the need for traveling wave tube amplifiers, providing soft-failure capabilities and thereby increasing system reliability.

Overall network interconnectivity is provided by intersatellite crosslinks, which provide interconnections to four neighboring satellites. Each intersatellite link will support up to 16 OC-1 channels. The communications subsystem on each satellite includes 72 wireless access group transponders, 32 OC-1 point-to-point transponders and 64 OC-1 intersatellite link transponders along with their associated switches.

a) Uplink and Downlink Communications Parameters

Communication links will support OC-1 rates both up and down links . CPE terminals will operate with 0.66 m to 1.5 m aperture antennas with up to 7.9 watts transmit RF power for cell site terminals and up to 46.1 watts for MTSO terminals. To reduce self-interference and interference to other systems -- and to provide robustness against rain -- dynamic power control will be exercised. A summary of the communication link parameters is included in Table IV-9.

Parameter Description	WAG/E-1 Specification	HBR Specification
Modulation Format	QPSK	QPSK
Coding	Convolutional Concatenated With Reed Solomon	Convolutional Concatenated With Reed Solomon
Target Bit Error Rate	10^{-6}	10^{-9}
Data Rates (information)	2.048 Mbps	51.84 Mbps
Downlink Bandwidth	3 GHz	3 GHz
Uplink Bandwidth	3 GHz	3 GHz
Eb/No requirement	2.2 dB.	2.7 dB
Ground Station RF Power Amplifier	up to 7.9 W for E-1 Terminals	up to 46.2 W for MTSO Terminals to Cell Site up to 79.5 W for HBR Terminals
Ground Terminal Aperture (m)	0.66	1.5
Ground Terminal Figure of Merit G/T	19.3 dB/K	26.4 dB/K

Table IV-9: Summary - Uplink & Downlink Communications Parameters

b) Intersatellite Links

Intersatellite links will support up to 16 OC-1 channels depending on the instantaneous network traffic demands. A summary of the link parameters for the intersatellite links is included in Table IV-10.

Parameter Description	Specification
Modulation Format	QPSK
Target Bit Error Rate	10^{-9}
Channel Data Rate (information)	51.84 Mbps
SNR Requirement	2.7 dB
Transmit Power Per Channel	0.235W
Transmit Antenna Directivity	55.9 dBi
Receiver Figure of Merit, G/T	27.0 dBK

Table IV-10: Intersatellite Link Communications Parameters

c) Telemetry, Tracking and Command (TT&C) Links

All TT&C functions necessary for monitoring and controlling the spacecraft will be performed by the TT&C subsystem. The TT&C terminals will be appropriately sized to maintain highly reliable TT&C links under all operating conditions. Command signaling will include authentication codes to prevent malicious or unintentional access to the spacecraft command functions.

The command and telemetry signaling will be assigned within the normal communications user service band using an additional beam dedicated to the TT&C function. As many as eight channels will be available for TT&C signaling, allowing simultaneous communications to multiple spacecraft from a single site. Each channel will use QPSK modulation.

During the spacecraft deployment phase and upon occurrence of an anomaly, an additional set of TT&C transponders will be available to maintain command and telemetry communications. The complete set of channels will occupy a maximum of 2.5 MHz, which includes an allowance for Doppler. A near omnidirectional antenna will be used on the spacecraft to support the secondary TT&C function.

3. Transmission Characteristics

This section provides a general overview of the transmission characteristics for the proposed uplinks, downlinks, and intersatellite links. More extensive tabulations of link performance and power flux density are provided in Appendix A.

a) Transmission Characteristics - Uplinks and Downlinks

The M-Star System is intended to provide wireless backhaul as well as other transport services. As such, the satellite portion of the system is essentially an offset frequency repeater. Ground terminal equipment will be provided to link cell sites and MTSOs to the constellation, and all necessary signal processing will take place at the ground terminal wherein the modulation formats and coding are operated upon.

Two distinct transmission modes are employed for links operating in the 38/48 GHz band: an FDMA/TDMA approach is employed for the cell-to-MTSO links, and an FDMA/TDM scheme is used for the MTSO-to-cell path. The M-Star transmission plan is based upon sets of Wireless Access Groups (WAG), with the transmission format within each WAG dependant upon the direction of the transmission path.

Each cell-to-MTSO WAG is formed from a 5-channel, 18 MHz/channel FDMA plan; each channel, in turn, supports a 5-timeslot TDMA format (Table IV-11). Hence, each of the channel-slot elements can support a 2.048 Mbps data rate. Twenty-five cell sites of 2.048 Mbps can be supported by a cell-to-MTSO WAG yielding a 51.48 Mbps overall rate.

(18 MHz/ Ch)	Time Slot #1	Time Slot #2	Time Slot #3	Time Slot #4	Time Slot #5
Channel 1					
Channel 2					
Channel 3					
Channel 4					
Channel 5					

Table IV-11: FDMA/TDMA Format For A Cell Site To MTSO Wireless Access Group

Because of the use of a 20% duty-cycle (5-timeslots/frame) TDMA format, the 2.048 Mbps uncoded base rate is transmitted/received at a 10.24 Mbps burst rate. The modulation format for these links will be QPSK. The 2.048 Mbps bitstreams are convolutionally encoded with an (R=1/2, K=7) approach concatenated with a (255, 229) Reed-Solomon code. This coding will yield a BER for the associated E_b/N_o specified in Table IV-9. The five bursts of 10.24 Mbps (uncoded rate) in each channel, combined with the TDMA bursts from the four other channels, yields the aggregate baseband rate of 51.84 Mbps uncoded.

The WAG plan for the MTSO-to-cell path employs the full 90 MHz transponder channel to permit the MTSO to transmit a common 51.84 Mbps baseband time division multiplexed signal to all cell sites. The modulation of this signal is also QPSK and the link is encoded in the same fashion as the cell site transmissions. This same approach is used where OC-1 interconnections are to be provided; in that case, the 51.84 Mbps bitstream, suitably coded, may be routed via one or more of the intersatellite links.

The WAG multiplexing permits a group of 25 cell sites to be associated with one MTSO during a frame time. Up to ten such frames can be grouped if needed to associate as many as 250 cell sites with an MTSO. The uplink data rates and modulation are summarized in Table IV-12.

Link	Uplink Burst Rate (Mbps)	Modulation Format	Bandwidth Per Channel (MHz)
Cell site/E-1 to Satellite	10.24 Mbps	QPSK	18
MTSO to Satellite	51.84 Mbps	QPSK	90
HBRT to Satellite	51.84 Mbps	QPSK	90

Table IV-12: Summary of Uplink Data Rates and Modulation

b) Transmission Characteristics - Intersatellite Links

Network connectivity is provided by intersatellite links. The intersatellite links operate as repeaters transferring information from source to destination. Four intersatellite links are established between any given satellite and its neighbors. In-plane links are maintained between satellites fore and aft and a link is maintained with one satellite in each of the two adjacent planes of the constellation. RF crosslinks in the 59 to 64 GHz band will be employed. Each of the four terminals comprising the crosslink subsystem is configured with a 1.2 meter parabolic reflector antenna. These links will operate in a full-duplex mode, transmitting on one subband and receiving on a second subband. The bandwidth of each link is expected to be 1.5 GHz. Because of the dynamics of the LEO constellation, the range between satellites can vary between approximately 3,200 and 7,700 km. Power control will be utilized to maintain adequate link margin without transmitting excessive power. Antenna tracking will maintain pointing losses of less than 1.0 dB.

c) Transmission Characteristics - TT&C Links

TT&C data is transferred between ground and satellite nodes utilizing the normal user communication bands. The command uplink uses a 56 kbps rate while the telemetry downlink uses a 100 kbps rate. Both links use convolutional (R=1/2,K=7) encoding and QPSK modulation. A 3 (three) meter antenna is used to transmit commands to the various satellites to provide sufficient link margin for rain fades. Appendix A contains a link budget for the TT&C links.

4. Power Flux Density

The estimated power flux densities have been calculated for worst case conditions at cell centers within the coverage footprint (i.e., at elevation angles at and above 22°). The design satisfies the maximum allowable power flux density of -105 dBW/m2 specified in Section 25.208(c) of the Commission's Rules. The results of these calculations are tabulated in Appendix A. For angles below 25°, the antenna characteristics attenuate the flux density levels below the limits specified in Section 25.208(c), as illustrated in Table IV-13.

Elevation Angle, degrees	Power Spectral Flux Density, dBW/m2/MHz
5	-135
10	-128
15	-115
20	-108
25	-105

Table IV-13: Maximum Flux Density Elevation Angles Below 25°

5. Traffic Capacity

The distribution of end users, which is correlated to the population distribution throughout the global coverage area, will naturally create high peak demands on the system. These peak demands are a key determinant of the overall spectrum requirements and of the design of the system. The LEO constellation geometry, in conjunction with a versatile satellite payload and antennas design, creates relatively small beam coverage areas in the satellite coverage footprint, which are instrumental in supporting the highly peaked traffic demands. A single space vehicle will support as many as 1,800 cell sites, each operating at E-1 rates with as many as 250 cell sites in a single beam coverage area. Based on conservative de-rating factors, the system can support greater than 43,000 simultaneous equivalent E-1 channels on the user service links over land mass. Additionally, the constellation can provide over 1,500 additional equivalent OC-1 channels globally.

D. Major Spacecraft Subsystems

1. Antenna Subsystem

a) Uplink and Downlink Antenna Subsystem

The satellite antenna subsystem for communicating with CPE terminals via the 48 GHz uplinks and 38 GHz downlinks is a set of phased-array antennas. One transmit and one receive phased-array antenna are paired to produce as many as 32 individual beams (with each beam being a transmit-receive pair). Each beam can be steered to any angle within the field-of-view of the satellite. A beam will be placed over a CPE terminal when that terminal enters the field-of-view of the satellite and kept there until that CPE is handed off to the next satellite. Each beam is assigned a portion of the 3000 MHz frequency band commensurate with the CPE which it must service at the time. The polarization will be RHCP on the uplink and LHCP on the downlink. In specific cases of localized highly peaked traffic demand, several beams may be overlaid. Beams can also be turned on and off, as appropriate, to accommodate traffic conditions.

Refer to Figures IV-7 through IV-10 for the antenna gain contours for the uplink and downlink antenna subsystem.

b) Telemetry, Tracking, and Command (TT&C) Antenna Subsystem

TT&C data is transferred between ground and satellite nodes utilizing the normal user communication band except during satellite deployment or in cases of emergencies. The command uplink uses a 3 meter reflector type antenna to provide reliable communications during periods of rain. The normal mission antennas will be used by the TT&C spacecraft subsystem to assure communications with the satellite at all times. When the secondary TT&C is in use, a near-omnidirectional antenna will be used aboard the spacecraft.

c) Intersatellite Antenna Subsystem

The RF intersatellite links use a total of four reflector antennas to provide four independent links. Each 1.2 meter reflector will be gimbaled and closed loop tracking will be used in order to maintain proper antenna pointing. Right- and left-hand circular polarization will be used to increase isolation between spatially isolated links operating at the same frequency.

2. Thermal Control Subsystem

The satellite uses a combination of paint, insulating blankets, heaters, thermal radiators, heat pipes, and capillary pumped loops to maintain temperatures in each of the subsystems within the ranges necessary for their reliable operation over the 8-year design life.

The thermal design of the M-Star satellites is based entirely on space-proven technology and hardware. Typically, maintaining a satellite's components within its allowable operating temperature range necessitates the expulsion of excess heat from the electronics, primarily in the payload and the antenna, by first transferring the heat from the electronics to the satellite's colder outer surfaces, where it can be radiated into the cold space environment. In most instances, the coupling of conduction and radiation techniques to such conventional devices as spacecraft structure and heat pipes will suffice to transfer the heat and maintain the temperatures of the electronic devices well within their operating regimes.

The thermal control challenge on the M-Star satellite comes from the substantial heat which is concentrated in one relatively small area: the transmitting 38 GHz antenna. By means of thermal doublers and an active capillary pumped loop, which are employed to transport the antenna's residual heat to the satellite's colder outer surfaces, the transmitting main mission antenna will be held well within its operating temperatures. The receiving main mission antenna may require a heat sink to operate while maintaining the desired low temperature.

3. Attitude Control Subsystem

The satellites will maintain stable attitude control in three axes using a Momentum Wheel Assembly and torque rods to produce the necessary control torques, along with thrusters for initial orbit installation and orbit perturbation compensation. Attitude sensing is accomplished via gyros, and Earth and star sensors. Global Positioning System (GPS) sensing is used for location determination.

4. Propulsion Subsystem

The satellite uses a liquid bipropellant propulsion system, with eight thrusters on the vehicle. The thrusters are used for initial installation on orbit and occasional orbit maneuvers.

5. Electrical Power Subsystem

The satellite power subsystem is capable of producing 3.1 kW peak power at EOL, including all housekeeping, distribution, and power subsystem overhead, to support anticipated traffic peaks of 11 minutes (about 10% of the orbital period), and 1.5 kW average over a day. The design includes provision for supporting the peak power demand during eclipse conditions at a 30% depth of discharge.

The design supports a bus voltage of 70 volts to maximize conversion efficiency and to minimize distribution losses. Gallium Indium Phosphide cells are planned for use in the solar arrays to minimize size and mass. For energy storage, the spacecraft design uses a single Nickel Hydrogen DPV 50 cell battery.

6. Telemetry, Tracking and Command (TT&C) Subsystem

The satellite design uses the 38/48 GHz band as the primary means of receiving commands and transmitting telemetry. This enables on-station satellite, constellation, and network operations with a high availability from one of four antenna sites in the coverage area connected to an Operations Facility.

The secondary TT&C subsystem utilizes an omnidirectional antenna on board each spacecraft to receive and transmit command and telemetry transactions during launch operations, deployment operations, parking and storage orbit operations, orbit transfers, and anomalous conditions on station that cause the satellite to drop out of the network. This narrow-band communications subsystem operates at command information rates of 56 kbps and a telemetry rate of 100 kbps. In order to accommodate simultaneous communications with the multiple satellites launched on each of the planned launch vehicles, the M-Star System will need eight separate TT&C transmit and receive channels.

7. Quantity of Satellites

The number of satellites simultaneously in-orbit is the number in the mission orbits, to provide service, plus the number of spare satellites in the sparing orbits. Seventy two satellites (six in each of twelve planes) are needed for the mission orbits. Following full operation capability, spare satellites may be placed in the sparing orbit planes. The number of spares in a plane will depend on the health and status of the satellites in the associated mission plane and the availability and selection of the sparing satellite launcher. It is unlikely that there will be more than two spares in any one sparing plane. Thus, the total number of satellites in orbit may range from 72 to as many as 96, when each of the twelve sparing orbits has two spares in it.

8. Satellite Operational Lifetime

The satellites are designed to satisfy Minimum Operational Capability (MOC) for an 8-year mission life. They will carry expendables for an extended life of at least 10 years. The requirements for MOC provide for a graceful degradation in satellite peak capacity, both from a standpoint of active mission channels and active intersatellite links. The capacity estimates for the constellation are derated to account for satellites operating at various peak capacities between MOC and their full operational capability.

The design for the M-Star satellites includes provision for varying degrees of redundancy to ensure the success of the mission as defined by the reliability criteria. Critical components, such as master references, distributed timing functions, and selected processing functions (e.g., command and telemetry processing), include fully redundant elements that can be switched "on line" in the event of excessive co-device degradation or failure. The satellite processing architecture, for example, provides for fully redundant handling of all mission critical functions and includes "warm" standby recovery mechanisms to mitigate Single Event Upsets (SEU) for all processing operations. Some key components comprising the satellite link design follow a 1 of N redundancy philosophy: one redundant component can be switched into a circuit to take the place of one of several identical components. Finally, some functions of a less critical nature are implemented with sufficient performance margin to permit them to be derated sufficiently at beginning of life to ensure the required probability of success.

E. Earth Segment

1. Ground Segment

The Ground Segment consists of 2 Ground Segment Facilities called Mission Operations Control Centers (MOCC), each comprised of a Satellite Control Center (SCC) and a Network Operations Control Center (NOCC). This approach provides both financial and technical advantages in the operation of the M-Star System. The MOCCs can be utilized in several ways to control and manage the network. One MOCC will function as the primary control facility for the network and the other as the back-up. This permits the option of utilizing both MOCCs in a cooperative manner to control the network. The MOCC will utilize a combination of co-located and geographically dispersed remote antenna facilities to command and control the on-orbit satellites. Figure IV-11 illustrates one possible configuration for the Ground Segment.

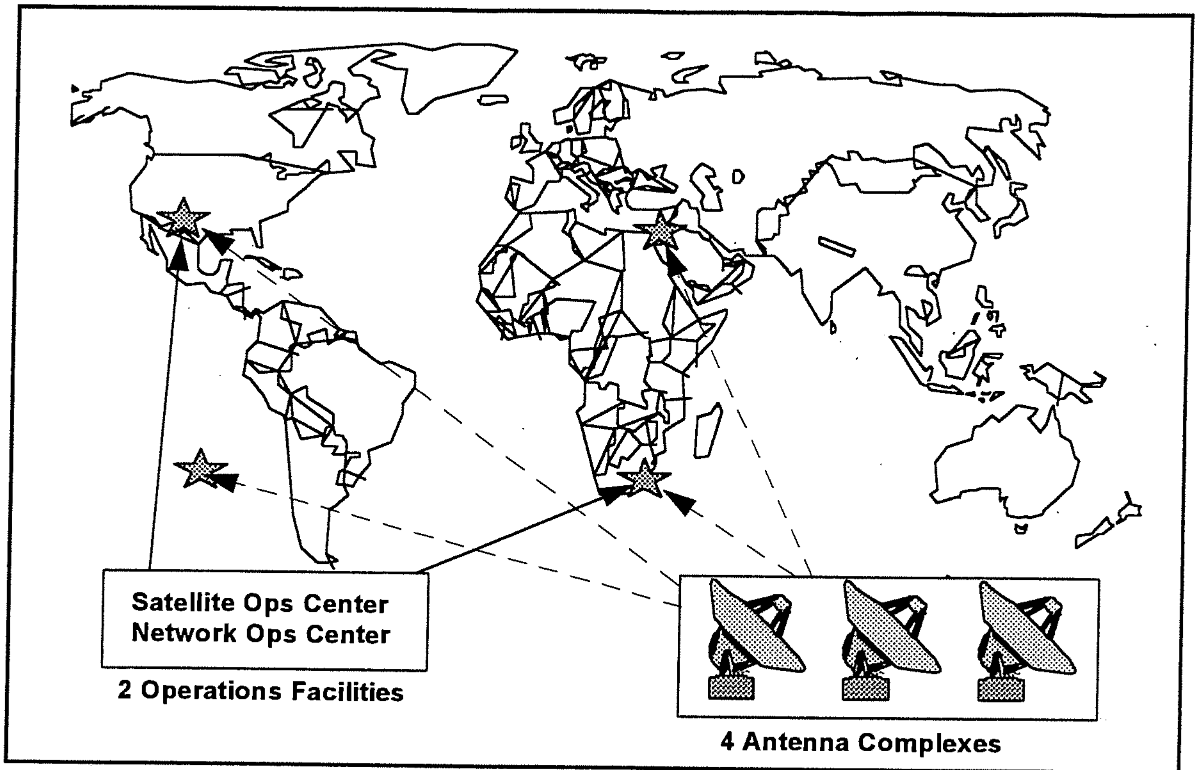

Figure IV-11: Ground Segment Facilities

The Satellite Control Centers will be responsible for managing the health and status of all satellites and maintaining their orbits. The Network Operations Control Centers will be responsible for controlling the performance of the network including, network routing, service beam assignments, the scheduling of all high data rate continuous connections with ground sites, and the allocation of all service providing subsystem resources on-board mission orbit satellites.

Each MOCC maintains communications with all the antenna sites including the Remote Antenna Facility (RAF) sites envisioned for the M-Star System. The antenna sites will be carefully chosen to provide line-of-sight contact with every satellite each orbit as well as to provide coverage during launch and initial on-orbit operations. There are a total of 4 antenna sites envisioned for the M-Star System.

All of these facilities will have nearby access to international communications hubs which will allow them to share data and manage the entire system.

2. Customer Premises Equipment (CPE)

Three categories of Customer Premises Equipment (CPE) provide access to the M-Star System infrastructure for end users:

1) Wireless Group Terminals support the cell-sites in a Wireless Access Group, allowing transmission at information rates up to 2.048 Mbps;
2) Wireless Group Controller supports the MTSO in a Wireless Access Group, aggregating the Group transmissions at information rates up to 51.84 Mbps; and
3) High Bit Rate terminals support other data connectivity applications, allowing transmission at information rates up to 51.84 Mbps.

All terminals will use directional antennas to maintain contact with the space constellation, with at least two independent antenna beams per terminal to support make-before-break handoffs. The CPE antennas planned for use with the M-Star System range in aperture size from 0.66 meters to 1.5 meters, depending on the terminal category.

Within each category, a variety of customer-selected options are anticipated, depending on the environment in which the equipment is installed. Fundamental to the CPE design, for example, are customer-specified protocol adapters that provide access to the M-Star System network in a manner that is transparent to the end users. CPE options include configurations to support the variety of standard electrical and optical interconnects used in existing telecommunications systems, such as E-1, T-1, OC-1, T-3, Ethernet, FDDI, and others; the various forms of system power available around the world, such as 120VAC, -48VDC, and others; and the vast assortment of network interconnection standards used in telecommunications systems, such as ATM, ISDN, X.25, Frame Relay, TCP/IP, and others.

A High Bit Rate Terminal can be combined with a Wireless Group Controller to provide global backhaul connections for Wireless Access Groups. This combination can also provide global transport services for E-1 terminal networks.

Additional CPE configurations are expected to expand a user's capacity beyond the specified Wireless Access Group or High Bit Rate capability by using multiple channel frequencies. The M-Star System will support Wireless Groups up to a capacity of 250 Wireless Group Terminals running at 2.048 Mbps and up to 10 High Bit Rate Terminals each in a 570 km^2 area.

F. System Link Availability

1. Estimated Link Availabilities

Estimated system availabilities for various cities are included in Table IV-14. These estimated availabilities were used in the link budget calculations of Tables A-1 through A-4 of Appendix A. The channel frequency assignments, polarization plan, and frequency reuse plan will insure that under rainy conditions, interference arising from crosspolarization, adjacent cells, and adjacent satellites will degrade the bit signal to noise ratio, Eb/No, less than 1 dB. These values do not take into account potential improvements due to satellite diversity, nor do they include the effects of sun outages. Availabilities for the TT&C links have been set at 99.99%.

City	System Availability
New York	99.0
Los Angeles	99.64
Paris	99.34
London	99.23
Berlin	99.34
Rome	99.0
Madrid	99.34
Moscow	99.64

Table IV-14: User Link Availability Estimates for Various Cities

2. Operation in Eclipse Conditions

The M-Star System satellites are designed to provide sufficient power to support the peak traffic demand for a cell cluster under eclipse conditions, assuming a realistic distribution of terminal sites throughout the coverage area. The predicted eclipse time for the requested orbits is 35 minutes in duration.

G. Launch Segment

The Launch Segment consists of the vehicles and facilities necessary to place the M-Star satellites into their parking orbits. The satellite has been sized so multiple stowed satellites can be accommodated by the dimensions anticipated for the next several generations of launch vehicles from various suppliers. Specific launch vehicles and launch sites have not been selected at this time; the launch costs in the financial overview are estimates based on existing vehicles. The trade studies to establish types and quantities of launch vehicles required to launch the constellation will include consideration of various factors, including quantities of satellites which can be launched using each vehicle type, constellation fill and sparing strategies, launch sites, shroud and dispenser design, system control sites, launch cost, and failure risk.

In order to support the M-Star satellite deployment plan, selected launch vehicles will be required to deliver multiple satellites to a circular parking orbit at an altitude of 200 km. After drop-off and deployment of appendages at this altitude, the satellites will use on-board thrusters to attain mission or sparing orbits, 1,350 km and 1,300 km, respectively.

V. INTERFERENCE AND SHARING ANALYSIS

Set forth below and in Appendix B are the interference and sharing considerations regarding the proposed system relative to current ITU allocations and U.S. allocations in the 37.5-40.5 GHz, 47.2 - 50.2 GHz and 59-64 GHz bands.

A. ITU And FCC Allocations

1. ITU Allocations

All ITU regions have the same allocation(s) as set forth in Tables V-1 through V-3 (note: the shaded regions denote the allocation).

As set forth in Table V-1, the 37.5 - 40.5 GHz band is allocated to the Fixed-Satellite Service (space-to-Earth) on a co-primary basis with the Fixed Service and Mobile Service. The band is also allocated to the Earth Exploration-Satellite Service (space-to-Earth) on a secondary basis. In portions of the band, the Mobile-Satellite Service (space-to-Earth in the 39.5 - 40.5 GHz band), the Earth Exploration-Satellite Service (Earth-to-space in the 40.0 - 40.5 GHz band) and the Space Research Service (space-to-Earth in the 37.5 - 38.0 GHz band, Earth-to-space in the 40.0 - 40.5 GHz band) are co-primary.

Service	ITU Allocations				US Allocations[13]			
	37.5 - 38 GHz	38-39.5 GHz	39.5-40 GHz	40 - 40.5 GHz	37.5 - 38.6 GHz	38.6-39.5 GHz	39.5-40 GHz	40 - 40.5 GHz
FIXED-SATELLITE (space-to-Earth)						NG		
FIXED						NG	NG	
MOBILE						NG	NG	
MOBILE-SATELLITE (space-to-Earth)								
SPACE RESEARCH (space-to-Earth)								
SPACE RESEARCH (Earth-to-space)								
EARTH EXPLORATION-SATELLITE (Earth-to-space)								
Earth Exploration-Satellite (space-to-Earth)								

Table V-1. Allocations in the 37.5-40.5 GHz Band

Service	ITU Allocations			US Allocations[13]		
	47.2-48.94	48.94-49.04	49.04-50.2	47.2-48.94	48.94-49.04	49.04-50.2
FIXED-SATELLITE (Earth-to-space)						
FIXED						
MOBILE						
RADIO ASTRONOMY		S5.555				

Table V-2. Allocations in the 47.2-50.2 GHz Band

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[13] All allocations are for both Government use and non-Government use unless indicated by "NG" for non-Government use only or "G" for Government use only.

As set forth in Table V-2, the 47.2-50.2 GHz band is allocated to the Fixed-Satellite Service (Earth-to-space), subject to footnote S5.552, on a co-primary basis with the Fixed Service and the Mobile Service, subject to footnote S5.340 (restricts emissions from airborne stations in the band 48.94 - 49.04 GHz). Also, the band 48.94-49.04 GHz is allocated to the Radio Astronomy Service on a co-primary basis (subject to S5.555 and S5.149).

Service	ITU Allocations	US Allocations[13]
	59 - 64	59 - 64
FIXED		
INTERSATELLITE		
MOBILE	S5.558	
RADIOLOCATION	S5.559	

Table V-3. Allocations in the 59 - 64 GHz Band

As set forth in Table V-3, the 59 - 64 GHz band is allocated to the Fixed Service, Intersatellite Service, Mobile Service (subject to footnote S5.558) and the Radiolocation Service (subject to footnote S5.559). These services are all co-primary in this band, although footnotes S5.558 and S5.559 require the aeronautical Mobile Service and Radiolocation Service to be operated subject to not causing harmful interference to the Intersatellite Service.

2. FCC Table of Allocations

The 37.5 - 40.5 GHz band is allocated in the US as follows (See Table V-1):

- 37.5 - 38.6 GHz Fixed Service and Mobile Service on a co-primary basis. This differs from the ITU designation of the Fixed-Satellite Service (space-to-

Earth). NASA plans to use this band to support further manned exploration of the solar system (Interplanetary Link System, space-to-Earth) and to provide wide band data return links from Very Long Baseline Interferometer (VLBI) observations from space (space-to-Earth). Motorola has petitioned to make this band co-primary for the Fixed-Satellite Service (space-to-Earth).

- 38.6 - 39.5 GHz Fixed-Satellite Service (space-to-Earth), Fixed Service and Mobile Service and on a co-primary basis subject to US291.[14]
- 39.5 - 40.0 GHz Fixed-Satellite Service (space-to-Earth), Fixed Service, Mobile Service and Mobile-Satellite Service (space-to-Earth) on a co-primary basis subject to US291. Government use is limited to military systems via US footnote G117.[15]
- 40 - 40.5 GHz Fixed-Satellite Service (space-to-Earth) and Mobile Satellite Service (space-to-Earth) on a co-primary basis. NASA plans to use this band for Earth-to-space links of its Interplanetary Link System. The government use is limited to military systems via US footnote G117.
- 47.2 - 50.2 Ghz Fixed Service, Mobile Service and Fixed-Satellite Service (Earth-to-space) on a co-primary basis and subject to

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[14] US291: Television pickup stations in the mobile service may be authorized to use frequencies in the band 38.6-40 GHz on a secondary basis to stations operating in accordance with the Table of Frequency Allocations.

[15] G117: In the bands 7.25-7.75 GHz, 7.9-8.4 GHz, 17.8-21.2 GHz, 30-31 GHz, 39.5-40.5 GHz, 43.5-45.5 GHz and 50.4-51.4 GHz, the Government fixed-satellite and mobile-satellite services are limited to military systems.

footnotes US264[16] and US297[17] (See Table V-2).

- 59 - 64 GHz Fixed Service, Mobile Service, Radiolocation Service and Intersatellite Service (See Table V-3).

B. M-Star System Bandplan

The M-Star System will operate as a global, non-geostationary system in the Fixed-Satellite Service (NGSO/FSS). The space-to-Earth links will operate in the 3 GHz of spectrum bounded by 37.5 GHz on the low side and 40.5 GHz on the high side with a minimum of 1.0 GHz required in this band exclusive of the Fixed Service and Mobile Service for high density urban operations. The Earth-to-space links will operate in the 3 GHz of spectrum bounded by 47.2 GHz on the low side and 50.2 GHz on the high side with a minimum of 1.0 GHz required in this band exclusive of the Fixed Service and Mobile Service for high density urban operations.

The satellite-to-satellite interconnectivity will be accomplished by radio frequency intersatellite links operating in the 59 - 64 GHz band. Each satellite will have a connectivity with up to 4 neighboring satellites, with each path having 16 carriers per link and each carrier having an information rate of 51.4 Mbps.

The Telemetry, Tracking and Command (TT&C) of the M-Star System will be in the 37.5-40.5 GHz and 47.2-50.2 GHz bands. The required amount of operational spectrum is 2.5 MHz, 8 channels each at data rates of 100 kbps. A suitable Fixed-Satellite Service band below 18

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[16] US264: In the band 48.94-49.04 GHz, airborne stations shall not be authorized.

[17] US297: The bands 47.2-49.2 GHz and 74.0-75.5 GHz are also available for feeder links for the broadcasting-satellite service.

GHz is required for launch and emergency operations to an omni-directional antenna aboard the satellite.

C. Interference And Sharing Analysis

The interference and sharing analysis for the M-Star addresses the potential for interference between the M-Star System and other services. The analysis shows that the M-Star System has the potential to operate effectively without causing or receiving unacceptable interference from other systems if appropriate steps are taken to avoid interference. There is also the potential of multiple NGSO/FSS systems sharing the same service link spectrum.

Only one other space-related system thus far proposes to use the 47.2-50.2 GHz spectrum: the Sky Station system.[18] While the categorization of Sky Station has yet to be determined, the system is supposed to operate such that each stratospheric platform is at the same azimuth and elevation relative to a point on the Earth for most of the time in this filing it will be considered an FS system.[19]

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[18] Application of Sky Station International, Inc. for Authority to Construct, Deploy and Operate a Global Stratospheric Telecommunications System, File No. 96-SAT-P/LA-96 (filed Mar. 20, 1996). Motorola Satellite Communications, Inc., a wholly-owned subsidiary of Motorola, Inc., has petitioned to dismiss or deny that application.

[19] Sky Station is similar to an FS system in that the position of the space station is fixed in azimuth and elevation relative to a point on the Earth. Geographic separation may be required to ensure that Sky Station and the M-Star System can share spectrum on a co-frequency basis. It should be noted that in the US paper submitted to the I.T.U. Working Group 4A/32, it is reported that Sky Station cannot share with the FSS, however, the interference analysis doesn't account for factors such as power control, antenna isolation and the use of standard mitigation techniques.

1. Intra-Service Interference

The M-Star System proposes to operate in the 47.2-50.2 GHz band (Earth to-space) and 37.5-40.5 GHz band (space-to-Earth) allocated to the Fixed-Satellite Service. Inter-satellite links will be in the 59-64 GHz band allocated to the Intersatellite Service.

a) FSS Links

(1) Interference With Other NGSO/FSS Systems

Because of the nature of NGSO systems, mutual interference is considered to be a certainty if joint mitigation techniques are not applied. The frequency and duration of these interference events are a function of the parameters of the conflicting systems. One possible approach for mitigating interference events is to invoke spatial diversity, which is a generic solution that can be applied in any frequency band. Since the M-Star System constellation has been designed to have multiple satellites in view of subscribers a large percentage of the time, the M-Star System has the potential to participate in a joint interference mitigation plan and to avoid harmful interference with other NGSO/FSS Systems.

A sharing analysis has been completed that evaluates the potential for sharing between the M-Star System and a fictitious NGSO/FSS system when satellite diversity is employed. This analysis is included in Appendix B and shows that if both NGSO/FSS systems are designed to facilitate sharing, it is likely that these systems could share a common band if the traffic density is not too high.[20] In particular, the M-Star System constellation has been designed to

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[20] If the traffic is very heavy on either satellite system, there may no longer be any system capacity available for the ground station to employ space diversity. For example, if the M-Star System has

provide at least two satellites in view most of the time from ground stations at latitudes below 60 degrees (Figure IV-5). In the case of receiving harmful interference, the ground terminal can be assigned to another serving satellite to continue service.

The cost of this capability is increased system complexity and reduction in throughput. The analysis suggests that, if both systems incorporate interference mitigation techniques, it is likely that co-frequency sharing of the bands is possible. Further analysis and coordination will be required to confirm a viable mitigation plan. The potential for sharing with a third system is less likely since the space capacity available to mitigate interference may be completely allocated for sharing with the first system. If future applicants were to include provisions for sharing in the design of their systems, it might be possible that the bands of interest could be used by more than two NGSO/FSS systems.

(2) Interference With GSO/FSS Systems

Because of the nature of NGSO systems and GSO systems, mutual interference is considered to be a certainty if joint mitigation techniques are not applied. The frequency and duration of these interference events are a function of the parameters of the conflicting systems. One possible approach for mitigating interference events is by use of space diversity. Since the M-Star System constellation has been designed to have multiple satellites in view of subscribers a large percentage of the time, the M-Star System has the potential to participate in a joint interference mitigation plan and to avoid harmful interference. Sharing in this case is easier to

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satellites that are fully loaded, there may no longer be a space station that has any unused capacity to switch to during an interference event.

accomplish than with NGSO/FSS systems since the portion of the sky where mitigation is required is always fixed relative to a ground station. This technique will be limited to the extent that sharing with other NGSO/FSS systems is required and by the number of GSO/FSS systems deployed.

b) Intersatellite Links

The intersatellite cross-links are in the 59-64 GHz band. It is unlikely that interference will be of a sufficient level or duration as to cause harm to Intersatellite links. This assumes that both systems will have narrow beamwidths associated with these links and that the two systems in which there may be a potential for interference will have differing orbital parameters. Based on these two assumptions, the likelihood of in-line occurrences is small and when an in-line event does happen it will be of a short duration.

2. Inter-Service Interference

a) Fixed Service

(1) FSS Service Links

The M-Star System uplinks and downlinks will operate in the 47.2-50.2 GHz and 37.5-40.5 GHz bands, respectively. The M-Star System will meet the power flux density limits of Section 25.208(c) of the Commission's Rules and ITU RR S21.16 (Article S21) (see Table IV-13 and Appendix A). Therefore, there should be no possibility of harmful interference from the satellite to a terrestrial microwave site. The proposed system does not operate below a 22 degree elevation angle from the ground station, which enables it to meet the EIRP limits of Section 25.204 of the Commission's Rules, thereby avoiding harmful interference into a terrestrial microwave site

(ITU Radio Regulations do not have any EIRP limits in the bands 47.2-50.2 GHz or 37.5-40.5 GHz).

Interference into the M-Star System downlink from a terrestrial microwave site is possible. Unacceptable interference will occur if the microwave sites do not employ power control and these microwave sites are pointing at the M-Star ground station. Coordination procedures or rules on the terrestrial microwave sites would enable sharing with this service.[21] In the locations where both terrestrial microwave and M-Star stations are expected to have a high density of use, coordination in these bands between the Fixed Service and the M-Star System may not be possible. If rules that enable sharing without coordination cannot be developed, MSS Inc. requests that at least 1.0 GHz of spectrum in both the downlink and uplink bands be allocated to the M-Star System exclusive of the Fixed Service.

Interference into the M-Star System's uplink from a terrestrial microwave site is not expected due to the low elevation of the microwave links and the large path loss between microwave sites and the M-Star satellites.

(2) Intersatellite Links

The M-Star System has Intersatellite links in the 59-64 GHz band, which is also allocated to the Fixed Service. The Fixed Service in this band is not expected to have any sharing problems with the Intersatellite Service due to the large attenuation of the atmosphere at these frequencies.

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[21] A limitation of the transmit EIRP and requiring power control on the terrestrial microwave sites would enable sharing without coordination. See Appendix B.

b) Mobile Service And Mobile-Satellite Service

(1) FSS Service Links

Due to the ubiquitous nature of the Mobile Service and the Mobile-Satellite Service, it is expected that sharing will not be possible with the FSS. Therefore, MSS Inc. requests that at least 1.0 GHz of spectrum be allocated to the M-Star System in each of the 37.5-40.5 GHz and the 47.2-50.2 GHz bands free of these services.

(2) Intersatellite Links

The Mobile Service in the 59-64 GHz band is not expected to have any sharing problems with the Intersatellite Service due to the large attenuation of the atmosphere at these frequencies. Additionally, MSS Inc. expects the Mobile Service in this band to adhere to ITU footnote S5.558, which requires that such operations be subject to not causing interference to the Intersatellite Service.

c) Radiolocation Service

The allocation of the Radiolocation Service in the 59-64 GHz band is subject to ITU footnote S5.559, which requires the Radiolocation Service to be operated subject to not causing harmful interference to the Intersatellite Service.

d) Radio Astronomy Service

The M-Star System uplinks will operate in the 48.94-49.04 GHz band. Harmful interference into the Radio Astronomy Service will not occur since the uplink beamwidths are very narrow and operate above 22 degrees elevation angle. The M-Star ground stations will likely be located in large cities which are sufficiently separated from all Radio Astronomy sites performing observations in the 48.94-49.04 GHz band. Such geographic separation will allow sharing with the Radio Astronomy Service.

e) Space Research and Earth Exploration-Satellite Services

(1) Space-To-Earth

The M-Star System downlinks in the 37.5-38 GHz band would be shared with the Space Research Service (space-to-Earth). The narrow beamwidths associated with the downlinks of the M-Star System along with the geographic separation between an M-Star ground station and Space Research Earth stations will allow the two services to share this band.

(2) Earth-To-Space

The M-Star System downlinks in the 40-40.5 band would be shared with the Space Research Service (Earth-to-space) and the Earth Exploration-Satellite Service (Earth-to-space). Since the M-Star System is operating in the reverse direction, it is unlikely that interference will occur between the two services.

VI. ADVANCE PUBLICATION AND COORDINATION

MSS Inc. is submitting in Appendix C all of the information required to advance publish the M-Star System with the ITU. MSS Inc. respectfully requests that the Commission immediately forward this information to the ITU for publication.

VII. COMPLIANCE WITH INTELSAT ARTICLE XIV OBLIGATIONS

MSS Inc. recognizes the consultation requirements imposed on the United States by Article XIV(d) of the INTELSAT Agreement to the extent applicable to the proposed system, and understands that the requested license could be subject to the successful completion of any necessary consultations.[22]

With respect to the economic component of Article XIV(d) consultation, MSS Inc. notes that the INTELSAT Assembly has determined that any separate system interconnected to the public switched network that is below the threshold of 8,000 64 kbps equivalent bearer circuits per satellite will be presumed to cause no economic harm to the INTELSAT system.[23] It is likely that this threshold will either be increased or eliminated in the near future.[24] In the unlikely event that the threshold is not increased or totally eliminated, the M-Star System may exceed the current threshold, and thus the presumption of no economic harm may not be available. In such an unlikely case, MSS Inc. is fully prepared to support the requisite consultations on economic harm.

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[22] See Agreement relating to the International Telecommunications Satellite Organization, Aug. 20, 1971, art. XIV(d), 23 U.S.T. 3813, T.I.A.S. No. 7,532, 10 I.L.M. 909 (1971).

[23] See In the Matter of Amendment to the Commission's Regulatory Policies Governing Domestic Fixed Satellites and Separate International Satellites, 10 FCC Rcd. 7789, 7793 (1995) ("Transborder/Separate Satellite Proposal") (noting recent Intelsat Assembly action raising the threshold to 8,000 64 kbps equivalent bearer circuits). The threshold for systems not interconnected to the public switched network is infinity.

[24] Id. at 7792 (United States has a goal of complete elimination of all interconnection restrictions by January 1997).

With respect to the technical component of INTELSAT consultation, MSS Inc. assures the Commission that it will provide all of the information necessary for such coordination when the consultation process is initiated.

VIII. LEGAL QUALIFICATIONS

MSS Inc. is legally qualified to hold the requested license for the M-Star System. The Commission recently passed upon the qualifications of Motorola, Inc. when it awarded Motorola Satellite Communications, Inc., also a wholly-owned subsidiary of Motorola, Inc., a license to construct, launch and operate the IRIDIUM® System.[25] Appendix E hereto contains an up-to-date FCC Form 430 reflecting all of the information required to find MSS Inc. legally qualified to hold the requested license.

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[25] Motorola Satellite Communications, Inc., Order and Authorization, 10 FCC Rcd. 2268 (1995), recon. denied FCC 96-279 (1996).

IX. FINANCIAL QUALIFICATIONS

A. Milestone Schedule

1. Contract Milestones

MSS Inc. requests permission to begin preliminary construction activities, at its own risk, prior to Commission approval of this application. A Section 319(d) request for waiver of construction authority is being filed concurrently with this Application. Authorization to begin satellite construction would enable MSS Inc. to continue to implement the M-Star System program during Commission consideration of this Application, and ensure that implementation of the system will proceed expeditiously following Commission approval.

Table IX-1 below profiles the M-Star System contractual milestones:

M-Star Contractual Milestones	Year after Authorization
Spacecraft RFP Issued	N/A
Spacecraft Contractor Selected	N/A
Spacecraft Contract Executed	1
Launch Services Contract Executed	2
Financing Completed	N/A

Table IX-1: Contract Milestones

The financing for the M-Star System will be secured from internal Motorola funds as well as other potential sources. As discussed in Section D, Motorola, Inc. satisfies the financial qualification standards set forth at 47 C.F.R. § 25.140.

2. Spacecraft Milestones

Table IX-2 below establishes the M-Star System spacecraft milestones:

M-Star Spacecraft Milestones	Months after Authorization
Satellite Construction Begins	6 Months
First Satellite Constructed	25 Months
First Satellite Launched	26 Months
Last Satellite Constructed	42 Months
Last Satellite Launched	45 Months
Full Operational Service	48 Months

Table IX-2: Spacecraft Milestones

B. Projected System Costs

Table IX-3 below provides, in detail, the estimated capital investment for the M-Star System. The business life of the M-Star constellation is expected to be eight (8) years. The total cost of the space, ground and business operating segments associated with the M-Star System is projected to be $6.150 billion. This investment includes the cost to develop and construct seventy-two (72) satellites, the associated launch services and launch insurance costs, satellite system control costs, and network management hardware, software and business operations costs. The costs for launch-related activities are based on current industry standards. Motorola intends to sub-contract appropriate portions of the R&D effort as well as selected segments of the satellite constellation and ground infrastructure construction activities.

Projected System Costs ($ Millions)

	Pre-Auth	Year 1	Year 2	Year 3	Year 4	Totals
Research and Development	**4**	**56**	**143**	**150**	**22**	**375**
Satellite Construction		**32**	**290**	**1,419**	**1,484**	**3,225**
Launch Services and Insurance			**882**	**882**	**706**	**2,470**
Ground Infrastructure		**7**	**12**	**28**	**33**	**80**
Total Capital Cost	**4**	**95**	**1,327**	**2,479**	**2,245**	**6,150**

Table IX - 3: Projected System Cost

End-user terminal equipment is not part of this filing and is not included in the total projected system cost. All necessary subscriber equipment will be purchased by end users.

Table IX-4 provides, in detail, the estimated annual operating expenses associated with offering competitive global communication services via the M-Star System. Operating costs include service delivery expense, maintenance expense, finance, marketing and other various administrative expenses. Annual operating costs are adjusted by an inflation factor. Depreciation expense is computed on a straight-line basis and commences when the satellites are placed into orbit.

Year After Authorize	**Pre-Operating Expense**	**Operating Expense**	**Total Operating Expense**
1	3		3
2	5		5
3	10		10
4	25		25
5		251	251
6		1,252	1,252
7		1,657	1,657
8		1,897	1,897
9		1,954	1,954
10		2,013	2,013
Totals	43	9,024	9,067

Table IX-4: Projected Operating Expenses ($ Millions)[26]

A comparison of Tables IX-3 and IX-4 shows that the estimated construction and launch costs for the entire system, plus operating expenses (excluding depreciation) through Year 5 (the first year of operation for the entire system) amount to $6.4 billion.

C. Projected Revenues

MSS Inc.'s estimate of the revenue stream from the M-Star System is illustrated in Table IX-5 below.

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[26] Note: Depreciation in $ Millions is expected to be $0 in Years 1 and 2, $364 in Year 3, and $769 in Years 4 through 10; for a total of $5,747.

	Years 1-4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total Revenues
Revenues	0	1,472	4,674	6,007	6,677	6,677	6,677	32,184

Table IX-5: Projected Revenues ($ Millions)

The consolidated revenue projections for the M-Star System are sufficient to recover all of the estimated operating expenses over the life of this project. Moreover, these projections represent a rate of return which sufficiently compensates MSS Inc. for the risk associated with this proposed telecommunications venture.

D. Financial Qualifications

Motorola has the current financial ability to meet the estimated costs of construction and launch of the proposed system, as well as the estimated expense of operating the entire system for one year after launch. The 1995 audited Consolidated Balance Sheet of Motorola, Inc., and Statement of Consolidated Earnings of Motorola, Inc., the applicants' sole corporate parent, are set forth in Appendix D. A declaration signed by Mr. Bary Bertiger, Corporate Vice President of Motorola, Inc., verifies the financial information set forth in the consolidated financial statements.

Motorola, Inc.'s current assets and operating income thus exceed the $6.4 billion estimated costs of construction, launch and first-year operating expenses for the entire system.

X. TECHNICAL QUALIFICATIONS

A. System Coverage

The M-Star System is designed to provide service to major urban centers over a major portion of the Earth's surface area, generally defined as the area (including land and water) between $\pm 58^\circ$ latitude. The average availability of links to a CPE site is expected to be better than the estimates for individual link availability shown in Section IV due to the fact that the M-Star System constellation provides for multiple coverage (i.e., diversity) for over 99% of anticipated terminal sites. The system is designed to maintain a high availability for all CPE sites with terminals in the coverage area at a minimum elevation angle at each CPE site of 22°.

B. Service in the United States

The M-Star System is designed to provide continuous service to CONUS, Hawaii, Puerto Rico, the Virgin Islands, and parts of Alaska. This service is for all CPE terminals in these coverage areas at a minimum elevation angle at each CPE site of 22°.

C. Bandwidth Utilization

The M-Star System satisfies the intent of Section 25.210 of the Commission's Rules by using the requested bandwidth in the uplink and downlink bands in a manner that maximizes the system capacities obtained from that bandwidth. Phased array antennas will project relatively narrow beam patterns, which create small cells on the Earth's surface. This implementation lends itself to efficient reuse of the spectrum. On a global basis, the same frequency bands can be reused in many locations simultaneously to provide high peaking capacity where and when it is needed to support the requested traffic demands.

The M-Star System implementation will include the capability to change transponder saturation flux densities by ground command as required by Section 25.210(b) of the Commission's Rules.

XI. REQUEST FOR PIONEER'S PREFERENCE

Pursuant to 47 C.F.R. Section 1.402, MSS Inc. herein requests the award of a pioneer's preference for the significant and innovative contributions it has made to the delivery of broadband services on a world-wide basis by efficiently using scarce spectrum resources in the 38/48 GHz band.[27] This pioneer's preference request is timely because the Commission has not yet issued a Notice of Inquiry or Notice of Proposed Rulemaking in response to Motorola's Petition for Rulemaking to allocate the 37.5 - 38.6 GHz band to the Fixed-Satellite Service (FSS).[28] While MSS Inc. recognizes that the Commission has adopted stringent standards for granting a pioneer's preference, it believes that the M-Star System satisfactorily meets each of the Commission's criteria.

While MSS Inc. intends to make a more complete showing to demonstrate its entitlement to a pioneer's preference subsequent to the filling of this Application, MSS Inc. takes this opportunity to discuss its development of some of the innovative technologies that entitle it to the requested preference.

MSS Inc. will clearly satisfy the articulated goals of the Commission's pioneer's preference program because it will significantly contribute "to the development of a new service".[29] The M-Star System will make possible, for the first time, the provision of FSS in the "millimeter wave" bands.

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[27] See 47 C.F.R. § 1.402 (1995).

[28] See 47 C.F.R. § 1.402(b) (1995). See also Review of Pioneer's Preference Rules, Third Report and Order, 78 RR 2d 37 ¶ 21 (1995).

[29] Review of the Pioneer's Preference Rules, Memorandum Opinion and Order, 2 R.R. 266 ¶ 2 (1996).

Through advances in technology, MSS Inc.'s M-Star System proposes to provide satellite-delivered transport, such as international carrier-to-carrier services, in a portion of the spectrum hitherto unused for commercial satellite services. MSS Inc. has been able to resolve in innovative ways the problem of excessive signal attenuation that has prevented commercial satellite services in this spectrum.

The technical innovations MSS Inc. has developed for its system include the possibility of sharing with other FSS systems by geometric diversity. By carefully designing its constellation of satellites, most populated points on the globe will enjoy coverage from two or three satellites for substantial periods of time. This will permit sharing with other satellite systems, in furtherance of the Commission's policies favoring efficient use of the frequency spectrum.

XII. REQUESTS FOR WAIVER OF THE COMMISSION'S RULES

MSS Inc. requests that the Commission grant the following waivers of Parts 2 and 25 of its Rules:

A. Request for Waiver of Section 25.114(a)

According to Section 25.114(a) of the Commission's Rules, a separate application must be filed for each space station that is to be constructed as part of a satellite system. MSS Inc. intends to construct, launch and operate a satellite system consisting of 72 operational satellites. Requiring MSS Inc. to adhere to Section 25.114(a) and file 72 identical satellite applications would be unduly burdensome, and serve no useful purpose.

Instead, MSS Inc. has included with its Application at Appendix F a representative application for one of its individual LEO satellites, and is hereby requesting a waiver of Section 25.114(a) of the Commission's Rules. MSS Inc. requests that the Commission adopt a "blanket" licensing approach for the millimeter wave bands similar to what has been adopted by the Commission in the Little LEO and Big LEO Orders.[30] With "blanket" licensing, an applicant files a satellite application that is representative of all of the technically identical satellites in the system's constellation. In response, the Commission issues a blanket license covering all of the operating space stations in the system specified by the applicant.

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[30] See Amendment of the Commission's Rules to Establish Rules and Policies Pertaining to a Non-Voice, Non-Geostationary Mobile-Satellite Service, 8 FCC Rcd. 8450, 8454 (1993) (Little LEO Order); Amendment of the Commission's Rules to Establish Rules and Policies Pertaining to a Mobile Satellite Service in the 1610-1626.5/2483.5-2500 MHz Frequency Bands, 9 FCC Rcd. 5936, 6006 (1994) (Big LEO Order).

MSS Inc.'s requested waiver is also consistent with the Commission's recent proposal to streamline the application and licensing procedures for all satellite systems.[31] To the extent that the Commission does not adopt this proposal and requires applicants such as MSS Inc. to submit an identical satellite application for each of its 72 space stations, MSS Inc. will comply with the Commission's direction.

B. Waiver of Section 25.210

The M-Star System satisfies the intent of Section 25.210 by using the required bandwidth in the uplink and downlink bands in a manner that maximizes system capacity. The LEO design of the M-Star System is inherently incapable of satisfying the explicit requirements of Section 25.210, which was intended to apply to geostationary orbit satellites. Pending a modification of this Rule to meet the design needs of LEO systems, MSS Inc. requests a waiver of Section 25.210 to the extent that the M-Star System is incapable of compliance with this Rule.

C. Waiver of Sections 2.106 and 25.202

MSS Inc. seeks a waiver of the Commission's allocation rules to use the 37.5-38.6 GHz band for Fixed-Satellite Service over the United States.[32] Currently, this band is allocated internationally for Region 2 for the Fixed-Satellite Service (space-to-Earth). In the U.S., this spectrum is allocated only for fixed and mobile use.[33]

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[31] See Streamlining the Commission's Rules and Regulations for Satellite Application Licensing Procedures, Notice of Proposed Rule Making, 10 FCC Rcd. 10624 (1995).

[32] Motorola has previously submitted a Petition for Rulemaking with the Commission that is consistent with this waiver request. See RM-8811.

[33] 47 U.S.C § 2.106.

MSS Inc. requests this waiver in order to ensure much-needed flexibility in coordinating its proposed LEO system on a global basis. MSS Inc. requires the use of 3.0 GHz in each direction in the 37.5-40.5 GHz and 47.2-50.2 GHz bands in order to provide high bandwidth, high-speed voice and data services. MSS Inc.'s use of these bands would conform to the power flux density limits of the International Radio Regulations applicable to the band.[34] MSS Inc.'s use of the band for FSS within these limits should not cause harmful interference with terrestrial fixed and mobile users. As such, the grant of this waiver is consistent with the Commission's waiver standards.[35] The existing international allocation to the FSS and the lack of harmful interference into other users constitutes sufficient "good cause" for grant of the requested waiver.[36]

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[34] International Telecommunication Union, Radio Regulations, Art. 28 § 4(8) (1994).

[35] See Fugro-Chance, Inc., DA 95-455 (rel. Mar. 16, 1995); Qualcomm Inc., 4 FCC Rcd. 1343 (1989); Geostar Positioning Corp., 4 FCC Rcd. 4538 (1989); Emerald Enterprises, Inc., DA 90-1802 (rel. Dec. 18, 1990)

[36] See 47 C.F.R § 1.3.

XIII. WAIVER PURSUANT TO SECTION 304 OF THE ACT

In accordance with Section 304 of the Communications Act of 1934, as amended, 47 U.S.C. § 304, MSS Inc. hereby waives any claim to the use of any particular frequency or of the electromagnetic spectrum as against the regulatory power of the United States because of the previous use of the same, whether by license or otherwise.

ANTI-DRUG ABUSE ACT CERTIFICATION

Pursuant to Section 1.2002 of the Commission's rules, 47 C.F.R. Section 1.2002 (1994), MSS, Inc. certifies that neither the Applicant nor any of its shareholders, nor any of its officers or directors, nor any party to this application is subject to a denial of Federal benefits pursuant to authority granted in Section 5301 of the Anti-Drug Abuse Act of 1988.

Motorola Satellite Systems, Inc.

By: [signature]
Bary R. Bertiger, Vice President

Dated: September 3, 1996

CONCLUSION

For the reasons set forth in this Application, MSS, Inc. requests that the Commission promptly issue it a license to construct, launch and operate the M-Star System, allowing MSS, Inc. to deliver to the public the enormous benefits detailed above at the earliest possible time.

The undersigned certifies individually and for MSS, Inc. that all of the statements made in this Application are true, complete and accurate to the best of his information, belief and knowledge, and are made in good faith.

Respectfully submitted,
Motorola Satellite Systems, Inc.

By: ______________________
Bary R. Bertiger, Vice President

Dated: September 3, 1996

CERTIFICATION OF PERSON RESPONSIBLE FOR PREPARING ENGINEERING INFORMATION

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this application, that I am familar with Part 25 of the Commission's Rules, that I have either prepared or reviewed the engineering information submitted in this application, and that it is complete and accurate to the best of my knowledge and belief.

By: John T. Knudsen

John T. Knudsen
Manager, Spectrum And Standards
Advanced Systems Division
Space and Systems Technology Group
Motorola, Inc.

Dated: September 3, 1996

APPENDIX A

THE M-STAR SYSTEM TRANSMISSION CHARACTERISTICS

APPENDIX A: TRANSMISSION CHARACTERISTICS

A. Transmission Characteristics -- Communications Uplinks and Downlinks

Tables A-1 through A-4 provide representative link budget calculations for the communication uplinks and downlinks and for the satellite crosslinks. For the communication uplinks and downlinks, performance is illustrated for clear air and for rain and are for the minimum ground elevation angle of 22 degrees, which is the longest ground-to-satellite path. The links are shown to close in all cases with zero margin. Power control on the links will minimize use of excess radiated power. The satellite uplink antenna has a diameter of 0.36 meters. The satellite downlink antenna has a diameter of 0.45 meters.

In Table A-1 the messaging path is from a Cell Site up to a satellite and down to a Mobile Telephone Switching Office (MTSO). The Cell Site antenna diameter is 0.66 meter and EIRP for the rain case is 56.8 dBW (48.5 dBW for clear air). The MTSO antenna diameter is 1.5 meters and G/T for the rain case is 25 dBK (26.4 dBK for clear air). The satellite G/T is 10.5 dBK. The satellite EIRP for the rain case is 29.1 dBW (19.9 dBW for clear air).

In Table A-2 the messaging path is from an MTSO up to a satellite and down to a Cell Site. The MTSO antenna diameter is 1.5 meters and EIRP for the rain case is 71.5 dBW (58.7 dBW for clear air). The Cell Site antenna diameter is 0.66 meters and G/T for the rain case is 17.8 dBK (19.3 dBK for clear air). The satellite G/T is 10.5 dBK. The satellite EIRP for the rain case is 42.7 dBW (31.6 dBW for clear air).

In Table A-3 the messaging path is from an MTSO up to a satellite, through six satellite-to-satellite crosslinks and down to an MTSO. In this table the effect of the crosslinks is indicated by the "Overdrive for 6 Crosslink Hops" entry of 3.3 dB. The dB value of this entry will be lower for a reduced number of crosslink hops. Each MTSO antenna diameter is 1.5

meters. MTSO EIRP for the rain case is 73.9 dBW (63.9 dBW for clear air). MTSO G/T for the rain case is 24.9 dBK (26.4 dBK for clear air). The satellite G/T is 10.5 dBK. The satellite EIRP for the rain case is 41.1 dBW (28.9 dBW for clear air).

The estimated power flux densities for various representative single channel-per-carrier TDM transmissions are illustrated in Tables A-5 through A-7 for the M-Star System. The maximum power flux density of -105 dBW/m^2 specified in Section 25.208(c) of the Commission's Rules is satisfied in any 1 MHz bandwidth for angles of arrival at and above 25°, as shown in the representative examples. For angles below 25°, the antenna characteristics attenuate the flux density levels to below the limits specified in Section 25.208(c) of the Rules.

The bandwidth spreading factor in the power flux density calculations include the effects of spectral shaping, overhead for packet routing, and bandwidth expansion due to forward error correction. In the power flux calculations, channel impairments such as atmospheric losses and rain fading are not included.

B. Transmission Characteristics - Intersatellite Links

In Table A-4 the intersatellite link (crosslink) performance is illustrated. Antenna diameters are 1.2 meters. Effective EIRP per carrier is 47.9 dBW when a messaging path includes six crosslink hops and will be lower as the number of hops reduces. Up to 16 carriers per link can be active. Receive G/T is 27 dB.

Cell Site Up To MTSO Down @ 10.24 Mbps.				
	Uplink		Downlink	
	Clear	Rain	Clear	Rain
Satellite Altitude, km	1350	1350	1350	1350
Grazing Angle, deg	22.0	22.0	22.0	22.0
Slant Range, km	2585.9	2585.9	2585.9	2585.9
SIGNAL PARAMETERS				
Frequency, MHz	50000	50000	40000	40000
Wavelength, cm	0.6	0.6	0.75	0.75
Information Rate, Mbps	10.24	10.24	10.24	10.24
Modulation	QPSK	QPSK	QPSK	QPSK
PATH PARAMETERS				
Path loss, dB	194.7	194.7	192.7	192.7
Atmospheric loss, dB	13.6	13.6	1.8	1.8
Rain loss, dB	0.0	8.9	0.0	6.8
Polarization loss, dB	0.13	0.13	0.13	0.13
Scintillation Loss, dB (3 sigma)	0.75	0.75	0.75	0.75
Edge of Coverage Loss, dB	1.00	1.00	1.00	1.00
Total propagation loss, dB	210.1	219.0	196.4	203.2
TRANSMIT RF PARAMETERS				
Power output, W	1.5	7.9	0.02	0.13
Output losses, dB	0.5	0.5	1.5	1.5
Antenna diameter, m	0.66	0.66	0.45	0.45
Antenna Gain, dB	49.3	49.3	40.6	40.6
Pointing loss, dB	1.0	1.0	1.0	1.0
Effective EIRP, dBW	49.5	56.8	21.1	29.1
RECEIVE RF PARAMETERS				
System temperature, degK	817	817	503	693
Antenna diameter, m	0.36	0.36	1.50	1.50
Antenna Gain, dB	40.6	40.6	54.4	54.4
Pointing loss, dB	1.0	1.0	1.0	1.0
Effective G/T, dBK	10.5	10.5	26.4	25.0
ONEWAY LINK SUMMARIES				
Received power per carrier, dBW	-121.0	-122.7	-121.9	-120.7
Received thermal noise, dBW	-128.7	-128.7	-130.8	-129.4
Received interference, dBW	-139.4	-141.0	-137.3	-136.2
TWO-WAY LINK SUMMARY				
Required Eb/(No+Io), dB			2.2	2.2
Modem loss, dB			1.5	1.5
Eb/(No+Io) at Modem, dB			4.7	3.7
EXCESS MARGIN, dB			1.0	0.0

Table A-1. Link Budget for a Cell Site up to an MTSO down at 10.24 Mbps