National Aeronautics and
Space Administration

Washington, D.C. 20546

NASA Long Range EM Spectrum Forecast

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PREFACE

The community served by NASA is not limited to scientists within the United States, nor is it limited to activities in space. NASA is an enabling Agency and has, since its inception in 1958, provided more scientific data for analysis to its Principal Investigators, than ever before in history. Indeed, it has provided more of such data than any other similar agency on Earth.

Additionally, NASA has delivered more technological breakthroughs and innovation than any other agency, in various fields, including: aviation safety, space transportation, ecological and environmental sensing systems, global and domestic communication systems, and scientific investigations. The benefits of these breakthroughs and innovation have not been limited to the public sector, but are manifest in many everyday activities involving the delivery of voice, data and entertainment information by satellite.

Indeed, NASA is charged with advocating commercial sector technical issues before the FCC and being a technical advisor to the FCC in matters relating to US commercial space activities.

The Agency has a unique worldwide reputation for excellence, cooperation and integrity.

NASA achievements are well-known to the public. What is not so well-known to the public is that these achievements are based on the access that the Agency has had to appropriate EM spectrum allocations, for both the acquisition (using sensor instruments) of data and the delivery (using communication systems) of that data.

Individual communication links are assigned the use of a specific frequency within an allocated band, with the approval of the Spectrum Planning Subcommittee of the IRAC. The collective use of the many frequencies assigned in this manner to NASA is addressed in more detail in the NASA Spectrum Operational Plan, a companion to this document.

The access to and repeated need for access (sustainability) to the frequency bands allocated to appropriate radio services are addressed in this document. NASA has carefully used, and protected all the frequency bands allocated to the radio services in which NASA programs' transmitters and receivers must operate.

In this way, and by using common communication systems in succeeding missions, the Agency has amortized the public investment in communication infrastructure. Additionally, NASA leads other space agencies in sharing the use of similar systems among space agencies, to further reduce the need for more infrastructure and more spectrum. The maximum re-use of frequencies by subsequent space missions, coupled with the implementation of new spectrum-efficient technologies, serves to reduce the congestion of this limited natural resource.

FOREWORD

National Aeronautics and Space Administration (NASA) space and aeronautical programs depend entirely on sustained, repeatable access to the electromagnetic (EM) spectrum to accomplish their mission objectives.

This Long-Range EM Spectrum Forecast is based on nine core principles, which are:

- To support a US spectrum policy that balances scientific needs in the public interest with economic security, recognizing that NASA requirements must be harmonized with other national needs.
- To identify EM spectrum requirements for our nation's current and future civil aeronautics and space communication and remote sensing systems.
- To promote effective use of available spectrum resources to provide better technical protection and improved sharing conditions for all spectrum users.
- To invest in new, spectrum–efficient technologies.
- To advocate the provision of spectrum resources required to enable emerging aerospace industry ventures.
- To facilitate coordination of US satellite industry spectrum issues to enhance global competitiveness.
- To advocate the introduction of new technology to minimize the US long-term requirements for additional spectrum.
- To promote/advocate US policies in international spectrum bodies and multi-lateral and bi-lateral negotiations for spectrum allocation and use.
- To support the President's Vision for Space Exploration for returning to the moon and on to Mars. The Space Communications Architecture specifically addresses this effort. In addition NASA has been proactive in gaining international support for the Space Communications Interoperability effort, especially from those nations with published plans for robotic or human missions to the moon and Mars.

While adhering to these principles, the NASA Spectrum Management staff will pursue the goals and objectives stated in the NASA EM Spectrum Management Strategy document.

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PURPOSE

The purpose of this Long Range electromagnetic (EM) Spectrum Forecast is to review the planned missions and programs of the National Aeronautical and Space Administration (NASA), to understand the communications and scientific observing systems that will be needed to successfully complete those missions, and to derive from this understanding the requirements that drive the need for reliable and sustainable access to the EM spectrum. It is important to identify any perceived deficiencies in available or sustainable spectrum so that adequate preparations to fulfill these deficiencies may be addressed in a timely manner within the national and international spectrum processes.

INTRODUCTION

It is the availability of properly protected EM spectrum that enables the implementation of all of the Agency's communication and remote-sensing systems. Ensuring that availability is the primary concern of the personnel engaged in spectrum management tasks at the various NASA Field Centers, led by the Director of Spectrum Policy and Plans in the Office of Space Communications at NASA Headquarters.

Additionally, NASA plays a key role in fundamental scientific and technology-enabling research both in the United States (US) and worldwide. With its comprehensive, spectrum-dependent public investment in space and aeronautics systems, NASA is a respected leader in EM spectrum management within the US and the world spectrum community. NASA personnel play an important role in fostering and sponsoring effective control and conservation of the limited natural resource that is the EM spectrum.

This Forecast will attempt to document planned NASA missions for up to thirty (30) years into the future. This is in line with the United States' Vision for Space Exploration, as NASA proceeds first, to Return to the Moon, and then to send astronauts to explore Mars. The reliability of detail in this forecast will diminish the further into the future such projections advance. However, the near term forecast, say the next ten years, will provide reliable information. Budget, technology and policy changes will undoubtedly cause the information contained herein to require periodic updating, and the Spectrum Policy and Plans Office in the Office of Space Communications, in concert with the Headquarters

> **SPECTRUM REGULATION**
>
> Member States of the International Telecommunication Union (ITU), a specialized agency of the United Nations, are responsible for the worldwide regulation of the use of the electromagnetic spectrum. The ITU periodically publishes the Radio Regulations, a treaty text agreed upon by Member States, which includes *inter alia*, the Table of Frequency Allocations. This Table depicts the agreed-to allocations of blocks of frequency spectrum for use by pre-defined Radiocommunication Services.
>
> Each Member State (*e.g.*, USA, France) of the ITU is responsible for regulating the use of radio frequencies by all entities falling under its sovereign jurisdiction.
>
> Use of the EM Frequency Spectrum by NASA is subject to regulation by the FCC and NTIA, within the US. Most of NASA's space missions operate in space above countries outside the US and therefore must also comply with the international Radio Regulations as published by the ITU.
>
> Additionally, NASA complies with OMB Directives A-11 and A-76 concerning the expenditure of public funds:-
>
> - NASA submits each of its spectrum requirements to the NTIA-managed Spectrum Review Process prior to program implementation.
>
> - NASA makes use of commercial communication systems wherever feasible, in order to satisfy its communication requirements.

Spectrum Management Forum (HSMF) of NASA Headquarters, will annually conduct a review and update as needed. The HSMF comprises representatives of all Mission Directorates and Mission Support Offices, led by the Director, Spectrum Policy and Plans. The HSMF meets every 90 days to consider updates in the use and demand for access to the EM spectrum. The Charter of the HSMF is given in Appendix 3.

> SPACE SCIENCE SERVICES
>
> The term 'space science services' is the collective term applied to the Radiocommunication Services, as defined by the International Telecommunication Union, that are used by space agencies as follows:
>
> Space Operation,
> Space Research,
> Earth Exploration-satellite,
> Meteorological-satellite, and
> Inter-satellite
>
> Space agencies make use of radio frequencies allocated to these services to satisfy their mission and program requirements.

With respect to the electromagnetic spectrum, NASA is primarily a user agency. However, its responsibilities include, not only ensuring the electromagnetic integrity of some twelve installations (Field Centers) inside the US, and providing technical advocacy and advice for the US satellite industry, but also (together with its partner space agencies) informally regulating and husbanding the spectrum allocations that have been made to the 'space science services' (see sidebar) by the ITU. This latter responsibility is discharged through the forums of the Space Frequency Coordination Group (SFCG) and the Consultative Committee for Space Data Systems (CCSDS), both of which enjoy strong NASA leadership.

It is important to note that NASA has to operate above many countries other than the US, and must comply with the international Table of Frequency Allocations. Additionally, NASA has chartered and leads the SFCG; a worldwide group of space agencies that make agreements about how best to use allocated frequency bands, how to provide cross-support to each other's missions etc. (The SFCG Terms of Reference are shown in Appendix 4). Such agreements, as noted earlier, allow mission goal achievement without the need to increase cost or increase spectrum requirements, thus reducing the impact to the public purse. NASA is also the leader of the CCSDS; another world wide group of space agencies that develop and promulgate standards for space hardware and software, and develop technologies for improving spectrum efficiency, for example, spectrum efficient modulation techniques.

It is also important to recognize that some of the EM frequencies that NASA requires access to, exhibit unique physical properties, for example, in the range between about 55 GHz and 63 GHz, the absorption of oxygen in the Earth's atmosphere causes a rise in attenuation of signal levels. Another example occurs around 1400 MHz, the so-called waterhole, due to the strong natural emissions of hydrogen around this frequency. Such frequencies provide important scientific data that cannot be obtained elsewhere in the EM spectrum. In many cases the ability to passively (no emissions) sense a number of such frequency bands simultaneously yields results more beneficial than sensing in a single band. This is due to enhanced data processing technologies that are now in place around the world.

BACKGROUND

NASA, since its formation in 1958 has played an integral role in the introduction of satellite communication services in the U. S. and around the world. This Agency developed the technology that enabled geostationary-satellite communication systems (e.g., Intelsat) in the 1970's, the mobile-satellite systems (e.g., Iridium) of the 1990's, and the digital audio satellite broadcasting systems (e. g., Sirius) of the 21st century.

During this time NASA has developed and implemented a continually evolving infrastructure of communication systems and networks (see sidebar) to support the exploration of space (throughout the Solar System and beyond), the exploration of our home planetary system (Earth and its moon), and the environmental and ecological monitoring (sensing) of the Earth itself. Exploration is conducted by means of, first, robotic machines, and subsequently, human astronauts. Together with its international space agency partners, NASA has built the first permanent human habitat remote from the Earth's surface, i.e., the International Space Station.

NASA communication systems provide the means to control the operation of spacecraft, and the acquisition and delivery of the scientific data obtained by the spacecraft instruments. Without access to communication systems, the exploration of space, and even the satellite sensing of our own planet would not be possible. Further, these communication systems could not be implemented without the availability and sustainability of appropriate bands of electromagnetic frequencies (the EM spectrum).

COMMUNICATION SYSTEMS

Scientific spacecraft must be tracked and controlled. The health and safety of the spacecraft must be monitored. The scientific data collected by the onboard instruments must be received and distributed to the mission's Principal Investigators.

These tasks are accomplished by means of the communication infrastructure that NASA has implemented, including the Tracking and Data Relay Satellite System (TDRSS), the Ground Network (GN), and the Deep Space Network (DSN).

The TDRSS utilizes communication satellites in geostationary orbit to relay data from a scientific spacecraft, operating in an orbit other than geostationary orbit, to a fixed location ground station.

The GN operates a number of ground-based tracking facilities to support scientific spacecraft directly without the need for a relay.

The DSN is used to support scientific spacecraft whose primary mission objectives can only be realized at distances more than two (2) million kilometers from the Earth, for example, missions to the other planets.

In order to assure that its technology and communication systems have access to the appropriate EM spectrum to support its missions, NASA employs a cadre of dedicated individuals led by the office of the Director, Spectrum Policy and Plans in the Office of Space Communications, NASA Headquarters, Washington, DC. Specialists at each of the NASA Field Centers are appointed to assure EM spectrum integrity, and to provide input to the overall spectrum requirement activities of the Agency. These individuals have, between them, extensive experience in both the domestic and international regulatory communities.

NASA SPECTRUM SELECTION PROCESS

NASA has developed, over many years, a spectrum selection process that is transparent, thorough and efficient (see the upper left section of Figure 1). Once a program or mission is approved or mandated, by Congress or the White House, NASA Headquarters assigns the task of managing that program to one of the NASA Field Centers. The designated Field Center is then responsible for analyzing the mission requirements and establishing a budget for that program for submission to NASA Headquarters. NASA Headquarters personnel consider, review, revise where necessary, and collate the budget requirements for all NASA aeronautical and space programs for submission to the Office of Management and Budget (OMB).

Among the many items to be considered when planning a mission, communication links and scientific sensors are important. During the analysis of the mission requirements, communication links and scientific sensors are identified, with particular emphasis on re-using existing technology and spectrum allocations. NASA has invested more than $ 70 billion in ground-based and space-based infrastructure to support US (and allied) space missions. It is of primary importance to maximize the return on this investment of public dollars, so each and every set of mission requirements is scrutinized with a view to making the best use of existing technology, equipment and available spectrum.

Once the communication links and scientific sensors are defined at the NASA Field Center (by the Center Spectrum Manager and the Mission Design Team) in terms of frequency band, bandwidth and data rates, submissions are prepared for the Interdepartment Radio Advisory Committee (IRAC) Spectrum Planning Subcommittee (SPS) in respect of all spectrum requirements that can be satisfied using existing allocations.

Subsequent to SPS approval, appropriate frequencies are assigned by the IRAC Frequency Assignment Subcommittee (FAS). Each of these assigned frequencies that are to be used in space must be coordinated with other countries through the International Telecommunication Union’s (ITU) Radiocommunication Bureau (BR). When the system is brought into operation, these frequencies must be published in the International Frequency List for the entire world to see. This process requires cooperation among NASA Headquarters, the IRAC Space Systems Subcommittee, the FCC International Notification Group and the ITU BR, as shown around the outside of Figure 1.

Any spectrum requirements that cannot be satisfied within existing allocations are submitted to NASA Headquarters for validation by the Headquarters Spectrum Management Forum. Once validated, and in compliance with OMB Directives A-11 and A-76, the requirements are submitted to the IRAC Spectrum Planning Subcommittee for further consideration.

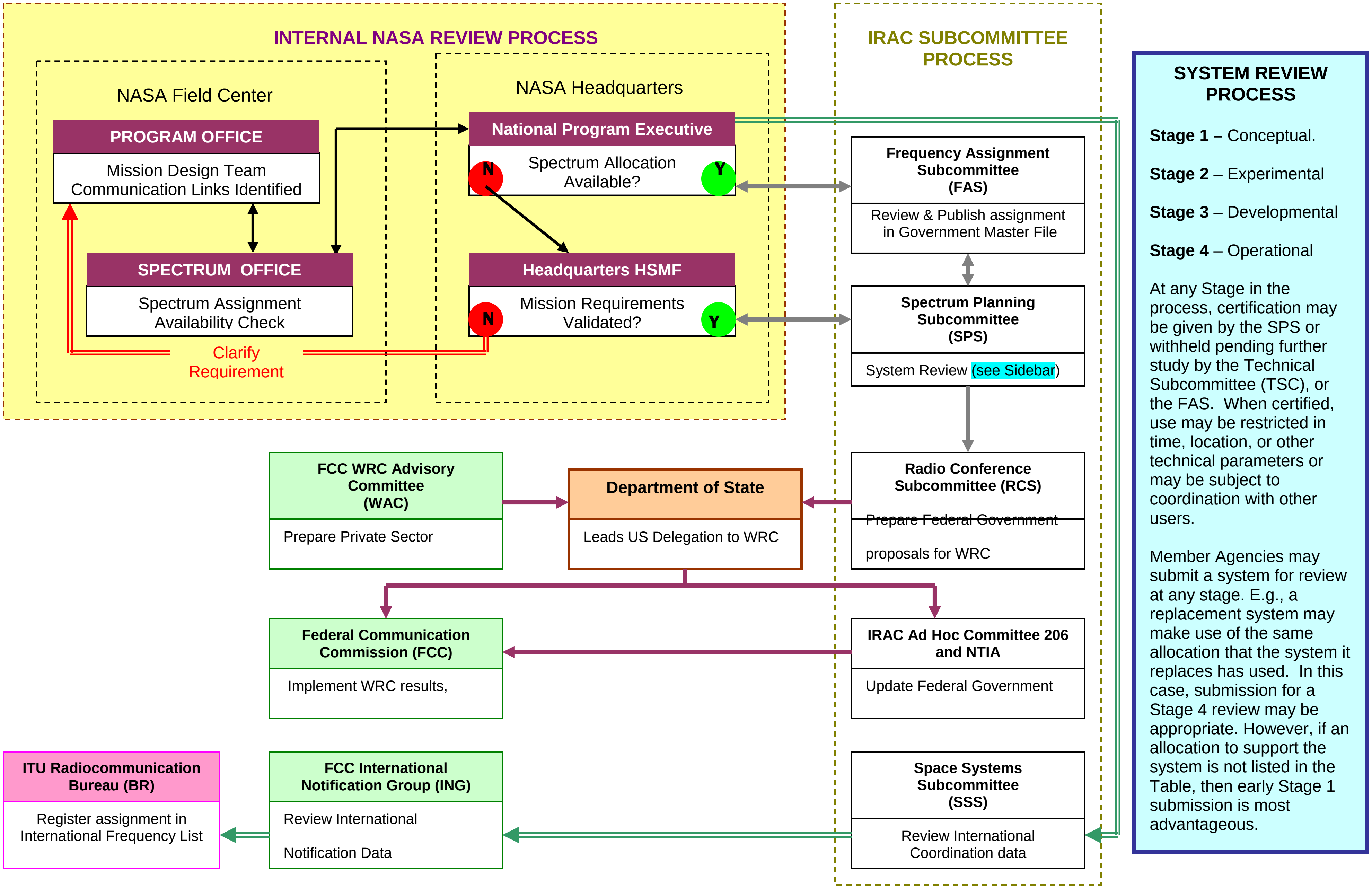

Figure 1 – Spectrum Allocation & Registration Process

US PROCESS FOR ACQUIRING NEW ALLOCATIONS

Should the National Telecommunication and Information Administration (NTIA) be unable to suggest alternative available spectrum then NASA would petition the IRAC Radio Conference Subcommittee (RCS) for a US proposal to an ITU World Radiocommunication Conference (WRC) to satisfy this spectrum deficiency with a new allocation. The process of acquiring new spectrum allocations is shown in Figure 1, starting in the middle with the IRAC Subcommittee Process, particularly the SPS, and following on through the RCS, and the Department of State (coordinated with FCC requirements), and taken to a WRC by an Ambassadorial delegation from the US. NASA has provided resources to support US delegations to WRCs for since 1959. Further, many highly-skilled and active members of such delegations, including a number in leadership roles, have been Agency employees. Additionally, NASA leads the technical studies associated with space science allocations that provide the basis for WRC decisions. Given success at a conference, then both NTIA and the FCC work together as shown to implement the results and to publish updated US Regulations.

Summary

This Long Range Spectrum Forecast projects NASA strategic (allocation) spectrum requirements based on existing, planned and foreseen NASA missions for a period up to thirty years. The companion Spectrum Operational Plan serves a similar purpose for NASA tactical (assignment) spectrum requirements for a period of five years. NASA frequency assignments are requested through the National System Review process from among the available frequency allocations.

There are four annexes to this document, which can be used by NTIA to update the National Spectrum Strategic Plan: Annex A lists NASA's spaceborne missions by name, start date and frequency band; Annex B lists the specific bands used or planned for use by space science systems for communication; Annex C lists the specific bands used or planned for use by space science systems for sensing; Annex D lists all existing international allocations available for use by the space sciences for communication or sensing. The spectrum deficiencies that have been identified in consultation between NASA and NTIA, and will likely be the basis for future WRC consideration.

There are also three appendices: Appendix 1 lists current spectrum deficiencies that must be addressed at future World Radiocommunication Conferences to support future requirements; Appendix 2 provides the Charter for the NASA Headquarters Spectrum Management Forum for considering the spectrum requirements from all program offices; and Appendix 3 provides the Terms of Reference for the Space Frequency Coordination Group which NASA utilizes as a venue for pre-coordinating spectrum uses between civil space agencies around the world.

Effective and timely execution of these plans will enable NASA to realize its vision of EM spectrum management as foreseen in the President's Initiative for United States Spectrum Management in the 21^{st} Century.

NASA USE OF SPECTRUM FOR FEDERAL COG, INTEROPERABILITY AND PUBLIC SAFETY

NASA is active in the National Communications System (NCS) and has a member on the Committee of Principals as well as a member on the working party effort. NASA also supports the Coop Exercises sponsored by the NTIA yearly to develop and train for continuing operations capability.

Glossary

OMB Circular A-11: Requires federal government agencies to obtain spectrum availability approval prior to any major expenditure of funds for space and ground systems.

OMB Circular A-76: Requires government agencies to explore and exhaust all efforts to use commercial communication services to satisfy mission requirements.

Electromagnetic (EM) Spectrum: The range of frequencies of electromagnetic radiation from about 20 kHz to above 3000 GHz.

Spectrum-Dependent Systems: Systems that require, operate in, or affect the electromagnetic spectrum.

Spectrum Management: Planning, coordinating and managing the use of the electromagnetic spectrum through operational, engineering and administrative or regulatory procedures, with the objective of enabling electronic systems to perform their function in the intended environment without causing or suffering unacceptable interference.

Telecommunication: Any transmission, emission, or reception of signs, signals, writings, images, sounds or information of any nature by wire, radio, visual, or other electromagnetic compatible system.

Acronyms

CCSDS – Consultative Committee for Space Data Systems

FCC - Federal Communications Commission

HSMF – Headquarters Spectrum Management Forum

ITU – International Telecommunication Union

IRAC – Interdepartment Radio Advisory Committee

NASA – National Aeronautics and Space Administration

NTIA – National Telecommunications and Information Administration

OMB – Office of Management and Budget

SFCG – Space Frequency Coordination Group

ANNEX A: LIST OF NASA MISSIONS AND FREQUENCIES

NASA DEEP SPACE MISSIONS

(Status as of October 2007)

TABLE 1: EARTH – SPACE

MISSION	FREQUENCY (MHz)	DIRECTION	EMISSION*	D.B.I.U.	NOTES
Voyager-2	2113.3125	E-S	32K0G2D	In Orbit	
Voyager-1	2114.676697	E-S	32K0G2D	In Orbit	
MSL	7150.753858	E-S	36K0G2D	2009/09	
Phoenix	7151.909724	E-S	36K0G2D	In Orbit	
JUNO	7153.065586	E-S	36K0G2D	2011	
Mars Odyssey	7155.377316	E-S	32K3G2D	In Orbit	
SIRTF	7161.156637	E-S	36K0G2D	In Orbit	
Kepler	7170.40355	E-S	36K0G2D	2009/02	
Cassini	7175.027006	E-S	33K0G2D	In Orbit	
~~Stardust~~ NEXT	7175.027006	E-S	32K3G2D	In Orbit	In July 07, Stardust had new assignment after successfully completed comet sample return to Earth in January 06. Now known as NEXT, it will flyby Temple 1 in February 2011.
MESSENGER	7177.338735	E-S	33K0G2D	In Orbit	
~~Deep Impact~~ EPOXI	7155.377316	E-S	36K0G2D	In Orbit	In July 07, Deep Impact had new assignment after successfully completed its primary mission. Now known as EPOXI, it is on the way for comet Boethin encounter in December 2008.
MERB	7179.650464	E-S	36K0G2D	In Orbit	
DAWN	7179.650464	E-S	36K0G2D	In Orbit	
New Horizon	7181.96219	E-S	36K0G2D	In Orbit	
MERA	7183.118057	E-S	36K0G2D	In Orbit	

TABLE 1: EARTH – SPACE CONT.

MRO	7183.118057	E-S	36K0G2D	In Orbit	
STEREO-A	7186.585649	E-S	36K0G2D	In Orbit	
STEREO-B	7188.897378	E-S	36K0G2D	In Orbit	
Cassini	34316.36243	E-S	1H00N0N	In Orbit	Radio Science only
JUNO	34365.45139	E-S	1H00N0N	2011	radio science only
SIM		E-S		2015	X- and Ka-band Frequency Assignment Under Study

* The indicated bandwidth contains approximately 90% of telecommand or telemetry power, ignoring ranging components and DOR tones, if any

NASA DEEP SPACE MISSIONS

(Status as of October 2007)

TABLE 2: SPACE-EARTH

MISSION	FREQUENCY (MHz)	DIRECTION	EMISSION*	D.B.I.U.	NOTES
Voyager-2	2295	S-E	135KG2D	In Orbit	Secondary Downlink
Voyager-1	2296.481481	S-E	135KG2D	In Orbit	Secondary Downlink
Cassini	2298.333333	S-E	1H00N0N	In Orbit	Radio Science when non-coherent
Cassini	2299.074074	S-E	1H00N0N	In Orbit	Radio Science when coherent with X-up
MSL	8401.419753	S-E	375KG1D	2009/09	
Phoenix	8402.77778	S-E	158KG2D	In Orbit	
JUNO	8404.135802	S-E	2M40G1D	2011	
Mars Odyssey	8406.851853	S-E	2M73G2D	In Orbit	
SIRTF	8413.641977	S-E	8M80G1D	In Orbit	
Voyager-2	8415	S-E	2M19G2D	In Orbit	
Voyager-1	8420.432097	S-E	2M19G2D	In Orbit	
Kepler	8424.506174	S-E	2M35G1D	2009/02	
Cassini	8427.222221	S-E	5M94G1D	In Orbit	
~~Stardust~~ NEXT	8427.222221	S-E	2M25G2D	In Orbit	In July 07, Stardust had new assignment after successfully completed comet sample return to Earth in January 06. Now known as NEXT, it will flyby Temple 1 in February 2011.
Cassini	8429.938271	S-E	5M94G1D	In Orbit	
~~Stardust~~ NEXT	8429.938271	S-E	2M25G2D	In Orbit	In July 07, Stardust had new assignment after successfully completed comet sample return to Earth in January 06. Now known as NEXT, it will flyby Temple 1 in February 2011.

TABLE 2: SPACE-EARTH CONT.					
MESSENGER	8432.654322	S-E	2M50G1D	In Orbit	
~~Deep Impact~~ EPOXI	8435.370372	S-E	800KG1D	In Orbit	In July 07, Deep Impact had new assignment after successfully completed its primary mission. Now known as EPOXI, it is on the way for comet Boethin encounter in December 2008.
MERB	8435.370372	S-E	2M50G2D	In Orbit	
DAWN	8435.370372	S-E	2M54G2D	In Orbit	
New Horizon	8438.086419	S-E	3M74G1D	In Orbit	
MERA	8439.444446	S-E	2M50G2D	In Orbit	
MRO	8439.444446	S-E	6M00G1D	In Orbit	
STEREO-A	8443.518519	S-E	3M84G1D	In Orbit	
STEREO-B	8446.23457	S-E	3M84G1D	In Orbit	
Cassini	32023.44444	S-E	1H00N0N	In Orbit	Radio Science when non-coherent
Cassini	32028.60494	S-E	1H00N0N	In Orbit	Radio Science when coherent with Ka
Cassini	32033.76543	S-E	1H00N0N	In Orbit	Radio Science when coherent with X-up
Kepler	32166.2963	S-E	11M5G2D	2009/02	
MRO	32223.33334	S-E	12M0G1D	In Orbit	
JUNO	32083.33333	S-E	1H00N0N	2011	radio science only. Coherent with Ka-up with turn-around ratio of 3599/3360
JUNO	32088.51852	S-E	1H00N0N	2011	radio science only. Coherent with X-up with turn-around ratio of 749/3360
SIM		S-E		2015	X- and Ka-band Frequency Assignment under Study

* The indicated bandwidth contains approximately 90% of telecommand or telemetry power, ignoring ranging components and DOR tones, if any.

NASA/JPL/DSN NEAR EARTH SATELLITES

(Status as of October 2007)

TABLE 3: EARTH-SPACE AND SPACE-SPACE (Forward)

SATELLITE	FREQUENCY (MHz)	DIRECTION	EMISSION*	D.B.I.U.	NOTES
Missions Managed by NASA/JPL:					
CLOUDSAT	1811.607	E-S	4M00---	In Orbit	Filed in ITU-R as USCLOUDSAT
QuikScat	2025.833	E-S	36K0G2D	In Orbit	
OCO	2035.318	E-S	36K0G2D	2008/12	Primary link.
OCO	2035.318	S-S	36K0G2D	2008/12	For initial checkout and spacecraft emergency only
GALEX	2039.646	E-S	36K0G2D	In Orbit	
AcrimSat	2065.5	E-S	36K0G2D	In Orbit	
WISE	2070.49375	S-S	6M00G7D	2009/11	using TDRSS Single Access
ST-8	2092.197792	E-S	64K0G1D	2009/11	
DSN-supported missions:					
Integral	2039.6458	E-S	2M00GXX	In Orbit	Supported by Goldstone only. Future ESA Missions.
SOHO	2067.271	E-S	2M40G2XXN	In Orbit	ESA Mission.
Cluster II/FM6	2070.954	E-S	2M40G2XXN	In Orbit	ESA Mission.
Chandra (AXAF)	2071.875	E-S	34K00G2D	In Orbit	
Cluster II/FM5	2077.4	E-S	2M40G2XXN	In Orbit	ESA Mission.
Geotail	2081	E-S	3M20G9W	In Orbit	JAXA Mission.
SELENE	2084.4	E-S	3M40G9W	In Orbit	SELENE, a JAXA mission, consists of three satellites, an orbiter containing most of the scientific equipment, a VLBI Radio satellite (Vstar), and a relay satellite (Rstar). Vstar and Rstar separations will occur at Lunar Orbit Injection (LOI) phase. DSN's prime support period covers LEOP, lunar transfer orbit phase, and LOI phase. After LOI, DSN supports the main module only during contingencies and Lunar eclipse events.

TABLE 3: EARTH-SPACE AND SPACE-SPACE (Forward) CONT.					
ISTP POLAR	2085.6875	E-S	250K0G9D	In Orbit	
Cluster II/FM7	2090.292	E-S	2M40G2XXN	In Orbit	ESA Mission.
WMAP	2090.66	E-S	36K0G2D	In Orbit	
Image	2092.5938	E-S	36K0G2D	In Orbit	
ISTP Wind	2094.8958	E-S	36K0G2D	In Orbit	
Cluster II/FM8	2096.738	E-S	2M40G2XXN	In Orbit	ESA Mission.
ACE	2097.9806	E-S	1M03G9D	In Orbit	
ERBS	2106.4063	E-S	34K0G2D	In Orbit	

* The indicated bandwidth for NASA/JPL missions contains approximately 90% of telecommand or telemetry power, ignoring ranging components, if any.

For non NASA-JPL missions, the bandwidth and other pertinent data are based on information provided by the responsible agency/center.

NASA/JPL/DSN NEAR EARTH SATELLITES

(Status as of October 2007)

TABLE 4: SPACE-EARTH AND SPACE-SPACE (Return)

SATELLITE	FREQUENCY (MHz)	DIRECTION	EMISSION*	D.B.I.U.	NOTES
Missions Managed by NASA/JPL:					
QuikScat	2209.5	S-E	4M00G1D	In Orbit	Quikscat's science data link
OCO	2210.3	S-E	4M00G1D	2008/12	For initial checkout and spacecraft emergency only
OCO	2210.3	S-S	64K0G1D	2008/12	For initial checkout and spacecraft emergency only
GALEX	2215	S-E	8M00G1D	In Orbit	
CLOUDSAT	2217.5	S-E	5M00G1D	In Orbit	Filed in ITU-R as USCLOUDSAT
WISE	2248.5	S-S	6M00G1D	2009/11	using TDRSS single access
AcrimSat	2250	S-E	230KG1D	In Orbit	
CLOUDSAT	2262.3	S-E	5M00G7D	In Orbit	Filed in ITU-R as USCLOUDSAT
QuikScat	2265	S-E	3M42G2D	In Orbit	Quikscat's house keeping data link
ST-8	2272.07	S-E	4M00G1D	2009/11	
OCO	8115.253	S-E	150MG1D	2008/12	Primary telemetry link.
GALEX	8190	S-E	50M0G1D	In Orbit	
WISE	15003.4	S-S	200MG1D	2009/11	Primary science link, using TDRSS multiple access
DSN-supported missions:					
Integral	2215	S-E	2M00G1D	In Orbit	ESA Mission supported by Goldstone only.
SOHO	2245	S-E	4M00G1DCN	In Orbit	ESA Mission.
Cluster II/FM6	2249	S-E	6M00G1DCN	In Orbit	ESA Mission.
Chandra (AXAF)	2250	S-E	4M80G9D	In Orbit	
Cluster II/FM5	2256	S-E	6M00G1DCN	In Orbit	ESA Mission.

TABLE 4: SPACE-EARTH AND SPACE-SPACE (Return) CONT.					
Geotail	2259.91	S-E	3M20G3N	In Orbit	JAXA Mission.
SELENE	2263.602	S-E	3M40G9W	In Orbit	SELENE, a JAXA mission, consists of three satellites, an orbiter containing most of the scientific equipment, a VLBI Radio satellite (Vstar), and a relay satellite (Rstar). Vstar and Rstar separations will occur at Lunar Orbit Injection (LOI) phase. DSN's prime support period covers LEOP, lunar transfer orbit phase, and LOI phase. After LOI, DSN supports the main module only during contingencies and Lunar eclipse events.
ISTP Polar	2265	S-E	2M82G9D	In Orbit	
Cluster II/FM7	2270	S-E	6M00G1DCN	In Orbit	ESA Mission.
WMAP	2270.4	S-E	8M00G7D	In Orbit	
Image	2272.5	S-E	2M40G2D	In Orbit	
ISTP Wind	2275	S-E	2M01G2D	In Orbit	
Cluster II/FM8	2277	S-E	6M00G1DCN	In Orbit	ESA Mission.
ACE	2278.35	S-E	1M03G9D	In Orbit	
ERBS	2287.5	S-E	2M18G2D	In Orbit	
Geotail	8474.66	S-E	5M20G3N	In Orbit	JAXA Mission.

* The indicated bandwidth for NASA/JPL missions contains approximately 90% of telecommand or telemetry power, ignoring ranging components, if any.

For non NASA-JPL missions, the bandwidth and other pertinent data are based on information provided by the responsible agency/center.

NASA GSFC SATELLITE NETWORK FREQUENCY

(Status as of October 2007)

TABLE 5: EARTH - SPACE

SATELLITE	FREQUENCY (MHz)	DIRECTION	EMISSION	D.B.I.U.	NOTES
MMS	2025-2110	E-S	TBD	2014/09	Frequency Assignment Under Study
CHIPSAT	2030.2533	E-S	84K40F1D 79K60F1D 74K00F1D	IN ORBIT	
TDRS	2030.4375	E-S	3M00G2D	IN ORBIT	
AQUARIUS (SAC-D)	2034.95	E-S	40K0G2D	2009/07	Aquarius, a NASA instrument, is on Argentina's SAC-D satellite.
TDRS	2035.9625	E-S	3M00G2D	IN ORBIT	
IBEX	2037.712	E-S	4K00G2D	2008/06	
TIMED	2039.6458	E-S	36K00G2D	IN ORBIT	
FAST	2039.6458	E-S	36K00G2D	IN ORBIT	
GALEX	2039.6458	E-S	36K00G2D	IN ORBIT	
GLORY	2039.6458	E-S	36K00G2D	2008/12	
ICESAT	2039.6458	E-S	40K00G2D	IN ORBIT	
RHESSI	2039.6458	E-S	36K00G2D	IN ORBIT	
SAMPAX	2039.6458	E-S	36K00G2D	IN ORBIT	
SWAS	2039.6458	E-S	36K00G2D	IN ORBIT	
TRACE	2039.6458	E-S	36K00G2D	IN ORBIT	
WIRE	2039.6458	E-S	36K00G2D	IN ORBIT	
JASON-1	2040.943	E-S	300K0G2D	IN ORBIT	
SDO	2044.3421	E-S	36K00G2D	2009/01	

TABLE 5 EARTH-SPACE CONT.					
GRACE (NASA & GERMANY)	2051	E-S	100K0G2D	IN ORBIT	
LCROSS	2070.49375	E-S	40K00G2D 2M02G2D	2008/10	2M02G2D includes ranging
FUSE	2070.9541	E-S	36K00G2D	IN ORBIT	
CHANDRA (AXAF)	2071.875	E-S	34K00G2D	IN ORBIT	
GRACE (NASA & GERMANY)	2073.5	E-S	100K0G2D	IN ORBIT	
SAC-C	2076.9396	E-S	40K00G2D	IN ORBIT	
TRMM	2076.9396	E-S	34K00G2D	IN ORBIT	
ISTP POLAR	2085.6875	E-S	250K0G9D	IN ORBIT	
EO-1	2090.66	E-S	36K00G2D	IN ORBIT	
WMAP	2090.66	E-S	36K00G2D	IN ORBIT	
JWST	2090.7521	E-S	32K50G2D 36K00G2D 64K00G1D	2013	Frequency Assignment Under Pre-Coordination
LRO	2091.4	E-S	1M00G2D 40K00G2D	2008/10	Frequency Assignment Under Pre-Coordination
HETE-2	2092.1333	E-S	36K9G1D	IN ORBIT	
SEASTAR	2092.59	E-S	38K40G1D	IN ORBIT	
IMAGE	2092.5938	E-S	36K00G2D	IN ORBIT	
FASTSAT	2093.404	E-S	86K40F1D	2009	
SORCE	2093.5148	E-S	36K00G2D	IN ORBIT	
TOMS-EP	2093.5148	E-S	36K00G2D	IN ORBIT	
ISTP WIND	2094.8958	E-S	36K00G2D	IN ORBIT	
CALIPSO (NASA & CNES)	2094.896	E-S	36K00G2D	IN ORBIT	
ACE	2097.9806	E-S	1M03G9D	IN ORBIT	

TABLE 5 EARTH-SPACE CONT.					
AIM	2101.8021	E-S	36K00G2D	IN ORBIT	
THEMIS	2101.8021	E-S	34K00G2D	IN ORBIT	
AQUA	2106.4063	E-S	36K00G2D	IN ORBIT	
AURA	2106.4063	E-S	36K00G2D	IN ORBIT	
ERBS	2106.4063	E-S	34K00G2D	IN ORBIT	
GLAST	2106.4063	E-S	36K00G2D	2008/01	
GPM	2106.4063	E-S	4K00G1D 128K00G1D	2013/06	
XTE	2106.4063	E-S	36K00G2D	IN ORBIT	
SWIFT	2106.4063	E-S	36K00G2D	IN ORBIT	
TERRA	2106.4063	E-S	36K00G2D	IN ORBIT	
TDRS	14600 -15250	E-S	50M00G2D	IN ORBIT	

NASA GSFC SATELLITE NETWORK FREQUENCY

(Status as of October 2007)

TABLE 6: SPACE - EARTH

SATELLITE	FREQUENCY (MHz)	DIRECTION	EMISSION	D.B.I.U.	NOTES
MMS	2200-2290	S-E	TBD	2014/09	Frequency Assignment Under Study
HETE-2	137.96	S-E	1K42G1D	IN ORBIT	
SEASTAR	1702.5	S-E	2M66G1D	IN ORBIT	
CHIPSAT	2204.8	S-E	390K40F1D 198K49FD 275K20FID	IN ORBIT	
TDRS	2205	S-E	2M06G2D	IN ORBIT	
Aquarius (SAC-D)	2209.9	S-E	40K0G2D	2009/07	Aquarius, a NASA instrument, is on Argentina's SAC-D satellite.
GRACE (NASA & GERMANY)	2211	S-E	2M00G1D	IN ORBIT	
TDRS	2211	S-E	2M06G2D	IN ORBIT	
IBEX	2212.9	S-E	4K00G1D 640KG1D	2008/06	
TIMED	2214.9727	S-E	7M00G1D	IN ORBIT	
FAST	2215	S-E	9M00G1D	IN ORBIT	
GALEX	2215	S-E	8M00G1D	IN ORBIT	
GLORY	2215	S-E	15K62G1D 250K00G1D 4M00G1D	2008/12	
ICESAT	2215	S-E	3M53G2D	IN ORBIT	
RHESSI	2215	S-E	8M00G1D	IN ORBIT	

TABLE 6: SPACE - EARTH CONT.					
SAMPAX	2215	S-E	10M00G1D	IN ORBIT	
SWAS	2215	S-E	7M20G1D	IN ORBIT	
TRACE	2215	S-E	9M00G1D	IN ORBIT	
WIRE	2215	S-E	9M00G1D	IN ORBIT	
JASON-1	2215.92	S-E	2M00G2D	IN ORBIT	
SDO	2220.1	S-E	2M18G2D	2009/01	
LCROSS	2248.5	S-E	3M41G2D 5M00G1D	2008/10	
FUSE	2249	S-E	8M20G2D	IN ORBIT	
CHANDRA (AXAF)	2250	S-E	4M80G9D	IN ORBIT	
SAC-C	2255.5	S-E	260K00G2D	IN ORBIT	
TRMM	2255.5	S-E	6M00G1D	IN ORBIT	
GRACE (NASA & GERMANY)	2260.8	S-E	2M00G1D	IN ORBIT	
ISTP POLAR	2265	S-E	2M82G9D	IN ORBIT	
CALIPSO (NASA & CNES)	2268.456	S-E	1M90G1D	IN ORBIT	
EO-1	2270.4	S-E	4M00G1D	IN ORBIT	
WMAP	2270.4	S-E	8M00G7D	IN ORBIT	

TABLE 6: SPACE - EARTH CONT.					
JWST	2270.5	S-E	115K00G2D 160K00G1D	2013	Frequency Assignment Under Pre-coordination
LRO	2271.2	S-E	3M40G2D 4M57G2D 5M00G1D	2008/10	Frequency Assignment Under Pre-coordination
HETE-2	2272	S-E	1M00G1D	IN ORBIT	
IMAGE	2272.5	S-E	4M40G2D	IN ORBIT	
FASTSAT	2273.38	S-E	2M70F1D	2009	
SORCE	2273.5	S-E	6M00G1D	IN ORBIT	
TOMS-EP	2273.5	S-E	3M07G9D	IN ORBIT	
ISTP WIND	2275	S-E	2M61G9D	IN ORBIT	
ACE	2278.35	S-E	1M03G9D	IN ORBIT	
AIM	2282.5	S-E	4M00G1D	IN ORBIT	
THEMIS	2282.5	S-E	4M19G1D 2M31G2D	IN ORBIT	
AQUA	2287.5	S-E	2M08G1D	IN ORBIT	
AURA	2287.5	S-E	2M08G1D	IN ORBIT	
ERBS	2287.5	S-E	2M18G2D	IN ORBIT	
GLAST	2287.5	S-E	5M00G1D	2008/01	
GPM	2287.5	S-E	4M00G1D 2M00G1D	2013/06	

TABLE 6: SPACE - EARTH CONT.					
XTE (RXTE)	2287.5	S-E	4M10G1D	IN ORBIT	
SEASTAR	2287.5	S-E	4M00G1D	IN ORBIT	
SWIFT	2287.5	S-E	5M00G1D	IN ORBIT	
TERRA	2287.5	S-E	2M18G1D	IN ORBIT	
ICESAT	8100	S-E	40M00G1D	IN ORBIT	
AQUA	8160	S-E	150M00G1D 15M00G1D	INORBIT	
AURA	8160	S-E	150M00G1D 15M00G1D	IN ORBIT	
GALEX	8190	S-E	50M00G1D	IN ORBIT	
GLORY	8190	S-E	40M00G1D	2008/12	
TERRA	8212.5	S-E	150M00G1D	IN ORBIT	
EO-1	8225	S-E	105M00G1D	IN ORBIT	
CALIPSO (NASA & CNES)	8330	S-E	80M00G1D	IN ORBIT	
TDRS	13400 - 14050	S-E	650M00G1D	IN ORBIT	
JWST	25900	S-E	56M00G1D	2013	Frequency Assignment Under Coordination
LRO	25650	S-E	57M25G1D 114M50G1D 229M00G1D	2008/10	Frequency Assignment Under Coordination
SDO	26500	S-E	300M00G1D	2009/01	

NASA MSFC SATELLITE NETWORK FREQUENCY (EARTH→SPACE)

(Status as of October 2007)

TABLE 7: *EARTH-SPACE*

SATELLITE	FREQUENCY (MHz)	DIRECTION	EMISSION	D.B.I.U.	NOTES
GP-B	2106.4	E-S	16K0G1D	IN ORBIT	

NASA MSFC SATELLITE NETWORK FREQUENCY (SPACE→EARTH)

(Status as of October 2007)

TABLE 8: *SPACE – EARTH*

SATELLITE	FREQUENCY (MHz)	DIRECTION	EMISSION	D.B.I.U.	NOTES
GP-B	2287.5	S-E	2M50G1D	IN ORBIT	

NASA JSC SATELLITE NETWORK FREQUENCY (EARTH→SPACE)

(Status as of October 2007)

TABLE 9: EARTH-SPACE

SATELLITE	FREQUENCY (MHz)	DIRECTION	EMISSION	D.B.I.U.	NOTES
BIGELOW AEROSPACE	2044.3	E-S	2M00G1D	2006/06	Inflatable Space Hotel

NASA JSC SATELLITE NETWORK FREQUENCY (SPACE→EARTH)

(Status as of October 2007)

TABLE 10: SPACE-EARTH

SATELLITE	FREQUENCY (MHz)	DIRECTION	EMISSION	D.B.I.U.	NOTES
BIGELOW AEROSPACE	2220.1	S-E	2M00G1D	2006/06	Inflatable Space Hotel

TDRS SATELLITE NETWORK FREQUENCY (SPACE→SPACE)

(Status as of October 2007)

TABLE 11: SPACE - SPACE

SATELLITE	RETURN FREQUENCY (MHz)	FORWARD FREQUENCY (MHz)	DIRECTION	RETURN EMISSION	D.B.I.U.	
MMS	2200-2290	2025-2110	S-S	TBD	2014/09	Frequency Assignment Under Study
MMS	N/A	2025-2110 (TBD)	S-S	TBD	2014/09	Frequency Assignment Under Study. This is the MMS-to-MMS intersatellite link.
OCO	2210.3	2035.318	S-S	64K00G1D	2008/09	For initial checkout and spacecraft emergency only.
IBEX	2212.9	2037.712	S-S	4K00G1D	2008/06	LEO&A and Contingency.
GALEX	2215	2039.6458	S-S	64K00G1D	IN ORBIT	Contingency
GLORY	2215	2039.6458	S-S	15K62G1D	2008/12	LEO&A
SHUTTLE	2217.5	2041.9479	S-S	5M00G1D	IN ORBIT	
NPP (NOAA)	2247.5	2067.3	S-S	6M00G1D	2008/04 (TBR)	LEO&A Contingency
WISE	2248.5	2070.4938	S-S	6M00G1D	2009/11	
HST	2255.5	N/A	S-S	6M00G1D	IN ORBIT	
TRMM	2255.5	2076.9396	S-S	5M00G1D	IN ORBIT	
ISS	2265	2085.6875	S-S	6M00G1D	IN ORBIT	
EO-1	2270.4	2090.66	S-S	8K00G1D	IN ORBIT	Contingency
LRO	2271.2	2091.397	S-S	9K16G1D	2008/10	L&EO. Under coordination
SORCE	2273.5	2093.51	S-S	16K00G1D	IN ORBIT	Contingency

TABLE 11 SPACE - SPACE CONT.						
AIM	2282.5	2101.8	S-S	16K00G1D	IN ORBIT	LEO&A and Emergency
THEMIS	2282.5	2101.8	S-S	2M05G2D	IN ORBIT	LEO&A and Emergency
AQUA	2287.5	2106.4	S-S	5M00G1D	IN ORBIT	
ATV (ESA)	2287.5	2106.4	S-S	5M00G1D	2007/05	
AURA	2287.5	2106.4	S-S	5M00G1D	IN ORBIT	
C/NOFS	2287.5	2106.4	S-S	5M00G1D	TBD	
ERBS	2287.5	2106.4	S-S	5M00G1D	IN ORBIT	
GLAST	2287.5	2106.4	S-S	5M00G1D	2008/01	
GP-B	2287.5	2106.4	S-S	5M00G1D	IN ORBIT	
GPM	2287.5	2106.4	S-S	5M00G1D 4M60G1D	2013/06	
HST	2287.5	2106.4	S-S	5M00G1D	IN ORBIT	
HTV (JAXA)	2287.5	2106.4	S-S	5M00G1D	2009/07	
LANDSAT-7 (NOAA)	2287.5	2106.4	S-S	5M00G1D	IN ORBIT	
SHUTTLE	2287.5	2106.4	S-S	5M00G1D	IN ORBIT	
SWIFT	2287.5	2106.4	S-S	5M00G1D	IN ORBIT	
TERRA	2287.5	2106.4	S-S	5M00G1D	IN ORBIT	
XTE	2287.5	2106.4	S-S	5M00G1D	IN ORBIT	
ISS	15003.4	13775	S-S	225M00G1D	IN ORBIT	
SHUTTLE	15003.4	13775	S-S	200M00G1D	IN ORBIT	
GLAST	15003.4	N/A	S-S	80M00G1D	2008/01	
WISE	15003.4	N/A	S-S	200M00G1D	2009/11	
GRACE	32700	24700	S-S	N/A	IN ORBIT	Non-TDRSS s-s LINK

NASA MANNED FLIGHT SUPPORT

(Status as of October 2007)

TABLE 12: SPACE – SPACE

SPACECRAFT	FREQUENCY (MHz)	DIRECTION	EMISSION	D.B.I.U.	NOTES
JEM ICS (VIDEO/VOICE/DATA)	26350	S-S	250M00G7D	NET 2007	Japanese DRTS prime, possibly TDRSS as backup
APM COF DRTS	26254	S-S		NET 2007	
LSAM-LUNAR RELAY RETURN LINK	26150	S-S	50M00G7D 300M00G7D	NET June 2019	Proposed frequency. Constellation Lunar Missions
Orion/LSAM TDRS RETURN LINK	25953	S-S	50M00G7D	NET Sept 2013	Proposed frequency. Constellation LEO & lunar Missions
Orion/LSAM TDRS RETURN LINK	25847	S-S	50M00G7D	NET Sept 2013	Proposed frequency. Constellation LEO & lunar Missions
Orion/LSAM TDRS RETURN LINK	25795	S-S	50M00G7D	NET Sept 2013	Proposed frequency. Constellation LEO & lunar Missions
JEM TRACKING BEACON	23540	S-S	1M00N0N	NET 2007	
JEM ICS (VIDEO/VOICE/DATA)	23385	S-S	30M00G1D	NET 2007	Japanese DRTS prime, possibly TDRSS as backup
LSAM-LUNAR RELAY FORWARD LINK	23121.6	S-S	12M00G7D 50M00G7D	NET June 2019	Proposed frequency. Constellation Lunar Missions
TDRS-Orion/LSAM FORWARD LINK	22947.41	S-S	12M00G7D	NET Sept 2013	Proposed frequency. Constellation LEO & lunar Missions

TABLE 12: SPACE - SPACE CONT.					
TDRS-Orion/LSAM FORWARD LINK	22853.69	S-S	12M00G7D	NET Sept 2013	Proposed frequency. Constellation LEO & lunar Missions
TDRS-Orion/LSAM FORWARD LINK	22807.71	S-S	12M00G7D	NET Sept 2013	Proposed frequency. Constellation LEO & lunar Missions
SSO MSBLS	15460	S-S	5M00P0N	During Entry only	
SM LIRA RETURN LINK	15155	S-S	34M00F3E	IN ORBIT	Hardware onboard the ISS but not in use currently - Russian DRTS is not active/available
ISS-TDRS KU-BAND RETURN	15003.4	S-S	225M00G1WCT	IN ORBIT	
SSO-TDRS KU BAND RETURN	15003.4	S-S	700M00G9W	IN ORBIT	During a Shuttle Mission
SSO KU-AND RENDEZVOUS RADAR	13779-13987	S-S	26M00P0N	IN ORBIT	During a Shuttle Mission, used only during rendezvous with the ISS or a payload (such as the HST)
TDRS-ISS KU-BAND FORWARD	13775	S-S	225M00G1WCT	IN ORBIT	
TDRS-SSO KU-BAND FORWARD	13775	S-S	50M00G1D	IN ORBIT	During a Shuttle Mission
SM LIRA FORWARD LINK	13528	S-S	34M00F3E	IN ORBIT	Hardware onboard the ISS but not in use currently - Russian DRTS is not active/available
FGB KURS (Tx)	3298.9	S-S	4M85G9W	IN ORBIT	Not used during nominal ops scenario - backup to SM KURS
SM KURS (Rx)	3298.9	S-S	4M85G9W	IN ORBIT	
SOYUZ KURS-A	3298.9	S-S		IN ORBIT	
PROGRESS KURS-A	3298.9	S-S		IN ORBIT	
FGB KURS (Tx)	3294.2	S-S	4M85G9W	IN ORBIT	Not used during nominal ops scenario - backup to SM KURS
SOYUZ KURS-A (Tx)	3294	S-S		IN ORBIT	
PROGRESS KURS-A	3294	S-S		IN ORBIT	
KURS-P (SM/FGB)	3245	S-S		IN ORBIT	

TABLE 12: SPACE - SPACE CONT.					
KURS FOR ATV(Rx)/SM(Tx)	3244.7	S-S		IN ORBIT	Not in used yet - first ATV flight is planned for 2004/2005
FGB KURS (Rx)	3240	S-S	4M85G9W	IN ORBIT	Not used during nominal ops scenario - backup to SM KURS
SM KURS-P	3240	S-S		IN ORBIT	
FGB KURS (Rx)	3234	S-S	4M85G9W	IN ORBIT	Not used during nominal ops scenario - backup to SM KURS
SM KURS-P	3234	S-S		IN ORBIT	
FGB KURS (Rx)	3230	S-S	4M85G9W	IN ORBIT	Not used during nominal ops scenario - backup to SM KURS
SM KURS (Tx)	3230	S-S	4M85G9W	IN ORBIT	ISS Russian Segment System
SOYUZ TRACKING	2860	S-S		IN ORBIT	ISS Russian Segment System
PROGRESS TRACKING	2860	S-S		IN ORBIT	ISS Russian Segment System
ISS/SSO WVS CH2	2470	S-S	20M00F3F	IN ORBIT	Used only during EVAs
ISS IOL/ SSO LAN	2402-2480	S-S	80M00G1BDN	IN ORBIT	79 Hopping Channels with 1.6 MHz bandwidth per channel. Only used internal to the ISS.
ISS/SSO WVS CH1	2410	S-S	20M00F3F	IN ORBIT	Used only during EVAs
Orion/LSAM TDRS RETURN LINK	2287.5	S-S	6M00G7D	NET Sept 2013	Proposed frequency - Constellation LEO Missions. Spread spectrum mode only.
SSO-TDRS S-BAND RETURN	2287.5	S-S	5M00G9D	IN ORBIT	During a Shuttle Mission
ISS-TDRS ACS RETURN	2265	S-S	6M00G1D	IN ORBIT	ISS S-band return link
Ares-I/Ares-V-TDRS RETRUN LINK	2254.0	S-S	6M00G7D	NET Sept 2013	Proposed frequency - Constellation link used during ascent phase only for launch vehicle - starting at 6.5 Minutes to Transponder shut-off at 15 minutes after liftoff.

TABLE 12: SPACE - SPACE CONT.					
LSAM TDRS RETURN LINK	2268.2	S-S	6M00G7D	NET Dec 2018	Proposed frequency - Constellation Missions
Orion TDRS RETURN LINK	2216.5	S-S	6M00G7D	NET Sept 2013	Proposed frequency - Constellation Missions
SSO-TDRS S-BAND RETURN	2217.5	S-S	5M00G9D	IN ORBIT	During a Shuttle Mission
Orion-LSAM PROXIMITY LINK	2203.2	S-S	6M00G7D	NET Dec 2018	Proposed frequency - Constellation Missions.
Orion-ISS PROXIMITY LINK	2203.2	S-S	6M00G7D	NET Sept 2013	Proposed frequency - Constellation Missions.
ATV/HTV PROXIMITY RETURN LINK	2205	S-S	6M00G9W	ATV: NET 2007/2008 HTV: NET 2008	Used only during prox ops with the ISS. ATV: 23 km; HTV: 30 km
SSO PAYLOAD INTERROGATOR TELEMETRY	2025.8~2119.8 and 2200~2299.8	S-S	4M00G9D	IN ORBIT	Not used on every Shuttle Mission - only when there is a specific payload prox ops requirements. SSO->Payload 2025.8~2119.9. Payload->2200~2299.8
TDRS-Orion/LSAM FORWARD LINK	2106.4063	S-S	6M00G7D	NET Sept 2013	Proposed frequency (corresponding to 2287.5 MHz return link) - Constellation Missions.
TDRS-SSO S-BAND FORWARD	2106.4	S-S	22M00G9W	IN ORBIT	During a Shuttle Mission
TDRS-ISS ACS FORWARD	2085.7	S-S	6M00G9W	IN ORBIT	
TDRS-Ares-I/Ares-V FORWARD LINK	2075.5583	S-S	6M00G7D	TBR	Uplink Constellation command channel frequency for launch- frequency for planning purposes only - currently no operational plan for this link.
TDRS-LSAM FORWARD LINK	2088.6342	S-S	6M00G7D	NET Dec 2018	Proposed frequency (corresponding to 2268.2 MHz return link) - Constellation Missions.
TDRS-Orion FORWARD LINK	2041.0271	S-S	6M00G7D	NET Sept 2013	Proposed frequency (corresponding to 2216.5 MHz return link) - Constellation Missions.
TDRS-SSO S-BAND FORWARD	2041.9	S-S	22M00G9W	IN ORBIT	During a Shuttle Mission
Orion-LSAM PROXIMITY LINK	2028.7800	S-S	6M00G7D	NET Dec 2018	Proposed frequency (corresponding to 2203 MHz return link) - Constellation Missions.

TABLE 12: SPACE - SPACE CONT.					
Orion-ISS PROXIMITY LINK	2028.7800	S-S	6M00G7D	NET Sept 2013	Proposed frequency (corresponding to 2203 MHz return link) - Constellation Missions.
ATV/HTV PROXIMITY FORWARD LINK	2030.43	S-S	6M00G9W	ATV: NET 2007/2008 HTV: NET 2008	Used only during prox ops with the ISS. ATV: 23 km; HTV: 30 km
SSO PAYLOAD INTERROGATOR COMMAND	2025-2120	S-S	4M00G7D	IN ORBIT	Not used on every Shuttle Mission - only when there is a specific payload prox ops requirements
GPS RECEIVER	1575.42	S-S	20M00G7D	IN ORBIT	On ISS and Shuttle
GPS RECEIVER	1227.6	S-S	20M00G7D	IN ORBIT	On ISS and Shuttle
SSO TACAN	1025~1150	S-S	650K00V1A	SSO	SSO Landing-1 day Check
KVANT-B	922.76	S-S	25MOOP0N	IN ORBIT	On Progress vehicles
SOYUZ COMMAND	922.76	S-S		IN ORBIT	
SPHERES LAPTOP TRANSMITTER	916.5	S-S		IN ORBIT	Internal to ISS modules
SSO MICRO-WIS	916.5	S-S		SSO	During a Shuttle Mission
SSO MICRO-TAU/SGU	916.5	S-S		SSO	During a Shuttle Mission
SSO WING LEADING EDGE (WLE)	916.5	S-S		SSO	During a Shuttle Mission
WSGIS (WIS)	916.5	S-S		SSO	During a Shuttle Mission
I-WIF	916.5	S-S		SSO	STS-121
ISS WIS/SSO WIS	915	S-S	22M00G1BDN	IN ORBIT	Wireless Instrumentation on ISS and Shuttle
ISS HEART RATE MONITOR	915	S-S		IN ORBIT	Internal to ISS modules
ISS HEART RATE MONITOR	868.35	S-S		IN ORBIT	Internal to ISS modules
SPHERES	868.35	S-S		IN ORBIT	Internal to ISS modules

TABLE 12: SPACE - SPACE CONT.					
REGUL (Rx)	770.5	S-S	2M00G9W	IN ORBIT	On ISS Russian Segment
SM TV	463	S-S	20M00F3F	IN ORBIT	On ISS Russian Segment
FGB TORU	463	S-S		IN ORBIT	On ISS Russian Segment
PROGRESS TV				IN ORBIT	On ISS Russian Segment
SOYUZ TV	463	S-S		IN ORBIT	On ISS Russian Segment
SSCS	417.1	S-S	1M91F1D	IN ORBIT	Used during Shuttle/ISS rendezvous and docking ops and during EVAs (secondary freq to 414.2 MHz)
SSCS	414.2	S-S	1M91F1D	IN ORBIT	Used during Shuttle/ISS rendezvous and docking ops and during EVAs (primary operating freq)
Orion/LSAM CONTINGENCY VOICE LINK	401.425	S-S	25K00J3E 25K00F3E	NET Sept 2013	Launch/Landing Support and Contingency ops in LEO
WVS COMMAND	400.15-401	S-S	800K00G1D	IN ORBIT	Used only during EVAs
SSO UHF ATC	296.8	S-S	8K00A3E	SSO	SSO Landing-1 day Check
SSO UHF ATC	259.7	S-S	8K00A3E	SSO	SSO Landing-1 day Check
ORLAN TELEMETRY	247	S-S	512K00F3E	IN ORBIT	only when Russian EVA suits are used
SSO RESCUE	243	S-S	8K00A3E	SSO	SSO Landing-1 day Check
ORLAN TELEMETRY	231	S-S	512K00F3E	IN ORBIT	only when Russian EVA suits are used
SM/SOYUZ/PROGRESS TELEMETRY	166	S-S	4M00F3F	IN ORBIT	Used during Soyuz/Progress docking/undocking
SM/SOYUZ/PROGRESS (Tx)	143.625	S-S	40K00F3E	IN ORBIT	Used during Soyuz/Progress docking/undocking
SM VOICE (Rx)	139.208	S-S	30K00F3E	IN ORBIT	Used during Soyuz/Progress docking/undocking
SM/SOYUZ/PROGRESS/ORLAN VOICE (Tx)	130.167	S-S	40K00F3E	IN ORBIT	Used during Soyuz/Progress docking/undocking

TABLE 12: SPACE - SPACE CONT.					
PROGRESS TORU (Rx)	130.167	S-S	30K00F3E	IN ORBIT	Used with Progress vehicles
SM TORU (Tx)	130.167	S-S	30K00F3E	IN ORBIT	Used with Progress vehicles
PROGRESS TORU (Tx)	121.75	S-S	30K00F3E	IN ORBIT	Used with Progress vehicles
SM TORU (Rx)	121.75	S-S	30K00F3E	IN ORBIT	Used with Progress vehicles
SM/SOYUZ/PROGRESS/ORLAN VOICE (Tx)	121.75	S-S	30K00F3E	IN ORBIT	Used for communications between the SM and Soyuz/Progress/Orlan
SM VOICE (Rx)	121.75	S-S	30K00F3E	IN ORBIT	Used for communications between the SM and Soyuz/Progress/Orlan
SM VOICE (Rx)	121.125	S-S	30K00F3E	IN ORBIT	Used for communications between the SM and Soyuz/Progress/Orlan
MARES	13.5			IN ORBIT	ESA experiment - internal to the ISS

NASA MANNED FLIGHT SUPPORT

(Status as of October 2007)

TABLE 13: GROUND - SPACE

GROUND STATION SYSTEM	FREQUENCY (MHz)	DIRECTION	EMISSION	D.B.I.U.	NOTES
GN LSAM SUPPORT	23121.6	E-S	12M00G7D 50M00G7D	NET Dec 2018	Constellation Lunar Missions
GN Orion/LSAM SUPPORT	22947.41	E-S	12M00G7D	NET Sept 2013	During Constellation Missions
GN Orion/LSAM SUPPORT	22853.69	E-S	12M00G7D	NET Sept 2013	During Constellation Missions
GN Orion/LSAM SUPPORT	22807.71	E-S	12M00G7D	NET Sept 2013	During Constellation Missions
KOMPARUS	7208.299	E-S	8M00G9W	GROUND STATION	Receiving system on ISS SM
KOMPARUS	7202.674	E-S	8M00G9W	GROUND STATION	Receiving system on ISS SM
Orion/LSAM CONTINGENCY VOICE	7190 - 7235	E-S	TBR	TBR	Beyond LEO
DSN Orion SUPPORT	7145 - 7190	E-S	TBR	TBR	Category B Constellation Missions
FGB TRACKING	2725	E-S	2M00P0N	GROUND STATION	Receiving system on ISS SM
SM TRACKING	2725	E-S	2M00P0N	GROUND STATION	Receiving system on ISS SM
GSTDN-SSO PM UPLINK	2106.4	E-S	3M6G9D	GROUND STATION	Receiving system on Shuttle Orbiter
GN Orion/LSAM SUPPORT	2106.4	E-S	6M00G7D	NET 2018	During Constellation Missions - beyond LEO
GN LSAM SUPPORT	2088.634167	E-S	6M00G7D	NET 2018	During Constellation Missions - beyond LEO
GN Orion SUPPORT	2041.027083	E-S	6M00G7D	NET 2018	During Constellation Missions - beyond LEO
GERMAN GROUND STATION - ROKVISS	2058	E-S	512K00G9W	GROUND STATION	ISS Service Module (Russian Segment) – Operating on non-interference basis – ITU registration pending

TABLE 13: GROUND – SPACE CONT.					
GSTDN-SSO PM UPLINK	2041.9	E-S	3M6G9D	GROUND STATION	Receiving system on Shuttle Orbiter
AFSCF UPLINK (SSO S-BAND PM)	1831.787	E-S	3M6G9D	Air Force Satellite Control Facility	Service is still available
AFSCF UPLINK (SSO S-BAND PM)	1775.733	E-S	3M6G9D	Air Force Satellite Control Facility	Service is still available
REGUL (Rx)	771.8	E-S	2M00G9W	GROUND STATION	System on ISS SM
REGUL (Rx)	755.4	E-S	2M00G9W	GROUND STATION	System on ISS SM
Orion/LSAM CONTINGENCY VOICE	401.425	E-S	25K00J3E 25K00F3E	NET Sept 2013	Constellation Program LEO missions
TRANZIT	344	E-S	512K00F3E	GROUND STATION	Receiving system on ISS SM
GTS TIMING UPDATES	330-399	E-S	50K00G9W	GROUND STATION	Receiving system on ISS SM
TRANZIT	249	E-S	512K00F3E	GROUND STATION	Receiving system on ISS SM
TRANZIT	247	E-S	512K00F3E	GROUND STATION	Receiving system on ISS SM
TRANZIT	231	E-S	512K00F3E	GROUND STATION	Receiving system on ISS SM
SM/SOYUZ/PROGRESS VHF-I UPLINK	139.208	E-S	25K00F3E	GROUND STATION	WSMR uplink to Russian Segment of the ISS
SM/SOYUZ/PROGRESS VHF-II UPLINK	130.167	E-S	25K00F3E	GROUND STATION	Russian Ground Station uplink to Russian Segment of the ISS

NASA MANNED FLIGHT SUPPORT

(Status as of October 2007)

TABLE 14: SPACE - GROUND

SPACECRAFT	FREQUENCY (MHz)	DIRECTION	EMISSION	D.B.I.U.	NOTES
LSAM DIRECT DOWNLINK	26150	S-E	50M00G7D 300M00G7D	NET Dec 2018	Constellation Lunar Missions
Orion/LSAM DIRECT DOWNLINK	25953	S-E	50M00G7D	NET Sept 2013	Constellation LEO and Lunar Missions
Orion/LSAM DIRECT DOWNLINK	25847	S-E	50M00G7D	NET Sept 2013	Constellation LEO and Lunar Missions
Orion/LSAM DIRECT DOWNLINK	25795	S-E	50M00G7D	NET Sept 2013	Constellation LEO and Lunar Missions
Orion/LSAM CONTINGENCY VOICE	8450 - 8500	S-E	TBR	TBR	Beyond LEO
DSN Orion SUPPORT	8400 - 8450	S-E	TBR	TBR	Category B Constellation Missions
FGB TRACKING	2890	S-E	2M00P0N	IN ORBIT	Backup to the SM system
SM TRACKING	2805	S-E	2M00P0N	IN ORBIT	ISS Russian Segment
KOMPARUS	2367.063	S-E	8M00G9W	IN ORBIT	ISS Russian Segment
KOMPARUS	2366.75	S-E	8M00G9W	IN ORBIT	ISS Russian Segment
SSO PM DIRECT DOWNLINK	2287.5	S-E	5M00G9D	IN ORBIT	During a Shuttle Mission
AFSCF PM DIRECT DOWNLINK	2287.5	S-E	5M00G9D	IN ORBIT	Service still available
Orion/LSAM DIRECT DOWNLINK	2287.5	S-E	6M00G7D	NET Sept 2018	Constellation Missions - beyond LEO
LSAM DIRECT DOWNLINK	2268.2	S-E	6M00G7D	NET Dec 2018	Constellation Missions - beyond LEO
SSO FM DIRECT DOWNLINK	2250	S-E	5M00F9D	IN ORBIT	During a Shuttle Mission

TABLE 14: SPACE – GROUND CONT.					
Orion DIRECT DOWNLINK	2216.5	S-E	6M00G7D	NET Sept 2018	Constellation Missions - beyond LEO
ROKVISS (GERMAN PAYLOAD ON SM)	2234.9	S-E	8M00G9W	IN ORBIT	ISS Service Module (Russian Segment) – Operating on a non-interference basis – ITU registration pending
SSO PM DIRECT DOWNLINK	2217.5	S-E	5M00G9D	IN ORBIT	During a Shuttle Mission
AFSCF PM DIRECT DOWNLINK	2217.5	S-E	5M00G9D	IN ORBIT	Service still available
SM GTS	1430/1428	S-E	50K00G9W	IN ORBIT	Permanently shutdown, hardware disconnected from the antenna. Non-compliance to ITU RR and caused interference to the RA ground stations
REGUL (Tx)	924.6	S-E	2M00G9W	IN ORBIT	ISS Russian Segment
FGB/SM TELEMETRY	634	S-E	512K00F3E	IN ORBIT	ISS Russian Segment
FGB/SM TELEMETRY	632	S-E	512K00F3E	IN ORBIT	ISS Russian Segment
BITS	630	S-E	512K00F3E	IN ORBIT	ISS Russian Segment
BITS	628	S-E	512K00F3E	IN ORBIT	ISS Russian Segment
SM TV	463	S-E	20M00F3F	IN ORBIT	TV from Russian Segment to Russian Ground Stations
SOYUZ/PROGESS TV	463	S-E	20M00F3F	IN ORBIT	TV from Russian Segment to Russian Ground Stations
MISSE 5 (PAYLOAD USING AMSAT-II RADIO)	437.975	S-E		IN ORBIT	amateur-satellite service
ARISS	436.5	S-E		IN ORBIT	amateur-satellite service
SAREX	436.5	S-E		IN ORBIT	amateur-satellite service
MISSE 5 (PAYLOAD USING AMSAT-II RADIO)	435.275	S-E		IN ORBIT	amateur-satellite service
Orion/LSAM CONTINGENCY VOICE	401.425	S-E	25K00J3E 25K00F3E	NET Sept 2013	LEO

TABLE 14: SPACE – GROUND CONT.					
SM GTS	400.1	S-E	50K00G9W	IN ORBIT	Temporarily shutdown, will resume operation after registration with the Russian authority and the ITU
SSO UHF ATC	296.8	S-E	8K00A3E	SSO	SSO Landing-1 day Check
SSO UHF ATC	259.7	S-E	8K00A3E	SSO	
SSO RESCUE	243	S-E	8K00A3E	SSO	SSO Landing-1 day Check
MISSE 5 (PAYLOAD USING AMSAT-II RADIO)	145.825	S-E		IN ORBIT	amateur-satellite service
SAREX (AMATEUR RADIO)	144-146	S-E	25K00F3E	IN ORBIT	amateur-satellite service
SM/SOYUZ/PROGRESS VHF-I DOWNLINK	143.625	S-E	25K00F3E	IN ORBIT	Russian Segment to US and Russian Ground Stations
SM/SOYUZ/PROGRESS VHF-II DOWNLINK	121.75	S-E	25K00F3E	IN ORBIT	Russian Ground Stations Only

NASA MANNED FLIGHT SUPPORT

(Status as of October 2007)

TABLE 15: AIR - GROUND

SPACECRAFT	FREQUENCY (MHz)	DIRECTION	EMISSION	D.B.I.U.	NOTES
Ares-I/Ares-V DOWNLINK	2254	A-G	15M00G7D	NET Sept 2013	Proposed frequency - Constellation launch vehicle usage only, first 6.5 minutes of ascent to existing ground asset at launch head.
SSO MSBLS	15460	A-G	5M00P0N	SSO	During Shuttle landing only
SSO ET CAMERA	2272.5	A-G	17M00F3F	SSO	Ascent usage only, transmitter shut-off at 15 minutes after liftoff
SSO ET CAMERA	2230.5	A-G	17M00F3F	SSO	Ascent usage only, transmitter shut-off at 15 minutes after liftoff
SSO TACAN	1025~1150	A-G	650K00V1A	SSO	During Shuttle landing only
Orion CONTINGENCY VOICE	401.425	A-G	25K00J3E 25K00F3E	NET Sept 2013	During CEV Launch/Landing
SSO UHF ATC	296.8	A-G	8K00A3E	SSO	During Shuttle landing only
Orion RESCUE	282.8	A-G	8K00A3E	NET Sept 2013	Civilian SAR
SSO UHF ATC	259.7	A-G	8K00A3E	SSO	During Shuttle landing only
SSO RESCUE	243	A-G	8K00A3E	SSO	Emergency
Orion RESCUE	243	A-G	8K00A3E	NET Sept 2013	Emergency SAR
Orion RESCUE	157.1	A-G	8K00A3E	NET Sept 2013	Emergency in the event of wet landing
Orion RESCUE	156.8	A-G	8K00A3E	NET Sept 2013	Emergency in the event of wet landing
Orion RESCUE	121.5	A-G	8K00A3E	NET Sept 2013	Emergency SAR

NASA MANNED FLIGHT SUPPORT

(Status as of October 2007)

TABLE 16: GROUND - AIR

GROUND STATIONS SYSTEMS	FREQUENCY (MHz)	DIRECTION	EMISSION	D.B.I.U.	NOTES
MSBLS	15412~15688	G-A	5M00P0N	GROUND STATIONS	During Shuttle landing only
Ares-I/Ares-V UPLINK	2075.558333	G-A	6M00G7D	NET Sept 2013	Uplink Constellation command channel frequency for launch - frequency for planning purposes only - currently no operational plan for this link.
TACAN	962~1213	G-A	650K00V1A	GROUND STATIONS	During Shuttle landing only
Orion EPIRB	406.1	G-A		NET Sept 2013	COSPAS/SARSAT EPIRB
Orion CONTINGENCY VOICE	401.425	G-A	25K00J3E 25K00F3E	NET Sept 2013	During CEV Launch and Landing
SSO UHF ATC	296.8	G-A	8K00A3E	GROUND STATIONS	During Shuttle landing only
Orion RESCUE	282.8	G-A	8K00A3E	NET Sept 2013	Civilian SAR
SSO UHF ATC	259.7	G-A	8K00A3E	GROUND STATIONS	During Shuttle landing only
SSO RESCUE	243	G-A	8K00A3E	GROUND STATIONS	Emergency
Orion RESCUE	243	G-A	8K00A3E	NET Sept 2013	Emergency SAR
Orion RESCUE	157.1	G-A	8K00A3E	NET Sept 2013	Emergency in the event of wet landing
Orion RESCUE	156.8	G-A	8K00A3E	NET Sept 2013	Emergency in the event of wet landing
Orion RESCUE	121.5	G-A	8K00A3E	NET Sept 2013	Emergency SAR

NASA ACTIVE AND PASSIVE SENSORS

(Status as of October 2007)

TABLE 17: SENSORS

MISSION: SENSOR	FREQUENCY (MHz)	BANDWIDTH (kHz)	ACTIVE/ PASSIVE	D.B.I.U.	NOTES
AQUA: AMSR-E	6,925.0	350,000.0	PASSIVE	IN ORBIT	
AQUA: AMSR-E	10,650.0	100,000.0	PASSIVE	IN ORBIT	
AQUA: AMSR-E	18,700.0	200,000.0	PASSIVE	IN ORBIT	
AQUA: AMSR-E	23,800.0	400,000.0	PASSIVE	IN ORBIT	
AQUA: AMSR-E	36,500.0	1,000,000.0	PASSIVE	IN ORBIT	
AQUA: AMSR-E	89,000.0	3,000,000.0	PASSIVE	IN ORBIT	
AQUA: AMSU	23,800.0	400,000.0	PASSIVE	IN ORBIT	
AQUA: AMSU	31,400.0	400,000.0	PASSIVE	IN ORBIT	
AQUA: AMSU	50,300.0	200,000.0	PASSIVE	IN ORBIT	
AQUA: AMSU	52,800.0	500,000.0	PASSIVE	IN ORBIT	
AQUA: AMSU	52,825.0	450,000.0	PASSIVE	IN ORBIT	
AQUA: AMSU	53,596.0	730,000.0	PASSIVE	IN ORBIT	
AQUA: AMSU	54,400.0	500,000.0	PASSIVE	IN ORBIT	
AQUA: AMSU	54,940.0	500,000.0	PASSIVE	IN ORBIT	12 Sensors
AQUA: AMSU	55,500.0	500,000.0	PASSIVE	IN ORBIT	12 Sensors
AQUA: AMSU	57,290.3	1,000,000.0	PASSIVE	IN ORBIT	12 Sensors
AQUA: AMSU	89,000.0	6,000,000.0	PASSIVE	IN ORBIT	2 Sensors
AQUA: HSB	150,000.0	2,000,000.0	PASSIVE	IN ORBIT	
AQUA: HSB	183,310.0	1,000,000.0	PASSIVE	IN ORBIT	
AQUA: HSB	183,310.0	2,000,000.0	PASSIVE	IN ORBIT	
AQUA: HSB	183,310.0	4,000,000.0	PASSIVE	IN ORBIT	3 Sensors
AQUARIUS: Radiometer	1,413.0	27,000.0	PASSIVE	2009	
AQUARIUS: Scatterometer	1,260.0	4,000.0	ACTIVE	2009	

TABLE 17: SENSORS - CONT.				
AURA: MLS	118,000.0	7,000,000.0	PASSIVE	IN ORBIT
AURA: MLS	190,000.0	30,000,000.0	PASSIVE	IN ORBIT
AURA: MLS	240,000.0	19,000,000.0	PASSIVE	IN ORBIT
AURA: MLS	640,000.0	36,000,000.0	PASSIVE	IN ORBIT
AURA: MLS	2,500,000.0	42,000,000.0	PASSIVE	IN ORBIT
CLOUDSAT: CPR	94,050.0	2,000.0	ACTIVE	IN ORBIT
GPM: KuPR	13,597.0	3,360.0	ACTIVE	2013
GPM: KuPR	13,603.0	3,360.0	ACTIVE	2013
GPM: KuPR	35,547.0	1,680.0	ACTIVE	2013
GPM: KuPR	35,547.0	3,360.0	ACTIVE	2013
GPM: KuPR	35,553.0	1,680.0	ACTIVE	2013
GPM: KuPR	35,553.0	3,360.0	ACTIVE	2013
JASON-1: JMR	18,700.0	200,000	PASSIVE	IN ORBIT
JASON-1: JMR	23,800.0	400,000	PASSIVE	IN ORBIT
JASON-1: JMR	33,800.0	800,000	PASSIVE	IN ORBIT
JASON-1: SSALT	5,300.0	320,000	ACTIVE	IN ORBIT
JASON-1: SSALT	13,575.0	320,000	ACTIVE	IN ORBIT
QUIKSCAT: SEAWINDS	13,402.0	400	ACTIVE	IN ORBIT
TOPEX: ALT	5,300.0	320,000.0	ACTIVE	IN ORBIT
TOPEX: ALT	13,600.0	320,000.0	ACTIVE	IN ORBIT
TOPEX: ALT	13,650.0	330,000.0	ACTIVE	IN ORBIT
TOPEX: TMR	18,000.0	200.0	PASSIVE	IN ORBIT
TOPEX: TMR	21,000.0	200.0	PASSIVE	IN ORBIT
TOPEX: TMR	37,000.0	200.0	PASSIVE	IN ORBIT
TRMM PRECIP RADAR	13,796.0	1,720.0	ACTIVE	IN ORBIT
TRMM PRECIP RADAR	13,802.0	1,720.0	ACTIVE	IN ORBIT
TRMM MICROWAVE IMAGER	10,650.0	100,000.0	PASSIVE	IN ORBIT
TRMM MICROWAVE IMAGER	19,350.0	500,000.0	PASSIVE	IN ORBIT
TRMM MICROWAVE IMAGER	21,300.0	200,000.0	PASSIVE	IN ORBIT
TRMM MICROWAVE IMAGER	37,000.0	2,000,000.0	PASSIVE	IN ORBIT
TRMM MICROWAVE IMAGER	85,500.0	3,000,000.0	PASSIVE	IN ORBIT

NASA OTHER TERRESTRIAL SYSTEMS

(Status as of October 2007)

TABLE 18: OTHER TERRESTRIAL SYSTEMS

SYSTEM NAME	BAND (MHz)	NOTES
METEOR RADAR SYSTEM	20-40	Ground Based Radar
W-LAN	4200-4400	Non-Part 15, Mobile System

TABLE 19: SYSTEMS REMOVED SINCE 2005

(Status as of October 2007)

SPACECRAFT	NOTES
COLUMBUS COMMUNICATIONS TERMINAL (ESA MODULE ON ISS)	ISS Communication assets will be used.
GENESIS	Filed in ITU-R as USAGENESIS. The last contact with mother ship was made in January 2005. Freq. assignment deleted in December 2005.
HYDROS	Mission cancelled prior to launch
ION-F	Mission cancelled prior to launch
Mars Global Surveyor (MGS)	MGS went silent in November 2006 after completing more than four times as long as the prime mission originally planned. Frequency assignment was deleted in May 07
PDM (a.k.a. HRSDM)	Mission cancelled prior to launch
TOPEX/POSEIDON	Mission ended in January 2006
TRIANA	Mission cancelled prior to launch
UARS	Mission completed after 14 years of Earth observations

TABLE 20: NEW SYSTEMS ADDED SINCE 2005

Note: Technical details of these systems are provided in Tables 1-14 and 17

(Status as of October 2007)

SPACECRAFT	D.B.I.U.	General Objective
BIGELOW	IN ORBIT	Technology demonstration. Prototype for an inflatable space hotel.
IBEX	2008/06	Space science. IBEX images reveal global properties of the interstellar boundaries that separate our heliosphere from the local interstellar medium.
LRO	2008/10	Lunar Surface. LRO will conduct measurement and investigations of the lunar surface and environment. Primary objectives include high resolution topographic mapping of the surface and characterization of the lunar radiation environment.
LCROSS	2008/10	LCROSS is the secondary payload on a launch vehicle delivering the Lunar Reconnaissance Orbiter (LRO) to the moon. The primary mission for the LCROSS is to further clarify whether some form of water exists on the lunar surface. The mission will last no longer than 180 days.
ARES I	NET 2009	Launch Vehicle. Ares I is an in-line, two-stage rocket topped by the Orion crew exploration vehicle, its service module and a launch abort system.
ST-8	2009/02	Space Technology 8 (ST8) is a mission to space validate four new subsystem-level technologies never before tried in space. Each of these technologies was selected for its promise in advancing NASA's most important future science missions, as so deemed by the science community of the U.S. and the world.
WISE	2009/11	This space-based telescope will scan the entire sky in infrared light, revealing cool stars, planetary construction zones and the brightest galaxies in the universe.
JUNO	2011	Planetary exploration. This mission will orbit Jupiter in a polar orbit to conduct a first-time, in-depth study of the giant planet. The mission proposes to place a spacecraft in a polar orbit around Jupiter to investigate the existence of an ice-rock core; determine the amount of global water and ammonia present in the atmosphere; study convection and deep wind profiles in the atmosphere; investigate the origin of the Jovian magnetic field; and explore the polar magnetosphere.
ORION	NET 2013	Manned Exploration. America will send a new generation of explorers to the moon aboard NASA's Orion crew exploration vehicle. Orion will be capable of carrying crew and cargo to the space station. It will be able to rendezvous with a lunar landing module and an Earth departure stage in low-Earth orbit to carry crews to the moon and, one day, to Mars-bound vehicles.
MMS	2014/09	Astrophysics. Investigation of how small-scale processes control large-scale phenomenology, such as magnetotail dynamics, plasma entry into the magnetosphere, and substorm initiation.
ARES V	NET 2018	Launch Vehicle. Ares V will serve as NASA's primary vessel for safe, reliable delivery of large-scale hardware to space — from the lunar landing craft and materials for establishing a moon base, to food, fresh water and other staples needed to extend a human presence beyond Earth orbit.
LSAM	NET 2019	Manned Lunar Exploration. LSAM is the Lunar Surface Access Module

Annex B: List of Space Science Allocations[1] in Bands
Used or Planned for Use for Communications by NASA

The bands provided in Table 21 are recognized in the ITU Radio Regulations (WRC-03) as applicable to space science communication applications and are either currently in use or are planned for use on future missions.

Table 21: Frequency bands, Applicable[2] footnotes and Services

LOW	HIGH	UNITS	SERVICES	Applicable ITU FNs	Applicable US FNs[3]
400.15	401	MHz	SRS (s->E)	5.263	
410	420	MHz	SRS (space-to-space)	5.268	
1750	1850	MHz	SRS (E->s) SPACE OPS (E->s)	5.386	
2025	2110	MHz	SRS (E->s)(s->s) EESS (E->s)(s->s) SPACE OPS (E->s)(s->s)		US90 US222 US346 US347
2110	2120	MHz	SRS (E->s)(deep space)		US252
2200	2290	MHz	SRS (s->E)(s->s) EESS (s->E)(s->s) SPACE OPS (s->E)(s->s)		US303
2290	2300	MHz	SRS (s->E)(deep space)		
7145	7190	MHz	SRS (E->s)(deep space)	5.460	US252
7190	7235	MHz	SRS (E->s)	5.460	
8025	8175	MHz	EESS (s->E)		US258
8175	8215	MHz	EESS (s->E) METSAT (E->s)		US258
8215	8400	MHz	EESS (s->E)		US258
8400	8500	MHz	SRS (s->E)	5.465	
13400	13750	MHz	SRS EESS (active)	5.501A 5.501B	
13750	13770	MHz	srs eess	5.502 5.503	US337 US356 US357
13770	13780	MHz	SRS eess	5.502 5.503	US337 US356 US357
13780	14000	MHz	srs eess	5.502 5.503	US337 US356 US357
14000	14300	MHz	srs		

1 These are the science related bands where NASA has mission requirements. NASA does not necessarily have systems operating using all listed services in any given band

2 "Applicable" meaning the footnote either clarifies the services status or defines sharing conditions applicable to that service.

3 Footnotes taken from Tables of Frequency Allocations and Other Extracts From: Manual of Regulations and Procedures for Federal Radio Frequency Management – May 2003 Edition

Table 21 (cont.)

LOW	HIGH	UNITS	SERVICES	Applicable ITU FNs	Applicable US FNs
14500	15350	MHZ	srs		US310
25250	25500	MHz	SRS (s->s) EESS (s->s)	5.536	
25500	27000	MHz	SRS (s->s)(s->E) EESS (s->s)(s->E)	5.536A 5.536B 5.536C	
27000	27500	MHz	SRS (s->s) EESS (s->s)	5.536	
31800	32300	MHz	SRS (deep space) (s->E)	5.547C 5.548	US262
34200	34700	MHz	SRS (deep space) (E->s)		US252

ANNEX C: List of Space Science Allocations[4] in Bands Used or Planned for Use for Sensing By NASA

The bands provided in Table 22 are recognized in the ITU Radio Regulations (WRC-03) as applicable to space science sensing applications and are either in use or are planned for use on future missions.

Note: The 64-65 GHz sensing band was listed as being used by the UARS program in the NASA Long-Range Spectrum Forecast provided in November 2005. This mission has concluded after 14 years of operations.

Table 22: Frequency bands, Applicable[5] footnotes and Services

FREQUENCY BAND	RADIO SERVICE	RADIO SERVICE	Applicable ITU FNs	Applicable US FNs[6]
1215-1240 MHz	EESS (active)	SRS (active)	5.332	
1400-1427 MHz	EESS (passive)	SRS (passive)	5.340, 5.341	US246
5250-5255 MHz	EESS (active)	SRS	5.447D	
5255-5350 MHz	EESS (active)	SRS (active)	5.447D	
5350-5460 MHz	EESS (active)	SRS (active)	5.448B, 5.448C	
5460-5470 MHz	EESS (active)	SRS (active)	5.448B	
5470-5570 MHz	EESS (active)	SRS (active)	5.448B	
6425-7075 MHz	eess (passive)	srs (passive)	5.458	
10.6-10.68 GHz	EESS (passive)	SRS (passive)		
10.68-10.7 GHz	EESS (passive)	SRS (passive)	5.340	US246
13.25-13.4 GHz	EESS (active)	SRS (active)	5.498A	
13.4-13.75 GHz	EESS (active)	SRS	5.501A, 5.501B	
18.6-18.8 GHz (Rgn 1 & 3)	EESS (passive)	srs (passive)		
18.6-18.8 GHz (Rgn 2)	EESS (passive)	SRS (passive)		
21.2-21.4 GHz	EESS (passive)	SRS (passive)		US263
22.21-22.5 GHz	EESS (passive)	SRS (passive)	5.532	US263
23.6-24 GHz	EESS (passive)	SRS (passive)	5.340	US246
31.3-31.5 GHz	EESS (passive)	SRS (passive)	5.340	US246
31.5-31.8 GHz	EESS (passive)	SRS (passive)	5.340	US246
33.4-34.2 GHz	*No Allocation but used by JMR on JASON-1*			
35.5-36 GHz	EESS (active)	SRS (active)	5.549A	
36-37 GHz	EESS (passive)	SRS (passive)		US263
50.2-50.4 GHz	EESS (passive)	SRS (passive)	5.340	US246

[4] These are the science related bands where NASA has mission requirements. NASA does not necessarily have systems operating using all listed services in any given band

[5] "Applicable" meaning the footnote either clarifies the services status or defines sharing conditions applicable to that service.

[6] Footnotes taken from Tables of Frequency Allocations and Other Extracts From: Manual of Regulations and Procedures for Federal Radio Frequency Management – May 2003 Edition

Table 22 (cont.):

FREQUENCY BAND	RADIO SERVICE	RADIO SERVICE	Applicable ITU FNs	Applicable US FNs
52.6-54.25 GHz	EESS (passive)	SRS (passive)	5.340	US246
54.25-55.78 GHz	EESS (passive)	SRS (passive)		
*55.78-56.9 GHz**	*EESS (passive)*	*SRS (passive)*		*US263*
*56.9-57 GHz**	*EESS (passive)*	*SRS (passive)*		*US263*
57-58.2 GHz	EESS (passive)	SRS (passive)		US263
*58.2-59 GHz**	*EESS (passive)*	*SRS (passive)*		
*59-59.3 GHz**	*EESS (passive)*	*SRS (passive)*		
* This is one continuous block of spectrum with multiple consecutive bands allocated to EESS (passive) and SRS (passive) the *gray italicized* bands are not currently used by NASA,				
86-92 GHz	EESS (passive)	SRS (passive)	5.340	US246
94-94.1 GHz	EESS (active)	SRS (active)	5.562, 5.562A	
*114.25-116 GHz**	*EESS (passive)*	*SRS (passive)*	*5.340*	*US246*
116-119.98 GHz	EESS (passive)	SRS (passive)		US263
*119.98-122.25 GHz**	*EESS (passive)*	*SRS (passive)*		US263
* This is one continuous block of spectrum with multiple bands allocated to EESS (passive) and SRS (passive) the *gray italicized* bands are not used by NASA.				
148.5-151.5 GHz	EESS (passive)	SRS (passive)	5.340	
*174.8-182 GHz**	*EESS (passive)*	*SRS (passive)*		*US263*
182-185 GHz	EESS (passive)	SRS (passive)	5.340	US246
185-190 GHz	EESS (passive)	SRS (passive)		
190-191.8 GHz	EESS (passive)	SRS (passive)	5.340	
* This is one continuous block of spectrum with multiple bands allocated to EESS (passive) and SRS (passive) the *gray italicized* bands are not used by NASA.				
200-202 GHz	EESS (passive)	SRS (passive)	5.340	US263
*202-209 GHz**	*EESS (passive)*	*SRS (passive)*	5.340	
240 GHz	*No Allocation but used by MLS on AURA*			
640 GHz	*No Allocation but used by MLS on AURA*		5.565	
2.4 THz	*No Allocation but used by MLS on AURA - See also ITU-R Res 950*			

Note: In addition to the spectrum listed in recognized bands in the table above, NASA also has several missions using infrared and optical spectrum. These include, but are not limited to those in Table 23:

Table 23: Frequency bands, Applicable footnotes and Services

Mission	Center Frequency	Purpose
AQUA	50.25 THz	The Atmospheric Infrared Sounder (AIRS) is an advanced sounder containing 2378 infrared channels and four visible/near-infrared channels, aimed at obtaining highly accurate temperature profiles within the atmosphere plus a variety of additional Earth/atmosphere products.
	385.4 THz	The Moderate Resolution Imaging Spectroradiometer (MODIS), is a 36-band spectroradiometer measuring visible and infrared radiation and obtaining data that are being used to derive products ranging from vegetation, land surface cover, and ocean chlorophyll fluorescence to cloud and aerosol properties, fire occurrence, snow cover on the land, and sea ice cover on the oceans.
EO-1	435 THz	This hyperspectral imager analyzes 220 contiguous spectral channels, allowing the use of derivatives and sophisticated analysis techniques. The large number of bands allows more complex systems to be addressed without the under-sampling inherent in multispectral systems.
ICESAT	283 THz	This system is an active sensing LIDAR used to perform altimetry measuring ice-sheet topography and associated temporal changes, cloud and atmospheric properties, and along-track topography over land and water.
	566 THz	This system is an active sensing LIDAR measuring along-track cloud and aerosol height distributions with a vertical resolution of 75 to 200 m. The horizontal resolution can vary from 150 m for dense clouds to 50 km for aerosol structure and planetary boundary layer height.
TERRA	31.25 THz, 155.25 THz & 466.5 THz	This multispectral imager measures clouds at three distinct frequency bands. With its high spatial resolution, broad spectral coverage and stereo imaging capability, this instrument will provides essential measurements of cloud amount, type, spatial distribution, morphology and radiative properties.
	385.4 THz	This system plays a vital role in the development of validated, global, interactive Earth system models able to predict global change by measuring parameters such as land, cloud, and aerosol boundaries and temperatures, ocean biogeochemistry, and cloud-top height.
TRMM	385.9 THz	This system investigates the global incidence of lightning, its correlation with convective rainfall, and its relationship with the global electric circuit. The lightning sensor consists of a staring imager that is optimized to locate and detect lightning with storm-scale resolution (4 to 7 km) over a large region (600 × 600 km) of the Earth's surface.

ANNEX D: LIST OF ALL INTERNATIONAL ALLOCATIONS AVAILABLE TO SPACE SCIENCE APPLICATIONS

The bands provided in Table 24 are recognized in the ITU Radio Regulations (WRC-03) as applicable to space science applications.

- Cells highlighted in blue are for communication use;
- Cells highlighted in yellow are for sensing use;
- Cells highlighted in green are for communication or sensing use;
- Cells highlighted in purple are for deep space communication use;
- Allocations in square brackets are provided in a footnote.

Table 24: Frequency bands, Applicable[7] international footnotes and Services

Frequency Band	Radio Service	Radio Service	FN	FN
2501-2502 kHz	srs			
5003-5005 kHz	srs			
10,003-10,005 kHz	srs			
15,005-15,010 kHz	srs			
18,052-18,068 kHz	srs			
19,990-19,995 kHz	srs			
25,005-25,010 kHz	srs			
30.005-30.01 MHz	SRS	SOS (Satellite ID)		
39.986-40.02 MHz	srs			
40.98-41.015 MHz	srs			
137-137.025 MHz	SRS (s-E)	SOS (s-E)		
137.025-137.175 MHz	SRS (s-E)	SOS (s-E)		
137.175-137.825 MHz	SRS (s-E)	SOS (s-E)		
137.825-138 MHz	SRS (s-E)	SOS (s-E)		
138-143.6 MHz	srs (s-E)		Regions 2 & 3 Only	
143.6-143.65 MHz	SRS (s-E)			
143.65-144 MHz	srs (s-E)		Regions 2 & 3 Only	
148-149.9 MHz	[SOS (E-s)]		5.218	5.219

[7] "Applicable" meaning the footnote either clarifies the services status or defines sharing conditions applicable to that service.

Table 24 (cont.): Frequency bands, Applicable international footnotes and Services

Frequency Band	Radio Service	Radio Service	Radio Service	FN	FN	FN
267-272 MHz	sos (s-E)			5.257		
400.15-401 MHz	SRS (s-E)(s-s)	sos (s-E)		5.263		
401-402 MHz	EESS (E-s)	SOS (s-E)				
402-403 MHz	EESS (E-s)					
410-420 MHz	SRS (s-s)			5.268		
432-438 MHz	eess (active)			5.279A		
449.75-450.25 MHz	[srs (E-s)]	[sos (E-s)]		5.256		
460-470 MHz	[eess (s-E)]			5.289		
1215-1240 MHz	EESS (active)	SRS (active)		5.332		
1240-1300 MHz	EESS (active)	SRS (active)		5.332	5.335	5.335A
1370-1400 MHz	[eess (passive)]	[srs (passive)]		5.339		
1400-1427 MHz	EESS (passive)	SRS (passive)		5.340		
1427-1429 MHz	SOS (E-s)					
1525-1530 MHz	eess	SOS (s-E)				
1530-1535 MHz	eess	SOS (s-E)				
1660.5-1668 MHz	SRS (passive)					
1668-1668.4 MHz	SRS (passive)			5.379D		
1690-1710 MHz	[eess (s-E)]			5.289		
1750-1850 MHz (Rgn 2)	[SRS (E-s)]	[SOS (E-s)]		5.386		
2025-2110 MHz	EESS (E-s) (s-s)	SRS (E-s) (s-s)	SOS (E-s) (s-s)	5.392		
2110-2120 MHz	SRS (deep space) (E-s)					
2200-2290 MHz	EESS (s-E) (s-s)	SRS (s-E) (s-s)	SOS (s-E) (s-s)	5.392		
2290-2300 MHz	SRS (deep space) (s-E)					
2640-2655 MHz	[eess (passive)]	[srs (passive)]		5.339		
2665-2670 MHz	eess (passive)	srs (passive)				
2670-2690 MHz	eess (passive)	srs (passive)				
2690-2700 MHz	EESS (passive)	SRS (passive)		5.340		
3100-3300 MHz	eess (active)	srs (active)				

Table 24 (cont.): Frequency bands, Applicable international footnotes and Services

Frequency Band	Radio Service	Radio Service	Radio Service	FN	FN	FN	FN
4200-4400 MHz	[eess (passive)]	[srs (passive)]		5.438			
4950-4990 MHz	[eess (passive)]	[srs (passive)]		5.339			
4990-5000 MHz	srs (passive)						
5250-5255 MHz	EESS (active)	SRS [(active)]	[srs]	5.447D	5.447F	5.448A	
5255-5350 MHz	EESS (active)	SRS (active)		5.447F	5.448A		
5350-5460 MHz	EESS (active)	SRS (active)		5.448B	5.448C		
5460-5470 MHz	EESS (active)	SRS (active)		5.448B			
5470-5570 MHz	EESS (active)	SRS (active)		5.448B			
5650-5725 MHz	srs (deep space)						
6425-7145 MHz	*[eess (passive)]*	*[srs (passive)]*		5.458			
7145-7190 MHz	*[eess (passive)]*	*[srs (passive)]*	SRS (deep-space)(E-s)	5.458	5.460		
7190-7235 MHz	*[eess (passive)]*	*[srs (passive)]*	SRS (E-s)	5.458	5.460		
7235-7250 MHz	*[eess (passive)]*	*[srs (passive)]*		5.458			
8025-8175 MHz	EESS (s-E)			5.462A			
8400-8450 MHz	SRS [(deep space)] (s-E)			5.465			
8450-8500 MHz	SRS (s-E)						
8550-8650 MHz	EESS (active)	SRS (active)		5.469A			
9500-9800 MHz	EESS (active)	SRS (active)		5.476A			
10.6-10.68 GHz	EESS (passive)	SRS (passive)					
10.68-10.7 GHz	EESS (passive)	SRS (passive)		5.340			
12.75-13.25 GHz	srs (deep space) (s-E)						
13.25-13.4 GHz	EESS (active)	SRS (active)		5.498A			
13.4-13.75 GHz	EESS (active)	[SRS (active)]	[srs]	5.501A	5.501B		
13.75-14 GHz	eess	srs		5.503			
14-14.25 GHz	srs						
14.25-14.3 GHz	srs						
14.4-14.47 GHz	srs (s-E)						
14.5-14.8 GHz	srs						
14.8-15.35 GHz	[eess (passive)]	srs	[srs (passive)]	5.339			
15.35-15.4 GHz	EESS (passive)	SRS (passive)		5.340			

Table 24 (cont.): Frequency bands, Applicable international footnotes and Services

Frequency Band	Radio Service	Radio Service	Radio Service	FN	FN	FN	FN
16.6-17.1 GHz	srs (deep space) (E-s)						
17.2-17.3 GHz	EESS (active)	SRS (active)		5.513A			
18.6-18.8 GHz (Rgn 1 & 3)	EESS (passive)	srs (passive)					
18.6-18.8 GHz (Rgn 2)	EESS (passive)	SRS (passive)					
21.2-21.4 GHz	EESS (passive)	SRS (passive)					
22.21-22.5 GHz	EESS (passive)	SRS (passive)		5.532			
22.55-23.55 GHz	INTER-SAT						
23.6-24 GHz	EESS (passive)	SRS (passive)		5.340			
24.05-24.25 GHz	eess (active)						
24.45-24.65 GHz	INTER-SAT			5.533			
24.65-24.75 GHz	INTER-SAT						
25.25-25.5 GHz	INTER-SAT			5.536			
25.5-27 GHz	INTER-SAT	EESS (s-E)	SRS (s-E)	5.536	5.536A	5.536B	5.536C
27-27.5 GHz	INTER-SAT			5.536	5.537		
28.5-29.1 GHz	eess (E-s)			5.541			
29.1-29.5 GHz	eess (E-s)			5.541			
29.5-29.9 GHz	eess (E-s)			5.541			
29.9-30 GHz	eess (E-s)			5.541			
29.95-30 GHz	eess (E-s)(s-s)			5.541	5.543		
31-31.3 GHz	srs			5.544			
31.3-31.5 GHz	EESS (passive)	SRS (passive)		5.340			
31.5-31.8 GHz	EESS (passive)	SRS (passive)		5.340	5.546		
31.8-32 GHz	SRS (deep space) (s-E)			5.547B	5.548		
32-32.3 GHz	SRS (deep space) (s-E)			5.547C	5.548		
32.3-33 GHz	INTER-SAT			5.547D	5.548		
34.2-34.7 GHz	SRS (deep space) (E-s)						
34.7-35.2 GHz	srs						
35.5-36 GHz	EESS (active)	SRS (active)		5.549	5.549A		
36-37 GHz	EESS (passive)	SRS (passive)					

Table 24 (cont.): Frequency bands, Applicable international footnotes and Services

Frequency Band	Radio Service	Radio Service	Radio Service	FN	FN	FN
37-37.5 GHz	SRS (s-E)					
37.5-38 GHz	eess (s-E)	SRS (s-E)				
38-39.5 GHz	eess (s-E)					
39.5-40 GHz	eess (s-E)					
40-40.5 GHz	EESS (E-s)	eess (s-E)	SRS (E-s)			
50.2-50.4 GHz	EESS (passive)	SRS (passive)		5.340	5.340.1	
52.6-54.25 GHz	EESS (passive)	SRS (passive)		5.340		
54.25-55.78 GHz	INTER-SAT	EESS (passive)	SRS (passive)	5.556A		
55.78-56.9 GHz	INTER-SAT	EESS (passive)	SRS (passive)	5.556A	5.557A	5.558
56.9-57 GHz	INTER-SAT	EESS (passive)	SRS (passive)	5.558	5.558A	
57-58.2 GHz	INTER-SAT	EESS (passive)	SRS (passive)	5.556A	5.558	
58.2-59 GHz	EESS (passive)	SRS (passive)				
59-59.3 GHz	INTER-SAT	EESS (passive)	SRS (passive)	5.556A	5.558	5.559
59.3-64 GHz	INTER-SAT			5.558		
64-65 GHz	INTER-SAT					
65-66 GHz	INTER-SAT	EESS	SRS			
66-71 GHz	INTER-SAT			5.558		
74-76 GHz	srs (s-E)					
76-77.5 GHz	srs (s-E)					
77.5-78 GHz	srs (s-E)					
78-79 GHz	[EESS (active)]	[SRS (active)]	srs (s-E)	5.560		
79-81 GHz	srs (s-E)					
81-84 GHz	srs (s-E)					
86-92 GHz	EESS (passive)	SRS (passive)		5.340		
94-94.1 GHz	EESS (active)	SRS (active)		5.562	5.562A	
100-102 GHz	EESS (passive)	SRS (passive)		5.340		
105-109.5 GHz	SRS (passive)			5.562B		
109.5-111.8 GHz	EESS (passive)	SRS (passive)				
111.8-114.25 GHz	SRS (passive)			5.562B		
114.25-116 GHz	EESS (passive)	SRS (passive)				
116-119.98 GHz	INTER-SAT	EESS (passive)	SRS (passive)	5.562C		
119.98-122.25 GHz	INTER-SAT	EESS (passive)	SRS (passive)	5.562C		
122.25-123 GHz	INTER-SAT			5.558		

Table 24 (cont.): Frequency bands, Applicable international footnotes and Services

Frequency Band	Radio Service	Radio Service	Radio Service	FN	FN	FN
130-134 GHz	INTER-SAT	EESS (active)		5.558	5.562A	5.562E
148.5-151.5 GHz	EESS (passive)	SRS (passive)		5.340		
155.5-158.5 GHz	EESS (passive)	SRS (passive)		5.562B	5.562F	
164-167 GHz	EESS (passive)	SRS (passive)		5.340		
167-174.5 GHz	INTER-SAT			5.558		
174.5-174.8 GHz	INTER-SAT			5.558		
174.8-182 GHz	INTER-SAT	EESS (passive)	SRS (passive)	5.562H		
182-185 GHz	EESS (passive)	SRS (passive)		5.340		
185-190 GHz	INTER-SAT	EESS (passive)	SRS (passive)	5.562H		
190-191.8 GHz	EESS (passive)	SRS (passive)		5.340		
191.8-200 GHz	INTER-SAT			5.558		
200-202 GHz	EESS (passive)	SRS (passive)		5.340		
202-209 GHz	EESS (passive)	SRS (passive)		5.340		
217-226 GHz	SRS (passive)			5.562B		
226-231.5 GHz	EESS (passive)	SRS (passive)		5.340		
235-238 GHz	EESS (passive)	SRS (passive)	[EESS/SRS (active)]	5.563B		
250-252 GHz	EESS (passive)	SRS (passive)				
275-1000 GHz	*[eess (passive)]*	*[srs (passive)]*		5.565		

APPENDIX 1

NASA SPECTRUM ALLOCATION DEFICIENCIES – 2007

Table 25, below, describes the deficiencies in access to available frequency spectrum that have been identified by NASA during the preliminary analysis of communication and sensor requirements of planned NASA missions and programs.
The primary current stimulus for these activities is the President's Vision for Space Exploration.

The spectrum requirements described below have been prepared for NTIA and for consideration by the IRAC's Spectrum Planning SubCommittee. If these requirements cannot be satisfied from existing frequency allocations then, it may be necessary for the U.S. to make appropriate proposals to a World Radiocommunication Conference (WRC) in the near future, preferably WRC-2011.

Table 25 – NASA Spectrum Allocation Deficiencies

Program(s)' Requirement(s)	Bandwidth Required	Comments, Guidance
WRC-2003 made a primary space research service (space-to-Earth) allocation in the band 25.5-27.0 GHz to support a wide range of space research missions. The President of the United States initiated a Vision for Space Exploration, which tasked NASA to plan and execute a program of exploration of the Moon and Mars. To support the SRS missions in near Earth orbit, including missions to the moon, downlink (space-to-Earth) transmissions will operate in the 25.5-27.0 GHz SRS allocation. However, there is a need for a companion uplink (Earth-to-space) band to provide the mission data, command and control links for these missions. Due to the potential for many concurrent exploration related systems and the large bandwidth requirements of these systems, especially those supporting manned missions, it is projected that a total uplink bandwidth of up to 500 MHz will be needed.	500 MHz	It is important, when considering this requirement, to note the technical need for a transmitter – receiver Turn-around ratio within the current technology capability. If this spectrum requirement cannot be satisfied from within existing allocations, NASA would like to have an agenda item on the WRC-2011 Agenda. The Agenda Item should point out the need for 500 MHz of bandwidth and the need for proximity to the allocated downlink band (25.5 – 27.0 GHz).

Table 25 (cont.)– NASA Spectrum Allocation Deficiencies		
Program(s)' Requirement(s)	**Bandwidth Required**	**Comments, Guidance**
The amount of spectrum needed to support the space-to-Earth links of deep-space missions is expected to take a quantum leap 10-30 years into the future. This is attributed to two factors. Firstly, future US deep space missions are predicted to require a much higher data rate capability, sending data generated by on-board instruments at rates in excess of hundreds of megabits per second. Secondly, the number of missions is predicted to increase as more space agencies send missions to explore the solar system and beyond. On-board instruments require very high data rates. For example, a radar may require a data rate of 100 Mbps and a hyperspectral imager 150 Mbps. These instruments can be flown on both robotic and human missions. Developments undertaken by NASA will enable future deep space missions to send science data to the Earth at a much higher rate than they presently can. NASA is implementing a large array of antennas with a G/T one order of magnitude higher than the existing 70m antennas in NASA's Deep Space Network (DSN). This will enable spacecraft to transmit at a much higher rate in the future than they presently can, without requiring a huge EIRP from the spacecraft. A recent internal JPL study predicted a downlink throughput data rate of 125 Mbps, 150 Mbps, and 1500 Mbps for the highest data rate user in the 2010, 2020 and 2030 time frame, respectively. While there is some uncertainty in these extremely long-range projections, they do point to a trend toward higher and higher data rates for deep space missions. They indicate that the bandwidth required to support future deep space missions will far exceed the capacity of all existing allocations, even after accounting for possible use of bandwidth efficient modulation schemes in the future.	2.5 GHz	If this spectrum requirement cannot be satisfied from within existing allocations, NASA would like to have an agenda item on the WRC-2015 Agenda Because deep space links generally require 99% or higher link availability, it is clear that a W-band link will have a much more severe link degradation than a Ka-band link. Although there is ample spectrum in W-band, it should be avoided if at all possible. The region of Ka-band from about 27.5 GHz to about 40 GHz provides the optimum range of frequencies to satisfy this requirement, being located close to the existing deep space allocation at 31.8-32.3 GHz.

Table 25 – NASA Spectrum Allocation Deficiencies

Program(s)' Requirement(s)	Bandwidth Required	Comments, Guidance
NASA has identified a requirement for 1 MHz of bandwidth for a synthetic aperture radar (SAR) system in the range 100 – 150 MHz. The name of the mission is the Microwave Observatory of Subsurface and Subcanopy (MOSS). The subject SAR operates in conjunction with another 1 MHz – wide SAR operating at 432-433 MHz, and will enable vegetation and deep soil penetration observations.	1MHz	If this spectrum requirement cannot be satisfied from within existing allocations, NASA would like to have an agenda item on the WRC-2015 Agenda. The radio service classification of the SAR system may be as follows: - Earth exploration-satellite service; - Meteorological-satellite service; or - Space research service. In the frequency range from 100 to 150 MHz only the 137-138 MHz band is allocated on a primary basis to the space research service. Other services which are allocated in the frequency range 100-150 MHz include: Broadcasting, Aeronautical Radionavigation, Aeronautical Mobile, Space Operation (space-to-Earth), Meteorological-Satellite (space-to-Earth), Mobile-Satellite (space-to-Earth), Space Research (space-to-Earth), Fixed, Mobile except aeronautical mobile (R), and Amateur. Studies need to be conducted to confirm that sharing is feasible with the existing allocated services.

APPENDIX 2

CHARTER OF HEADQUARTERS SPECTRUM MANAGEMENT FORUM

1. NASA, IAW NPD 2570.5E, shall create and maintain the Headquarters Spectrum Management Forum (HSMF) for the consideration of spectrum requirements from all program offices.

2. The HSMF should meet periodically to consider the requirements at intervals of not more than ninety (90) days.

3. The Associate Administrator for Space Operations Mission Directorate is responsible for appointing a Space Operations Mission Directorate Spectrum Liaison who will coordinate the Space Operations programs for the International Space Station and Space Shuttle as well as for future operational human space flight missions. In addition, the liaison will coordinate the communications requirements of the Ground and Space Networks, for all missions, and present them to the HSMF as the Space Operations program interface to that forum.

b. The Associate Administrator for Exploration Systems Mission Directorate shall appoint an Exploration Systems Spectrum Liaison who will coordinate the Exploration Program's communications requirements, for both robotic and human space flight missions, and present them to the HSMF as the Exploration Systems program interface to that forum.

c. The Associate Administrator for Science Mission Directorate shall appoint a Science Spectrum Liaison who will coordinate the Science program's remote-sensing (both active and passive) requirements and communications requirements and present them to the HSMF as the Science program interface to that forum.

d. The Associate Administrator for Aeronautics Research Mission Directorate shall appoint an Aeronautics Spectrum Liaison who will coordinate the Aeronautics Program's radio navigation, remote control, telemetry, and communications requirements and present them to the HSMF as the Aeronautics program interface to that forum.

e. The Assistant Administrator for External Relations shall appoint an External Relations Spectrum Liaison who will initiate formal bilateral agreements governing the use of EM spectrum resources with entities outside the United States (U.S.) and its possessions in accordance with NPD 1050.1 and other U.S. laws and regulations as applicable, and consulting with the U.S. Department of State as appropriate. The External Relations Spectrum Liaison shall be an ex officio member of the HSMF.

f. The Assistant Administrator for Legislative Affairs shall appoint a Legislative Affairs Spectrum Liaison who will initiate any contacts concerning the use of EM spectrum resources with entities of the U.S. Congress, its committees, subgroups, or staff. The Legislative Affairs Spectrum Liaison shall be an ex officio member of the HSMF.

g. The Office of the General Counsel shall appoint a General Counsel Spectrum Liaison who will be responsible for advising the Associate Administrator for Space Operations concerning the legal aspects of EM spectrum regulation. The General Counsel Spectrum Liaison shall be an ex officio member of the HSMF.

h. Officials-in-Charge of relevant Headquarters Offices are responsible for ensuring that long-range Agency communications and remote-sensing spectrum requirements are coordinated with the Associate Administrator for Space Operations Mission Directorate as early as possible in the program planning phase to permit identification of appropriate EM spectrum allocations in support of program needs. In the absence of adequate allocations, the HSMF will determine appropriate actions to be taken to secure new or alternative allocations.

The above appointed liaisons to the HSMF will at least quarterly apprise the Spectrum Management Office in SCaN of new requirements and the status of current spectrum use for NASA missions in their Program Control.

APPENDIX 3

TERMS OF REFERENCE OF SPACE FREQUENCY COORDINATION GROUP (SFCG Resolution A6-1R2)

The SFCG,

NOTING

i) the letter of the Director General of the European Space Agency (ESA) of 16 January, 1980 in which he proposed the creation of SFCG and accepted that ESA provide the permanent secretariat;

ii) the importance of periodically updating its Terms of Reference;

CONSIDERING

a) that the Group has successfully conducted annual meetings since 1980;

b) that the Terms of Reference are updated periodically to maintain current relevance;

RESOLVES

To establish the following Terms of Reference:

SFCG provides a forum for multilateral discussion and coordination of spectrum matters of mutual interest concerning, in particular, the following space radiocommunication services, as defined in the ITU Radio Regulations:

- Space research
- Space operations
- Earth exploration satellite
- Meteorological satellite
- Inter-satellite
- Radionavigation satellite
- Radioastronomy and radar astronomy to the extent that they are relevant to spacecraft missions,

The agreed upon results of SFCG work will be expressed in the form of Resolutions, Recommendations, or whatever form may be appropriate for the case. SFCG members will attempt to ensure that findings of SFCG are taken into account by their agencies.

SFCG will:

- facilitate early understanding of present and future plans for space systems and services and of other systems affecting these;
- identify problem areas and coordination needs, and study potential solutions associated therewith;
- identify issues and policy matters relating to the future orderly use of the frequency bands allocated to respective space radiocommunication services;
- suggest courses of action to be taken by SFCG member agencies with regard to current and future frequency needs of the space radiocommunication services identified above,

- identify those matters for which member agencies should facilitate contributions to regional bodies (e.g. APT, CEPT, CITEL), ITU-R Study Groups; or to encourage their administrations to make proposals to ITU WRCs;
- closely cooperate in the area of frequency management with other space agencies as well as with commercial or research users of frequency bands allocated to the services identified above;
- consider any other items of technical, operational, or administrative nature which affect the interests of the Group; and
- maintain strong ties with other international bodies with related objectives.

DECIDES

to accept ESA's offer to provide the permanent Secretariat of the SFCG.