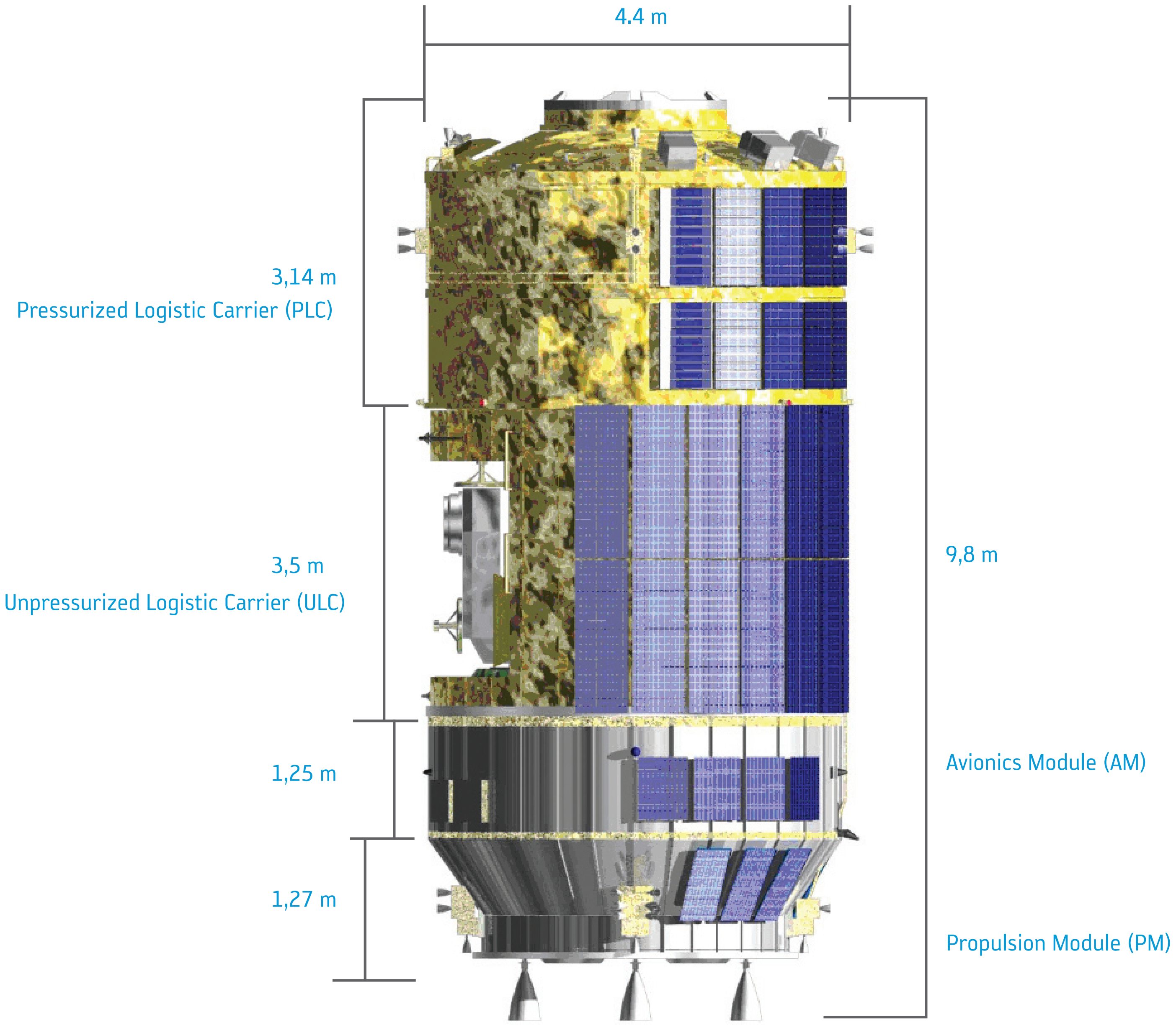
→ H-II TRANSFER VEHICLE (HTV)

Japanese logistics vehicle

The H-II Transfer Vehicle (HTV) is a 16 t unmanned cargo transfer spacecraft designed and developed under the supervision of the Japanese Aerospace Exploration Agency (JAXA). HTV delivers supplies to the International Space Station (ISS). It is composed of a pressurized and an un-pressurized compartment. HTV is capable to deliver up to 6,000 kg of cargo to the ISS. At the end of its mission, it can be loaded with trash to be disposed during its destructive re-entry into the Earth's atmosphere. The first flight of HTV has been taken place on 10 September 2010.



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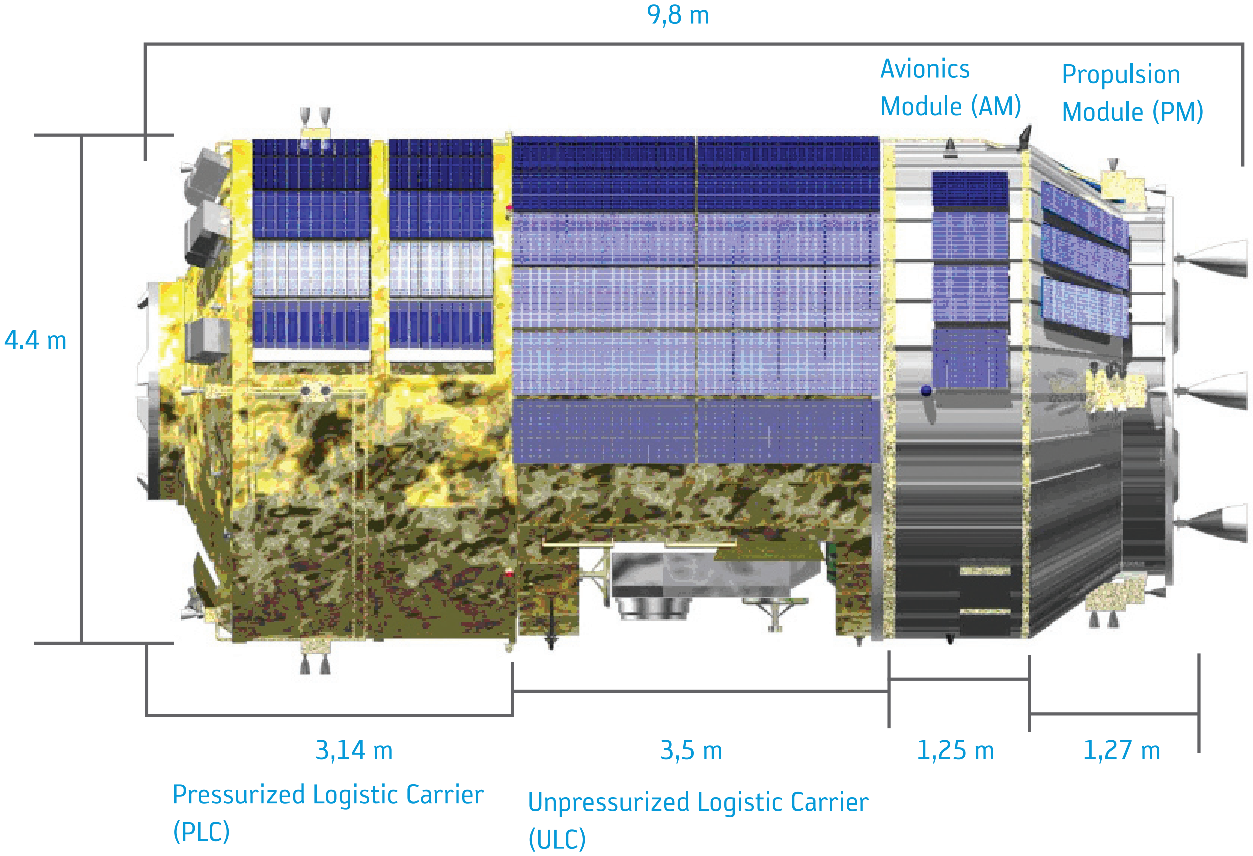
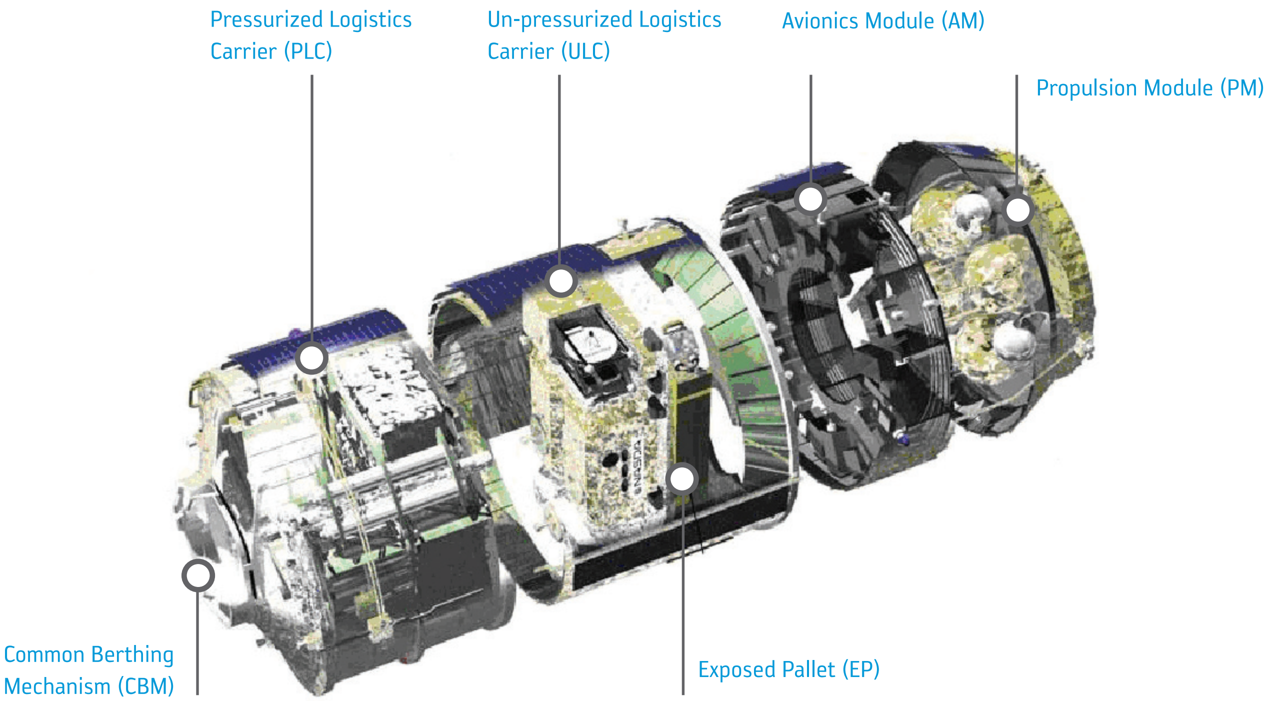
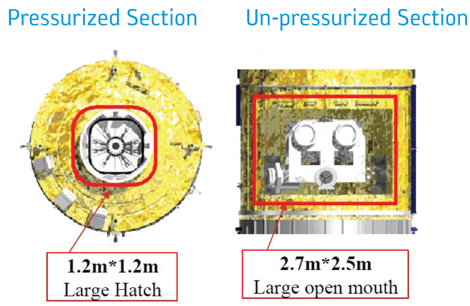




HTV PLC and ULC passage clearances



HTV Components

H-II TRANSFER VEHICLE (HTV) CONSISTS OF TWO LOGISTIC CARRIERS:

- Pressurized Logistics Carrier (PLC)
- Un-pressurized Logistics Carrier (ULC), including Exposed Pallet (EP), Avionics Module (AM) and a Propulsion Module (PM).

The Japanese Experiment Module (JEM), known as “Kibo,” is equipped with antennas, reflectors and a Proximity Communication System (PROX) that will enable inter-orbit communication with the HTV as the HTV approaches the ISS.

PRESSURIZED LOGISTIC CARRIER

The Pressurized Logistics Carrier (PLC) will carry cargo such as International Standard Payload Racks (ISPR), drinking water and clothes that will be used aboard the ISS. The PLC’s internal air pressure is controlled and maintained at one atmospheric pressure (1 atm). While the HTV is berthed with the ISS, the ISS crew will be able to enter the PLC to unload the supplies. After the supplies are unloaded, waste material will be loaded. The ISS crew members enter and exit through the HTV’s berthing port that is equipped with the Common Berthing Mechanism (CBM).

UN-PRESSURIZED LOGISTIC CARRIER

The Un-pressurized Logistics Carrier (ULC) will carry the Exposed Pallet (EP).

EXPOSED PALLET

The Exposed Pallets (EPs) will carry un-pressurized payloads, as well as the ISS battery Orbital Replacement Units (ORUs). There are two types of Exposed Pallets, Type I and Type III.

Type I: This type of pallet carries payloads that will be used on Kibo’s Exposed Facility (EF). Two or three Kibo Exposed Facility Payloads per flight can be delivered. This pallet will be attached to the EF.

Type III: This type of pallet carries the US un-pressurized ORUs, such as the battery ORUs. This pallet will be attached to the Station’s Mobile Base System (MBS). Up to six battery ORUs can be delivered.

AVIONICS MODULE

The Avionics Module contains navigational and electrical systems used for navigation control, communication and supplying power. The Avionics Module will enable an HTV remote-controlled flight to navigate by receiving commands sent from the ground or to navigate by HTV autonomous flight systems. In addition, the Avionics Module distributes power to each component of the HTV.

PROPULSION MODULE

The Propulsion Module has four propellant tanks. The HTV’s thrusters generate propulsion for orbital adjustment or attitude control. The HTV has in total 32 thrusters installed.

PROXIMITY COMMUNICATION SYSTEM (PROX)

The Proximity Communication System (PROX), which is installed in Kibo, consists of a PROX antenna, a PROX-GPS antenna, PROX communication equipment and a Hardware Command Panel (HCP). With the exception of the PROX antenna, the PROX-GPS antenna and the HCP, the PROX is installed in the JEM Pressurized Module.

When the HTV approaches close to the ISS, the PROX antenna will initiate communications with the HTV. This antenna contains GPS receivers. The ISS’s orbital location and speed are immediately relayed to the HTV through the PROX. At the same time, data from the HTV are relayed to the ISS. In addition, the antenna relays commands sent from the ground to the HTV.

Specifications

DIMENSIONS

Length:	9,800 mm (including the lenght of the main thruster)
Largest diameter:	4,400 mm

MASS BUDGET

Vehicle dry mass:	10,500 kg
Total cargo upload capacity:	6,000 kg

CARGO CAPACITY

Pressurized Carrier:	4,500 kg (food, clothing, potable water, passive experiment racks and equipment)
Un-pressurized Carrier:	1,500 kg (exposed experiments, consumables for outside the ISS)
Waste download capacity:	6,000 kg
Target Orbit to ISS:	350 - 460 km altitude, 51.6° inclination

PROPULSION

Main propulsion system:	4 x 490 N thrusters (2 units x 2 strings)
Attitude control system:	28 x 110 N thrusters (14 units x 2 strings - redundant structure - 12 units on the outer wall of PLC)
Propellant:	Monomethyl hydrazine fuel and Nitrogen tetroxide oxidizer

COMMUNICATIONS INFRASTRUCTURE

To ground:	via TDRS satellite
HTV to ISS:	Proximity Communication System PROX
Navigation:	GPS (RVS Navigation)

THERMAL/ENVIRONMENTAL CONTROL

Thermal Control:	Multi Layer Insulation material, thermal control with thermal sensors integrated in the walls of PLC
ECLSS:	air circulation, air temperature monitoring

ELECTRICAL POWER

Ascent to ISS and de-orbit:	50 Vdc (35 W average, 70 W peak) via the Avionics Module
Required power supplied by ISS:	120 Vdc (90 W average, 180 W peak)

MAIN CONTRACTOR

Mitsubishi Heavy Industries Ltd. and Mitsubishi Electric Corp.

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REFLECTOR

The reflectors are installed on the Nadir (bottom) side of Kibo. The reflectors reflect the lasers that are beamed from the HTV’s Rendezvous Sensor (RVS) during the HTV close proximity operation.

Utilisation Relevant Data

LAUNCH CONFIGURATION

Launch vehicle: H-IIB
Target Orbit to ISS: 350 - 460 km altitude, 51.6° inclination
Launch site: Tanegashima Space Center (TNSC), Japan.
First flight: 10 September 2010
Flight rate: Mean: 1/year

After separating from the H-IIB launch vehicle, the HTV will automatically start-up the HTV sub-systems and initiate communications with the HTV Mission Control Room (HTVMCR) at Tsukuba Space Center (TKSC).

ON ORBIT OPERATIONS AND CONFIGURATION

Rendez-vous

After H-IIB separation, the HTV will automatically start-up the communication system and initiate communications with NASA's Tracking and Data Relay Satellite (TDRS).

The HTV status will be monitored from the HTVMCR at TKSC. After three days the HTV reaches the "proximity communication zone" (23 km from the ISS), the HTV will then be able to directly communicate with the ISS via the Proximity Communication System (PROX). While communicating with PROX, the HTV will approach the ISS guided by GPS signals until the HTV is 5 km behind the ISS.

Guided by GPS signals, the HTV will approach to within 500 meters below the ISS. While using the Rendez-vous Sensor (RVS), the HTV will move closer to the ISS guided by the reflectors that are installed on Kibo. The HTV approach speed during this phase is 1 to 10 meters/minute. During the approach, the ISS crew can send commands such as "HOLD," "RETREAT" or "ABORT" to the HTV.

Once the HTV is within 10 m distance from the ISS, the HTV thrusters will be disabled. Next, the HTV is grappled by Canadarm2 (Space Station Remote Manipulator System - SSRMS) and berthed to the Nadir (bottom) side of "Harmony" (Node 2), through Harmony's Common Berthing Mechanism (CBM).

Berthing with the ISS (Berthing Phase)

While the HTV is berthed to the ISS, both the HTV and ISS hatches will be opened. The ISS crew will then transfer the supplies (ISPRs, drinking water, clothes, etc.) from the HTV Pressurized Logistics Carrier (HTV-PLC) to the ISS. After the supplies are transferred, the HTV will be loaded with waste from the ISS.

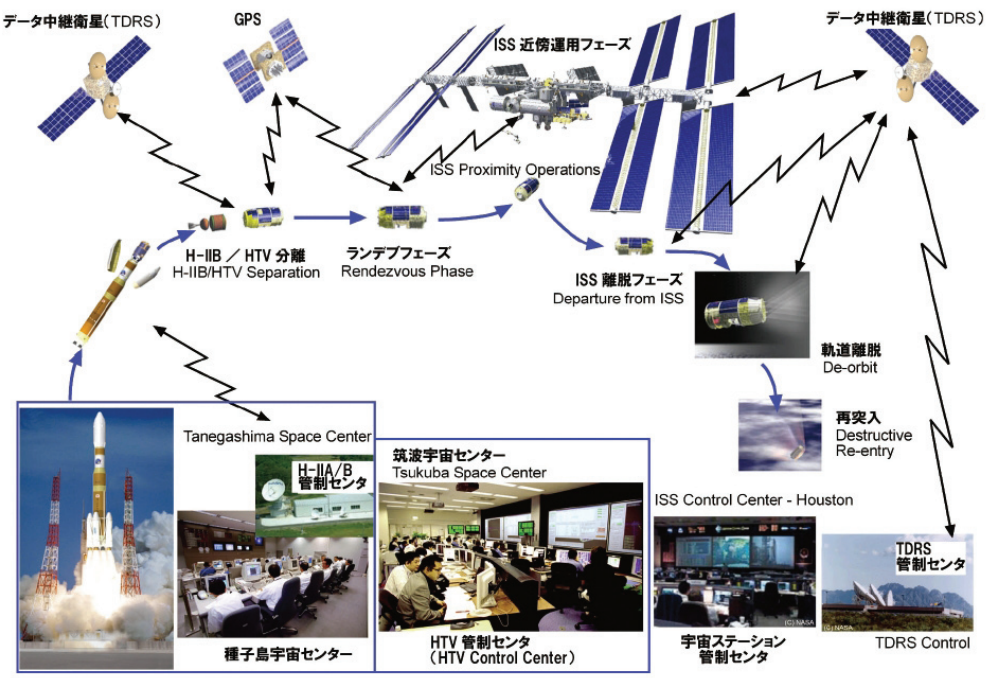
Next, the ISS crew will unload the Exposed Pallet from the HTV Un-pressurized Logistics Carrier and attach it to the ISS Mobile Base System or Kibo's Exposed Facility using the Canadarm2.

DEPARTURE FROM THE ISS AND RE-ENTRY

After being loaded with waste, the HTV will undock and separate from the ISS and then be destroyed during re-entry into the atmosphere. The HTV debris are expected to fall within the South Pacific Ocean. However, the Indian Ocean is also planned as a backup area.

HTV Operations Profile

- Launch - Rendez-vous with the ISS - Berthing with the ISS - Operations while berthed with the ISS - Undock/ Departure from the ISS/Re-entry



Illustrations: JAXA