**Orbit and Mission Control**

|  |  |  |
| --- | --- | --- |
|  |  | Menu0:00 |
| Graph showing the changing altitude of the ISS from November 1998 until January 2009 |  | Animation of ISS orbit from a North American geostationary point of view (sped up 1800 times) |

The ISS is maintained in a nearly circular orbit with a minimum mean altitude of 330 km (205 mi) and a maximum of 410 km (255 mi), in the center of the Thermosphere, at an inclination of 51.6 degrees to Earth's equator, necessary to ensure that Russian Soyuz and Progress spacecraft launched from the Baikonur Cosmodrome may be safely launched to reach the station. Spent rocket stages must be dropped into uninhabited areas and this limits the directions rockets can be launched from the spaceport. The orbital inclination chosen was also low enough to allow American space shuttles launched from Florida to reach the ISS.

It travels at an average speed of 27,724 kilometers (17,227 mi) per hour, and completes 15.7 orbits per day. The station's altitude was allowed to fall around the time of each NASA shuttle mission. Orbital boost burns would generally be delayed until after the shuttle's departure. This allowed shuttle payloads to be lifted with the station's engines during the routine firings, rather than have the shuttle lift itself and the payload together to a higher orbit. This trade-off allowed heavier loads to be transferred to the station. After the retirement of the NASA shuttle, the nominal orbit of the space station was raised in altitude. Other, more frequent supply ships do not require this adjustment as they are substantially lighter vehicles.

Orbital boosting can be performed by the station's two main engines on the *Zvezda* service module, or Russian or European spacecraft docked to Zvezda's aft port. The ATV has been designed with the possibility of adding a second docking port to its other end, allowing it to remain at the ISS and still allow other craft to dock and boost the station. It takes approximately two orbits (three hours) for the boost to a higher altitude to be completed. In December 2008 NASA signed an agreement with the Ad Astra Rocket Company which may result in the testing on the ISS of a VASIMR plasma propulsion engine. This technology could allow station-keeping to be done more economically than at present.

The Russian Orbital Segment contains the station's engines and control bridge, which handles Guidance, Navigation and Control (ROS GNC) for the entire station. Initially, Zarya, the first module of the station, controlled the station until a short time after the Russian service module Zvezda docked and was transferred control. Zvezda contains the ESA built DMS-R Data Management System. Using two fault-tolerant computers (FTC), Zvezda computes the station's position and orbital trajectory using redundant Earth horizon sensors, Solar horizon sensors as well as Sun and star trackers. The FTCs each contain three identical processing units working in parallel and provide advanced fault-masking by majority voting. Zvezda uses gyroscopes and thrusters to turn itself around. Gyroscopes don't need propellant, rather they use electricity to 'store' momentum in flywheels by turning in the opposite direction to the station's movement. The USOS has its own computer controlled gyroscopes to handle the extra mass of that section. When gyroscopes 'saturate', reaching their maximum speed, thrusters are used to cancel out the stored momentum. During Expedition 10, an incorrect command was sent to the station's computer, using about 14 kilograms of propellant before the fault was noticed and fixed. When attitude control computers in the ROS and USOS don't communicate properly, it can result in a rare 'force fight' where the ROS GNC computer must ignore the USOS counterpart, which has no thrusters. When an ATV, Nasa Shuttle, or Soyuz is docked to the station, it can also be used to maintain station attitude such as for troubleshooting. Shuttle control was used exclusively during installation of the S3/S4 truss, which provides electrical power and data interfaces for the station's electronics.