**Docking**

See also: Spacecraft Docking and Berthing Mechanisms

View through automatic (left) and NASA shuttle (right) docking systems.

All Russian manned spacecraft, modules, and progress craft are able to rendezvous and dock to the space station without human intervention. Using Kurs radar they detect and intercept the ISS from over 200 kilometers away. The European ATV uses star sensors and GPS to determine its intercept course, when it catches up it then uses laser equipment to optically recognize Zvezda, with Russian Kurs redundancy. Crew supervise these craft, but do not intervene except to send abort commands in emergencies. The Japanese H-II Transfer Vehicle parks itself in progressively closer orbits to the station, and then awaits 'approach' commands from the crew, until it is close enough for the crew to grapple it with a robotic arm and berth it to the USOS. The American Space Shuttle was manually docked, and on missions with a cargo container, the container would be berthed to the Station with the use of manual robotic arms. Berthed craft can transfer International Standard Payload Racks. Japanese spacecraft berth for one to two months. Russian and European Supply craft can remain at the ISS for six months, allowing great flexibility in crew time for loading and unloading of supplies and trash. NASA Shuttles could remain docked for 11–12 days.

The American manual approach to docking allows greater initial flexibility and less complexity. The downside to this mode of operation is that each mission becomes unique and requires specialized training and planning, making the process more labor-intensive and expensive. The Russians pursued an automated methodology that used the crew in override or monitoring roles. Although the initial development costs were high, the system has become very reliable with standardizations that provide significant cost benefits in repetitive routine operations. An automated approach could allow assembly of modules orbiting other worlds prior to manned missions.

Space Shuttle *Endeavour*, ATV-2, Soyuz TMA-21 and Progress M-10M docked to the ISS during STS-134, as seen from the departing Soyuz TMA-20

Soyuz manned spacecraft for crew rotation also serve as lifeboats for emergency evacuation, they are replaced every six months and have been used once to remove excess crew after the Columbia disaster. Expeditions require, on average, 2 722 kg of supplies, and as of 9 March 2011 (2011 -03-09)[update], crews had consumed a total of around 22 000 meals. Soyuz crew rotation flights and Progress resupply flights visit the station on average two and three times respectively each year, with the ATV and HTV planned to visit annually from 2010 onwards. Following retirement of the NASA Shuttle Cygnus and Dragon will begin to fly cargo to the station until at least 2015.

From 26 February 2011 to 7 March 2011 four of the governmental partners (United States, ESA, Japan and Russia) had their spacecraft (NASA Shuttle, ATV, HTV, Progress and Soyuz) docked at the ISS, the only time this has happened to date.

**Launch and docking windows**

Prior to a ship's docking to the ISS, navigation and orientation (GNC) is handed over to the ground control of the ships' country of origin. GNC is set to allow the station to drift in space, rather than fire its thrusters or turn using gyroscopes. The solar panels of the station are turned edge-on to the incoming ships, so residue from its thrusters does not damage the cells. When a NASA shuttle docked to the station, other ships were grounded, as the carbon wingtips, cameras, windows, and instruments aboard the shuttle were at too much risk from damage from thruster residue from other ships movements.

Approximately 30% of NASA shuttle launch delays were caused by poor weather. Occasional priority was given to the Soyuz arrivals at the station where the Soyuz carried crew with time-critical cargoes such as biological experiment materials, also causing shuttle delays. Departure of the NASA shuttle was often delayed or prioritized according to weather over its two landing sites. Whilst the Soyuz is capable of landing anywhere, anytime, its planned landing time and place is chosen to give consideration to helicopter pilots and ground recovery crew, to give acceptable flying weather and lighting conditions. Soyuz launches occur in adverse weather conditions, however the cosmodrome had been shut down on occasions when buried by snow drifts up to 6 meters in depth, hampering ground operations.