Engineering Resilient Space Systems Introduction to Short Course

Co-Leads

Leonard Reder, John Day, Mitch Ingham – JPL/Caltech

Richard Murray – Caltech

Brian Williams – MIT

July 30, 2012

CL#12-3209

Study Question?

How to conceive, develop and operate a future class of spacecraft that will require unprecedented resilience?

1. Ability to execute a mission with changing science objectives
2. Adaptability to unexpected changes in spacecraft health, performance, and/or the environment

- Study integrates concepts from another proposed study entitled *"New Space Exploration Concepts Enabled by Revolutionary Flight Software Architectures"*
- Question: ***What will spacecraft flight software look like in 25 years and why?***

What is a resilient control system?

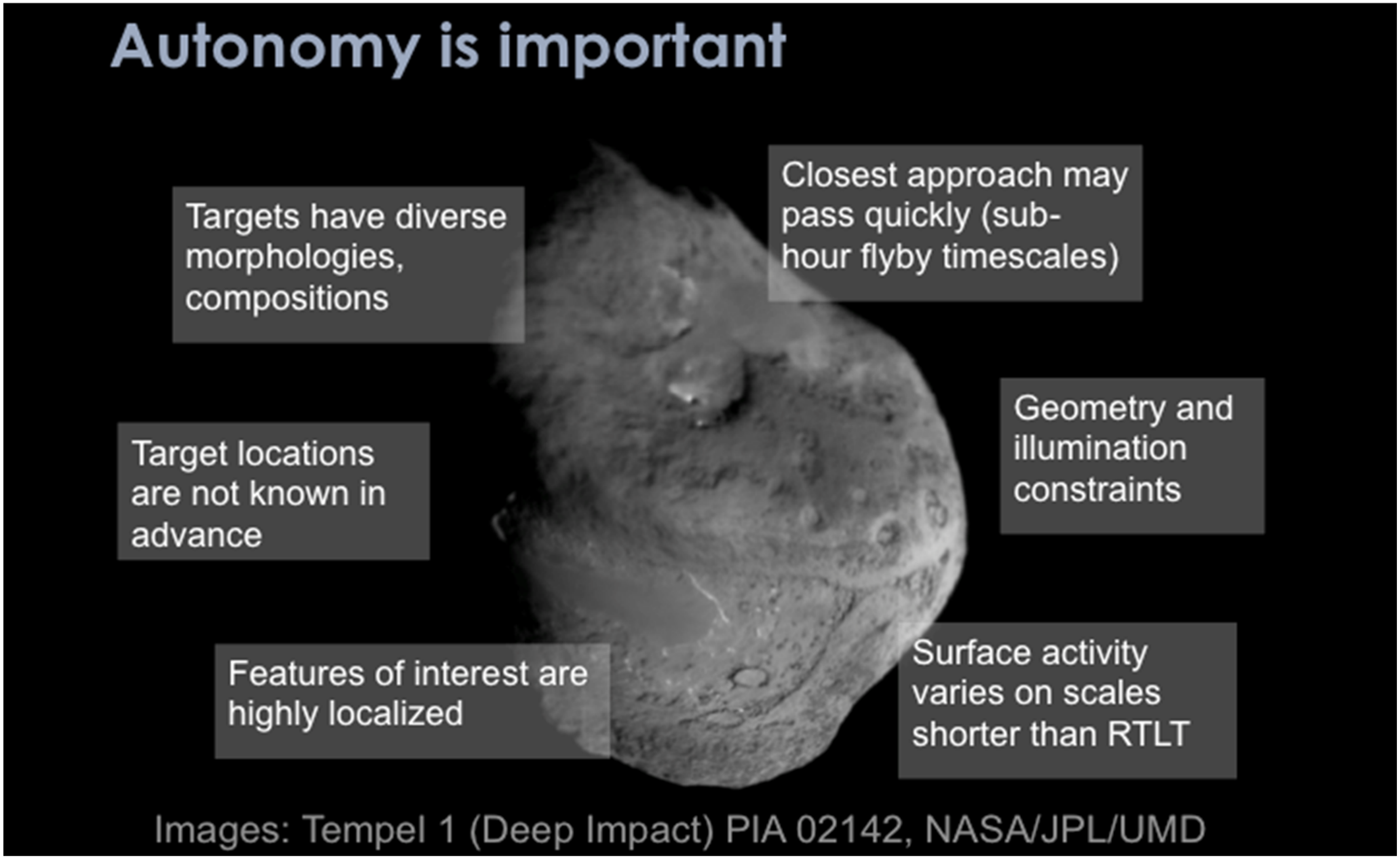
- From Wikipedia (Resilient Control Systems):
  - *"Resilient control systems are those that tolerate fluctuations via their structure, design parameters, control structure and control parameters"*
  - *"… is one that maintains state awareness and an accepted level of operational normalcy in response to disturbances, including threats of an unexpected and malicious nature"*

Resilience Engineering

- *"Resilience engineering is concerned with building systems that are able to circumvent accidents through anticipation, survive disruption through recovery, and grow through adaptation"*
  - *Failures represent inability to adapt*
  - *Opposite of resilience is "brittleness"*
    - *A system unsuitable to adapt to the unexpected is brittle!*
  - *Resilience implies "elasticity"*
    - *Systems with capability to return to original stable state after being bent, compressed or stretched by unexpected change*

"Towards a Conceptual Framework for Resilience Engineering"
Azad M. Madni and Scott Jackson
IEEE Systems Journal, Vol. 3, No. 2, June 2009

Autonomy Is Important



Short Course

- Resilient space systems engineering is inherently multidisciplinary!!
- Short course talks do not present resilient systems discussions, but rather, provide the context and background information to enable productive discussion of the topic
- Topics:
  1. *Principled System Architecture - Rasmussen*
  2. *Capturing FSW Architectures Using DSLs - Gostelow*
  3. *Control Theory and Methods - Murray*
  4. *Autonomy Practices - Williams*
  5. *Ultra-Reliability for Interstellar Missions - Garrett*

Engineering Resilient Space Systems
July 30 - August 3 2012
Overview Schedule

Monday, July 30, 2012 - Hameetman Auditorium - Cahill Building		
Time	**Short Course - Open to All Interested Parties**	**Speaker**
8:00 - 8:30	Coffee and refreshments	
8:30 - 8:45	Introduction to Short Courses - What is a resilient system?	Team Leads; Short Courses Moderated By: Len Reder
8:45 - 10:00	Principled System Architecture (includes 15 minutes for Q+A)	Robert Rasmussen
10:00-10:30	Break (Coffee, Discussion)	
10:30-11:45	Capturing Flight Software Architecture using DSLs (includes 15 minute for Q+A)	Kim Gostelow
11:45 - 12:45	On site, informal lunch provided by KISS for all short course attendees	
12:45 - 2:00	Control Theory and Methods (includes 15 minutes for Q+A)	Richard Murray
2:00 - 2:30	Break (Coffee, Discussion)	
2:30-3:45	Autonomy Practices (includes 15 minutes for Q+A)	Brian Williams
3:45-5:00	Ultra-Reliability for Interstellar Missions (includes 15 minutes for Q+A)	Henry Garrett
5:00	SHORT COURSE CONCLUDES	