DESERT RESEARCH AND TECHNOLOGY STUDIES (D-RATS) 2010 MISSION OVERVIEW. B. A. Romig[1] and J. J. Kosmo[1], [1]EC, NASA Johnson Space Center, Houston, TX 77058.

Introduction: Desert Research and Technology Studies (Desert RATS) is a multi-year series of test activities of hardware and operations that are carried out annually in the high desert area of northern Arizona. Conducted since 1997, these activities are designed to exercise prototype planetary surface hardware and representative mission scenario operations in relatively harsh climatic conditions where long-distance, multi-day traversing activities are achievable. Such activities not only test vehicle subsystems through extended rough-terrain driving, they also stress communications and operations systems and allow testing of science operations approaches that will advance human and robotic surface exploration capabilities. Desert RATS is a venue where new ideas and emerging technologies can be tested, both individually and as part of an integrated mission operation with multiple elements. By conducting operations that test hardware over multiple yearly cycles, ideas that "make the cut" on a given year can be iterated, improved, or enhanced and then subsequently integrated into testing during the follow-on years. This ultimately enables both the hardware development maturity time and the technical personnel hands-on "lessons learned" experience in the kind of multi-element integrated operations that will be necessary for future human planetary exploration.

2010 was the thirteenth year of D-RATS remote field analog testing activities. This was the third year in a row at Black Point Lava Flow near Flagstaff, Arizona. The team consisted of about 200 engineers, scientists, and mission planners from eight NASA centers and academia. There were about 120 people in the field during the 14-day traverse, about 40 of which were planetary scientists on the science strategic and tactical teams. Ten primary hardware elements about about thirty technologies were successfully tested and demonstrated during the mission.

Field Test Overview: Desert RATS 2010 tested two crewed rovers designed as first generation prototypes of small pressurized vehicles. Each rover provided the internal volume necessary for crewmembers to live and work for periods up to 14 days, as well as allowing for extravehicular activities (EVAs) through the use of rear-mounted suit ports. The 2010 test was designed to simulate geologic science traverses over a 14-day period through a terrain of cinder cones, lava flows and underlying sedimentary units. Prior to the test, a series of traverses were planned using techniques that were first developed during Apollo [Hörz and Gruener, LSPC 2010]. These traverses were based on a photogeologic interpretation of air photo and satellite images conducted by the U.S. Geological Survey Branch of Astrogeology in Flagstaff. They were designed to simulate a reconnaissance investigation of a planetary surface with a variety of communications constraints. Predicted communications coverage was overlaid on the planned traverses [Seibert and Downs, LPSC 2010] and geological stations were adjusted to ensure communications supported the planned test conditions (e.g., continuous communications operations) during each day of the test. The resulting set of traverses and stations were then field checked by the applicable test team leads to ensure compliance with planned test conditions.

Conduct of the actual test took place between 31 August and 13 September 2010. Two crewmembers lived in and drove each rover for a single week with a "shift change" on day 7, resulting in a total of eight test subjects for the two week period. Each crew consisted of an engineer/commander and an experienced field geologist. Three of the engineer/commanders were experienced astronauts with at least one Space Shuttle flight. The field geologists were drawn from the academic community. Three of the crews were male, with the fourth crew being female.

The rovers were tested in different communications and operations states. Three days of each week were tested with the rovers in continuous communications with mission operations team, and three days were tested with communications only for ≈1 hour in the morning and ≈1 hour at the end of the traverse day.

Primary Test Objectives and Hypothesis: There were two primary objectives for the 2010 test: 1) Understand differences in productivity for crew operations and ground support with continuous communication and twice-a-day communication and 2) Evaluate and compare two different operations concepts: a) Lead and Trail and b) Divide and Conquer. During twice-a-day communication, communication was established with "Earth" (mission operations and science support rooms) at the beginning and end of each day, and data was sent to Earth overnight while the crew slept. In the Lead and Trail mode of operation, the rovers operated within close proximity of each other, exploring the same geological terrain using routes and stations that were highly complementary. There was no more than 1-2 km of separation, mostly within line of sight, but not always. In the Divide and Conquer mode, the rovers were separate from each other to explore geologically separate areas. Communications repeaters were used as needed to maintain communication between rovers, and each rover had continuous communication with Earth.

The hypothesis was that there would be no significant difference in productivity between any of the communications or operational concept modes. Comparing communication modes is important because there is potentially significant cost and/or operational implications in maintaining continuous communication between Earth and the rovers. Additionally, we need to learn how to operate without real-time support from Earth, which will not be available for exploration to some destinations other than the moon.

Major Accomplishments: The two rovers conducted a coordinated traversed over a 14-day period and a combined distance of 305 km over the duration of the field test (this distance includes "unmanned span" operation, the 14-day traverse, and pre- and post-mission checkout and demonstrations). Rover A traversed 140 km; Rover B traversed 165 km.

Figure 1. Dual Rover Traverse Routes in 2010

Figure 2. Both Rovers on a Traverse

The Centaur 2 chassis conducted an engineering assessment and evaluation of its systems and other payloads.

The pair of Tri-ATHLETE (All-Terrain Hex-Limbed Extra-Terrestrial Explorer) robots conducted a long-distance traverse (about 60 km) and rendezvous with rover overnight locations during the 14-day mission.

The Habitat Demonstration Unit (HDU) in the Pressurized Excursion Module (PEM) configuration went through an engineering assessment and evaluation, as well as demonstrated many technologies. The Geo-Science Lab was used during integrated testing with the rover crew.

Figure 3. Two Rovers Docked to the HDU/PEM

The science team conducted expanded operations with strategic and tactical teams located at the base camp and in Flagstaff.

Extra Vehicular Activities (EVAs) were conducted from the rover suit ports, utilizing shirtsleeve backpacks and a suite of geology tools.

Expanded Education and Public Outreach (EPO) activities were conducted to inform and engage the public. A participatory exploration exercise where the public voted to choose an area to explore was very successful. VIP/Media and student visitation days were held at the end of the field test.

The team is still analyzing test data and drawing conclusions for final reporting.

Forward Planning: Plans are being developed for the next D-RATS field test in August/September 2011. Operations will be conducted under a Near Earth Object (NEO) mission architecture using a rover and HDU in the Deep Space Habitat (DSH) configuration. The Deep Space Network (DSN) communication system will be mimicked to limit bandwith and simulate space-to-ground communication delays. Robotic systems will also be operated remotely and under time delay. The science backroom may be located at a different site, e.g. the Johnson Space Center, where data could then be shared with scientists located around the world at their respective country's space agency location.