

ICRA 2012
WORKSHOP 8:
ROBOTIC SATELLITE SERVICING

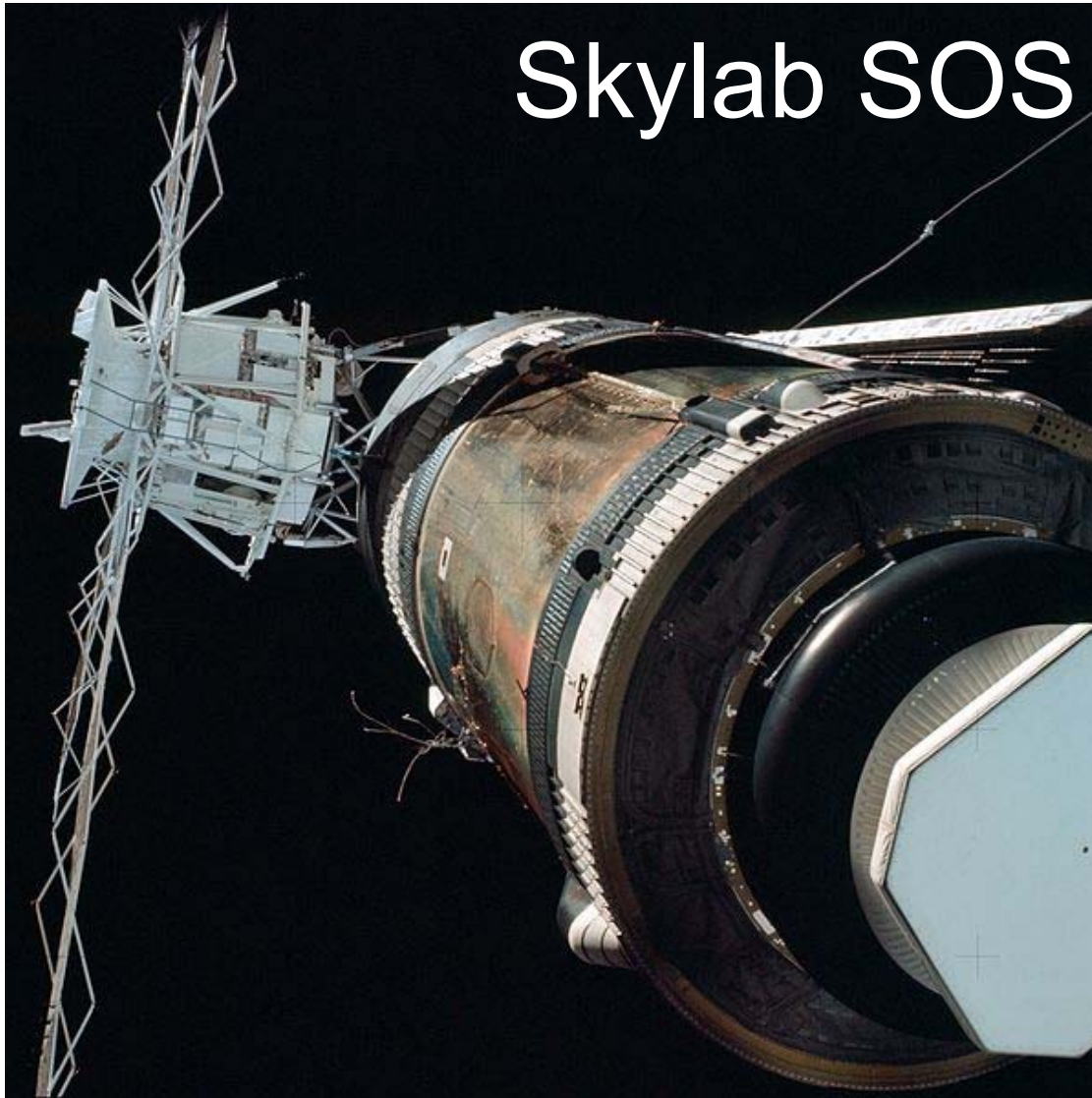
ORGANIZERS:

CRAIG CARIGNAN, UNIVERSITY OF MARYLAND, USA
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WENDELL CHUN, UNIVERSITY OF DENVER, USA

**IEEE International Conference on
Robotics & Automation (ICRA),
St. Paul, Minnesota, May 14, 2012**

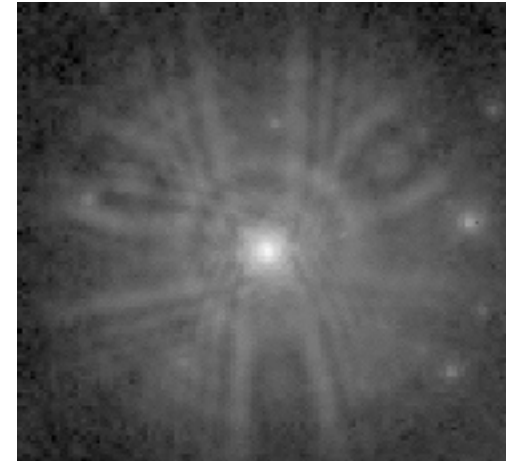


Nobody thought that much about fixing things in space until Skylab happened ...



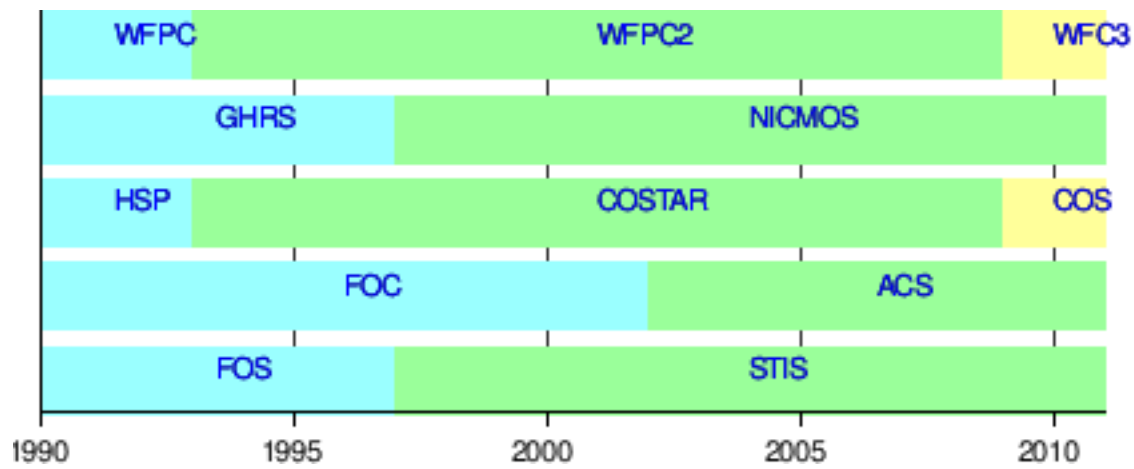
A view of the Skylab 1 space station Orbital Workshop showing the micrometeoroid shield missing. A parasol solar shield was later deployed to shade this exposed area. This picture was taken from the Skylab 2 Command/Service Module during its "fly around" inspection. The Apollo Telescope Mount is in the background. The damaged and partially deployed OWS solar array system wing is at lower right. After an aluminum strapping was cut during the June 7th extravehicular activity, the solar panel fully deployed. The OWS solar panel on the opposite side was completely ripped off during the Skylab 1 launch on May 14th leaving only cables and tubing. (Wikipedia)

Then came the "Hubble Trouble" ...



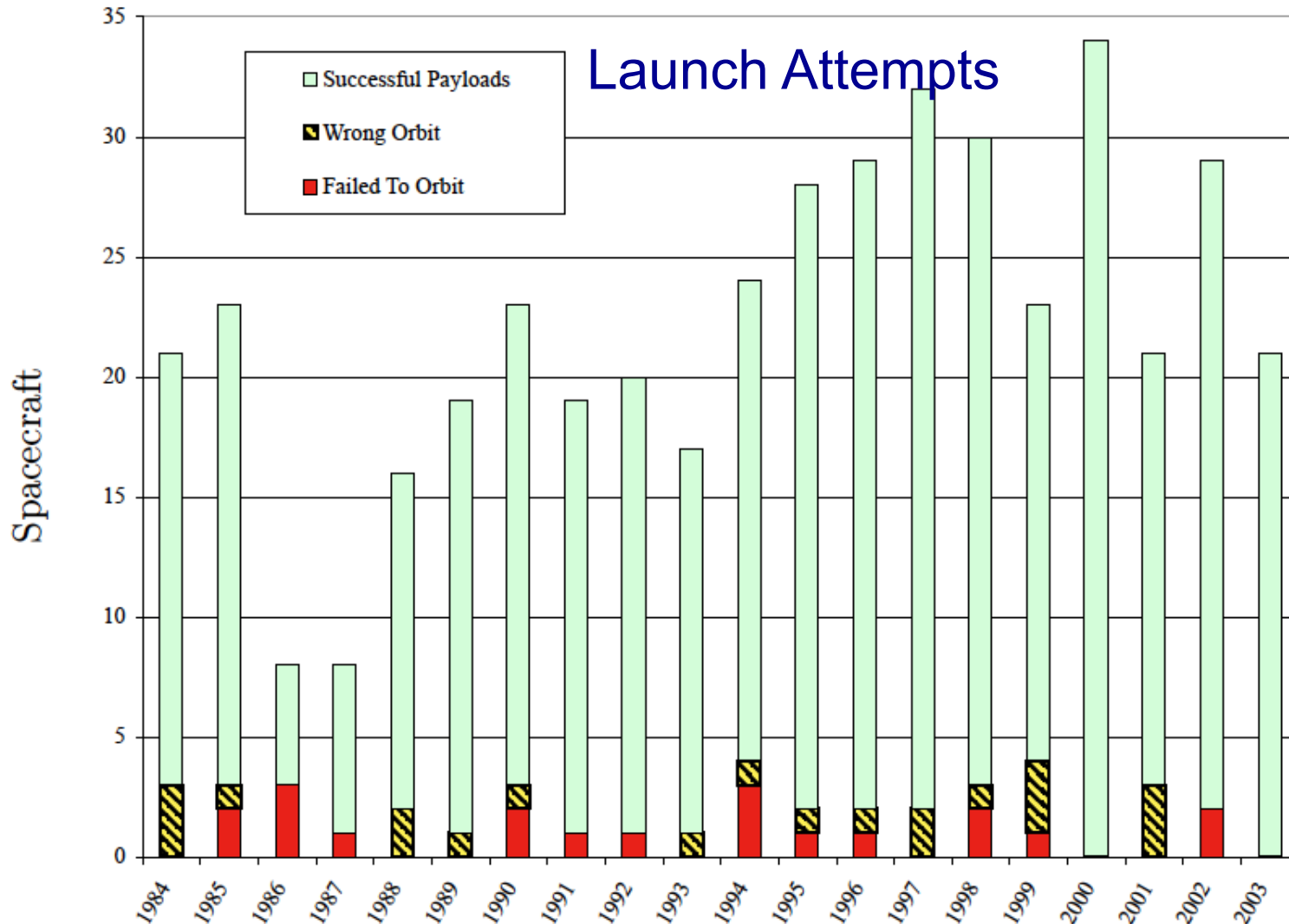
WHAT???

Instruments replacement over five servicing missions



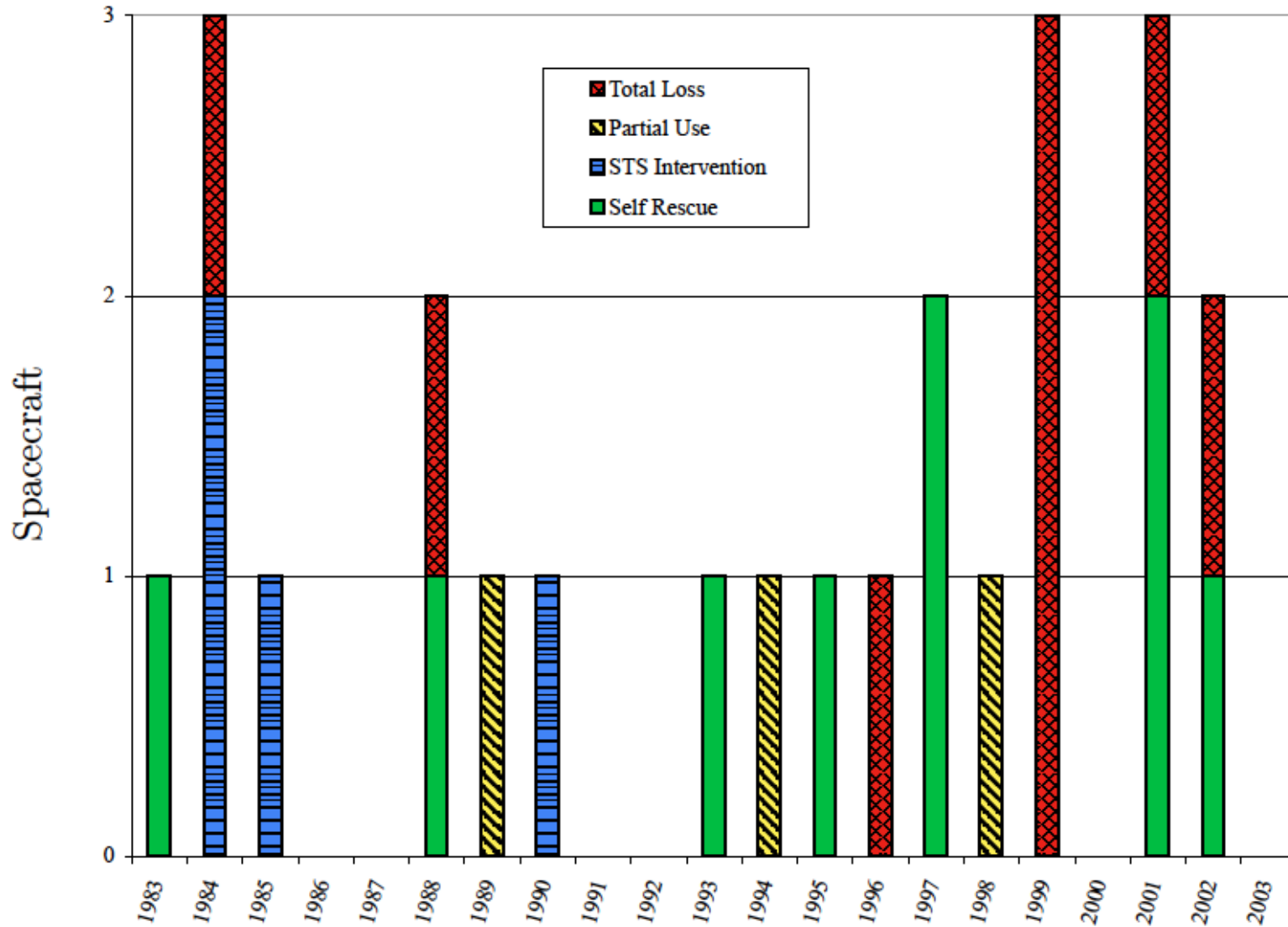
Before / After

So what about GEO satellites?

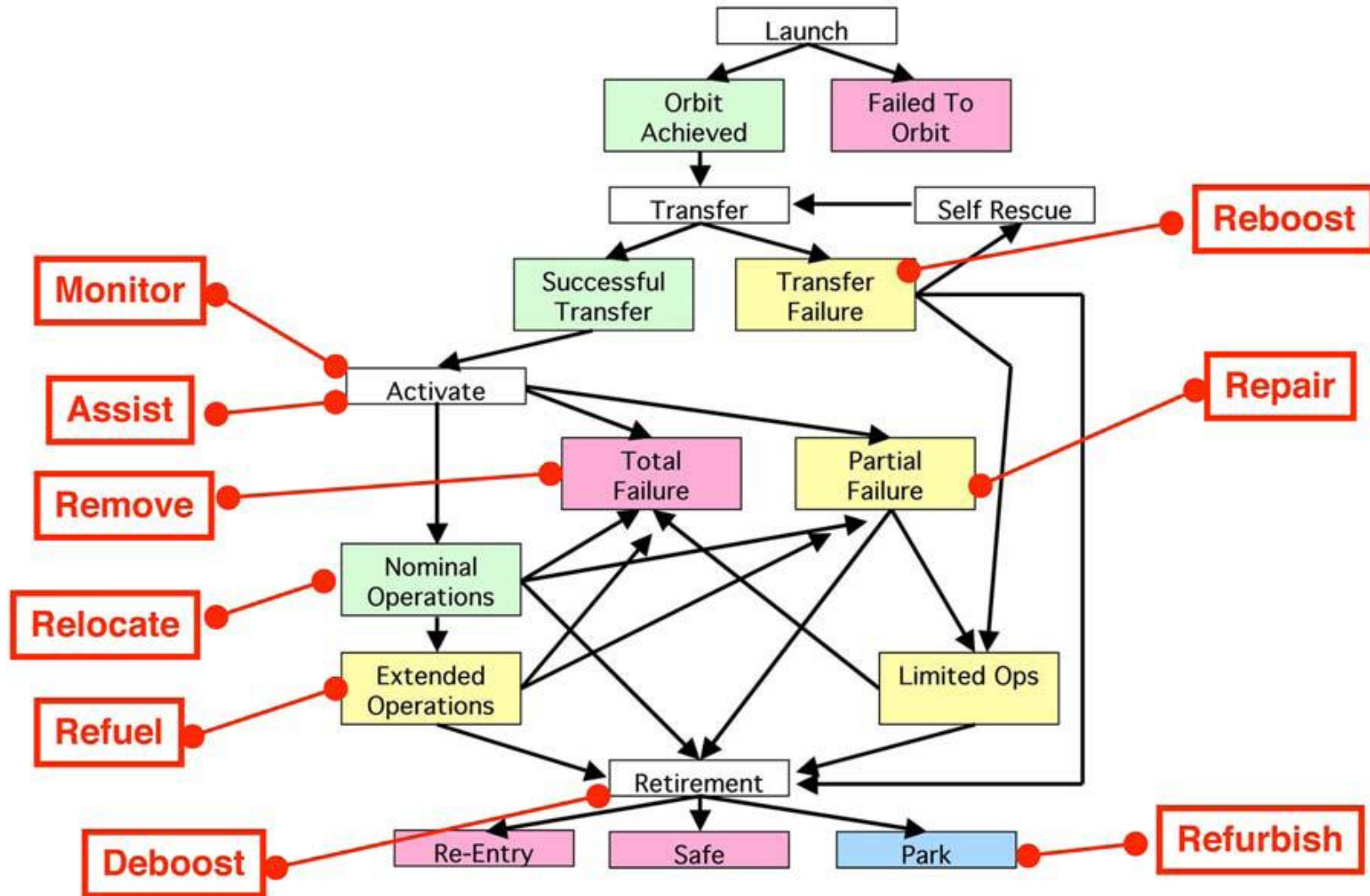


Sullivan, B., *Technical and Economic Feasibility of Telerobotic On-Orbit Servicing*, Ph.D. dissertation, University of Maryland, 2005.

Resolution of Satellite Anomalies

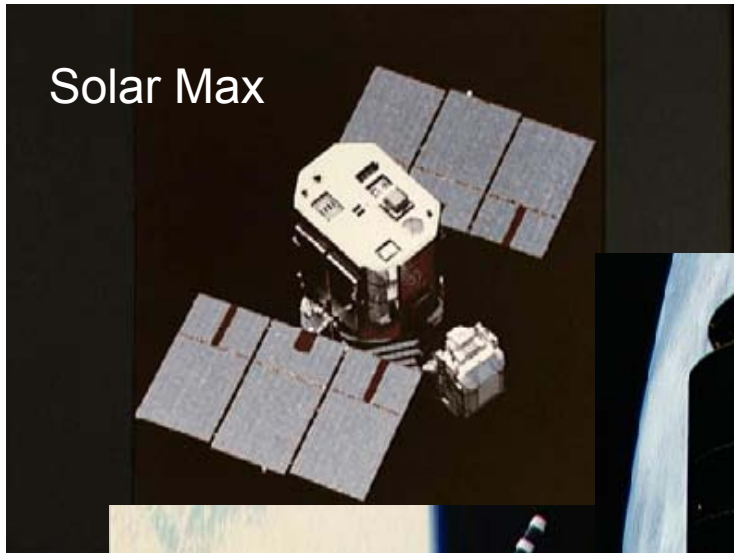


Life Cycle Path with Intervention



(Sullivan, 2005)

A few got rescued ...



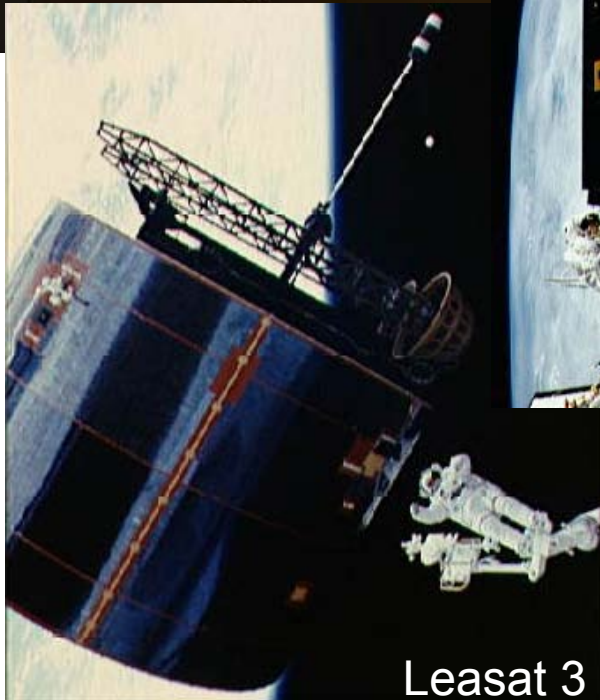
Solar Max



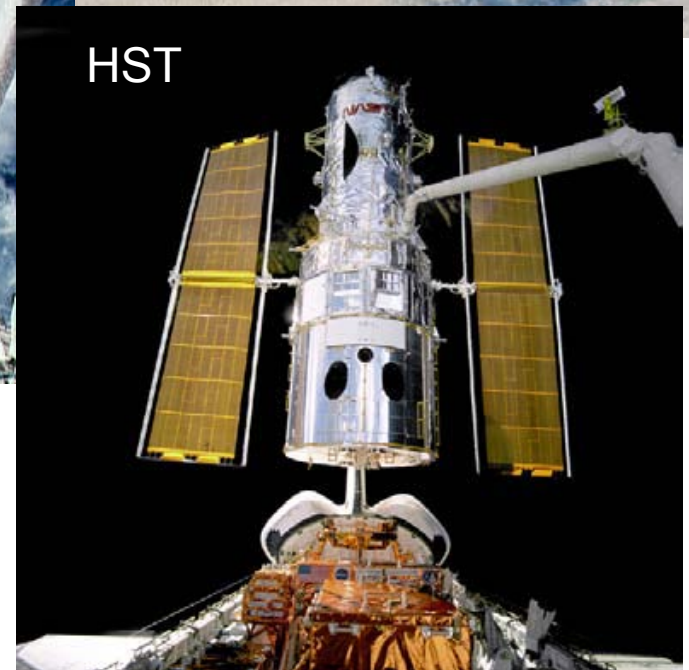
Westar 6



Intelsat 603



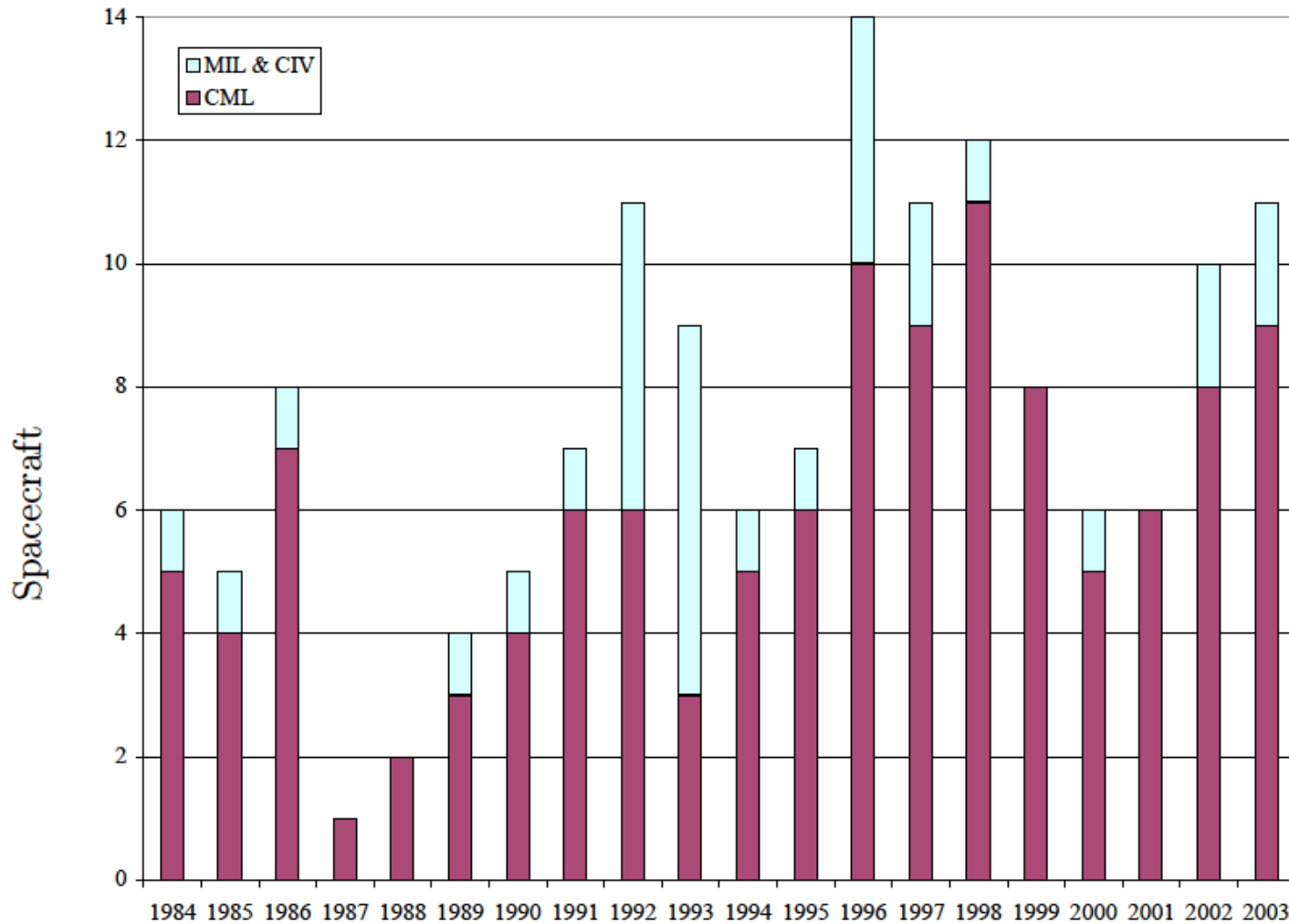
Leasat 3



HST

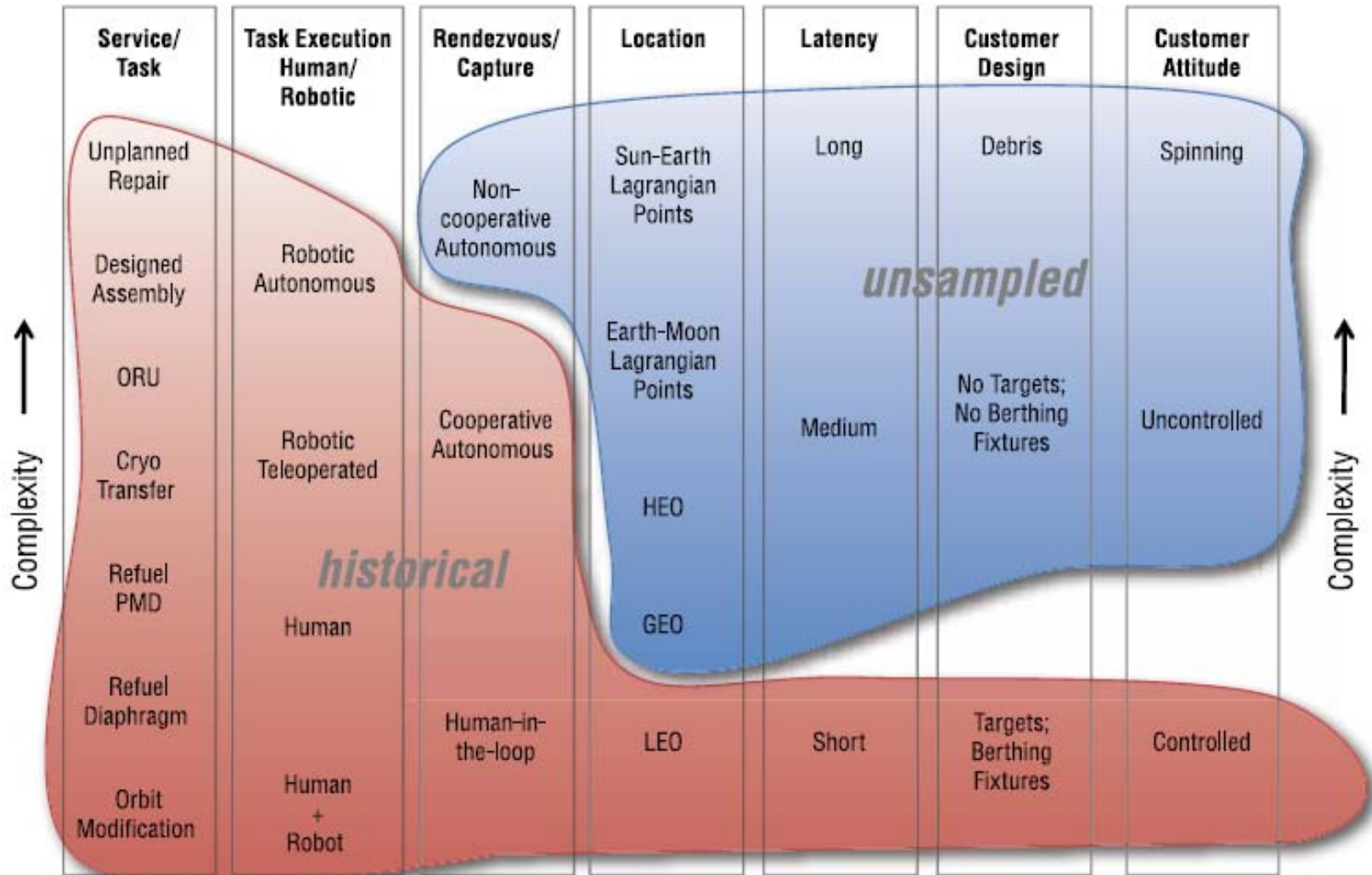
Can we also prolong their useful life?

Satellites Retiring from 1984 to 2003



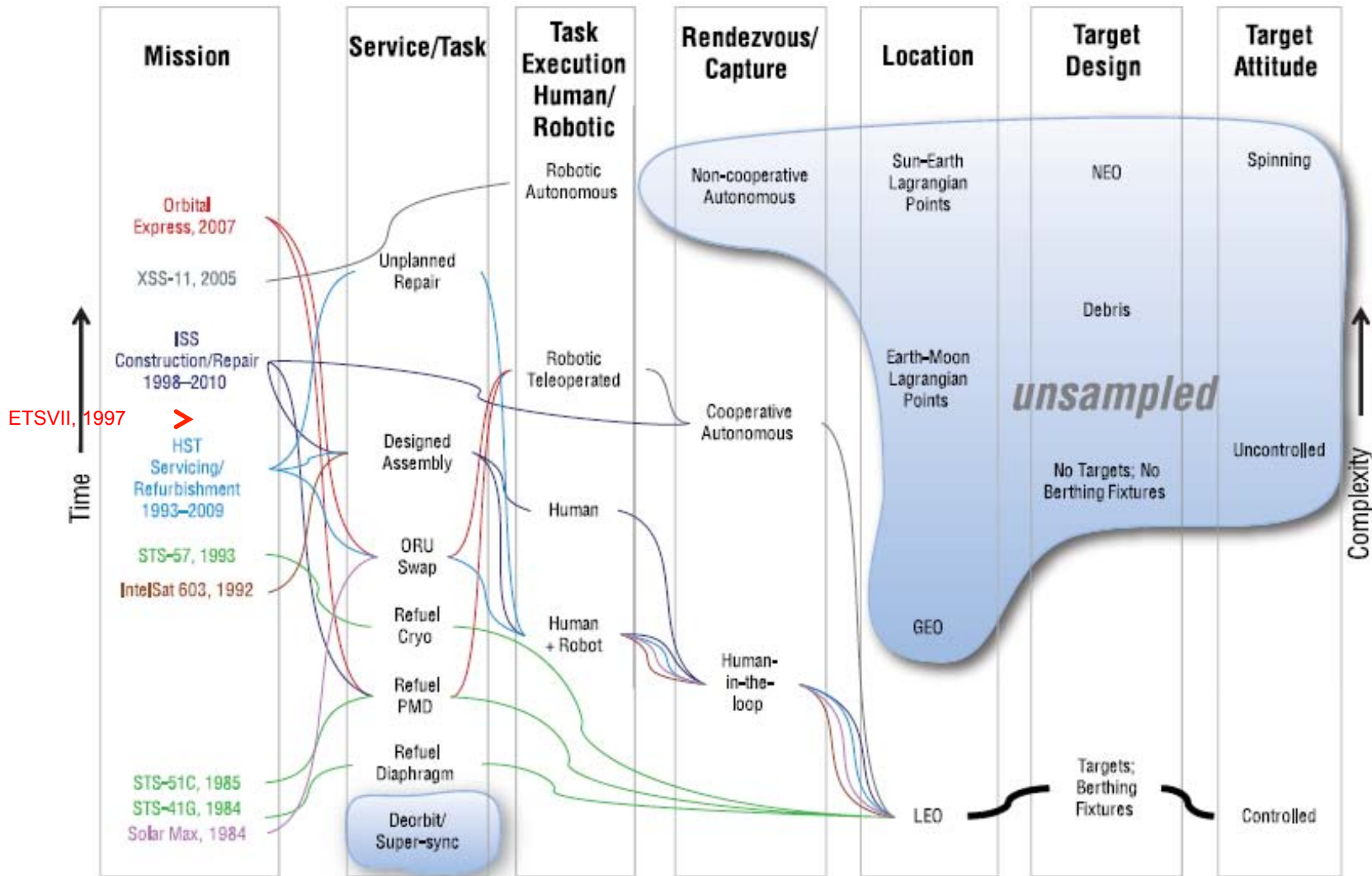
(Sullivan, 2005)

Servicing Study Trade Space



On-Orbit Satellite Servicing Study: Project Report, NASA Goddard Space Flight Center, October 2010
 (http://ssco.gsc.nasa.gov/images/NASA_Satellite%20Servicing_Project_Report_0511.pdf)

Seminal Missions To-Date



On-Orbit Satellite Servicing Study: Project Report, NASA Goddard Space Flight Center, October 2010.

Workshop Objectives

- ❑ Discuss the priorities of the IEEE Technical Committees in related technology areas
- ❑ Survey the most current results in robotic satellite servicing
- ❑ Invent new strategies that can capitalize on links to other technology sectors
- ❑ Develop plans for future seminal missions that explore the unsampled trade space

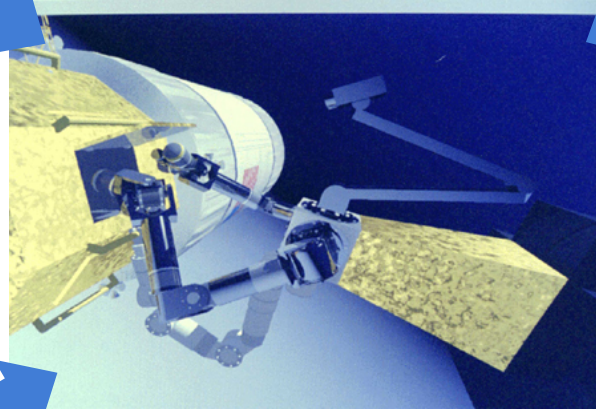
Leveraging Technologies



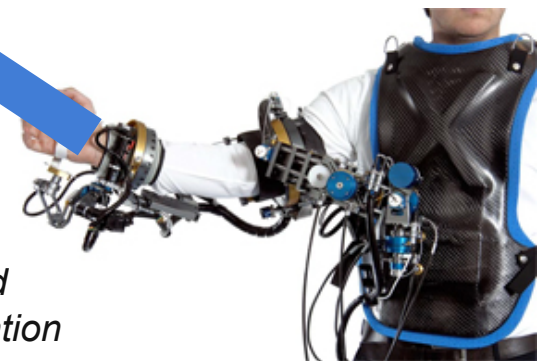
*underwater
servicing &
inspection*



*autonomous
mapping &
navigation*



*minimally
invasive
robotic
telesurgery*



*advanced
teleoperation
and human
interfaces*

Schedule

08:40 – 10:00	Session I: IEEE TC Perspectives
10:00 – 10:30	Coffee Break
10:30 – 11:30	Session II: Autonomous Rendezvous & Docking
11:30 – 11:50	Session III: Servicing Systems
11:50 – 13:30	LUNCH (on your own)
13:30 – 14:50	Session III (cont'd)
14:50 – 15:50	Session IV: Robotic Manipulation
15:50 – 16:30	Coffee Break
16:30 – 16:50	Session IV (cont'd)
16:50 – 17:30	Closing Panel Discussion

Detailed Agenda

SESSION 1: IEEE TECHNICAL COMMITTEE PERSPECTIVES

- 8:40 **Telerobotics TC**
Jordi Artigas Esclusa (German Aerospace Center)
- 9:00 **Marine Robotics TC**
Giacomo Marani (West Virginia University Research Center)
- 9:20 **Space Robotics TC**
Kazuya Yashida (Tohoku University)
- 9:40 **Panel Discussion**
Esclusa, Marani, Yashida
- 10:00 **COFFEE BREAK**

SESSION 2: AUTONOMOUS RENDEZVOUS & DOCKING

- 10:30 **Supervisory Control Tool for Servicing AR&D**
John Ringelberg – Lockheed-Martin, Corp.
- 10:50 **Autonomous Rendezvous and Docking and
Relative Navigation Systems for Robotic
Servicing**
Kevin Miller – Ball Aerospace
- 11:10 **Maturation of AR&D algorithms with
SPHERES**
*Alvar Saenz-Ontero – MIT Space Systems
Laboratory*

SESSION 3: SERVICING SYSTEMS

- 11:30 **Underwater Servicing**
Hans Thomas – Monterey Bay Research Aquarium
- 11:50 **LUNCH BREAK** (on your own)
- 13:30 **Simulation of On-Orbit Servicing Tasks in Neutral Buoyancy**
David Akin – University of Maryland Space Systems Laboratory
- 13:50 **ETS-VII, a Precursor for the Space Station Logistic Support and Satellite Servicing**
Mitsushige Oda – Japan Aerospace Exploration Agency
- 14:10 **Robotics Servicing Challenges**
Brian Roberts – NASA Goddard Space Flight Center
- 14:30 **Overview of the DARPA Phoenix Mission**
Glen Henshaw – U.S. Naval Research Laboratory

SESSION 4: ROBOTIC MANIPULATION

- 14:50 **Enabling Technologies for Remote Robotic
Telemanipulation with Time Delay**
Peter Kazanzides – Johns Hopkins University
- 15:10 **Towards semi-autonomous grasping of a non-
cooperative target**
Robert Lamperiello – DLR Robotic Mechatronic Center
- 15:30 **The FRENDA Robotic Arm**
Sean Dougherty – MDA-US (Alliance Space Systems)
- 15:50 **COFFEE BREAK**
- 16:30 **Robonaut 2 Status**
Nicolaus Radford – NASA Johnson Space Center
- 16:50 **CLOSING PANEL DISCUSSION**
- 17:30 **END OF WORKSHOP**