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Monitoring and Managing the Modern Data Center

Intel® Data Center Management (Intel® DCM) software and Intel® Power Thermal Aware Solution (Intel® PTAS), combined with Chunghwa Telecom's Intelligent Energy Network (iEN) data center solution, can reduce the power consumption of data center cooling equipment by up to 30% and improve overall data center operating efficiency.

With the rising demand for cloud service, businesses today require increasingly more compute capability from their data centers. This compute increase will most likely come from higher rack and room power densities.

But an increase in a data center's business-critical IT equipment (servers, hubs, routers, wiring patch panels, and other network appliances), not to mention the infrastructure needed to keep these devices alive and protected, encroaches on another IT goal: to reduce long-term energy usage.

IT facilities use electric power for lights, security, backup power, and climate control to maintain temperature and humidity levels that minimize downtime due to heat issues. By benchmarking power consumption, you are comparing the power needed to run business-critical equipment with the power needed to maintain that equipment.

Challenges

- **Reduce power consumption/costs.** How to raise the IT and power density of data center racks to meet business growth and better service delivery is a top concern for many cloud service providers and a barrier to some companies' growth. For efficient and intelligent operation and for improved service, data centers must maximize available resources while reducing operating costs.

- **Cool equipment intelligently and efficiently.** Tailoring data center cooling needs on a case-by-case, server/rack/row basis has not been possible until now.

Solution

- **Intel® DCM and Intel® PTAS.** The PTAS technology solution provides platform telemetry data, metrics, and analytics to enable real-time power and thermal monitoring and reporting, analytics, cooling, and compute control in a data center. (Early hot spot identification, monitor events in server/rack, advanced CRAC control strategies.)

- **Chunghwa Telecom iEN Service.** CHT's Intelligent Energy Network (iEN) data center solution decreases power usage and increases operation efficiency by combining intelligent management of your data center's infrastructure and power system (including air conditioning, lighting, security, and environmental monitoring) in one platform.

Benefits

- **Up to 30% energy savings.** Decrease energy consumption by reducing overcooling, while achieving PUE 1.52 to meet LEED standard for green data center operation.

- **Increased reliability of data center operation.** Intel® platform telemetry data, metrics, and analytics solution enables real-time monitoring and energy efficiency management. Data center administrators get real-time information on cooling issues and heat distribution alarms.

Chunghwa Telecom
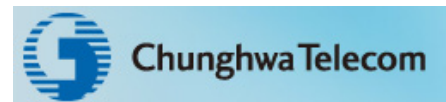
"Working with Intel on this data center management proof-of-concept has shown us that we can deliver real-time level 3 PUE measurements on a fully operational data center. And not only can we monitor our data center's energy efficiency through the cloud, we can also intervene when necessary, redistributing resources and facility infrastructure according to need.

"We are optimistic about the feasibility of integrating real-time individual server data with a building energy management system to dynamically manage a facility's cooling infrastructure. We look forward to validating this next step in Chunghwa Telecom's long-term plan to improve data center efficiency management."

— Ruey-Chang Hsu,
Vice President of Network Department,
Chunghwa Telecom

Benchmarking power usage

Before you can intelligently reduce your data center's energy consumption, you need to know what its current consumption is. Monitoring energy consumption is the first step to managing your data center's energy efficiency. Benchmarking helps you understand the existing level of efficiency in your data center.

Power Usage Effectiveness (PUE) and its reciprocal Data Center Infrastructure Efficiency (DCiE), developed by the Green Grid consortium, are internationally accepted benchmarking standards that measure a data center's power usage for actual computing functions (as opposed to power consumed by lighting, cooling, and other overhead).

$$PUE = \frac{\text{Total facility power}}{\text{IT equipment power}}$$

$$DCiE = \frac{\text{IT equipment power}}{\text{Total facility power}}$$

A data center that operates at 1.5 PUE or lower is considered efficient (see *Table 1*).

Table 1 PUE/DCIE efficiency standards [a]

PUE	DCIE	Efficiency
1.2	83%	Very efficient
1.5	67%	Efficient
2.0	50%	Average
2.5	40%	Inefficient
3.0	33%	Very inefficient

a. Source: Green Grid

Identifying where power is lost is key to making your data center run more efficiently. Three ways to measure PUE:

- **Level 1.** Measure at least twice a month from the data center's UPS (uninterruptible power supply).

- **Level 2.** Measure daily at the PDU (power distribution unit).

- **Level 3.** Measure continuously throughout the day, including data from the PDU and UPS.

Level 3 measurements are the most accurate and most useful, and they are easy to acquire with Intel® PTAS.

Intel® PTAS gives you precise indicators to match supply with demand, comparing the power currently used for the IT equipment with the power used by the infrastructure that keeps that equipment cooled, powered, backed up, and protected. By addressing inefficiencies at the rack level, you can optimize by row, and eventually address the whole data center's efficiency, reducing power consumption and related energy costs—in both operating and capital expenses—and thereby extend the useful life of your data center.

Cooling needs

Because heat is a leading cause of downtime in data centers, rooms filled with racks of computers and other heat-producing IT equipment require a lot of energy to cool. Some experts claim a data center's infrastructure may be responsible for as much as 50% of the DC's energy bill—a good portion of that coming from cooling equipment.
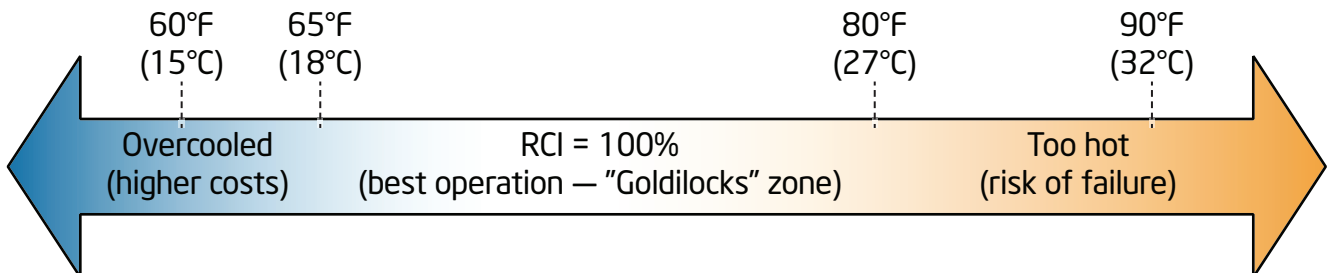
The energy required by this cooling equipment may come at the expense of actual compute power. So reducing the power fed to your cooling solution may allow greater utilization of your power resources for actual business.

The Rack Cooling Index (RCI)*, which monitors rack overtemperatures and undertemperatures, is another useful industry benchmark. In short, an RCI score of 100% indicates that temperatures did not exceed the acceptable highs (or lows). Anything above 90% is acceptable, and above 96% is considered good. A data center that maintains 100% for both highs and lows is in the "goldilocks zone"—the optimal operating temperature that is not too hot or too cold. Generally speaking, the goldilocks zone for data centers is between 65 and 80°F (18 and 27°C). Anything cooler is probably wasted energy, and anything warmer may result in equipment failures and more downtime (*Figure 1*).

But because IT professionals seldom have access to real-time controls to optimize power and temperature, many will overcool their data centers to meet peak or "worst case" conditions. Overcooling a data center wastes energy, but IT professionals rarely have the tools they need to cool their data centers wisely and economically.

Figure 1 Data center operating temperature ranges

60°F (15°C) 65°F (18°C) 80°F (27°C) 90°F (32°C)

Overcooled (higher costs) RCI = 100% (best operation — "Goldilocks" zone) Too hot (risk of failure)

Intel® PTAS and how it works

Intel® PTAS is Intel's DCIM solution with integrated platform telemetry and analytics to identify and address energy efficiency issues. It provides server level power monitoring through Intel® DCM, calculates efficiency metrics, and develops 3D thermal maps of with PUE Level 3 measurements. It also works out air conditioning control strategies and stimulation, logging events for any abnormal behavior in a server, rack, or room.

One server acts as the Intel® DCM Server. It gathers information from the other servers, then sends this data through API to the iEN-Box, and both interact with each other in real-time (*Figure 2*). For example, if the Intel® DCM Server were to notify the iEN-Box that a server was running hot, the iEN-Box, through controlling devices, could increase the cooling for that rack location.

Then iEN builds thermal maps and efficiency metrics from Intel® DCM data. As a result, data center administrators can identify unused or idle servers for consolidation, avoid potential failures before they occur, and run the data center more efficiently.

Figure 2 Proof of concept configuration
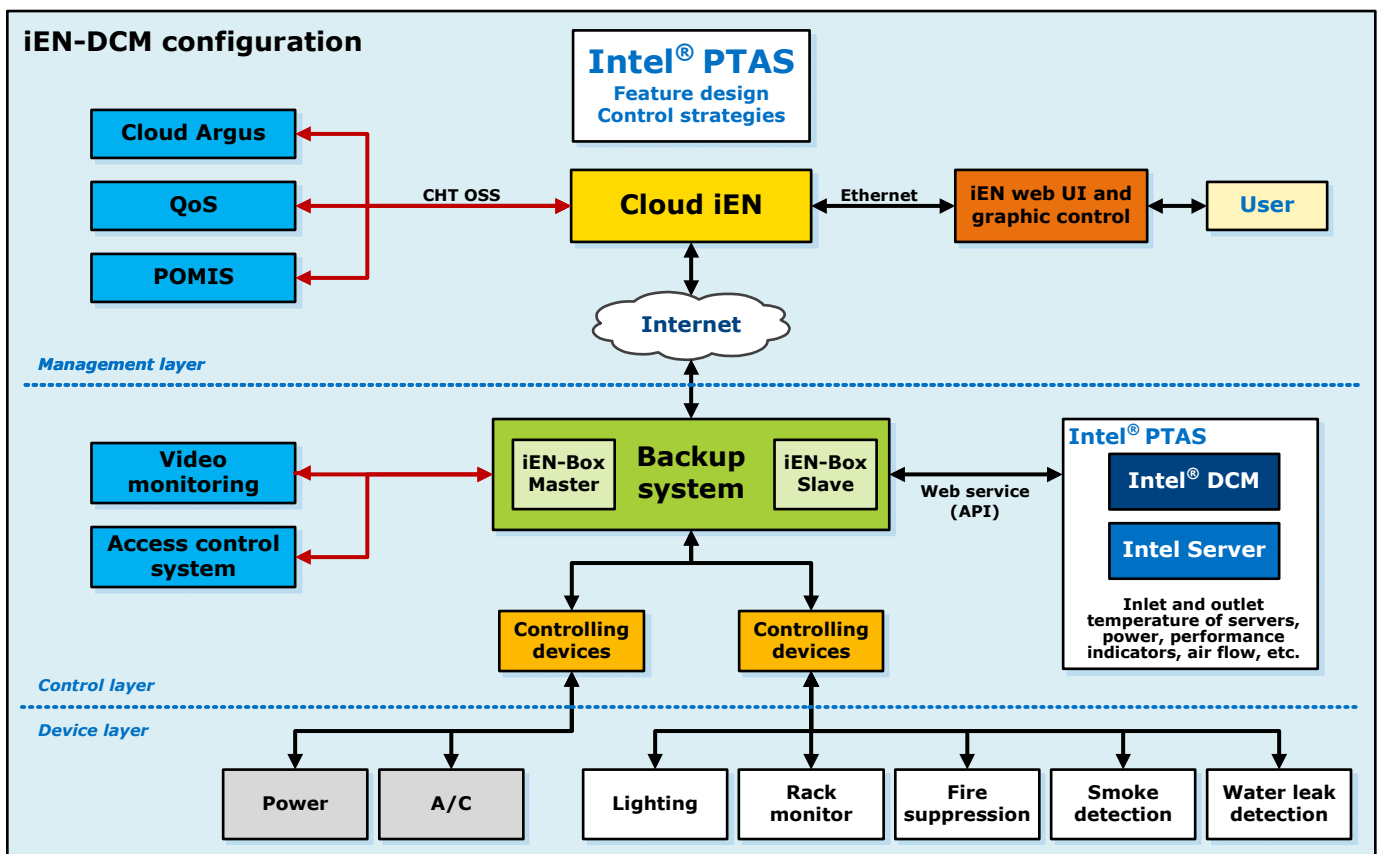
Results

Intel helped conduct a proof of concept at Chunghwa Telecom's 2,427-square-foot data center to evaluate Intel® DCM and Intel® PTAS working with CHT's iEN. The test involved an internal data center with separate hot and cool aisles, using 19 QCT and Intel servers[1]—with at least four units in each of four dedicated racks within a single row—to monitor and compare results with the influence of different locations. A twentieth server, acting as the Intel® DCM server, gathered data on itself and the other servers. The administrator could log onto the Intel® DCM server through the cloud and get real-time information on each server's power usage, air flow, temperature, CPU utilization, etc. (*Figure 3*). In this example, with a CUPS threshold of 50, the system alerts you when any unit exceeds 50 CUPS[2].

The two-dimensional "floorplan" view of the data center shows server thermal distribution in real-time. Clicking on a monitored rack or on an alarm icon displays a three-dimensional representation of the servers in the rack (*Figure 4*), with detailed readings and color-coded thermal indicators for each server.

1. **Nine Quanta* QCT servers:** One Intel® Xeon® E2600 v3 65 W CPU, one DIMM, and one 2.5 in. HDD.
   Ten Intel servers: Two Intel® Xeon® DP E5-2680 130 W CPUs, one 200 GB SSD, and one 2.5 in. HDD.

2. CUPS = compute usage per second; a measurement of the amount of "useful" work a server is performing.

With integrated CUPS telemetry and thermal metrics, Intel® PTAS balances compute load to correct thermal events. So if the system exceeds a threshold, or an uneven temperature distribution occurs, Intel® PTAS provides color-coded visual warnings, notifies you of the event (by alert, e-mail, or SMS), and recommends corrective actions.

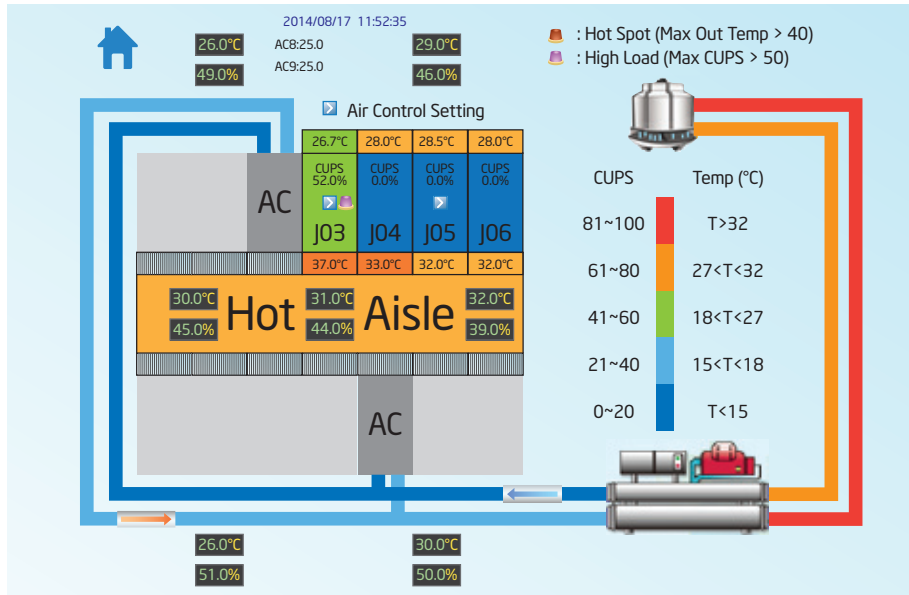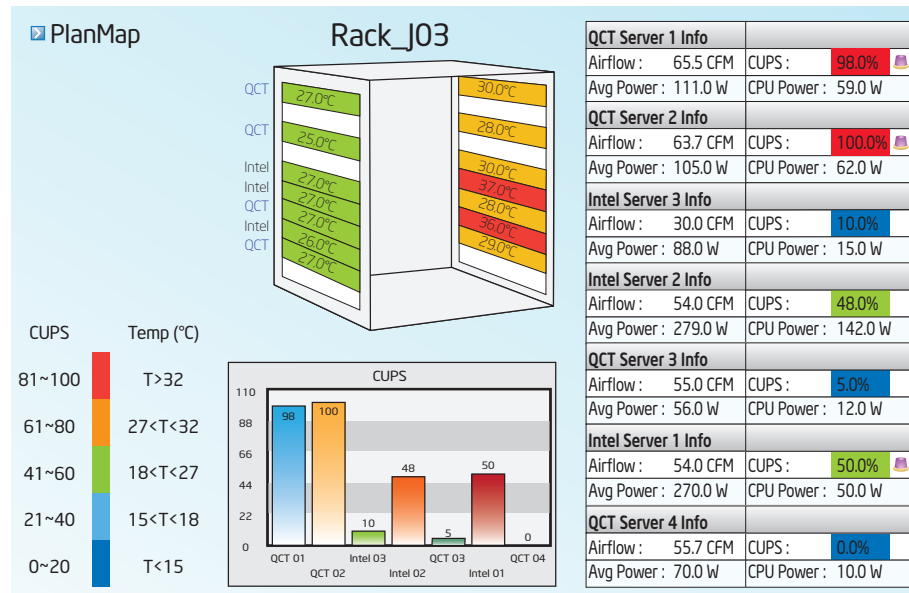**Figure 3** Real-time two-dimensional representation of power usage, air flow, temperature, CPU utilization

Figure 4 Three-dimensional representation of a specific rack

Summary

Our tests showed that integrating CUPS data with thermal readings to balance server loads, using supply-side optimization (which allowed us to raise ambient temperatures), and using server sensors to control cooling equipment reduced cooling needs and resulted in savings.

An administrator can choose the hottest, coldest, or average temperature to trigger cooling remedies. We found that using the hottest temperature as the control point (and switching from return-side to supply-side monitoring) improved AC efficiency by 10 to 15%.

Integrating Intel® PTAS, Intel® DCM Energy Director with Intel® Node Manager, and Chunghwa Telecom's iEN data center solution improved operating efficiency and reduced power consumption by up to 30%.