A Summary of Space Flight Missions Supported by the Deep Space Network

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This article is a summary of all space flight missions that the Deep Space Network has supported, beginning with the Ranger Program and ending with the continuing coverage of the Voyager Program.

I. Introduction

The Deep Space Network (DSN) is managed and operated by the Jet Propulsion Laboratory under a NASA contract and has been since NASA was formed in 1958. The DSN is tasked to support all deep space planetary probes, including the lunar exploration.

Since the Ranger series in the 1960s the DSN has evolved to a highly sophisticated telecommunications and data acquisition network. The 26-meter antennas have been converted to 34 meters, and 64-meter antennas have been built at all complexes. The L-band systems were changed to S-band, with X-band now also being used on Voyager and Pioneer 12. Ranging systems were developed and are now used along with other techniques to determine exact spacecraft locations. Many other developments occurred during this period to support the requirements of future space flight missions.

II. The Programs

A. Ranger Program

The Ranger missions were a series of lunar probes to obtain pictures from different areas of the Moon, study space physics in transit, and analyze the human environment from a landed instrument package. The primary objective was the collection of preliminary information for scientific studies of possible landing sites for the NASA manned lunar program.

Several major technical advances were first used on Ranger. First, the spacecraft was fully stabilized in attitude, keeping a high-gain antenna pointed at Earth and solar cell panels aimed at the Sun, which was a technical challenge in the early 1960s. The second technical advance attempted, but not completed, was the landing of an instrument capsule on the lunar surface by means of a retrorocket.

B. Surveyor Program

The objective of these missions was the softlanding on the lunar surface of instrumented spacecraft capable of performing operations that would contribute scientific knowledge about the lunar surface. The Surveyors also returned data to explore landing sites in support of the Apollo Project.

C. Lunar Orbiter Program

These were photographic missions to obtain high-resolution pictures of the lunar surface while in orbit around the Moon.

The primary purpose was to search for and survey landing sites for the Apollo Project.

D. Mariner Program

This series of flight missions consisted of 10 different launches, of which three failed, that flew by Venus, Mars, Mercury, and orbited Mars. The objectives of these missions were to make interplanetary and planetary measurements consisting of the different science phenomena, and except for the first 2 Mariners, to return TV pictures of the different planets. The Mars Orbiter mapped the planet and returned data for site analysis for the Viking Landers.

E. Pioneer Program

The primary objective of the Pioneer 6 through 9 missions is to collect scientific data relative to interplanetary phenomena within a region approximately 0.8 to 1.2 astronomical units (AUs) from the sun. Phenomena of particular interest include the characteristics of electric and magnetic fields; electron density along the earth-spacecraft path; and temporal and spatial distribution of plasma, cosmic rays, high-energy particles, and cosmic dust.

The primary objectives of the Pioneer 10 and 11 missions are to conduct investigations of the nature of the Asteroid Belt, the physical characteristics of Jupiter and its immediate environment, and the interplanetary medium beyond the orbit of Mars and to the extreme of the spacecrafts' communications capabilities. Additionally, Pioneer 11 has a primary objective to investigate the physical characteristics of Saturn and its immediate environment.

The Pioneer Venus multiprobe spacecraft investigated the characteristics of the Venusian atmosphere down to the lowest scale height above the surface.

The Bus was retarded after the probes were released so that it did not enter the atmosphere until after completion of the probes' descent to the surface. In this way, the Bus acted as a frequency reference for an interferometric determination of the atmospheric wind effects on the probes during their descents.

The objectives of the Orbiter spacecraft were to conduct investigations of the characteristics of the upper atmosphere of Venus and the region about the planet. Additionally, the spacecraft performed radar altimetry and imaging of the planetary surface.

F. Helios Program

The objective of this mission was to place two solar orbiting spacecraft in highly elliptical orbits to achieve a perihelion of 0.3 AU and aphelion of 1.0 AU. With these trajectories the spacecraft were able to study the properties of the Sun at close range, and enable better understanding of the Sun's influence upon the Earth. One of the spacecraft is still active after 7 years in a changing thermal and radiation environment. This Program is a joint space venture between the Federal Republic of West Germany and the United States of America.

G. Apollo Program

This manned spacecraft mission was able to place the first men on the lunar surface. The DSN had a secondary role to the prime NASA tracking network, and was able to help support the Apollo 8 through Apollo 17 Missions.

H. Viking Program

The primary objectives of the Viking spacecraft were to study the planet Mars from orbit and the surface by the use of two Orbiters and two Landers. This was done while the Vikings took more than 10,000 pictures from orbit and the surface; conducted a search for microbial life; performed organic and mineralogical studies of the Martian soil; studied physical and magnetic properties of the soil; made daily weather reports and listened for seismic activity. An extended mission known as the Lander Monitor Mission (LMM) is still in operation. The primary objectives of the LMM are to continue radio science experimentation using Lander 1 as a radio source on Mars, to continue to monitor Mars' meteorology and to continue periodic picture taking of Martian terrain around Lander 1.

I. Voyager Program

The primary objectives of the Voyager Mission were to conduct exploratory investigations of the Jupiter and Saturn planetary systems and the interplanetary medium between Earth and Saturn. This was accomplished by two launches in 1977 on flyby trajectories that employ a Jupiter's gravitational assist to reach Saturn. The primary science objectives were to conduct comparative studies of the planetary systems of Jupiter and Saturn, including their environment, atmosphere, surface, and body characteristics. Additional objectives included the investigation of one or more satellites of each planet, the nature of Saturn's rings, and the interplanetary and interstellar media throughout the cruise phase of the mission. The Voyager Mission designs included one spacecraft, Voyager 2, which is using Saturn's gravitational assist to go on to a Uranus and a Neptune flyby.

III. Summary

All space flight missions previously described in this article are summarized in Table 1.

Table 1. Space flights supported by the Deep Space Network

Mission	Launch date	Objective	Results
Ranger 1	23 Aug 61	Lunar flyby	Decayed in Earth orbit
Ranger 2	18 Nov 61	Lunar flyby	Decayed in Earth orbit
Ranger 3	26 Jan 62	Soft land seismometer	Passed within 22,862 miles
Ranger 4	23 Apr 62	Soft land seismometer	Impacted on backside
Ranger 5	18 Oct 62	Soft land seismometer	Passed within 450 miles
Ranger 6	30 Jan 64	Lunar photo-impact	TV system failed
Ranger 7	28 Jul 64	Lunar photo-impact	Returned 4316 photos
Ranger 8	17 Feb 65	Lunar photo-impact	Returned 7137 photos
Ranger 9	21 Mar 65	Lunar photo-impact	Returned 5814 photos
Surveyor 1	30 May 66	Lunar soft landing	Successful engineering flight; over 11,000 photos
Surveyor 2	20 Sep 66	Lunar soft landing	Failed due to vernier engine
Surveyor 3	17 Apr 67	Lunar soft landing	Made 3-bounce landing, measured surface bearing; 6326 photos
Surveyor 4	14 Jul 67	Lunar soft landing	Lost during retro maneuver
Surveyor 5	8 Sep 67	Lunar soft landing	Provided soil analysis; over 19,000 photos
Surveyor 6	7 Nov 67	Lunar soft landing	Performed first lateral hop; over 30,000 photos
Surveyor 7	7 Jan 68	Lunar soft landing	Scientific exploration of a highland region; 21,038 photos
Lunar Orbiter 1	10 Aug 66	Equatorial orbit	Photographed complete equatorial belt of Moon for Apollo. First Earth pictures from deep space
Lunar Orbiter 2	6 Nov 66	Equatorial orbit	
Lunar Orbiter 3	5 Feb 67	Equitorial orbit	
Lunar Orbiter 4	4 May 67	Polar orbit	Photographed approximately 98% of lunar surface
Lunar Orbiter 5	1 Aug 67	Polar orbit	
Mariner 1	22 Jul 62	Venus flyby	Destroyed by range safety officer
Mariner 2	27 Aug 62	Venus flyby	Passed within 21,594 miles
Mariner 3	5 Nov 64	Mars photo flyby	Shroud failed to separate
Mariner 4	28 Nov 64	Mars photo flyby	Returned 22 photos
Mariner 5	14 Jun 67	Venus flyby	Obtained atmospheric, ionospheric, other data
Mariner 6	24 Feb 69	Mars flyby	Studied surface and atmosphere: returned TV images
Mariner 7	27 Mar 69	Mars flyby	Studied surface and atmosphere: returned TV images
Mariner 8	8 May 71	Mars orbiter	Failed to achieve Earth orbit
Mariner 9	30 May 71	Mars orbiter	Mapped nearly all of planet's surface; determined landing sites for Viking
Mariner 10	3 Nov 73	Venus/Mercury flyby	Studied clouds of Venus, returned TV images of Mercury: first to use gravity of one planet as aid in reaching another

Table 1 (contd)

Mission	Launch date	Objective	Results
Pioneer 6	16 Dec 65	Investigation of interplanetary environment	Obtained data on solar flares, solar wind, interplanetary particles and fields
Pioneer 7	17 Aug 66	Investigation of interplanetary environment	Obtained data on solar flares, solar wind, interplanetary particles and fields
Pioneer 8	13 Dec 67	Investigation of interplanetary environment	Obtained data on solar flares, solar wind, interplanetary particles and fields
Pioneer 9	8 Nov 68	Investigation of interplanetary environment	Obtained data on solar flares, solar wind, interplanetary particles and fields
Pioneer 10	2 Mar 72	Jupiter flyby	Studied Jovian system, asteroid belt, and heliosphere
Pioneer 11	5 Apr 73	Jupiter-Saturn flyby	Made additional studies of Jovian system; reached Saturn with assist from Jupiter's gravity
Pioneer 12	20 May 78	Venus Orbiter	Studied Venusian atmosphere from orbit
Pioneer 13	8 Aug 78	Venus atmosphere probes	Studied Venusian atmosphere via 4 decending probes and instrumented carrier
Helios 1	10 Dec 74	Heliocentric orbiter	Studied Sun from an orbit near center of solar system
Helios 2	16 Jan 76	Heliocentric orbiter	Studied Sun from an orbit near center of solar system
Apollo 8	21 Dec 68	Manned circumlunar flight	Command-service module orbit of Moon. Returned TV pictures of surface
Apollo 9	3 Mar 69	Manned Earth orbiter	First flight of lunar module. First Apollo EVA, live TV
Apollo 10	18 May 69	Manned circumlunar flight	First lunar module orbit of Moon. First color TV from space
Apollo 11	16 Jul 69	Manned lunar lander	First landing. Obtained surface samples, performed EVA and surface experiments, live TV
Apollo 12	14 Nov 69	Manned lunar lander	Second landing. Placed experiments package on surface, returned parts from Surveyor 3, obtained surface samples
Apollo 13	11 Apr 70	Manned lunar lander	Service module oxygen tank rupture. Crew returned safely to Earth after flight around Moon
Apollo 14	31 Jan 71	Manned lunar lander	Third landing. Returned surface samples, performed experiments
Apollo 15	26 Jul 71	Manned lunar lander	Fourth landing. First use of Rover vehicle, obtained surface samples
Apollo 16	16 Apr 72	Manned lunar lander	Fifth landing. Obtained surface samples, performed experiments, explored with Rover vehicle

Table 1 (contd)

Mission	Launch date	Objective	Results
Apollo 17	7 Dec 72	Manned lunar lander	Sixth landing. Obtained surface samples, performed experiments, explored with Rover vehicle
Viking 1 Orbiter	20 Aug 75	Mars Orbiter	Studied Martian surface and atmosphere from orbit; relayed Viking Lander data to Earth
Viking 2 Orbiter	9 Sep 75	Mars Orbiter	Studied Martian surface and atmosphere from orbit; relayed Viking Lander data to Earth
Viking 1 Lander	20 Aug 75	Mars Lander	Studied surface conditions; analyzed soil; returned TV images of landscape
Viking 2 Lander	9 Sep 75	Mars Lander	Studied surface conditions; analyzed soil; returned TV images of landscape
Voyager 1	20 Aug 77	Jupiter/Saturn flyby	Studied two planetary systems; returned TV images including Jupiter's Red Spot, Saturn's rings, and many satellites
Voyager 2	5 Sep 77	Jupiter-Saturn flyby	Studied two planetary systems; returned TV images including Jupiter's Red Spot, Saturn's rings, and many satellites