# Reducing the Hidden Costs Associated with Upgrades of Data Center Power Capacity

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# Executive Summary

**Scaling the power capacity of legacy UPS systems leads to hidden costs that may outweigh the very benefit that scalability intends to provide. A scalable UPS system provides a significant benefit to the Total Cost of Ownership (TCO) of data center and network room physical infrastructure. This paper describes the drawbacks of scaling legacy UPS systems and how scalable rack-based systems address these drawbacks. The cost factors of both methods are described, quantified and compared.**

# Introduction

Scalability in the design of Uninterruptible Power Supply (UPS) systems has been shown to be a significant benefit in the Total Cost of Ownership as discussed in APC White Paper #6, "Determining Total Cost of Ownership for Data Center and Network Room Infrastructure". This is due to the ability to match the size of the infrastructure to the critical load that must be supported as more equipment is installed in a data center.

While not included in the Total Cost of Ownership financial model reviewed in APC White Paper # 6, the ability to scale UPS systems "on the fly" in response to load growth without incurring downtime contributes directly to the bottom line of a company employing such a strategy. In this paper, the real costs of UPS capacity expansion employing a legacy type of UPS will be compared and contrasted to the costs of employing a scalable UPS system.

# Case Model: Two Approaches to Scalability

An IT manager has an identified need for an N+1 UPS design for a 4,800 square foot (446 square meter) data center with an ultimate build-out capacity of 50 watts per square foot (538 watts per square meter). This translates into a total ultimate need of 240kW of UPS power with sufficient redundancy to take one of the power modules off line for service, or to repair on failure without losing the ability to stay on conditioned power during the repair procedure.

The manager is faced with choosing two topologies: a conventional legacy system or a scalable, rack-based system. The legacy system can be designed to afford a degree of scalability by adding conventional UPS power modules to a parallel bus, provided the paralleling switchgear is purchased on initial installation with sufficient power handling capacity to handle the final, full size power handling capacity of the final UPS system configuration. The scalable, rack-based system affords the same advantage in that the supply matches the load as load growth in the racks occurs, but the necessity to purchase a large scale paralleling system cabinet, with its attending cost penalty, is avoided.

# The Legacy Solution

To minimize upfront capital project costs, the IT manager plans to build expandability into the legacy system by buying the system in stages. To compare the costs for each approach, an assumption is made that the load growth will occur in 80kw increments. On day one, then, the plan is to employ two (2) 80kW legacy UPS modules in parallel so that the anticipated 80kW initial load can be supported by either module in an N+1 configuration. When the load begins to exceed the 80kW capacity of the redundant system, the manager plans to install another 80kW module to maintain UPS redundancy while meeting the capacity requirements of the load, which would then grow to 160kW. When the last tier of growth is imminent, the last

80kW UPS module will be installed to bring the total capacity to 240kW, with one redundant 80kW module. The legacy UPS system in final configuration would then be a 4 module parallel system. In this manner, a plan is developed to have the advantage of a degree of scalability in a conventional legacy-designed UPS system. The costs of installing the full size paralleling equipment necessary for the final power configuration of the legacy system is included in the initial purchase.

## The Alternate Approach

A similar plan is developed, for purposes of aiding in the business decision, using the scalable, rack-based UPS system. On day one, to meet the 80kW initial load demand, the purchase of an 80kW unit is necessary, but the scalable rack-based system has redundant 10KW power modules within the unit, providing an N+1 configuration without ordering a second 80kW unit. Since the scalable system has no need of the large parallel electrical distribution equipment, that cost can be avoided. As the load grows past the 80kW level, a second unit is purchased and the new loads are dedicated to its output. It also has a built-in N+1 redundancy. As the data center grows to full capacity, a third 80kW unit is installed, also having an N+1 internal redundancy.

The plans to use either the rack-based scalable or the conventional legacy UPS system appear very similar in outcome. Indeed, if the legacy UPS system can be purchased at less component cost than the N+1 rack-based scalable system, a business decision to proceed with the legacy system might appear justified. But there is a problem with that strategy.

## The Pain of Growth Problem

The IT manager faced with choosing between the two design approaches has to consider how capacity is added to the systems and what the resulting effect is on the IT operations.

Legacy UPS systems installed with equipment to parallel the necessary modules (for reasons of scalability and redundancy) have common tie points where the output of each module is attached to the load distribution equipment. This is the “critical bus” where the power supplied by any UPS module is coupled with the power from the other modules. On initial commissioning of the system, the ability of the modules to parallel, share load and demonstrate redundancy is verified. As modules are added in a legacy system, the critical bus must be powered down to safely tie in the new module and the function of the system as a whole has to be re-verified through another commissioning exercise. To implement the planned expansion of the legacy system as described above involves a minimum of two shutdowns of the critical bus. A typical shutdown to tie in and test a legacy UPS expansion module is 24 hours, if no problems are experienced.

The IT manager must now factor in the costs of shutting down the IT processing operations for a minimum of two (2) 24 hour periods to achieve the growth plan using legacy UPS equipment. The costs include:

- Lost processing time.
- Server/processor technicians to power down.
- Applications specialists to minimize impact to operating systems.
- Customer management meeting time.
- Management planning meeting time.
- Contingency planning.
- Server/processor technicians to power up.
- Application specialists to verify restoration of operating systems.
- Large scale commissioning costs (the full output of the modified UPS system has to be verified driving the need for load banks, cables, instrumentation, trades technical labor, etc.).

This is the “pain of growth” faced with expanding conventional legacy UPS systems when expansion is necessary.

# Assessing the Cost

The cost of upgrading the legacy system by requiring (2) 24-hour shutdowns can be conservatively estimated as follows:

Assumptions:

1. Downtime costs are a modest $10,000 per hour, impacting a low order application with minimal financial losses. (Documented costs for downtime in highly critical applications are estimated to be $500,000 per hour, or more, for certain financial institutions.)
2. The IT manager is familiar with the process.
3. Management time is minimal, since the technical details were specified during the original design of the system and time has to be provided only to manage the change process and coordinate resources.
4. Technicians are outsourced labor, operating under a service agreement with the IT equipment providers.
5. Contingency planning effort is minimal, since it involves invoking only the planned downtime aspect of a company wide contingency plan.
6. Application specialists are outsourced software support for the business applications running on the IT equipment.

See **Table 1** for a breakdown of the costs associated with upgrading the capacity of the legacy system.

***Table 1*** *– Cost of upgrading legacy system capacity*

| Cost Factor | Impact | Estimated Cost | Total |
|---|---|---|---|
| Lost Processing Time | 48 hours downtime | $10,000 / hour | $480,000 |
| Server / Processor technicians to power down | 4 Technicians, 4 hours each for each shutdown, 32 hours total | $150 / hour, premium time | $4,800 |
| Application Specialists | 2 Specialists, 4 hours each for each shutdown, 16 hours total | $200 / hour, premium time | $3,200 |
| Management Planning | 2 Managers, 40 hours each per shutdown, 160 hours total | $80 / hour, assuming in-house labor | $12,800 |
| Contingency Planning | 1 Planner, 20 hours for each shutdown, 40 hours total | $60 / hour, assuming in-house labor | $2,400 |
| Server / Processor technicians to power up | 4 technicians, 4 hours each for each shutdown, 32 hours total | $150 / hour, premium time | $4,800 |
| Application Specialists | 2 Specialists, 4 hours each for each shutdown, 16 hours total | $200 / hour, premium time | $3,200 |
| Commissioning Costs | Two commissioning teams with equipment, labor on premium time | $10,000 per installation | $20,000 |
| **Total** | | | **$531,200** |

Factoring out the cost of downtime, an additional cost of at least $51,200 must be added the initial capital cost of the legacy solution to achieve scalability. This provides basic technical services to perform the required two (2) complete shutdowns.

# A Simpler Approach

The IT manager can achieve growth in a rack-based, scalable UPS system with minimal impact on operations. These systems are designed to be load specific within the data center with each UPS supplying a dedicated number, or field, of racks. As long as the provision is made for supplying power to the expansion systems on initial data center construction (this is also required for the legacy system modules) there is minimal impact to concurrent operations as the new UPS systems are installed and tested. The systems that provide additional capacity can be load tested using smaller load banks, since there is no paralleling function to be tested and the capacity of each test is limited to 80kW. No shutdown of existing processing is required, because there is no common critical bus that needs to be tied in to provide power. The critical bus of each UPS system is dedicated to the 80kW of loads it is designed to support.

The costs associated with expansion of a scalable design are much smaller (**Table 2**). The work can be performed in non-critical time, because the system is expanded without taking the existing loads off-line.

***Table 2 –*** *Cost of upgrading rack-based scalable system capacity*

| Cost Factor | Impact | Estimated Cost | Total |
|---|---|---|---|
| Lost Processing Time | None | $10,000 / hour | $0 |
| Server / Processor technicians to power down | None Required | $150 / hour, premium time | $0 |
| Application Specialists | None Required | $200 / hour, premium time | $0 |
| Management Planning | No shutdown planning or management, 40 hours of project coordination. | $80 / hour, assuming in-house labor | $3,200 |
| Contingency Planning | None Required | $60 / hour, assuming in-house labor | $0 |
| Server / Processor technicians to power up | None Required | $150 / hour, premium time | $0 |
| Application Specialists | None Required | $200 / hour, premium time | $0 |
| Commissioning Costs | Load test is performed at equipment start-up, no parallel test required. | $2,500 per start up | $5,000 |
| **Total** | | | **$8,200** |

The additional cost to install a rack-based scalable solution will total $8,200 in this example. The significant difference is the avoidance of downtime, but raw costs of the scalable system are 84% less than the legacy system even if downtime costs are excluded.

# Conclusion

There are additional cost factors to be considered when incorporating a UPS system into a data center design that go beyond a standard Total Cost of Ownership analysis of competing systems. To achieve scalability in UPS design using legacy systems, significant costs to expand by integrating standard UPS modules have to be planned. Because of the nature of adding capacity to a parallel system, data center downtime costs are going to be incurred which can be avoided by employing a rack-based, scalable UPS system. Planned growth can occur easily with minimal impact to existing IT processing applications, eliminating the pain of growth associated with legacy systems.

## About the Author:

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