

Edge computing in action: Space

Make critical decisions where data is produced, avoiding lag while data travels to Earth and back

Use cases

- Predict the location of ice that can be processed to produce liquid hydrogen and oxygen for fuel
- Perform analytics on local sensor data for International Space Station (ISS) experiments
- Detect moving objects around the ISS
- Predict failures on space suits and equipment for preventive maintenance
- Identify the location of materials needed for [3D printing](#) of supplies like bolts or girders
- Analyze astronauts' medical images to support healthcare decisions
- Identify imminent weather disasters near satellites without waiting crucial minutes for high-resolution images to be transmitted to Earth

Read [more use cases](#).

To boldly go millions of miles from the datacenter

Astronauts in deep space need to make critical decisions quickly. Are atmospheric and surface conditions suited for an experiment? Where is the most likely location for moon ice for conversion to fuel? What kind of medical treatment do astronauts need? Are there any signs of failure in on-board equipment or extravehicular activity (EVA) suits?

Minutes count. But sending data from sensors in space to Earth for analysis creates long delays. A single temperature reading takes 5–20 minutes to travel from the moon to the ground. High-resolution images from the Perseverance craft sent to Mars took [two days](#) to arrive, and high-resolution spectrum analyses take exponentially longer.

Solution: Make decisions locally, with artificial intelligence at the edge

NASA and its contractors are accelerating decisions in space with [edge computing](#). Data is processed close to where it is generated—not sent back to Earth. Compact edge devices on the spacecraft or satellites ingest sensor data (images, gasses, core sampling) and run machine learning (ML) models to produce a yes or no decision on the spot, typically in seconds or minutes.

The barrier to edge computing in space, until now, has been the very limited physical space, power, and cooling resources aboard space stations and satellites. However, data scientists accustomed to nearly infinite cloud resources are now rethinking the way they develop code.

Red Hat approach

With Red Hat® platforms, NASA and its contractors can mix and match edge hardware, based on space, power, cooling, and connectivity constraints on space stations and satellites. Options include remote worker nodes and three-node clusters.

To start, build ML models on Red Hat OpenShift®, which packages the code with everything it needs to run, including the operating system, tools, and libraries. One advantage of containerized applications in space is their size—typically a few megabytes compared to gigabytes for an equivalent virtual machine. Another advantage is portability. Researchers can develop an ML model once and then deploy it on any hardware—at the edge, in the cloud, or spread across both (the hybrid model). During peer review, other scientists can reproduce the results on any platform, regardless of operating system, libraries, or system configuration.

To ingest data from diverse sensors in space, use Red Hat AMQ streams. Based on the sensor data, Red Hat OpenShift Serverless scales the application up or down. When no data is coming in, Red Hat Ansible® Automation Platform turns off the model to conserve power and cooling. When sensor data begins streaming again, Ansible Automation Platform dynamically spins up the right number of instances of the model to meet performance targets.



Red Hat solutions for edge computing

[Red Hat Enterprise Linux for edge computing](#), optimized for small-form-factor devices

[Red Hat OpenShift Container Platform](#) with [Red Hat OpenShift Serverless](#)

[Red Hat CodeReady Containers](#), integrated development environment

[Red Hat Ceph® Storage](#)

[Red Hat Ansible Automation Platform](#)

[Red Hat AMQ streams](#), to integrate with sensors in space and process data streams

Red Hat provides the 24x7 support needed to support NASA's mission. We extensively test software from the open source community before distributing it. And our engineers work continually to improve features, reliability, and security to make sure the software infrastructure remains stable in high-stakes environments like space.

Red Hat in action: International Space Station (ISS)

Challenge: Aboard the ISS, mission specialists are studying microbes on surfaces and in water to assess whether it is safe to drink. Transmitting results of each DNA sequencing run to Earth for analysis would take weeks.

Solution: NASA is accelerating research with a containerized ML application running aboard the ISS. A proof of concept with a Hewlett Packard Enterprise (HPE) computer running Red Hat Enterprise Linux® ran from 2017 to 2019. In February 2021, NASA sent the Spaceborne Computer-2 to the ISS. The compact edge device runs Red Hat CodeReady Containers, which are one-node OpenShift clusters. Developers build the code on the ground and push it to the ISS. Results of edge analysis are available immediately to ISS personnel and also relayed to scientists on the ground.

Results: NASA expects the Spaceborne Computer-2 with CodeReady Containers to speed time to insight from months to minutes for on-board experiments on DNA sequencing and other sensor data analytics. Experience gained during this project will help NASA prepare for further deep-space exploration, including the Artemis mission to return to the moon. Read more about the [ISS edge computing solution](#).

Learn more about [Red Hat's edge computing solutions](#).

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