rel. Feb. 25, 2005) ("*ATC Reconsideration Order*").

5 TMI is currently authorized to share one fifth, or 4 MHz, of the available 2 GHz MSS spectrum in each direction. Under the Commission's rules, the March 2005 surrender of two MSS authorizations caused the available spectrum to be divided among the three then-remaining 2 GHz MSS grantees, providing TMI one third or approximately 6.67 MHz in each direction. *See* Letter from Peter D. Shields, Wiley, Rein & Fielding, Counsel to Iridium 2 GHz LLC to Marlene H. Dortch, Secretary FCC, *Voluntary Surrender of 2 GHz Authorization and Notice of Withdrawal of Related Applications*, File Nos. SAT-LOA-19970926-00147 *et al* (dated March 16, 2005); *and* Letter from Joseph

2 x 20 MHz spectrum block allocated to this service reflects the Commission's decision in 2003 to reallocate 2 x 15 MHz of MSS spectrum to provide additional spectrum for terrestrial advanced wireless services.[6] Within the remaining spectrum, the Commission has permitted MSS licensees to construct a crucially important ATC to complement their satellite-based communications systems.[7] The ATC component will allow MSS licensees to provide more effective and spectrally-efficient service to their customers.

The Commission also has established a system under which any spectrum surrendered by an "NGSO-like" licensee – a term which includes MSS[8] – would be distributed *pro rata* among the remaining NGSO-like licensees in the same band as the surrendering licensee. In the *Licensing Reform Order,* the Commission specifically found that this approach "would likely put the spectrum into use more quickly than any other alternative."[9] Despite its recognition of the benefits of additional spectrum for MSS, the Commission found that it would only apply the redistribution procedure on a *de facto* basis if a "sufficient number of licensees" remain to make "reasonably efficient use of the frequency band."[10] The Commission "presume[ed]" that a sufficient number of licensees would be three.[11] The Commission held, however, that parties may rebut this presumption by providing convincing evidence that "allowing only two licensees in the frequency band will result in extraordinarily large, cognizable and non-speculative efficiencies."[12]

P. Markoski and Bruce A. Olcott, Counsel for The Boeing Company to Marlene H. Dortch, Secretary, FCC, *re: Notice of Surrender of License and Withdrawal of Application*, File Nos. 79-SAT-P/LA-97(16) *et al* (dated March 28, 2005). The subsequent surrender of the Celsat, Inc. MSS authorization on April 12, 2005 thus provides the additional opportunity to redistribute half of Celsat's prior *de facto* allocation (that is, half of 2 x 6.67 MHz , approximately) to TMI, such that TMI would then have 10 MHz in each direction (6.67 + 3.34 MHz, approximately). *See* Letter from David D. Otten, Chairman & Chief Executive Officer, Celsat to Marlene H. Dortch, Secretary, FCC (dated April 12, 2005).

6 *See Amendment of Part of Part 2 of the Commission's Rules to Allocate Spectrum Below 3 GHz for Mobile and Fixed Services to Support the Introduction of New Advanced Wireless Services, including Third Generation Wireless Systems,* 18 FCC Rcd. 2223, 2249 (2003).

7 *See Establishment of Policies and Service Rules for the Mobile Satellite Service in the 2 GHz Band,* 15 FCC Rcd. 16127, 16138 (2000).

8 *Licensing Reform Order*, 18 FCC Rcd. at 10774.

9 *Id.* at 10778.

10 *Id.*

11 *Id.*

12 *Id.*

It appears that the Commission was motivated principally by competitive concerns in adopting this presumption. However, the FCC made clear that, even if only two MSS licensees were left, a portion of the remaining spectrum could still be reallocated to a surviving licensee if it could make a verifiable, non-speculative showing that the additional spectrum allocation would result in an extraordinarily efficient use of the remaining 2 GHz frequencies. That is exactly the case here as evidenced by this letter and supporting affidavits.

It bears emphasis at the outset that there is little reason to be concerned with the state of competition in the market for mobile telecommunications and for MSS, in particular. Even if there are but two MSS operators in the 2 GHZ band, at least four other MSS providers exist in other bands. On the other hand, the incremental spectrum redistribution requested here by TMI/TerreStar will, via the parties' unique satellite design, offer benefits that demonstrably outweigh an alternative distribution of the spectrum. Accordingly, the Bureau should determine that the public interest would be served by TMI/TerreStar having access to an additional 2 x 3.34 MHz of spectrum allocated from the redistribution of surrendered spectrum.

II.
Distributing Surrendered Spectrum to Existing MSS Licensees Will Permit Spirited Price and Service Competition

We begin by noting that the Commission's 2003 assumption that a "reasonably efficient use of the frequency band" requires at least three licensees does not appear to be borne out by the commercial and competitive realities facing the MSS industry today. In the *Licensing Reform Order*, the Commission cited the *EchoStar DirecTV Hearing Designation Order* to support its presumption that three MSS operators would be required for competitive reasons.[13] The analogy to direct broadcast satellite ("DBS") is, however, inapposite to MSS. Permitting the EchoStar and DirecTV merger would have resulted in only one supplier of DBS service and would have necessarily offered consumers only two alternatives for multichannel video services in any geographic area – one satellite provider and one cable provider.[14]

Yet permitting two 2 GHz MSS providers to share the current allocation will not limit MSS to two competitors. To consumers, the spectrum band in which an MSS provider operates is irrelevant. Other MSS licensees in the L-band, 1.6/2.4 GHz ("Big LEO"), and Little LEO bands, such as Inmarsat, Globalstar, MSV, and ORBCOMM, would provide competition to the two 2 GHz MSS providers. The 2 GHz MSS providers also face competition from Fixed Satellite Service operators that provide

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13 *Id.*

14 Application of EchoStar Communications Corporation, General Motors Corporation and Hughes Electronics Corporation, *Hearing Designation Order*, 17 FCC Rcd 20559, 20604-05 ¶¶ 99-103 (2002) ("*EchoStar-DirecTV Hearing Designation Order*").

land,[15] aeronautical,[16] and maritime[17] MSS. Also, given the recent surrenders of 2 GHz MSS authorizations, the Commission should not rely on *a priori* judgments about the number of 2 GHz MSS competitors that the market will actually support or the spectrum that they will need. The 2 GHz MSS is in its infancy, with satellite launch milestone still two years away. For all of these reasons, an inflexible assumption about the number of 2 GHz MSS competitors necessary to make reasonably efficient use of surrendered spectrum is no longer supportable.[18]

Finally, even if the competitive analysis were to focus solely on the 2 GHz MSS band, competition between current satellite-based businesses demonstrates that sufficient competition nonetheless will exist with two providers. DirecTV and EchoStar, for example, are the only two DBS providers in the United States and these two companies engage in spirited price and service competition that has dramatically expanded the market for satellite-delivered video services.[19] When the Commission issued service rules for the digital audio radio service ("DARS"), moreover, it refused to allow more than two licensees to occupy that band.[20] As the Commission is aware, the two licensees, XM Satellite Radio and Sirius Satellite Radio, compete vigorously for customers based on technology, services, and price. The same will be true of TMI/TerreStar and its presumptive competitor in the 2 GHz band, ICO.

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15 *See Qualcomm, Inc., Memorandum Opinion, Order and Authorization*, 4 FCC Rcd 1543 (1989) (authorizing land mobile MSS on a secondary basis in the Ku-band).

16 *Service Rules and Procedures to Govern the Use of Aeronautical Mobile Satellite Service Earth Stations in Frequency Bands Allocated to the Fixed Satellite Service, Notice of Proposed Rulemaking*, 20 FCC Rcd. 2906 (2005) (proposing rules for operation of aircraft earth stations in the Ku-band); *Boeing Company, Order and Authorization*, 16 FCC Rcd 22645 (2001) (permitting operation of two-way mobile terminals aboard aircraft in the Ku-band).

17 *See Procedures to Govern the Use of Satellite Earth Stations on Board Vessels in the 5925-6425 MHz/3700-4200 MHz Bands and 14.0-14.5 GHz/ 11.7-12.2 GHz Bands, Report and Order*, 20 FCC Rcd. 647 (2005) (establishing licensing and service rules for Earth Stations on Vessels ('ESVs') in the C-band and Ku-band).

18 *See also Applications for consent to the Transfer of Control of Licenses from MediaOne Group, Inc. to AT&T Corp.*, 15 FCC Rcd. 9816, ¶ 123 (2000); *Applications of AT&T Wireless Servs., Inc. and Cingular Wireless Corp. for Consent to Transfer of Control of Licenses and Authorizations*, 19 FCC Rcd. 21522, ¶ 78 (2004).

19 *See Annual Assessment of the Status of Competition in the Market for the Delivery of Video Programming*, FCC 05-13, MB Docket 04-227, at 7 (rel. Feb. 4, 2005) ("DBS continues to increase its share of the [multichannel video programming distributor ('MVPD')] market, while other MVPDs continue to experience losses in market share.").

20 *Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310-2360 MHz Frequency Band*, 12 FCC Rcd. 5754 (1997).

III.
The Distribution of Incremental Spectrum to TMI/TerreStar Will Result in *"Extraordinarily Large, Cognizable and Non-Speculative Efficiencies"*

TMI/TerreStar has developed and is building a sophisticated ATC-enhanced MSS system capable of delivering ubiquitous and redundant voice and high-speed packet data communications services throughout North America. This system will uniquely help to assure the safety of first responders, assist in safeguarding homeland security, and extend high-speed capacity to rural and remote areas that otherwise will be left behind. At a *minimum*, as explained below, TMI/Terrestar needs access to 10 MHz of uplink and downlink spectrum to achieve these public benefits.[21]

Based on the efficiencies resulting from the distribution of an additional 3.34 MHz of surrendered spectrum to TMI/TerreStar, the Bureau should find that the presumption in the *Licensing Reform Order* has been rebutted. As explained in detail below and in the attached expert statements, a successful mobile satellite service requires deployment of handsets that are virtually indistinguishable in size, function, and cost from the terrestrial mobile handsets to which consumers have become accustomed. As a result, to be competitive, any MSS handset must be essentially "transparent" to the user *vis-à-vis* a terrestrial mobile handset. This "transparency" requirement places significant new demands on the design of any integrated mobile satellite service, dictating a robust and large satellite capable of receiving the weakest of signals from the small handset. While this system will require access to additional spectrum, the efficiencies and public benefits that flow from the resultant hybrid satellite/terrestrial mobile telecommunications system are "extraordinarily large, cognizable and non-speculative."

A. Transparency in Mobile Handsets

As noted, the "transparency" principle has guided the design of TMI/TerreStar's satellite, which, to minimize the processing needs and power of mobile handsets, must be capable of delivering a very powerful signal from space while, at the same time, receiving a weak signal from a mobile handset and thereby minimizing the RF performance needs of the handset.

Accordingly, as a technical matter, TMI/TerreStar's satellite will deliver a G/T of 21 dB/K using a large aperture antenna providing approximately 48 dBi of gain. This design means that the satellite will be very sensitive to weak signals of the small handsets. Such sensitivity is achieved by use of a very large aperture reflector on the satellite (over 60 feet in diameter) to provide highly-focused spot beams of approximately 250 km in diameter. While the large reflector enables significant aggregate EIRP (AEIRP), the satellite requires access to sufficient bandwidth to fully utilize this AEIRP

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21 Without at least 2 x 10 MHz of spectrum, the public benefits of TMI/TerreStar's system cannot be fully realized; that is, a significant portion of the satellite's power will lay fallow because the system will be spectrally limited. *See infra,* Technical Appendix.

for useful communications. As documented in the attached technical statement, with 2 x 10 MHz of spectrum TerreStar's satellite will make use of nearly all available AEIRP.

B. State-of-the-Art Air Interfaces

In addition to using its full range of spectrum for MSS, TMI/TerreStar will use the requested 2 x 3.34 MHz of spectrum in providing ATC, which is a necessary element of a robust and efficient mobile satellite service.[22] By terrestrially reusing its satellite spectrum to provide ATC service, TMI/TerreStar's MSS will generate unprecedented spectral efficiencies. This spectrum reuse will permit consumers to realize the benefits of a nationwide ubiquitous, mobile satellite service with access at every point in the nation regardless of topology. The Commission recently has reiterated that ATC would "advance the Commission's goal of ensuring efficient and intensive use of the spectrum."[23]

To deploy a modern ATC network, however, at least 2 x 10 MHz of spectrum is needed. Access to sufficient bandwidth will permit TerreStar to offer its hybrid terrestrial/satellite consumers the wider carrier bandwidths that are being developed across the mobile communications services industry. Current channelization for CDMA voice and data transmission requires 1.25 MHz-wide channels. Newer technologies use even wider bandwidths. Third-generation broadband air interface standards that require carrier bandwidths of 5 MHz already have been deployed in Europe and Japan; one example of such a standard is W-CDMA. Other fourth-generation ("4G") standards currently under development are based on pure IP high-speed packet data transport (including WiMAX, among others), and are expected to be in use in two to three years from now. Such fourth-generation technologies are being developed to accommodate carrier bandwidths of up to 20 MHz.

These technological changes are not surprising; wide channel bandwidths offer many advantages, including greater multipath resistance and higher burst throughputs for data services. In light of these technical realities, and taking into account the 15-year life expectancy of TMI/TerreStar's satellite(s), a sufficient amount of spectrum is needed for the system to remain competitive and to serve consumers effectively over its expected life.

C. Spectrum Efficiencies

TMI/TerreStar's satellite will generate significant spectral efficiencies in addition to those described above. As a result, the Commission can be certain that any additional spectrum allocated will be fully and efficiently used.

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22 Other MSS providers have recognized the importance of ATC to a successful mobile satellite service. *See, e.g.*, SAT-MOD-20050301-00054, *Description of Globalstar MSS/ATC System and Public Interest Statement* (filed March 1, 2005).

23 *See ATC Reconsideration Order* at ¶¶ 9 and 95.

Most notably, the TMI/TerreStar satellite is being developed with the capability to form optimum satellite spot beams via a technique called Ground-Based Beam Forming ("GBBF").[24] These spot beams are formed adaptively on the ground at the satellite gateway earth station, rather than at the satellite itself. The signal processing of GBBF will form an optimum beam on each communications channel for each user, and that beam will even follow the user in the event the user changes position during a communications session. In addition to forming optimum satellite beams, GBBF is also capable of Adaptive Interference Cancellation (AIC), which maximizes spectrum efficiency by allowing (1) greater loading of the satellite beams than would be possible otherwise, and (2) the reuse of spectrum between the ground and space segments through cancellation of ATC-induced uplink interference.

Given the very large service link antenna aperture of TMI/TerreStar's satellite and the flexibility provided by GBBF, the frequency reuse by the satellite will be significant. This design innovation attests to the spectral efficiency of the TMI/TerreStar system and provides further assurance to the Bureau that the additional spectrum requested will be put to highly efficient use.

D. Consumer-Priced Handsets

Sufficient bandwidth for MSS will permit equipment manufacturers to produce inexpensive mass-market MSS handsets. Without scale economies provided by mass production, the MSS industry cannot hope to meet the well-recognized consumer expectations of full-featured, powerful and small digital handsets.

Specifically, and as explained in the attached Declaration of Peter Cowhey, Dean of the Graduate School of International Relations and Pacific Studies at the University of California, San Diego, a competitive handset/terminal "means that TMI/TerreStar has to achieve the economies of the mass consumer electronic industry."[25] To make that effort worthwhile, any manufacturer will expect a minimum production run of substantially over one million units per year. Even that quantity, however, will be too small to keep costs at a level competitive with handsets for large terrestrial systems. Therefore, TMI/TerreStar believes that a single vendor will require a potential market of approximately 1.5 to two million units per year in order to supply new equipment. Moreover, to maintain a competitive supply of handsets, TerreStar must have access to at least three vendors, or about 4.5 to six million handsets.

Of course, no vendor, and much less three, will make that many handsets unless they believe TMI/TerreStar has the capacity to attract the customers to buy them. Factoring in customer churn (*i.e.*, the percentage of customers leaving TMI/TerreStar in a year), rates at which handsets are replaced by new models, and the degree to which competitors for integrated satellite/terrestrial systems may have similar equipment orders, TerreStar has concluded that maintaining a sales volume for three vendors at the

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24 *See infra*, Technical Appendix.

25 Declaration of Peter Cowhey, *infra*, at 4.

minimum scale over a multi-year period necessitates a system capable of supporting between fifteen to twenty-five million customers. It is estimated that a *minimum* of 2 x 10 MHz would be required to serve such a significant volume of consumers.

IV. Rural America will Experience Advanced Mobile Data and Digital Voice Services Similar to That Available in Urban Areas

Congress and the Commission have worked hard over the past several years to create mechanisms and incentives to facilitate the provision of digital data services to rural America. For example, years before it eliminated the CMRS spectrum cap entirely, the Commission raised the cap from 45 MHz to 55 MHz in rural areas, in part to "encourage deployment of PCS and other broadband services to rural areas."[26] Last year, the Commission adopted an Order in order to achieve the goal of "facilitating the provision of spectrum-based services to rural areas."[27]

Just last month, the Commission adopted a streamlined licensing mechanism to "stimulate the rapid expansion of wireless broadband services – especially in rural areas."[28] Congress, too, has established a Rural Broadband Access Loan and Loan Guarantee Program, which in fiscal year 2004 made over $2 billion available for constructing broadband service to qualified rural communities.[29] Numerous other legislative measures have been proposed to enhance rural consumers' access to data technology.[30]

TMI/TerreStar's MSS system will be capable of significantly improving the speed and sophistication of mobile communications services in rural areas. Because the powerful satellite signal eases the technological burden on the handsets, consumers in underserved areas will gain access to high-quality MSS equipment at reasonable costs. As noted above, this equipment will be nearly indistinguishable from ordinary terrestrial

26 15 FCC Rcd. 9219, 9257 (1999).

27 19 FCC Rcd. 19078 (2004). As part of that effort, the Commission increased power levels by 100 percent for broadband PCS base stations located in rural areas. *Id.* at ¶ 95. It has also encouraged providers to obtain Universal Service Fund support for extending coverage to rural areas. *See, e.g., Petition of Highland Cellular for Designation as an Eligible Telecommunications Carrier in the Commonwealth of Virginia*, 19 FCC Rcd. 6422 (2004) (granting Highland Cellular status as a competitive ETC in various rural service areas).

28 *Wireless Operations in the 3650-3700 MHz Band*, Report and Order and Memorandum Opinion and Order, ET Docket No. 04-151, FCC 05-56, at ¶ 1 (rel. March 16, 2005).

29 19 FCC Rcd. 19078, at ¶ 43.

30 *See, e.g.*, Broadband Rural Revitalization Act of 2005, S. 497, 109th Cong. (2005); Rural America Digital Accessibility Act, H.R. 144, 109th Cong. (2005).

mobile phones, in sharp contrast to cost-prohibitive and unwieldy satellite phones sold in the U.S. to date. Such provision of integrated data and voice services to low-cost hand-held user equipment in rural and remote areas of the United States is an unquestionable public interest benefit and precisely the sort of efficiency sought by the *Licensing Reform Order*.[31]

For many Americans in rural and remote areas, this will be their first access to reliable mobile voice and advanced mobile data technology at affordable prices.[32] As explained in the attached Declaration of Peter Cowhey, "for residential and SME customers who are purely in the rural market there are, in many cases, no alternatives for this kind of integrated voice and data service."[33]

Of particular importance, TMI/TerreStar's system will provide advanced mobile data services from the moment it is launched in 100 percent of the land area of the continental United States (and much of Canada), in keeping with President Bush's call for such access "in every corner of America"[34] by 2007. There are few technologies and services available to respond to the President's call with the same comprehensive coverage of a hybrid satellite/terrestrial system. To ensure that the mobile data and voice services afforded by TMI/TerreStar's MSS service reach a maximum level of rural America, it is essential that TMI/TerreStar have access to an additional 2 x 3.34 MHz of spectrum.

V.

TMI/TerreStar's System Will Become a Unique and Essential Tool For First Responders and Will Help to Safeguard Homeland Security

The principal beneficiaries of TMI/TerreStar's fully-capable hybrid satellite and terrestrial mobile telecommunications system will be public safety first responders and critical infrastructure entities, such as utility companies, power-generation facilities and remote airports. A system without sufficient spectrum could not provide service to such entities in a cost-effective manner.

Satellite communications are essential to a truly secure homeland. In times of emergency, whether man-made or natural, immediate and widespread access to a

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31 *Licensing Reform Order*, 18 FCC Rcd. at 10788.

32 Rural consumers using a booster antenna attached to their PC may be able to achieve speeds as high as 2 Mbps.

33 Declaration of Peter Cowhey, *infra*, at 2.

34 President George W. Bush, Remarks at the U.S. Dept. of Commerce (June 24, 2004) ("Sometimes the problem we face here in America is that technology is available in maybe just the big cities... What we're interested in is to make sure broadband technology is available in every corner of America by the year 2007.").

ubiquitous and redundant voice and data network can be decisive.[35] MSS systems are uniquely positioned to provide this essential service because satellites, unlike terrestrial base stations and wired telephone networks, are significantly less vulnerable to attack or natural disaster.[36] The amount of spectrum available is, of course, central to any system's ability to function at the higher levels demanded by potential crises. Given sufficient spectrum, TMI/TerreStar's system will be able to operate at the sharply increased capacity demanded by peak usage surrounding such incidents.

In addition to these essential first-response benefits, TMI/TerreStar's system will benefit our Nation's homeland security efforts by providing a ubiquitous and redundant digital communications system to homeland safety workers literally anywhere in the United States from the moment the system is activated.[37] Homeland security officials require access to a system that can communicate over the entire United States, providing essential access to data transmission and voice services at the site of rural power plants and transmission facilities. The 104 nuclear power plants operating in the United States, for example, are located predominantly in highly rural areas where traditional wireless services are less likely to be available than in urban areas.[38] The same is true for critical infrastructure in the form of bridges, dams, energy transmission facilities, and other types of power-generation plants.

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35 *See, e.g.*, 19 FCC Rcd. 16830, 16836 (2004) (discussing the immediate aftermath of the terrorist attacks of Sept. 11, 2001, and noting that "[S]atellite communications… were used to initiate the movement of equipment and personnel into the affected areas for restoration purposes and to coordinate their work.").

36 *See, e.g.*, Trudy Walsh, *Connecticut Emergency Calls Go Via Satellite*, Gov't Computer News, May 17, 2004, at 17 (discussing the Connecticut Dept. of Public Health's decision to acquire a satellite-based emergency dispatch network because it "wanted something that was completely independent of the public switched telephone network or any other infrastructure such as a tower.").

37 The terrestrial wireless industry has taken remarkable steps toward providing access to the vast majority of the U.S. population, but even the most optimistic scenarios of the industry cannot predict coverage of the entire land mass of the continental United States. *See, e.g.*, *Annual Report and Analysis of Competitive Market Condition with Respect to Commercial Mobile Services*, 19 FCC Rcd. 20597, at App. B (2004).

38 *See, e.g.*, Energy Information Administration, Department of Energy, *U.S. Nuclear Reactors*, www.eia.doe.gov/cneaf/nuclear/page/nuc_reactors/reactsum.html (last visited April 16, 2005).

Conclusion

The Bureau should promptly amend TMI's LOI authorization by redistributing an additional 3.34 MHz of recently surrendered spectrum in the 2 GHz uplink and downlink bands to TMI, so as to ensure a vibrant and competitive marketplace for MSS. TMI/TerreStar's state-of-the-art MSS system requires at least 10 MHz of spectrum in each direction to provide the maximum benefits to the consumer market, first responders, homeland security, and rural America. The construction and operation of an MSS system that optimizes the use of spectrum to serve these markets provides precisely the type of extraordinary efficiencies that the Commission contemplated when determining its spectrum allocation framework in the *Licensing Reform Order*. These efficiencies can be realized to their fullest extent only if the Bureau grants TMI/TerreStar's request.

Respectfully submitted,

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APPENDIX A

Technical Appendix

Certification of Santanu Dutta

Technical Appendix

1.0 Summary

The purpose of this technical Appendix is to demonstrate that a minimum of 10 MHz of spectrum is needed by TerreStar's satellite system to enable the TerreStar satellite to utilize all of its available power in providing voice and broadband data services and reach a critical mass of subscription potential to enable the development of cost-effective, feature rich and mass-produced user equipment. More specifically:

(1) A competitive MSS/ATC business requires user equipment that is similar in features, size and cost to current cellular/PCS user equipment. A sufficient amount of spectrum is needed by a MSS/ATC system to be able to serve enough customers to provide incentives for manufacturers to develop and market attractive and low-cost user equipment. Moreover, efficient use of the Aggregate EIRP (AEIRP) resources of a satellite that supports such user equipment requires at least 10 MHz of spectrum to avoid becoming bandwidth limited and to be able to use all of its available AEIRP in providing voice and broadband data services (this aspect of the satellite design is demonstrated in the attached link budgets; *see* Supplements I and II).

(2) At least 10 MHz of spectrum is necessary to permit a MSS/ATC system to deploy 3G and 4G technologies, with wider carrier bandwidths, which will permit the MSS/ATC system to remain competitive over the 15 year life of the satellite and provide broadband services to rural and underserved areas. With 10 MHz of spectrum, 2 Mbps packet data rates will initially be provided to properly configured user equipment on some carriers, increasing to higher rates as technology evolution of terminal equipment and infrastructure allows.

2.0 Detailed Discussion

2.1 A Transparency-Class Satellite needs 10 MHz of Spectrum

TerreStar uses the term, "transparency" to describe a MSS/ATC service that is available via an integrated user device providing satellite and ATC communications, with the device resembling a mainstream, terrestrial-only, end user device in aesthetics, features and manufacturing cost. TerreStar's objective is to provide user equipment that offers both terrestrial and satellite services and still *looks, feels, functions and costs* like modern cellular equipment. Such equipment is termed "transparent" equipment and the satellite serving such equipment is termed a "transparency class" satellite.

Transparency is a revolutionary concept, which, besides promising for the first time, a sustainable and profitable MSS/ATC business, has many implications for the public good. It makes modern wireless services available to rural and remote areas with the same terminals that are used in urban areas. User equipment is obtained through mass market distribution channels and not niche channels as has been the case for MSS in the past. The terminals are competitive in features and applications with the best terrestrial-only terminals. There are also significant benefits for the public safety industry. The latter is moving to the use of mass market terminals, such as GSM and CDMA2000, with special security features authorized by the Government. Transparency adds ubiquitous coverage to secure handsets, greatly increasing their utility.

Although transparency is a new concept, its time has come because of the capabilities of modem satellites. Based on link budgets provided in Supplement I for voice services, a geosynchronous satellite that can deliver a G/T of 21 dB/K can support a transparent handset. *A transparent handset is characterized by an average antenna gain of -4 dBi, which is representative of the antenna gain of cellular/PCS mobile phones,*[1] *and a maximum ERP of 250 mW (-6 dBW) for CDMA2000 phones.* The return link is the *weak link* in supporting transparency, as additional power can be assigned to temporarily disadvantaged terminals since the satellite's AEIRP is available on a pooled basis. Hence the focus is on the return link in accommodating transparency.

The high G/T of a transparency-class satellite is achieved by having a high antenna gain (of the order of 48 dBi) through the use of a very large reflector (over 60 feet across). Such a reflector provides highly focused spot beams (of diameters around 250 km).[2] A geostationary satellite with such a reflector necessarily uses a large satellite bus and other components. The DC power availability of the bus and power amplifier efficiency in the satellite payload, which do not have a strong impact on the cost of the space segment, imply that a transparency-class satellite comes with a large AEIRP (~80 dBW). In order to utilize this large AEIRP fully, sufficient bandwidth must be made available to the service; otherwise some of the satellite power will lay fallow. Supplement I shows link budgets for TerreStar's planned S-band satellites with 6.67 MHz and 10 MHz of available spectrum. It is clear that, while with 6.67 MHz of spectrum, the system is spectrum limited, with 10 MHz of spectrum the satellite becomes substantially balanced between AEIRP and available spectrum. Thus, with 10 MHz of spectrum, all of the available power (AEIRP) of the satellite will be utilized in providing communications services to a larger population of users whereas with less than 10 MHz of spectrum, some of the satellite's power will inadvertently remain unutilized (*i.e.*, the satellite will be spectrally limited).

2.2 A modern MSS/ATC system requires at least 10 MHz of spectrum to Remain Competitive over the 15 Year Life of the Satellite

ATC is an essential component of a modern MSS for a multitude of reasons, as has been pointed out by the Commission in the ATC Order. These include: (a) the ability of the

[1] The phone is oriented as if held to a human ear and the antenna gain is averaged over a domain of 30 – 50 degrees in elevation and all azimuth angles.

[2] A low system noise temperature, T, in the satellite receiver is also a necessity. However, as this parameter does not vary greatly between satellites operating at a given frequency band, the factor that distinguishes a transparency-class and a non-transparency-class satellite is the antenna gain, G.

MSS provider to offer more economically and qualitatively attractive services in urban areas than is feasible with a satellite-only network, and (b) generate the volumes of user terminals necessary to support transparency. In order to offer *mass market* integrated MSS/ATC terminals, the annual production volumes must exceed a minimum threshold, typically in the millions of units, in order to attract mass market terminal manufacturers. Even with the 250 km satellite spot beams stated above, the potential re-use from satellite alone is far too low to achieve such volume. Such volume is only possible if (a) the MSS terminal has an integrated ATC mode that is aligned with a modern mass market standard, and (b) if the service has sufficient capacity (i.e., spectrum) to support appropriate device volumes. With 10 MHz of MSS spectrum, an adequate incentive will exist for equipment manufacturers to develop and produce integrated MSS/ATC transparency-class handsets in large volumes.

Alignment with modern terrestrial air interfaces is necessary to provide broadband services. Terrestrial wireless standards are moving to wider carrier bandwidths, witness the move from 30 kHz (DAMPS) through 200 kHz (GSM) and 1.25 MHz (IS-95 and CDMA2000) to 5 MHz and beyond (WCDMA and WiMax). It is very likely that, in the near future, channel/carrier bandwidths greater than 1.25 MHz will become the norm. Wider channel bandwidths offer many advantages, ranging from greater multipath resistance to higher burst throughputs for packet data services. To be aligned with mass market air interface modes, the MSS/ATC system needs at least 10 MHz of spectrum in order to develop a reasonable frequency reuse cluster size over the satellite spot beams and associated frequency reuse in the ATC.

It is noteworthy that, in the satellite mode, the data rate for broadband access is limited by the user terminal's antenna gain.[3] The link budget of Supplement II is for a user terminal with a 7 dBi antenna gain, which is achievable for a palm-top type of data device. The scenario corresponds to 10,830 users accessing the forward link of a satellite-adapted Flash-OFDM air interface with an instantaneous burst data rate of 495 kbps. The peak data rate available to an individual user, on demand, is the full burst rate of 495 kbps.

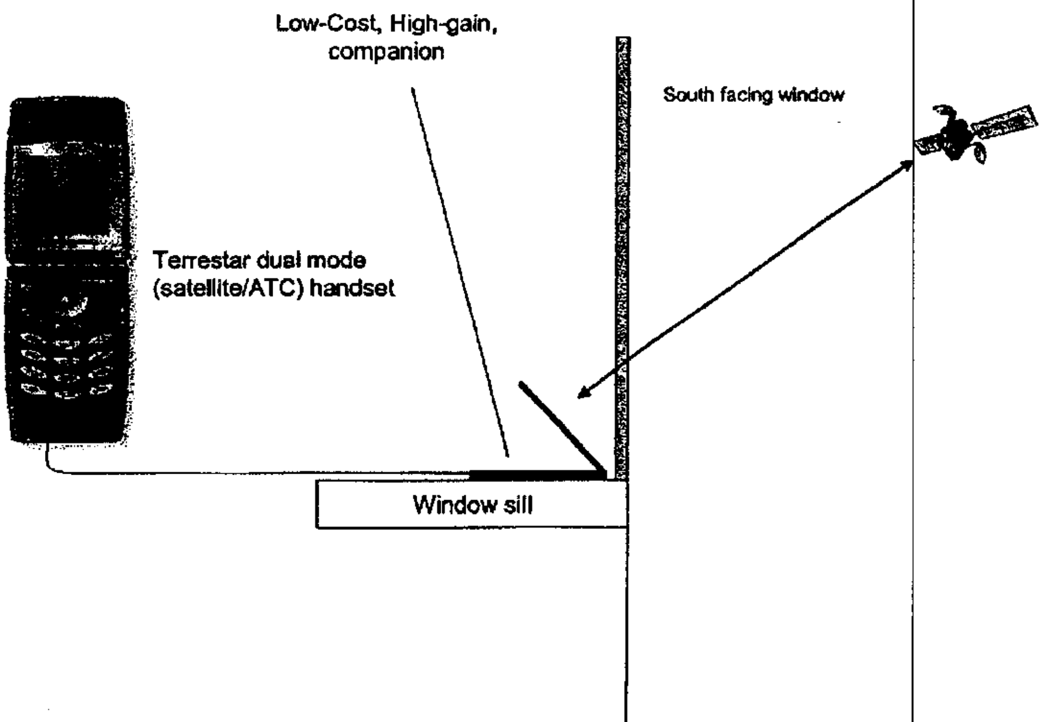
It is noteworthy that the data link budget is spectrum limited even at a 10 MHz level of available bandwidth (power limited capacity is higher than the spectrum limited capacity). Clearly, allocating *at least* 10 MHz of bandwidth is necessary for offering high data rate services on satellite comparable to 3.5-4G services.

The allocation of 10 MHz of spectrum would also allow the deployment of higher burst rate satellite carriers of wider channel bandwidth, thereby increasing the *on demand* throughput to selected user classes. A burst rate of 2 Mbps (or higher) could be supported on a 5 MHz bandwidth carrier with the same, 7 dBi-antenna-gain user terminal

[3] Relatively high antenna gains can be realized in transportable terminals with circularly polarized patch antennas integrated into the lids of data devices like palm-top and laptop computers. Alternatively, dual mode (satellite/ATC) TerreStar hand-held units can be connected to low cost "companion" devices that provide the necessary antenna aperture and are pointed at the satellite with user assistance, as shown in the Figure. The companion will comprise a RF power booster low noise amplifier, and duplexers, but no baseband processors, i.e. it can be thought of as an *active antenna*.

and higher satellite EIRP. The following Figure illustrates one of several user device configurations that would be able to take advantage of the broad-band capability and power resource of the satellite to receive high-speed packet data rates at 2 Mbps or more.

High Speed Data Access with TerreStar Handset using a Companion Device



Finally, it is noteworthy that, the TerreStar satellite will be based on an innovating technology whereby satellite beams (cells) are formed adaptively on the ground (at a satellite gateway) by a technique called Ground-Based Beam Forming (GBBF). Besides forming optimum satellite beams (cells) GBBF is also capable of Adaptive Interference Cancellation (AIC). As such, TerreStar would be making the best possible use of its spectrum. In other words, TerreStar would be maximizing spectrum efficiency, because AIC would allow (a) greater loading of the satellite beams than would be possible otherwise, and (b) the reuse of spectrum between the ground and space segments would be optimized through cancellation of ATC-induced uplink interference. The signal processing of GBBF, which would reside at a satellite gateway thus relieving the satellite of complexity and risk, would operate on each communications channel, of each user, to form, for each user, an optimum beam, that would follow the user in the event the user changes position during a communications session, and would thus, in conjunction with its ability to suppress interference, provide the most robust communications link possible.

Supplement I.1 (Voice Link Budgets)
Available Bandwidth : 6.67 MHz

Results for Voice Link Budgets for CDMA-2000 System over NextGen Satellite

Systemwide Parameters	**Unit**	
Spectrum available	MHz	6.67
Total number of spot beams		285
Average fade & blockage margin	dB	5
Codes per carrier		10
Satellite system capacity	Users	2,850
Capacity limiting factor		Spectrum Available
Forward Link		
Satellite AEIRP	dBW	80
Average EIRP/Carrier	dBW	52.4
Allocated fading & blockage	dB	6
Return Link		
Mobile EIRP	dBW	-12
Allocated fading & blockage	dB	6

NextGen Satellite CDMA2000 Forward Voice Link Budget

Frequency reuse factor 5

	Common Parameters	Sync. Channel	Paging Channel	Traffic Channel	Units
		<— Channel-specific —>			
CHANNEL PARAMETERS:					
Total number of chnls. per forward carrier:		1	3	10	
Channel info. rate (for calculating Ebi):		1200.0	4800.0	4800.0	bps
Transmit duty factor or voice activity fac.:		0.0	0.0	-4.0	dB
Forward carrier chip rate:	1.2288				Mcps
Pct. forward cxr. pwr. allocated to Pilot Ch.:	20.0%				
Total number of co-frequency spot beams:	57				
DOWNLINK Ebi/N0 (thermal):					
Satellite EIRP per channel:		37.8	43.8	43.8	dBW
Path loss:	-191.0				dB
Polarization mismatch loss (CP to LP):	-3.0				dB
Fading and blockage allocation	-6.0				dB
User terminal G/T:	-31.0				dB/K
Boltzmann's constant:	-228.6				dBW/Hz.K
Downlink Ebi/N0:		4.6	4.6	4.6	dB
UPLINK Ebi/N0 (thermal):					
E/S EIRP to Satellite EIRP conversion:	5.0				dB
Earth station EIRP per channel:		42.8	48.8	48.8	dBW
Uplink path loss:	-206.7				dB
Uplink rain loss (assume site diversity):	-6.0				dB
Satellite G/T:	14.0				dB/K
Boltzmann's constant:	-228.6				dBW/Hz.K
Uplink Ebi/N0:		41.9	41.9	41.9	dB
INTRA-BEAM SELF INTERFERENCE (due to imperfect rejection of Walsh codes):					
Orthogonality impairment factor:	8.0				dB
Forward carrier EIRP (time-averaged):	53.1				dBW
CDMA processing gain:		30.1	24.1	24.1	dB
Self-Interference Ebi/I0 (multi-path):		22.8	22.8	22.8	dB
INTER-BEAM INTERFERENCE:					
Sat. antenna adjacent spot beam discrimination:	28.0				dB
Total number of interfering co-freq. carriers:	56				
Interfering carrier EIRP (time-avg.):	53.4				dBW
CDMA processing gain:		30.1	24.1	24.1	dB
System loading		100%	100%	100%	
Adjacent Beam Interference Ebi/I0:		25.0	25.0	25.0	dB
TOTAL:					
TOTAL Ebi/(N0 + I0):		4.5	4.5	4.5	dB
Min. reqd. Ebi/N0 (1% frame error rate):	3.5				dB
Implementation Loss Margin		1.0	1.0	1.0	dB

NextGen Satellite CDMA2000 Return Voice Link Budget

Frequency reuse factor 5

INFORMATION RATE (for calculating Ebi):

User data plus in-band signaling:	4.0	kbps

CHANNEL/SATELLITE LOADING:

Simultaneous users per carrier:	10
Total number of co-freq. beams:	57

UPLINK Ebi/N0 (thermal):

Terminal SSPA Output Power	-6.0	dBW
Diplexer/Feed Loss	-1.0	dB
Terminal Tx Antenna Gain	-4.0	dBi
Reduction in Ebi due to pilot power:	-1.0	dB
Terminal Uplink EIRP:	-12.0	dBW
U/L Path Loss	-190.3	dB
Allocated fading and blockage loss	-6.0	dB
S/C G/T:	20.5	dB/K
2-Polarization recombination gain	1.0	dB
2-satellite diversity improvement	0.0	dB
Uplink Ebi/N0:	5.0	dB

DOWNLINK Ebi/N0 (thermal):

Reston Hub E/S G/T	36.5	dB/K
Total S/C downlink EIRP	47.0	dBW
Total return downlink bandwidth	250.0	MHz
Bandwidth per CDMA channel	1.25	MHz
Num. simultaneous users per channel	10.0	
Satellite EIRP per user per return carrier:	14.0	dBW
Rain loss (w/ site diversity)	-6.0	dB
Path loss	-205.2	dB
2-satellite diversity improvement - D/L:	0	dB
Boltzmann's constant	-228.6	dBW/Hz.K
Downlink Ebi/N0:	31.1	dB

INTRA-BEAM SELF INTERFERENCE Ebi/I0:

Num. Interfering Terminals in Beam	9	
Imperfect Power Control Factor	0.5	
Chip rate:	1228.8	kcps
Processing Gain:	256.0	
Ebi/I0 due to processing gain only:	11.4	dB
2-Polarization recombination gain	1.0	dB
2-satellite diversity improvement:	0.0	dB
Voice activity improvement factor:	2.0	dB
Self-Jamming Ebi/I0 (intra-beam):	14.4	dB

INTER-BEAM INTERFERENCE Ebi/I0

Avg. S/C antenna discrimination to adj. beams:	28.0	dB
Total interbeam C/I	10.5	
Number of co-freq. interfering beams:	56	
Number of simultaneous users per beam:	10.0	
Processing Gain:	256.0	
Imperfect Power Control Factor	-3.0	dB
Ebi/I0 due to processing gain only:	21.5	dB
2-satellite diversity improvement:	0.0	dB
2-Polarization recombination gain	1.0	dB
Voice activity improvement factor:	2.0	dB
System loading	100%	
Aggregate Ebi/I0 fm. all adjacent beams:	24.5	dB

SUMMARY:

U/L Ebi/N0 (thermal):	5.0	dB
Intra-beam Self-Jamming Ebi/I0:	14.4	dB
D/L Ebi/N0 (thermal):	31.1	dB
Adj. spot beam interference Ebi/I0	24.5	dB
TOTAL Ebi/(N0 + I0):	4.5	dB
Min. reqd. Ebi/N0 (1% frame error rate):	3.5	dB
Implementation Loss Margin	1.0	dB

NextGen Satellite CDMA2000 Voice Capacity Budget		
Capacity Limit Based on Satellite Power:		
Average fading and blockage	5	dB
Satellite antenna gain:	48.0	dBi
Sat. SSPA total output power:	33.0	dBW
Satellite feed losses	-1.0	dB
Satellite aggregate EIRP	80.0	dBW
2-satellite operation:	0.0	dB
% sat. EIRP available for CDMA:	100.0%	
Total available satellite EIRP:	**80.0**	dBW
EIRP per forward carrier:	52.4	dBW
Total # forward cxrs. supported:	**580**	
Max. users per carrier:	10	
Total # simultaneous voice ccts.:	**5,800**	
Capacity Limit Based on Available Banwidth		
Available bandwidth	6.67	MHz
Frequency reuse factor	5	
No. of spot beams	285	
No. of frequency reuse clusters	57	
No. of frequency sets in each cluster	1	
No. of (distinct) frequencies in each cluster	5	
Occupied bandwidth	6.25	MHz
No. of carriers in total system	**285**	
Max. users per carrier:	10	
Total # simultaneous voice ccts.:	**2,850**	

Supplement I.II (Voice Link Budgets)
Available Bandwidth : 10 MHz

Results for Voice Link Budgets for CDMA-2000 System over NextGen Satellite

Systemwide Parameters	**Unit**	
Spectrum available	MHz	10
Total number of spot beams		285
Average fade & blockage margin	dB	5
Codes per carrier		10
Satellite system capacity	Users	5,670
Capacity limiting factor		Satellite Power
Forward Link		
Satellite AEIRP	dBW	80
Average EIRP/Carrier	dBW	52.5
Allocated fading & blockage	dB	6
Return Link		
Mobile EIRP	dBW	-12
Allocated fading & blockage	dB	6

NextGen Satellite CDMA2000 Forward Voice Link Budget

Frequency reuse factor 4

CHANNEL PARAMETERS:	Common Parameters	Sync. Channel	Paging Channel	Traffic Channel	Units
		<== Channel-specific	==>		
Total number of chnls. per forward carrier:		1	3	10	
Channel info. rate (for calculating Ebi):		1200.0	4800.0	4800.0	bps
Transmit duty factor or voice activity fac.:		0.0	0.0	-4.0	dB
Forward carrier chip rate:	1.2288				Mcps
Pct. forward cxr. pwr. allocated to Pilot Ch.:	20.0%				
Total number of co-frequency spot beams:	71				
DOWNLINK Ebi/N0 (thermal):					
Satellite EIRP per channel:		37.9	43.9	43.9	dBW
Path loss:	-191.0				dB
Polarization mismatch loss (CP to LP):	-3.0				dB
Fading and blockage allocation	-6.0				dB
User terminal G/T:	-31.0				dB/K
Boltzmann's constant:	-228.6				dBW/Hz.K
Downlink Ebi/N0:		**4.7**	**4.7**	**4.7**	**dB**
UPLINK Ebi/N0 (thermal):					
E/S EIRP to Satellite EIRP conversion:	5.0				dB
Earth station EIRP per channel:		42.9	48.9	48.9	dBW
Uplink path loss:	-206.7				dB
Uplink rain loss (assume site diversity):	-6.0				dB
Satellite G/T:	14.0				dB/K
Boltzmann's constant:	-228.6				dBW/Hz.K
Uplink Ebi/N0:		**42.0**	**42.0**	**42.0**	**dB**
INTRA-BEAM SELF INTERFERENCE (due to imperfect rejection of Walsh codes):					
Orthogonality impairment factor:	8.0				dB
Forward carrier EIRP (time-averaged):	53.2				dBW
CDMA processing gain:		30.1	24.1	24.1	dB
Self-Interference Ebi/I0 (multi-path):		**22.8**	**22.8**	**22.8**	**dB**
INTER-BEAM INTERFERENCE:					
Sat. antenna adjacent spot beam discrimination:	28.0				dB
Total number of interfering co-freq. carriers:	70				
Interfering carrier EIRP (time-avg.):	53.5				dBW
CDMA processing gain:		30.1	24.1	24.1	dB
System loading		100%	100%	100%	
Adjacent Beam Interference Ebi/I0:		**24.1**	**24.1**	**24.1**	**dB**
TOTAL:					
TOTAL Ebi/(N0 + I0):		**4.5**	**4.5**	**4.5**	**dB**
Min. reqd. Ebi/N0 (1% frame error rate):	3.5				dB
Implementation Loss Margin		**1.0**	**1.0**	**1.0**	**dB**

NextGen Satellite CDMA2000 Return Voice Link Budget

Frequency reuse factor 4

INFORMATION RATE (for calculating Ebi):

User data plus in-band signaling:	4.8	kbps

CHANNEL/SATELLITE LOADING:

Simultaneous users per carrier:	10
Total number of co-freq. beams:	71

UPLINK Ebi/N0 (thermal):

Terminal SSPA Output Power	-6.0	dBW
Diplexer/Feed Loss	-1.0	dB
Terminal Tx Antenna Gain	-4.0	dBi
Reduction in Ebi due to pilot power:	-1.0	dB
Terminal Uplink EIRP:	-12.0	dBW
U/L Path Loss	-190.3	dB
Allocated fading and blockage loss	-6.0	dB
S/C G/T:	20.5	dB/K
2-Polarization recombination gain	1.0	dB
2-satellite diversity improvement	0.0	dB
Uplink Ebi/N0:	5.0	dB

DOWNLINK Ebi/N0 (thermal):

Reston Hub E/S G/T	36.5	dB/K
Total S/C downlink EIRP	47.0	dBW
Total return downlink bandwidth	250.0	MHz
Bandwidth per CDMA channel	1.25	MHz
Num. simultaneous users per channel	10.0	
Satellite EIRP per user per return carrier:	14.0	dBW
Rain loss (w/ site diversity)	-6.0	dB
Path loss	-205.2	dB
2-satellite diversity improvement - D/L:	0	dB
Boltzmann's constant	-228.6	dBW/Hz.K
Downlink Ebi/N0:	31.1	dB

INTRA-BEAM SELF INTERFERENCE Ebi/I0:

Num. Interfering Terminals in Beam	9	
Imperfect Power Control Factor	0.5	
Chip rate:	1228.8	kcps
Processing Gain:	256.0	
Ebi/I0 due to processing gain only:	11.4	dB
2-Polarization recombination gain	1.0	dB
2-satellite diversity improvement:	0.0	dB
Voice activity improvement factor:	2.0	dB
Self-Jamming Ebi/I0 (intra-beam):	14.4	dB

INTER-BEAM INTERFERENCE Ebi/I0

Avg. S/C antenna discrimination to adj. beams:	28.0	dB
Total interbeam C/I	9.5	
Number of co-freq. interfering beams:	70	
Number of simultaneous users per beam:	10.0	
Processing Gain:	256.0	
Imperfect Power Control Factor	-3.0	dB
Ebi/I0 due to processing gain only:	20.5	dB
2-satellite diversity improvement:	0.0	dB
2-Polarization recombination gain	1.0	dB
Voice activity improvement factor:	2.0	dB
System loading	100%	
Aggregate Ebi/I0 fm. all adjacent beams:	23.5	dB

SUMMARY:

U/L Ebi/N0 (thermal):	5.0	dB
Intra-beam Self-Jamming Ebi/I0:	14.4	dB
D/L Ebi/N0 (thermal):	31.1	dB
Adj. spot beam interference Ebi/I0	23.5	dB
TOTAL Ebi/(N0 + I0):	4.4	dB
Min. reqd. Ebi/N0 (1% frame error rate):	3.5	dB
Implementation Loss Margin	0.9	dB

NextGen Satellite CDMA2000 Voice Capacity Budget

Capacity Limit Based on Satellite Power:		
Average fading and blockage	5	dB
Satellite antenna gain:	48.0	dBi
Sat. SSPA total output power:	33.0	dBW
Satellite feed losses	-1.0	dB
Satellite aggregate EIRP	80.0	dBW
2-satellite operation:	0.0	dB
% sat. EIRP available for CDMA:	100.0%	
Total available satellite EIRP:	**80.0**	dBW
EIRP per forward carrier:	52.5	dBW
Total # forward cxrs. supported:	**567**	
Max. users per carrier:	10	
Total # simultaneous voice ccts.:	**5,670**	
Capacity Limit Based on Available Banwidth		
Available bandwidth	10	MHz
Frequency reuse factor	4	
No. of spot beams	285	
No. of frequency reuse clusters	71	
No. of frequency sets in each cluster	2	
No. of (distinct) frequencies in each cluster	8	
Occupied bandwidth	10	MHz
No. of carriers in total system	**568**	
Max. users per carrier:	10	
Total # simultaneous voice ccts.:	**5,680**	

Supplement II (Data Link Budgets), Available Bandwidth: 10MHz

TerreStar Satellite OFDM Data Capacity Analysis

Assumptions		
Number of satellites	1	
Satellite Type	TerreStar 1	
Satellite Available Power (EIRP)	80	dBW
Satellite G/T	20.5	dB/K
Average Satellite beam discrimination	28	dB
Total number of illuminated beams per satellite	285	
Number of CONUS beams/satellite	285	
Carrier bandwidth	1.25	MHz
Average downlink throughput/SDC	25	kbps
Number of Traffic FFT	96	
Handset antenna gain	-7	dBi
Available bandwidth	10	MHz
Frequency reuse factor	4	
Fade margin	-4	dB
Average Fade Margin (for capacity)	-4	dB

Results	
Number of SDC's for CONUS	**10,830**
Capacity limiting factor	**Spectrum Available**
Downlink throughput	**495 kbps**
Average uplink throughput per user	**4.8 kbps**
Maximum uplink throughput per user	**77.3 kbps**

Capacity Analysis

Capacity Limit Based on Satellite Power	
Average EIRP per carrier	50.4 dBW
TCH per carrier per beam per satellite	1
Number of SDCs/TCH	19
VAD gain	1
# of SDCs per carrier	19
Total number of forward carriers supported	912
Total system-wide number of SDCs.:	**17,328**
Capacity Limit Based on Available Bandwidth	
No. of frequency reuse clusters	72
No. of frequency sets in each cluster	2
No. of (distinct) frequencies in each cluster	8
Occupied bandwidth	10 MHz
No. of carriers in total system	**576**
Max. SDCs per carrier/beam:	19
Total system-wide number of SDCs.:	**10,830**

SDC = Simultaneous Data Circuit

NextGen Satellite OFDM Return Data Link Budget
(Average throughput per user)

Uplink Es/No (thermal):			
Terminal Output Power	24.0	dBm	
Diplexer Loss	-2.5	dB	
TX Antenna Gain	7.0	dBi	
Terminal EIRP	28.5	dBm	
	-1.5	dBW	
Number of tones	1		
Code rate	1/4		
UL burst rate	4.8	kbps	
TCH EIRP	28.5		
UL Pass loss	-190.3	dB	
Allocated fading and blockage loss	-4.0	dB	
S/C G/T	20.5	dB/K	
Boltzmann's constant	-198.6	dBm/HzK	
2-polarization recombination gain	0.0		
2-satellite diversity improvement	0.0		
UL thermal Es/No	**12.8**		
Avg S/C antenna discrimination to adj. Beams	28.0	dB	
number of co-freq interfering beams	70		
adj beam loading	19.8%		
UL interference Es/Io	**16.6**		
vad gain (40%)	0.0	dB	
2-satellite diversity improvement	0.0	dB	
2-polarization recombination gain	0.0	dB	
Improved UL interference (Es/Io)	**16.6**		
Es/(No + Io)	**11.3**	dB	
coding gain	2.9	dB	
Es/(No+Io)	14.1	dB	
Required SNR	1.5	dB	
Implementation Loss Margin	12.6	dB	

Terrestar Satellite OFDM Return Data Link Budget

(Maximum throughput per user)

Uplink Es/No (thermal):		
Terminal Output Power	24.0	dBm
Diplexer Loss	-2.5	dB
TX Antenna Gain	7.0	dBi
Terminal EIRP	28.5	dBm
	-1.5	dBW
Number of tones	16	
Code rate	1/4	
UL burst rate	77.3	kbps
TCH EIRP	28.5	
UL Pass loss	-190.3	dB
Allocated fading and blockage loss	-4.0	dB
S/C G/T	20.5	dB/K
Boltzmann's constant	-198.6	dBm/HzK
2-polarization recombination gain	0.0	
2-satellite diversity improvement	0.0	
UL thermal Es/No	**0.7**	
Avg S/C antenna discrimination to adj. Beams	28.0	dB
number of co-freq interfering beams	70	
adj beam loading	90.6%	
UL interference Es/Io	**10.0**	
vad gain (40%)	0.0	dB
2-satellite diversity improvement	0.0	dB
2-polarization recombination gain	0.0	dB
Improved UL Interference (Es/Io)	**10.0**	
Es/(No + Io)	**0.3**	dB
coding gain	2.9	dB
Es/(No+Io)	3.1	dB
Required SNR	1.5	dB
Implementation Loss Margin	1.6	dB

NextGen Satellite OFDM Forward Data Link Budget

Downlink Es/No (thermal):		
Satellite carrier EIRP	50.4	dBW
Pilot & ASG overhead	3.0	dB
N TCH (number of channels)	1	
Satellite TCH EIRP	47.4	dBW
number of tones	96	
code rate	1/4	
DL burst rate (PHY rate)	495	kbps
Polarization mismatch loss	0.0	dB
TCH EIRP	47.4	dBW
DL Pass loss	-191.0	dB
Allocated fading and blockage loss	-4.0	dB
MT G/T	-20.0	dB/K
Boltzmann's constant	-198.6	dBm/HzK
DL thermal Es/No	**0.7**	dB
Avg S/C antenna discrimination to adj. Beams	28.0	dB
number of co-freq interfering beams	70	
adj beam loading	100.0%	
spreading gain	0.0	dB
DL interference Es/Io	**6.5**	dB
vad gain (40%)	0.0	dB
Improved DL interference (Es/Io)	**6.5**	dB
Es/(No + Io)	**-0.3**	dB
coding gain	2.9	dB
Es/(No+Io)	2.5	dB
Required SNR	1.5	
Implementation Loss Margin	**1.0**	dB

TECHNICAL CERTIFICATION

I, Dr. Santanu Dutta, Vice President Systems Engineering of Mobile Satellite Ventures, LP certify under penalty of perjury that:

I am the technically qualified person with overall responsibility for preparation of the technical information contained in this filing. I am familiar with the requirements of the Commission's rules, and that the technical information contained in the present filing is true and correct to the best of my belief.

Dr. Santanu Dutta
Vice President Systems Engineering

April 19, 2005

APPENDIX B

Declaration of Peter Cowhey

Declaration of Peter Cowhey

My name is Peter Cowhey. I am the Dean of the Graduate School of International Relations and Pacific Studies at the University of California, San Diego. I am also the Qualcomm Professor of Communications and Technology Policy. I have published numerous books and papers on the global communications industry and policy, including studies of the wireless and satellite markets. In addition, I have served as the Senior Counselor for International Economic and Competition Policy at the FCC and as the Chief of the International Bureau of the FCC. I have also advised numerous companies in the communications industry, including wireless and satellite technology firms.

TMI/TerreStar has asked me to offer my expert opinion on two closely related questions:
1. Would the TMI/TerreStar system enhance consumer welfare in its target market?
2. What are the minimum economies of scale necessary for a satellite system like TMI/TerreStar to succeed? In particular, what economies of scale are necessary in the provision of terminal equipment in order to have a competitive offering? What do these economies of scale imply about system capacity and spectrum?

I have examined the proprietary information of TMI/TerreStar in regard to its business plan and vendor relationships. I have compared this information to my own analysis of the dynamics of the industry in order to assess the claims of TMI/TerreStar. This declaration states my expert conclusions.

I. Consumer Benefits and Competition Issue

TMI/TerreStar proposes to launch a 2GHz (S Band) Satellite system featuring a satellite with very substantial capacity that allows it to serve terrestrial terminals effectively. These satellites will be integrated with an ancillary terrestrial component (ATC) in a manner that will conform to the FCC requirements stipulated in its February 25 Order.[1] The result will be a hybrid system that can serve both urban and rural areas on a seamless basis with voice and broadband data services utilizing a single terminal.

A. Benefits for Consumers

The target markets where the system will offer particular benefit, in my opinion, especially in three segments: 1. emergency and public services requiring ubiquity, high quality and reliability of service standards (including survivability in adverse conditions), and security measures; 2. vertical market segments of business applications featuring both urban and rural coverage, such as electric utilities and trucking systems that require quality of assurance, reliability and security guarantees; and, 3. rural consumers in both the residential and business markets who lack robust competition in phone services and have few alternatives for data services better than 56 K dial-up modems.

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[1] FCC, *Flexibility for Delivery of Communications by Mobile Satellite Service Providers in the 2 GHz Band, the L Band and the 1.6/2.4 GHz Band*, IB Docket No. 01-185, FCC 05-30 (released Feb. 25, 2005)

From the viewpoint of analyzing the gain for consumer welfare from TMI/TerreStar the key is its national rural coverage with a combination of voice and data rates that easily exceed conventional cellular systems while providing high levels of security, reliability, and quality. (Second generation wireless systems (2G), for example, provide data rates that are significantly less than even 56K landline modems.[2]) This combination of features is what is particularly attractive in the first and second market segments because advanced wireless networks for these market segments are likely to remain clustered around urban centers and the largest highway corridors for the next several years. And for residential and SME customers who are purely in the rural market there are, in many cases, no ready alternatives for this kind of integrated voice and data service (including higher data rates than conventional dial-up services).[3]

B. Competition Analysis

The Commission has created a rebuttable presumption that there should be more than two MSS providers in the 2GHz band. The purpose of the presumption is that it will enhance consumer welfare by providing more competition. However, the TMI/TerreStar petition shows why the Commission's presumption does not serve its goal of enhancing consumer welfare by assuring more MSS competitors in this band. In fact, this approach clashes with the Commission's own rethinking of spectrum policy. An approach more consistent with general Commission policy on spectrum would release large enough blocks of spectrum for MSS systems in the 2GHz band to allow market driven choices about technology and service mixes.

While it is perfectly appropriate for the Commission to be worried that spectrum allocations and assignments might in some cases lead to limited numbers of competitors in a market, this is not the risk here. Permitting two 2 GHz MSS providers to share the current allocation will not limit MSS to two competitors. To consumers, the spectrum band in which an MSS provider operates is irrelevant. Other MSS licensees in the L-band, 1.6/2.4 GHz ("Big LEO"), and Little LEO bands, such as Inmarsat, Globalstar, and

[2] A representative estimate of 2G speeds is 10-30 kbps. 2.5G systems are considerably faster but also not extensively deployed outside the major market centers. 3G systems are more distance sensitive in their signals. Morgan Stanley, Telecommunications Services and Equipment: Cross-Industry Insights, Feb. 2005..

[3] The Commission has been modifying its spectrum policies so as to make new terrestrial wireless systems, such as higher powered versions of 802.11 systems, more easily deployed in rural areas. These services do provide data rates higher than conventional cellular and dial-up landline services. They can also support VoIP in theory. However, these services on unlicensed bands do not offer guarantees of quality, reliability, and security comparable to those made possible by the TMI/TerreStar system. An alternative service with these guarantees, attractively priced and with substantial data speed, would be a substantial addition to consumer choice in rural areas.

ORBCOMM, would provide competition to the two 2 GHz MSS providers.[4] The 2 GHz MSS providers also face competition from Fixed Satellite Service operators that provide land,[5] aeronautical,[6] and maritime[7] MSS. Also, given the recent surrenders, it no longer seems defensible for the FCC to make an *a priori* judgment about the number of 2 GHz MSS competitors that the market will actually support or the spectrum that they will need. The 2 GHz MSS is in its infancy with satellite launch milestone still 2 years away. For all of these reasons, an inflexible assumption about the number of 2 GHz MSS competitors necessary to make reasonably efficient use of surrendered spectrum is no longer legally or factually supportable

Second, it would be a mistake to define the consumer end market by the supply technology. The effective consumer welfare question is how to increase competition and service options for certain consumer segments that currently have limited supply options. In short, the Commission should look at competition policy analysis as its primary tool and not rely on a mechanical use of limits on spectrum holdings.[8] The question really before the Commission is whether or not to increase the effective number of competitors for the provision of integrated voice and high speed data services to market segments (defined in I.A of this declaration) with few existing choices. Creating new competitive supply options in the 2GHz MSS market will increase effective competition in these end market segments. This is especially true because new entrants like TMI/TerreStar have every incentive to offer innovative service and price packages in order to compete against incumbents who have well developed brands.

II. Economies of Scale and System Capacity

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4 Each of these systems has its own particular mix of technical capabilities and market strategies. They will compete against TMI/TerreStar's market offerings according to these capabilities and strategies.

5 *See Qualcomm, Inc., Memorandum Opinion, Order and Authorization*, 4 FCC Rcd 1543 (1989) (authorizing land mobile MSS on a secondary basis in the Ku-band).

6 *Service Rules and Procedures to Govern the Use of Aeronautical Mobile Satellite Service Earth Stations in Frequency Bands Allocated to the Fixed Satellite Service, Notice of Proposed Rulemaking*, FCC 05-14 (February 9, 2005) (proposing rules for operation of aircraft earth stations in the Ku-band); *Boeing Company, Order and Authorization*, 16 FCC Rcd 22645 (Int'l Bur. & OET, 2001) (permitting operation of two-way mobile terminals aboard aircraft in the Ku-band).

7 *See Procedures to Govern the Use of Satellite Earth Stations on Board Vessels in the 5925-6425 MHz/3700-4200 MHz Bands and 14.0-14.5 GHz/ 11.7-12.2 GHz Bands, Report and Order*, FCC 04-286 (January 6, 2005) (establishing licensing and service rules for Earth Stations on Vessels ('ESVs') in the C-band and Ku-band).

8 Bruce Owen. and Gregory L. Rosston "Spectrum Allocation and the Internet," Stanford Institute for Economic Policy Research Discussion Paper No. 01-09, December 2001. Published in Cyber Policy and Economics in an Internet Age, W. Lehr and L. Pupillo, (eds.) , Kluwer Academic Publishers, New York, 2002.

The ability of the TMI/TerreStar system to provide consumer benefits depends crucially on its success in creating a handset/terminal device that provides for a seamless satellite/terrestrial experience wherever the customer goes. To be viable it must match the cost, battery life, and form (e.g., weight, size, and screen) factors of handsets/terminals for terrestrial only systems. Otherwise, TMI/TerreStar will face the same market difficulties that plagued earlier, failed MSS systems. For emergency/public services and vertical business segments TMI/TerreStar must be a viable alternative for the convenience, price and ease of use of terrestrial systems.

A competitive handset/terminal means that TMI/TerreStar has to achieve the economies of the mass consumer electronic industry. Mobile handsets constitute the largest single market. In 2004 there were 650 million handsets shipped in the industry and a handful of vendors dominate.[9] This has generated very large scale economies. For example, despite being a relatively new and sophisticated product that requires substantial new tooling and engineering work, 3G phones are shipping for around $300-500 per phone, according to Morgan Stanley.[10] Moreover, both of the currently dominant versions of 3G—cdma 1X/EVDO and UMTS—now have multiple vendors rapidly turning out a stream of new product offerings.[11] A multi-vendor supply chain provides a more competitive array of innovative features and cost performance improvements at a faster pace. This is particularly important because the overall market for handsets is moving to higher end smart phones.[12]

The TMI/TerreStar handset/terminal will require significant engineering work. These requirements in themselves, as a rule of thumb in the industry, necessitate a minimum production run of substantially over one million units per year. Keeping costs down to be competitive with handsets for large terrestrial systems requires even larger minimum volumes.[13] Therefore, TMI/TerreStar estimates that a vendor will require a potential

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9 In-Stat estimated the market to be about 670 million handsets in 2004. In-Stat, Handset Market Thunders, But Leaner Growth Ahead: Q4, 2004. March 2005. The market leader, Nokia, typically has roughly 30% of the world market. The top five vendors are typically Nokia, Motorola, Samsung, Sony Ericsson, and Siemens although LG, Kyocera and Sanyo are larger players in the CDMA market. Thus, there are huge scale economies in these producers. Even a company not in the top five vendors, such as Sharp, expects to produce 10 million units in a year. "Sharp targets 10% growth in cellular handsets," http://smh.com.au,articles/2004/07/09/10890000324924.html.

10 Morgan Stanley, Telecom Services and Equipment: Cross-Industry Insights, February 2005. These prices include some level of carrier subsidy.

11 Morgan Stanley, Telecom Services and Equipment.

12 One forecast is that mid range feature to high end smart phones will constitute 85% of new unit sales by 2009. ARC, Future Mobile Handsets, Worldwide Market Analysis and Strategic Outlook, 2004.

13 The average sales price of the 119 million mobile handsets sold in the US in 2005 was $145. While TMI/TerreStar is competing at a more sophisticated level of features than the average handset provides, this price suggests the competitive discipline of the

market of approximately 1.5 to 2 million units per year in order to supply new equipment.[14] This number seems entirely reasonable given the sophistication of the new product and the necessity of keeping costs comparable to conventional terrestrial terminals.

A scale of 1.5 to 2 million units for a vendor has further implications for the necessary size of a competitive TMI/TerreStar system.[15] A competitive offering requires constant, quick innovation in product offerings and improvement in cost structures as margins also grow narrower over time. Thus, to maintain a competitive supply base for handsets, TerreStar needs a market capable of supporting three vendors (or an ultimate volume of about 4.5 to 6 million units per year). However, it takes a larger customer base (and, hence, system capacity) to support this annual volume of sales.

The calculation of the necessary customer base to create the volume of handset production required for economies of scale is sensitive to the churn rate for customers (the percentage of customers leaving TMI/TerreStar in a year), rates at which handsets/terminals are replaced by new models, and the degree to which other competitors for integrated satellite-terrestrial systems have similar equipment orders. Using a variety of assumptions TMI/TerreStar has concluded that maintaining a sales volume for three vendors at the minimum scale over a multi-year period implies the need for a system capable of supporting a total of fifteen to twenty five million customers.[16] I have examined the TMI/TerreStar calculations and find them to be reasonable.

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market. Ed Wallace, US Mobile Markets: Analysis and Forecasts, The Diffusion Group, February 2005.

14 This range might incorporate several different models from a vendor. There are joint costs for engineering, for example, that can be spread across the models.

15 In my judgment it is not feasible to be overly precise about the total scale economies because assumptions about pricing drive the margins of the equipment vendors and thus the precise volume of production needed.

16 For example, this total is sensitive to how much volume for handset/terminals is generated by a competitor to TMI/TerreStar in the 2 GHz band. The calculation of the necessary base is also sensitive to the churn rate. TMI/TerreStar has used a base line estimate of a 20% churn rate, which is somewhat higher than that of Nextel (another specialized product offering) but lower than the industry norm. A common number used for major European carriers, for example, is 22%. (The more mature European mobile wireless market is a relevant benchmark for where the United States will be in the next two or three years.) A higher churn rate reduces the total size of the necessary customer base because there would be a higher level of handset/terminal replacement each year. Therefore, the choice of a twenty percent churn rate means that TMI/TerreStar has not used a churn rate that inflates the estimates of system capacity upward. The lowest churn rate of which I am aware is that of Teliasonera in Sweden at 12%. Analysis Research, Retaining Customers and Minimising Churn, 2004. The European average is much higher. The 22% figure is from: Michelle de Lussanet, "Boosting Mobile Customer Loyalty," Forrester Research, March 2005.

TMI/TerreStar has argued that the spectrum necessary to support this customer capacity and the service features required in the growing market for sophisticated mixes of data and voice is at least 2 x 10 MHz. I cannot offer an expert opinion on this engineering calculation concerning spectrum. However, as a practical matter, licensed mobile carriers are finding the economics of the new broadband systems supporting voice and data require larger spectrum capacity in order to support flexible mixes of services with high levels of quality and reliability. A recent survey of major European markets showed that the smallest amount of spectrum per carrier for 3G is 20 MHz and some countries are allocating up to 40 MHz[17]. All studies with which I am familiar expect a significantly rising share for data on the wireless systems of the future. Even with more spectrum efficient technologies this implies that major competitors will have to seek more bandwidth to stay competitive. This is arguably an important benefit from some of the proposed mergers of wireless carriers now pending before the Commission. The smallest spectrum holding of any major U.S. or Canadian wireless carrier is 20 MHz, and all others are, or prospectively will be, substantially larger.[18] Thus, if the purpose of the Commission is to generate more consumer choices, especially in markets involving rural customers, it would make sense to assign more spectrum for each entrant if it is possible. In the case of the 2GHz MSS systems, the option of more spectrum for each entrant is available.

III. Summary

The potential for a satellite system like TMI/TerreStar depends on delivering a seamless satellite-terrestrial network with a handset/terminal that is comparable to those of a pure terrestrial network. This will require major economies of scale. In turn, a large system capacity is necessary to service the minimum customer base that can generate the necessary demand for handsets. It is reasonable to size this customer capacity at 15 to 25 million users.

If TMI/TerreStar succeeds, it can provide significant consumer welfare benefits to key markets where there are few competitive supply options. This is particularly true in rural markets and markets that need to cover an integrated rural-urban base (such as emergency services). The benefit is particularly attractive because TMI/TerreStar (and comparable satellite/terrestrial systems) can provide integrated voice and high speed data services with key features involving quality of service, reliability and security. As is the case with all major mobile wireless services today, increased spectrum holdings to allow sustained high performance for a greater variety of applications have emerged as a major feature of the market place. TMI/TerreStar's request for a minimum of 2x10 MHz is completely consistent with the spectrum holdings deemed essential by all of its major competitors. This grant of spectrum would enhance, not reduce, competition in the relevant end markets.

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17 Morgan Stanley.

18 The next smallest would be the combined Sprint PCS-Nextel holding of 47 MHz. Morgan Stanley, p. 4.

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