Executing Geologic Science with Long Latency Robotic Assets
What’s the point?

- **Goal:** Get the highest-quality science out of our field work on another planet.
- **Objective here:** Determine the best science operations architecture to accomplish this.
- **Latency** is one of the variables that feeds into that architecture.
Outline

• Context, definitions, boundaries
• A nominal planning cycle
• Off-nominal planning cycle
• Benefits and challenges
Key Points

• Time and space are required to do high-quality science
• Human/non-science factors play a crucial role in determining the effects and importance of long latency
Context — MSL Curiosity

• Science operations is a complete system to be tested.
• MSL science ops is based on MER but is more complex
• MSL also has a different science focus: exploring a site for signs of habitability
Long latency

- Latency is the time required for a command cycle

- Mars has a long latency
Definitions

- Sol
- Tactical vs. strategic
- Pass
- Science Block
- Contact Science
Science Operations — Resources

Science instruments

Power

Communications

Arm/turret

Mobility
Science Operations — the lead-up

Timescale

Resources

Activity

Science discussions

Strategic planning

Pre-tactical planning

Current sol plan

Role
Science Operations — the lead-up

Timescale
- Weeks to months

Resources
- Orbital data
- Knowledge of spacecraft health

Activity
- Science discussions
- Strategic planning
- Pre-tactical planning
- Current sol plan

LTPs
Science Operations — the lead-up

Timescale

Days to weeks

LTPs, PULs

Resources

In situ data
Sense of spacecraft position, sol timing

Activity

Science discussions
Strategic planning
Pre-tactical planning
Current sol plan
Science Operations — the lead-up

Timescale

Resources

Activity

1-2 days

STLs, PULs, SC

Actionable data
Notional sense of DV, time, power

Science discussions
Strategic planning
Pre-tactical planning
Current sol plan
Science Operations — Sol n

Timescale

Resources

Activity

- Science discussions
- Strategic planning
- Pre-tactical planning
- Current sol plan

Sol n

- STLs, PULs, SC

Actionable data
Power, DV, Time finalized
Science Operations — A nominal day

Science-driven

Science delivery

SOWG Meeting

Engineering-driven

Sol n+1 Kickoff

Science Discussion
Science Operations — Off-nominal day

• Challenge with long latency
• Usually three outcomes:
  – Stand-down
  – “Groundhog’s Day”
  – Plan B

• Effect on science: mixed
Now that we know what long latency looks like in action, what does it mean for science output?
Benefits — A big team with lots of experience
**Benefits**

- Natural stopping points mean that systematic data collection is easier.

**Systemic**
throughout the whole system

**Systematic**
methodic or according to a plan

[Keck Institute for Space Studies Logo]
Benefits

- Built-in time for science to "happen"
Challenges

• Long latency means that even simple faults can cause (sometimes significant) loss of science data.

I’m not going anywhere until you figure out what’s wrong!
Challenges

• Tactical planning means scientists still must work counter to training
Challenges

• Non-science factors
  – Initial makeup of operations team (science and engineering)
  – Day-to-day makeup of operations team (science and engineering)
  – Logistical factors (scheduling, holidays, schedule changes due to anomalies, etc.)
Summary

• Long latency provides *some* of the time and space required to do high-quality science.
• Human/non-science factors undercut some of the benefits of long latency.
• Problems can take longer to diagnose and correct.
Backup slides
The first selfie
Follow Curiosity!

Mission Website:
mars.jpl.nasa.gov/msl

Twitter:  @MarsCuriosity

Be A Martian!
beam.jpl.nasa.gov

www.nasa.gov/msl