Jet Propulsion Laboratory
California Institute of Technology

Mars 2020 Landing Site Workshop

Surface Operations Productivity

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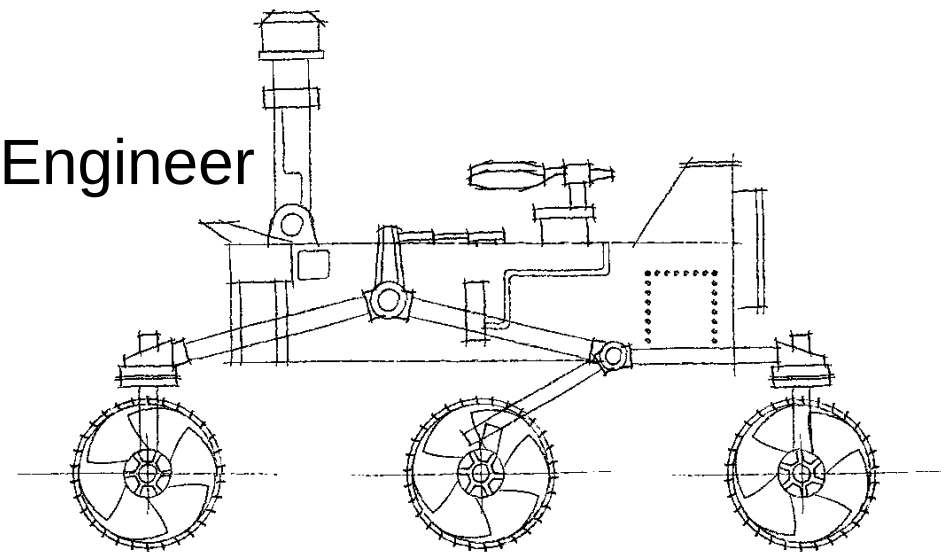

14 May 2014

Pre-decisional, for discussion purposes only

Mars 2020 Project

Acknowledgements

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Relevant Draft Level 1 Requirements

L1-5 The project system shall be able to land with an error of 10 km or less radially from a designated point on the surface of Mars (excluding any uncontrolled effects of winds during parachute descent).

L1-8 The Project shall deliver to Mars a rover with capability of a total traverse path length of at least 20 km. The threshold for total traverse capability is 10 km path length.

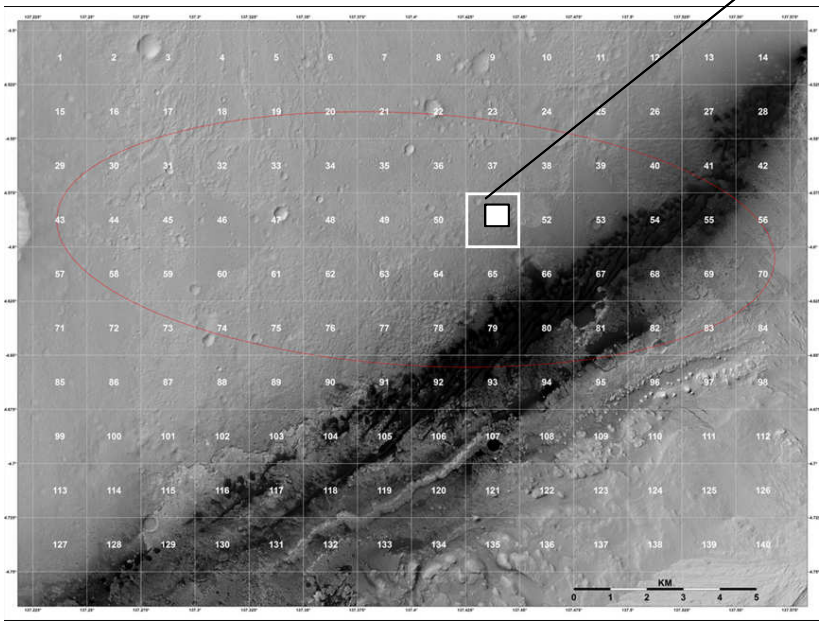
L1-9 The project system shall be capable of selecting and acquiring TBD samples of rock and/or regolith and placing them in a returnable cache. The threshold capability is TBD samples.

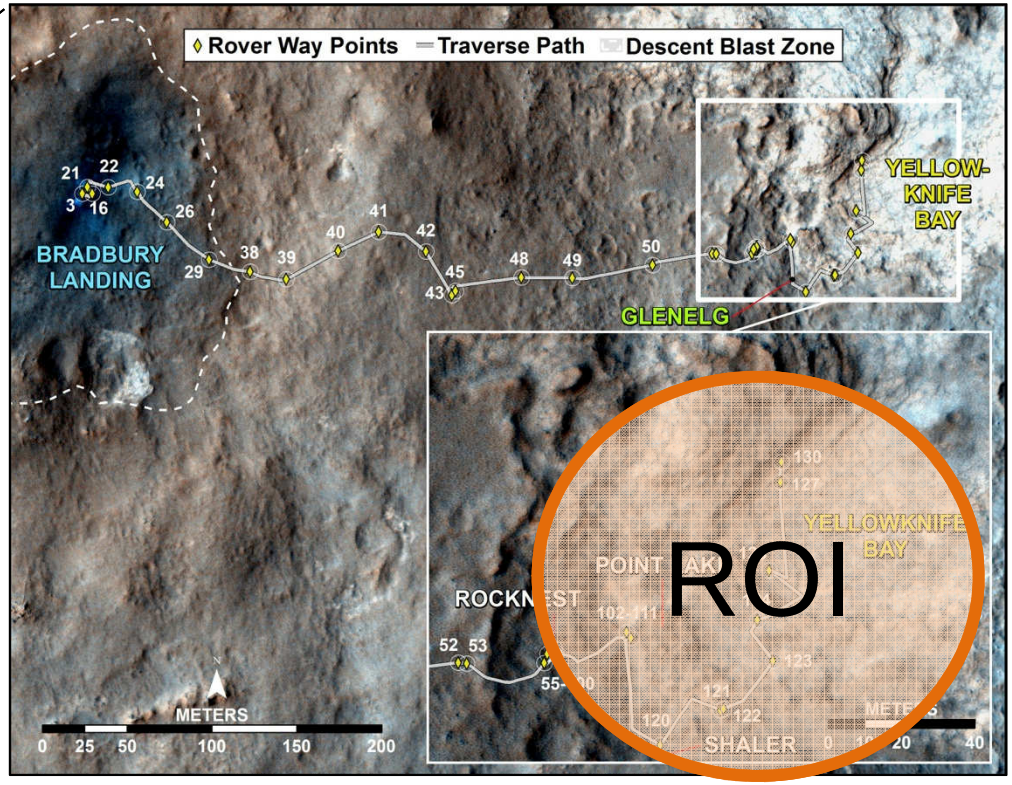
L1-4 The project system shall be capable of landing and operating at sites between 30°N and 30°S latitude selected as late as one year before launch without compromising overall mission safety.

L1-7 The project system shall be capable of conducting operations on the surface of Mars with the rover and its scientific payload for at least one Martian year (669 sols).

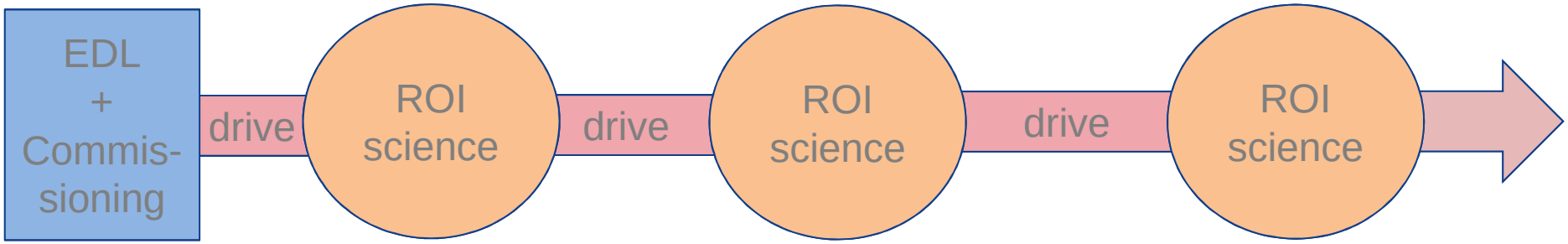
Regions of Interest

- A Region of Interest (or ROI) is defined as a location where the rover will conduct an extensive scientific campaign
  - Usually because multiple related science targets are present in a small geographic area (~100 m diameter)
  - Rocknest/Yellowknife Bay is one ROI for MSL





Science Operations Concept



Conceptual Sol Allocation

	Scheduled Sols	% of Martian Year	Estimate with current design concept
Initial Checkout/Commissioning	60	9%	
Conjunction	15	2%	
Driving to and from ROIs	182	27%	10 km assuming good traversability
In Situ Science, Fieldwork, Sampling and Caching	278	42%	[25] samples*
Margin	134	20%	
Total	669	100%	

* Example assuming MSL Yellowknife Bay scenario, 3 sols for collecting and caching each sample and all samples taken from 3 ROIs. Several liens exist.

Open Project-Level Trades

- **Land closer to high priority sites (see Chen "EDL Engineering Constraints" presentation)**
  - Range Trigger for parachute deploy
  - Terrain Relative Navigation to avoid previously mapped hazards
- **Decrease driving sols required per km**
  - Increase distance per sol achievable by ground-based traverse planning
  - Increase distance per hour of autonomous traverse "Autonav"
  - Increase number of hours per sol available for Autonav
    - Earlier start time (address thermal limitations)
    - Later end time (MRO relay pass limitation)
- **Increase Operations Team efficiency**
  - Multi-sol planning cycles for driving
  - Reduced planning cycle time for "Drive-Only" and other simple objective activities
  - Mars Time/Earth Time hybrids
- **Examine Fieldwork efficiency**
  - Develop estimates based on MSL experience, starting with Yellowknife Bay
  - Develop scenarios around fewer Regions of Interest - with more cores per ROI
    - Currently assuming 3 ROIs

Sols Spent Driving

Driving Sols Required = Distance Required / Average Distance per sol

- **Features that reduce the distance required:**
  - Multiple acceptable ROI groups such that the specific ROI can be selected after landing depending on landing location
  - Compact groups of ROIs to reduce inter-ROI driving
  - ROIs near center of landing ellipse
  - Few large scale obstacles that need to be driven around
- **Features that increase the average distance per sol**
  - Mobility system capability
  - Operations team scheduling/human factors
  - Site traversability (fewer rocks, limited slopes, multiple acceptable paths)

Blue highlight for site-selection-related items

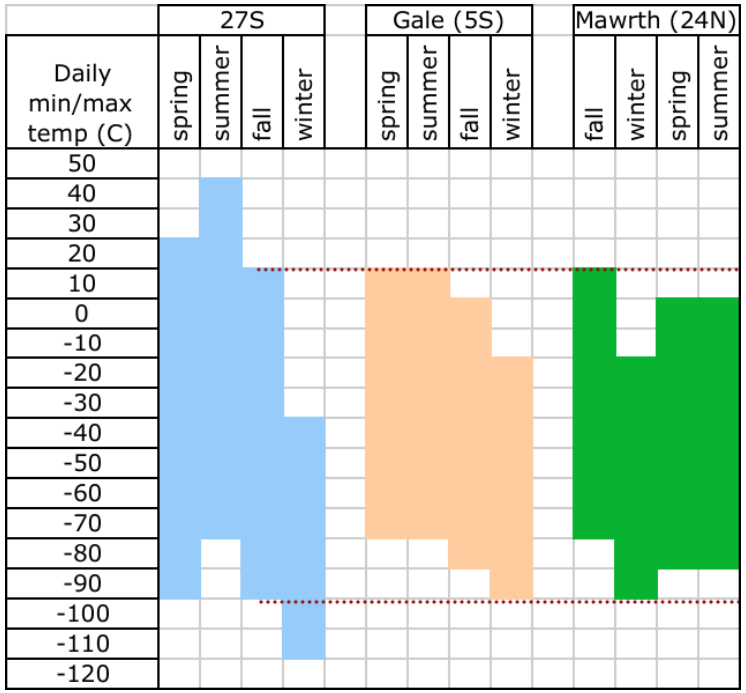
Sols Spent on Fieldwork and Sampling

- **Features that reduce the fieldwork required:**
  - Few distinct ROIs (e.g. 2-3) such that the time invested on context science and understanding an ROI is shared among more samples
  - Samples outside ROIs require little fieldwork
  - Instrument suite used in fieldwork
  - Operations team scheduling/human factors

Blue highlight for site-selection-related items

How does performance change with latitude?

- **Performance not yet evaluated for Mars 2020, but MSL's rough assessment was:**
  - The seasonal temperature variation, and therefore seasonal performance, changes with latitude/landing site.
  - Saw < 10% change in overall mission performance.



Summary

- **Site Selection items of greatest interest for Surface Operations Productivity:**
  - Total required driving distance
  - Terrain traversability
  - Number of ROIs required for success
  - Multiple acceptable ROI groups associated a landing site

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