Use of the DCS-7280PR3-24-F to Realize SINET6 and a 400 Gbps Supercomputer Fugaku Connection via Dark Fiber

Highlights

Challenges

Faster access to supercomputer Fugaku

Arista Solutions

DCS-7280PR3-24-F

SINET6 with a total 1.2 Tbps connection using a 400G line, 400G-ZR, and LineSystem

Configuration of a base 400G network

CloudVision® telemetry acquisition

Results

The integration of the Arista 7280R3 and transceivers enables joint use as a

terminal device on a typical dedicated direction connection service.

The facilitates not only a simple device configuration but also reduces costs.

RIKEN Center for Computational Science (R-CCS) is a research institution operating under the mission to implement the latest research that integrates simulation, big data analysis, and AI through high performance computing (HPC) to solve scientific and social issues to bring about a revolutionary development of our society. R-CCS installed, manages, and operates two generations of supercomputers K and Fugaku, which have both ranked in as the highest performance supercomputers in the world. RIKEN began operation of the K computer in 2012 until it was decommissioned in 2019. The supercomputer Fugaku launched in April 2020 as a prioritized trail for the purpose of combating the spread of the COVID-19 virus. Fugaku has earned the "Four Crowns" for four consecutive terms from June 2020 as the top supercomputer on all four major world rankings of supercomputer. Today, Fugaku is used broadly as the highest-performance supercomputer in the world.

Customer Data

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Supercomputers and the Underlying Network

Fugaku realizes one-hundred-times the application execution performance of its predecessor, the K computer. As of November 2022, Fugaku has solidified itself as the ultimate supercomputer by demonstrating the world's top application execution performance according to the HPCG and big data analysis performance according to the Graph500 for six consecutive terms, while clocking in second for computational speed according to the TOP500, and third in AI performance according to the HPL-AI. Even outside of its dominance at the top of various rankings, Fugaku has been hailed as essential HPC infrastructure to prove the concept of cyber-physical systems that are a core principle to Society 5.0, which the Japan government advocates in its 5th Science and Technology Basic Plan.

A connection to the Science Information NETwork SINET6 enables universities and research institutions to use Fugaku over the internet, whether in Japan or overseas. Upon its initial launch for full joint use in March 2021, Fugaku connected to the SINET5 network using an exclusive 100 Gbps line. As of April 2022, the system has been using three 400 Gbps lines between the Kobe Data Center and Osaka Data Center to realize a high-capacity connection with a total 1.2 Tbps bandwidth. The R-CCS adopted the Arista Networks 7280R3 Series switches to handle this connection.

The line to establish connections to a supercomputer plays a very important role.

These systems must prevent any bottleneck when accessing data to fully utilize the computing power of a supercomputer. That is why Fugaku front loads the data necessary for calculations by copying the data to a high-speed storage device on its end to read and write at ultra-high speeds using an internal internet connection. Users use an external connection with SINET to copy data to a Fugaku storage device.

Each and every year though, the volume of data handled by this supercomputer is continually rising, and in turn the amount of data transferred to Fugaku to prepare for these calculations is dramatically rising as well.

Obviously, there is no one standard because the volume of data necessary varies according to the application and workload, but the data can range from at least several gigabytes for small calculations to petabytes for large ones. Keiji Yamamoto, the R-CCS Unit Leader of the Advanced Operation Technologies Unit in the Operation and Computer Technologies Division in charge of Fugaku operations and the external network, explains, "Five or six years ago, I didn't think we'd be using the entire 100 Gbps bandwidth of the 100 Gbps SINET5 connection. Several years later though, we are almost at that 100 Gbps limit.

Our transition to SINET6 increases this bandwidth to 400 Gbps, which still gives up plenty of leeway for now, but I am sure the day will come eventually where R-CCS is at almost the full 400 Gbps capacity while using SINET6."

The purpose of a supercomputer is to provide ultra-high-speed processing of a tremendous amount of data. Modern society also continues to drive up the volume of this data with explosive speed as it digitizes everything into data. That's why it goes without saying high-speed network switches that can more quickly support the latest standards have an enormous role to play as well.

Background of the Adoption

Shinichi Miura, Technical Scientist in the R-CCS Advance Operation Unit who was responsible for selecting the network devices in preparation of implementing the 400 Gbps line, reflects on the adoption of Arista Networks switches saying, "Our need for network devices that could process 400 Gbps of traffic at a wire rate limited our options to the major vendors. Arista Networks offered not only a high level of cost performance but also gave us the ability to use a transceiver supporting fiber optic transmission multiplexing. This support was important to us because it satisfied our need for a long-distance, high-speed connection."

The connection between Fugaku and SINET6 is done via the Kobe and Osaka Data Centers.

A connection over an exclusive line between Kobe R-CCS and SINET6 at the Kobe Data Center realizes 400 Gbps, but the connection to SINET6 at the Osaka Data Center runs through the R-CCS Osaka Data Center.

The Osaka R-CCS Data Center and SINET6 Osaka Data Center have a long-distance connection that uses 400GBASE-FR4. A direct connection between the R-CCS and Osaka Data Center is only about 30 km. The use of dark fiber, a 400G-ZR module, and a Line System enables a two channel 400 Gbps line (800 Gbps) that can secure a total bandwidth of 1.2 Tbps in combination with the dedicated Kobe Data center line. The number of people expressing the need for greater bandwidth had also been rising. This led to the addition of 400G-ZR modules to each Arista 7280PR3 between the R-CCS and Osaka Data Center to realize a bandwidth reaching up to 3.2 Tbps.

The multiplexing of connections between the Kobe Data Center and Osaka Data Center is significant as a measure to prepare for any issues too. This configuration even offers simultaneous functionality as a venue for testing new technologies. Akihiro Nomura, Senior Technical Staff in the Advanced Operation Technologies Unit of the Operations and Computer Technologies Division explains, "The exclusive 400 Gbps line on the Kobe Data Center side uses a dedicated direct connection service from a telecommunications provider, which is essentially the adoption of proven technology.

Conversely, the Osaka Data Center decided to take on the challenge of new technology to establish a connection ourselves by leasing dark fiber." The R-CCS took on the

responsible for building its own network in addition to the trouble entailed with handling the day-to-day operations. An in-house system is expected to dramatically reduce costs compared to those required to outsource this connection to an external service contractor. The actual development, configuration, and ongoing management of a supercomputer is quite costly. As the top system in the world of course, R-CCS has to reduce Fugaku costs as much as possible, which makes efforts to maintain a high level of cost performance indispensable. The integration of the Arista 7280R3 and transceivers enables joint use as terminal devices on a typical dedicated connection service, which facilitates not only a sample device configuration but also reduces costs. Shinichi Miura says he equates the dramatic reductions in usage fees offered by using dark fiber instead of a dedicated direction connection service to saving enough money to buy new Arista 7280PR3 switches every year.

Obviously, only an organization with the technical capabilities to build and manage a high-speed network on leading-edge standards is up to such a task. This makes the R-CCS uniquely suited for such a challenge as an expert versed in supercomputers. The product quality and ease of management delivered by the Arista 7280R3 Series have also been praised for helping realize the adoption of this kind of system.
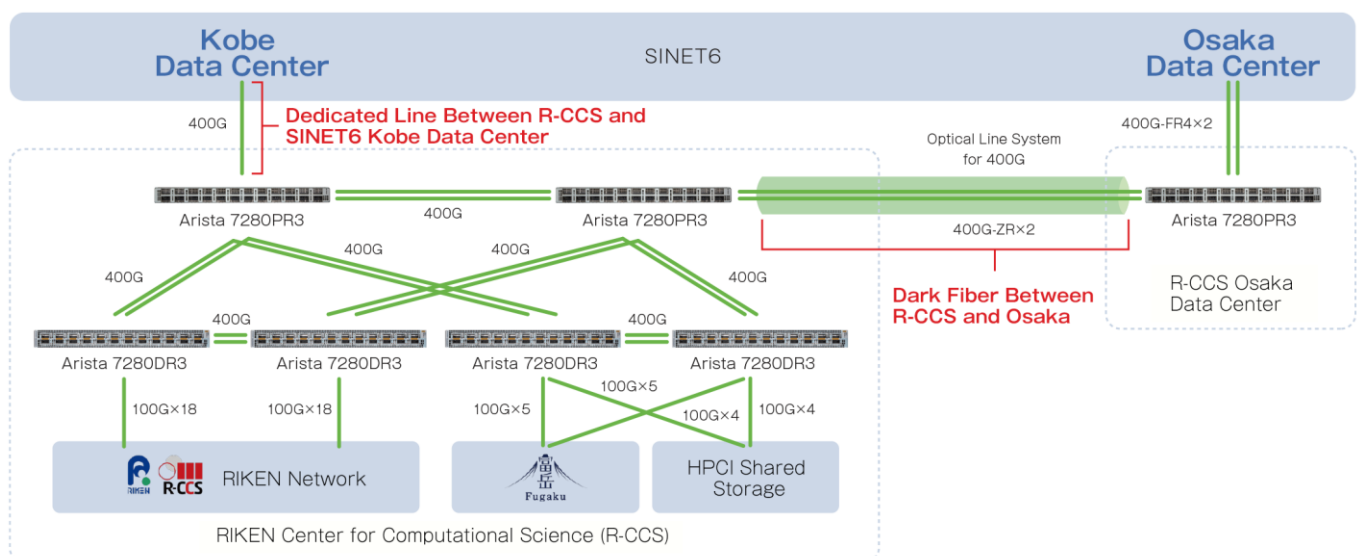
Praise for the Arista 7280R3 Series

As described earlier, the R-CCS underwent preparations to configure this system assuming something would go wrong because it was the first time it had taken on the challenge of building a network using dark fiber. Shinichi Miura was surprised by how simple it actually was. "We connected it all, and turned on the power establishing the connection that we are using now without any problems at all." The R-CCS has even given high praise to the operation and management offered by the Arista EOS CloudVision.

Joint use of Fugaku coincided with the COVID-19 pandemic. It acted as a core system central to remote and telework even at the R-CCS. The R-CCS raved about the convenience in remotely managing the status for each switch centrally during this crisis.

The shift to internal management required the R-CCS to obtain more detail information than conventionally necessary. CloudVision allows the R-CCS to refer to detailed logs to check on any past issue that happened to find out exactly what went wrong. In fact, the R-CCS did have experience with some routing trouble that caused connection problems due to an issue related to inappropriate Border Gateway Protocol (BCP) messages, but CloudVision made it very easy to verify statuses in detail during troubleshooting.

There are almost no examples of optical multiplexing using a 400 Gbps connection even when looking worldwide, which makes the R-CCS system the very first case study pioneering this revolutionary technology.

One key point was ensuring the leeway to expand the bandwidth to support the latest standards in the future. This is made possible by the use of multiplexing technology. The R-CCS can use the existing dark fiber while upgrading only the transceiver modules of the switches when expanding the future bandwidth.

The R-CCS has been expanding its adoption of Arista Networks products due to its fantastic experience with the high product cost performance as well as the ease of operation and management. As a result, CloudVision is said to have realized an environment that can fully capitalize on centralized management.

Although mainstream switches in this class made by other companies are primarily chassis switches, Arista Networks has a comprehensive compact box lineup, which R-CCS also praised highly for the excellent space savings.

Arista Networks will always delivery the latest technologies with a high level of cost performance and the highest standard of products packing easy operation and management as well as reliability and safety to support every advanced user who needs to put in place the most cutting-edge networks.

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