Press Release
For immediate release

NASA's Curiosity Rover Maximizes Data Sent to Earth by Using International Space Data Communication Standards

WASHINGTON, 22 August 2012 (CCSDS) – NASA's Mars Science Laboratory (MSL) mission began its planned 2-year Mars surface exploration mission on August 6 after landing its large, mobile laboratory called Curiosity. The goal of the mission is to assess whether Mars has ever had, or still has, environmental conditions favorable to microbial life.

Curiosity, with its one-ton payload carrying capacity carries 10 science instruments that will gather samples of rocks and soil, and process and distribute them to onboard test chambers inside analytical instruments. Some of the rover's scientific data, including images of the surface of Mars collected by Curiosity's 17 onboard cameras, are sent directly to and from Earth via NASA's Deep Space Network (DSN) of large ground antennas. However, once Curiosity becomes fully operational most of the scientific and engineering data will be transferred via relay satellites that are in orbit around Mars. These are primarily the Mars Reconnaissance Orbiter (MRO) and the Mars Odyssey (ODY) spacecraft. The MSL Mars-Earth communications systems are using internationally-agreed space data communications standards to enable reliable transmission of the expected rich data sets to be gathered by Curiosity. These standards were developed by a team of international space data communication specialists collaborating within the Consultative Committee for Space Data Systems (CCSDS). Use of internationally-agreed upon standards reduce cost and risk to space missions, and also offer rich "cross-support" capabilities to collaborate since key data interfaces are inherently interoperable.

For Curiosity, the CCSDS data standards facilitate straightforward, reliable, and robust data transfer through weak-signal relay or direct-to-Earth space links, in addition to the cross-support capability of using the European Space Agency's (ESA) Mars Express Orbiter which relays to and from Earth via ESA's deep space tracking network, ESTRACK.

Standards facilitate the maximum amount of data to reach the scientists and public during the brief data transmission windows that are available each day. Since Mars and the Earth are both rotating on their axes, the rover and the relay satellites are only periodically visible from Earth and to each other making direct-to-Earth communications limited to brief opportunities. Additionally,

communicating directly between Earth and Mars requires large amounts of power since the radio signals have to penetrate the Martian atmosphere, traverse millions of miles of deep space, and then reach a ground station through the Earth's atmosphere. The Curiosity rover has limited power and its signals received on Earth are very weak, noisy and convey data at a low rate of delivery.

Data relay operations offer a whole new vista of communications capabilities, since the rover only needs to be able to communicate with an orbiter that is a short distance away in Mars orbit. If the rover can see the orbiter and the orbiter can see the Earth, real-time operations are possible. If the orbiter cannot see either, then the communications systems employ a "store-and-forward" mode of communications whereby the spacecraft data streams are buffered in the orbiter's memory until a direct link to the Earth or the Martian surface can be established. The workhorse data communications standards for Curiosity consist of two major groups:

- "Long haul" communications directly to and from Mars.
- "Proximity" communications between the orbiter and the Martian surface.

The long-haul standards are the internationally-agreed CCSDS "Packet Telemetry" and "Packet Telecommand", which respectively permit the fully-standardized communication of spacecraft measurement and control information. These protocols have been specifically tailored to provide very high performance over weak, long-delay radio channels.

Proximity communications are accomplished using special NASA and ESA UHF radios on the orbiters, each optimized for short-delay, short-contact communications passes between orbiter the surface. These radios implement the CCSDS Proximity-1 Space Link Protocol (Prox-1), which is central to the data return strategy of Curiosity. The rover expects to relay over 95% of its telemetry using Prox-1 via the Mars Reconnaissance Orbiter (MRO) or Mars Odyssey.

The MSL mission will demonstrate new Adaptive Data Rate (ADR) data return technology over Prox-1, which allows for up to an average 50% greater telemetry return over the life of the mission by monitoring the signal strength between the MRO and Curiosity and then adapting the rover's data transmission rate to maximize the throughput. In addition, Prox-1 will be built into the UHF radio for the next NASA Mars orbiter called MAVEN, which is planned for launch in 2014, as well as the European Space Agency's (ESA) 2016 orbiter, providing on-going mission-to-mission cross-support at Mars.

CCSDS data standards are also used in the MSL Operations Center in the Jet Propulsion Laboratory in Pasadena, Calif. NASA's Advanced Multi-Mission Operations System (AMMOS) provides standardized, multi-mission tools and services to missions, including MSL, to reduce operation costs while providing higher reliability and performance than would be the case if the mission acquired their own unique tools and services. AMMOS and Curiosity are together utilizing a set of 11 CCSDS data standards for telemetry processing and for sending commands to Curiosity.

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About CCSDS

Established in 1982 by the world's most influential space agencies, the Consultative Committee for Space Data Systems (CCSDS) provides well-engineered international space data handling standards that enhance government and commercial interoperability and cross-support, while also reducing risk, project cost, and development time.

A pioneer in international cooperation in space, CCSDS is made up of leading space communications experts representing 30 countries, its founding member space agencies, 28 observer space agencies, and over 140 private companies. CCSDS members include national space agencies from Japan, the United Kingdom, France, Germany, Italy, Brazil, Russia, Canada, China, and the United States, as well as the multinational European Space Agency.

To date, more than 500 missions to space have chosen to fly with CCSDS protocols and the number continues to grow. For more information on participation or to access CCSDS standards and protocols free of charge, please visit www.CCSDS.org.

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