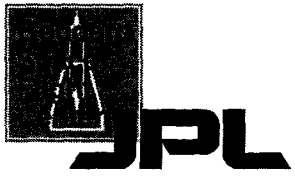
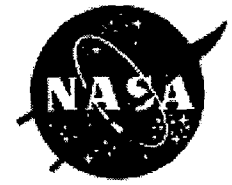


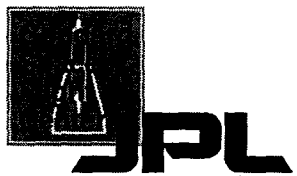


Future Missions and Their Challenges -- A JPL Perspective

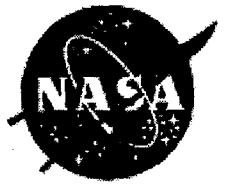
Dr. Richard J. Doyle

Leader, Center for Space Mission Information and Software Systems
Manager, Information Technology Program Office

Jet Propulsion Laboratory



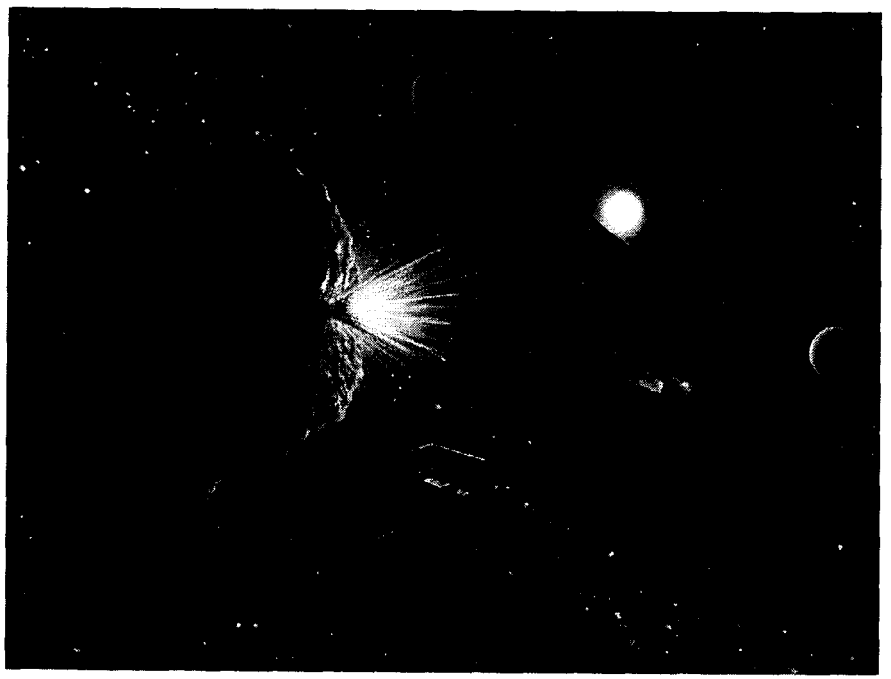
The "Flight Software Problem" Root Causes



- Requirements late
- Requirements inadequately specified for software implementation
- Late and/or inadequate testbed resources
- Inadequate time for testing
- Lack of software engineering perspective in project and flight systems engineering
- Flight and ground software not integrated
- Software complexity increasing while schedules becoming shorter
- Lack of a reusable code base for FSW and simulations
- Distribution of software development across multiple organizations
- Lack of contractor oversight

Thanks to Dave Nichols and Chris Jones

Deep Impact (DI)

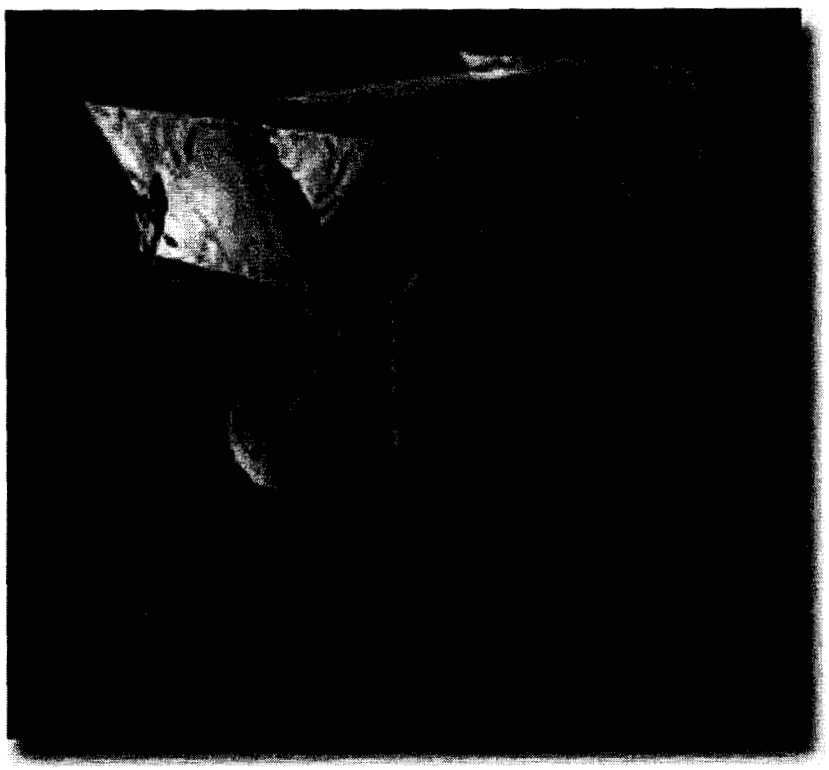


- Flyby and impactor spacecraft to excavate and study primordial material from a comet
- Unique autonomous navigation challenge to guide impactor
- Fault protection engine implemented with auto-generation of fault detection and response code
- Strong partnering with contractor on FSW

Mars Science Laboratory (MSL)

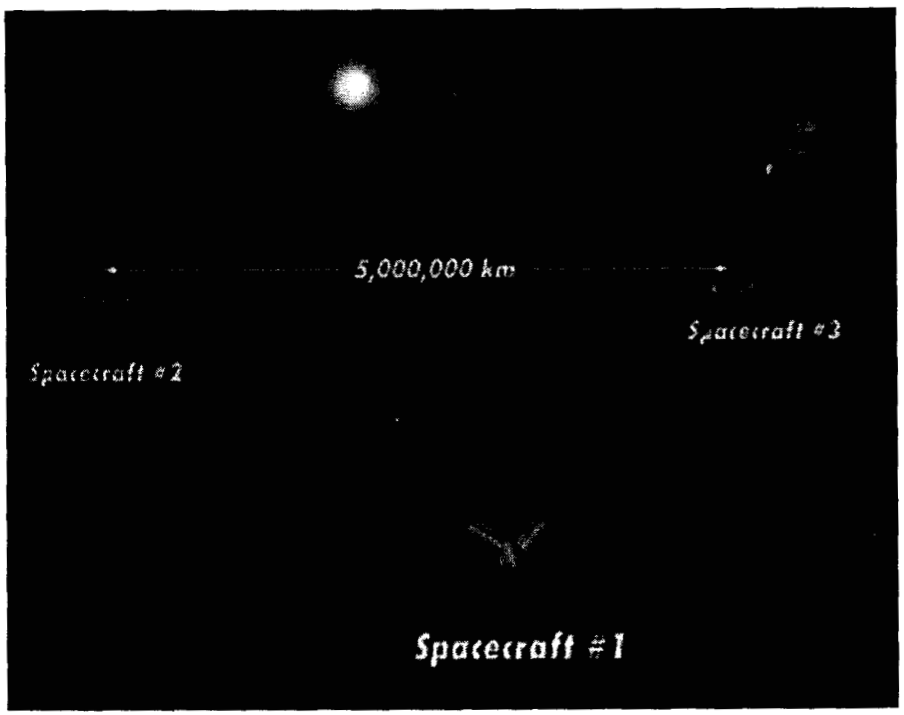
- Unprecedented challenges for precision landing and surface operations on Mars
- Possible use of active hazard avoidance during descent
- Possible use of enhanced instrument placement capability
- Strong emphasis on simulation-based testing
- Autonomy possibly a driver for new system validation approaches
- Extended surface operations a driver for new operations concepts

Space Interferometry Mission (SIM)



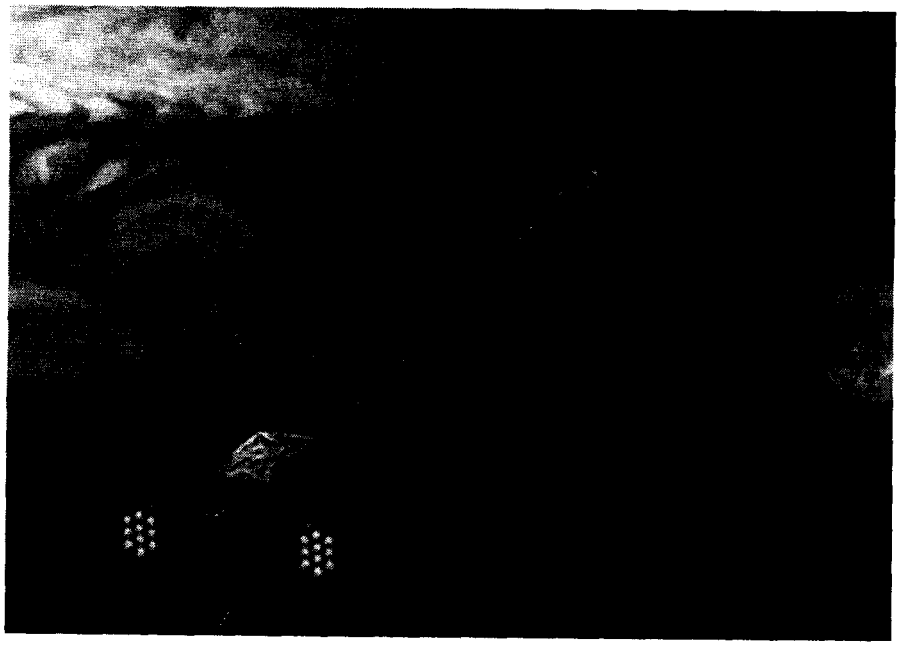
- Deep-space interferometer to search for extra-solar planets
- Unprecedented precision requirements for controlling an instrument
- Unprecedented performance requirements for a real-time control loop
- Spacecraft fairly conventional

Laser Inteferometry Space Antenna (LISA)



- Joint GSFC-JPL mission
- Spacecraft in free fall around reference masses - perturbation sources carefully modeled - residual signal amounts to a gravity wave detection
- Initial formation creation requires sophisticated control approach
- Autonomous operations and fault protection needed to avoid data outages

Jupiter Icy Moons Orbiter (JIMO)



- New propulsion and power concepts enable moon-hopping (Europa, Ganymede, Callisto)
- "Missions within a mission" highlights the need for a design approach to reusable software

Europa Cryobot / Hydrobot

QuickTime™ and a
decompressor
are needed to see this picture.