Autonomy Drivers

- Cost of manned missions
- Light delays and bandwidth limitations
- Chaotic, uncertain environments
- Increasing mission complexity
**Mission Driver: Robotic Exploration of Mars**

*Sojourner (1997)*
- Mission Duration: 30 days
- Total Traverse: 100 meters
- Meters/Day: 3-10
- Science Mission: single instrument

*Mars Exploration Rover (2004)*
- Mission Duration: 90 days
- Total Traverse: 60-1000 meters
- Meters/Day: 100
- Science Mission: 5 instruments + rock abrasor

*Mars Smart Lander (2009)*
- Mission Duration: 1000 days
- Total Traverse: 3000-69000 meters
- Meters/Day: 230-450
- Science Mission: 7 instruments, sub-surface science package (drill, radar), in-situ sample “lab”
Mission Driver: Titan Aereobot

1. Cruise to area of interest at high altitude
   Wind speeds are too high to move against: must find stream going right way and ‘ride it’; may require moving up or down to find the right stream. Also need to discern absolute position of aerobot.

2. Cruise at low altitude
   Descend to where wind speeds are 1-2kph so that aerobot can drive against winds. Terrain hazards may extend through this ceiling, so need to avoid hazards. Max speed at this altitude is 1-2kph.

3. Explore for science targets
   Identify potential targets with remote sensing at low altitude. May decide to approach immediately or wait to see more and return later.

4. Anchor & acquire sample
   - Anchor at site
   - Acquire sample
   - Process sample
Autonomy Research Area: Limited Contingency Planning

Just in Case Planning

1. Seed plan
2. Identify best branch point
3. Generate a contingency branch
4. Integrate the branch
Autonomy Research Area: Limited Contingency Planning

Visual servo (-2, -.15)  Dig(60)  Drive (-2)  NIR  V = 100

Condition?  Utility?  Goals?

Possible Goals

Plan Graph

Utilities: V = 100, V = 5, V = 15, V = 50, V = 25

Resources

Utility

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Autonomy Research Area: Verification and Validation

- V&V is extremely important for confidence building
- Field tests are expensive and do not represent the environment on other planets
- High fidelity simulation is a critical part of V&V both before and during the mission
Autonomy Research Area: Onboard Processing Limitations

- Obstacle avoidance
- Science autonomy
- Diagnosis
- Planning and scheduling