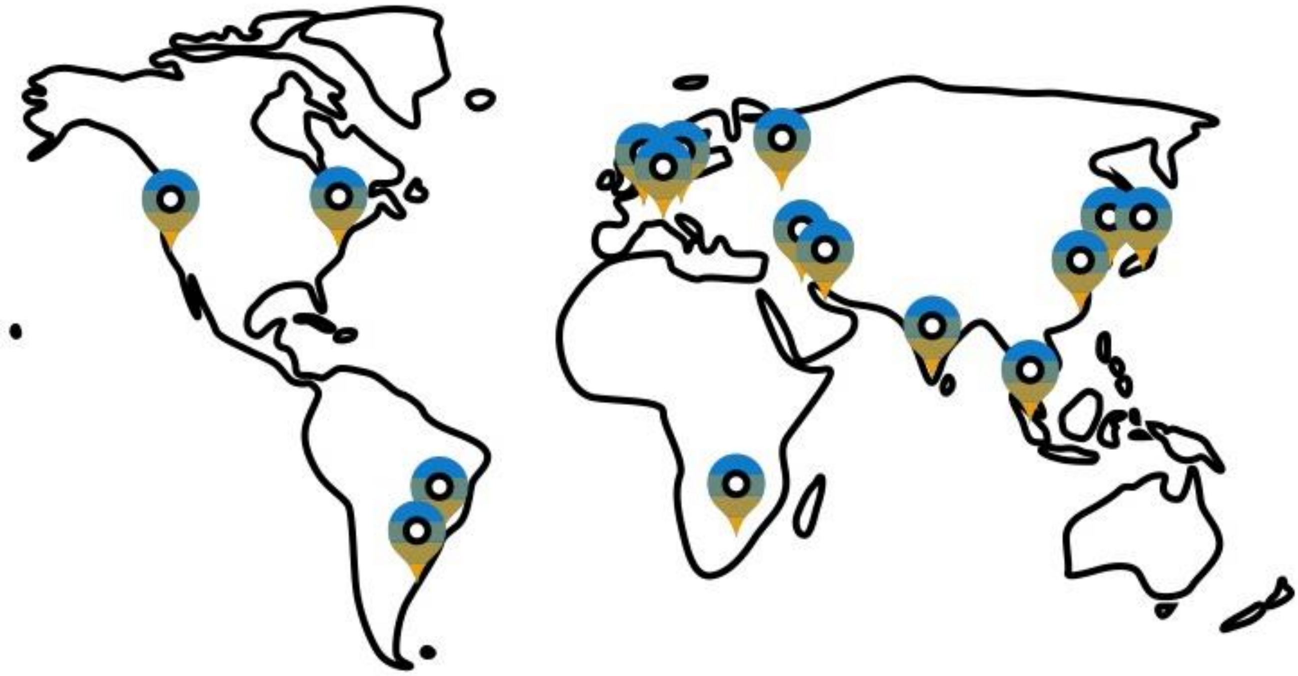
White Paper

Improve Power Utilization of SAP HANA® with Software-Defined Power

Using AI and Machine Learning to Optimize Power by Workload, Rack, Row, and Data Center



Virtual Power Systems

SAP Co-Innovation Lab

THE BEST RUN SAP

ACKNOWLEDGMENTS

This document is the work of a virtual project team at SAP® Co-Innovation Lab, whose members include the following people from both SAP and Virtual Power Systems (VPS).

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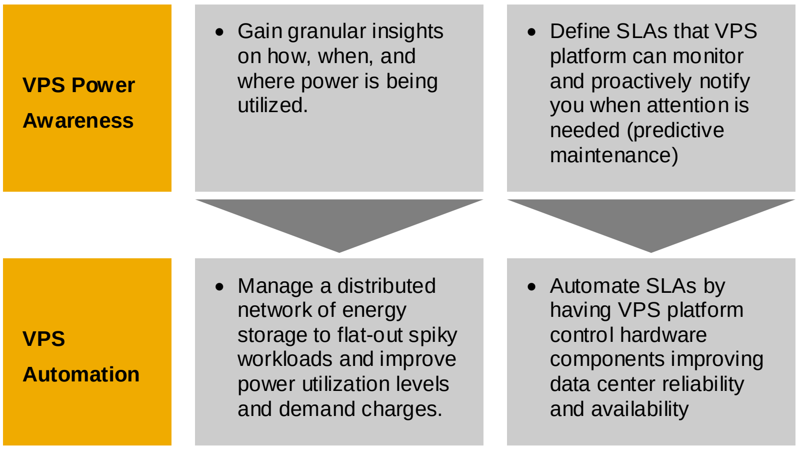
EXECUTIVE SUMMARY

Virtual Power Systems (VPS) was founded to drive innovation at the intersection of software and hardware with the single purpose of enabling the fourth pillar of a software-defined data center – or virtualized power. VPS has created innovative designs and forged critical industry partnerships to revolutionize the way power is consumed in the data center. By bringing AI and machine learning to an infrastructure space that was traditionally viewed as a pure hardware play, VPS enables both data center operators and power equipment vendors to leverage software-defined Power to increase capacity, ensure availability, and enable automation.

The VPS Intelligent Control of Energy (ICE) platform enables data center operators to move from a utilization of 20% to 30% to a utilization of 50% to 60% in a 2n data center without affecting the reliability of the existing infrastructure. This drives up not only power utilization but also application availability.

At SAP Co-Innovation Lab, VPS helped to increase power awareness by providing the operator with granular insights on how, when, and where power is being utilized. With this information, VPS is able to create an automation process to manage a distributed network of energy storage to facilitate a steady, flat power profile while workloads continue to do what they are meant to do: improve power utilization levels and demand charges.

With power awareness, data center operators can define the service-level agreements (SLAs) that the ICE platform can monitor. ICE will notify the operators when they need to perform predictive maintenance. Armed with this information, VPS automation can maintain and automate SLAs by controlling ICE-compatible hardware components, improving data center reliability and availability.



VPS SOFTWARE-DEFINED POWER PLATFORM: ICE (INTELLIGENT CONTROL OF ENERGY)

Overview

The ICE platform continuously interrogates devices within a data center's topology to try to identify sources of stranded power, such as over-allocation, unused reserve capacity, energy storage opportunities, and others. By implementing advanced predictive analytics, ICE determines where, when, and how much power capacity will be available. ICE then issues recommendations to the data center operator on how they can optimize the data center's capacity utilization today and in the future. Referred to as data-driven capacity planning, this enables 30% to 40% of stranded power capacity to be recaptured.

Figure 1 shows how the ICE platform operates inside a data center.

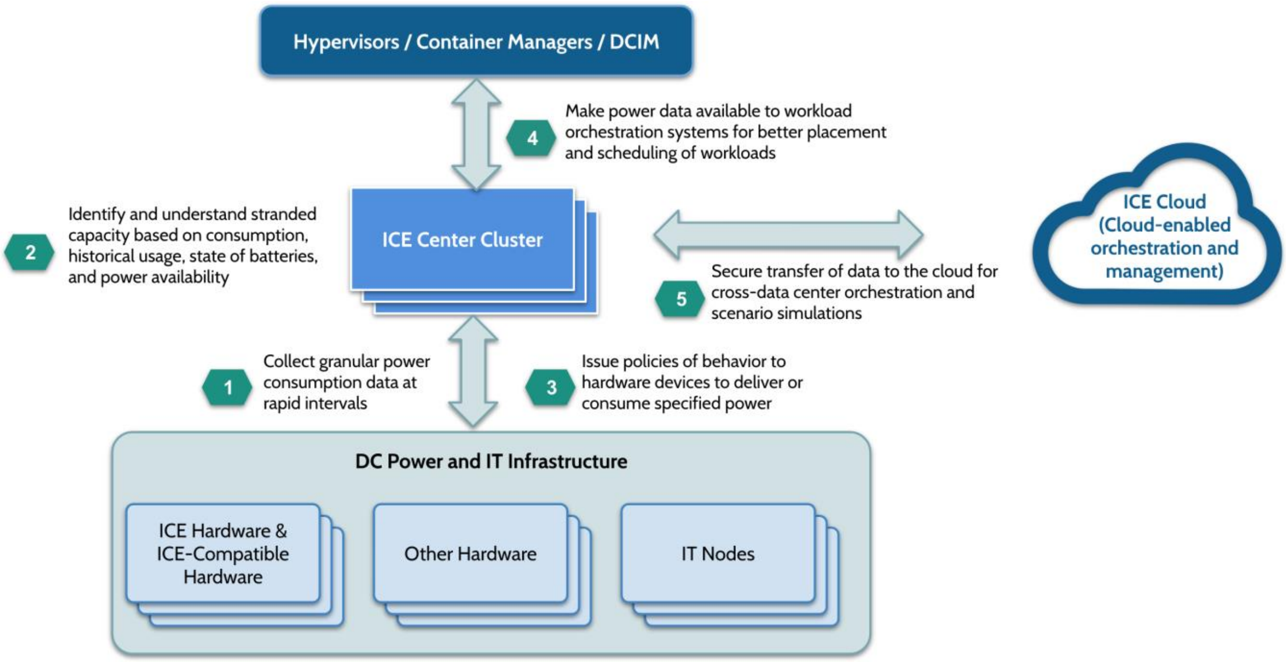


Figure 1: Software-Defined Power Platform

In addition to making recommendations, ICE can leverage its automation capabilities to help users mitigate risks associated with oversubscription of IT or redundant infrastructure. In addition, by combining ICE with multiple hardware mechanisms (for example, energy storage, soft breakers, and static transfer switches) and software (for example, power-aware workload orchestration, node capping with IT server managers, and building management systems), data center operators will be able to increase availability and reliability of their mission-critical applications.

DATA COLLECTION FOR AN SAP HANA® RACK

The team deployed an ICE system in the SAP® Co-Innovation Lab in the Palo Alto Computing Center and collected data from an SAP HANA rack in the center for an entire month. Figure 2 shows the data that the system collected from the two PDUs powering the rack.

The first step in deploying ICE is to allow the ICE software to collect data regarding the data center topology, power consumption, and business model. Once ICE has ingested this power profile information, ICE can then be configured with multiple mechanisms to help the data center reduce stranded power and increase its overall power utilization over time.

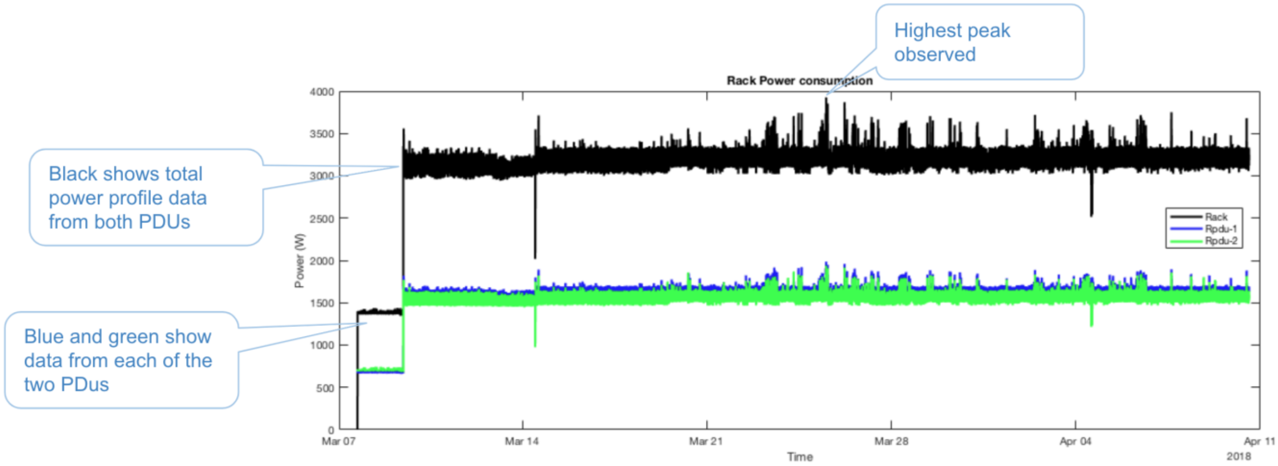


Figure 2: Power Data Collected Over One Month for One SAP HANA® Rack

According to the graph shown in Figure 2, we can extrapolate the following power consumption averages and peak:

Average Power Consumption	Peak Power Consumption	Highest Spike
3.18 kW	3.91 kW	23%

IMPROVED POWER ALLOCATION – REMOVAL OF UNNECESSARY SAFETY BUFFERS WITH ICE

ICE collects information at multiple levels of the data center. In combination with the topology and power distribution infrastructure information, ICE can determine if the power allocation configured by the data center can be improved based on power consumption predictions.

Because most data centers lack the power awareness to understand power consumption patterns and seasonal behaviors, they resort to allocating power with extra buffers for unknowns (as shown in Figure 3). ICE can help data center operators reduce such buffers and liberate capacity that can be used for new workloads or can be integrated into upstream planning systems.

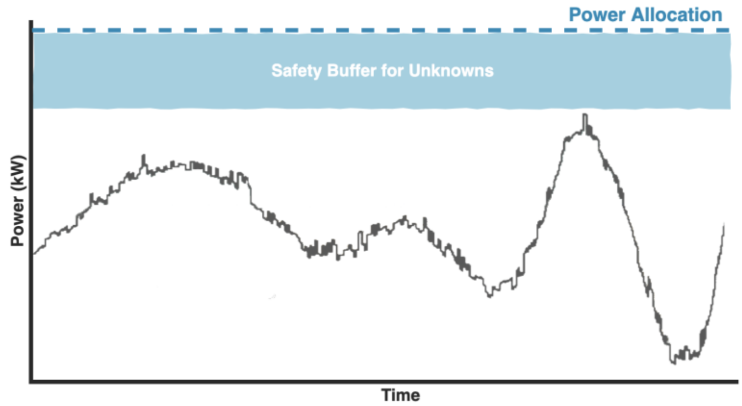


Figure 3: Safety Buffers of Power Allocation

POWER ASSURANCE WITH ICE

Once the unnecessary buffers are eliminated and power allocation matches power consumption, ICE can then be used in combination with software solutions (for example, node capping with Intel Node Manager) or hardware solutions, such as peak-shaving (see Figure 4) with local energy storage devices (LES) controlled by the ICE software, to protect data center power constraints (for example, breakers and UPS inverters).

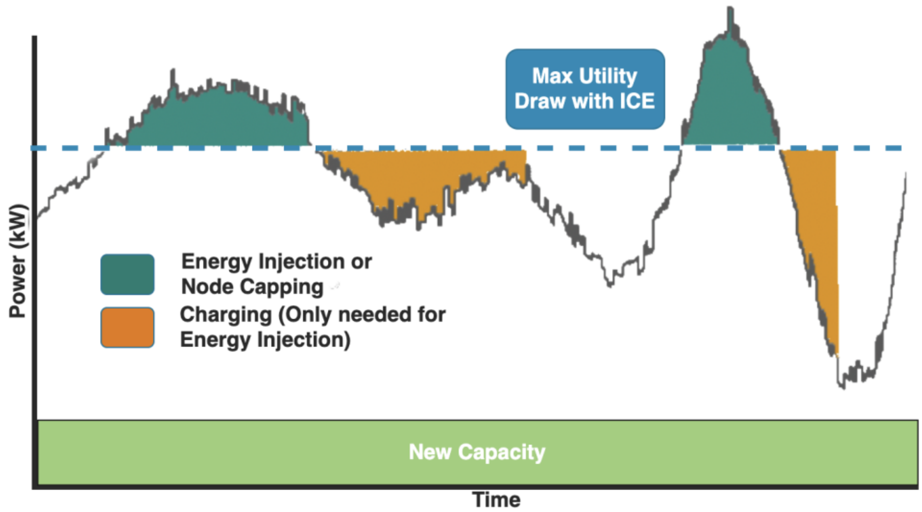


Figure 4: Power Assurance with ICE – Peak Shaving with Dynamic Power Injection

ICE helps data center operators to provision workloads with higher levels of capacity utilization. At the same time, ICE ensures that power limits will be met and properly managed by utilizing a set of available mechanisms in the software. New software mechanisms can be added on the fly, based on new and unique use cases.

In addition, data center operators that are running spiky workloads with seasonal peaks (for example, daily, weekly, monthly, and yearly) can be optimized with ICE. This enables data center operators to allocate power to applications based on their mean usage and not the peak, removing what otherwise would be stranded power capacity (as depicted earlier in Figure 3).

For this use case at SAP Co-Innovation Lab, ICE improved allocation and power assurance, enabling the introduction of new workloads and increasing the utilization of each UPS system close to 50% (maximum value for a 2n data center to account for failover), while simultaneously removing approximately 20% to 30% of the stranded power capacity.

For a video demo on peak shaving with ICE, please click here: ICE Peak Shaving

IMPROVED UTILIZATION AND POWER ASSURANCE FOR SAP HANA

With the availability of additional power capacity by using ICE, data center operators can provision power for the expected SAP HANA workloads while retaining the resiliency and availability for each rack (see Figure 5). Using machine learning, ICE can learn the power profiles of each SAP HANA deployment over time and assign the appropriate power limits for peak-shaving. At the same time, ICE can also ensure that the limits are met by analyzing the stored energy health and performance on a consistent basis.

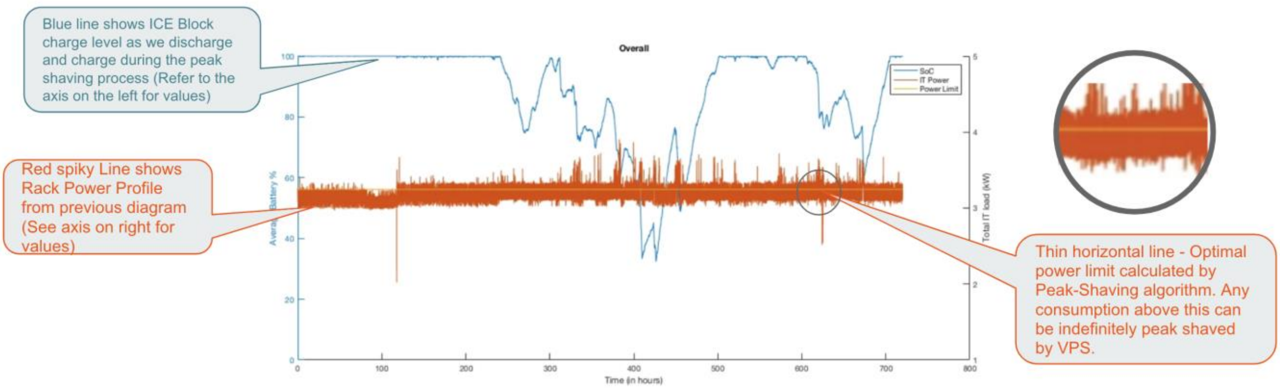


Figure 5: Improved Allocation and Power Assurance for an SAP HANA® Rack

The following shows the average, peak, and highest spike patterns:

Average Power Consumption	Peak Power Consumption	Highest Spike	Optimal Power Limit	Buffer Recovered	Level of Peak-Shaving
3.18 kW	3.91 kW	23%	3.25 kW	0.66 kW	16.8%

Note that the peak shaving percentage is less than the highest peak because the ICE software has determined that this is the maximum peak it can shave and still maintain battery charge at a level at which ICE can continue to peak shave (forever).

In addition to determining the average power consumption for SAP HANA based on a time period, ICE also learns the peak power consumption for SAP HANA and the percentage of the workload power spikes in relation to the average and then recommends the optimal power limit that the battery storage installed on premise can sustain while peak shaving.

If the data center operator wishes to increase the level of peak-shaving capabilities, additional battery packs can be added, and the machine learning capabilities of ICE will then recalculate the power metrics and provide new suggestions based on the expanded energy storage.

For a video demo of dynamic power with ICE, please click here: ICE Dynamic Power

POWER-AWARE WORKLOAD ORCHESTRATION

Although not tested in SAP Co-Innovation Lab due to time and facility constraints, the power-aware workload orchestration capability with ICE can play an important role in allowing data centers that have virtualized workloads (for example, containers and virtual machines (VMs)) to use ICE to increase their power distribution utilization and improve the uptime of their applications.

This mechanism allows data center operators to define new application-centric (SLAs) and create multiple availability zones, taking into account the reliability already embedded in their software before defining the availability of their power infrastructure. Examples of such SLAs are those stating that active-active workloads can be shut down during a power outage (considering the application will be running in another location) and that similar configurations can be achieved for n-tier distributed applications.

Specifically for SAP HANA, ICE can utilize power-aware workload orchestration to notify SAP HANA that there has been a power event. Once SAP HANA receives this signal, it can then begin to push in-memory data onto the data storage drives in order to avoid data loss during an unexpected power event. Based on sample data collected from an SAP HANA system, the SLA required to complete this task is roughly five minutes. As soon as the holdup time has been reached, the active-active workloads can be shut down or these workloads can be migrated to another rack or data center that has sufficient power to maintain the workload.

The data center used for this business case has a 2n topology (see Figure 6), with half of its capacity idle as reserve capacity. Using ICE, data center operators can tap into that redundant power infrastructure to power workloads that don't need "five 9s" of availability and fully utilize their data center going beyond the standard 50% capacity of traditional 2n data centers.

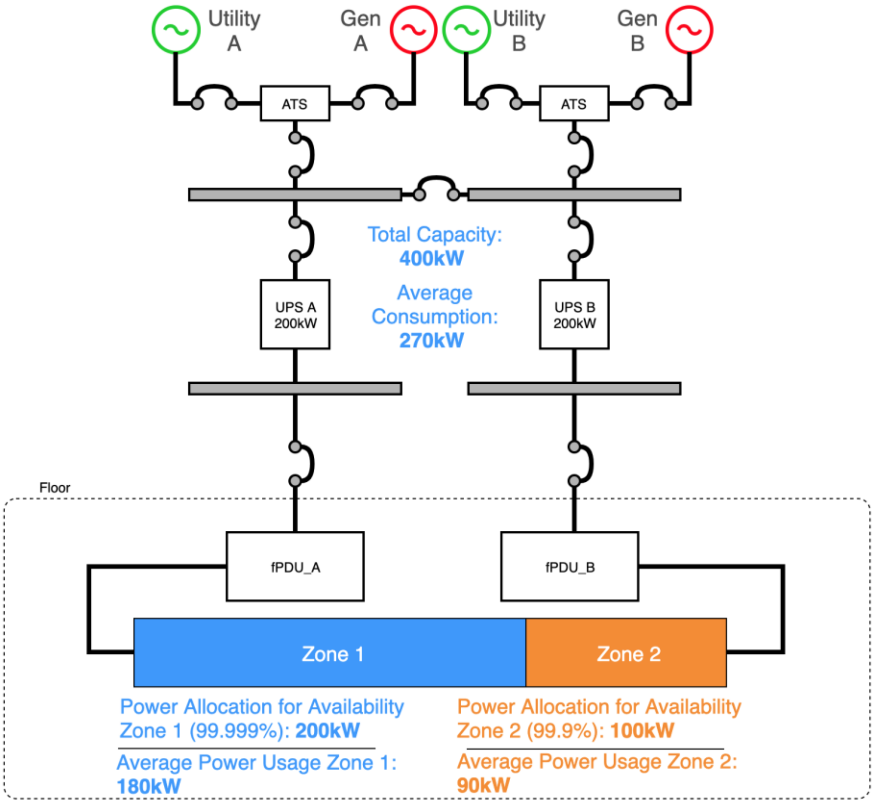


Figure 6: 2N Data Center Running Multiple Availability Zones

ICE creates multiple availability zones to ensure that it can give the redundant capacity back to the workloads when needed (for example, during a power outage or maintenance) by leveraging a variety of mechanisms, including one or more of the following:

- Smart breakers and energy injection to ride through a power outage
- Holding up racks while triggering virtual machine migration to another location
- Holding up racks to provide enough time for a graceful shutdown (active-active applications)
- Using software mechanisms such as node capping, if available, to ensure the redundant capacity is made available when needed

For a video demo on power-aware workload orchestration, please click here: Power-Aware Workload Orchestration

Additional Information

For general information related to Virtual Power Systems, SAP, and ROI for ICE, see:

Virtual Power Systems

ICE Peak Shaving

ICE Dynamic Power

Power Aware Workload Orchestration

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