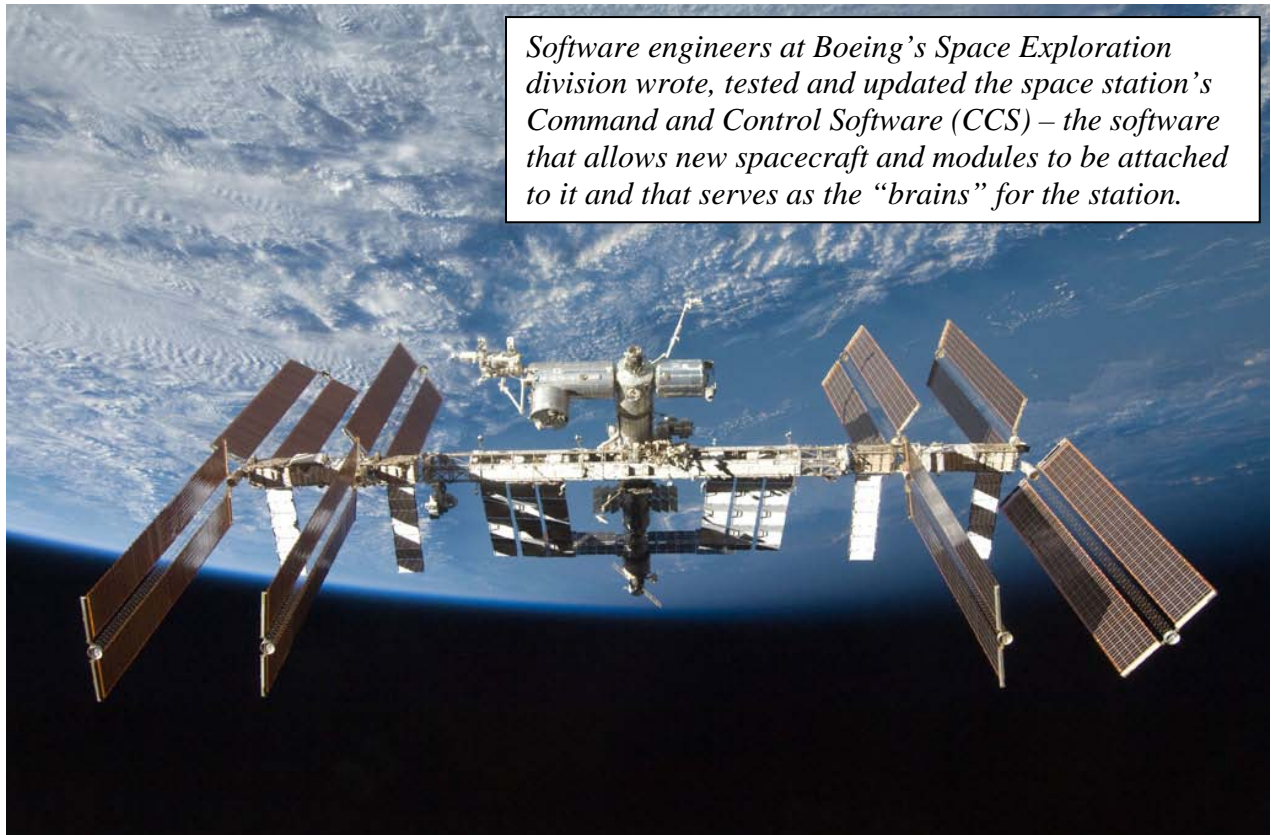




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Pulling strings 220 miles above Earth - The ISS software serves as the orbiting lab's central nervous system



Software engineers at Boeing's Space Exploration division wrote, tested and updated the space station's Command and Control Software (CCS) – the software that allows new spacecraft and modules to be attached to it and that serves as the “brains” for the station.

There's a saying in the world of the International Space Station – “nothing moves on station without software being involved.” So what happens when the world's most complex engineering feat needs a software update?

When people update their computer operating systems, there are often problems with hardware and applications, but the upgrade brings new capabilities and enhancements. Likewise, when the software is updated on the ISS, it also brings new functionality. But glitches are not an option because astronauts trust their

lives to the software that keeps the systems of the multi-billion dollar global asset functioning as they live and work some 220 miles above the Earth.

Software engineers at Boeing's Space Exploration division wrote, tested and updated the space station's Command and Control Software (CCS) – the software that allows new spacecraft and modules to be attached to it.

“The CCS controls all the top-level software that takes care of everything,” said Boeing hardware and software integration manager Dale Kohn.

The CCS provides the ISS-level control necessary to accomplish each

mission and serves as the “brains” of the space station software. It controls the operation of the on-orbit vehicle portion of the ISS, controls audio and video equipment, manages data communication between the spacecraft and the ground, crew and external vehicles and the distribution of the data between functional areas of the ISS. It also provides added capability for current and future vehicle dockings such as the Japanese H-II Transfer Vehicle (HTV), an unmanned supply spacecraft used for ferrying supplies to the ISS, as well as added support for international partners.

The CCS runs on three ISS computers, which are designated as a primary, backup, and standby. The software update, with about 730,000 lines of code, was loaded August 3-5 and is the eighth major software update since 1998.

“All of the interaction on the space station with mission control, ground facilities and the other systems on the

space station comes through our computers,” explains Cary Cheatham, Boeing manager of the CCS development team.

“Our system monitors for fires or any kind of events that would be a safety issue for the space station and our software will automatically initiate valve closing and isolation maneuvers to ‘safe’ the ISS,” Cheatham added. “CCS monitors data from all the other ISS computers to decide what actions to take.”

Each update takes about a year of development and testing to make sure it works properly on orbit. Whenever new software is developed, Boeing defines the requirements and then hands the requirements off to the software development team to write the code. The software development team tests its software at the component level before system- level testing in the Software Development Integration Laboratory (SDIL) at Johnson Space Center. SDIL is

The Boeing Command and Control System development team shown here develops software code using a programming language called Ada. The Boeing Houston site has one of the largest number of Ada programmers in the United States.



an exact replica of the computers, cabling and other components of the station on orbit.

“The update has gone seamlessly. We have done it before with earlier versions, but this is the very first time that we have done an update with the international partner elements attached,” Kohn said. Besides the CCS update, the Russian Service Module and Canadian robotics software were also updated at the same time and many of the international partners had to make updates to their software to accommodate new visiting spacecraft.

“Because the command and control software interfaces with every international partner module, the international partners were a part of our development and testing team,” said Kohn. “So when we swapped out the brains of the computer, we had to put the international partner software in a hold mode, then we uplinked it and changed it over and reintegrated them back into the system.”

Although the computers do not pose any serious limitations, they are run from an Intel 80386SX microprocessor, a chip that was introduced in 1985. “We are continually trying to put 10 pounds of content into a five pound bag. The older systems come with less memory and are much slower than what is available today. We have to ensure we are not

putting in more functionality than the processor can handle,” Cheatham said. Boeing plans to upgrade the computers in 2011.

The software for the space station is written in a programming language called Ada. The Defense Department commissioned the Ada programming language in the late 1970s and mandated its use to establish a single standardized programming language, but dropped the requirement in 1997. “Back when this was decided, Ada was the up-and-coming language. It had a lot of features that were good for software development, but like anything, these languages change over time and something better always comes along,” Cheatham said.

The folks tasked with updating software for something as complicated as the ISS liken themselves to surgeons of sorts. “We are going in and changing software that exists and runs without problems. The challenge is to do ‘surgery’ on the code and add something that wasn’t there before in terms of features, while also making sure we are not affecting anything else,” Cheatham said.

Boeing has a long-term schedule of updates for the CCS, which includes software release updates about every two years beginning in 2012.

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