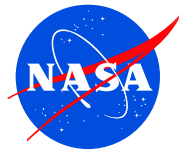


ISS International Partner Relationships  
AIAA Conference  
January 11, 2007

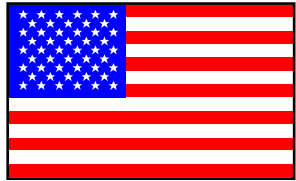


Dan Jacobs  
Manager, Partners  
External Integration  
ISS Program

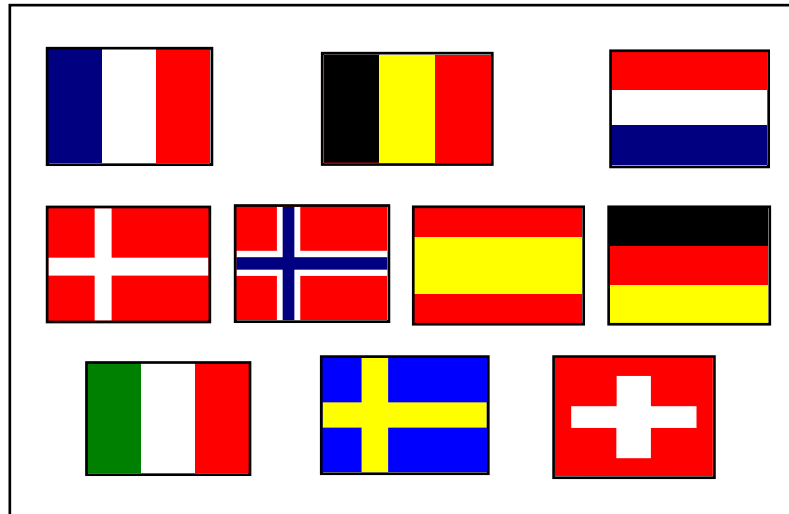


# International Space Station Program Partnerships

United States



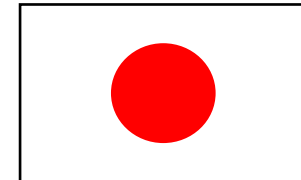
Canada



European Space Agency (ESA)

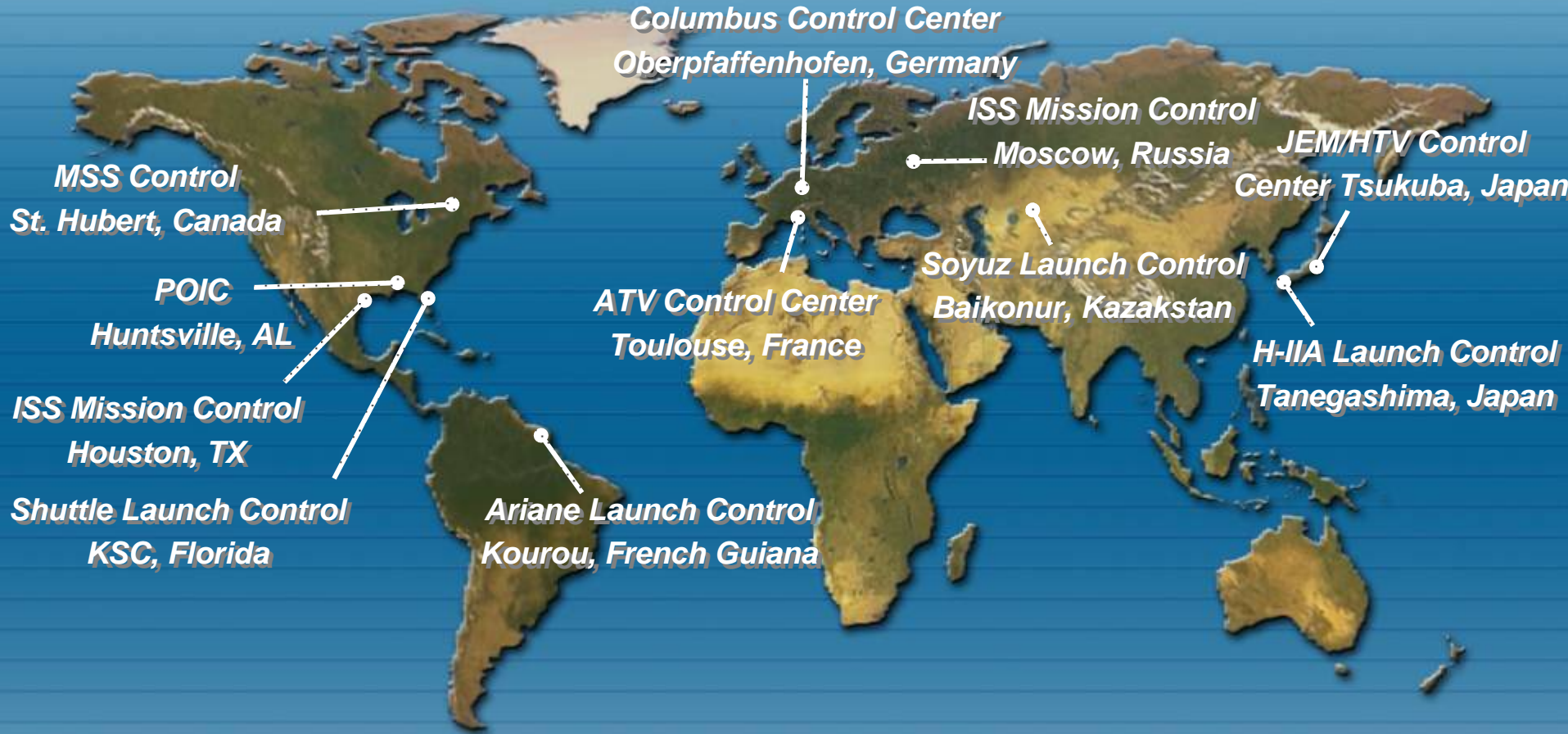
**France, Belgium, Netherlands, Denmark,  
Norway, Spain, Germany, Italy, Sweden,  
Switzerland**

Russia



Japan

# NASA and International Partner Operations



United States



Russia



Canada

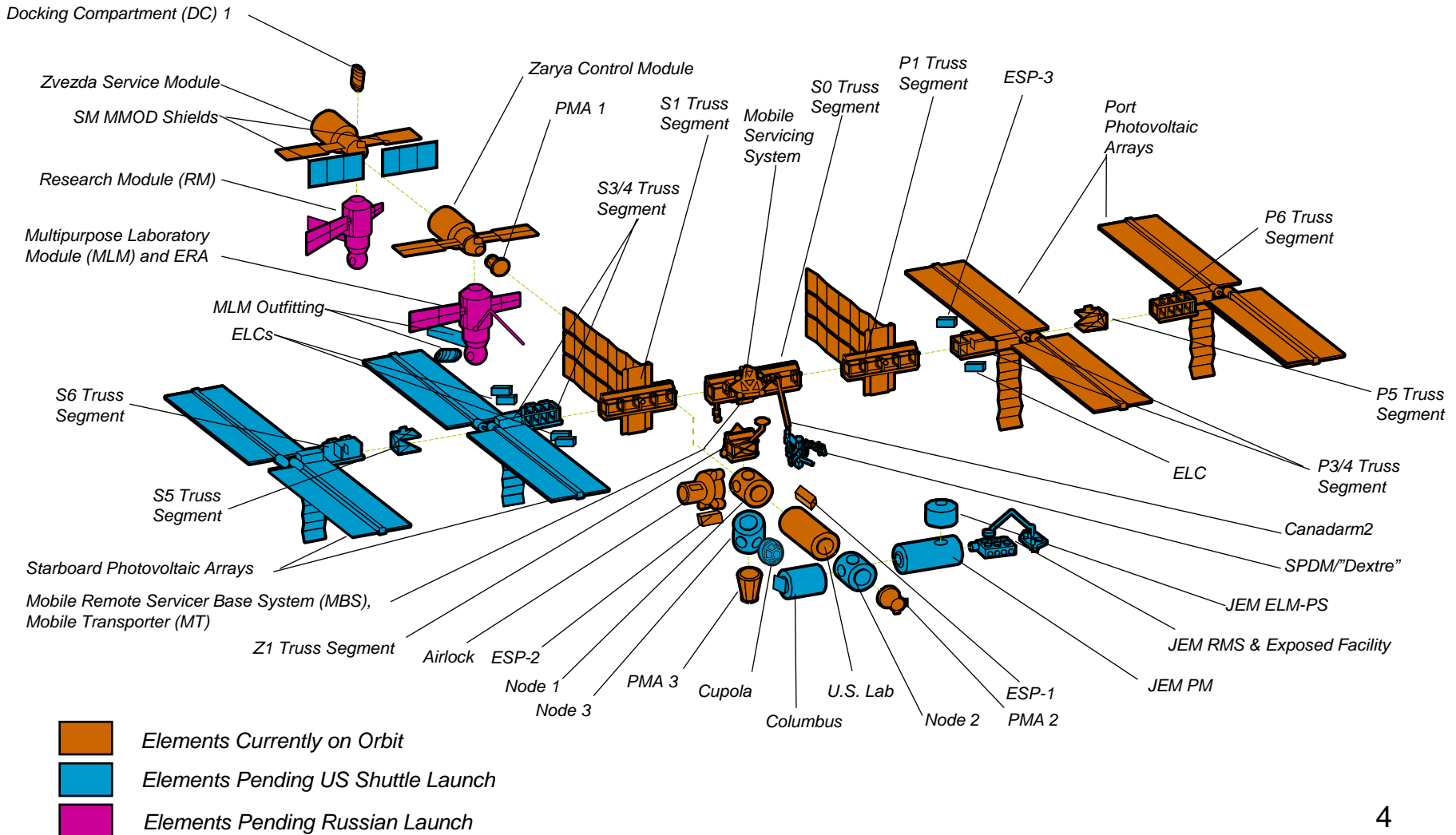


Europe



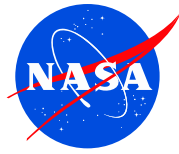
Japan

# ISS Configuration

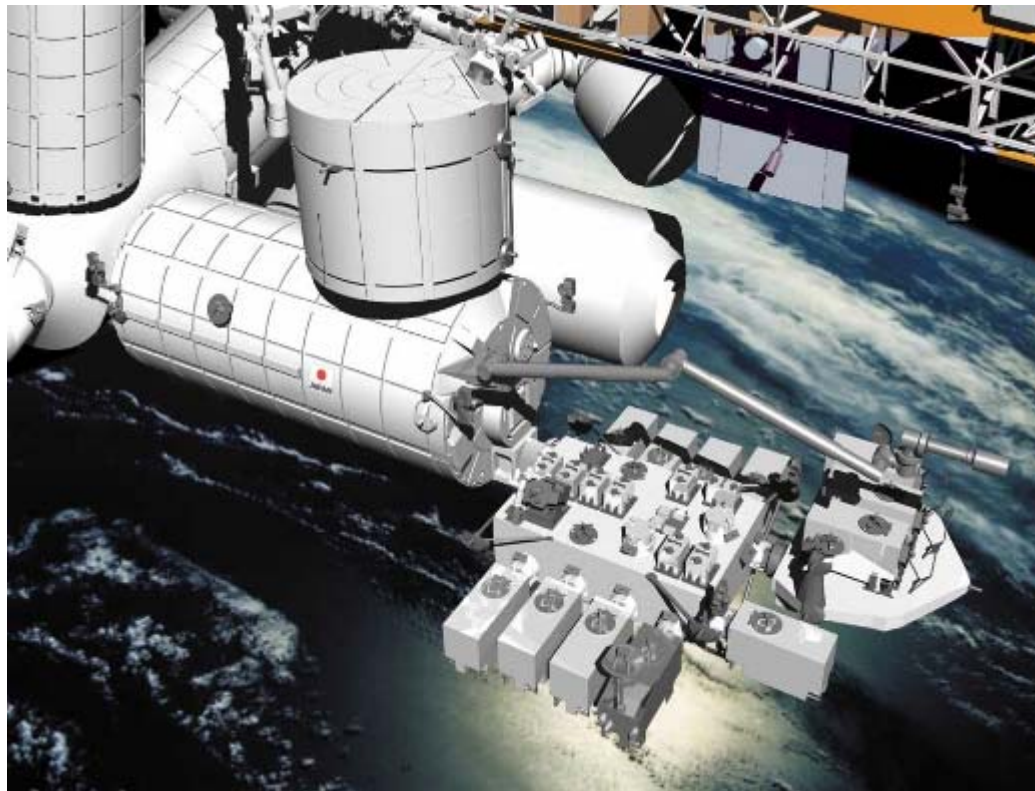




# Japanese Experiment Module (JEM)

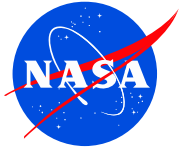


“Kibo” is Japan’s first manned space activities facility and is the largest single ISS module. In this facility, a maximum of four astronauts can perform experimental activities in a pressurized laboratory as well as use the exposed facility for unpressurized experiments. JAXA plans to launch “Kibo” in February 2008.



JEM on ISS

# Japanese H-IIB Transfer Vehicle (HTV)



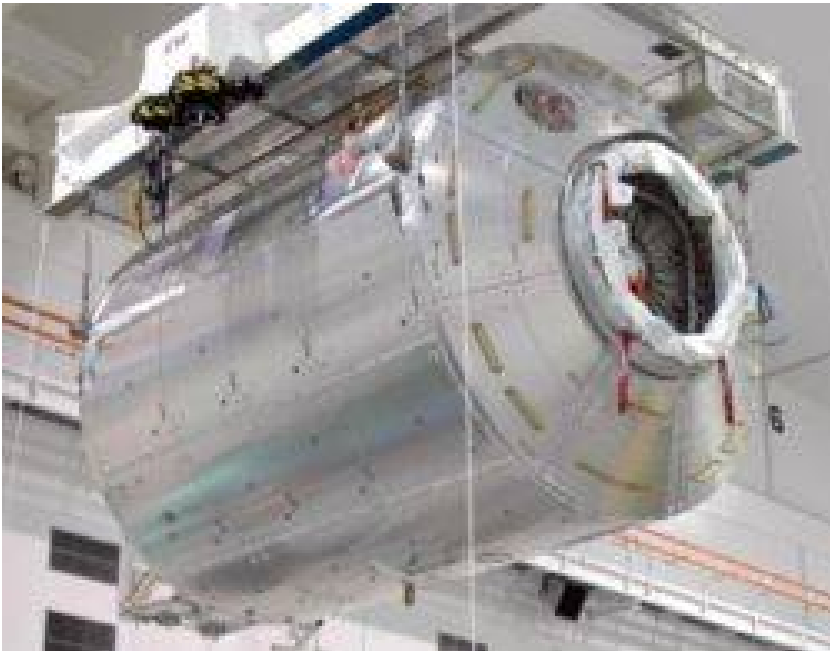
The HTV is an unmanned orbital carrier, designed to deliver up to six tons of goods to the ISS in orbit at an altitude of approximately 400 kilometers and dispose of spent equipment, used clothing, and other waste materials. The HTV is scheduled to be launched by the H-IIB launch vehicle, which is currently under development, in 2009.



# ESA's Columbus Laboratory



The Columbus laboratory is ESA's biggest single contribution to the ISS. It is equipped with flexible research facilities that offer extensive science capabilities. Columbus is due for launch in late 2007.

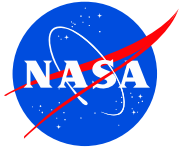


Columbus at Kennedy Space Center (KSC)



Cutaway view of Columbus on ISS

# Europe's Automated Transfer Vehicle (ATV)

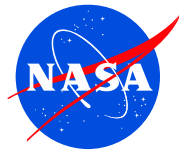


The ATV is an unmanned ESA spacecraft designed to supply the ISS with propellant, water, air, payload experiments and other cargo. The ATV, which will be one of the largest orbital spacecraft, will carry up to 9 tons of cargo to the ISS. In addition, the ATV can *re-boost* the station, restoring its orbit that shrinks over time due to friction with the atmosphere. The first flight of the ATV is scheduled for July 2007.





# International Partner Research Racks



- **ESA Racks (Flight 1E, October 2007)**

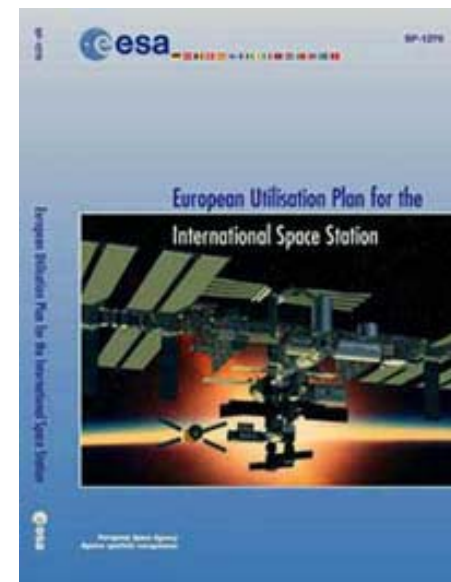
- Fluid Science Laboratory (FSL)—optical diagnostics module, experiment containers, front-mounted camera
- European Transportation Carrier (ETC)—carrier/stowage
- European Physiology Modules (EPM)—cardiolab, EEG, bone analysis module
- European Drawer Rack (EDR)—carrier/stowage
- Biolab—glovebox, incubator w/2 centrifuges, spectrophotometer, microscope
- More Information: “European Utilization Plan for the ISS” SP-1270  
<http://esapub.esrin.esa.it/sp/sp1270/sp.html>

- **JAXA (Flight 1J/A, December 2007)**

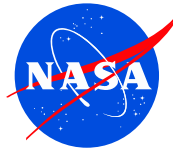
- Saibo—cell biology
- Ryutai—fluids and crystallization

- **JAXA (Flight HTV-1, July 2009)**

- Kobairo—Gradient Heating Furnace



# Canada's Canadarm and Canadarm2

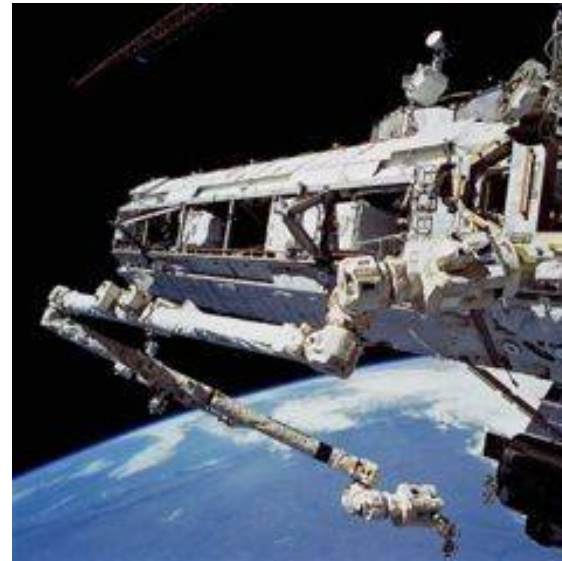


The Remote Manipulator System (RMS), or **Canadarm**, on the Space Shuttle, is a mechanical arm that maneuvers a payload from the payload bay of the Shuttle orbiter to its deployment position and then releases it; it can also grapple a free-flying payload, maneuver it and berth it in the orbiter.

**Canadarm2** is a robotic arm that is part of the Mobile Servicing System (MSS) on the ISS that plays a key role in Station assembly and maintenance: moving equipment and supplies around the station, supporting astronauts working in space, and servicing instruments and other payloads attached to the ISS.

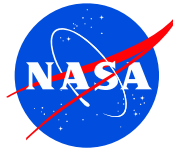


Canadarm →



← Canadarm2

# Russian Segment



The Russian Segment currently consists of the Service Module (Zvezda), the Functional Cargo Block (FCB or Zarya) and the Docking Compartment (Pirs). In the future, the Multi-Purpose Logistics Module (MLM) and Research Module (RM) will be added.





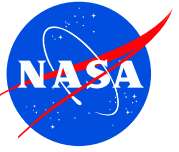
# Russian Soyuz Vehicle



The Soyuz provides crew rotation and emergency evacuation capability.



# Russian Progress Vehicle

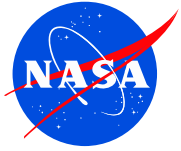


Supplies and fuel are brought to the Station by the Russian Progress vehicle.





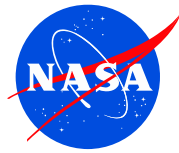
# Italian-Built Multipurpose Logistics Modules



Supplies are also carried aboard the Shuttle in one of three Italian-built Multipurpose Logistics Modules – Leonardo, Raffaello, and Donatello.



# ISS Launch and Logistics



**Space Shuttle**

**Proton**

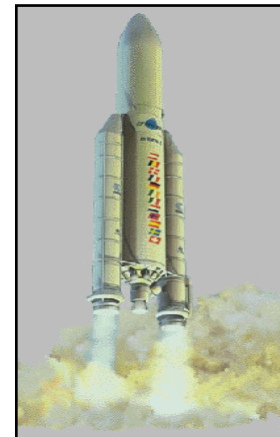


ROSCOSMOS



**Soyuz and Progress**

**Ariane 5/ATV**



**H-IIB/HTV**



An international fleet of space vehicles:

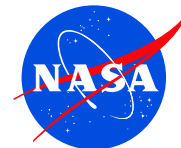
- Rotates crews
- Delivers propellant & supplies
- Replenishes science experiments

**Future Launch Capabilities**



European Space Agency





# International Strategic Working Groups

## Independently Chartered

- **International Space Life Sciences Working Group** – enables a more complete coordination of the international development and utilization of spaceflight and special ground research facilities
- **Multilateral Commercialization Group** - provides a multilateral forum where the international partners can consult and coordinate on policies and procedures related to ISS commercial development
- **International Microgravity Strategic Planning Group** – coordinates the development and use of research apparatus among microgravity research programs in areas of common interest to maximize the productivity of microgravity research internationally

## ISS Chartered

- **User Operations Panel** – facilitates collaboration and resource balancing/utilization on ISS among international partners to maximize science returns
- **Systems Operations Panel** – facilitates collaboration and resource balancing/utilization on ISS among international partners to minimize shared operational costs, reach offset agreements, and ensure equitable allocation of resources

# Utilization Resources Allocation – Post Assembly Complete (2010)



Utilization

- Crew Time
- Transportation
- TDRSS Downlink

<u>Partner</u>	<u>Percent</u>
<b>Russian</b>	<b>100.0</b>
<u><b>Non-Russian</b></u>	
<b>NASA</b>	<b>76.6</b>
<b>JAXA</b>	<b>12.8</b>
<b>ESA</b>	<b>8.3</b>
<b>CSA</b>	<b><u>2.3</u></b>
	<b>100.0</b>

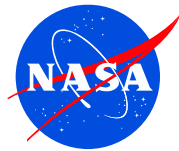
On-orbit Utilization Volume Allocations

ESA: ½ of Columbus (5 racks)

JAXA: 5 racks of JEM + ½ of EF payload attachment sites (5 sites)

NASA: ½ of Columbus (5 racks) + 6 racks of JEM + ½ of EF payload attachment sites (5 sites)

# ISS: Preparing for the Future



- International cooperation is of fundamental importance for gaining the maximum utilization return from ISS
  - Avoid duplication of facilities
  - Share data among investigators
  - Recover from technical challenges
  
- ISS is the only opportunity for long-duration studies of the effects of the microgravity environment on human health
  - Countermeasures exist in areas such as exercise, pharmacology, nutrition, environment, and behavior
  - Mars transit and longer stays on the lunar surface will significantly benefit from ISS long-duration studies
  
- ISS is an ideal platform for risk mitigation as a test bed in the space environment for new technology and operations

***We stand at the threshold of a great new age of exploration; the knowledge we create together will be critical for our future journeys***