Right-Sized Power Systems: A Means to Improved Energy Efficiency

This Dell Technical White Paper explains how choosing the right power systems can improve your system efficiency and reduce costs.

Dell

Eric Wilcox, Mark Muccini
Executive summary

As the cost of energy continues to rise, and the global focus turns to extracting as much as possible from our energy resources, there is an increasing need to optimize IT deployments for optimum efficiency. Companies are now focusing on using resources in their IT environments to support business needs for longer durations. Other organizations have outgrown their IT resources and are considering new data centers to align with their growing business. Combine these business needs with growing environmental pressures and social responsibilities, and energy efficiency has become a priority for many companies.

Traditionally, energy efficiency is understood as the ratio of energy-in versus energy-out, but we will explore a more in-depth look at that interaction within power supplies used in enterprise-class servers. Any IT asset is an investment, and it may seem logical to utilize that asset to its fullest potential. However, for power supplies and power infrastructure products, there is an industry trend to over-size the asset compared with the workload it will support. Dell hopes to establish a new trend and explain how to right-size your power supply based on the configuration and workload of your IT deployment, which can translate into energy savings and greater ROI.

Contents

Efficiency is a curve .............................................................. 3
Savings potential ................................................................. 5
The goal for asset utilization .................................................. 6
Comparing efficiency improvement .......................................... 6
Pursuit of the peak ............................................................... 7
Power dissipation: a different way of quantifying the right approach ............. 8
Beyond the power supply ..................................................... 9
Summary ............................................................................. 9
Efficiency is a curve

When choosing the right power supply for your system, a variety of factors that impact system loading must be considered. Hardware configuration, operating temperature, system design, and workloads vary how much power is required to support a server, both in deployment and operation. Past generations of IT equipment have taken a worst-case approach when considering power budgeting and system design. Although it has been rare to deploy equipment into the upper range of operating temperatures, which drives higher system fan power usage, power budgeting has often been poorly accounted for. Most hardware configurations rarely include high-power processors, the highest-available memory allocations, maximum I/O population, and other options with the highest available capacity or power consumption on a general purpose server. Additionally, there are very few workloads or operating requirements that simultaneously tax each and every sub-system in the hardware configuration. However, that is the exact scenario that many power supplies are designed to support in traditional servers.

This design approach produces a power supply that is very capable and can support extreme operating conditions, but the actual use case rarely exists. In general deployments, Dell is seeing many instances of over-provisioning and operation that are not within the optimal range on the energy efficiency curve. As we interact with our customers, we find that many of them are aware of the peak efficiency of their system’s power supply. For the typical power supply efficiency curve shown in Figure 1, many customers are often aware of the peak value which surpasses 92% and approaches 93%. Looking at the same curve, we can see there would be great benefit in running the system loading at or above 50%, the best efficiency for the power sub-system.

Figure 1. Target range of operation
When using redundant power supplies, the ability to reach peak efficiency cannot be attained. The focus turns to attaining loading as close to the 50% point as possible.

To enhance system up-time with redundant power supply deployments, which use branch replication in power distribution, the highest attainable utilization is 50%. A single power supply must be able to support system loading if the redundant power supply or the utility feeding the branch fails or is taken offline. Most deployments are focused on serviceability, reliability, and availability, which represents approximately 80% deployment with redundant power supply units (PSUs). With that in mind, the ability to reach the peak efficiency, which is at or above 50% loading, cannot be attained. Therefore, the focus turns to attaining loading parameters as close to the 50% point as possible. As the loading transitions towards lighter loads (as shown on the left side of the curve in Figure 1), the efficiency of the system will see continued degradation.

To better explain this concept, we will use an example with ideal conditions, foregoing parameters such as load-sharing accuracy, regulation, power-factor correction, and other minor contributors. This example (as shown in Figure 2) uses a system that is designed with a power supply to support 1000W, with corner-case parameters understood and budgeted for concerning hardware configuration, operating conditions, and workload. However, using a typical configuration, this system has a mid-level processor, about 50% of memory capacity and frequency, and populates only one or two I/O slots in the system. Under the actual workload, the system is found to draw 400W under the most extreme usage model. When operating with redundant power supplies, the power capability is 2000W, but only a maximum of 400W is required. The 400W represents the maximum draw, with many instances of IT workloads representing less than 400W, as workloads are dynamic. In this case, the system is utilizing only 20% of its capacity. Instead of operating above 92% efficiency, it operates at or below 88% efficiency.

The main limitation for power efficiency was caused by using 1000W PSUs. One solution to this problem can be to select lower-power variants based on configuration and operating conditions. In this example, if two 500W PSUs were used in redundant operation, the operating position on the efficiency curve would be at 40% load and approximately 92% efficiency. This is a good example of right-sizing a power supply for the actual system load.
Right-sizing your power supplies can translate to more return and less investment in your ROI equation.

**Savings potential**

To translate this into more meaningful parameters, this example of right-sizing would result in an efficiency improvement of 4%, or 16W per server. Industry experts suggest that for each watt saved per server, per year, a savings of $2.12 can be saved annually. In our example, the savings would represent approximately $34 per server, per year.

If you consider the utility costs, operating expenditures, and capital expenditures associated with distributing and provisioning power throughout your data center, these savings can be very attractive. To add to these savings, lower-power devices are available at lower cost, which can translate into more return and less investment in your ROI equation. This allows for simple reductions on both sides—a win-win proposal.

---

The old adage, *more is better*, does not necessarily apply for power-supply sizing.

**The goal for asset utilization**

In the previous example, there is still an underlying need for the power supply to be able to support corner-case configurations and operating modes. With the availability of right-sized power supplies, a new barrier has emerged that needs to be addressed. The old adage, *more is better*, does not necessarily apply for power-supply sizing. Many IT professionals are making assumptions and over-provisioning the power systems to ensure there is sufficient headroom and to avoid downtime conditions. With the advent of power management features in today’s systems, which enable real-time assessment of power requirements and comparison against power supply capacity through an intelligent interface, the exposure to downtime is negligible. Today’s servers are capable of understanding worst-case predictions based on configuration, following up with real-time consumption measurements, and managing resources and uptime accordingly.

System throttling (through various means) can reduce the overall consumption, maintaining system operation using the available resources from the power sub-system. Within Dell’s server design parameters, this is addressed as an excursion event, not as typical operation. This is an important point, as there is a common misconception that running a system at or near its potential will automatically result in reduced performance. In fact, Dell systems are only designed to throttle as a fail-safe, which rarely occurs in normal operating conditions.

The power supply is an asset within the data center and has been designed to operate at its maximum rated power with high reliability and availability. There is no need to de-rate the power supply or over-provision, as there are no tangible benefits—there are only additional costs of operation and procurement. The goal for power supply asset-utilization should be targeted at maximum power capability.

Another reason for over-provisioning is to accommodate potential future needs, such as provisioning additional memory, hard drives, I/O, or other system resources. A simple answer to this dilemma is to expand the power-supply capability at the point when additional resources are procured. Dell has provided a common form factor and system interface to make the power supplies easily interchangeable and upgradeable. The savings realized from right-sized deployments can help offset the upgrade costs when aligning to new system hardware. If you follow a planned cadence of upgrades that makes sense from an initial investment standpoint, choosing a properly-sized power supply for the majority of your system’s operating life is the best approach.

**Comparing efficiency improvement**

Many regulatory and compliance agencies have focused on improving efficiency curves over the past several years with great improvement in the overall reduction of energy consumption. This next comparison intends not to slight those efforts, but to
highlight the comparative benefits of a right-sized approach. Consider our earlier power supply efficiency curve with the additional curve shown in Figure 3.

![Figure 3. Silver and Gold PSU efficiency](image)

Efficiency curves, such as these, have been continually improved in the IT industry through much design effort, additional expense to attain performance, and engineering excellence. Between the two curves shown in Figure 3, which represent EPA 80-Plus Gold- and Silver-compliant power supplies, there is a difference of 2% (at most) to 0.5% or less in various locations. To attain the upper-efficiency curve represented by Gold compliance, an additional investment is required, but the maximum potential benefit is only a 2% improvement. Compare this result with the previous right-sizing example, which represented a minimum of 4% improvement and reduced the procurement burden. Not only do intelligent sizing and provisioning for system needs provide more of a measurable benefit, but they do so at reduced cost when compared to standard engineering efficiency improvements.

**Pursuit of the peak**

As discussed earlier, efficiency is a curve, and our goal is to make sure you are able to operate your systems at peak efficiency. For systems operating in non-redundant mode, taking advantage of peak operation is a bit more attainable. For systems operating in redundant operation, the importance of right-sizing is more critical, as the highest-attainable utilization under normal conditions is 50%.

To compliment your right-sizing approach, Dell offers features within the power-management system, such as hot standby, which allows the product to operate at higher efficiency for light loads. By putting the redundant power supply in a ready position, the power supply that supports the load climbs the curve for loading and
efficiency towards a peak operating efficiency. Also, Extended Power Range operation, which is built in to Dell systems, moves the operating load up the efficiency curve and utilizes system management to respond to a power-supply module failure through system management resources. One of Dell’s main goals is to continually find ways to optimize operating efficiencies and ensure product operation in real-world environments at their peak.

**Power dissipation: a different way of quantifying the right approach**

So far, the examples and information we have provided have been discussed in terms of efficiency. In order to quantify how many watts will be saved in these examples, power dissipation should be understood. For the following 502W and 717W PSU examples, the associated power dissipation (Pdis) curves are respectively shown in Figure 4 and Figure 5.

![Figure 4. Single 717W Silver PSU: Pdis vs. load](image1)

![Figure 5. Single 502W Gold PSU: Pdis vs. load](image2)
Returning to our example of a 400W system load, assuming redundant operation, each PSU would be operating at approximately 200W of load. From the power dissipation curves shown in Figure 4 and Figure 5, you can see how this translates to ~18W of dissipation for a 502W PSU while the same system load supported with a 717W translates to ~27W of dissipation. The net of the improved efficiency and right-sized approach is 9W of power dissipation savings per PSU, or 18W per system.

Beyond the power supply

While the efficiency curves represented in this document are not an exact representation of all power conversion devices, many UPSs, VRs, and other power conversion devices have similar characteristics and operating behaviors. With the expansion of intelligent power and infrastructure devices and their ability to interact with system power-management controls, the principles of right-sizing apply beyond the power supply. As an IT professional who is interested in improving the overall efficiency of an IT solution, a more rigorous investigation of actual operating behaviors for products can provide some much-needed insight. Once the operating behaviors are understood, a focus on asset utilization to its rated capacity and right-sizing for operational and cost efficiencies can yield significant benefit.

Summary

Right-sizing is an action that you can take today in your data center or compute solution. Right-sizing offers the following benefits:

- Full-asset utilization
- Optimal efficiency and performance
- Reduced procurement expense
- Reduced power-supply and server-operating expense
- Reduction in overall infrastructure and facility provisioning
- Flexibility to grow as you go with alternate power levels in the same form factor
- No additional exposure to downtime or performance degradation
- Intelligent provisioning and utilization of industry-leading technology that empowers you to do more within your IT environment

If you are looking for non-redundant or redundant options, Dell offers right-sized products in our mainstream, performance, and value products that can help you to extract the efficiency benefits outlined in this document. Dell continues to invest in the right-sizing strategy and will continue to expand our right-sized offerings with multiple variants of power supplies for each model, as well as an entire portfolio approach to anticipate the varying needs of our customers.
Learn more

Visit [Dell.com/PowerEdge](http://Dell.com/PowerEdge) for more information on Dell™ PowerEdge™ servers.

About the authors

Eric Wilcox: Marketing Power and Cooling Portfolio Manager at Dell

Mark Muccini: Advanced Engineering Sr. Consultant at Dell.