



**JPL**

---

# **Mars Exploration Rover Science Operations During Cruise, Prime and Extended Mission**

**Albert F. C. Haldemann<sup>1</sup>, Joy A. Crisp<sup>1</sup>,  
David M. Kass<sup>1</sup>, J. Tim Schofield<sup>1</sup>,  
Steve W. Squyres<sup>2</sup>, Ray E. Arvidson<sup>3</sup>,  
and John L. Callas<sup>1</sup>**

**<sup>1</sup> JPL, Caltech, Pasadena, CA**

**<sup>2</sup> Cornell University, Ithaca, NY**

**<sup>3</sup> Washington University, St. Louis, MO**



- **How does the Mars Exploration Rover project do science?**
- **MER is “big science”:**
  - ~ 50 co-investigators
  - ~ 100 collaborators
  - ~ 200 engineers
- **Different approaches in different mission phases:**
  - Cruise
  - Prime (or Nominal)
  - Extended

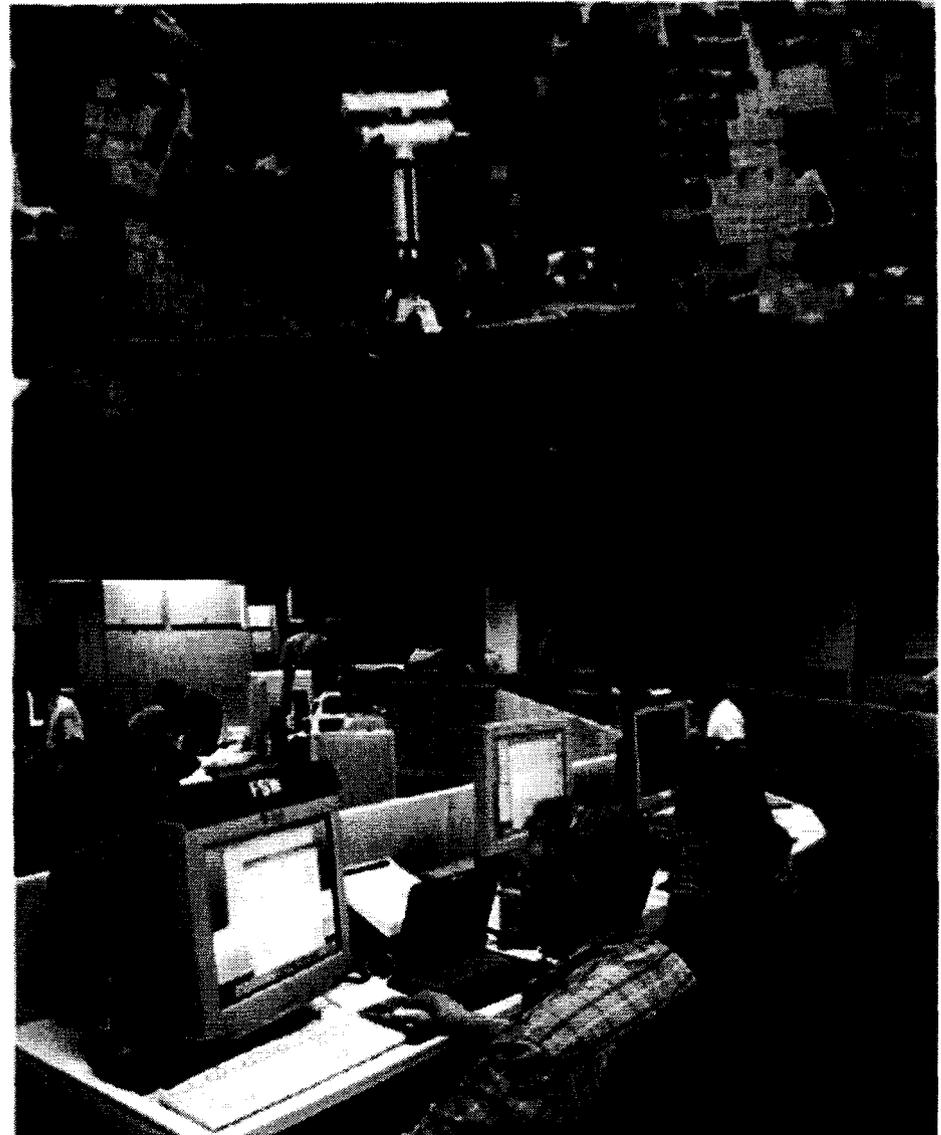




# Cruise Science Operations



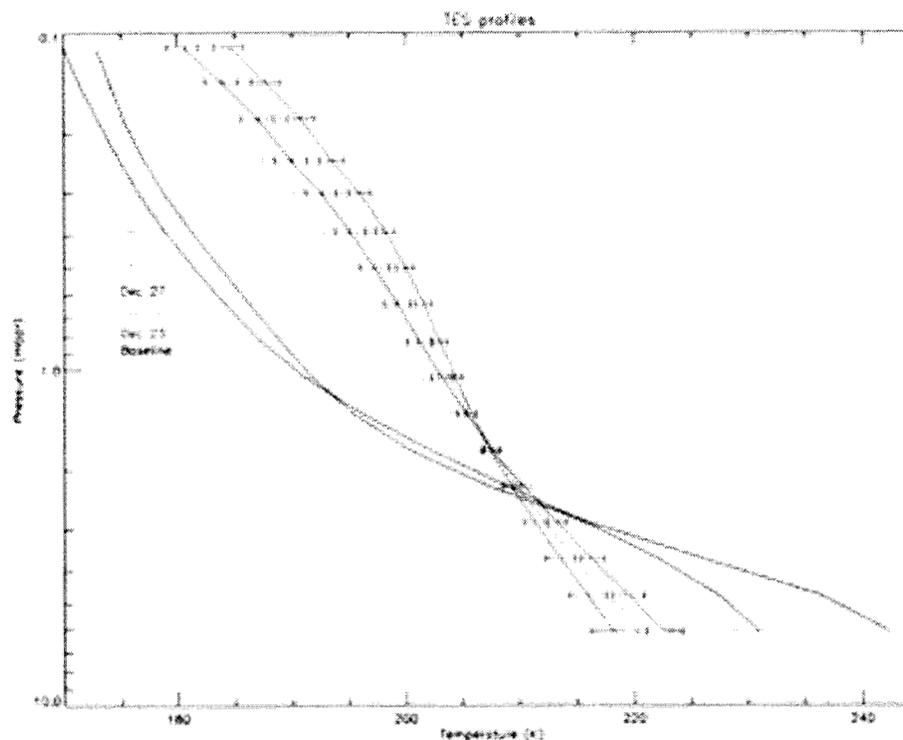
- **No cruise science investigations**
- **Instrument check-out**
  - Came ra testing
  - Instrument health checks (on/off)
  - Mössbauer characterization
- **Science Team training**
  - Operational Readiness Tests (ORT's) with testbed rovers
  - Develop and test the operations processes
  - Develop and test the operations tools (software)





## EDL preparation:

- **Wind characterization modeling**
- **Weather prediction / monitoring with MGS data**
- **Regional dust storm effects characterization**





## Landing site targeting with TCM evaluations:

- **Spirit:**
  - PI requested targeting to center on dust devil track, PM demured
- **Opportunity:**
  - maximize he matite and avoid roughness





- **Robotic field geologists**

- How do you do field geology with a rover that can do in one day what a human geologist does in 45 seconds?

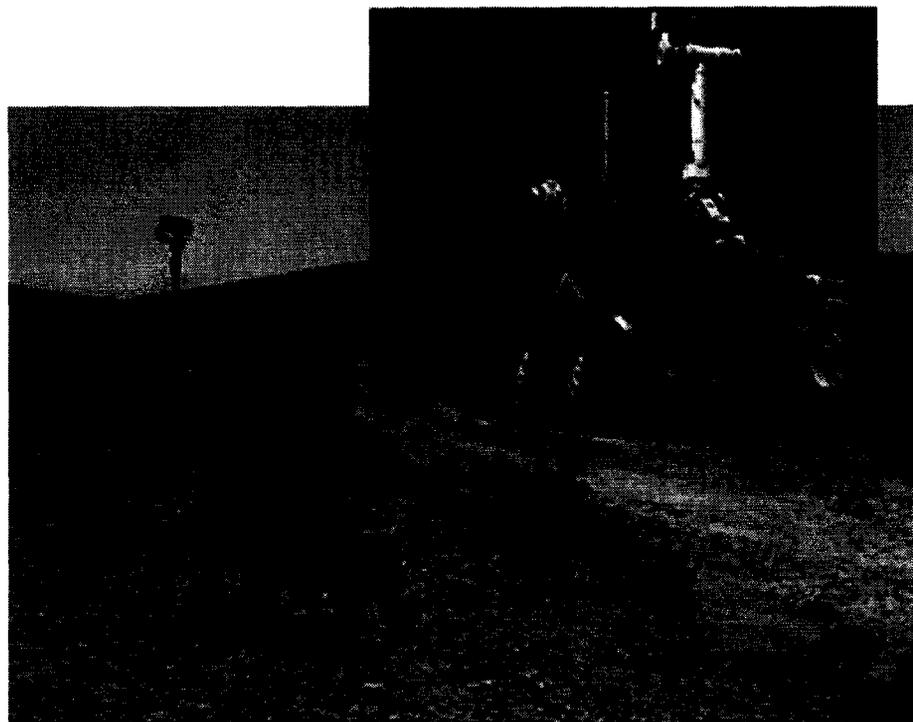
- Live with constraints

- Take advantage of strengths

- **Mars time**

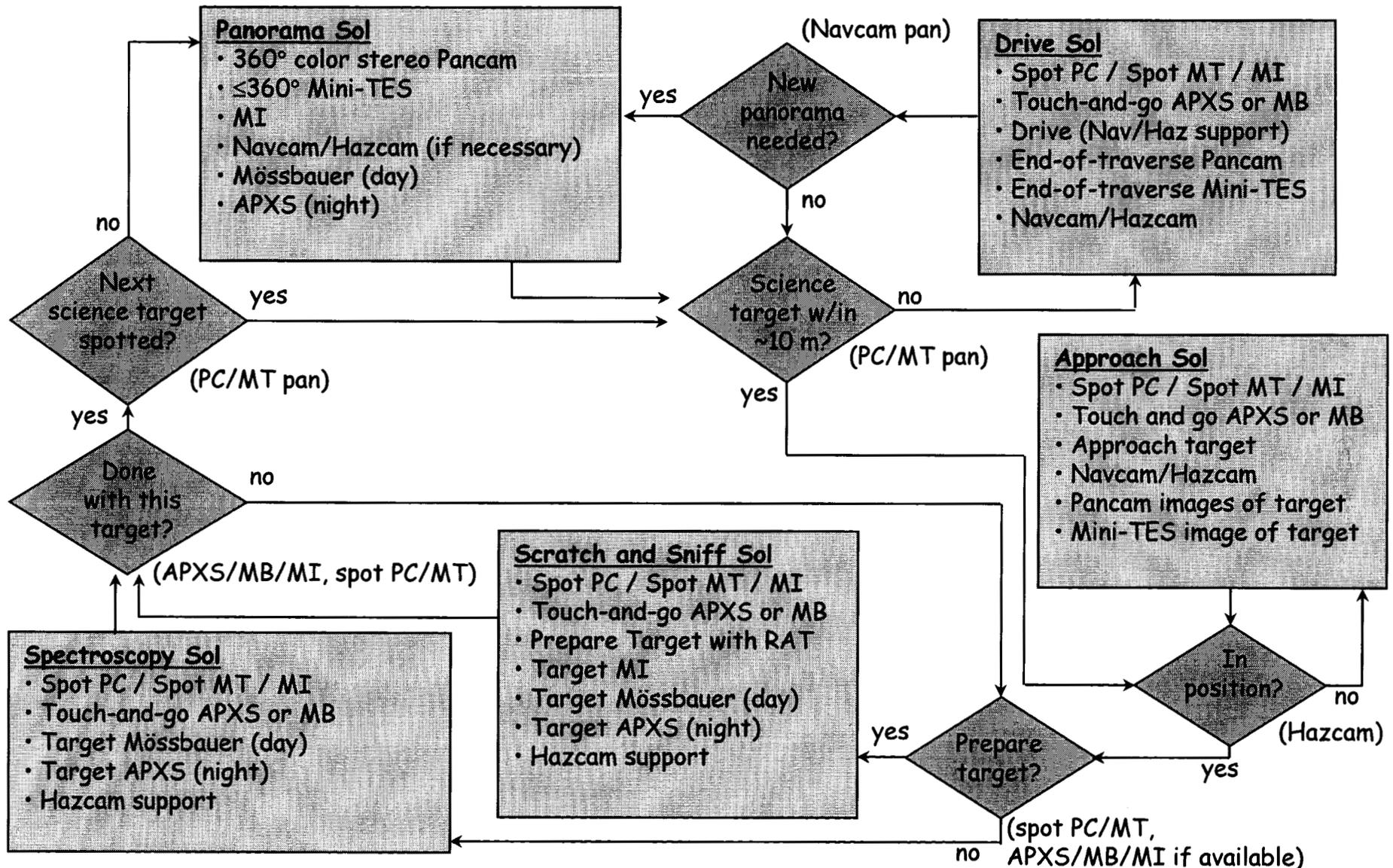
- Daily (Mars-)overnight planning

- Phase the (Earth-time) work shifts to the martian day



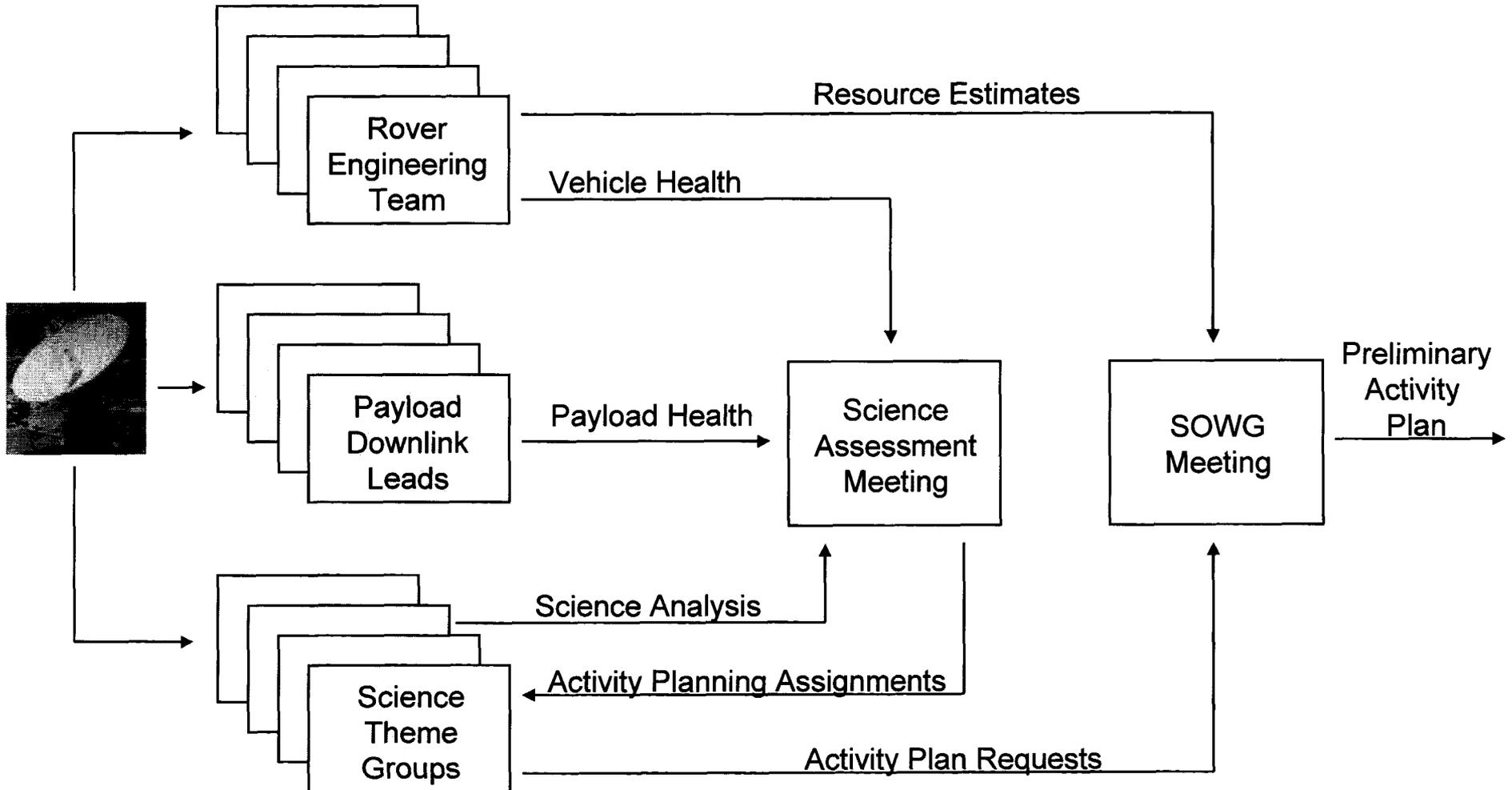


# Modular Exploration Scheme



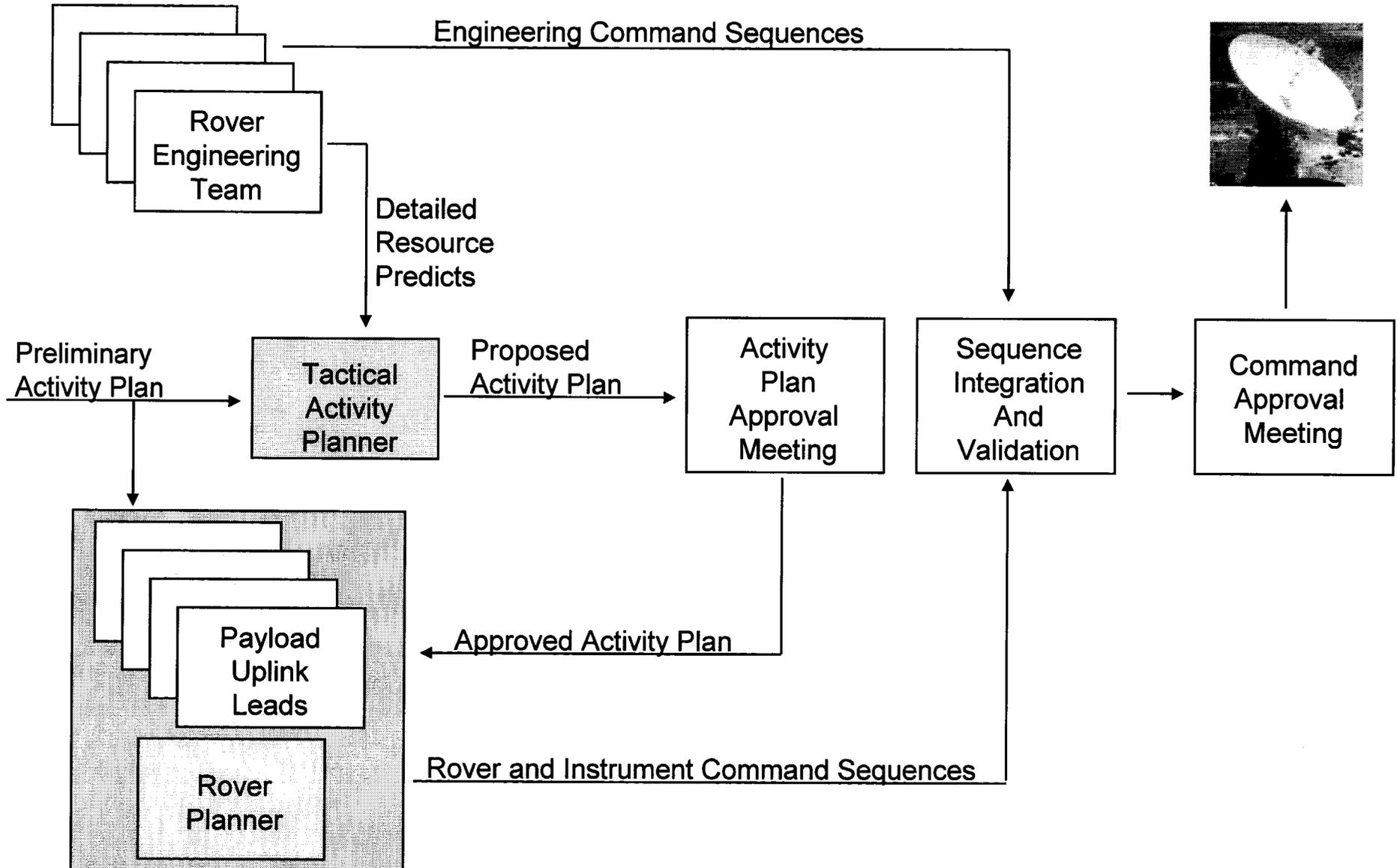


# Daily Operations Flow



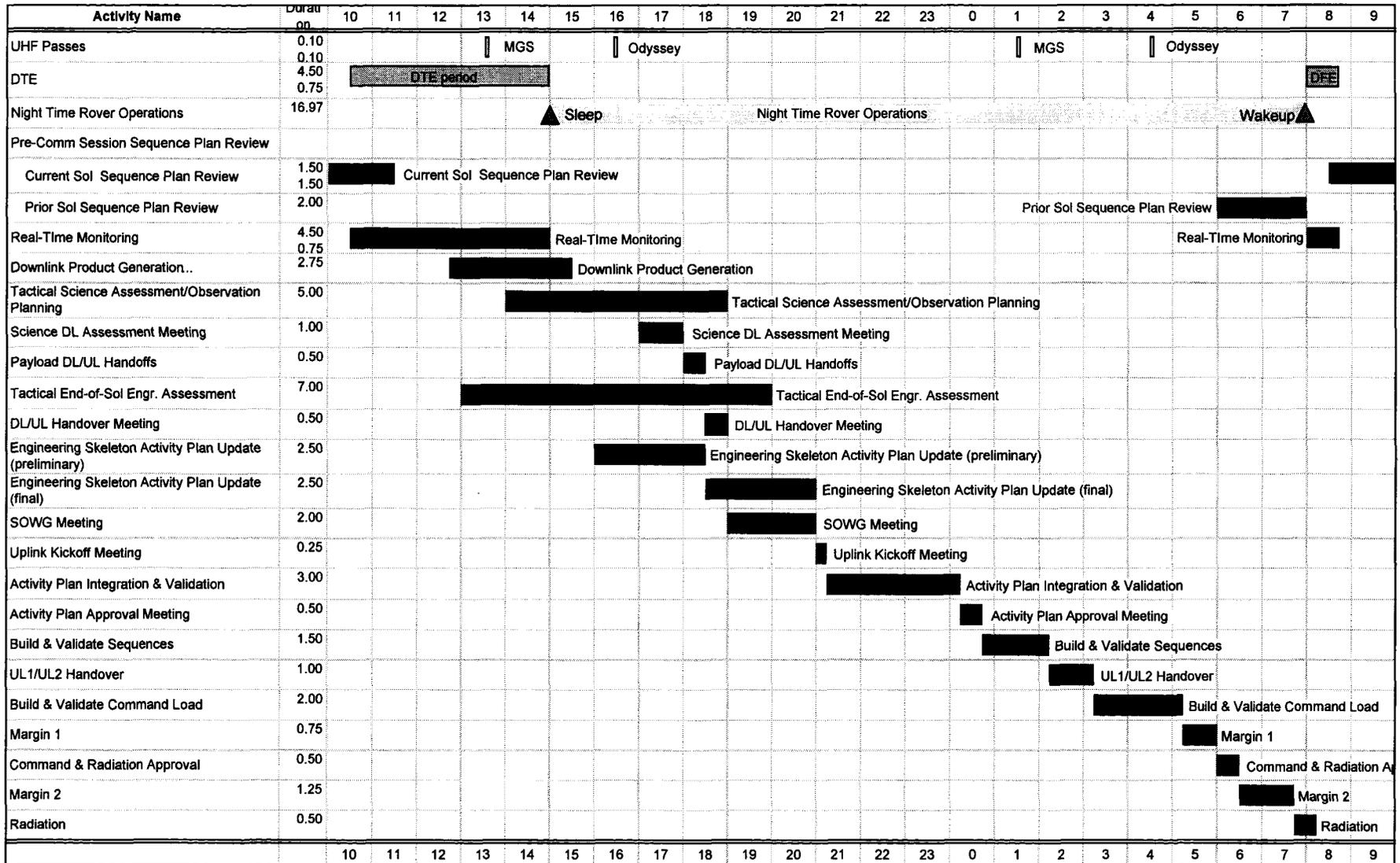


# Daily Operations Flow con't





# Daily Operations Flow con't





## Extended Mission Science Ops



- **Over 3 months we became more efficient with the overnight process**
  - by Spirit's sol 85 we had shortened the overnight planning cycle from 17 hours to 12.
- **MER potential lifetime through at least 09/2004 requires reduced rate of resource use**
  - Reduced monthly cost by 40% from nominal mission
  - Overnight plan in 10 hours
  - Move to Earth time, and accept some inefficiencies due to phasing to the Mars day
  - Distributed operations with science team
- **Same approach to acquiring science data, but accepts more potential inefficiencies.**



## Lessons



- **Robotic field geology on an alien world is “big science” that requires operational approaches that are appropriate to the available resources and to the specific alien environment.**
- **Science return on investment improves with planning and practice.**



# Planetary Data System Archive Schedule



<b>Sols 1-30:</b>	<b>Aug. 3 (Spirit) Aug. 24 (Opportunity)</b>
<b>Sols 31-90:</b>	<b>Oct. 4 (Spirit) Oct. 24 (Opportunity)</b>
<b>Sols 91-end:</b>	<b>6 months after each rover end-of-mission</b>



## URL's



- <http://marsrovers.jpl.nasa.gov>
- <http://photojournal.jpl.nasa.gov>

Other query options → Search by feature name

- <http://athena.cornell.edu>
- <http://panoramas.dk>

Search on “Mars”: virtual reality panoramas