CASE STUDY

Cloud Data Center
CERN LHCb

Helping Solve the Mysteries of the Universe

Intel® DCM delivers real-time power and thermal monitoring in high performance computing environment, improving server utilization and health

CERN

supplier

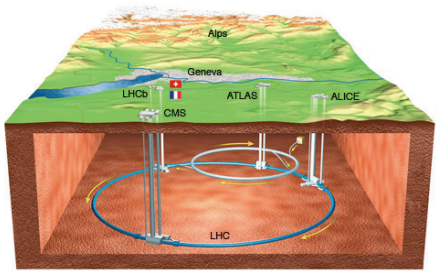
CERN: European Organization for Nuclear Research

Headquarters: Route de Meyrin, 1211 Geneva, Switzerland

Established: 1954

Activities: Scientific Research

www.home.cern



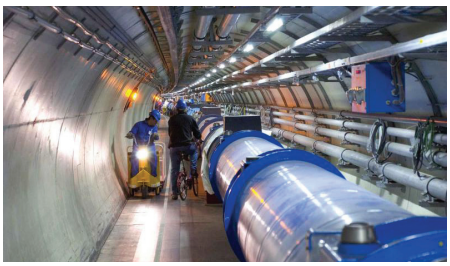


Figure 1. The Large Hadron Collider tunnel (Images: CERN)

Challenges

- Real-time power and thermal monitoring
- Server utilization
- Increase energy efficiency
- Efficient data center operation

Solution

- Intel® Data Center Manager

Executive Summary

CERN's LHCb IT staff deployed the Intel® Data Center Manager in its High Performance Computing (HPC) data center environment. The Intel® Data Center Manager provided the CERN LHCb IT staff with accurate real-time power and thermal consumption data to deliver the insights needed to manage the data center power usage and hotspots. This included real-time monitoring of actual power and inlet temperature data aggregated to servers, racks, and groups of servers, as well as server health component monitoring at a granular level. Additionally, real-time thermal data from Intel® DCM enabled CERN LHCb IT to reduce cooling cost and improve Power Usage Effectiveness (PUE) by safely raising the temperature of the server room while continuously monitoring data center devices for temperature issues, thus increasing energy efficiency.

Background

Located in Geneva, Switzerland, the physicists and engineers at CERN, the European Organization for Nuclear Research, are probing the fundamental structure of the universe. Founded in 1954, the CERN laboratory was one of Europe's first joint ventures and now has 22 member states. The physicists there use the world's largest and most complex scientific instruments to study the basic constituents of matter. These fundamental particles are made to collide together at close to the speed of light. This process offers clues about how the particles interact and provides insights into the fundamental laws of nature.

One of CERN's flagship experiments is the Large Hadron Collider beauty (LHCb) experiment, which is set up to explore what happened after the Big Bang that allowed matter to survive and build the Universe we inhabit today. The LHCb experiment will help us to understand why we live in a Universe that appears to be composed almost entirely of matter, but no antimatter.

The key scientific instrument in this exploration is the Large Hadron Collider (LHC), a particle accelerator that is located approximately 100 meters underground.

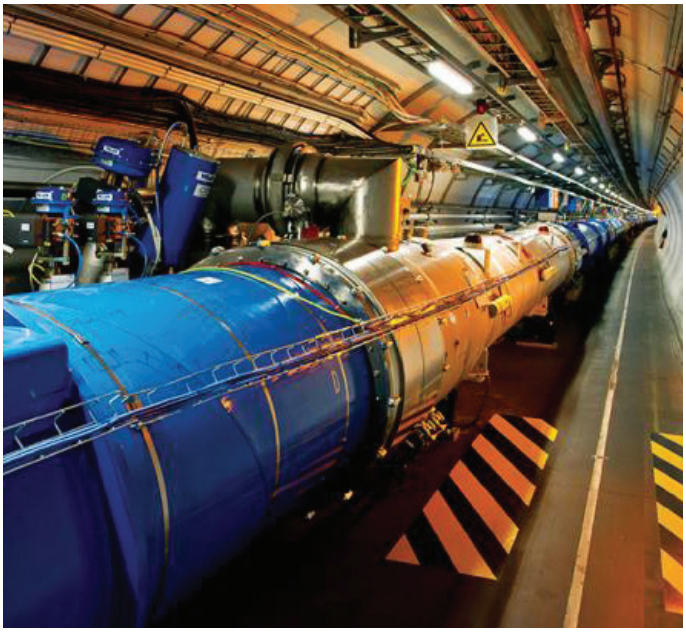


Figure 2. The Large Hadron Collider is the world's largest and most powerful particle accelerator (Image: CERN)

Figure 3. Intel® Data Center Manager Console

Approximately 2100 million times per second, particles collide within the LHC, and each collision generates particles that often decay in complex ways into even more particles. Electronic circuits record the passage of each particle through a detector as a series of electronic signals, and send the data to the CERN data center for digital reconstruction. The digitized summary is recorded as a "collision event." Physicists must sift through approximately 30 petabytes of data produced annually to determine if the collisions have demonstrated any interesting physics.

Processing a Colossal Amount of Data, Every Second

The current LHCb Data Acquisition (DAQ) computing farm consists of two rooms of 75 square-meters each that are located 100 meters underground, totaling approximately 600 kW. With a total of 95 racks, this data center uses rear-door water cooling with chilled water at 17 degrees C. It serves to filter the data from the experiment, and at each second more than 60 Gigabytes of collision data must be analyzed in real-time.

The future LHCb data center, which will go into production in 2019, will consist of six modules with a total capacity of almost 3 MW on the surface, using free air cooling with adiabatic assisted cooling technology.

Intel® Data Center Manager Provides Server Health Monitoring and Cooling Analysis at a Granular Level

To gain visibility of thermal management in its High Performance Computing (HPC) data center, LHCb IT staff deployed the Intel® Data Center Manager on 1000 servers in its production environment. CERN's LHCb HPC cluster is used for real-time data analytics, data acquisition and storage, and distribution. Intel® Data Center Manager (Intel® DCM) is a software and technology product that monitors, manages and optimizes the energy consumption and temperature of data center servers.

LHCb IT staff installed Intel® DCM to measure power and thermal data for individual servers and groups, as well as direct power consumption to specific systems vital to completing operationally critical work. The deployment was particularly significant to LHCb because of its plans to migrate its computing operations from its underground data center to an above-ground facility in 2019. Hence, the Intel® DCM deployment was a very important tool in the migration to a new data centre with a – for LHCb – new cooling technology.

Intel® DCM was deployed in a short amount of time, and because its dashboard is very intuitive and focused on applying real-time monitoring to specific data center operational challenges, the CERN LHCb IT management team was able to immediately start quantifying and visualizing the current energy and temperature patterns related to servers and cooling solutions.

The Intel® Data Center Manager provided the CERN LHCb IT staff with accurate real-time power and thermal consumption data to deliver the insights needed to manage the data center power usage and hotspots. This included real-time monitoring of actual power and inlet temperature data aggregated to servers, racks, and groups of servers, as well as server health component monitoring at a granular level — a capability that CERN LHCb IT administrators previously lacked.

Using the Intel® DCM cooling analysis, CERN LHCb IT staff discovered that while some legacy servers were running hot, newer devices in the data center were significantly overcooled, indicating a considerable cost savings opportunity. Real-time thermal data from Intel® DCM enables IT staff to reduce cooling cost and improve Power Usage Effectiveness (PUE) by safely raising the temperature of the server room while continuously monitoring data center devices for temperature issues. This capability allowed CERN

LHCb IT to confidently raise the server room temperature, thus increasing energy efficiency.

The CERN LHCb data center uses rear-door water cooling. Rear-door water cooling uses a closed loop. The future data center – on the surface – will use adiabatic assisted water cooling in addition to free air cooling. This adiabatic assisted water cooling produces optimal cooling and waste-water. With the help of Intel® DCM, CERN LHCb IT staff will be able to minimize water wastage. Additionally, real-time thermal monitoring eliminated the need to purchase costly intelligent PDUs.

Intel® DCM's server health monitoring and utilization feature provided CERN LHCb IT administrators with granular sub-component failure analysis. Moreover, the health monitoring feature enabled LHCb IT to receive alerts based on custom power and thermal events, which will further ensure uptime.

Additional Key Benefits

One of the challenges of having a single solution for power management across all devices in the data center is that there are multiple proprietary power measurement and control protocols supported by different OEMs. One of the key features of Intel® Data Center Manager is its functionality in a heterogeneous server environment, which satisfied CERN LHCb IT's requirement for interoperability across all of its equipment.

Intel® DCM licenses are transferable from its present 500 kW facility to its future data center of up to 3 MW. These licenses are not bound to its present hardware and can be reused when CERN's new facility goes online.

Finally, CERN LHCb IT staff benefitted from Intel® DCM's short learning curve, ease of use, and simplicity of deployment. The use of Intel DCM eliminates the need for complex, device-specific configuration, setup or customization.

In the future, when CERN LHCb IT migrates its computing operations from its underground data center to its new above-ground site, Intel® DCM's ability to provide detailed information about server power characteristics will assist the program's IT managers to set fixed-rack power envelopes, and enable then to safely increase server count per rack, which will improve utilization. Intel DCM will help CERN LHCb IT to better understand the racks utilization in the new data center and will help with rightsizing of the infrastructures of the new data center to what they really need.

Intel DCM will help CERN LHCb IT to have a smoother migration and relocation to the new data center by providing real data of the power consumption of the existing environment before the move. It will also assist to better plan the heat distribution of the new data center and avoid hotspots that might have existed in the old data center.

Intel® Data Center Manager Deployment Results

Intel® Data Center Manager provided the CERN LHCb IT staff with accurate real-time power and thermal consumption data to deliver the insights needed to manage the data center power usage and hotspots.

- Real-time thermal data from Intel® DCM enables IT staff to reduce cooling cost and improve Power Usage Effectiveness (PUE) by safely raising the temperature of the server room while continuously monitoring data center devices for temperature issues.
- Intel® DCM's server health monitoring and utilization feature provided CERN LHCb IT administrators with granular sub-component failure analysis and out of band real-time utilization data including CPU, disk and memory.

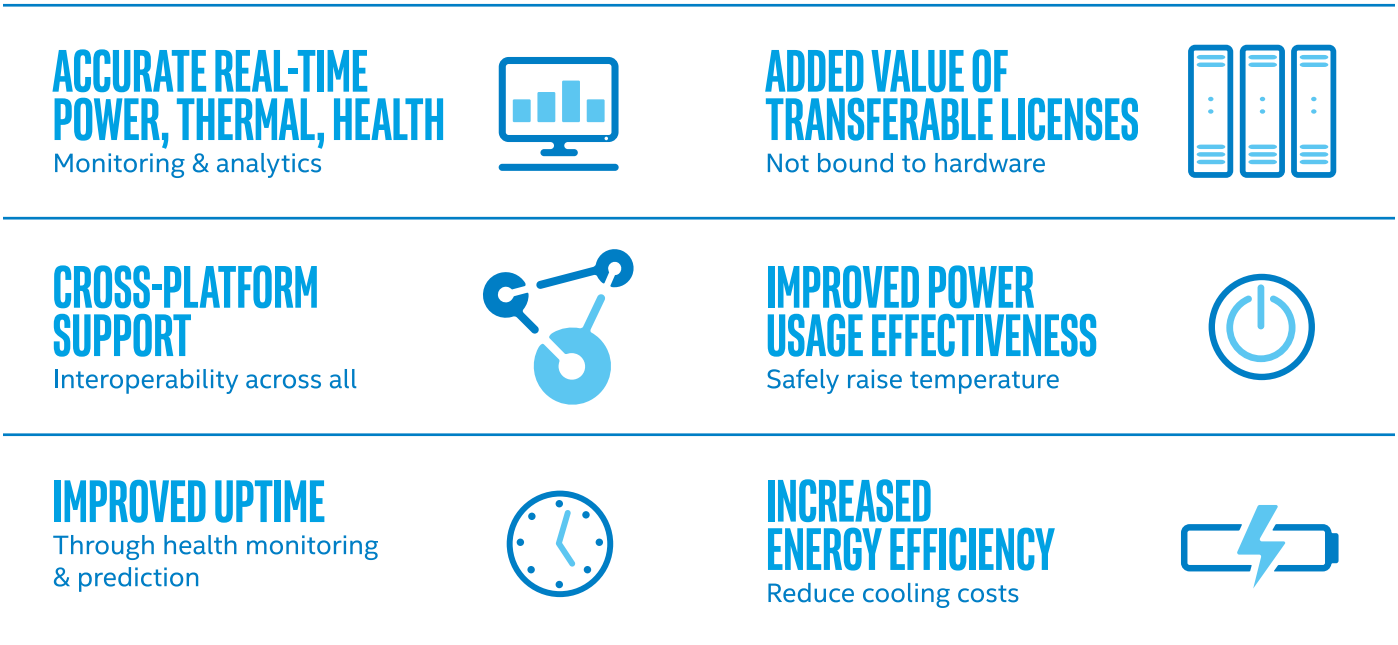


Figure 4. Key Benefits of CERN LHCb IT's Engagement with Intel® DCM

Quote/Client Testimonial

"We are happy to see that the Intel® Data Center Manager is being used at the CERN LHCb data center on a day-to-day basis, and we foresee a tremendous value for our technology solution across other HPC data center environments. Intel® now has many successful engagements with HPC customers with compute-intensive workloads that are striving to increase their data centers' efficiency through the use of the Intel® DCM solution."

– Jeff Klaus, General Manager
Intel® Data Center Management Solutions

"Processing an enormous amount of information on a daily basis, CERN's Large Hadron Collider beauty (LHCb) data center houses mission-critical systems that are essential to functioning of the experiment as well as servers and data storage for further physics analysis. The Intel® Data Center Manager not only provided CERN LHCb IT staff with accurate real-time power and thermal consumption data to manage the data center power usage and hotspots in our current facility, but promises to deliver great value when deployed at our future site."

– Niko Neufeld, Deputy Project Leader at CERN

Where to Get More Information

For more information on Intel® Data Center Manager, visit **intel.com/dcm** or contact **dcmsales@intel.com**

About Intel® Data Center Manager

Intel® Data Center Manager (Intel® DCM) provides accurate, real-time power, thermal and health monitoring and management for individual servers, group of servers, racks and IT equipment in the data center. It's a capability that is useful for both IT and facility administrators, which allows them to work jointly to increase data center efficiency and uptime.

PUE is an indicator defined by Green Grid, a global consortium working to improve power efficiency in the data center system. PUE is a metric for the efficiency of electricity use, defined as:

$$\text{PUE} = \frac{\text{Total power dissipation in a target facility}}{\text{Total power consumption for the IT equipment}}$$