Essential NCPI Service Requirements for Next Generation Data Centers

By Richard Sawyer

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Executive Summary

Data Centers are a significant investment to the corporations and IT departments who they serve. Whether or not they actually achieve the availability of the design is highly dependent on the quality of the service personnel and their ability to meet the challenges specific to data center management. This paper presents a categorized and prioritized collection of those service challenges and the requirements needed to overcome them. It is based on information obtained in systematic interviews with data center clients and users.

Introduction

Historically the success of data centers in meeting the availability expectations of their owners and users has been highly dependent on the capabilities of the service organizations supporting the Network-Critical Physical Infrastructure (NCPI). Extremely reliable designs have been frequently compromised or experienced actual catastrophic failures due to nothing more than human error on the part of the people hired as "experts" to assure uptime. Human error is responsible for over 40-60% of data center failures, and studies have shown that a significant contributor to that number is the service organizations actually hired to prevent failures. This exposure to service-related failures is compounded by ever increasing complexity within data centers as technologies advance, and the lack of standardization in the design and selection of data center components. This lack of standardization leads to a greater level of customization in the service support requirements and actually works against reliability by requiring highly site specific procedures, processes and skill sets to maintain and operate a data center effectively.

Outsourcing vs. In-house Services

Compounding the complexity of providing reliable services is the current dilemma faced by IT managers: Should I outsource, or provide those services in-house? Driven by costing imperatives in the corporate world, there is significant pressure to outsource non-core business activities, and data center NCPI service is a prime target. An effective argument can be made that, given the complexity of the NCPI, expert service can only be provided by outsourced personnel who have the specialized training and extensive experience in servicing the same problems across a large pool of NCPI installations. The supporting argument is that the resources required to train and expose in-house service personnel to the same level of expertise is cost prohibitive, even though the sense of "ownership" in the site, and site problems, may be higher. Data center managers have adopted this approach, even to the level of outsourcing the application support layer in IT processing.

In interviews of IT and real estate managers conducted by APC, success in outsourcing has been highly dependent on the ability of the organization to achieve a "one-stop shopping" approach to acquiring the service skill sets necessary to actually achieve high availability. Through a strategy of standardizing the NCPI design and components, setting up strong service level agreements and working in partnership with one global service vendor that handles all NCPI components and systems, companies have succeeded in meeting their performance objectives using out-sourced labor.

In the same interviews, companies that have chosen to follow a strategy of meeting service needs in-house expressed the importance of the support structure provided by their equipment and systems vendors. In effect, even the choice to service NCPI in-house had a major "out-sourcing" component since the in-house staffs relied on the expertise of the vendor's service personnel in times of emergency and for those maintenance periods where the capabilities of the in-house personnel were limited, either by staffing levels or expertise.

Clearly, the ability to achieve the desired availability goals in a data center is highly contingent on the capabilities of the service personnel chosen to provide either direct support through an outsourcing strategy or indirect support of in-house technical staffs.

Inadequacy of current service models

Current solutions and capabilities for servicing data center NCPI components and systems are frequently incomplete, expensive and non-standardized. This is no surprise given the traditional business model of vendors supplying equipment and the related services required to maintain them. Until now (and still in many cases), NCPI equipment vendors marketed core components outside of an integrated solution approach, frequently at very low margins based on the lowest bid. They then relied on selling after-sale services at high margins to make up for the profits lost on the initial sale. Data center users often found that the cost of servicing a key component of NCPI, such as the UPS system, amounted to 7-10% of the purchase price, annually. In effect, the cost of ownership over a 10 year period was twice the purchase price, mostly due to the services that were "mandated" by the supplier to reasonably assure the availability desired by the buyer would be achieved.

This approach is highly reflective of a non-standard approach to specifying equipment from a variety of vendors, and it is prevalent today. The low-bid approach, which involves issuing a set of specifications for data center key equipment components, irrespective of how well it integrates on a seamless basis with other key components, and then having vendors drop their margins to a minimum to obtain the sale invites the traditional business model for service. Where else is the money going to come from for the vendor to stay in business?

The internal company project processes create this behavior. Because costs are not looked at over the life of the equipment (the "total cost of ownership") in the selection process, focus is on obtaining the lowest capital cost for the project. Service costs are operational costs, which are budgeted separately. Often ignored is the simple fact that even capital costs are operational costs, through the mechanism of depreciation, which must be funded every year until the depreciation is fully realized. The depreciation costs, combined with the annual operating costs are the true cost of annual, and lifetime, ownership.

Today, this traditional, expensive approach to buying and servicing NCPI is no longer necessary, or desirable. There are reputable suppliers that can furnish highly integrated NCPI systems that have power, cooling, racks and monitoring systems that work seamlessly together and that do not require expensive, custom services to assure the availability necessary for a data center. Through standardization of components, systems, and interfaces, service costs can be driven down significantly, contributing to a total cost of ownership that is less expensive. For more information on assessing the total cost of ownership, see APC White Paper #6, "Determining Total Cost of Ownership for Data Center and Network Room Infrastructure".

Driving Down the Cost of Service

Key to driving down the service cost component in the total cost of ownership is the selection of a manufacturing vendor-partner that:

- reduces costs by lowering service requirements
- employs field data to improve reliability
- provides predictive maintenance features

This approach to service changes the basic business model explained above. By developing systems that are not designed to be service intensive, the manufacturer becomes a true vendor-partner that delivers high value to the customer in delivering the lowest total cost of ownership for high availability systems.

Lowering the service requirements

By designing around standardized, modular components, the need for expensive, highly skilled technical service can be substantially reduced. The traditional method of providing service to a legacy UPS design is to have an on-site technician troubleshoot to a component level, and replace an SCR, power transistor or capacitor that has failed. The skill set for doing this has to be extensive, since there are a lot of individual electronic components and there is a large array of products that the technician must not only be familiar with, but for which there must also be a large, accessible reservoir of spare parts. But, by incorporating standard power module components in the design, the technician is faced with only identifying the failed module, replacing it and checking the after-repair performance. By incorporating the right diagnostics in the standard design, the system will tell the technician what component has failed, and also perform the post-repair testing and issue a confirming report that the repair has succeeded. The module is then shipped back to the factory for forensic analysis and repair, rather than being field repaired. The technical skill set required of the field service personnel is reduced significantly, the quality and speed of the repair is improved, and the total cost of the service is reduced. Indeed, if the manufacturer has designed the system employing modular components that have self-diagnostic features, a repair can be made by customer service personnel without the intervention of factory service personnel, further reducing costs.

Using field data to improve reliability

The manufacturer that uses the standardized, modular approach to design further reduces service costs by increasing the reliability level of the systems through improved quality. By repairing modules at the factory, rather than the field, a significant source of failure data is obtained that can be used to identify quality issues based on total field operating history of a particular model rather than through isolated system problem reports. A module returned for repair can be fully analyzed, with a true root-cause failure analysis that is useful not only to the customer in understanding what happened with their individual machine, but also to the manufacturer in understanding the failure within the context of all machines in the field. By applying the lessons learned from the field failed devices returned to the factory for repair, the manufacturer can address service issues proactively in other units that may be subject to the same type of failure, thus reducing the

likelihood of similar failures for all their customers. This contributes to lowering service costs by increasing the overall quality in the long run, and by addressing potential service issues before they have result in expensive downtime.

Providing predictive maintenance features

It has long been recognized in the mission critical industry that operating costs could be lowered if failures could be anticipated before they occur. Not only is the actual cost of the failure lowered, but the repair is scheduled at the most convenient time to minimize the impact to IT operations. In an effort to incorporate this basic recognition, the use of infrared thermography has spread, as has vibration analysis of rotating components, such as HVAC components and generators, to identify problems before they occur. Actual predictive maintenance features built into systems has been limited until now, chiefly due to the cost of applying the technologies required. This has now changed and it is possible for manufacturers to use software and firmware to incorporate diagnostic features into mission critical equipment economically and reliably. High maintenance items such as batteries, cooling fans, capacitors and air filters in HVAC equipment can be routinely monitored digitally for their ongoing performance against their design specification to identify early stage failure modes. Alarms are now sent when a failure is impending rather than after it has occurred, allowing service technicians to respond proactively to operational problems. By integrating this into a standards-based monitoring system (such as SNMP), notification can be easily sent, not only to the owner's service personnel, but also over the web to the manufacturer's service personnel supporting the customer's NCPI equipment, allowing a dispatch of service technicians prior to, and not after, a failure. This lowers service costs by knowing exactly what the problem is, where it is located, and what resources are needed to correct the defect, all prior to an actual failure that is likely to have much larger indirect costs in a data center environment.

Hand-in-hand with the predictive capabilities made possible by software integrated into critical equipment is the capability of storing histories of failures, and ultimately, the complete service history of any piece of mission critical equipment. By knowing the service history, the service provider can trend the actual service-life performance against the expected performance and identify issues that would require upgrades, replacement or corrective action on a proactive basis, again contributing to a lower cost service factor in the total cost of ownership.

The Survey

To identify current and future service challenges experienced by data center owners and managers, APC conducted a survey which provides insight into how systematic strategies can be developed to assist in meeting the essential service requirements of data centers.

APC invited 24 nationwide representatives of Fortune 1000 companies to a forum on essential services required for "best in class" data centers in the fall of 2004. Using open-ended response survey techniques to

solicit “voice of the customer” data, key service challenges were identified that are valid for any manufacturer or service organization supporting data center owners and managers.

Results: Service Challenges in Mission Critical Installations

Survey responses were grouped according to common concepts, and for each group a solution requirement, corresponding to a challenge for mission critical installation design, was derived. This process identified 16 core challenges. These core challenges were then grouped according to their phase in the data center life cycle, as follows:

- Consulting & design
- Installation
- Maintenance & repair
- Monitoring
- Decommissioning

For each of these categories, the challenges, underlying problems, and service requirements are presented in tabular form. Within each table, the challenges for that particular phase are listed in order of importance or priority.

Consulting & Design Service Challenges		
Challenge	**Underlying problems**	**Service Requirements**
Decrease the number of design engineers involved in a single project	Using multiple engineers to design distinct parts of the data center causes inconsistencies when the project is brought together, resulting in missed-deadlines.	A service vendor-partner that offers an integrated design service as well as integrated products. A scope of services ranging from the needs-assessment stage through to project completion. Standardization of the design process and tools to avoid design variances
Enable the ease of specification and configuration based on performance criteria, through standard design tools for design engineers	Design engineers use non-standardized specification documentation based on traditional, customized approaches, resulting in extensive design engineering time and cost. Design engineers re-invent solutions that are readily available in integrated forms from manufacturers.	Easy to use software applications to design and configure solutions, that are based on availability performance requirements. Standardized performance criteria, based on industry best practices, used in meeting customer-expressed business needs.

There is a large entitlement for cost and time savings in the design phase of a data center's life cycle. Respondents to the survey agreed that a simpler design process, based on standardized tools and integrated approaches would eliminate much of the wasted resources in traditional design and planning.

Installation Service Challenges		
Challenge	**Underlying problems**	**Service Requirements**
Complete installations on time and within budget	A service team's unfamiliarity with complexities of design and installation of a project causes unexpected developments and cost overruns during the installation phase of the system. Field staff lack correct tools to complete the job at hand.	Project Managers that are specially trained and thoroughly familiar with the design and application of the system being installed, as well as local building and electrical codes. In-depth method statements and risk assessments that cover all aspects of installation. Field Service Engineers that have carefully selected qualifications, ensuring ability to offer high level of expertise. Comprehensive training and re-certification programs for technicians that ensures the most up-to-date technical knowledge. Standardized tools that eliminate the need for shopping sprees in the middle of the night.
Deliver and install equipment to the site damage-free	Frequently, shipping companies are not properly equipped to move large scale components. Unfamiliarity with components causes damage if the delivery company is unaware of special requirements. For instance, some sites may require special rigging to move equipment from the loading dock to the installation site.	Use a standard shipping company that can be trained on how deliveries must be handled. Site visits that are conducted in advance of delivery to determine any special needs by site. Service Level Agreements used in selecting and contracting shipping and rigging companies, to assure standardization of performance in delivering mission critical equipment.
Complete critical installations in accordance with local codes	Electrical and building codes differ significantly from region to region. This results in data center designs that do not comply to local codes, causing project delays and added expenses.	Local technicians that work exclusively in any given region, who are thoroughly familiar with local electrical and building codes to ensure compliance of the system installation. "Installation Standards" that cover all codes/requirements– giving a uniform installation standard and ease of future maintenance. Field Service Engineers that not only know their equipment, but the application and how it integrates into the building infrastructure to assure compliance with local codes.
Seamlessly integrate NCPI information into existing building management / monitoring systems	Typical field service installations do not include tasks such as software integration, IT cable management, and server migration, leaving the system installation incomplete and unorganized.	Adopt open protocols that enable easy interface into existing platforms, or reliable, easy to use bridges that facilitate integration.

Installation services that are designed in a similar manner to standardized and modular NCPI hardware results in higher quality installations with reduced opportunities for human error, greater likelihood of meeting deadlines, and cost savings from optimized resources. Survey respondents experienced many of these problems first hand, and agreed that traditional installation services lacked these critical design criteria necessary for a successful data center implementation.

Maintenance and Repair Service Challenges		
Challenge	**Underlying problems**	**Service Requirements**
Eliminate or reduce system downtime for maintenance visits	Preventive maintenance visits frequently require a system shut down in order to effectively upgrade firmware, replace consumable components or conduct full systems testing.	Non- intrusive preventive or predictive maintenance through software monitoring or heat sensor or vibration equipment, that would ensure a system shut down is entirely necessary as opposed to shutting down on a regular basis. Simplify maintenance and repair service procedures to eliminate potential downtime risks.
Document what really exists at the customer site, and maintain the information for ready access	Updates in hardware and firmware significantly change system functionality, making it difficult for customer to anticipate problems in advance, or to back out once installed. Updates in hardware and firmware that are not documented result in downtime from human error, caused by inadvertently using outdated information.	Basic end user training and updated system documentation that is included as part of each preventive maintenance visit to keep the customer informed of all new aspects of system operation. Apply asset management concepts and software that cover equipment content; commissioning and witness test/start up test reports; serial numbers of all assets; log of equipment “events”; log of maintenance visits and replacement items; single line diagram and switching procedure (also including user manual).
Minimize outages caused by human error	Outages are caused by inexperienced technicians or end user employees working on the system. For example, outages can occur after preventive maintenance visits.	Standardized process for diagnosis, maintenance and repair from technical support and field service that are integrated with customer process and policy. Constant improvement in processes through learning from past problems. Standardized tools for all Field Service Engineers Field Service Engineers that are carefully selected based on qualifications, ensuring ability to offer high level of expertise. Comprehensive training and re-certification programs for technicians that ensure most up to date technical knowledge. Standardized interfaces and nomenclatures. Change-of-state operations that are intuitively obvious and simple to perform.

Maintenance and Repair Service Challenges		
Challenge	**Underlying problems**	**Service Requirements**
		Visual graphics used to represent state changes rather than text.
Minimize vendor interfaces	Too many vendors servicing the data center makes it difficult for the data center manager to handle the maintenance and repair requirements. Unclear boundaries result when multiple vendors are servicing the same facility. This can result in downtime due to unfamiliarity with the disparate systems in the location.	The use of a vendor-partner management company to directly provide or manage service contracts and relationships, and to provide a one-source basis for resolving problems.
Reduce Mean Time to Recover (MTTR)	The dispatch process causes redundant diagnosis, first by technical support then by field service causing extended recover time. Spare parts are frequently unavailable at the time of field service visits, causing return visits by field service engineers and delaying recover time. System repair history is frequently unavailable causing an inability to use system failure trends in diagnosing the current problem.	Continuous trouble shooting via telephone, accompanied by simultaneous dispatch of field service technician to coordinate diagnosis and repair. Robust real time communication of trouble ticket information to the field. Access to service history and previous failure modes by the assigned technician at the machine, rather than through a remote data base which may be inaccessible.
Upgrade system software immediately, as new revisions are released	Software upgrades are often performed only as part of a preventive maintenance visits, leaving the system without upgrades for up to a year at a time.	Software management system that automatically checks for available updates and installs them as necessary. Accessible database of software that is available for download by technician for application to customer problems or needs as required. Software level history in machine memory for verification.

Intrusive maintenance must be minimized and repairs must be performed with the highest level of quality to ensure availability goals are met. Survey participants strongly expressed the need for responsiveness, both with phone and field-based support, to decrease the amount of time they are vulnerable to downtime.

Monitoring Service Challenges		
Challenge	**Underlying problems**	**Service Requirements**
Monitor the system in real time without security concerns	Remote monitoring systems often use intrusive protocols to perform systems checks and results in general security concerns by IT managers.	Remote Monitoring services that utilize outbound polling for systems checks. Ability to address equipment directly through an out-of-band connection (i.e. phone line).
Monitor entire NCPI with a single service vendor	IT managers find it difficult to reconcile status of systems when multiple vendors are monitoring components of NCPI.	Remote Monitoring services that are capable of monitoring cross-vendor NCPI.

The ability to monitor systems provides visibility to system performance and forewarns the IT manager of impending problems. Integration of all NCPI under one service with proper security measures ensures these systems are operational.

Decommissioning Service Challenges		
Challenge	**Underlying problems**	**Service Requirements**
Eliminate downtime during system cutover	Downtime is frequently experienced to facilitate equipment cutover, either by design or accident.	Service personnel operate from written cutover procedures that have been tested prior to implementation. Back-out scenarios are identified that allow recovery of systems if problems impede further cutover activity.
Safely dispose of UPS and battery components, cooling equipment refrigerants, and similar potentially hazardous materials to conform with applicable codes	There is frequently no plan or thought given to what to do with NCPI components after their useful life is at an end, leading to potential liability on the part of the owner or managers.	Service provider that can remove and dispose of potentially hazardous materials and document the disposal in conformance with local and federal regulations.

Decommissioning tends to be an afterthought of the data center life cycle. However, without consideration of these service requirements, liability can result.

Services for Next Generation Data Centers

From the data gathered from Fortune 1000 customers in the survey noted above, it is apparent that the traditional approach to providing NCPI services needs to be changed. Traditionally, the data center owner and managers have a host of service providers that typically provide very focused service products directed at their specific components supplied to the NCPI (i.e. the UPS provider services the UPS, the cooling provider services CRAC units, the BMS provider services the building management system). As manufacturers expand product offerings across the NCPI array of equipment and systems, and use an integrated approach in how they work seamlessly together, customers are looking for competent one-stop providers that can manage not only NCPI components after installation, but also provide pre-sales and end-of-life services. Customers are looking for a vendor-partner that can provide a holistic menu of services that address the life cycle of the data center, from needs assessment, through the design and construction stage to the last days of the useful life of the data center.

This expressed need of customers for an end-to-end solution leads to a paradigm shift for service providers: No longer can they focus on specific maintenance offerings for specific equipment, but now must offer a high degree of service solutions offered on an integrated basis. These service organizations must provide:

- Needs assessment services
- Conceptual design services
- Construction design services
- System configuration services
- Construction services
- Training of operations personnel
- Delivery and testing services
- Integrated monitoring, both local and remote
- Decommissioning and disposal services

Modern data centers will require the same degree of integration of services as they do integration of NCPI systems to assure high availability, agility and low total cost of ownership. Failure to standardize on a suitable service vendor-partner capable of providing these services will result in a highly customized service solution employing multiple vendors and labor forces, which will introduce a high degree of human error into the data center environment – the primary cause of data center failures.

Training services

The effort to minimize human error is highly dependent on the training services provided by the vendor-partner. Data centers are not only increasingly more complex, with even small data centers adopting highly redundant, fault-tolerant NCPI solutions, but they are increasingly more important to the economic health of

the companies they serve. The loss of a single server that tracks package deliveries, for example, can lead to significant liability for failure to perform by a package delivery company. Vendor-partners of NCPI services must not only furnish the training for the service team performing the services for a variety of equipment sourced from different manufacturers on a one-stop basis, but they must also provide training for site personnel comprehensive enough for site operations to perform first response and basic repairs of items such as hot-swappable components. The customer is an integral part of the service process. No one better knows the impact, of a particular NCPI design, on a companies operation, nor knows better the actual nuances of the NCPI design for a particular site than does the operations staff. The one-stop vendor service provider must provide the training on NCPI equipment to the operations staff to achieve the maximum service benefit to the owner. The training must be, according to the surveyed customers, an integral part of the installation and testing efforts at start-up and continue into the operational life of the data center as part of an integrated service plan.

Conclusions

Data centers are inherently designed to have high reliability and availability. Whether or not the availability of the design is actually achieved is dependent on the quality of the services provided to design, install, test and operate the NCPI components and systems. Surveys indicate customers are seeking a broad range of services from vendor-partners that supply the NCPI systems. These services must demonstrate the same dedication to high quality and integration that the manufacturer exercises in designing and building the equipment itself. Modern data center owners and managers are looking for a single source of these services, which changes the traditional dedicated service contract model. As companies focus on the total cost of ownership in the life of data center NCPI equipment, the service model of selling a product at close to cost and making up for the margin in service costs is obsolete. NCPI equipment with high levels of predictable maintenance features built into easy-to-service, standardized and modular components that are designed to be fully integrated, will drive down TCO and increase availability. The services needed to design, install, operate, and maintain these NCPI systems with these characteristics will reflect “best-in-class” practices needed in the modern data center.

About the Author

Richard L. Sawyer is a Sr. Systems Application Engineer for APC. He has 25 years of experience in large scale data center construction and operations for Fortune 100 companies. He is on the Board of Directors, AFCOM.