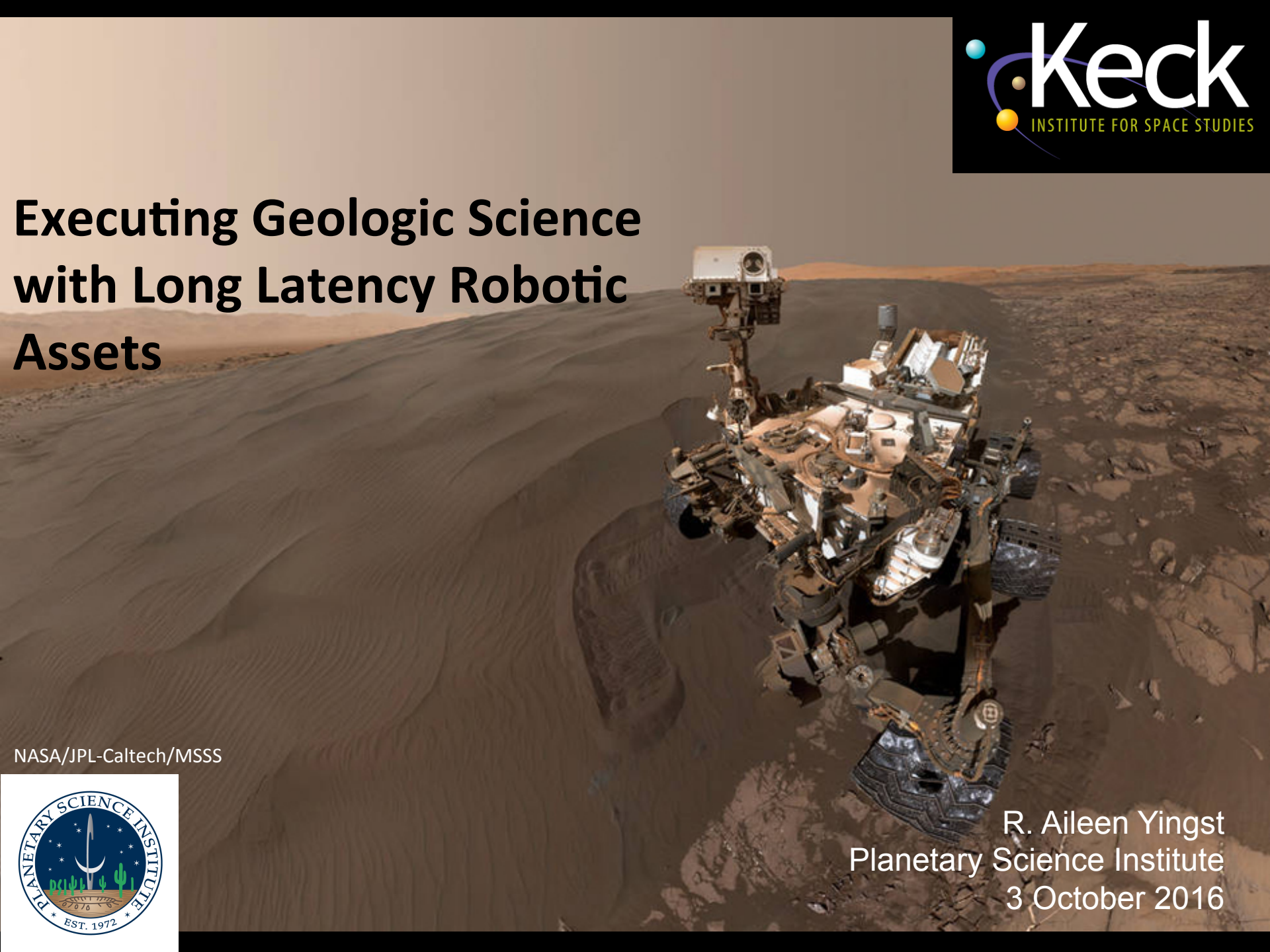
Executing Geologic Science with Long Latency Robotic Assets



NASA/JPL-Caltech/MSSS

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Planetary Science Institute
3 October 2016

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.

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Outline

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

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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

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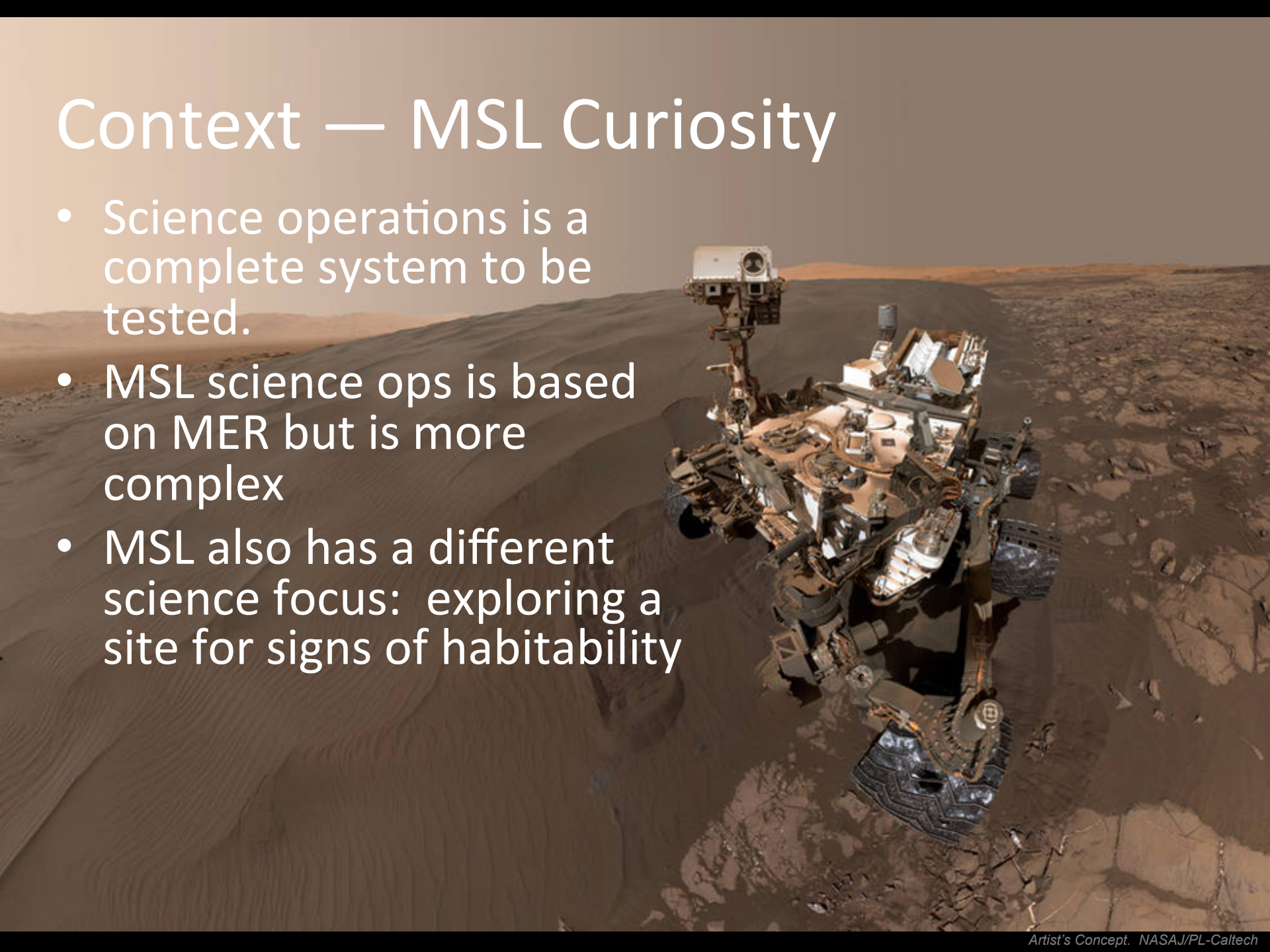
Context — MSL Curiosity

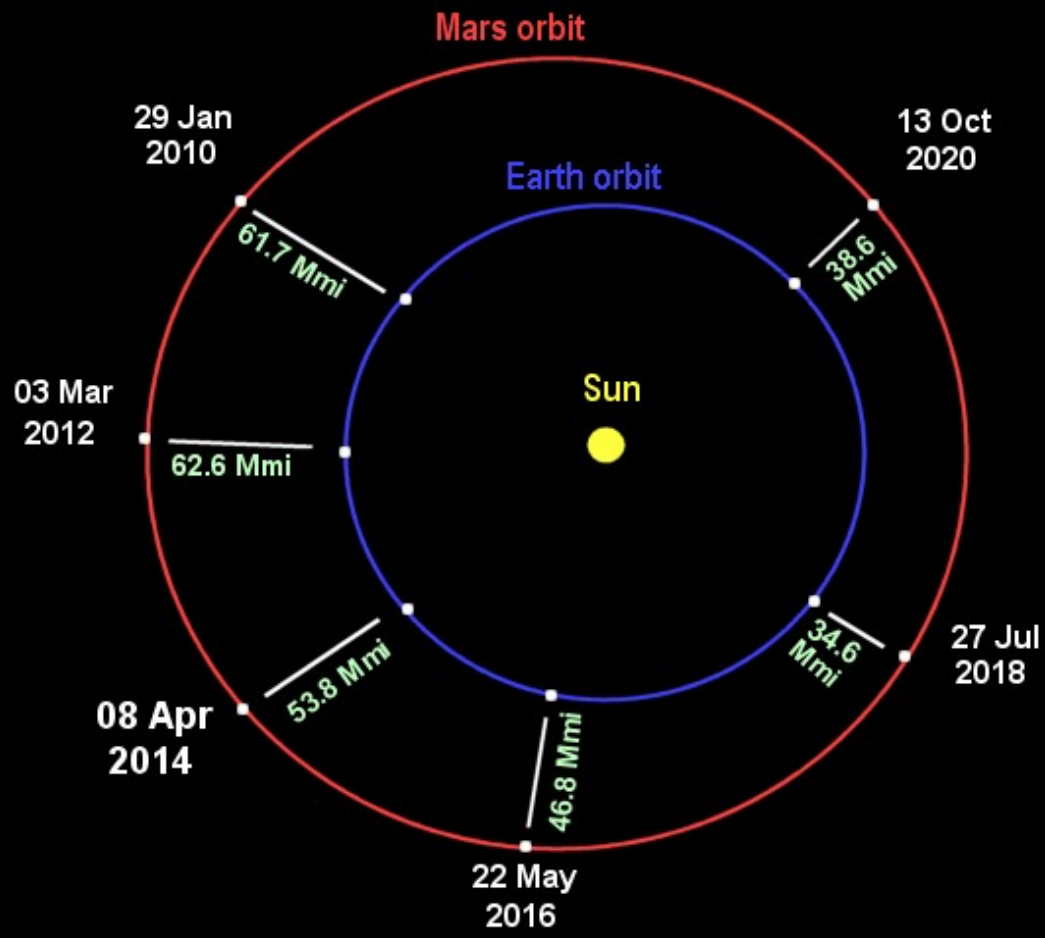
- Science operations is a complete system to be tested.
- MSL science ops is based on MER but is more complex
- MSL also has a different science focus: exploring a site for signs of habitability



Artist's Concept. NASAJ/PL-Caltech

Long latency

- Latency is the time required for a command cycle
- Mars has a long latency



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Definitions

- Sol
- Tactical vs. strategic
- Pass
- Science Block
- Contact Science

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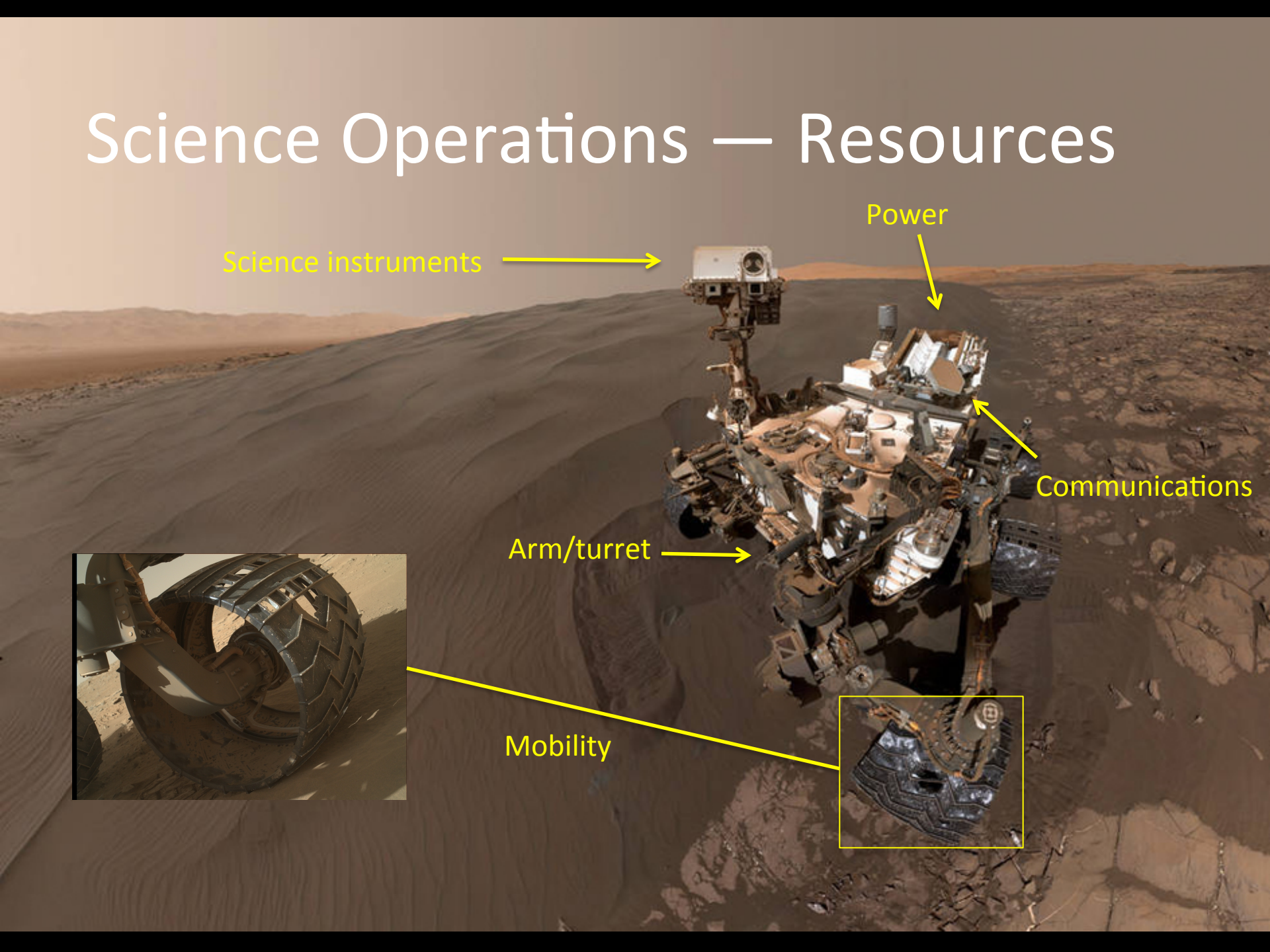
Science Operations — Resources



Science Operations — the lead-up

Timescale

Resources

Activity

Role

Science discussions

Strategic planning

Pre-tactical planning

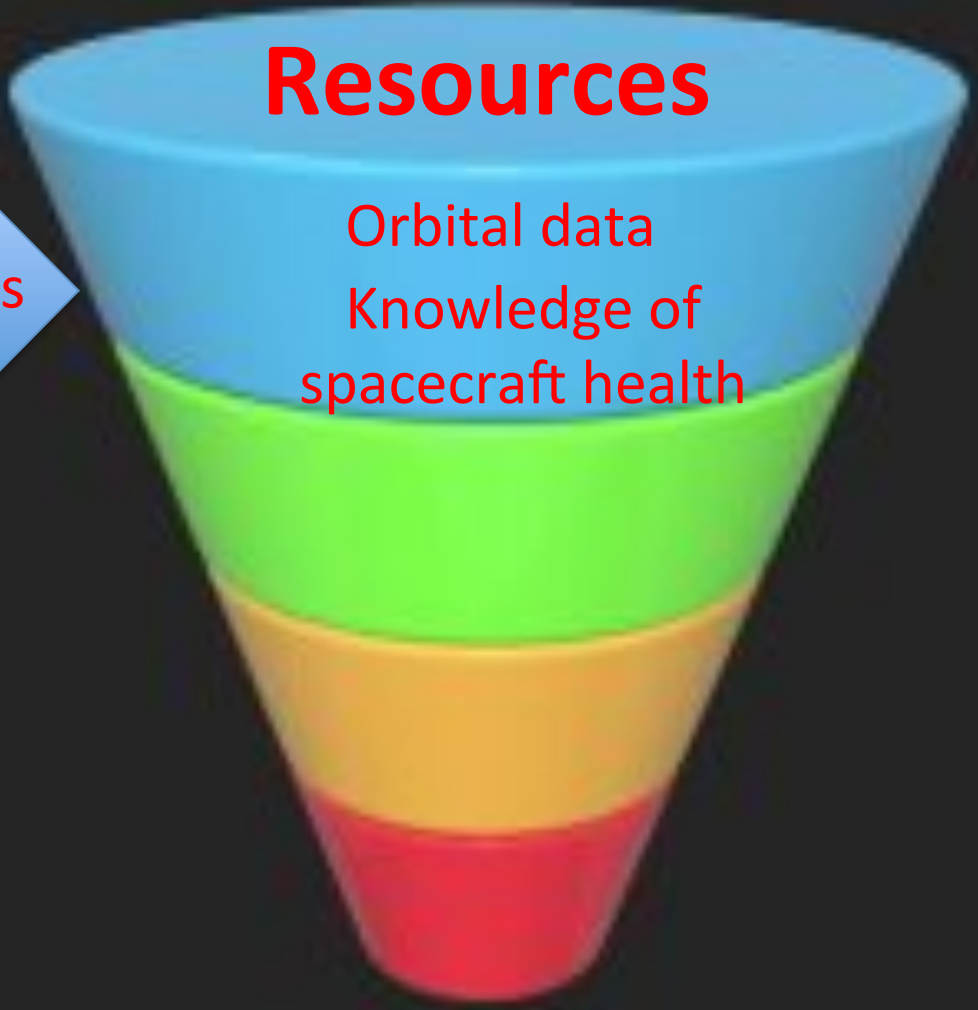
Current sol plan

Science Operations — the lead-up

Timescale

Weeks to months

LTPs



Resources

Orbital data
Knowledge of spacecraft health

Activity

Science discussions

Strategic planning

Pre-tactical planning

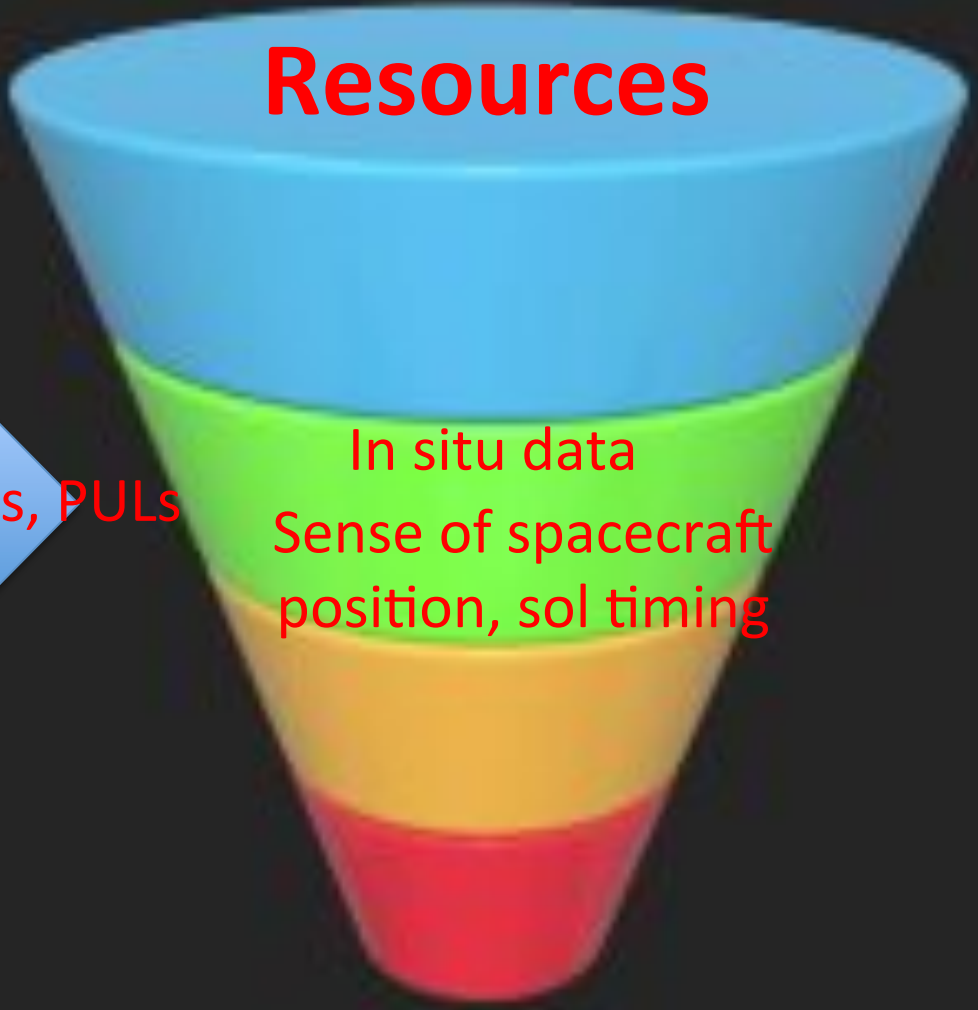
Current sol plan

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

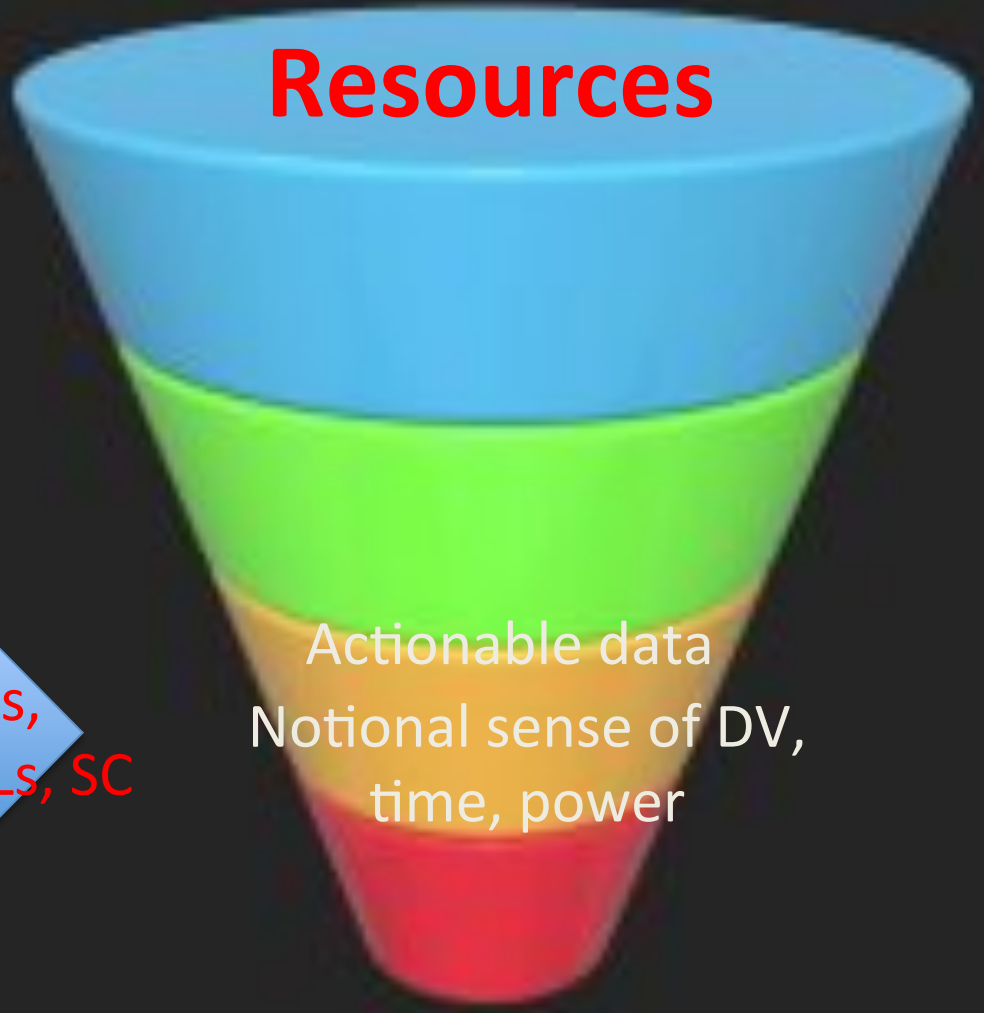
Current sol plan

Science Operations — the lead-up

Timescale

Resources

Activity



Science discussions

Strategic planning

Pre-tactical planning

Current sol plan

1-2 days

STLs, PULs, SC

Actionable data
Notional sense of DV, time, power

Science Operations — Sol n

Timescale

Resources

Activity

Science discussions

Strategic planning

Pre-tactical planning

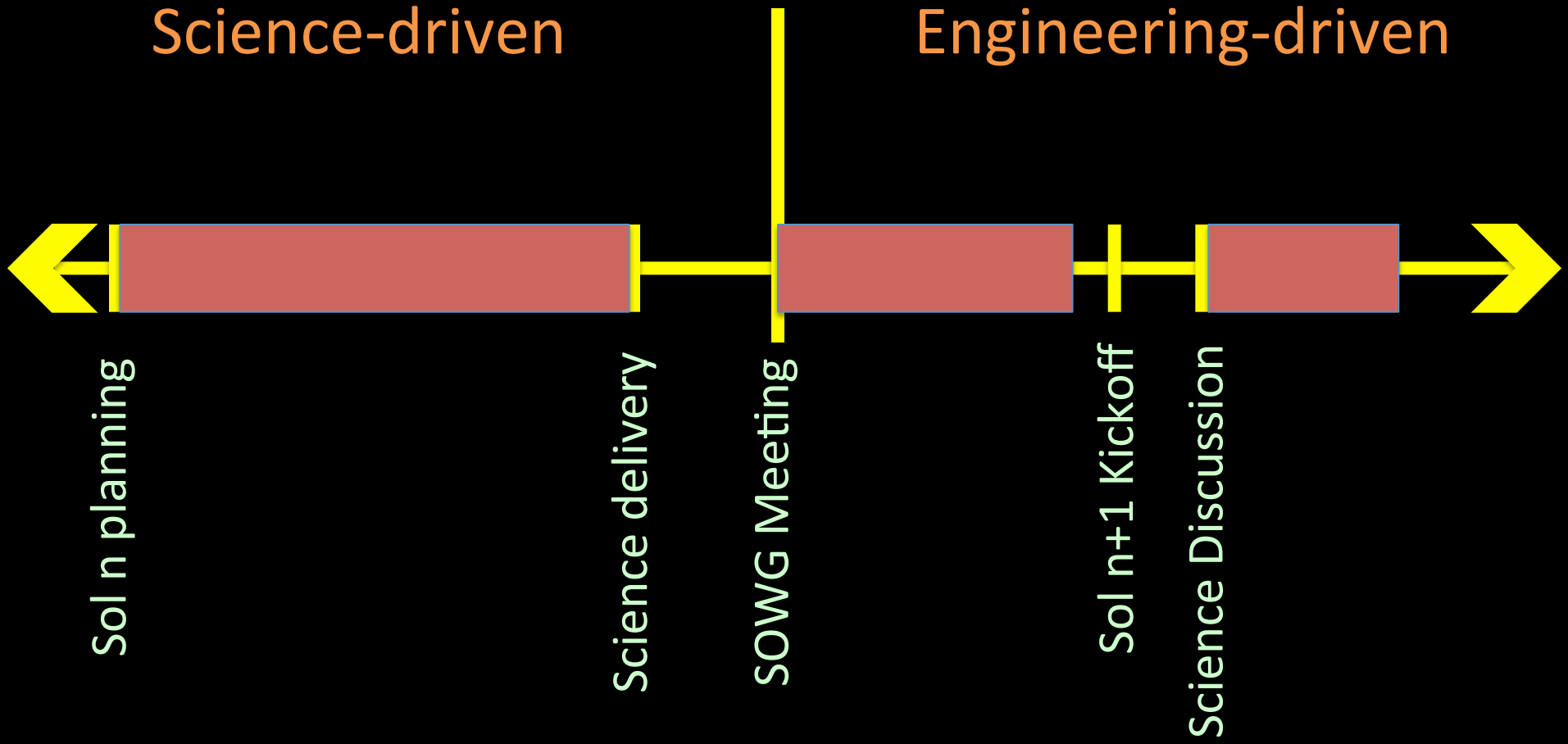
Current sol plan

Sol n

STLs, PULs, SC

Actionable data
Power, DV, Time
finalized

Science Operations — A nominal day



Science Operations — Off-nominal day

- Challenge with long latency
- Usually three outcomes:
  - Stand-down
  - "Groundhog's Day"
  - Plan B

- Effect on science: mixed

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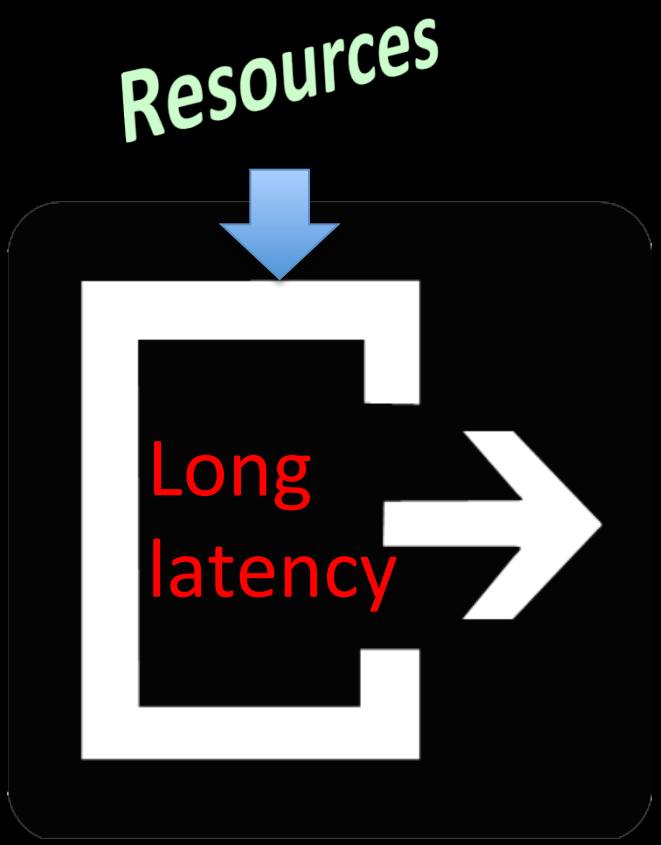
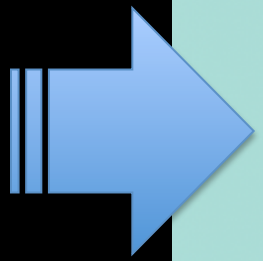
Now that we know what long latency looks like in action, what does it mean for science output?

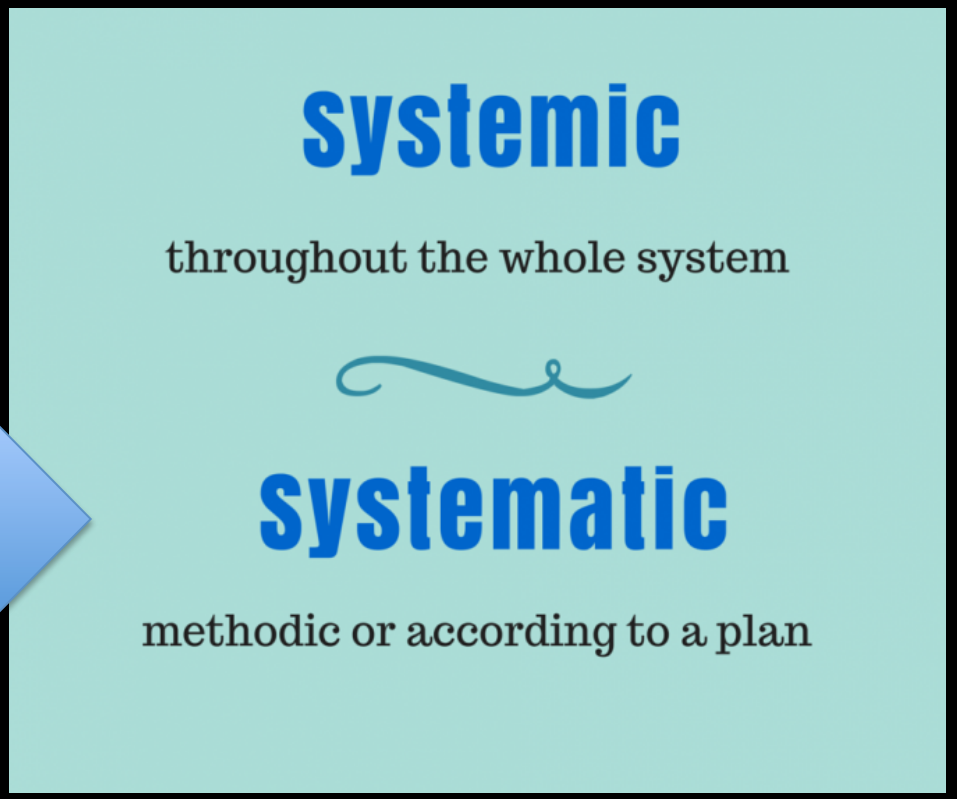


Benefits — A big team with lots of experience

Benefits

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





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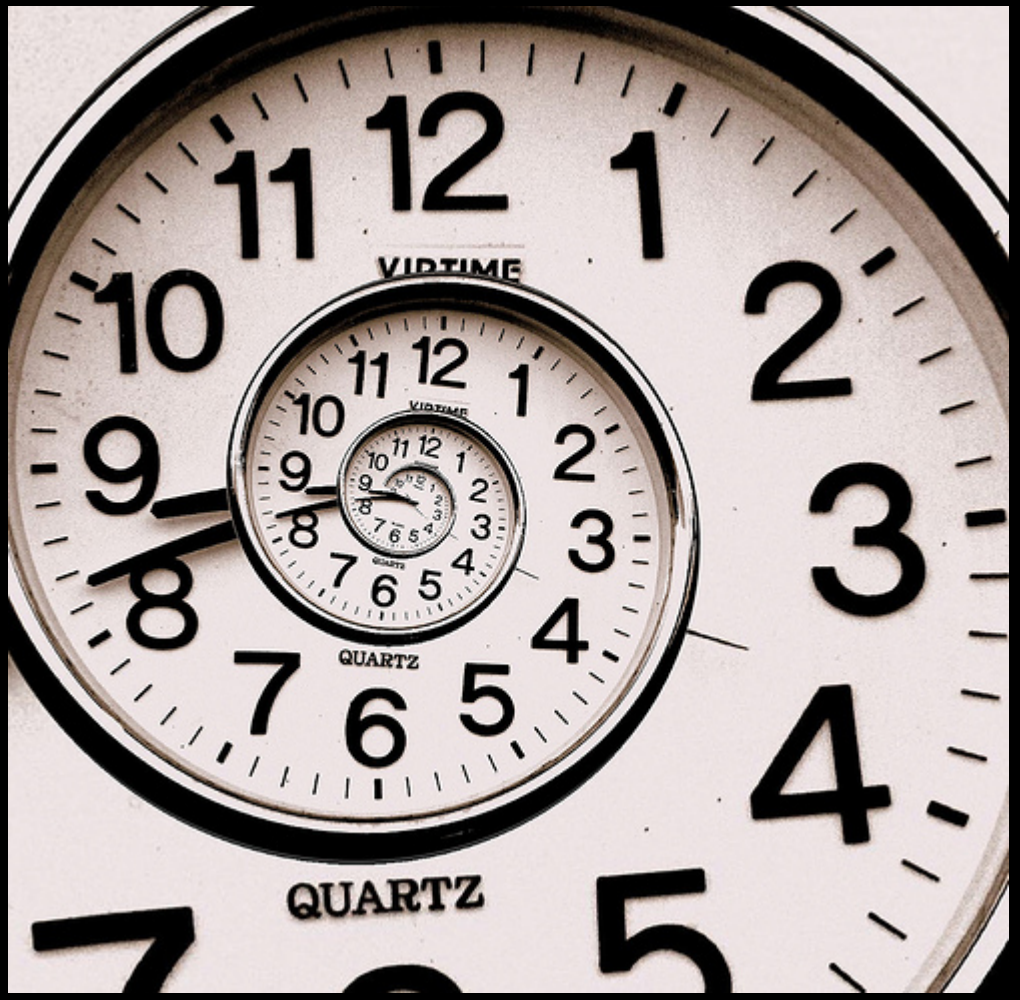
Benefits

- Built-in time for science to "happen"



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Challenges

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

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.)

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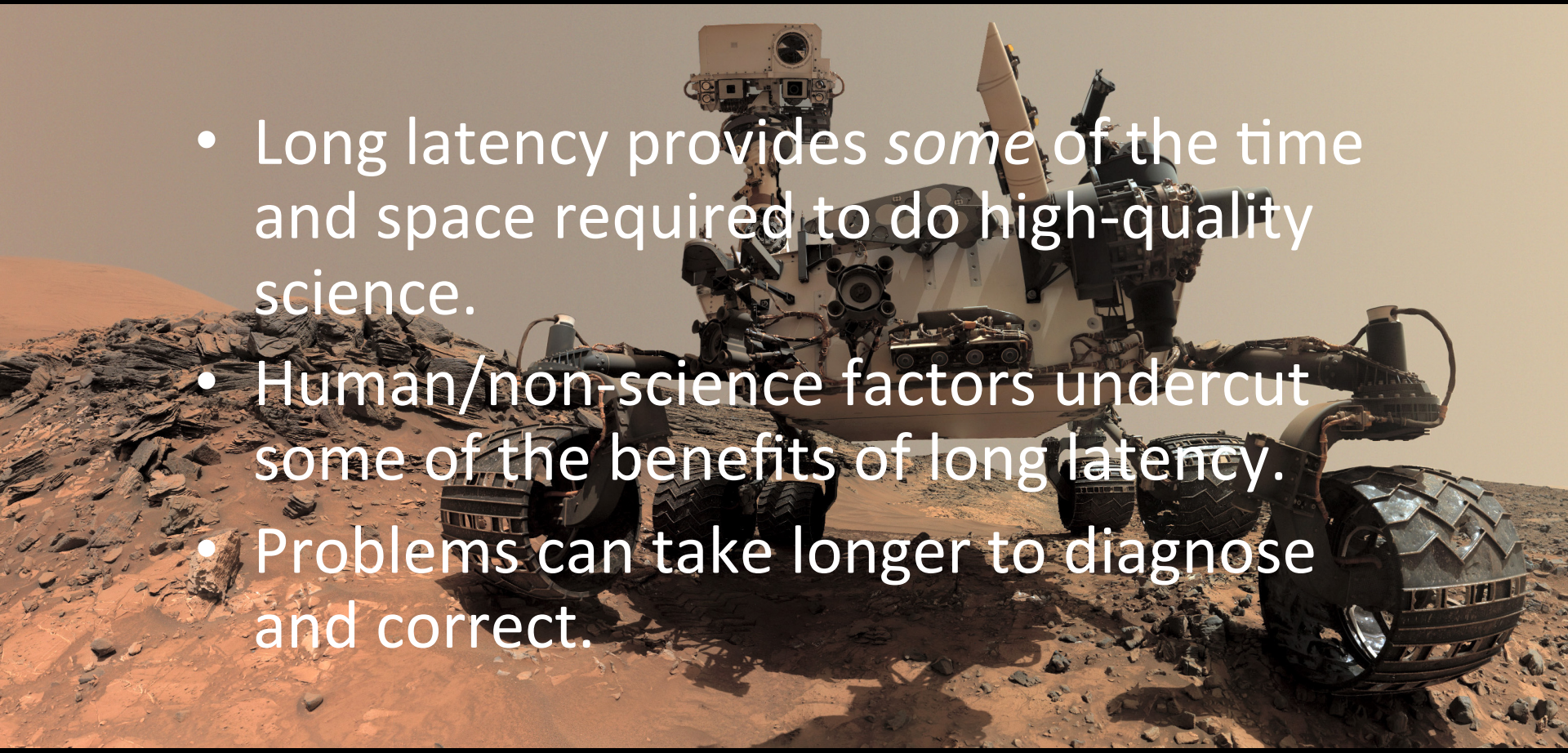
Summary



- 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.

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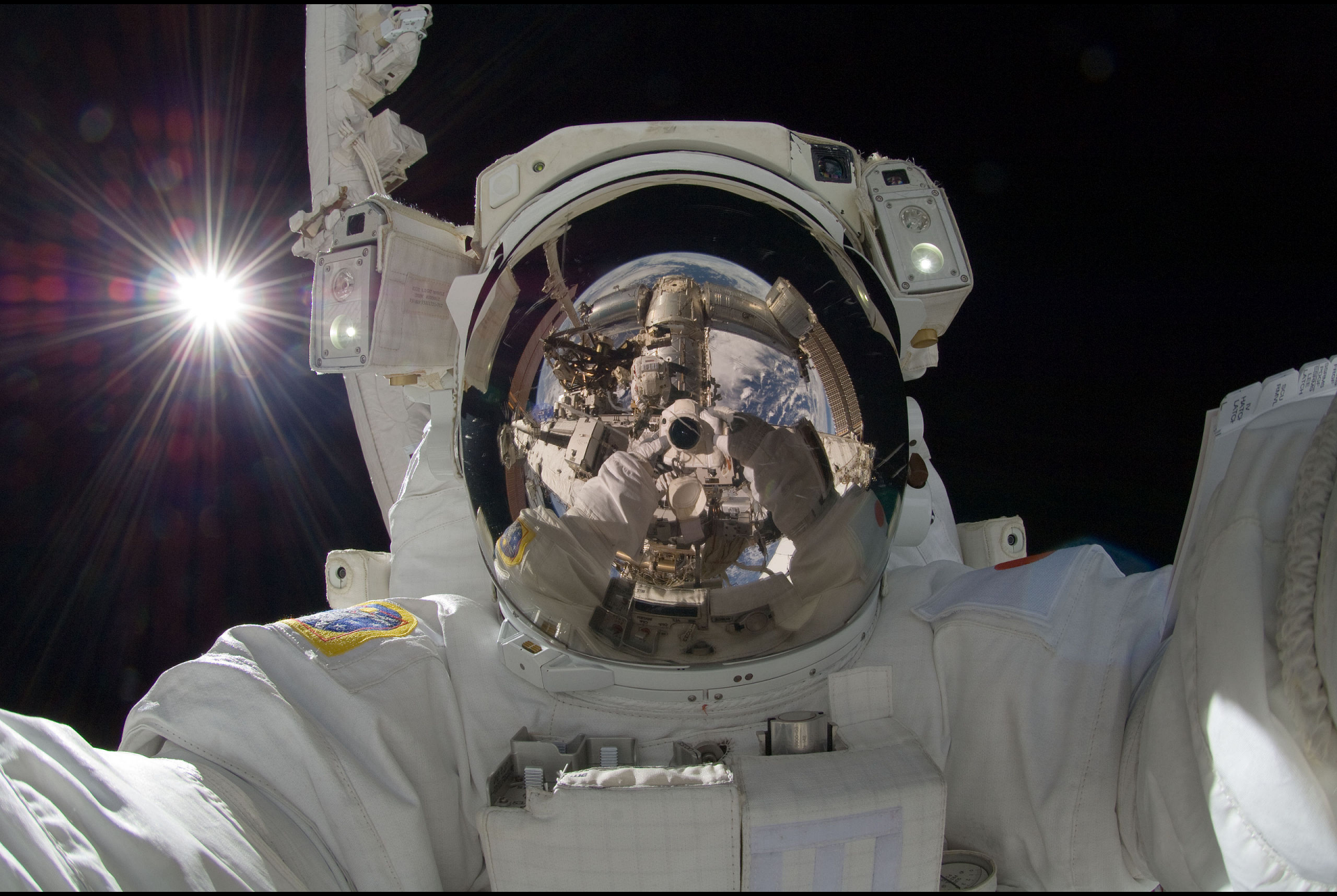
Backup slides

The first selfie

NASAJ/PL-Caltech



Artist's Concept. NASAJ/PL-Caltech

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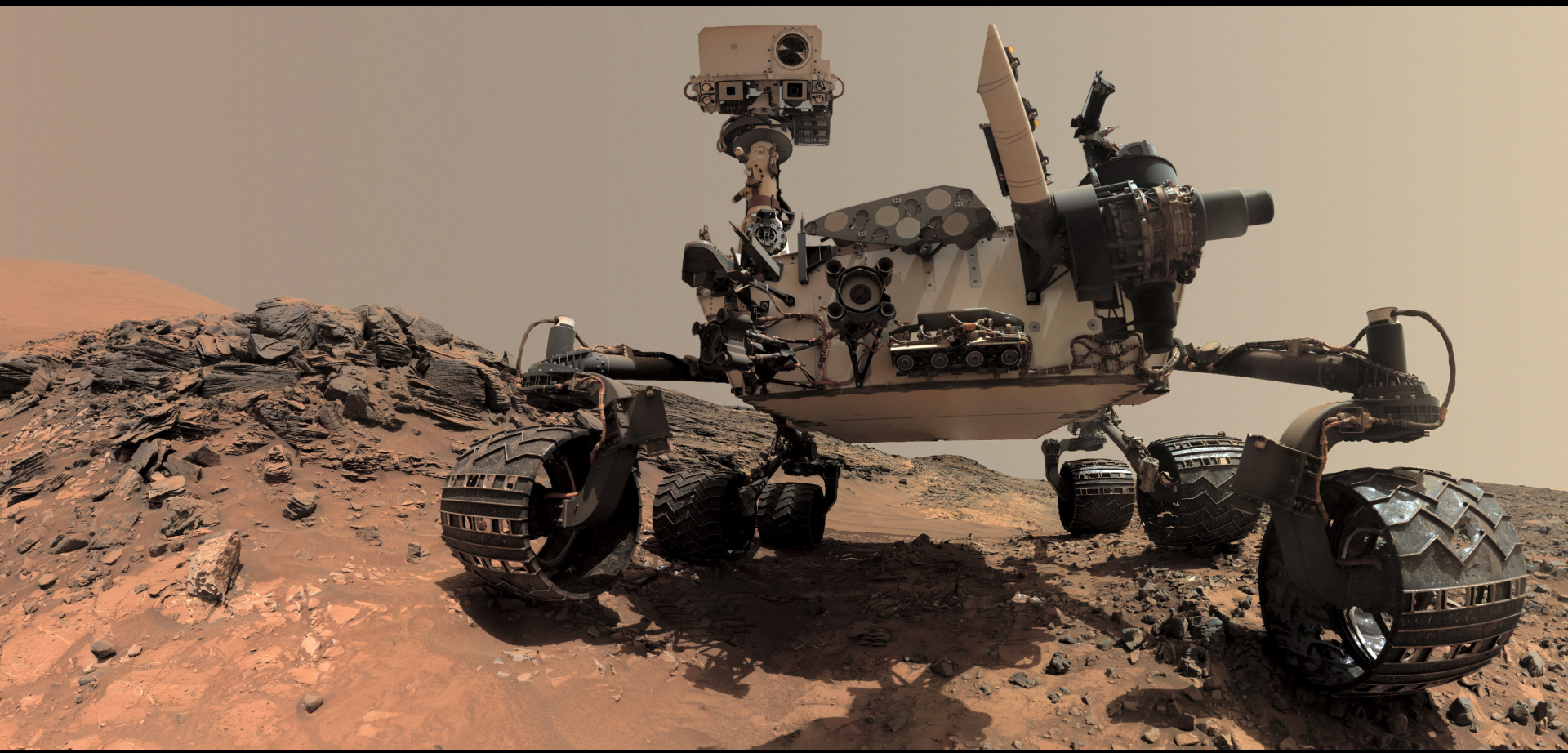

Artist's Concept. NASAJ/PL-Caltech

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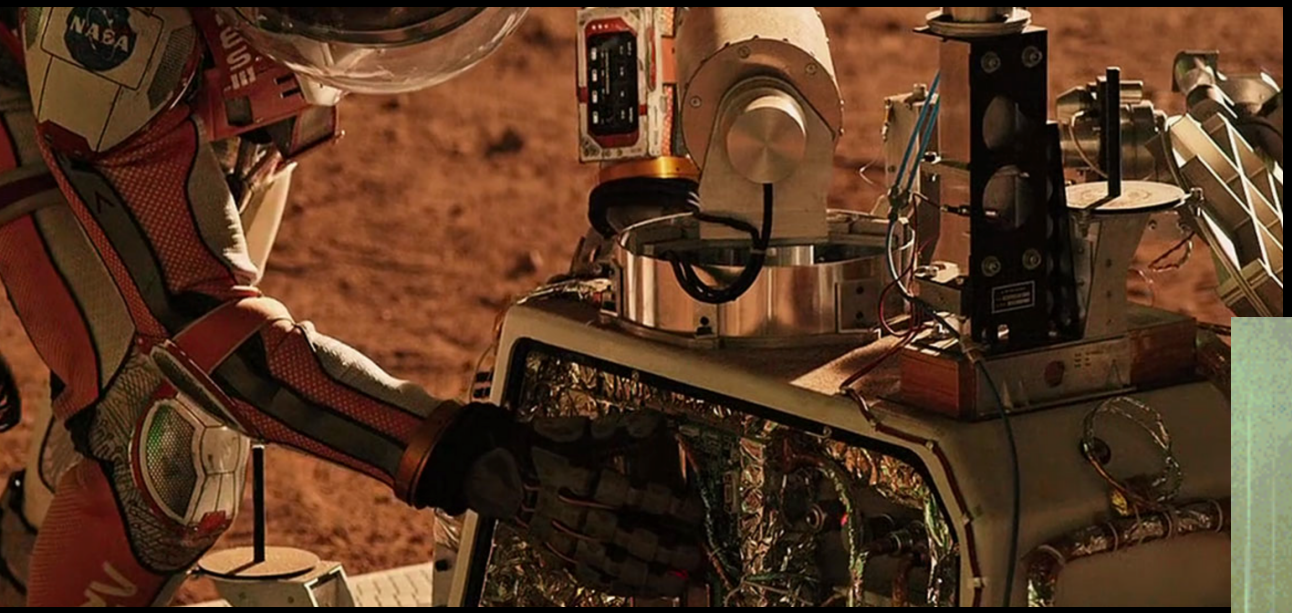
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