MISSION SUPPORT

FISCAL YEAR 2001 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE FLIGHT **SPACE COMMUNICATIONS SERVICES**

SUMMARY OF RESOURCES REQUIREMENTS

	FY 1999 OPLAN 12/23/99	FY 2000 OPLAN REVISED	FY 2001 PRES BUDGET	Page Number
		(Thousands of Dollars)		
Space Network	110,300	36,100	--	MS 2-4
NASA Integrated Services Network	75,500	53,600	--	MS 2-9
[Reimbursements [non-add]]	[45,900]	[43,000]	--	
Total	185,800	89,700	--	
Distribution of Program Amount by Installation				
Johnson Space Center	34,400	47,000	--	
Kennedy Space Center	30,200	14,000	--	
Marshall Space Flight Center	46,900	7,700	--	
Goddard Space Flight Center	67,500	17,500	--	
Jet Propulsion Laboratory	3,800	2,800	--	
Headquarters	3,000	700	--	
Total	185,800	89,700	--	

Note -- Beginning in FY 2001, funding for all these activities is requested under the Science, Aeronautics and Technology appropriation under the Space Operations program.

PROGRAM GOALS

The Space Communications goal is to provide high quality, reliable and cost-effective space operations services, which enable Enterprise, mission execution. Reliable electronic communications are essential to the success of every NASA flight mission, from planetary spacecraft to the Space Transportation System (STS) to aeronautical flight tests.

The Space Operations Management Office (SOMO), located at the Johnson Space Center in Houston, manages the telecommunications, data processing, mission operation, and mission planning services needed to ensure the goals of NASA's exploration, science, and research and development programs are met in an integrated and cost-effective manner. In line with the National Space Policy, the SOMO is committed to seeking and encouraging commercialization of NASA operations services and to participate with NASA's strategic enterprises in collaborative interagency, international, and commercial initiatives. As NASA's agent for operational communications and associated information handling services, the SOMO seeks opportunities for using technology in pursuit of more cost-effective solutions, highly optimized designs of mission systems, and advancement of NASA's and the nation's best technological and commercial interests.

The Space Communication Services segment of NASA's Space Communications program is composed of two major elements. The Space Network element provides communications support to human space flight missions and low-Earth orbital spacecraft compatible with the Tracking and Data Relay Satellite (TDRS) system and to expendable launch vehicles and research aircraft. The NASA Integrated Services Network (NISN) program element provides telecommunications interconnectivity among NASA flight support networks, project and mission control centers, data processing centers and facilities, contractor facilities, and investigator science facilities located throughout the nation and the world.

STRATEGY FOR ACHIEVING PROGRAM GOALS

The Space Operations program provides command, tracking, and telemetry data services between the ground facilities and flight mission vehicles. This includes all the interconnecting telecommunications services to link tracking and data acquisition network facilities, mission control facilities, data capture and processing facilities, industry and university research and laboratory facilities, and the investigating scientists. The program provides scheduling, network management and engineering, pre-flight test and verification, flight system maneuver planning and analysis. The program provides integrated solutions to operational communications and information management needs common to all NASA strategic enterprises.

The Space Operations program provides the necessary research and development to adapt emerging technologies to NASA communications and operational requirements. New coding and modulation techniques, antenna and transponder development, and automation applications are explored and, based on merit, demonstrated for application to future communications needs. NASA's flight programs are supported through the evaluation and coordination of data standards and communication frequencies to be used in the future.

Many science and exploration goals are achieved through inter-agency or international cooperation. Services from NASA's Space Operations assets are provided through collaborative agreements with other U.S. Government agencies, commercial space enterprises, academia, and international cooperative programs. Consistent with the National Space Policy, NASA procures commercially available goods and services to the fullest extent feasible, NASA develops selected technologies

which leverage commercial investments and enable the use of existing and emerging commercial telecommunications services to meet NASA's Space Operations needs. These are all parts of the strategic approach to providing the vital communications systems and services common to all NASA programs and to achieve compatibility with future commercial satellite systems and services.

The Consolidated Space Operations Contract (CSOC) was successfully implemented on 1 January 1999 under the direction of the Space Operations Management Office and Lockheed Martin Space Operations Company as the Prime Contractor. CSOC provides end-to-end space operations mission and data services to both NASA and non-NASA customers. CSOC is a $3.44B contract with a Basic Period of Performance from January 1999 through December 2003 and an option period though December 2008. The contract is a Performance Based Cost Plus Award Fee (CPAF) with possible conversion to Fixed Price Incentive Fee (FPIF) within 2 years. A total of nine contracts were consolidated at the inception of CSOC, a further four contracts have been consolidated in FY 2000 to date and two further contracts are to be consolidated in FY 2001. CSOC reflects a significant change in NASA philosophy as accountability and day to day direction for providing space operations services shifts from NASA to the CSOC contractor.

Beginning in FY 2001, funding for these activities is requested under the Science, Aeronautics and Technology appropriation under the Space Operations program, so as to link these activities more directly with the agency programs which constitute the principal users of these facilities and services. The consolidation of Space Communication Services, along with that part of the Space Operations program already included in the SAT appropriation (Mission Communication Services), will enable the Space Operations Management Office (SOMO) at Johnson Space Center to more effectively manage the Space Operations program. This will ensure that the goals of NASA's exploration, science, and research and development programs are met in an integrated and cost-effective manner. A set of budget crosswalk tables between the Space Communication Services and Mission Communications Service budget and the consolidated Space Operations program is described in the Special Issues section.

BASIS OF FY 2001 FUNDING REQUIREMENT

SPACE NETWORK

	FY 1999	FY 2000	FY 2001
		(Thousands of Dollars)	
Space Network Services	7,700	4,400	--
TDRS Replenishment Spacecraft	66,700	17,700	--
TDRS Replenishment - Launch Services	30,200	14,000	--
Total	104,600	36,100	--

PROGRAM GOALS

The Space Network program goal is to provide reliable, cost-effective space-based tracking, command and data acquisition telecommunications services to the Human space Flight program, other low-Earth-orbital science missions including observatory-class flights, and selected sub-orbital flight missions. The Space Network program provides for the implementation, maintenance, and operation of the communications systems and facilities necessary to ensure and sustain the high-quality performance of NASA flight operations systems. Replenishment Tracking and Data Relay Satellites (TDRS) and the launch systems required to deploy them are also included in this program.

The Space Network participates in collaborative interagency and international programs, and independently provides communications services to other national and commercial endeavors on a reimbursable basis.

STRATEGY FOR ACHIEVING GOALS

NASA's Space Network is comprised of a constellation of geosynchronous TDRS and associated dual ground terminals located in White Sands, New Mexico. The current TDRS constellation consists of four fully operational satellites in service (TDRS-4, 5, 6 & 7), and two partially functional spacecraft (TDRS-1 & 3). TDRS-3 is positioned over the Indian Ocean, in conjunction with a remote terminal in Guam, to increase data return from the Compton Gamma Ray Observatory (CGRO), other users and to support Shuttle/International Space Station operations. TDRS-1, now in its sixteenth year, is still providing service to expendable vehicle launches and other peak loads in the eastern network node.

The Goddard Space Flight Center manages the Space Network program, including the TDRS Replenishment Spacecraft program, and the modification and/or system replacement of the ground facilities and equipment as necessary to sustain network operations for current and future missions. The Replenishment Spacecraft program providing three TDRS spacecraft under a fixed-price, commercial practices contract with Hughes Space and Communications Company. The first spacecraft's launch readiness is scheduled for June 2000. The program provides for spacecraft compatibility modifications to the New Mexico ground terminals. Lockheed Martin Corporation is the prime contractor for launch services for the TDRS Replenishment Spacecraft.

The Lockheed Martin Space Operations Company was recently awarded the Consolidated Space Operations Contract (CSOC) on October 1, 1998, and became the primary support service contractor responsible for systems engineering, software development and maintenance, operations, and analytical services beginning in January 1999.

The Space Network provides communication services at data rates up to 300 megabits-per-second (MBPS) using its Ku-band single-access services, data rates of up to three MBPS using its S-band, single-access services, and a low-rate service of up to 150 kilobits-per-second (KBPS) through its multiple-access service. These services provide unparalleled, flexible high-data-rate communications capabilities for flight operations of low-Earth-orbital missions. Customer satellites are provided with command, tracking, and telemetry services via the TDRS spacecraft, which act as relays for commands from and science telemetry return to the ground terminals. The ground terminals are interconnected with flight control, data capture and processing facilities responsible for mission operations.

Communications services are provided to non-NASA customers on a reimbursable basis. A large share of the Space Network Services program that provides for the operations and maintenance of the ground terminal complex is funded with the receipts from reimbursable services. This reimbursable revenue is anticipated to continue and has been taken into account in formulating the NASA FY 2001 budget request.

Space Network services provides the primary communications for orbital operations of the Space Transportation System and its attached payloads. Services are also provided to automated Earth-orbital missions that have communications systems compatible with the TDRS, and can provide nearly continuous high-data-rate services. The Space Network initiated communications services for the International Space Station (ISS) beginning in FY 1999. Services will also be provided on an agreed-to basis to NASA's International partners. Agreements are in place with Japan, the European Space Agency, and Canada. Negotiations are continuing with the Russian Space Agency as a participant for potential cooperative endeavors in telecommunications.

In addition to the day-to-day operations of the Space Network satellites and ground terminals, the program provides for the replenishment of the satellite assets.

SCHEDULE AND OUTPUTS

	FY 1999		FY 2000		FY 2001
	Plan	Actual	Plan	Current	Plan
Number of hours of network service (thousands)	54,100	57,800	62,000	62,000	--
Number of Space Shuttle Launches supported	6	4	8	6	[9]

The initiation of the ISS assembly and the launches of Terra and Landsat-7 necessitated an increased level of communication services in FY 1999. In FY 2000, full-up support to the ISS will necessitate further increases in the level of communication services.

TDRS Replenishment Spacecraft

Pre-Environmental Review for TDRS-I Plan: March 1999	Verification that the spacecraft is ready for system level environmental testing. Pre-environmental reviews were rephased due to a number of unit level problems on TDRS

Actual: May 1999	H, the uniqueness of the TDRS-H payload, and the first-time use of electronic ground test software on TDRS H.
Pre-Environmental Review for TDRS-J Plan: May 1999 Revised: February 2000	Verification that the spacecraft is ready for system level environmental testing. Pre-environmental reviews were rephased due to a number of unit level problems on TDRS H, the uniqueness of the TDRS-H payload, and the first-time use of electronic ground test software on TDRS H.
Complete Integration and Test - TDRS-H Plan: April 1999 Revised: November 1999	Completion of spacecraft performance and environmental tests allows final assembly and re-testing to begin prior to shipment for launch.
Complete Integration and Test – TDRS-I Plan: June 1999 Revised: March 2000	Completion of spacecraft performance and environmental tests allows final assembly and re-testing to begin prior to shipment for launch.
Complete Integration and Test – TDRS-J Plan: August 1999 Revised: May 2000	Completion of spacecraft performance and environmental tests allows final assembly and re-testing to begin prior to shipment for launch.
Launch TDRS-H Plan: 3rd Qtr FY 2000	Launch within five years of contract award will be performed, ensuring the continuity of TDRSS services to user space flight systems. Launch of TDRS-I and TDRS-J is now scheduled for 2002 and 2003.

CONSOLIDATED SPACE OPERATIONS CONTRACT (CSOC)

Phase 1 Contract Award	May 1997
Phase 2 Proposal due	January 1998
Phase 2 Contract Award	October 1998
Phase 2 Phase-In	October-December 1998
Phase 2 CSOC In Force	January 1999

ACCOMPLISHMENTS AND PLANS

The Space Network is required to operate 24 hours per day, 7 days per week, providing data relay services to many flight missions. In FY 1999, the missions supported included four Space Shuttle flights and their attached payloads, observatory-class spacecraft in low-Earth orbit such as Hubble Space Telescope (HST) and the Compton Gamma Ray Observatory(CGRO), as well as other compatible missions such as Ocean Topography Experiment, Extreme Ultraviolet Explorer (EUVE), Department of Defense customers, the Rossi X-ray Timing Explorer (RXTE), the Starlink research aircraft, Engineering Test Satellite (ETS-VII), Tropical Rainfall Measurement Mission(TRMM), and the Long Duration Balloon program. The Space Network extended service (on a reimbursable basis) to the expendable launch vehicle community including agreements with US Air Force Titan and Lockheed Martin's commercial Atlas programs.

In FY 1999 and FY 2000, the Space Network continued to provide services to the Space Shuttle Flights and their attached payloads as well as the construction phase of the International Space Station, LANDSAT-7, and the Terra mission.

In FY 1999, work began on the TDRS low power transceiver (LPT) development. This initiative seeks to provide a lower cost, lighter weight and lower power-demanding alternative to today's expensive transponder options for spacecraft telemetry, command, and orbit determination requirements. The multiple-mode nature of the LPT allows for flexible multiple-frequency implementations that also provide for Global Positioning System (GPS) position processing including time determination. Suggested applications include use on smaller satellites, satellite crosslinks and NASA/DOD network interoperability. This effort will continue into FY 2000 with the delivery of a prototype unit and the initiation of flight unit development; completed flight units are planned to be delivered in FY 2001.

Work will begin in FY 2000 on various components of the DAS, including the Third Generation Beam Forming System (TGBFS). The TGBFS development activity was initiated to augment the TDRSS multiple-access (MA) capability and to permit customers to implement new operations concepts incorporating continuous return link communications. The DAS will expand existing Multiple Access (MA) return service capabilities by allowing customers to directly obtain services from the Space Network without scheduling through the Network Control Center (NCC). The TGBFS component is planned to be completed in FY 2001. The DAS will be installed at White Sands, New Mexico, and is expected to be operational and available for customer use in FY 2002.

Space Network ground terminal modifications in support of the TDRS replenishment project were completed at White Sands Complex in FY 1999. Development f the White Sands Alternate Resource Terminal (WART) was initiated. The WART will support National Science Foundation activities in the Antarctic. This system is planned to become operational in FY 2000.

Development activities for the TDRS Replenishment Spacecraft program continue to progress. Integration activities associated with TDRS-H were completed and the spacecraft underwent environmental testing. TDRS-I and TDRS-J spacecraft manufacturing, integration, and testing activities continue. Modifications and testing of the ground systems were completed at the White Sands Complex in preparation for TDRS-H on-orbit checkout and operations.

In FY 2000, all integration activities on TDRS-H will be completed. Launch readiness is planned for June 2000. On-orbit testing and acceptance of the TDRS-H spacecraft will be completed. Modifications to the ground terminal will undergo final acceptance after the launch of TDRS-H. The TDRS-I spacecraft will have completed integration and testing activities. TDRS-

I will undergo a pre-storage review and the contractual option to store the spacecraft will be exercised. The TDRS-J spacecraft will have completed all environmental test activities and initiate final functional test activities.

BASIS OF FY 2001 FUNDING REQUIREMENT

NASA INTEGRATED SERVICES NETWORK (NISN)

	FY 1998	FY 1999	FY 2000
		(Thousands of Dollars)	
NASA Integrated Services Network	81,200	53,600	--

PROGRAM GOALS

The NASA Integrated Services Network (NISN) goal is to provide high-quality, reliable, cost-effective telecommunications systems and services for mission control, science data handling, and program administration for NASA programs. The NISN program provides for the implementation, maintenance, and operation of the telecommunications services, control centers, switching systems, and other equipment necessary to provide an integrated approach to NASA communication requirements.

The NISN supports NASA's programs in collaborative interagency, international, and commercial enterprises. Many collaborative arrangements are performed on a reimbursable basis.

STRATEGY FOR ACHIEVING GOALS

NISN is a nationwide system of leased voice, video, and data services; leased wide-band terrestrial and satellite circuits; and control centers, switching centers, network equipment and other communications devices. International telecommunications links are also provided to NASA's Deep Space Network (DSN) sites in Australia and Spain; Spaceflight Tracking and Data Network (STDN) sites outside the Continental U.S.; and common telecommunications exchange points that provide interconnectivity to NASA international partners. Administrative, scientific, and mission control exchanges among NASA and its industrial and scientific partners are supported by NISN networks and systems. Support and participation by other U.S. agencies, universities, and research centers, and by other space-faring nations, are also facilitated, including the provision of secure circuits, systems, and facilities. Domestic Telecommunications circuits are primarily leased by NASA under the FTS-2000 contract managed by the General Services Administration; international circuits are leased under separate contractual arrangements. NISN maintains cooperative networking agreements for exchanging services with the European Space Agency (ESA), Canada, Japan, France, and Russia. The Computer Science Corporation and AlliedSignal Technical Services Corporation provide engineering and operations support for the NISN.

The NISN Project Office manages the NISN at the Marshall Space Flight Center in partnership with the Goddard Space Flight Center. NISN provides unique mission and mission support telecommunications services to all NASA Centers, supporting contractor locations, international partners, research institutes, and universities. NASA also provides telecommunications services to non-NASA customers on a reimbursable basis.

Command, telemetry, and voice systems communications are provided between spacecraft mission control facilities, tracking and data acquisition networks, launch sites, NASA data processing centers, and scientific investigators whose support is critical to

mission control and command. NISN support NASA aeronautical test sites, as well as preflight verification of NASA spacecraft systems and their interconnectivity with NASA communications systems.

The NISN interconnects NASA installations and national and international aerospace contractors, laboratories, scientific investigators, educational institutions, and other Government installations in support of administrative, science data exchange, and other research and analysis activities. Specific mission support services provided by the NISN are voice and video teleconferencing, broadcast television, computer networking services, as well as data handling and transfer services including Internet connectivity.

NISN provides for the improvement, operation and maintenance of NASA network systems and facilities. Telecommunications network systems include digital voice, data and video switching equipment, audio and video conferencing and bridging systems, wide-band multiplexing equipment, and sophisticated network management, monitoring, and fault isolation systems. Equipment and facilities of NASA Select Television are also provided by the NISN.

Telecommunications services are rapidly developing and maturing. With the advancements of telecommunications technology and standards, NASA telecommunications services are now more readily available from commercial sources. NISN continually analyzes current telecommunications requirements to determine the feasibility of providing NASA telecommunications services through commercial sources. NISN also maintains a close relationship with the NASA Research and Education Network (NREN), NASA's research and development, to determine what information technologies are beneficial to support NASA's growing telecommunications needs. As technologies become standard and commercially available, NISN conducts study and cost analyses to determine the feasibility of purchasing these services for use by the NASA community.

SCHEDULE AND OUTPUTS

	FY 1999 Plan	Actual	FY 2000 Plan	Current	FY 2001 Plan
Number of locations connected	410	410	420	420	--

ACCOMPLISHMENTS AND PLANS

In FY 1999, NISN will complete the necessary changes for the network resources to be Y2K compliant in December 1998. This will support NASA's goal to be Y2K compliant by February 1999. NISN will continue to support the development of the NGIXs, which will increase NISN's ability to provide enhanced-routed data services to NISN customers such as ISS and EOS. NISN will continue to play an active role in technology assessments, focusing on voice over ATM and IP, QoS prototyping, and routing protocol evaluation. NISN will add additional capacity, network connections, and services as necessary to support the initial implementation of the IFMP, and the growth of the ISS and EOS programs. NISN will complete the migration of services to the new Consolidation Space Operations Contract (CSOC) and the Federal Telecommunications Services - 2001 (FTS2001) contracts.

In FY2000, NISN will continue to analyze commercial services for potential use in meeting NASA's expanding Mission Requirements. NASA will be adding services in support continued implementation of IFMP, CoSMO, ISS Phase II, National Oceanic and Atmospheric Administration (NOAA)-K, Earth Observation System, Advanced Composition Explorer (ACE), Advanced Earth Observing Satellite (ADEOS) and TRMM.

NASA Integrated Services Network (NISN) provides for the implementation, maintenance, and operation of the telecommunications services, control centers, switching systems, and other equipment necessary to provide an integrated approach to NASA communications requirements. NISN completed the transition of the NISN Video Teleconferencing Service to the General Services Administration's Federal Telecommunications Services (FTS) 2000 Switched Compressed Video Transmission Service (SCVTS). This video service is shared by several government agencies, provides connectivity to commercial video services such as those provided by Sprint and MCI, and is also compatible to desktop video systems. This transition standardizes NASA video teleconferencing service on the industry standard of voice activated switching, and provides greater access to non-NASA video systems.

NISN completed the transition of its transmission infrastructure for mission support routed data services to an Asynchronous Transfer Mode (ATM) infrastructure, provided by FTS2000 Network B vendor- Sprint. NISN has also expanded the use of this network from the originally planned eight locations to ten NASA locations. NISN and NASA Research and Education Network (NREN) continue to share these services, resulting in lower network infrastructure costs for NASA as a whole. In addition to commercialization of the transmission, NISN began several studies to strengthen its peering relationships at common network access points, such as the Chicago Network Access Point (NAP) and the Sprint NAP. These are in addition to existing connectivity to internet exchange points on both the west and east coast. These additional connections have increased NISN's access to other government and education locations. NISN is also participating in the development of the Next Generation Internet Exchange (NGIX) sites in conjunction with the Department of Defense, Department of Energy, and the industry provided Abilene network. This will allow network connectivity to many NASA partners without the installation of dedicated services. These peering relationships will greatly benefit the distribution of the Earth Observing System (EOS) data as well as provide connectivity to many of the ISS principle investigators. In FY 2000, NISN will continue to analyze commercial services for potential use in meeting NASA's expanding mission requirements.