Talking the Same Power Language

Improving accuracy and consistency of power measurements in the data center

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There is a lot of talk about power these days, and a lack thereof in the data center arena. Accurate measurement and visibility of power usage is a critical part of planning and operations for businesses. In addition, with increasing stakeholder demands to reduce greenhouse gas (GHG) emissions and reporting requirements, insight into your company's energy consumption has never been more important.

According to the International Energy Agency (IEA)'s Electricity 2024 report, power generation is currently the largest source of carbon dioxide (CO_2) emissions in the world. World electricity demand is expected to jump 3.4% from approximately 27,682 terawatt-hours (TWh) in 2023 to 30,601 TWh by 2026. Electricity consumption from data centers, AI, and other high performance computing needs could more than double from 2022 (460TWh) to 2026 (1,000+TWh). (*Source: Electricity 2024: Analysis and forecast to 2026, International Energy Agency, January 2024).*

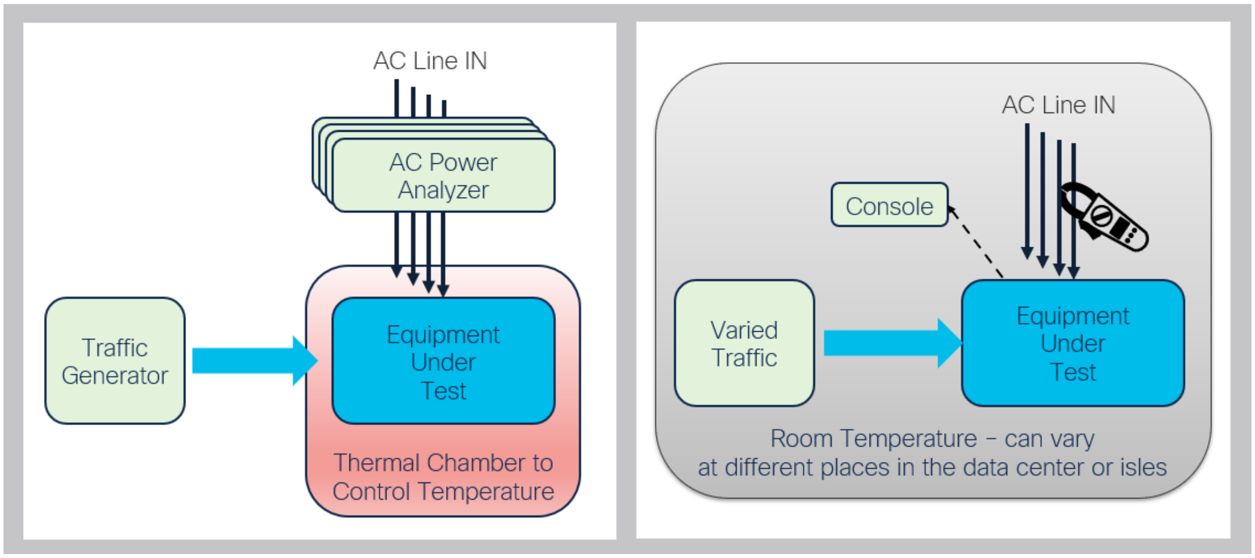
In our In our first paper, we talked about the challenges and discrepancies involved in measuring power accurately across our devices. To address common mistakes, Cisco has been working on specific measurement strategies and methodologies for data center equipment power usage. With a more consistent, repeatable method to measure your power, you can make better IT, building operations and data center management decisions, and reporting of IT energy consumption.

Cisco is planning to help standardization efforts to more accurately measure product power across the information and communications technology (ICT) industry. This approach goes beyond ATIS TEER (Alliance for Telecommunications Industry Solutions Telecommunication Energy Efficiency Ratio) analyzing (1) the physical setup, (2) traffic and temperature, and (3) understanding software readings and sources of error.

A More Accurate Power Measurement Methodology:

(1) Physical Setup: How you measure power is the most critical piece of the puzzle

Let's dive right in. Accurate methods to measure power use an inline power meter.
For better results, use a device, like the Chroma 66205, inserted into the current path to measure power. An inline power meter isolates the power supply feed and blocks any interaction among the Power Supply Units (PSUs) or power distribution network itself. Current clamps are often used due to their simplicity and accessibility, but lack calibration, are placement dependent, and provide only a simple current reading. This can lead to confusing "real" power with "apparent" power (see our first paper), and, as a result, trusting an inaccurate reading.



For greater accuracy in Cisco's lab, PSUs are **measured separately using a dedicated power meter.** Equipment in a data center could be powered by two to dozens of PSUs. Electronics inside each PSU are constantly adjusting as they try to reach an equal current or load share. However, the share is never perfect, leaving a 1-5% disparity between PSU loads. Assuming there is equal load distribution across these PSUs can lead to significant measurement errors. Connecting multiple PSUs to a single power meter can allow for interactions between them which can significantly affect power factor and measurement accuracy. Using wired-only connections mitigates this issue and produces accurate and repeatable measurements.

For most power measurement applications, constant measurement with this level of accuracy isn't necessary. Wired-only connections can be expensive and require a lot of space for the equipment. But when trying to troubleshoot power or understand the impact of a specific device, using power meters is our recommended approach.

(2) Traffic and Temperature: Understand the effects of variations on hardware and power

Internet traffic varies from day to day and even minute to minute. This makes comparing lab measurement and real-world implementation difficult at best. For measurement accuracy, the effects of traffic on the hardware and power need to be included. For instance, shorter packets, such as voice calls, require more memory and faster processing times, while large packets require more time to process and move data.

Standards bodies such as ATIS and ETSI (European Telecommunications Standards Institute) attempt to guide traffic patterns and data rates for power measurement. Unless a measurement is being taken for an audited standard, traffic patterns are driven by customer usage at the time, making it hard to compare one product or generation to another. Even within IMIX (internet mix) traffic, there are 30+ common profiles used today throughout industry.

At Cisco, we are building standardized power measurements using several data traffic patterns with different characteristics and stressors. This can help customers find the best match for their traffic trend. Simulating the exact traffic pattern a customer experiences in a lab setting is nearly impossible, but a "close enough" pattern can be extremely useful.

When building new or updated data centers, you need to understand the real power a system uses. In the past, data sheets typically indicated maximum power for worst case scenarios. Cisco is moving towards a power usage number that applies to normative environments, publishing a minimum, maximum, and typical use case for a system in operation. To create this normative environment, the product is tested and measured under various traffic patterns, temperature, and traffic load use cases. With this new information, customers can run tests using the same data or see where their own network traffic fits within the Cisco data. By aligning this measurement data with specific use cases, customers can also make more informed comparisons and understand how to optimize their own setup.

(3) Understanding Software Readings and Sources of Error

Although one-time measurements are the most accurate and helpful for comparisons and planning, they are laborious and costly. Live, instantaneous measurements read from software at time-based intervals (such as 10 seconds or 1 minute) have many advantages, but also several shortcomings.
Internal voltage and current sensors have an innate error tolerance in component variation. Analog-to-digital conversion further facilitates the error, depending on the transformation period. As stated above, there can be a constant readjustment of load sharing or load variation. When sampling times are longer than microseconds, error can be introduced by reading a power supply at one second and again at a another even though the load balancing may have changed in between. Calculation of power can introduce error because voltage and current are instantaneous and separately read, creating a non-real power value.

In light load conditions, decreases in power efficiency and power factor can exaggerate errors. Although, the industry is working on improvements in this area, one should use caution when relying on these values. The most accurate and repeatable power measurements use power meters.

Cisco is working on the consistency of how we pull and report power data across our products. We want to make it easier for you to understand Cisco product data and how it relates to your own day-to-day operations.

Creating a common language for the ICT industry

Power measurement accuracy is critical to determine where to make changes and increase energy efficiency from the data center to the campus and industry. Given the exponential energy usage forecast for data centers, it is not only financially beneficial but also essential for advancing environmental sustainability.

Measuring real power in a consistent, accurate way helps us speak the same language. This helps Cisco with your analysis, product comparisons, and upgrade decisions. Better data can lead to a clearer understanding and estimation of GHG emissions, and more informed decision-making for future proofing your data center or your campus environments.

In the next paper, we will discuss the power of this data (pun intended), including how using telemetry can help understand the sustainability footprint of your data center and building operations. We'll also discuss how to standardize our ability to optimize power usage across a limited resource – a challenge upon us all to help solve.