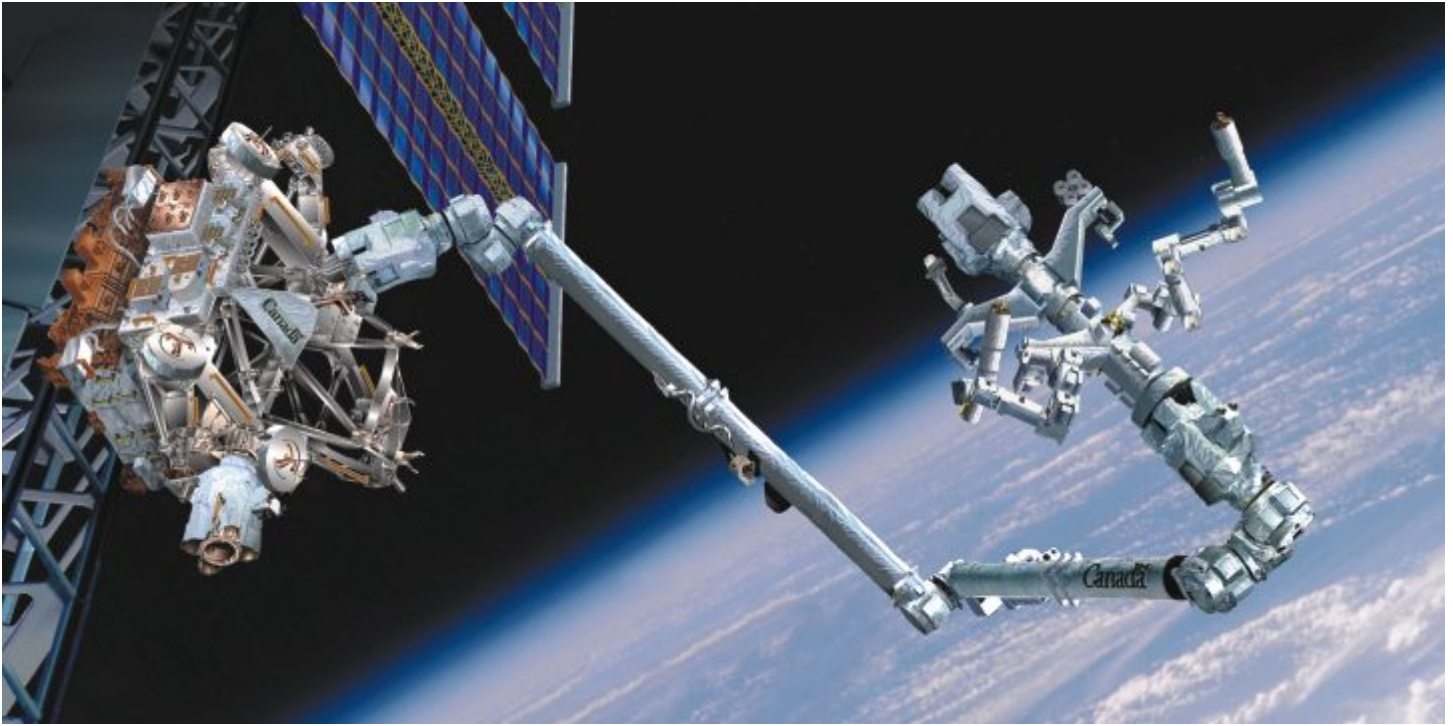


Mobile Servicing System



The International Space Station (ISS) is the largest and most ambitious space program since the Apollo moon landings and the largest scientific joint effort among nations in history. The International Space Station partners a global team led by NASA.

Countries involved in the program include the United States, Canada, Japan, Russia, Brazil and a consortium of European communities under the flag of the European Space Agency. Each of the international partners is providing key elements to the program. The first components of the station were placed in orbit in late 1998.

The space station will provide unique laboratories to conduct research in fields such as astronomy, life sciences and materials, as well as locations to assemble satellites and space platforms too large and fragile to launch directly from Earth. The advanced technologies being used to construct the station will find applications in many industries on Earth.

Canada's contribution to the International Space Station is the Mobile Servicing System (MSS), a sophisticated robotic system critical to the assembly, maintenance and servicing of the station itself. Under government contract to the Canadian Space Agency, MD Robotics is leading a Canada-wide industrial team in the building of the MSS.

The MSS comprises the following elements

- Canadarm2 or Space Station Remote Manipulator System, is a new generation robotic arm capable of handling large payloads, and assisting with the docking of the shuttle.
- The Special Purpose Dexterous Manipulator (SPDM) is a two-armed robot capable of handling many of the servicing and assembly tasks currently performed by astronauts on space walks.
- The Mobile Base (MBS) is a work platform and storage area for Canadarm2, SPDM, various tools and payloads.
- Astronauts inside the space station operate Canadarm2 and the SPDM robotics from the Robotic Workstation (the RWS is an element related to the MSS and is being supplied under separate contract to NASA).



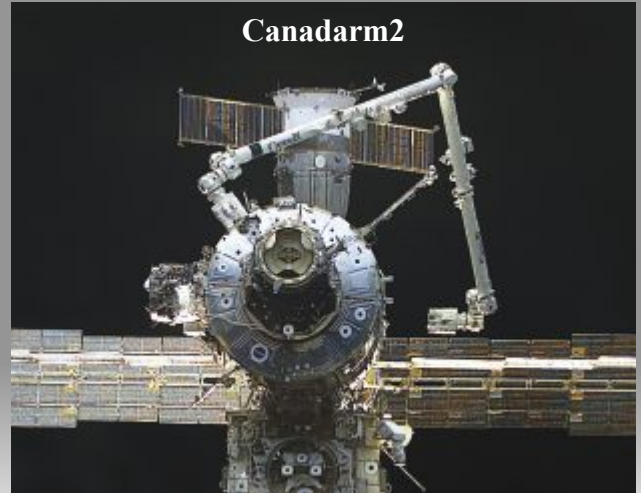
Robotic Workstation

RWS

The RWS is the control station for MSS
Launched March 8th, 2001 - Flight 5A.1 (STS-102)

The Robotic Workstation (RWS) provides an operator with the capability to control and monitor Canadarm2, the Special Purpose Dexterous Manipulator, Mobile Base System, Artificial Vision Unit and payloads.

The first unit was installed in the U.S. Lab Module in March 2001, the second unit will later be installed in the Cupola. Each RWS can be commanded by the station Management and Control to operate either as the primary workstation or as the back-up workstation with only one workstation configured as primary at any time. The Robotic Workstation, featuring display and control panels, hand controllers, video monitors, and computers are designed and built to provide a highly reliable, seamless interface between man and machine.



Canadarm2

This 17.6 metre long manipulator will do much of the assembly and maintenance work on the Space Station
Launched April 19th, 2001 - Flight 6A (STS-100)

Canadarm2 is a new generation Canadarm, the first component of the Mobile Servicing System (MSS).

Now a full-time resident on the International Space Station, Canadarm2 has the capability to move around the station's exterior. Each end of the arm is equipped with a specialized mechanism called a Latching End Effector (LEE) that can lock on one of many special fixtures, called Power Data Grapple Fixtures (PDGF), then detaching its other end and pivoting it forward. The range of accessibility of Canadarm2 will be limited only by the number of PDGF's strategically installed on the station. The LEE is designed to provide power and data signals at both ends of the arm. Unlike the original Canadarm, Canadarm2 stays in space for its useful life. This requirement necessitates an innovative design feature which allows astronauts to repair it on-orbit. Canadarm2 is built in sections called Orbital Replacement Units (ORU's) which are easily removed and then replaced by either an astronaut or the Special Purpose Dexterous Manipulator.

Canadarm2 is equipped with four TV cameras that feed wide and close-up views to the operators of the Canadian-built robotics. Two cameras are mounted on the booms, one on each side of the elbow joint. The remaining two cameras are located on the latching end effectors, one at each end of the arm.

Canadarm2 features an advanced vision system which has the ability to track payloads, and can sense various forces and moments to ensure smooth movement of payloads. The station arm also has a collision-avoidance capability.



**Mobile Base System
MBS**

The foundation of the MSS, this system will be employed as a working Platform and storage area
Launch: Spring 2002 - Flight UF-2

The Mobile Base System (MBS) is an aluminum structure that serves as a storage location and work platform for astronauts. The MBS is equipped with four Power Data Grapple Fixtures and a LEE to hold payloads (or hold the SPDM). The MBS also provides a Common Attach System to accommodate transportation and servicing, and provides structural and electrical interfaces to users.



**Special Purpose
Dexterous Manipulator
SPDM**

This two-armed robot will perform delicate assembly and servicing tasks
Launch: 2003/2004 - Flight UF-4

The Special Purpose Dexterous Manipulator (SPDM) is an extremely advanced, highly dexterous dual-armed robot with a body that includes two shoulder structures that provide support for the arms. Each arm has seven joints, terminating with an Orbit Replacement Unit/Tool Changeout Mechanism (OTCM), the mechanism through which the SPDM arm interfaces with payloads and tools. The SPDM is also equipped with lights, video equipment, a tool platform and four tool holders. This two-armed robot will be able to touch and feel much like a human. It can sense various forces and moments on the payload and in response, can automatically compensate to ensure the payload is moved smoothly.

The SPDM's primary role will be to carry out delicate maintenance and servicing tasks on the International Space Station. Tasks include installing and removing small payloads such as batteries, power supplies and computers; operate robotic tools such as specialized wrenches and socket extensions; provide power and data connectivity to payloads; manipulate, install, remove and inspect scientific payloads. The SPDM will be controlled by the ISS crew via the Robotic Workstation and will perform a great many of the tasks that would otherwise require an astronaut to perform on spacewalks.

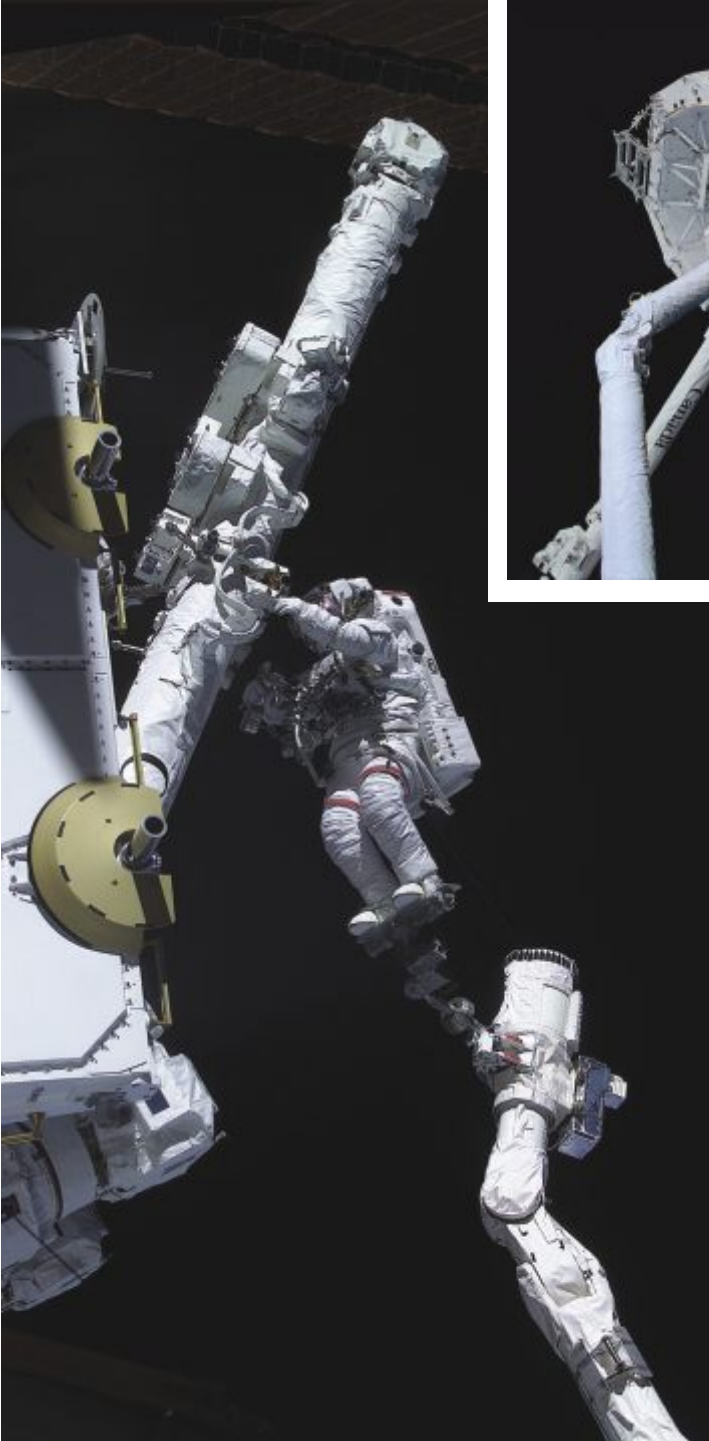
The SPDM will normally sit on the Mobile Base System and Canadarm2 will manipulate a payload to within the range of the SPDM for repair, maintenance or upgrade. Alternatively, the SPDM can be grappled by the free end of Canadarm2 and manoeuvred into position next to the payload for assembly requiring its delicate touch.

Mobile Servicing System Technical Details

	Canadarm2	SPDM	MBS
Length (Metres)	17.6	3.5	5.7 x 4.5 x 2.9
Mass (approx.)	1,800 kg	1,662 kg	1,450 kg
Mass Handling Transportation Capacity	116,000 kg	600 kg	20,900 kg
Degrees-of-Freedom	7	15	FIXED
Peak Power (operational)	2,000 w	2,000 w	825 w
Average Power Keep Alive	1360 w 435 w	600 w	365 w
Stopping Distance (under maximum load)	0.6 metres	0.15metres	n/a

Canadarm2

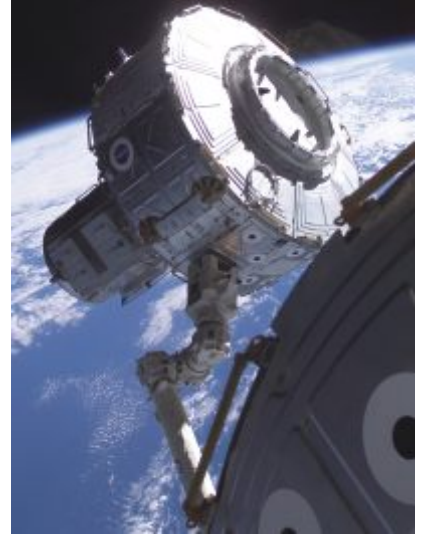
Supported by the Shuttle's Canadarm, Canadian Astronaut Chris Hadfield assists with the installation of Canadarm2 on the International Space Station.



Canadarm2 transfers the launch pallet that it arrived on back to the Shuttle Canadarm for return to earth. This first dual arm operation has become known as the historic "handshake" in space.



Canadarm2 installs the U.S. Quest airlock onto the side of Unity Node 1 of the International Space Station (ISS).



A view of Canadarm2 installed aboard the International Space Station.