A White Paper from the Experts in *Business-Critical Continuity*™

Maximizing Data Center Efficiency, Capacity and Availability through Integrated Infrastructure

Efficiencies and Cost Benefits Intrinsic to Integrated Infrastructure Solutions

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Executive Summary

As the business needs and drivers of today's enterprise companies continue to evolve, so too do the demands and challenges placed on their IT infrastructures. Today's data center manager is challenged by a wide array of data center objectives—including capacity, availability, efficiency and performance—while adhering to budgetary limitations. How IT departments approach their physical infrastructure strategies can affect their effectiveness in balancing these objectives as technologies and business requirements change. To address these demands, countless IT departments have refocused their approaches to data center management to maximize efficiencies in infrastructure design/deployment, operations, management and planning. For these new strategies to be successful, a number of fundamental best practices must be observed.

While conventional approaches to data center infrastructure design are also based on best practices and are effective in balancing efficiency and availability, for larger spaces requiring greater customization, they can also be resource intensive. Some vendors have introduced new solutions that employ "integrated" infrastructure architectures in a variety of configurations to address organizations' unique business needs while increasing efficiency, ensuring availability and reducing cost of deployment or ownership. These integrated solutions are modular and scalable and designed to be quickly implemented, often in spaces without existing IT infrastructure.

This white paper will explore the typical infrastructure challenges facing today's data center manager, and the proven industry best practices. It also will examine the role of new "integrated" infrastructure solutions in helping data center managers fulfill these best practices and highlight three types of integrated solutions with their associated applications and benefits. Finally, it will offer a detailed cost analysis comparing the cost of conventional infrastructure approaches to integrated solutions for three scenarios.

Recognizing Typical Data Center Challenges

Today's data center manager faces an unprecedented array of challenges and pressures. Chief among these are the serious implications for availability and efficiency created by common business drivers emphasized by the C-suite – namely improving business processes and maximizing the availability and usefulness of its IT infrastructure while reducing costs.

In response to these business imperatives, IT departments have turned to new technologies and strategies designed to help data centers achieve the necessary business results, including server virtualization, application consolidation, unified communications, cloud computing and storage "tiering." However, while many of these initiatives can be instrumental in addressing the leading business drivers, each brings with it a host of new challenges for the data center and, in turn, the data center infrastructure.

According to a recent Gartner study, the leading challenges facing today's data centers are intrinsic to many of the aforementioned business drivers and their associated IT solutions. Top challenges cited include:

- Keeping up with data growth
- Maintaining system performance and scalability
- Mitigating network congestion and connectivity issues
- Minimizing power, cooling and space costs
- Effectively managing the data center and its infrastructure

Furthermore, according to a 2011 survey of the Data Center Users' Group (DCUG), the leading infrastructure challenges included data center availability, high heat densities, energy efficiency and maintaining adequate power densities (see Figure 1). Each of these challenges resonates closely with the leading data center challenges faced by IT professionals.

These findings are hardly surprising when considering how each is directly tied to an IT initiative and associated business need.

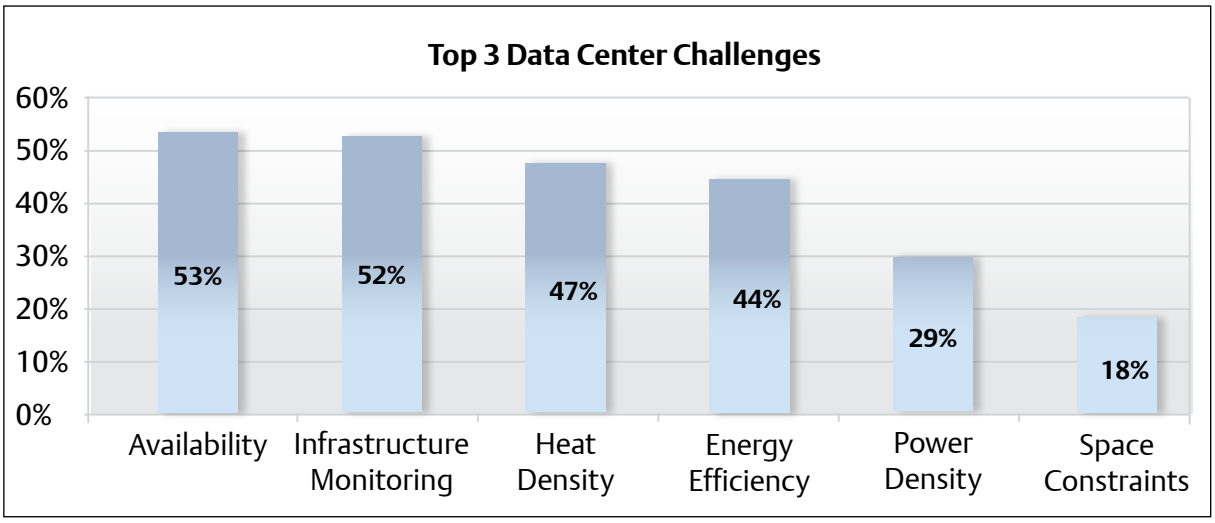


Figure 1: Data center infrastructure challenges reported by IT professionals in 2011

For example, enhanced data center management capabilities are required to effectively control an increasingly complex environment; power and heat density are an increasing concern as virtualization is introduced in high-density server configurations to increase capacity without extensive CAPEX; and budget constraints continue to increase the emphasis on achieving energy efficiency without compromising availability.

Fortunately, data center managers can employ a variety of field-tested and proven best practices for improving efficiency in a strategic manner that span all facets of the data center infrastructure, without adversely impacting availability or inflating a data center's total cost of ownership (TCO).

Data Center Management Strategies and Best Practices

IT and facilities teams are focusing on data center best practices to achieve business objectives and increase efficiency of data center operations. These best practices center on three key areas of the data center lifecycle:

- **Data Center Design and Deployment:** Simplifying the data center's configuration to reduce design and deployment times and minimize equipment capital costs and space requirements

- **Data Center Operations:** Reducing costs through the implementation of energy efficient technologies and configurations without sacrificing availability. IT productivity is increased through improved visibility and management technologies that enable IT departments to streamline processes

- **Data Center Management and Planning:** Installing solutions faster in response to business requirements; enhancing control over the IT environment; reducing the time spent on break/fix maintenance; and streamlining how equipment is added and/or changed

In order for these strategies to be effective, a number of infrastructure best practices should be observed. The following seven best practices address a wide spectrum of infrastructure needs in order to ensure that the data center's physical infrastructure is properly designed, operated and managed:

1. Maximize the return temperature at the cooling units to improve capacity and efficiency

As heat densities continue to rise with the proliferation of high-density configurations, server consolidation and server virtualization, air flow management is a growing concern. Fortifying a data center with adequate cooling capacity is no longer enough, and adopting an airflow management strategy suited for high-density computing is critical to maximizing efficiency and preserving availability by minimizing the occurrence of "hot-spots."

Row-based precision cooling solutions are ideal for data centers with high-heat densities and growing IT infrastructures because they are uniquely equipped to deliver cooling directly to specific heat loads. They maximize efficiency by ensuring that capacity is utilized only where and when it is needed. In addition, some solutions, such as the Liebert CRV precision cooling system, use intelligent controls to dynamically scale capacity as IT needs dictate. In a virtualized environment, for example, this ensures cooling is available where the load is shifted.

Aisle containment configurations can further enhance airflow management by creating a partition between hot and cold air in the data center. This partitioning increases the return air temperature to the row-based cooling systems. By doing so, a data center with intelligent row-based cooling and cold aisle containment can achieve efficiency gains of up to 30 percent. According to a recent survey of the DCUG, more than 49 percent of data center managers have adopted or are planning to adopt cold-aisle containment as an air flow management strategy.

2. Match cooling capacity and airflow with IT loads

With virtualization, today's data center computing loads are dynamic and have peaks and valleys of utilization. To maximize efficiency of your data center the output of the Precision Cooling units should match the varying requirements of the IT load.

By implementing temperature sensors, digital scroll compressors, and variable frequency drives; all of which are connects and controlled though a state-of-the art system like Liebert iCOM, your data center's cooling will match the load which will prevent overcooling during times of low IT utilization

3. Utilize cooling designs that reduce energy consumption

The precision cooling units found in data centers consume much of the electricity used to run the facility. By utilizing units that are designed with fewer energy-consuming parts or with options that can turn components off, significant operating cost savings can be realized.

Such energy-saving features of precision cooling units include digital scroll compressors, EC fans, variable speed drives as well as cutting edge technology like the Liebert XDR which as a rear door heat exchanger, eliminates cooling fan motors all together.

4. Select a power system to optimize your availability and efficiency needs

The integration of higher density, high-availability UPS systems with built-in redundancy into the row helps data center managers to eliminate single points of failure and ensure that power fluctuations or interruptions do not result in downtime or catastrophic equipment failures.

Row-based technologies, such as the Liebert APM, offer data center managers the ability to scale UPS capacity as needed while operating at efficiencies up to 94 percent.

5. Design for flexibility using scalable architectures that minimizes footprint

Modular systems can help in managing a data center infrastructure that experiences fluctuations in capacity needs.

Virtually every component of the physical infrastructure is now available in a modular design. Modularity can be applied to specific infrastructure equipment such as UPS systems which can be expanded by adding power cores, or rack power distribution units such as the Liebert MPX which snaps together to add or change power strip receptacles. Modularity can also be achieved holistically by quickly adding containerized enclosures to a data center when capacity is being added on a large scale.

Modularity and scalability of infrastructure equipment improves speed, ease and cost of deployment when adding capacity.

6. Enable data center infrastructure management and monitoring to improve capacity, efficiency and availability

A robust monitoring capability is a key to maximizing data center efficiency and availability. In fact, according to a spring 2011 survey of the DCUG, more than 52 percent of respondents indicated that establishing adequate data center monitoring capabilities is a top concern faced in data centers across the United States.

However, monitoring alone is no longer enough to adequately ensure the availability of data center infrastructure.

A more holistic approach to data center infrastructure management is required, encompassing all power, cooling, IT and support equipment to optimize capacity planning, resource allocation and equipment management.

7. Use local design and service expertise to extend equipment life, reduce costs and address your data center's unique challenges

In addition to integrating efficient, high-availability power, cooling, monitoring and IT equipment, a robust service portfolio is a critical component in maximizing data center infrastructure availability, efficiency and performance over the life of the data center. As such, data center managers should seek a vendor partner that offers a broad range of proactive and reactive services, including preventive maintenance, 24/7 support, emergency repair capabilities and design assessments (power and cooling infrastructures).

Integrated Infrastructure Solutions

Recognizing the challenges facing today's data center managers while adhering to the aforementioned infrastructure best practices, Emerson Network Power offers intelligent, integrated infrastructure solutions optimized for a variety of needs and configuration scenarios.

Integrated infrastructure solutions are specifically designed to provide advantages compared to a conventional physical infrastructure because they are:

- **Efficient** in power usage, space utilization and IT employee productivity
- **Economical** in initial cost by making use of existing infrastructure and not requiring expensive room upgrades
- **Interoperable** through simplified design and implementation of systems and components
- **Controllable** through planning, monitoring and management over the changing IT environment

These integrated solutions—ranging from single row deployments to modular data center enclosures—are preconfigured with power, precision cooling and management infrastructures in accordance with design best practices and optimized for the efficiency and availability needs of today's data center managers.

However, while it may be clear that integrated solutions offer a number of unique benefits, a significant question still remains: What is the true benefit of integrated solutions over conventional approaches to data center design with respect to a data center's total cost of ownership (TCO)?

As many integrated data center solutions require an investment in additional equipment to achieve the best practices they are designed to promote, it is easy to assume the CAPEX required for such solutions exceeds that of conventional approaches to data center design. While in some cases this assumption is correct, in others it is not. It does not take into consideration the significant gains in efficiency, capacity and space that can have a dramatically positive impact on a data center's TCO over time.

To illustrate this point, we will examine three data center design scenarios and compare the costs of utilizing a conventional approach with traditional data center infrastructure equipment versus utilizing one of three specific integrated solutions from Emerson Network Power.

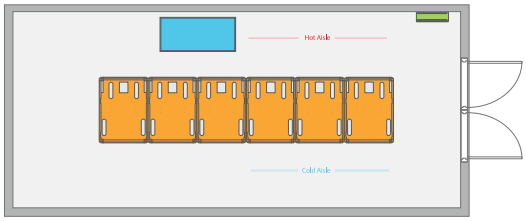
Scenario 1: 18 kW of IT Deployed in a Non-IT room

For our first scenario, we examine a data center requiring a capacity of 18 kW of IT equipment and a comprehensive power and precision cooling infrastructure in a non-IT ready room.

Choosing the Right Integrated Solution: SmartRow

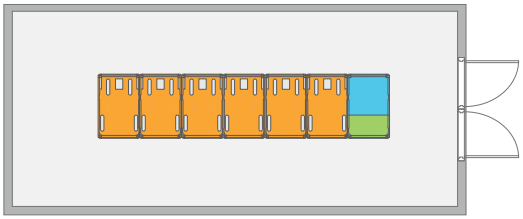
For new IT spaces, remote locations and backup sites, high costs and slow deployment times can hinder projects and adversely affect availability of critical systems. Conventional data center designs often require a physical infrastructure that is too costly or slow to implement for the needs of some IT and data center managers.

Scenario 1:



Conventional Approach

- 18 kW, 288 sq. ft.
- 1 row, 6 racks
- Ceiling-mounted ducted cooling
- (6) 5 kVA UPS
- Room renovation, fire suppression installation



Integrated Approach

- 18 kW, 288 sq. ft
- 1 row, 6 racks
- SmartRow containment solution
- 1 Liebert Challenger (Downflow)
- 6 Liebert GXT 5 kVA UPS
- Room-neutral configuration

NOTE: To ensure that cost analysis was conducted with the highest levels of vendor-neutrality, Emerson Network Power approached a third-party data center design firm and asked them to offer cost estimates for three distinct build-out scenarios. In each case, two options were requested: a build-out utilizing conventional and traditional data center infrastructure equipment and another utilizing an integrated solution.

Integrated infrastructures, like the SmartRow offering from Emerson Network Power, allow data center managers to easily deploy and effectively manage an integrated IT infrastructure without being limited by building systems, such as fire suppression and cooling. The SmartRow offering is ideal for environments where IT room improvements are not practical, such as existing work spaces.

This type of solution also "forces" the adoption of best practices, since they are pre-configured before they are deployed.

Cost Analysis

While both the conventional and integrated approaches would require the same amount of IT equipment and supporting power and cooling infrastructure, the conventional approach dictates extensive renovations to the room housing the data center. Because the room would essentially be a closet or vacant office space, the installation of specialized facilities systems would be required to turn it into an IT-capable room (fire suppression systems, vapor barrier, ceiling, etc.).

Utilizing the data from the data center design firm, we can calculate the capital costs and the operating costs of the two designs (See Table 1).

As expected, while the integrated solution– in this case, Emerson Network Power's SmartRow – required a slightly greater investment for infrastructure equipment (approximately $4,000 over a conventional approach), the utilization of an integrated solution offered significant savings (28 percent, or $17,000) on room costs due to SmartRow's fire suppression systems and the room-neutrality benefits afforded by the enclosure.

Essentially, the savings on room costs eclipsed the additional infrastructure costs by more than five-fold.

In addition to the facility-related savings, the investment in containment and precision cooling equipment optimized for this environment also would yield significant savings on the efficiency front.

Because the integrated solution employs a closed-loop cooling design as opposed to traditional ceiling-mount precision

Core Benefits of the SmartRow Solution

- **Efficient:** Gain significant energy savings from variable capacity precision cooling systems; system is optimized for space efficiency through integrated systems.
- **Economical:** "Room neutrality," an attribute unique to self-contained solutions, ensures that the deployment will not affect the existing space. Reduced cost of installation means that data center managers do not need to undertake expensive upgrades to fire suppression systems, cooling capacity or flooring.
- **Interoperable:** Solution can be deployed in weeks rather than months due to simplicity in both design & deployment. Vendors offer local data center experts and service teams for configuration, installation, maintenance and repair.
- **Controllable:** Ability to monitor temperature and controls. Precision cooling varies operating levels dynamically. Monitor equipment for quicker response and resolution.

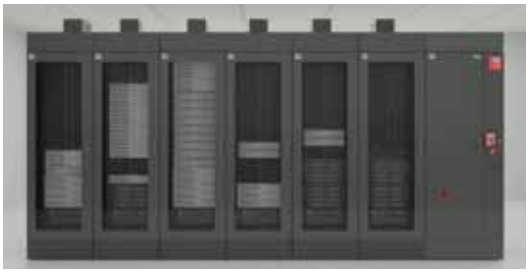
cooling, servers can be effectively cooled at much higher densities, maximizing intake temperatures to ensure that cooling capacity is not wasted–in turn, maximizing the efficiency of the system. As a result, the integrated solution consumes nearly 30 percent less energy annually compared to the conventional infrastructure configuration.

In light of these costs, the installation of an integrated solution would dictate a five year TCO of $184,000 – **$25,000 (or 12 percent) less than its conventionally designed counterpart.** This figure is a direct result of the savings gained by averting significant room renovations, as well as the reduced energy consumption and OPEX intrinsic to the solution's design.

Critical questions to consider before choosing this type of solution:

How much capacity will the solution need to support?
Integrated solutions like SmartRow are ideal for accommodating 3-6 racks of equipment (approximately 20 kW of IT density).

For larger deployments, multiple row-based (for permanent installation) and/or modular (for temporary or mobile deployments), enclosures may be more appropriate.



Will you be starting "from scratch" or does your facility already have infrastructure in place?
If you already have infrastructure in place and are not seeking a rapid deployment or disaster recovery solution, implementing best-practice building blocks via a row-based approach may be a more suitable option.

How important is scalability to your IT needs?
If you anticipate rapid growth or frequent fluctuations in capacity that may exceed the capabilities of a self-contained integrated solution, an open infrastructure may be a more cost effective option.

Scenario 2:

Build a Space for 75 kW of IT

In the next scenario, Emerson Network Power once again asked the third-party design firm to compare two build options.

	Conventional	Integrated	Cost Savings	% Savings
Room Costs: Contractor, installation, engineering services	$60,000	$43,000	$17,000	28%
Infrastructure Equipment: UPS, distribution, cooling, racks, fire suppression	$105,000	$109,000	-$4,000	-3%
Total CAPEX	$165,000	$152,000	$13,000	8%
Annual Energy Consumption: Power & Cooling equipment energy use	$8,800	$6,400	$2,400	27%
5 Year OPEX	$44,000	$32,000	$12,000	27%
5 Year TCO	$209,000	$184,000	$25,000	12%

Table 1: Cost analysis for conventional versus an integrated SmartRow solution in an 18 kW IT deployment.

In this case, the prospective data center facility would need to house 75 kW of IT equipment. Since this would essentially be a new deployment, the organization would need to invest in all infrastructure equipment in addition to constructing a facility to house the data center.

Furthermore, because this scenario likely represents a physical expansion, remote data center deployment or other small new build environment, N+1 redundancy also would need to be integrated on both the power and cooling side of the data center infrastructure.

With these considerations in mind, the design firm was faced with two options: build a brand new building to house 75 kW of IT or deploy a modular integrated infrastructure – Emerson Network Power's SmartMod offering. Modular integrated solutions, like SmartMod from Emerson Network Power, are designed to address these needs by utilizing a secure, stand-alone enclosure equipped with a pre-configured power, cooling and monitoring infrastructure. Modular data center solutions are ideal for remote sites (especially where chilled water is not available). They also allow for fast expansion capacity by installing in a warehouse on a slab, or as part of a full or modular data center build-out strategy.

Modular integrated solutions allow data center managers to effectively manage a secure infrastructure that can optimize efficiency, capacity, availability, and space utilization in a variety of applications, including capacity overflow, remote locations and disaster recovery.

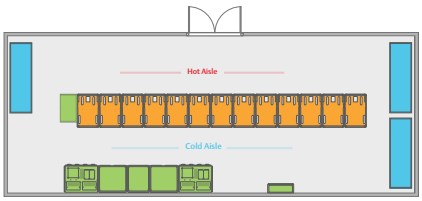
Modular integrated solutions also can accommodate a wider range of capacities and densities compared to smaller self-contained solutions, making this type of solution ideal for supporting both short- and long-term deployments for large data center operations.

Critical questions to consider before choosing this type of solution:

How much capacity will the solution need to support?

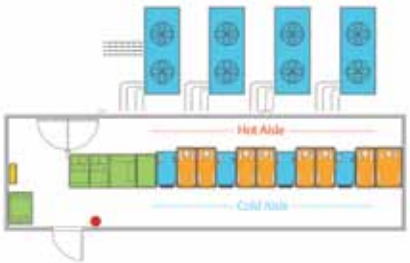
While modular integrated solutions can accommodate a wide range of IT capacities, they are less cost effective for smaller deployments (40 kW and less). When seeking a rapid deployment or disaster recovery for a smaller environment, utilizing single-row solutions instead may be ideal (accommodating 3-6 racks of equipment, approximately 20 kW of IT density).

Scenario 2:



Conventional Approach

- 75 kW, 921 sq. ft.
- 1 row, 13 racks
- 3 perimeter cooling units (N+1)
- (2) 100 kVA UPS (N+1)
- Construction of a new building



Integrated Approach

- 75 kW, 460 sq. ft
- 1 row, 8 racks
- 4 Liebert CRV (N+1), Liebert iCOM Controls
- 1 Liebert APM 90 kVA UPS (N+1)
- SmartMod Enclosure

What are your plans for long-term expansion of your modular data center deployment?

Modular deployments are an excellent option for accommodating spillover capacity from a brick-and-mortar data center, but may not be the most cost effective option if these events happen irregularly and only on occasion. If increased capacity needs are sporadic and relegated to a single data center location, a row-based integrated approach may be a more appropriate and cost-effective solution.

Cost Analysis

As in the case with SmartRow, the deployment of a modular integrated solution (See Table 2) would require a larger up-front infrastructure investment (for a SmartMod deployment, an additional $501,000 compared to a conventional approach).

However, this disparity is largely due to the fact that modular deployments require investment in an enclosure, which will essentially serve as the "room" for the IT equipment and data center infrastructure. As a result, the modular deployment would forgo all expenses related to building a dedicated room.

It also is important to point out that the key benefit of this approach, time-to-deployment for the modular integrated solution, would be much faster than the time required to construct a new data center facility. This is a unique attribute of a modular approach that further enhances the integrated solution's installation efficiency.

In terms of annual energy consumption, the modular integrated approach proves to be significantly more efficient than the conventional approach, using nearly 30 percent less energy annually – a $45,000 savings in OPEX over five years (See Table 2).

This can be attributed to the fact that many of the aforementioned best practices for maximizing efficiency, without compromising availability, have been factored into the overall design of the SmartMod solution.

For example, by utilizing row-based precision cooling with variable speed electrically commutated (EC) fans, digital scroll compressors and intelligent control capabilities, SmartMod offers enhanced airflow management over the conventional approach. In turn, the modular solution's cooling infrastructure achieves significant energy savings over traditional perimeter precision cooling.

Choosing the Right Integrated Solution: SmartMod

Core Benefits of the SmartMod Solution

- **Efficient:** High-efficiency power and cooling technologies integrated into the modular architecture can significantly reduce power consumption versus conventional data centers. Pre-engineered systems can be installed in just months, further enhancing operational efficiency.
- **Economical:** The modular architecture doesn't burden existing power and cooling infrastructure. Installation costs are significantly reduced by averting expensive expansion of existing data center or construction of new data center.
- **Interoperable:** The modular architecture's pre-engineered infrastructure is designed and matched for the most common data center densities. Integrated management software also can work seamlessly with existing systems.
- **Controllable:** Allows data center managers to remotely monitor and manage the infrastructure, environmental conditions, security systems and access to the enclosure.

In whole, considering the savings in room costs and energy consumption, the integrated approach would yield an 11% percent decrease on a million dollar total cost of ownership over five years compared to a conventional approach – **a 5 year total savings of more than $123,000.**

Scenario 3: Deploy 160 kW of IT in an Existing Room

In the final scenario, the design firm was asked to compare two options for a 160 kW IT deployment to an existing data center floor. Unlike the previous two scenarios, this data center will not require any additional build-out from a facilities perspective.

The firm was presented with two options: a data center with medium density racks organized in a traditional alternating hot/cold configuration and a high-density rack environment with a row-based integrated infrastructure equipped with precision cooling equipment and aisle containment – Emerson Network Power's SmartAisle.

Choosing the Right Integrated Solution: SmartAisle

As data center and IT managers pursue capacity expansions in their existing facilities, they often require new approaches to physical infrastructure to improve efficiency without sacrificing current investments or compromising future flexibility.

However, making frequent changes to an existing data center often can lead to incompatible infrastructure systems, hindering operational and energy efficiencies, as well as the flexibility to effectively manage rapid changes.

Row-based integrated infrastructures – like SmartAisle from Emerson Network Power – combine the many disparate parts of the IT infrastructure into a connected system which works together to improve cost, availability and management. These solutions integrate the data center's existing power, precision cooling and control technologies into an intelligent, row-based configuration that fulfills design best practices to optimize operational efficiency.

SmartAisle-based integrated infrastructures are ideal for existing facilities experiencing rapid growth. While deployment times can be slower than pre-configured integrated solutions, their scalability and interoperability with existing infrastructures make row-based integrated infrastructures ideal for these environments.

Also, because configurations can vary widely depending on the type of existing equipment already in place, best practices are not necessarily "forced" by this approach.

	Conventional	Integrated	Cost Savings	%Savings
Room Costs: Construction, engineering services	$579,000	$0	$579,000	100%
Infrastructure Equipment: UPS, distribution, cooling, racks, fire supression, install	$315,000	$816,000	-$501,000	-159%
Total CapEx	$894,000	$816,000	-$78,000	8%
Annual Energy Consumption Power & cooling equipment energy use	$31,000	$22,000	$9,000	29%
5 Year OpEx	$155,000	$110,000	$45,000	29%
5 Year TCO	$1,049,000	$926,000	$123,000	11%

Table 2: Cost analysis for conventional versus integrated SmartMod solution in a 75 kW IT deployment.

Conversely, row-based integrated infrastructures employ standard building blocks for achieving these design best practices and, as such, must be deployed and maintained to accommodate growth over time.

Critical questions to consider before choosing this type of solution:

Can you leverage your existing infrastructure?

While IT equipment interoperability is a core benefit to all integrated architectures, the existing infrastructure can be utilized in conjunction with a SmartAisle solution. Existing power, cooling and racks can be supplemented and optimized utilizing some of the new integrated solution offerings available today.

What is the expected capacity of the data center installation?

To maximize CAPEX and OPEX savings, an integrated architecture is best in installations up to 400 kW of IT. Conventional architectures are best-in-class technologies for large enterprise data centers. Using conventional enterprise technologies can reduce the capital cost of the power and cooling when the data center load is above 400-500 kW. Conventional methods may be a better option although integrated architectures can easily be utilized for high density pods inside of conventional designs.

What is the velocity of IT capacity additions?

If your data center experiences rapid increases in server deployments, interoperability between racks, rack PDU and electrical busway can greatly improve the speed of deployment and lower the installation costs.

These factors should be included when evaluating ROI for an integrated solution.

Cost Analysis

From a space efficiency standpoint, the integrated approach utilizes significantly less raised floor space than the conventional approach – more than 700 square feet. While the space savings are not reflected in the overall cost comparison, the utilization of a high-density open architecture would enable the organization to preserve an additional 600 square feet of raised floor space for a future expansion, averting the need for an expensive and time-intensive build out.

From a cost perspective, the approach offers significant savings in room costs due to the overall ease of installation intrinsic to integrated solutions, yielding an 11 percent savings ($56,000) over the conventional approach .

Core Benefits of the SmartAisle Solution

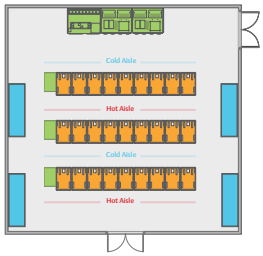
- **Efficient:** Can increase energy efficiency using high-efficiency, row-based cooling systems and aisle containment strategies; can streamline IT productivity by utilizing comprehensive management.
- **Economical:** Architecture can be used to retrofit existing infrastructure to support higher capacity and density.
- **Interoperable:** Racks, cooling, power modules are designed to be interoperable to ease data center design and change management.
- **Controllable:** Can streamline IT planning to optimize space and capacity utilization. Able to monitor equipment operating levels, power, temperature, humidity and controls to reduce break/fix events.

In addition, because the integrated approach uses significantly fewer racks – eliminating an entire row compared to the conventional approach – IT and infrastructure configurations can be completed significantly faster, once again enhancing the data center's design/deployment efficiency.

On the infrastructure side, the need for fewer racks, and the elimination of the need for a room-based PDU due to the integration of the Liebert MB managed busway solution, also make the open architecture integrated approach a more cost-effective option compared to the conventional data center resulting in a savings of $24,000 over the infrastructure costs for a conventional design.

From an energy consumption standpoint, the open-architecture's use of cold-aisle containment, paired with row-based precision cooling and intelligent control technology maximize the data center's cooling efficiency, using 27 percent less energy annually compared to the conventional design. Extrapolated over five years, these efficiency gains result in a five year savings of $85,000 in OPEX alone. These savings, paired with the CAPEX savings in room and infrastructure equipment costs, once again result in a significantly reduced TCO for the integrated approach compared to a conventional data center design – **a cost savings of $165,000**.

Scenario 3:



Conventional Approach

- 160 kW, 1482 sq. ft
- 3 rows, 27 racks
- 4 perimeter cooling units
- 200 kVA UPS
- 3 distribution cabinets

Integrated Approach

- 160 kW, 870 sq. ft
- 2 rows, 16 racks
- 4 Liebert CRV with Liebert iCOM Controls Cold Aisle Containment
- 2 Liebert APM 90 kVA UPS
- Liebert MB busway

	Conventional	Integrated	Cost Savings	% Savings
Room Costs: Contractor, installation, engineering services	$515,000	$459,000	$56,000	11%
Infrastructure Equipment: UPS, distribution, cooling, racks, fire suppression	$415,000	$391,000	$24,000	6%
Total CAPEX	$930,000	$850,000	$80,000	9%
Annual Energy Consumption: Power & cooling equipment energy use	$63,600	$46,600	$17,000	27%
5 Year OPEX	$318,000	$233,000	$85,000	27%
5 Year TCO	$1,248,000	$1,083,000	$165,000	13%

Table 3: Cost analysis for conventional versus integrated SmartAisle configuration in a 160 kW IT deployment.

Conclusion

Today's data center managers face new challenges not traditionally addressed by the IT industry. Operating in accordance with aggressive business drivers dictated by the C-suite, the IT department is now responsible for minimizing the total cost of ownership of the data center infrastructure without adversely impacting the availability of critical systems.

While conventional approaches to data center design can be leveraged – often at significant expense to time, space and resources – new integrated infrastructure architectures are emerging in a variety of configurations to address organizations' unique business needs while increasing efficiency, maintaining availability and speeding deployment.

As evidenced by the preceding cost analysis, intelligent, integrated infrastructures can offer data center managers significant gains in energy efficiency, space utilization and bottom-line costs compared to traditional approaches to data center design. These savings can be directly attributed to the intrinsic benefits of pre-configured data center solutions, as well as the strict observance of design best practices intended to maximize efficiency without compromising the availability of data center operations.

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