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# Near-Term Servicing Plans: A Canadian Perspective

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*THE SECOND INTERNATIONAL WORKSHOP  
ON ON-ORBIT SATELLITE SERVICING*

May 30 — May 31 ■ NASA's Goddard Space Flight Center ■ Greenbelt, Md.



# Outline

- Canadian Heritage
- Current Activities
- Future Opportunities
  - ◆ LEO
  - ◆ Exploration
- Conclusion
- Questions for Panel



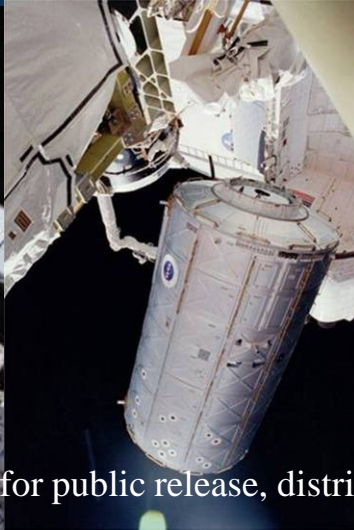
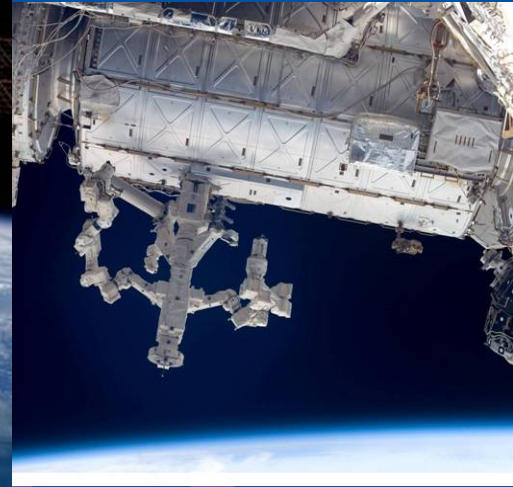


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# 30 Years of Robotic Operations on Shuttle / Station



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# NASA Shuttle Canadarm (1981 – 2011)



**Servicing of Hubble  
Space Telescope**



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# Participation in International On-Orbit Servicing (OOS) Forums

## ■ International Workshop on OOS, Cologne, Germany, 2002

- ◆ [http://www.on-orbit-servicing.com/workshop\\_2002/index02.html](http://www.on-orbit-servicing.com/workshop_2002/index02.html)
- ◆ [http://www.on-orbit-servicing.com/workshop\\_2002/OOS-Docs-ST6-1/2-2.pdf](http://www.on-orbit-servicing.com/workshop_2002/OOS-Docs-ST6-1/2-2.pdf)

## ■ International Workshop on OOS, Vancouver, Canada, 2004

- ◆ [http://www.on-orbit-servicing.com/workshop\\_2004/index04.html](http://www.on-orbit-servicing.com/workshop_2004/index04.html)
- ◆ [http://www.on-orbit-servicing.com/pdf/OOS2004\\_presentations\\_pdf/SettingTheScene\\_Piedboeuf.pdf](http://www.on-orbit-servicing.com/pdf/OOS2004_presentations_pdf/SettingTheScene_Piedboeuf.pdf)

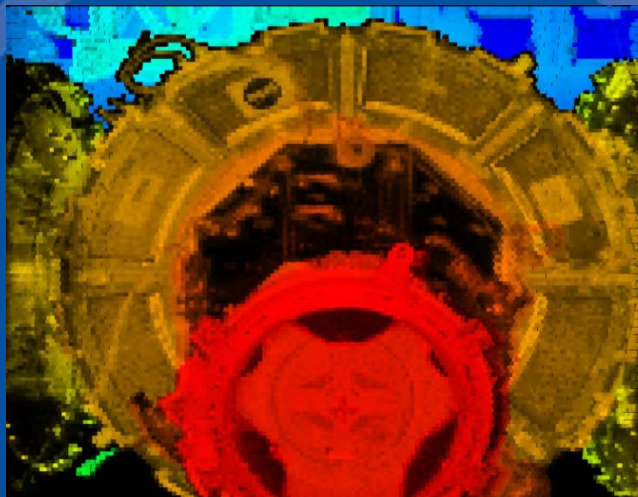
## ■ International Workshop on OOS, GSFC, Greenbelt, MD, 2010

- ◆ [http://ssco.gsfc.nasa.gov/workshop\\_2010.html](http://ssco.gsfc.nasa.gov/workshop_2010.html)
- ◆ [http://ssco.gsfc.nasa.gov/workshop\\_2010/day2/Daniel\\_Rey/GSFC\\_RFI\\_CSA\\_Presentation\\_RevA\\_May2010.pdf](http://ssco.gsfc.nasa.gov/workshop_2010/day2/Daniel_Rey/GSFC_RFI_CSA_Presentation_RevA_May2010.pdf)

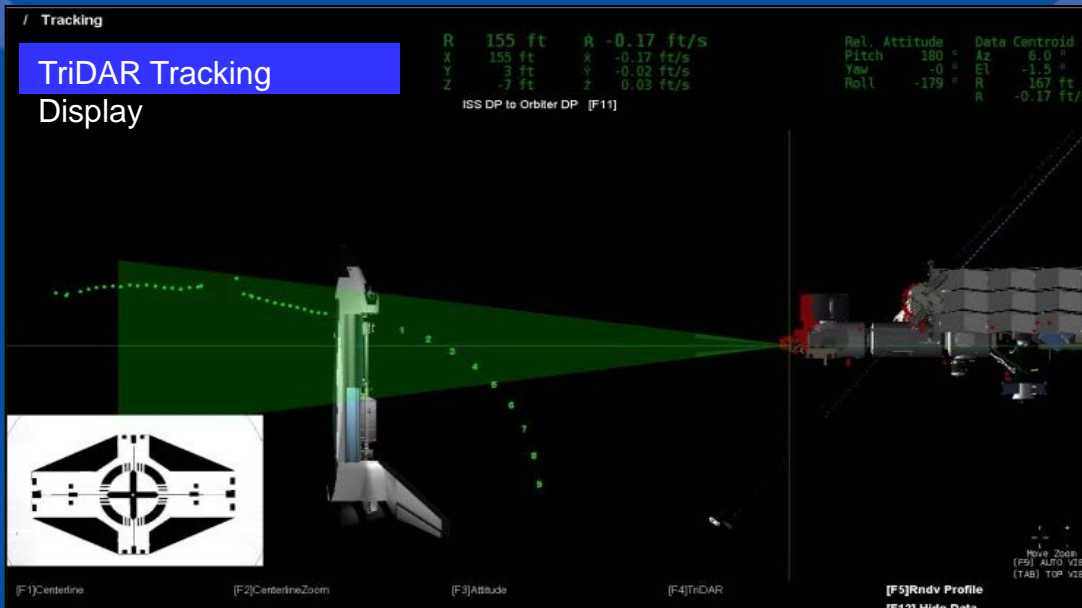
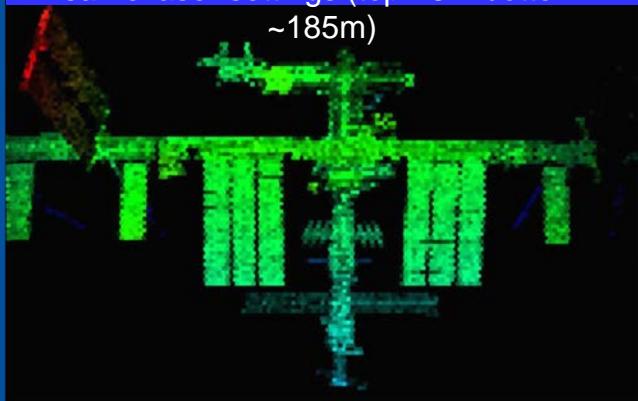




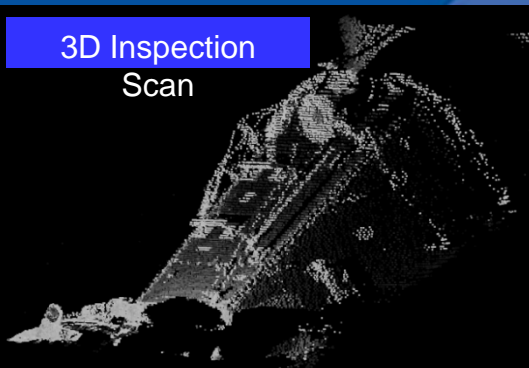
# STS-135 TriDAR DTO - Video



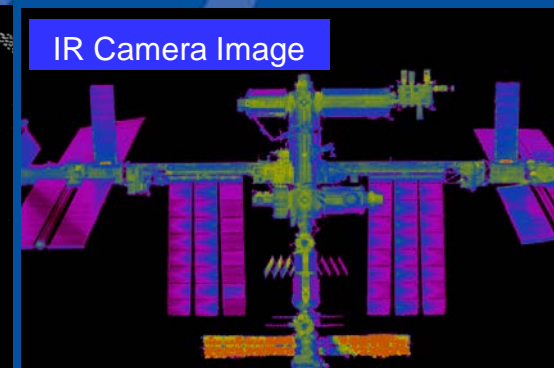
Color Coded 3D Range Images using  
same laser settings (top ~8m bottom  
~185m)



3D Inspection  
Scan



IR Camera Image







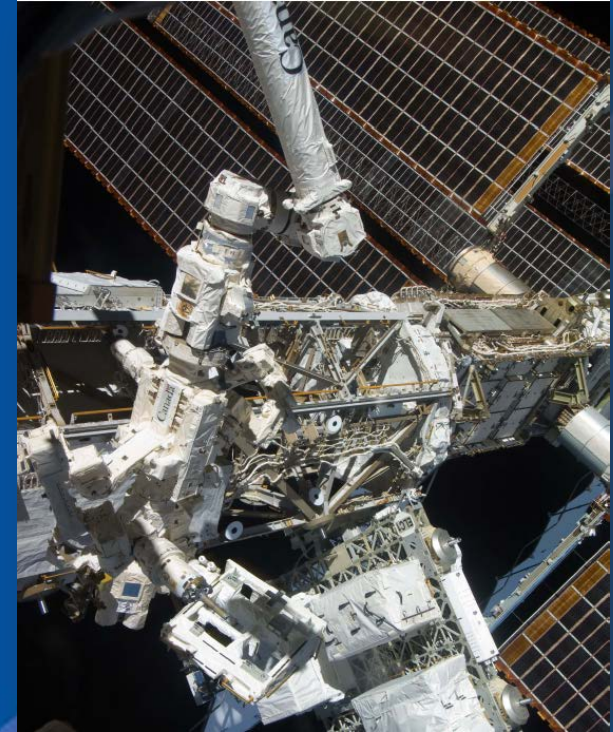
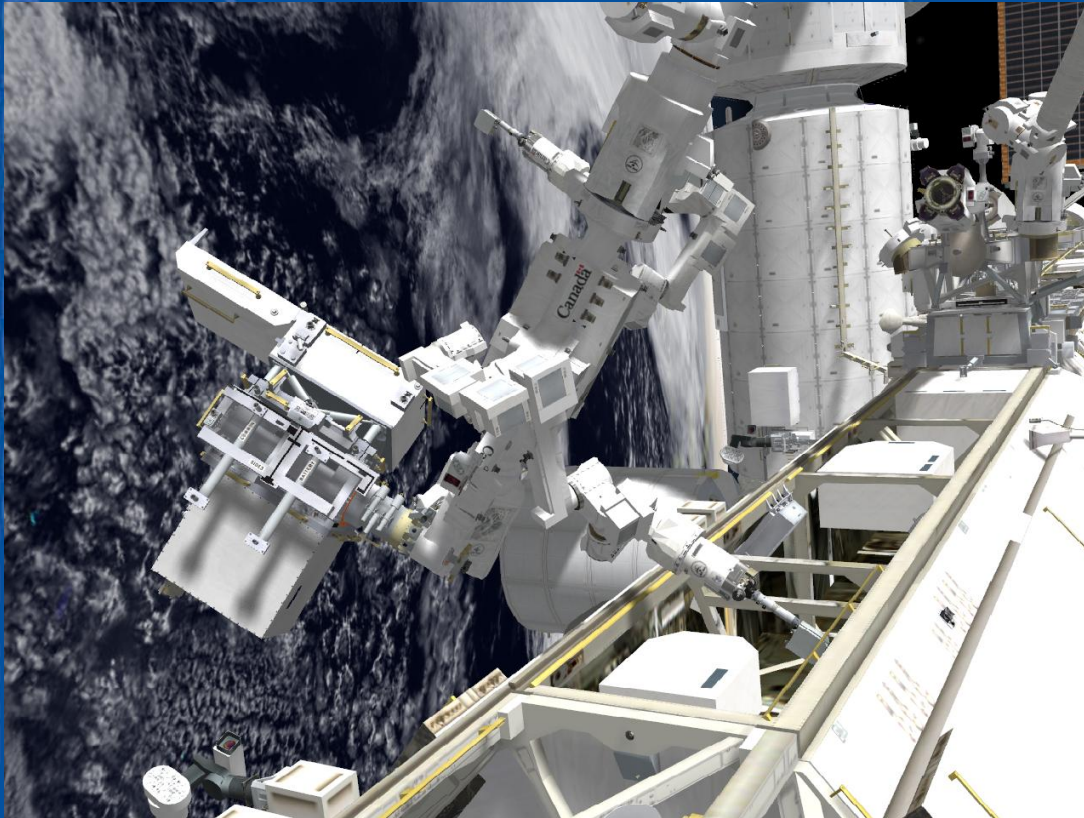
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# On-Going Servicing Activities on ISS

- Using Dextre to perform an RPCM replacement



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# On-Going Servicing Activities on ISS

## ■ Robotic Refuelling Mission

- ◆ MSS arms and end-effectors
- ◆ CSA Ops support
- ◆ Achieved new performance levels
- ◆ Collaboration with GSFC
  - ◆ Tools
  - ◆ Task boards







# Next Generation Canadarm

- Funded by Canada's Economic Action Plan, from Budget 2009.
  - ◆ Project completion: March 31, 2012
- Prime contractor: MDA, Brampton
- Project objectives:
  - ◆ Develop terrestrial prototypes of next generation of Canadarm for on-orbit servicing
  - ◆ Deliver four testbeds and two control stations:
    - ◆ Next Generation Small Canadarm (NGSC)
    - ◆ Next Generation Large Canadarm (NGLC)
    - ◆ Proximity Operations Station (POST)
    - ◆ Semi-Autonomous Docking System (SADS)
    - ◆ Mission Operations Station (2x) (MOS)
  - ◆ Demonstrate functionalities that are pertinent to on-orbit robotic servicing



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# Next Generation Canadarm

**NGSC** ("Next Gen. Small Canadarm")

**NGLC** ("Next Gen. Large Canadarm")

Mission Operations Station

**POST** ("Proximity Operations System Testbed")

**SADS** ("Semi-Autonomous Docking System")



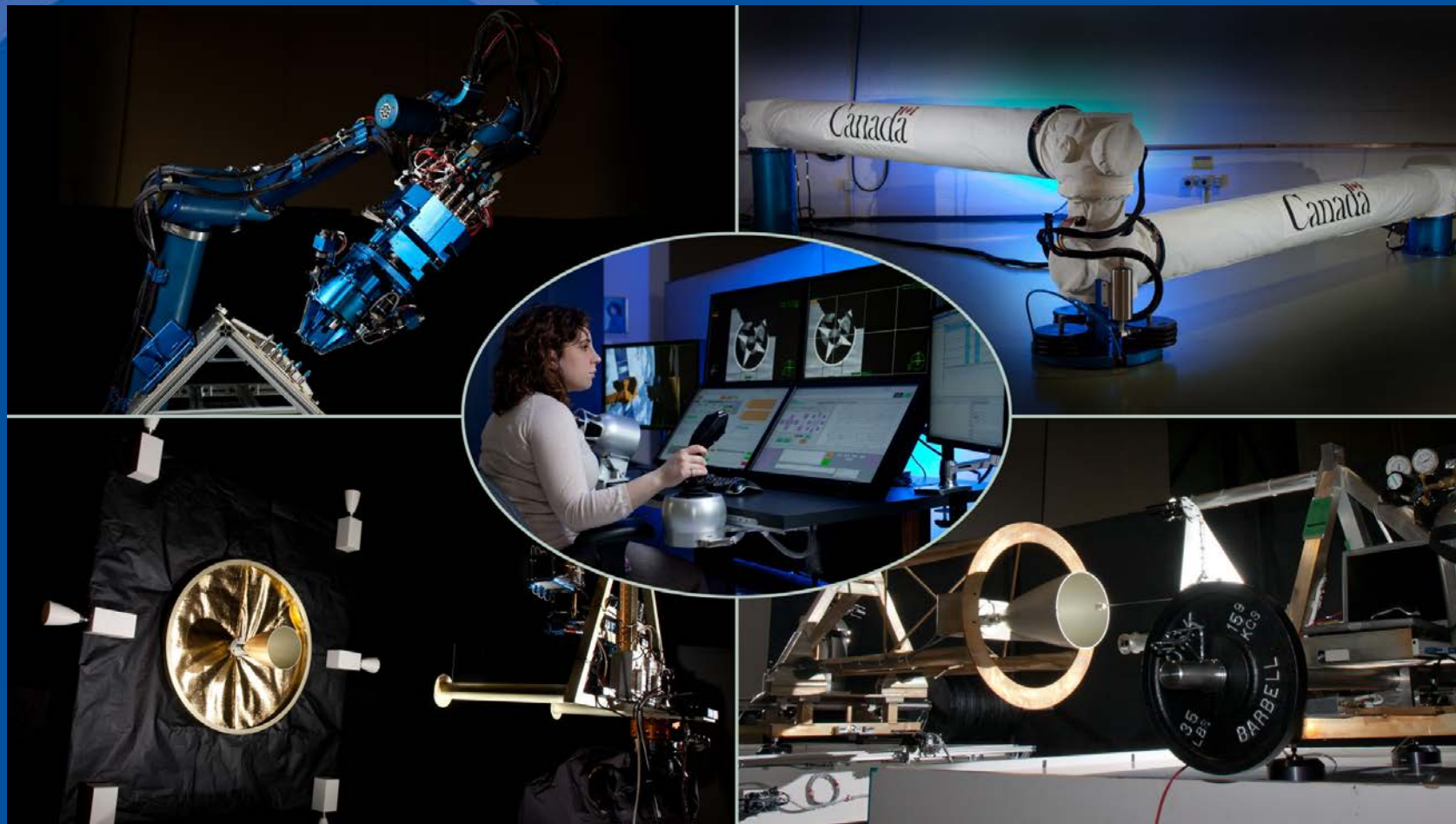


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# NGC - Video



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# MSS Evolution

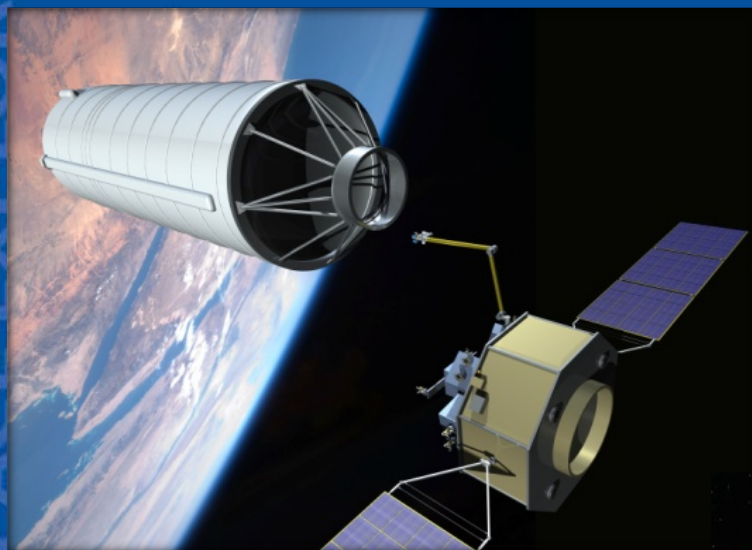
- Advanced Dextre Tools DTOs
  - Reduce EVA time, maximize robotic servicing capabilities
  - Demonstrate NGC tool technologies
  - Inspection and camera tools
- Advance Canadarm 2 capabilities
  - New camera systems
  - Visual servoing
    - Auto-capture of fixed object, e.g. ORU
    - Auto-capture of free-flyers, e.g. cargo vehicles, satellites
  - Semi-Autonomous operations, minimize crew time
- DTOs to support future exploration endeavours
  - Optical Testbed and Integration on ISS eXperiment (OPTIIX)
  - Telescopic boom featuring a high packing ratio making it compatible with size of future exploration vehicles
  - Autonomous inspection & servicing



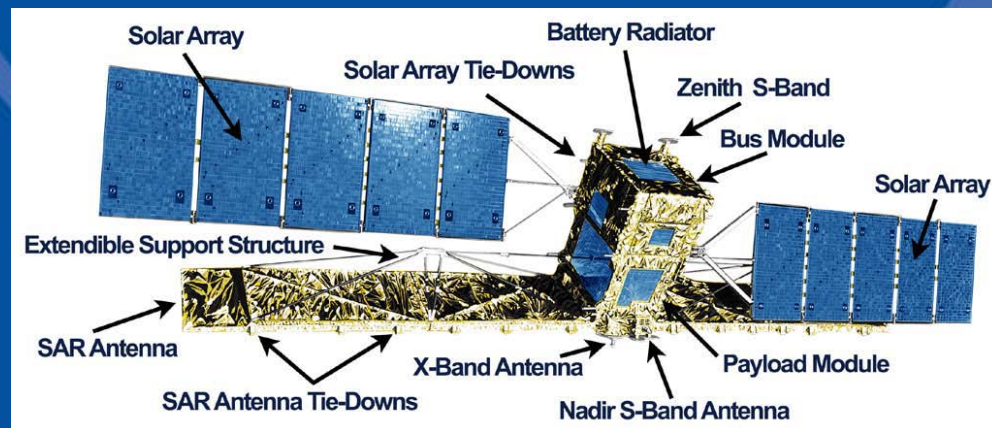


# OOS Future Opportunities

## LEO



Orbital Debris Removal



Legacy Government Satellites,  
e.g. Radarsat 1



Source: ESA

Failed Satellites,  
e.g. Envisat



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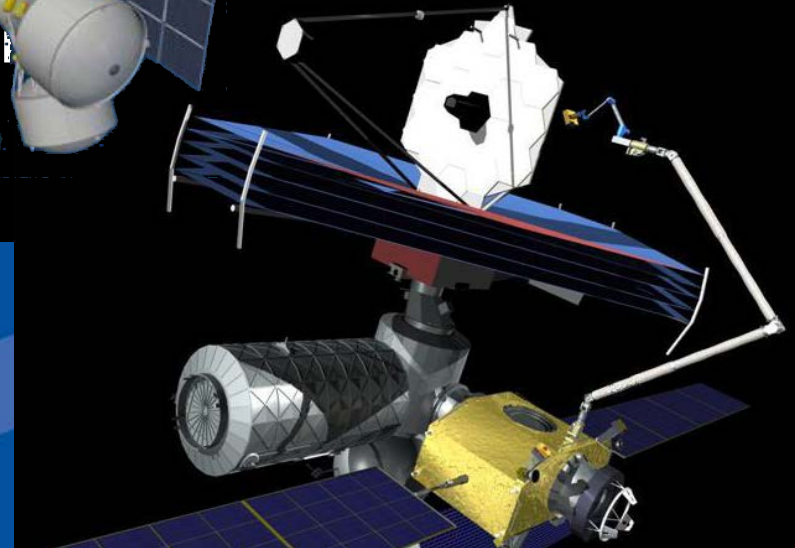
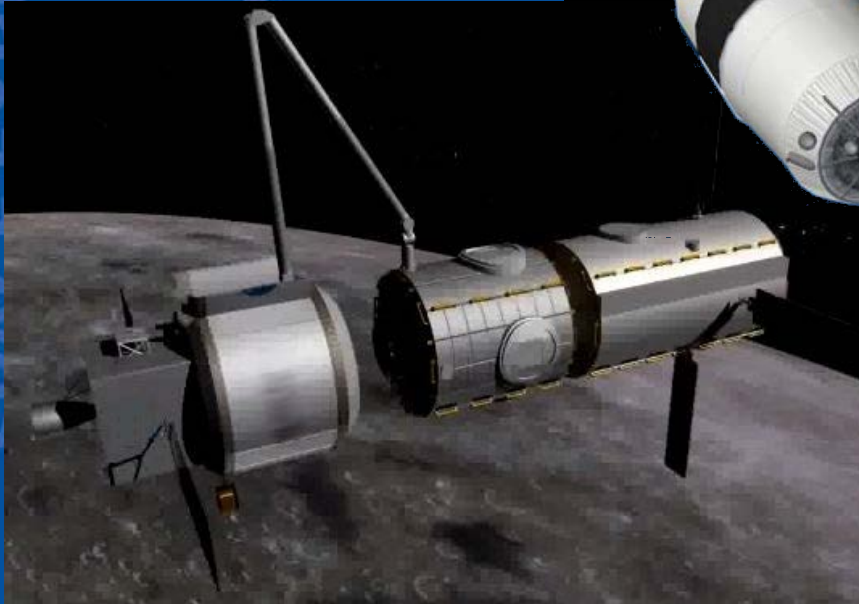
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# OOS Future Opportunities

## ■ Exploration

Fuel Depot



EML Spacecraft

Next Gen. Astronomy Satellite

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# Conclusions

- OOS has been considered for many years
- Technologies enabling OOS are mature
- OOS has been achieved through collaboration
- Many OOS opportunities require International participation/agreements
- CSA is open for collaboration



# Questions for Panel

- Why OOS now?
- What are the key enablers for a commercial success?
- What can governments, agencies do to enable OOS?

