Case Study

Enterprise Linux

European Space Agency

The European Space Operations Center (ESOC) within the European Space Agency has chosen SUSE® Linux Enterprise Server as its operating system in its deep space ground stations and spacecraft operational control center.

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With 390 instances of SUSE Linux Enterprise Server already deployed, and a further 50 to be deployed in 2013, ESOC is enjoying faster installation, better control over system configuration, excellent performance and reliability, strong technical support from SUSE, and the confidence that it has an operating system that it can maintain for the long term. Further deployment of SUSE Linux Enterprise Server is under consideration for the remaining antennas in the network (15m diameter class, used mainly for near-Earth missions) and for mission control for new spacecraft missions currently under preparation.

Overview

The European Space Agency (ESA) is Europe's gateway to space. An intergovernmental organization created in 1975, ESA aims to shape the development of Europe's space capability and ensure that investment in space delivers benefits to the citizens of Europe and the world. By coordinating the financial and intellectual resources of its members, ESA can undertake programs and activities far beyond the scope of any single European country.

"The use of reliable baseline operating systems plays an important role in ensuring the smooth and efficient operation of our satellites."

MARCO LANUCARA

Head of the Systems and Project Support Section in the Ground Stations Division
European Space Operations Center

Challenge

The European Space Operations Center (ESOC) in Darmstadt, Germany, is responsible for monitoring and controlling spacecraft throughout their operational life. ESOC also sets up, operates and maintains spacecraft-support infrastructure on the ground, including the network of ground stations in Argentina, Australia, Belgium, French Guiana, Portugal, Spain and Sweden (ESTRACK). The network must provide cost-effective, accurate and timely communications with manned and robotic missions that may be billions of kilometers from the Earth. It uses cutting-edge technology including high-precision pointing antennas, multi-frequency radio reception and transmission, cryogenically cooled low-noise amplifiers and high-power uplink amplifiers.

ESOC must also ensure consistent and reliable operations throughout the full duration of ESA missions that can span decades. This presents significant challenges in a number of areas, not least the technology platforms that support communication with and control of satellites and other spacecraft. The organization undertakes continuous research to determine which technologies will offer the best long-term maintainability.

European Space Agency (ESA) at a Glance:

ESA develops the launchers, spacecraft and ground facilities needed to keep Europe at the forefront of global space activities. It launches satellites for Earth observation, navigation, telecommunications and astronomy, sends probes to the far reaches of the Solar System and co-operates in the human exploration of space.

Industry and Location

Research and engineering, multiple locations globally

Products and Services

SUSE Linux Enterprise Server (versions 9 and 11)

Results

+ *Around 60 systems installed in ESA deep space ground stations will be migrated to SUSE Linux Enterprise Server between 2012 and 2014*
+ *Around 350 systems running SUSE Linux Enterprise Server have been deployed at ESOC, mainly for Spacecraft Mission Control*
+ *Motivation to migrate: implementing a robust, easy-to-configure OS for long-term maintainability*
+ *Deployed a stable and consistent baseline platform to support important scientific missions*

Ernesto Doelling, head of the ICT Evolution section at ESOC, said: "Performance is important, but it's the reliability and the maintainability that are key for the ESOC Missions Operations Infrastructure when it comes to operating systems. From an engineering perspective, we need a product that is easy to understand and that isn't overcomplicated. And it's vital to choose a system that will be backed by long-term professional support."

Depending on each mission's individual requirements, ESOC had previously deployed a variety of different operating systems, including Microsoft Windows NT, OpenVMS, Sun Solaris and other variants of UNIX.

Solution

Aiming to rationalize its IT landscape as far as possible, and considering factors such as usability, long-term maintainability, and the availability of professional external support, ESOC decided to adopt SUSE Linux Enterprise Server 11 as the operating system for its network of ground stations.

"Our internal IT function recommended Linux—and specifically SUSE Linux Enterprise Server—as the most reliable option," said Euan Hogg, Senior IT engineer at the European Space Operations Center.

ESA has deployed around 100 instances of SUSE Linux Enterprise Server within the last 12 months, including both new systems and migrated environments. However, some applications have remained on their legacy platforms.

"Most commonly, we migrate—but we evaluate on a case-by-case basis," said Marco Lanucara, Head of the Systems and Project Support Section in the ground stations division. "For example, we determined that for a certain application running on QNX, the link between the OS and the hardware made it better not to migrate."

The deployment of SUSE Linux Enterprise Server in the ground stations aligns them to the ESA baseline operating systems. Indeed, SUSE Linux Enterprise Server is the baseline for other ESA major applications, including the Mission Control Systems and the Simulator. In the future, although the hardware platform may vary from domain to domain, there will be a single version of Linux for all ESA applications using that operating system. Any new release or service pack will be validated at ESA, then uniformly used and deployed in all domains, including the ground stations. This was not the case in the past, when different approaches were used in different domains.

SIMPLE PORTING

ESA generally uses specialized applications custom-developed by external software companies. The porting to Linux is also handled by external companies—though not necessarily the same ones that wrote the original software. To increase maintainability and reduce risk, ESA has a policy of obtaining sufficient intellectual property rights for each piece of software to enable it to outsource future development to third parties.

"It reduces our risk in the long term if we know that two or three companies have done some work on the software, and if we have the source code," said Marco Lanucara.

While ESOC has encountered no major issues with deploying or using SUSE Linux Enterprise Server, there were some minor challenges to overcome during the migration of the telemetry/telecommand application from Solaris to SUSE Linux Enterprise Server. "The telemetry and telecommand processor is perhaps the most critical application we have in the ground stations," said Euan Hogg. "Telemetry is the data received from the satellite, while telecommand is the data we send to the satellite to operate it. Our colleagues in the software engineering division ported the application from Solaris to SUSE Linux Enterprise Server to keep it maintainable from an operating system point of view."

The key challenge ESOC faced was getting the telemetry/telecommand application to work with the legacy network infrastructure. "The system previously used six Ethernet ports, and there was all sorts of routing magic happening in the Solaris kernel to get the IP packets to go in the right direction and with the right quality of service," said Euan Hogg. "When we first migrated the application to SUSE Linux Enterprise Server, it worked perfectly, but we then decided to reduce the six Ethernet ports to two. The Solaris kernel behaves in a different way from the Linux kernel in routing packets, and it took some time and effort to fix. But that's really the only issue we encountered related to the porting—and we solved it!"

Results

For us, the key value in using SUSE Linux Enterprise Server lies more in what surrounds the system than in any specific functions," said Euan Hogg. "It's the ability to get the necessary patches, fixes and updates in a timely manner, and it's the visibility of software licenses. No configuration choices are forced upon you, and the

system is very logical and well-organized at the command line if you come from a traditional UNIX background."

With SUSE Linux Enterprise Server as its baseline OS for ground stations and mission control, ESOC has a reliable solution backed both by the open source community and by SUSE. This has given the organization confidence that the software will provide long-term maintainability—one of its key objectives.

"I've worked with open source since Slackware v.3 back in 1995," said Euan Hogg. "There's a huge community interested in open source products, and the industry over time has produced serious products worthy of being called enterprise-level. We are confident that we can rely on SUSE, and that our users can rely on us as a result. A key factor in our choice of SUSE Linux Enterprise Server was its combination of open source backed by enterprise-class support. As good as it is, we couldn't rely solely on the Linux community for something as important as the objectives of ESA."

CONSISTENT BASELINE

ESOC introduced the first Linux baseline for Mission Control systems eight years ago, during the preparation of the Ground Segment for Herschel and Planck, the first ESA missions in orbit controlled by SUSE Linux Enterprise Server. "Since the introduction of SUSE Linux Enterprise Server 9 in 2004, ESOC has successfully kept its Linux baseline up to date with SUSE Service Packs, and ultimately migrated to version 11 in 2011, ensuring continuity for both the Operational and Development/Engineering communities," said Ernesto Doelling.

A Snapshot of Current ESA Missions

Mars Express, Rosetta, and Venus Express, launched in 2003, 2004 and 2005, are the flying interplanetary missions of the European Space Agency. While the two orbiters have been in the science phase for several years now, Rosetta will meet the comet 67P/Churyumov–Gerasimenko in 2014, following a long cruise phase.

The Herschel and Planck satellites were launched in 2009, and are positioned around the Earth Sun Lagrange point L2, to perform observations of the universe in the microwave and infrared spectrum.

Gaia, due to launch in 2013, is a global space astrometry mission whose goal is to make the largest, most precise three-dimensional map of our galaxy by surveying an unprecedented number of stars—more than a thousand million—about 70 times over a five-year period. For all objects brighter than magnitude 15 (4,000 times fainter than the naked eye limit), Gaia will measure their positions to an accuracy of 24 microarcseconds. This is comparable to measuring the diameter of a human hair at a distance of 1,000 km, allowing the nearest stars to have their distances measured to the extraordinary accuracy of 0.001 percent.

Although Gaia's transmitter is weak, it will be able to maintain data transmission at an extremely high data rate (up to 10 Mbit/s) from a distance of 1.5 million km. ESA's most powerful ground stations, the 35 m-diameter radio dishes in Malargüe, Argentina, Cebreros, Spain, and New Norcia, Australia, will intercept the faint signal.

Launching in 2015 and arriving at the planet in 2022, the BepiColombo mission will study the composition, geophysics, atmosphere, magnetosphere and history of Mercury, the least explored planet in the inner Solar System. The mission consists of two orbiters: the Mercury Planetary Orbiter (MPO) to map the planet, and the Mercury Magnetospheric Orbiter (MMO) to investigate its magnetosphere.

The adoption of SUSE Linux as the current baseline at ESOC is making it easier to achieve standardization and consistency. ESOC uses YaST® and AutoYaST to create, maintain and automatically deploy different configurations of SUSE Linux Enterprise Server for different requirements. This enables the organization to ensure that can deliver additional or replacement servers for existing missions that exactly match the existing or outgoing hardware.

"One of the key benefits YaST gives us is trust from the people we deal with," said Euan Hogg. "The end-user has to be confident that he can get an exact replacement for what he had three years ago, and we can guarantee that now. YaST also gives us the option to do version control by using XML files, and we can then respond to requests to add, remove or configure applications through that mechanism—it's excellent. In my experience, Kickstart

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> European Space Operations Center

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in Red Hat Linux was a little less intuitive and accurate. YaST makes life extremely straightforward, but also it doesn't completely hide everything from you. I'm not often impressed by operating systems, but the whole AutoYaST system makes SUSE Linux a very powerful environment."

Equally, the move to SUSE Linux saves time and effort when it comes to deploying new or updated systems, ultimately reducing costs and improving quality for ESOC.

"Installation times are faster with AutoYaST, without a shadow of a doubt, and we have confidence that what we deliver is consistently the same every single time," said Euan Hogg. "There are always unforeseen things in any new software deployment, but the consistency and control that SUSE Linux gives us means we can rule many things out very quickly."

RELIABLE SUPPORT

While ESOC has substantial Linux skills in-house, it appreciates the ability to call on professional support from SUSE to short-cut troubleshooting exercises. "The SUSE engineers are brilliant," said Euan Hogg. "We used them for a problem where we began to lose the GUIs for certain applications, which continued to run without problems. The SUSE engineers examined the system dumps, and rapidly pinpointed it as a problem with sound—which we don't really use in any case. That would have taken me so long to find out! Speaking as a technical person, having that quality of support is a key part of choosing a platform."

With SUSE Linux Enterprise Server powering a significant number of its ground segment systems, ESOC has greater confidence in its ability to offer seamless, reliable operations.

"Our satellites are protected by multiple redundant systems, so any fault with the operating system of a ground computer wouldn't have a catastrophic impact," said Marco Lanucara. "But it's certainly true to say that the reliability of the OS basline plays a crucial role in ensuring the smooth and efficient operation of ESA's satellites, supporting the important scientific work they accomplish."

Contact your local SUSE Solutions Provider, or call SUSE at:

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