Consultation on an Application to Use Mobile Satellite Spectrum to Provide Complementary Terrestrial Mobile Service to Improve Satellite Coverage

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INDUSTRY CANADA

RADIONCOMMUNICATION ACT

Notice No. DGTP-009-01 — Consultation on an Application to Use Mobile Satellite Spectrum to Provide Complementary Terrestrial Mobile Service to Improve Satellite Coverage

The Department has received an application from TMI Communications and Company, Limited Partnership (TMI) for approval of a joint venture with an Motient corporation, an American corporation, to develop and operate a new generation of multi-beam mobile satellites using part of the L-band (1525-1559/1626.5-1660.5 MHz) to replace the MSAT satellite. This notice announces the release of a consultation paper inviting comments on a particular aspect of TMI’s application, namely the proposal to deploy a digital terrestrial mobile service, as in-fill or complementary service, to the mobile satellite service.

The terrestrial component, which would be implemented in conjunction with the deployment of the next generation of satellites, would extend the service in urban areas where the satellite coverage may be blocked by high-rise buildings. The first of two satellites is planned to be in operation in about four years after the approvals have been granted by the Canadian and American regulators.

Invitation to Comment

The Department of Industry invites submissions, preferably in electronic format, from all interested parties on the issues raised for comments in the consultation paper. This Notice is available electronically at the following address:

World Wide Web (WWW)
http://strategis.gc.ca/spectrum

or can be obtained in hard copy, for a fee from: Tyrell Press Ltd., 2714 Fenton Road, Gloucester, Ontario K1T 3T7, email: sales1@tyrellpress.ca, 1-800-267-4862 (Canada toll-free telephone), 1-800-574-0137 (United States toll-free telephone), (613) 822-0740 (Worldwide telephone), (613) 822-1089 (Facsimile); and DLS, St. Joseph Print Group, 45 Sacré-Coeur Boulevard, Hull, Quebec K1A 0S7, 1-888-562-5561 (Canada toll-free telephone), 1-800-565-7757 (Canada toll-free facsimile), (819) 779-4335 (Worldwide telephone), (819) 779-2833 (Worldwide facsimile).

Respondents are strongly encouraged to provide their comments in electronic format (WordPerfect, microsoft Word, Adobe PDF or ASCII TXT) to facilitate posting on the Department’s Web site. Documents submitted should be sent with a note specifying the software, version number and operating system used. All comments should make reference to "Comments - Gazette Notice DGTP-009-01" at the following Internet address: Wireless@ic.gc.ca.
Written submissions should be addressed to the Director General, Telecommunications Policy Branch, Industry Canada, 300 Slater Street, Ottawa, Ontario, K1A 0C8. All representations should cite the Canada Gazette, Part I, publication date, the title, and the Notice reference number (DGTP-009-01). To ensure there is time to consider all comments, submissions should be received no later than December 11, 2001.

Shortly after the close of the comment period, all comments received in response to this Notice will be posted on Industry Canada’s Spectrum Web site: [http://strategis.ic.gc.ca/spectrum](http://strategis.ic.gc.ca/spectrum).

Reply comments on these initial submissions will then be invited and should be sent to the Internet address Wireless@ic.gc.ca no later than December 28, 2001. Reply comments will also be made available to the public via Industry Canada’s Web site. All submissions must cite the Canada Gazette, Part I, publication date, the title and the Notice reference number (DGTP-009-01). Submissions can also be submitted to the Director by mail at: 300 Slater Street, Ottawa, Ontario, K1A 0C8.

October 19, 2001

Michael Helm
Director General
Telecommunications Policy Branch
1. **Intent**

The Department has received an application from TMI Communications and Company, Limited Partnership (TMI) for approval of a joint venture with Motient Corporation, an American corporation, to develop and operate a new generation of multi-beam mobile satellites using part of the L-band (1525-1559/1626.5-1660.5 MHz) to replace the MSAT satellite. This consultation paper, announced in Gazette Notice, DGTP-009-01, deals with one aspect of TMI Communications and Company, Limited Partnership (TMI) application, namely the proposal to deploy a digital terrestrial mobile service, as in-fill or complementary service, to the mobile satellite service. The terrestrial component would be implemented in conjunction with the deployment of the next generation of satellites to extend the service in urban areas where the satellite coverage may be blocked by high-rise buildings. The terrestrial component is described in the attached document, (see Appendix 1) Technical Description of L-band Terrestrial Fill-in System, by TMI Communications and Company, Limited Partnership. The first of two satellites is planned to be in operation in about four years after the approvals have been granted by the Canadian and American regulators.

TMI’s application is a request for greater flexibility in the use and optimization of the spectrum. This paper discusses the particulars of the terrestrial mobile service in the application and raises a number of questions for public comment.

2. **Background**

Industry Canada has been notified of a joint venture arrangement between TMI Communications and Company, Limited Partnership (TMI), operating the Canadian MSAT satellite at 106.5°W longitude, and Motient Corporation (formerly American Mobile Satellite Corporation) operating the American MSAT satellite at 101°W longitude. Each of these satellites uses portions of the L-band spectrum (1525-1559 MHz and 1626.5-1660.5 MHz) to provide mobile satellite service in the North American market. The Department has also received a two-part application from TMI for authorization under the Radiocommunication Act and Radiocommunication Regulations to transfer certain spectrum authorizations to two new companies, Mobile Satellite Ventures (Canada) Inc. (MSV Canada) and 3051361 Nova Scotia ULC.

The first part of TMI's application proposes a merging of the operation of the two MSAT satellite undertakings as a joint venture under Mobile Satellite Venture L.P. (MSV), a limited partnership incorporated in Delaware, and to integrate the satellite operation and resources in order to improve the commercial viability of these systems. The Canadian MSAT satellite would be licensed to MSV Canada and, as the Canadian satellite carrier, this carrier would continue to meet the existing conditions of licence, including Canadian ownership and control requirements. Mobile satellite service (MSS) for the North American market and beyond would be offered using the existing two MSAT satellites and these satellites would continue to use their respective assigned L-band spectrum as negotiated under the
Consultation on an Application to Use Mobile Satellite Spectrum to Provide Complementary Terrestrial Mobile Service to Improve Satellite Coverage

In 1996, the Administrations of Canada, the U.S.A., Mexico, the Russian Federation and Inmarsat reached a Memorandum of Understanding (MOU) for the intersystem coordination of geostationary satellite systems providing mobile services in the L-band. This MOU establishes an ongoing multilateral process for the satellite operators (TM1, Motient, Inmarsat, TM Sat, and Telecomm de Mexico) to develop annual operating agreements. More specifically, it defines the portions of L-band MSS spectrum available on an exclusive basis, within a geographical area, to each operator to serve the North American market.

The FCC has launched public proceedings in a Notice For Proposed Rule Making (NPRM) to deal with two applications, one from ICO in the 2 GHz MSS band (1990-2025/2165-2200 MHz) and the other by Motient in the L-band (1525-1559/1626.5-1660.5 MHz), that propose to implement complementary terrestrial mobile services. The FCC has included the use of the L-band and S-band (1610-1626.5/2483.5-2500 MHz) associated with Low Earth Orbiting (LEO) MSS operators in the proceedings.

In the second part of TMI’s application, it is proposed that Mobile Satellite Ventures L.P. construct and operate an advanced multi-beam mobile satellite at 101°W which would include a terrestrial mobile service component. This new satellite would begin operation in about four years, after receiving regulatory approval from both Industry Canada and the Federal Communications Commission (FCC) for both parts of the application. The application further proposes that the new multi-beam satellite would use all the L-band spectrum coordinated for TMI and Motient for their MSAT satellites for service links and the associated Ku-band spectrum for feeder links. This new multi-beam mobile satellite would be the first of two satellites replacing the two aging MSAT satellites. In the longer term, the application proposes that a second multi-beam mobile satellite will be launched using the Canadian orbital position at 106.5°W and the associated L-band MSS spectrum.

The first multi-beam geostationary mobile satellite at 101°W would use many relatively small spot beams (200 - 300 km) to cover North America. This utilization of small spot beams would provide an extensive reuse of the assigned spectrum to the two MSAT mobile satellites and would result in a significant increase of service capacity and spectrum efficiency.

The proposal in the second part of TMI's application is to use the existing assigned L-band spectrum designated for the Canadian MSAT to be authorized by Industry Canada and for the spectrum designated for Motient to be authorized by the FCC on the new U.S. mobile satellite. Under the plan in the application, the satellite would be licensed by the FCC and the United States would act as the notifying administration to the ITU.

There are number of complex issues being raised by the mobile satellite application which are being addressed by the Department using the traditional licensing process. However, the issue of developing a terrestrial mobile service complementary to the satellite offerings requires public discussion.

3. **Terrestrial Mobile Service Component**

The specific aspect of this consultation relates to the unique proposal in the application to utilize part of the assigned spectrum to operate a complementary terrestrial mobile service to enhance the mobile satellite coverage as an "in-fill". The application suggests that this in-fill capability is particularly important where satellite signals are blocked in urban centres by obstructions such as high-rise buildings.

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1. In 1996, the Administrations of Canada, the U.S.A., Mexico, the Russian Federation and Inmarsat reached a Memorandum of Understanding (MOU) for the intersystem coordination of geostationary satellite systems providing mobile services in the L-band. This MOU establishes an ongoing multilateral process for the satellite operators (TM1, Motient, Inmarsat, TM Sat, and Telecomm de Mexico) to develop annual operating agreements. More specifically, it defines the portions of L-band MSS spectrum available on an exclusive basis, within a geographical area, to each operator to serve the North American market.

2. The FCC has launched public proceedings in a Notice For Proposed Rule Making (NPRM) to deal with two applications, one from ICO in the 2 GHz MSS band (1990-2025/2165-2200 MHz) and the other by Motient in the L-band (1525-1559/1626.5-1660.5 MHz), that propose to implement complementary terrestrial mobile services. Also, the FCC has included the use of the L-band and S-band (1610-1626.5/2483.5-2500 MHz) associated with Low Earth Orbiting (LEO) MSS operators in the proceedings.
buildings. The application proposes that portions of the assigned mobile satellite spectrum can be reused in each of the small beams to develop a complementary terrestrial mobile service. TMI states that with the careful management of the spectrum for each of the two services on a satellite beam-by-beam basis, the operation of both services can be achieved without limiting the amount of spectrum available for MSS.

It is anticipated that the MSS L-band spectrum, coordinated for the existing two MSAT satellites, would provide sufficient contiguous spectrum for the new multi-beam mobile satellite to support the operation of a terrestrial mobile service. The application further proposes that the terrestrial mobile service would operate on the basis of not being protected from interference nor causing interference to the allocated primary service in the L-band i.e. mobile satellite service, or the allocated services in adjacent bands. The applicant expects that the new mobile satellite service together with the proposed complementary terrestrial mobile services would provide digital mobile service capability comparable to the second generation of digital personal communication services (PCS).

4. Discussion

This development of terrestrial mobile services, complementary to the mobile satellite service in the L-band spectrum, raises a number of issues. The L-band (1525-1559 MHz and 1626.5-1660.5 MHz) is allocated at the international and domestic levels to mobile satellite service on a primary basis. Also, the sub-band 1525-1535 MHz is allocated to space operation and sub-band 1660-1660.5 MHz to radio astronomy, on a primary basis. Under the ITU Radio Regulations, MSS at L-band is afforded access to the spectrum for regional and worldwide development. Furthermore, priority access is given to distress, urgency and safety communications of the Global Maritime Distress and Safety System (GMDSS) and the Aeronautical Mobile-Satellite (R) Service (AMS(R)S) in most of the L-band spectrum. This L-band spectrum is in significant demand to support five licensed geostationary mobile satellite systems (MSS) serving the North American market and operating with relatively large area or regional beams. It is expected that the new generation of MSS satellites will operate with a large number of small spot beams, with the promise of increasing satellite spectrum capacity by several fold and to support small hand held customer terminals. The development of terrestrial mobile services using assigned MSS spectrum as complementary to the mobile satellite service would be an efficient use of limited spectrum resources and should be considered as a matter of public policy.

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3 As an example, if a multi-beam MSS satellite model was to operate as a series of seven-beam clusters and each beam in a cluster were to be assigned 1+1 MHz of exclusive spectrum for a total of the 7+7 MHz, it could be technically feasible to utilize a large portion of the unused 6+6 MHz spectrum in each of the 200-300 km satellite beams to accommodate terrestrial mobile service. With terrestrial cellular spectrum reuse, this spectrum could provide good capacity for a mobile service to complement satellite service coverage in urban centres.

4 An assignment of some in-fill terrestrial mobile service in the L-band will not be permitted to cause interference to MSS systems which are coordinated under the ITU Radio Regulations in all regions of the world, nor can it cause interference to services in adjacent bands used domestically or in other countries. The terrestrial mobile service will not restrict or cause harmful interference to any component of the mobile satellite service, including aeronautical mobile-satellite services in the L-bands. Furthermore, the terrestrial mobile service will not be allowed to restrict or interfere with the spectrum priority access and operation of the GMDSS operating in accordance with ITU footnote S.5.353A and the AMS(R)S with footnotes S.5.356 and S.5.357A. Additionally, the terrestrial mobile service will not be permitted to restrict the growth and expansion of any MSS services.
As there is no international or domestic frequency allocation for terrestrial mobile service in the L-band spectrum, any prospective licensee of terrestrial mobile service in the L-band will have to operate under the strict restrictions that: (i) it cannot cause interference to any primary mobile satellite services operating in this band or any services allocated in adjacent bands; and, (ii) it cannot claim protection from mobile satellite services in this band or from any allocated services in adjacent bands. As the terrestrial mobile service would have no frequency allocation under the Canadian nor ITU Table of Frequency Allocations, use of the spectrum along the Canada-US border would be contingent upon commercial arrangements between the respective mobile satellite carriers. The terrestrial mobile service operations could be permitted (without any modification to the ITU Radio Regulations) through appropriate authorizations issued by Industry Canada and the FCC.

In order to avoid interference between the MSS service and the complementary terrestrial mobile service, there has to be common control of the assignment and use of particular spectrum on the basis of satellite beam\terrestrial area. The case could be made that the use of a portion of the assigned MSS spectrum for complementary terrestrial mobile services is only feasible if, and when, the mobile satellite operator(s) can control the frequency assignments for the complementary terrestrial mobile service in the satellite beams, in such a way as to facilitate the assignment of unused spectrum in particular beams. Furthermore, if a mobile satellite system was to cease operations, other regional mobile satellite systems could access the spectrum being released. Industry Canada could initiate a licensing process to ensure that a new MSS service is developed using this spectrum, irrespective of the permission given for terrestrial mobile service to complement MSS coverage. Hence, any associated Canadian terrestrial mobile service would likely have to cease operations should it interfere with mobile satellite service networks operating in the assigned spectrum.

Industry Canada will deal with TMI’s application in two separate parts. The decision on the first part, the merger of the operation of two mobile satellite undertakings, will be considered immediately through application of existing rules and policies. Through this public consultation, the Department is proceeding with the consideration of the second part of TMI’s application regarding the use of some coordinated MSS spectrum as a complementary mobile service to improve service provision in urban areas.

5. **Issues Raised for Comments**

The Department is seeking comments on TMI's application, and in particular for the complementary terrestrial mobile service aspect.

(a) Is it in the public interest to encourage a greater flexibility in the use of the mobile satellite spectrum resources by permitting complementary terrestrial mobile services to improve service coverage in urban centres? Would permitting the development of a terrestrial mobile system without protection or guaranteed continued spectrum access, create an unreasonable expectation for the service operator and the consumers?

(b) Given that the availability of the spectrum for terrestrial mobile services will depend explicitly on the design of the satellite and the operation and control by the satellite carrier of the frequencies used on a beam-by-beam basis, should approval for complementary terrestrial mobile services be granted as part of the approval of an MSS application? Or should there be an opportunity to consider
licensing other interested carriers who may wish to operate and offer the terrestrial mobile service as complementary to the mobile satellite service, under a set of requirements and on a no-protection, non-interference basis?

(c) What steps should be taken to address the potential for aggregate power interference of base-stations to other MSS systems (E-s service links) operating at co-frequencies and in different geographical areas (non co-coverage)?

(d) What measures should be taken to ensure that the terrestrial mobile service will not restrict or interfere with the spectrum priority access and operation of GMDSS and AMS(R)S according to ITU regulations?

(e) As the spectrum is allocated to the mobile satellite service, and any terrestrial mobile service offering cannot be protected or guaranteed continued access to spectrum, what conditions should be considered, if any, for the service offerings? Should associated subscriber terminals be limited to either single-mode (mobile satellite) service or dual-mode (mobile satellite and terrestrial mobile) service but not as single-mode terminals for terrestrial mobile service?

(f) In the event that the Department should decide to approve the terrestrial mobile service as complementary to mobile satellite service, what regulatory treatment should be provided to the licensee? For example, should a separate authorization be provided for the terrestrial component; should the use of the spectrum attract license fees similar to those for similar terrestrial mobile services; should the mobile spectrum aggregation limit, otherwise known as the spectrum cap, apply (spectrum defined in Radio System Policy RP-21 for PCS, cellular and similar high mobility radiotelephony services)?

(g) Other mobile satellite operators, of existing or future satellite networks, that may wish to seek similar spectrum flexibility to develop terrestrial mobile service to complement their mobile satellite services, are encouraged to participate in this consultation process.

(h) Are there other matters the Department should consider, relevant to the application?
6. **Next Step**

The public comments and other considerations will assist the Department in rendering a decision on the TMI mobile satellite application which includes proposal to use part of the L-band spectrum for terrestrial mobile service as a complementary component to the mobile satellite offerings.

Issued under the authority of the *Radiocommunication Act*

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Michael Helm  
Director General  
Telecommunication Policy Branch
Appendix 1

TMI Communications and Co. Ltd. Partnership

Technical Description of L-band Terrestrial Fill-in System

May 2001
Fill-in Base Station System for Ubiquitous MSS Service

One of the important limitations on the availability and quality of MSS services, as currently configured, is the lack of signal coverage in major urban centres. Large buildings cast signal “shadows” which block or degrade reception. Service is also unavailable for the same reason within buildings. This presents existing and potential users with a major limitation on the functionality of their handsets and the mobile satellite service itself. Most customers would like to obtain a service that operates in both urban and rural or remote areas.

In order to address this limitation, MSV Canada intends to utilize fill-in base stations in the L-band to supplement satellite coverage. The fill-in coverage areas and the satellite spot beams will be highly integrated, with traffic channels dynamically allocated based on demand, through a seamlessly integrated network. This network, the MNET, will thus ensure quality, interference-free service for a maximum number of users.

As a user travels throughout the MNET service area, the mobile terminal will continuously monitor the quality of both the satellite and the base transceiver station (“BTS”) signals. As the mobile terminal (MET) detects a degradation of the satellite signal and the presence of a valid BTS signal, the MET will inform a base station controller (“BSC”) to start a handover from satellite coverage to the identified BTS. In larger urban areas, where the satellite signal is generally impaired, there will be sufficient fill-in base stations to ensure transparent delivery of MSS service.

This reuse of spectrum between the satellite and the fill-in base station components of the system is only possible because of the proprietary, highly integrated MNET design.

All of the signalling between mobile terminals, fill-in base stations and satellites will occur in the sections of the L-band that have already been assigned to MSS service. The terrestrial gateway and a mobile switching centre (“MSC”) along with the BSCs
(described above) will handle most call management activities (i.e., call initiation, handoff, etc.). Interference among L-band users will not occur since all users and equipment (space segment and terrestrial) will be fully integrated with traffic channels being dynamically allocated throughout the entire network. A detailed System Description is attached.

This system will ensure that customers have continuous coverage wherever they travel. It will also result in a much more complete and efficient utilization of the L-band spectrum assigned to MSS. Currently, this spectrum is not fully utilized in urban areas where “shadowing” prevents delivery of MSS service. Indeed, even though L-band spectrum is currently assigned to MSS throughout North America, it cannot be effectively used in denser urban areas. Nor could it be re-assigned to another application, since MSAT terminals using this spectrum travel everywhere and would interfere with any alternative usage. However, under an integrated system, as described herein, using base stations to provide fill-in coverage, MSS service will efficiently utilize the assigned spectrum and ensure complete coverage in urban, rural and remote areas.
APPENDIX

System Description
APPENDIX - System Description

1. Summary
   1.1 Facilities

Figure 1-2 shows the overall system facilities. The space segment will consist of one or more geostationary satellites with coverage of North America, including the far North, extending through Central America, including the northern portion of South America and at least 200 miles offshore. The number, location, shape, and size of the beams are configurable within the total communications service area depicted in Figure 1-1, which shows 145 spot beams covering the area that MSAT-1 covers today.

Figure 1-1. Composite Mobile Communications Service Area

Figure 1-1 Coverage Area
In conjunction with the new satellites, the complementary terrestrial fill-in base station network will be implemented. This component of the network will use digital cellular technology. It will also consist of one or more Gateway Station Systems ("GSSs"), a Network Operations Centre ("NOC"), mobile switching centres ("MSCs"), base station controllers ("BSCs"), base transceiver stations ("BTSs") and a variety of mobile, portable, and fixed subscriber terminals ("METs"). The GSSs, MSCs, BSCs, and BTSs will provide the interconnection between METs and the Public Switched Telephone Network ("PSTN") and the Public Data Network ("PDN"). The first generation NOC will be augmented to provide the additional network management functions required by the highly integrated MSV Network ("MNET").

1.2 Operations
The service links will be at 1626.5-1660.5 MHz (Earth-to-space) and 1525-1559 MHz (space-to-Earth). Feeder links will be at 12.75-13.25 GHz (Earth-to-space) and 10.75-
10.95, 11.20-11.45 GHz (space-to-Earth). TT&C will be performed in the 14/12 and/or 13/11 GHz FSS bands.

The NOC, GSSs, and MSCs will use proprietary frequency reuse and call management techniques to monitor and efficiently assign and control this uniquely integrated network.

BTS will be used in those areas where the satellite signal is attenuated by terrain or geographical features, and to provide in-building coverage. Base station operations will use a standard wireless protocol. The current baseline protocol is GSM. In typical operations, defined as Fill-in Operations, METs will transmit at 1626.5-1660.5 MHz (MET-to-BTS) and receive at 1525-1559 MHz (BTS-to-MET).

1.3 Services

The new system is optimized to provide GMR/GMPRS services, a satellite-optimized GSM protocol and their terrestrial counterparts, GSM/GPRS. Point-to-multipoint applications will also be offered. The satellites are designed to provide a variety of ground-commanded, configurable antenna beam sizes and locations that can be tailored to the specific needs of a service. For example, using spot beams or base station operation, the system will be able to provide point-to-point telephone and data services at rates up to 160 kilobits per second. At the same time, certain point-to-multipoint dispatch services may use a single beam that covers the entire service area.

The space segment will use bent-pipe, frequency-translating transponders between the service links and the feeder links, allowing it to support all first-generation services as well as new services without the restrictions imposed by regenerative satellites. The space segment will also be able to support multiple GSSs.
2. Technical Description

2.1 Space Segment

2.1.1 Space Segment Frequency Plan and Polarization

For service links, the satellites will use the bands 1626.5-1660.5 MHz and 1525-1559 MHz. Polarization will be right-hand circular.

The satellites will use 500 MHz of spectrum in the 12.75-13.25 GHz band and 500 MHz of spectrum in the 10.70-10.95 and the 11.2-11.45 GHz bands for feeder links. Polarization will be linear and orthogonal between transmit and receive frequencies. These bands are unused by any nearby satellite, except for the portion licensed to MSAT-1 and AMSC-1. The old and new satellites will operate in adjacent portions of the same feeder link bands, making GSSs easily capable of operating on any satellite.

2.1.2 Communications Payload Subsystem

The communication subsystem will have frequency translating transponders on the forward and return links. Uplink Ku-band feeder link signals received will be amplified and translated to the L-band forward link (space-to-Earth) through a series of amplifiers with fixed and programmable digital filters. To transmit in a specific spot beam, these filters map a section of the feeder link into a section of the L-band forward link. L-band return links (Earth-to-space) are similarly cross-strapped to feeder downlinks at Ku-band. This flexible design will permit frequency and capacity management on a beam-by-beam basis.

There will be configurable beam-forming networks in the L-band receive and transmit paths. These beam-forming networks have the ability to establish beams of specific sizes, shapes, and locations for individual frequency sub-bands. The beam-forming network configurations are controlled by ground-generated commands.
2.1.3 Transmission Characteristics

The new satellite(s) will continue to support first-generation system transmissions in an emulation mode. The dominant traffic on the new satellite(s) will be the MNET traffic. Table 2-1 lists the principal service link transmission characteristics for the GMR links. (The GEO Mobile Radio (“GMR”) working group of ETSI SES is preparing two families of GMR specifications, GMR-1 and GMR-2. The GMR technical specifications define radio interfaces for Geostationary Earth orbit satellite access to the core GSM network.)

GSSs will have feeder link transmission characteristics complementary to those of the service links. Some, like the new main-site GSS, will have a remote diversity site to reduce fade outages and provide backup during maintenance on the main-site antenna.

Table 2-1- Service Link Transmission Characteristics Spot Beam Mode

<table>
<thead>
<tr>
<th>Direction</th>
<th>Forward</th>
<th>Return</th>
</tr>
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<tr>
<td>Access Mode</td>
<td>TDMA</td>
<td>TDMA</td>
</tr>
<tr>
<td>Modulation</td>
<td>QPSK</td>
<td>QPSK</td>
</tr>
<tr>
<td>Information Rate, kbps</td>
<td>270.8</td>
<td>67.7</td>
</tr>
<tr>
<td>Bandwidth, kHz</td>
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<td>50</td>
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<tr>
<td>EIRP, max, dBW</td>
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<td>5</td>
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<tr>
<td>Threshold C/No, dB-Hz</td>
<td>56</td>
<td>49</td>
</tr>
<tr>
<td>Receive G/T, dB/K</td>
<td>-26</td>
<td>x</td>
</tr>
<tr>
<td>MET Antenna Type</td>
<td>Omni</td>
<td>Omni</td>
</tr>
</tbody>
</table>
2.2 Base Stations

2.2.1 Number and Location of Base Stations
The satellite system will provide primary coverage of the service area. Nonetheless, the presence of shadowing and the satellite signal’s inability to penetrate inside buildings degrade satellite coverage, particularly in urban areas. To mitigate these effects, fill-in base stations will supplement satellite coverage in areas where there is severe shadowing. The current plan is to deploy fill-in base stations in major Canadian cities. Similar stations will also be deployed in the most populous urban centres of the United States.

2.2.2 Design
The design of the fill-in base station system will be comprised of Base Transceiver Stations, Base Station Controllers, and Mobile Switching Centers. BTSs and BSCs provide the air interface to the mobile terminals. MSCs are comprised of a GPRS support node/packet data router, a voice switch, a Home Location Register, a Visitor’s Location Register, an Authentication Center, and the connections to the PSTN and PDN. Figure 2-1 is a block diagram of the base station segment.
2.2.3 Frequency Plan and Polarization

The base stations will operate in the bands 1525-1559 MHz and 1626.5-1660.5 MHz. Linear polarization will be adopted. The NOC, GSSs, and MSCs will use proprietary frequency reuse and call management techniques to monitor and efficiently assign and control the uniquely integrated space and base station networks.

The base station network will use Fill-in Operations. Terrestrial base stations are used to fill in coverage areas where buildings and other obstructions might interfere with satellite transmissions. METs will transmit at 1626.5-1660.5 MHz and receive at 1525-1559 MHz.

2.2.4 Antenna Subsystems

Fill-in operations require special measures to avoid interference. One of these measures will be to install a specially designed base station antenna, which is used to focus energy toward the coverage area and reduce power transmitted skyward. Prototype versions of this antenna have been developed and are undergoing testing to characterize performance.
2.2.5 Transmission Characteristics

The base stations will support a standard wireless protocol very similar to that of the satellites. Currently, the baseline protocol is GSM. Table 2-1 lists the link transmission characteristics.

<table>
<thead>
<tr>
<th></th>
<th>Forward</th>
<th>Return</th>
</tr>
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<tbody>
<tr>
<td>Access Mode</td>
<td>TDMA</td>
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<td>Modulation</td>
<td>GMSK</td>
<td>GMSK</td>
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<tr>
<td>Information Rate, kbps</td>
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<td>Bandwidth, kHz</td>
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<td>Threshold C/No, dB</td>
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<tr>
<td>Receive Sensitivity, dBm</td>
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</tr>
<tr>
<td>MET Antenna Type</td>
<td>Omni</td>
<td>Omni</td>
</tr>
</tbody>
</table>

2.3 Subscriber Terminals

The new system will continue to be able to serve all existing terminal types. At the same time, the higher capacity of the new system will make it possible to produce a much higher volume of new terminals, thereby decreasing terminal costs, easing installation and maintenance, and improving reliability.

Mobile terminals will be significantly reduced in size and will have omni-directional antennas, while portable and fixed terminals will use directional antennas to support high-speed, high-throughput applications. These terminals will be multi-mode and multi-functional, capable of supporting voice, voice dispatch, packet-data, and multi-cast services with common hardware. They will be capable of detecting potential interference and adjusting configurations to ensure that signal-to-noise ratios are maintained for an error-free connection.
Base station and satellite components will be fully integrated at the network level to provide subscribers with continuity of coverage throughout North America. Common network hardware and software will result in commonality of equipment between satellite and base station components and will enhance efficient, interference-free services.

In the Fill-in Operations, the call control algorithms will allow a mobile user to be served by the terrestrial network only when the user is blocked from the satellite. A combination of intrasystem call control and intrasystem frequency management assures the network can use the frequencies efficiently and maintains system quality through interference management.

2.4 System Capacity and Spectrum Sharing
The capacity and spectrum efficiency of the next-generation system has the potential to far exceed that of the current system. The base stations add to capacity and spectrum efficiency by reusing spectrum which, at that base station’s particular location, is not usable for satellite service. However, it is only possible for this system to work when the frequency allocation is integrated between the base station and the satellite.