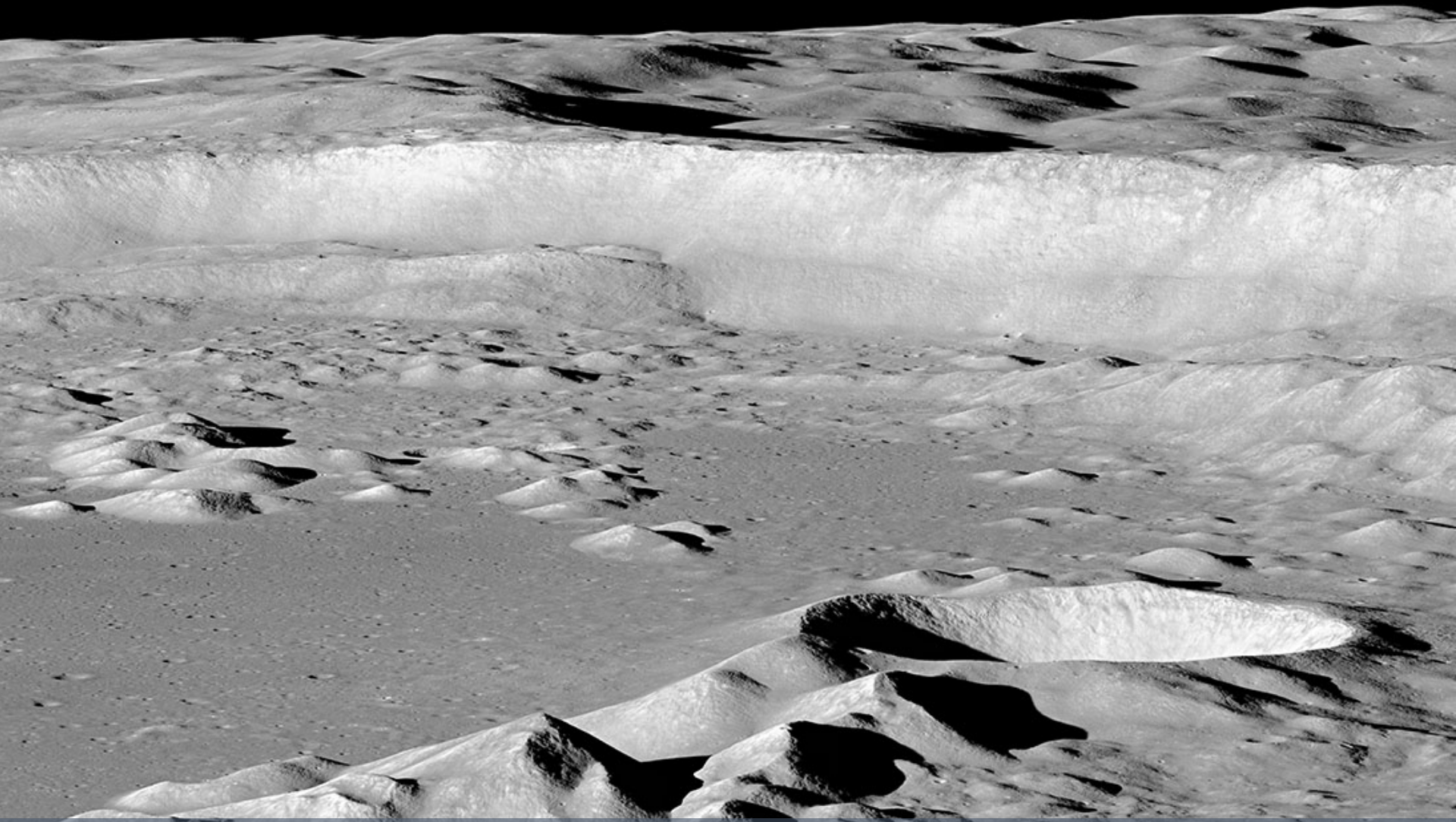
2018 Workshop on Autonomy for Future NASA Science Missions

Design Reference Mission for Lunar Surface Exploration



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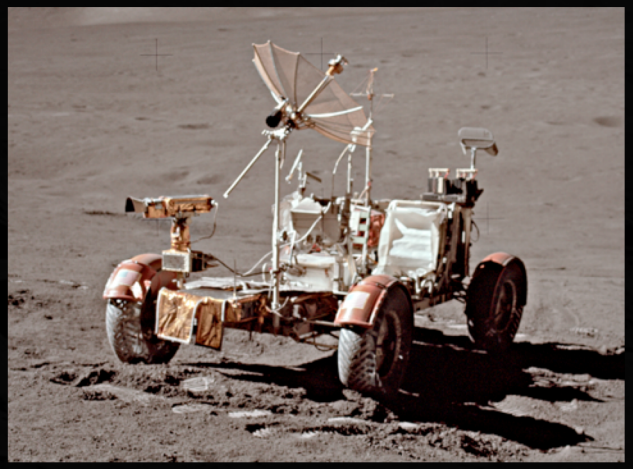
Lunar Exploration

- The Moon is an accessible target and an ideal location to demonstrate new technologies
- Recent mission results:
  - The Moon is more exciting than we thought
  - There is still more to learn (volatiles, volcanism, impact processes, tectonics, etc.)
- Future surface missions can provide much needed ground truth
- Automation will enhance future missions and enable exploration of extreme environments
  - Long duration / high speed rover
  - Robotic swarm to examine volatiles (ISRU)
  - Examine lunar caves with propelled robots

Lunokhod 2, 840 kg
Average speed 0.19 km/h

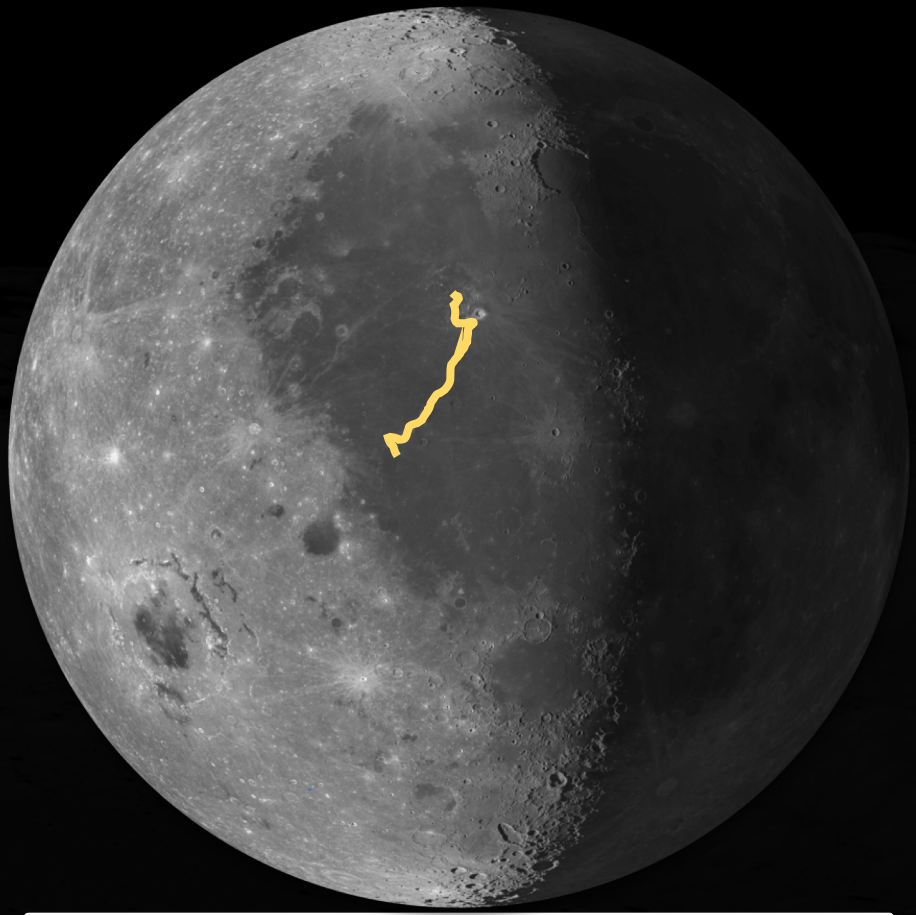


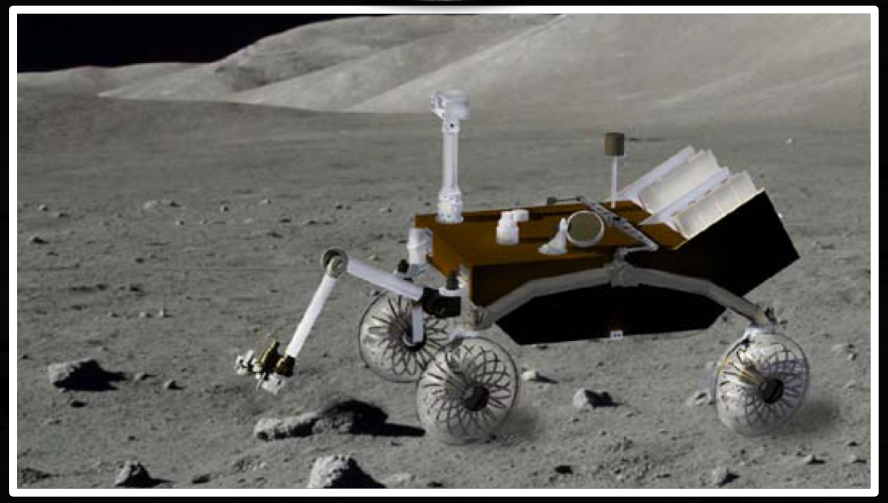
Apollo LRV 210 kg
Average speed 9 km/h

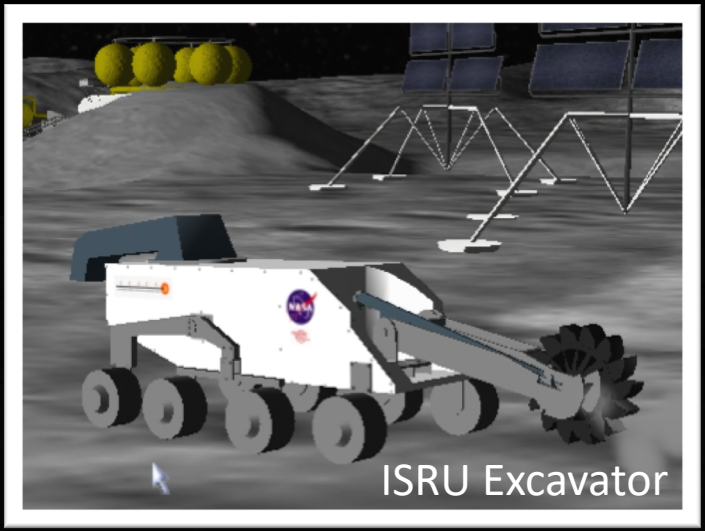
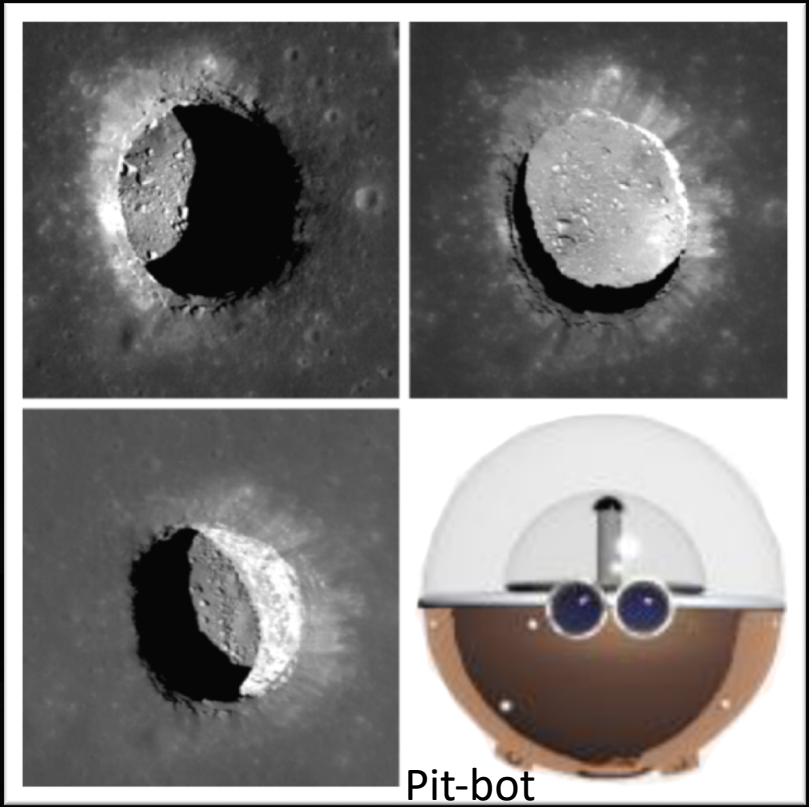
Lunar DRM (1)

Long-Lived / High-Speed Rover

- Investigate 4-5 major geologic terrains, 20+ major over two-year nominal mission
- Operate during daylight each month and cover ~1900 km
- Collect measurements while in motion, short duration stops, and during long duration stops
- Demonstrate technology required for future exploration of the Moon and other terrestrial bodies
    - Precision landing
    - Teleoperations
    - Autonomous driving at high speeds (1 km/hr) for sustained periods (>4hrs)
    - On board decision-making
    - Enhance human capabilities in joint exercises





Lunar DRMs

- "Swarm" of rovers/hoppers to locate volatiles in the polar regions
  - Need for real time decision making
  - Mother/daughter task management
  - Limited direct to Earth communication
  - Time sensitive measurements and experiments
- ISRU Excavator
  - Autonomous navigation and hazard avoidance
  - Process monitoring and control
- Lunar Cave Explorer
  - Precision landing/hazard avoidance
  - Flying payload (autonomous navigation)