Voyager Interstellar Mission

**Mission Need** – The original mission of both Voyager 1 and 2 was to make intensive flyby studies of Jupiter and Saturn with the option of flying by Neptune and Uranus. After the mission was successful in collecting valuable data from Jupiter and Saturn, the mission need was officially extended to explore Neptune and Uranus. Once the flybys of Neptune and Uranus were completed, the need was again changed to a more general “interstellar exploration”.

**Mission Goals** – The original mission goal was to take as many measurements of Jupiter and Saturn as possible. The other goal was to take pictures of the two planets. These goals were derived from the mission need by the desire to measure and learn as much as possible while doing a flyby of both Jupiter and Saturn.

**Mission Objectives** – The objectives were to collect useful interplanetary/interstellar fields, particles, and wave science using the ten sensors on-board. Specifically, there are five teams of scientist using the data collected on the magnetic field, low energy charged particle, plasma, cosmic ray, and plasma wave investigations. The descriptions of each investigator teams are found below:

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| --- | --- |
| Plasma Science | Properties and radial evolution of the solar wind (ions 10 eV - 6 keV, electrons 4 eV-6 keV) |
| Low-Energy Charged Particles | Energy spectrum of low-energy particles (electrons 10-10,000 keV, ions 10-150,000 keV/n) |
| Cosmic Ray Sub-system | Energy spectrum of high- and low-energy electrons (3-110 MeV) and cosmic ray nuclei (1-500 MeV/n) |
| Magnetometer | High (50,000 - 200,000 nT) and low (8-50,000 nT) magnetic field intensity |
| Plasma Wave Subsystem | Electrical field components of plasma waves in frequency range of 10 Hz to 56 kHz |

Table 1: Investigator information found on the Voyager NASA website (2)

There was also an objective to take several pictures during the flybys and to transmit the data collected back to Earth using the Deep Space Network.

**Primary Mission Description** – The primary mission was to collect as much data as possible from both Jupiter and Saturn with the possibility of extending the mission to a Neptune and Uranus flyby. Since all of these missions were successful, the primary mission was again extended to explore deep interstellar space and transmit whatever findings possible back to earth.

**Assumptions** – There were probably several assumptions made for this mission, but there wasn’t any discernible information about them in the information and descriptions available. The only partial assumption that was made was the fact that the satellite may only last 5 years, which was long enough to do a flyby of Saturn and Jupiter, but this is more of a design feature than an assumption. If the launch was coordinated a few years earlier, there could have been a large decrease in the time it took to reach interstellar space and the assumption would be a perfect alignment of planets in such a way that would give a large gravity delta v boost. This was partially used for this mission, but not to the extent that required major assumptions of planet alignments.

**Authority and Responsibility** – The Authority and Responsibility of the overall mission was given to NASA/JPL. JPL built the spacecraft and is still operating both satellites. The voyager missions are part of the NASA Heliophysics System Observatory, which is a division of the Science Mission Directorate in Washington. There are also five teams in charge of specific data sets coming in from the satellites. The stakeholders were the American public, as this was a scientific mission funded by the American tax dollars. They are listed below:

|  |  |
| --- | --- |
| Plasma Science | John Richardson from The  Massachusetts Institute of Technology |
| Low-Energy Charged Particles | Stamatios M. Krimigis from Johns Hopkins University |
| Cosmic Ray Sub-system | Edward C. Stone from California Institute of Technology |
| Magnetometer | Norman F. Ness from The University of Delaware |
| Plasma Wave Subsystem | Donald Gurnett from  University of Iowa |
| NASA JPL Voyager Project manager | Suzanne Dodd of JPL |

Table 2: Responsibility table for each investigator team.

**Constraints** – There was a large constraint in cost due to the expansion of the mission’s scope; Initially intended to only complete a flyby of Jupiter and Saturn, the goal to expand the mission towards exploration of interstellar space drastically increased the need for additional funds. Scheduling launches was an additional constraint, as there was a need to have a specific trajectory at a specific time when the planet was going to be there. A more recent constraint on the satellites is power. The diminishing energy sources have required that some sub-systems be turned off in order to keep collecting data in order to communicate it back to Earth. At the current rate (including scheduled power limitation dates), it is expected to have sufficient power to communicate back to Earth through 2020, possibly extending as long as 2025.

**Concept of Operations**:

**Narration of the ConOps**:

The Voyagers will be launched several weeks apart, then proceed with system checkouts. Both spacecrafts will then take measurements and pictures on the way to Jupiter, while sending data back to earth. The spacecrafts will then make their closest approach to Jupiter a few weeks apart around the 2 years from the initial launch, each taking measurements and pictures of the planet. The satellites will then proceed to Saturn, which will take a little over a year to make the trip. Once there, both satellites will again take as many measurements and pictures as possible, sending them back to Earth through the Deep Space Network. While the data is collecting back on Earth during the whole mission, scientist will have the measurement data in order to start analysis. This will be a separate process and not impede the data collection process at all. If this part of the mission is a success and the spacecraft has sufficient power, then the spacecraft will proceed to Uranus and Neptune for more data collection.

**Bibliography**:

(1) "Voyager - OPERATIONS PLAN TO THE END OF MISSION." *Voyager - OPERATIONS PLAN TO THE END OF MISSION*. N.p., n.d. Web. 17 Sept. 2013. <http://voyager.jpl.nasa.gov/science/thirty.html>.

(2) "NEWS & ARCHIVE." *Voyager*. N.p., n.d. Web. 17 Sept. 2013. <http://voyager.jpl.nasa.gov/news/factsheet.html>.

(3) "Space, Stars, Mars, Earth, Planets and More - NASA Jet Propulsion Laboratory." *Space, Stars, Mars, Earth, Planets and More - NASA Jet Propulsion Laboratory*. N.p., n.d. Web. 17 Sept. 2013. <http://www.jpl.nasa.gov/>.