# The Software-Defined Power Advantage


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## Introduction

An increase in high-density equipment, electricity consumption, and focus on efficiency have helped to shape the hyperscale/cloud computing industry and given rise to the adoption of new approaches to infrastructure from the core to the edge. In these environments, adaptive solutions enabled through software provide operators with the control required to meet ever-changing requirements.

Power infrastructure - specifically the power supply - has lagged the marketplace in terms of virtualization and software control. Power infrastructure policy has largely been static and primarily focused on fail-over and continuity use cases.

When you open up the data available from power infrastructure and enable power infrastructure to be dynamically controlled through automated policy-driven control, some very interesting use cases can be explored that deliver increased efficiency, additional capacity, and higher revenue potential.

This white paper discusses some of the ways a software-addressable power shelf coupled with intelligent software benefits both hyperscale and large data center environments.

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## OVERVIEW OF THE PLATFORMS

### Artesyn Data Center Power Solution

Artesyn Embedded Power is the global leader in power conversion and embedded computing technologies. Artesyn delivers power solutions from consumer to hyperscale, with a focus on telecom, industrial, as well as traditional computing, network, and storage infrastructure.

The evolution of power in large-scale deployments is shifting from discrete power supplies in a given server, network, or storage device to a shared approach in which a single power shelf delivers DC power across all of the equipment in a rack. This shared approach can provide for high efficiency, N+1 availability, and significantly lower hardware costs.

Power shelves come in many shapes and sizes. One of Artesyn's latest solutions leverages six 3kW power modules in a 1U shelf, providing 15kW of power in a N+1 configuration. Each 15kW power shelf can be paralleled with a second shelf to provide up to 33kW of N+1 power in only 2U of space.

Each power module in this power shelf is equipped with an addressable and embedded automatic transfer switch (ATS). Out of the box, the ATS provides for dual AC input to the power module, and high-reliability automated failover from one input to another as required.

For power availability, as an alternative to traditional UPS solutions, power shelves can be paired with battery backup units (BBUs) to provide DC power to equipment in a rack in the event of AC power failure. These power shelves and BBUs are able to be monitored and managed through an embedded controller that is capable of integration with common DCIM software platforms. Redfish, SNMP, and HTTP protocols are supported to enable fully controllable and software adaptable to monitoring and management systems.

### Virtual Power Systems

Virtual Power Systems (VPS) are the creators of Software Defined Power® (SDP). VPS' SDP is a software-based power control platform that utilizes machine learning and big data analytics to unlock trapped and underutilized power in the data center. This highly innovative solution drives aggressive vertical and rack-powered density, enabling 2:1 rack consolidation. The ability to halt rack sprawl through consolidation while increasing power density can slash the annual cost of a production IT rack by more than half. VPS' Intelligent Control of Energy (ICE®) software also enables dynamic power tiering, source

sharing of power, as well as power sharing across nodes.

Similar to software-defined approaches most people are familiar with in the compute, storage and network spaces, SDP provides a common control plane for power components. The results let data centers efficiently allocate available capacity along with reserves of redundant and back-up power. In the process, SDP improves IT density and paves the way for highly scalable, flexible and intelligent power distribution. It constitutes the final pillar to realize the vision of the software-defined data center.

Cost-efficient power distribution and utilization are the biggest constraints facing data center scalability today. SDP, is solving the problems that matter most while enabling the next generation of data center and cloud architecture.

## SOLUTION OVERVIEW

Artesyn and Virtual Power Systems have developed a comprehensive software-defined power solution designed to address a variety of electrical power-related challenges that plague the data center industry. VPS, through its Intelligent Control of Energy platform (ICE) brings software-defined power management and new efficiencies to the data center through Artesyn's addressable and scalable power shelves.

### Use Case #1: Peak Shaving

A typical IT load has transient peaks at certain times in the day. Data center architects have to leave sufficient power headroom to account for these occasional peaks in order to avoid circuit breakers overloads and tripping. This over-budgeting of power slowly adds up and is a big reason for low power utilization in the data center.

Data center operators can set a limit for utility draw and use Artesyn's power shelves and BBUs to provide additional power capacity during temporary peaks in IT load. By setting up this limit for utility draw, data center operators can create additional capacity within their existing power envelope. This, in turn, will lead to better power utilization with less over-provisioning for peaks.

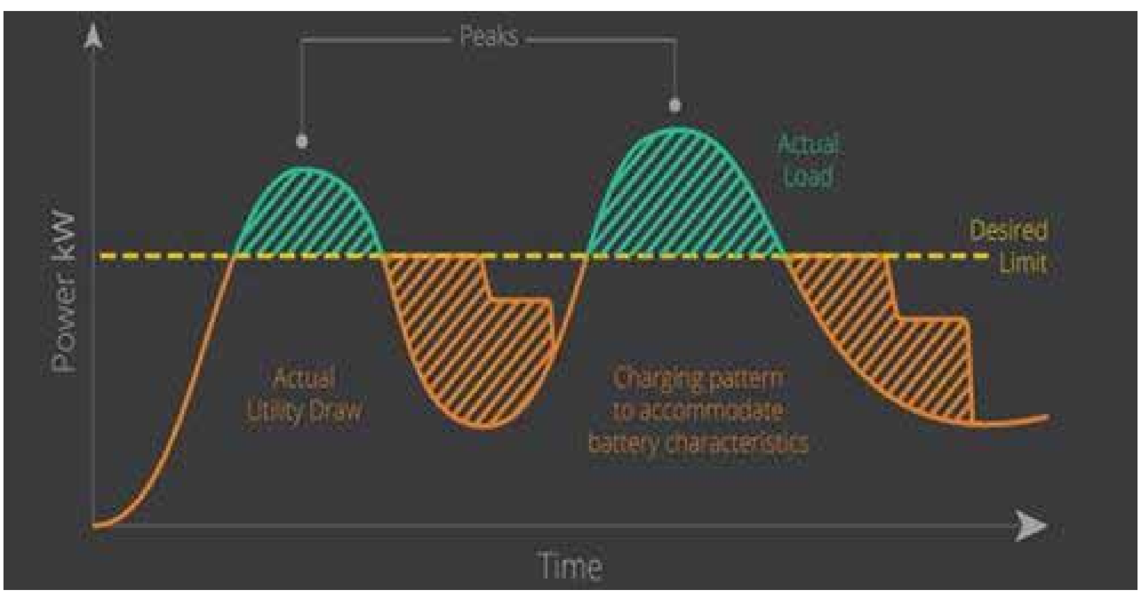


*Figure 1 a: Peak Shaving Concept*

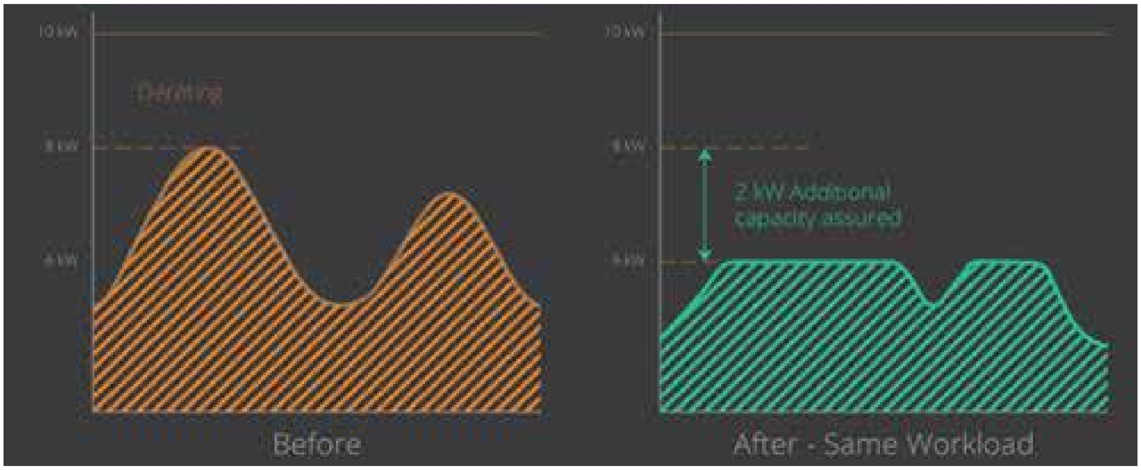


*Figure 1b: Peak Shaving Benefit*

But what about peaks with long durations? To address peaks that tend to drain the battery, VPS' ICE platform employs an innovative optimization algorithm that dynamically controls the mix of utility, local battery power and uninterruptible power supply (UPS) systems at various points in the data center. By adjusting these as required, ICE can force certain batteries to charge while others are discharging, and simulate "power-sharing" between batteries across the data center, thus creating a broad and dynamic power capacity pool as needed.

### Use Case #2: Phase Balancing

When deploying infrastructure, great care is applied to balancing out the three-phase power load across a data center. Balanced loads enable higher overall power utilization, produce less stress on generators, maximize UPS capacity, and can result in reduced power bills. Maintaining balanced three- phase through moves, changes, and additions can be difficult, but is extremely important for an efficient data center.

In the past, phase balancing was achieved by monitoring incoming feeds and manually moving equipment or by controlling rack installed transfer switches. These methods are inefficient, unreliable and consume valuable rack space.

In order to address this very important issue, Artesyn has developed an addressable ATS capability embedded in our power supply units (PSUs). This patented arrangement of switches are integrated into the PSUs leveraged in Artesyn power shelves.

The Artesyn ATS implementation utilizes mechanical relays which switch at zero current to increase efficiency and reliability. As part of the PSU, the ATS does not consume any additional rack space.

Figure 2 below illustrates an implementation of phase balancing at a data center. In this illustration, the incoming line current to the power infrastructure is measured by Hall effect sensors or other current monitoring equipment. This information is processed by data center infrastructure management (DCIM) in conjunction with VPS ICE software to control the power shelves.

This provides real-time monitoring and control of whole power architecture while the data center undergoes routine load changes. As the power demands change in the data center, the PSUs in any power shelf can be dynamically moved from one input to another, shedding load from one phase to another phase as desired, providing for a phase balanced load across the entire data center.

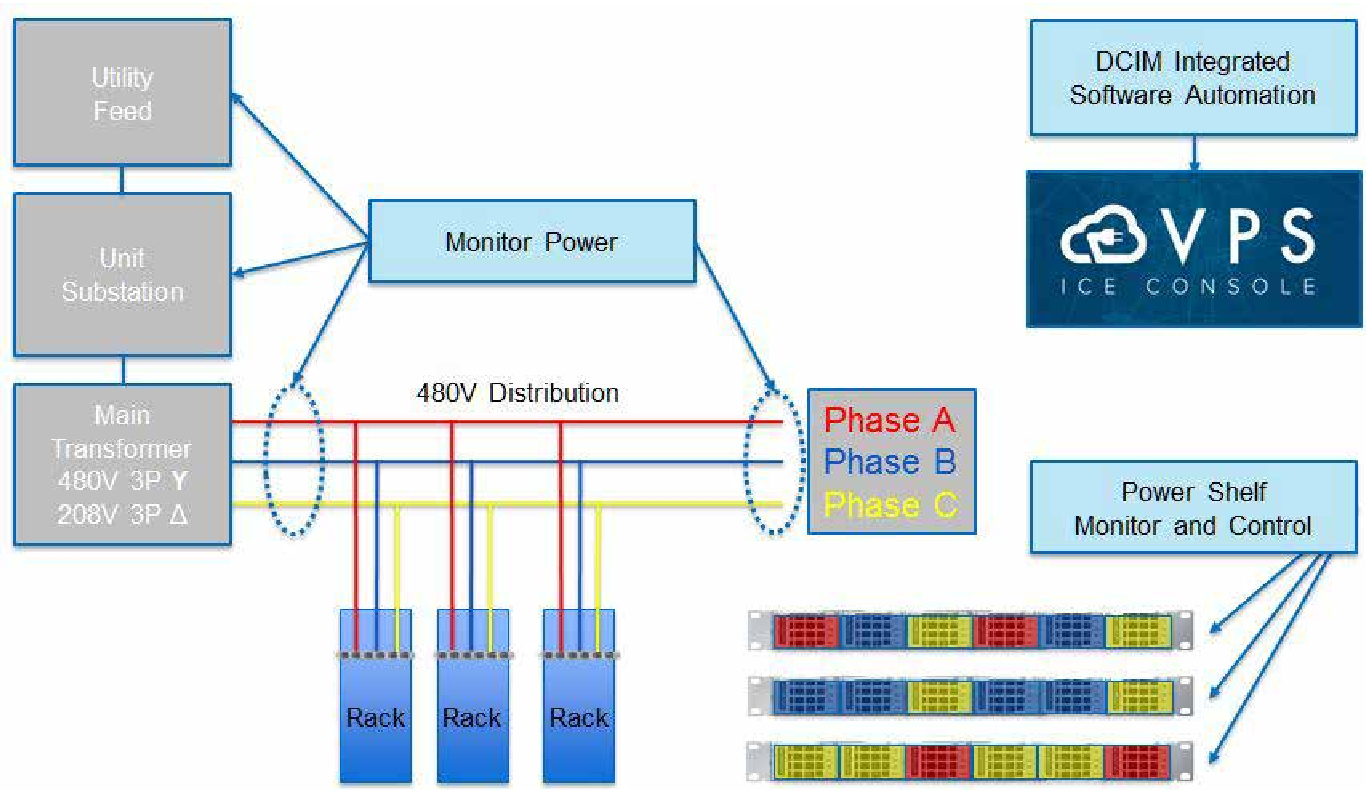


*Figure 2: Phase Balancing Example*

## Use Case #3: Dynamic Redundancy

During normal operation of a typical 2N data center, the power utilization is low. The is intentionally done due to uncertainty. Typically data center Standard Operating Procedures require a UPS system to be limited to 40% of their capacity during normal operations and then run at 80% of total capacity in the case one system is offline. Typically the buffer capacity and the redundant capacity in a 2N UPS system are not used.

Artesyn's power shelf allows the data center operator to manage racks based on workload priority. When power conditions cannot support the full connected load, it then becomes possible to throttled down (or shutdown) the lowest priority loads. As a result, the data center manager can eliminate buffers and tap into the redundant capacity in the data center power system - increasing total power utilization during normal conditions, and shedding loads as required during periods of maintenance or when system failures occur.

An intelligent power shelf is typically installed in the middle of a rack and connects to the rack's shared DC bus. The power shelf is fed by two AC utility feeds of the data center, and provides DC power to infrastructure (compute, network, storage) within the rack.

The power shelf uses software-defined policies to dynamically control redundancy based on the priorities of the workload in the rack and predictive algorithms based on historical load patterns.

As required, the shelf can be directed to power a rack from either or both AC feeds, or to not power the rack at all. Should a feed failure occur, the power shelf will draw power from the alternative AC feed and will continue to provide DC power to the rack infrastructure. A high availability 2N / N+1 rack will experience uniform power quality during a power source transfer.

For a lower priority rack, a feed failure will cause the shelf to make an instantaneous decision (based on power availability) to keep the rack power consistent, throttle down the rack, or turn the rack off completely.

The coordinated control loop is provided by VPS ICE software which is able to gather all power system data each second, apply predictive analytics, and then issue control policy to all power shelf equipment.

Because of this control scheme each power shelf is an autonomous agent in the power system with a policy based on a global perspective. A power shelf with an up-to-date policy will always act instantaneously to a change of state in the power system that demands and action to maintain the stability of the overall power system. Power availability across the data center will always favor the high priority racks over low priority racks.

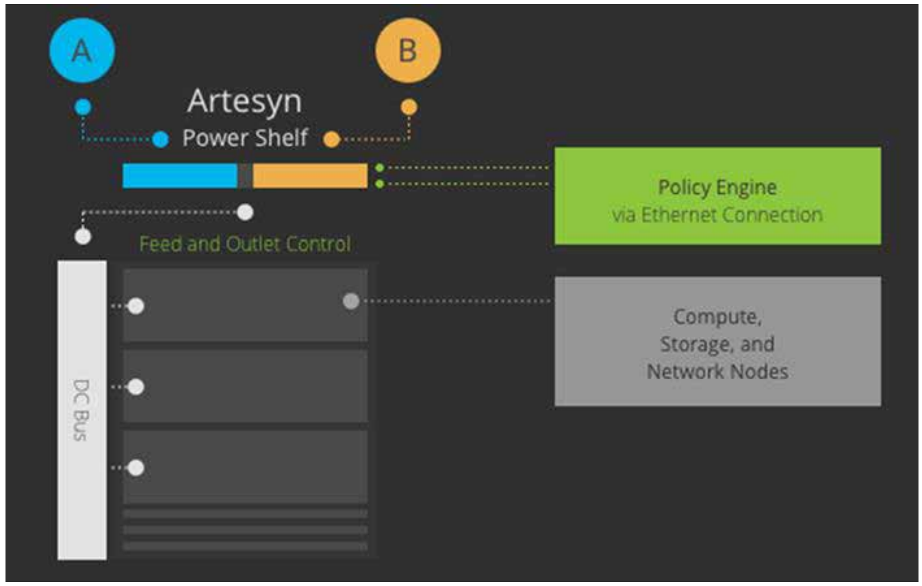


*Figure 3a: Artesyn Power Shelf Setup*

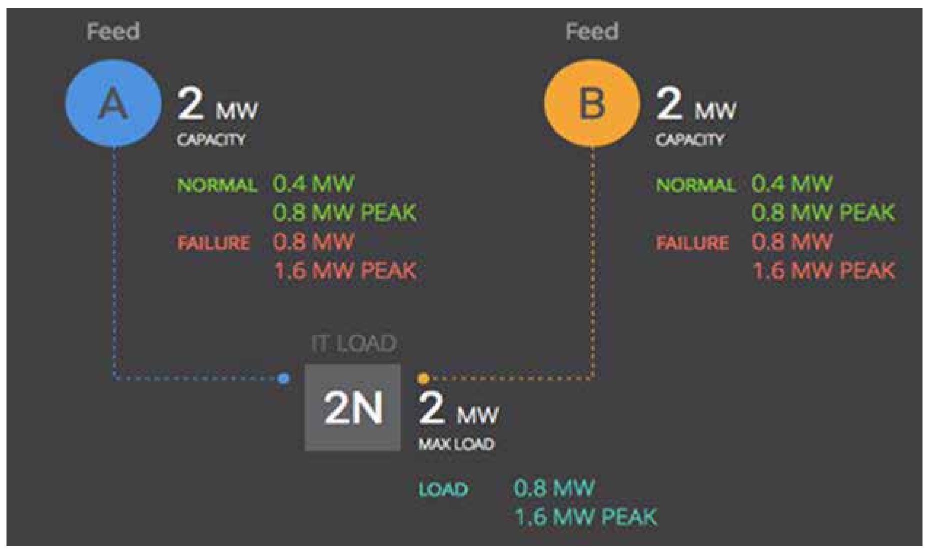


*Figure 3b: Dynamic Redundancy Concept*

Data centers deploy high levels of redundancy to make IT loads tolerant to utility and equipment failures. When designed, data center architects create alternate power paths that can activate or take on additional loads in the event of failures. Figure 3b on page 5 illustrates a representative 2MW data center with two fully redundant power paths from the substation or from two different utilities.

In the example shown in Figure 3b, the normal load is 0.8MW and the peak load is 1.6MW; which means that both can be handled by a single feed when another feed is unavailable. This creates under-utilization during normal conditions, with a 4MW available utility feed with only 1.6MW maximum load at any point in time.

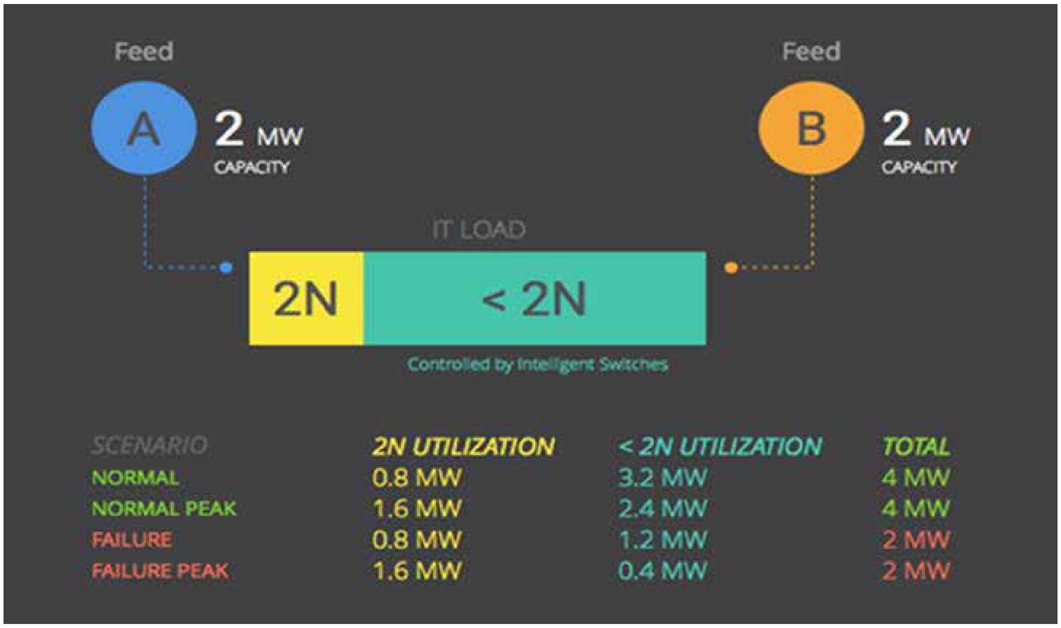


*Figure 3c: Dynamic Redundancy Concept*

Hyperscale data centers, colocation data center space providers, and Enterprise data centers can augment their 2N capacity with slightly lower priority workloads (we call them "less than 2N" or "<2N"). This takes advantage of unused redundant power capacity.

Figure 3c shows the power that can be unlocked in our example data center. There is a potential to add almost 2.4MW of power workload.

Dynamic redundancy unlocks redundant power capacity while mitigating the risk of bringing critical workloads down due to a feed/equipment failure. Through integration with VPS ICE, shelves operate not only by watching the power flowing through their own connections, but also analyzing power consumption across the entire data center.

Armed with this full picture, the power shelves can coordinate with each other and react quickly when there is a failure by throttling/shutting down power to non-critical workloads and leaving critical loads fully operational within the limits of the available feed.

## SUMMARY

The peak shaving, phase balancing, and dynamic redundancy use cases briefly described in this white paper represent three of many possible benefits from software-defined power.

Artesyn and VPS advocate and support the deployment of well-instrumented power systems that are software addressable and configurable. We enable our customers to extend the power system to their needs, implement custom use cases, and make better operational decisions to maximize utilization, control performance, and reduce their total cost of ownership.

For more information, visit Artesyn at www.artesyn.com/datacenter and VPS at www.virtualpowersystems.com

## ABOUT VIRTUAL POWER SYSTEMS

Virtual Power Systems (VPS) is transforming how next-generation data center and cloud providers provision, manage and utilize power capacity with its ground-breaking Software-Defined Power® and Intelligent Control of Energy® (ICE) technology platform.

VPS eliminates the need to over-provision power as ICE dynamically adjusts power delivery as demand fluctuates across data-center workloads, servers and racks. ICE enables data center and cloud providers to generate significant additional revenue within existing power and IT footprints while avoiding millions of dollars in capital expenditures and operating expenses.

Additionally, VPS empowers enterprise customers to reduce power infrastructure wait times and costs. To accelerate market adoption, VPS is developing a robust partner ecosystem, which includes Artesyn Embedded Power, HP Enterprise, Intel, Lenovo, Schneider Electric and Vertiv.

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## ABOUT ADVANCED ENERGY

Advanced Energy (AE) has devoted more than three decades to perfecting power for its global customers. We design and manufacture highly engineered, precision power conversion, measurement and control solutions for mission-critical applications and processes.

Our products enable customer innovation in complex applications for a wide range of industries including semiconductor equipment, industrial, manufacturing, telecommunications, data center computing, and medical. With deep applications know-how and responsive service and support across the globe, we build collaborative partnerships to meet rapid technological developments, propel growth for our customers, and innovate the future of power.

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