Lunar Robotics
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- A look at the Constellation Lunar Architecture
  - Where can Robotics Play a Role?

- Turning those Concepts into Reality
  - NASA’s ETDP Human Robotics Systems Program
Lunar Architecture Campaign Level View
(Trade Set 1 ICP with integrated ATHLETE legs)

Cumulative Days on Surface

- Crew Size
- Mission Duration

1437 total surface days

Notes:
- Unpressurized, Liquid, & Gas carriers not shown
- Each Crewed Lander & Flight 1 has 500 kg of Science
- ICP/SA includes 2 kW of net power generation
- ICP/LA includes 10 kW of net power generation

Outpost Phases – A1

Test & Reconnaissance
Minimum Habitation Capability & Human Return to the Moon
Enhanced Mobility
Extended Mobility
Long Duration Outpost Capability
Outpost Phases – A2

Test & Reconnaissance  Minimum Habitation Capability & Human Return to the Moon  Enhanced Mobility

Extended Mobility  Long Duration Outpost Capability

Lunar Outpost Surface Systems

- 2 kW Array (net)
- 10 kW Array (net)
- Integrated Cargo Pallet (ICP) (Supports / scavenges from crewed landers)
- Habitation Element
- Logistics Pantry
- Common Airlock with Lander
- ISRU Oxygen Production Plant
- Unpressurized Rover
- ATHLETE Mobility System (2)
- Small Pressurized Rover (SPR)
- ICP (Facilitates SPR docking & charging)
Architecture Concept – Mobile Habitat

- <20,000 Kg Payload
- Integrated Power
- Docking Together
- 1000+ Km Range

Architecture Concept – Small Pressurized Rover

- Fast Out the Door
- Radiation Protection
- Hatch Docking
- 100+ Km Range
NASA’s Exploration Technology Development Program

Turning the Cartoons into Reality
The Players

HRS
Technology Description (ATHLETE)

- Leadership
  - NASA JPL
  - B. Wilcox

- Technologies
  - Wheel-on-limb Mobility
  - Mobility & manipulation
  - Active suspension
  - Payload offloading
  - Habitat docking
  - Hatch mating

- Collaborations
  - Stanford (Latome)
  - Michelin (Switzerland)
### HRS Technology Description (Chariot)

- **Leadership**
  - NASA JSC
  - Ambrose, Bluethmann, Junkin

- **Technologies**
  - Novel chassis kinematics
  - Active/Passive suspension
  - Upright crew accommodations
  - Chassis leveling
  - Small Pressurized Rover Ops

- **Collaborations**
  - ETDP Advanced Suits
  - ETDP Thermal Control
  - ETDP ISRU
  - ETDP Power

### HRS Technology Description (Centaur)

- **Leadership**
  - NASA JSC
  - Ambrose, Diftler, Bluethmann

- **Technologies**
  - Autonomous Manipulation
  - Dexterity
  - Mobile Manipulation
  - Time Delayed Supervision
  - Astronaut Assistance
  - Surface Science

- **Collaborations**
  - UMass (Grupen)
  - MIT (Brooks)
  - Vanderbilt (Peters)
  - Many earlier grants
HRS Technology Description (K-10)

- **Leadership**
  - NASA ARC
  - Fong, Deans

- **Technologies**
  - Site survey sensing
  - Remote supervision
  - Mapping & prospecting

- **Collaborations**
  - Ball Aerospace
  - CMU

HRS Technology Description (Scarab)

- **Leadership**
  - NASA GRC & CMU
  - Whittaker, Caruso

- **Technologies**
  - Novel chassis kinematics
  - Integrated drill
  - Wheel spikes for drilling
  - Dark navigation

- **Collaborations**
  - CMU
  - NorCat
  - ETDP ISRU
Surface Scenario Video (2 minute)

Plans for FY08

- June 2008 Field Test
  - Desert West
    - Nevada, Washington, California
  - Architecture Landings
    - Landers 1, 2, 3 & 6
- October 2008 Field Test
  - Desert West
  - Architecture Landings
    - Landers 4 & 5
    - Long Range Excursion w/ Crew
- November 2008
  - Hawaii
  - ISRU Evaluations
    - O2 Production from Regolith
    - Prospecting
HRS Team
(7 NASA Centers and 10+ Companies)