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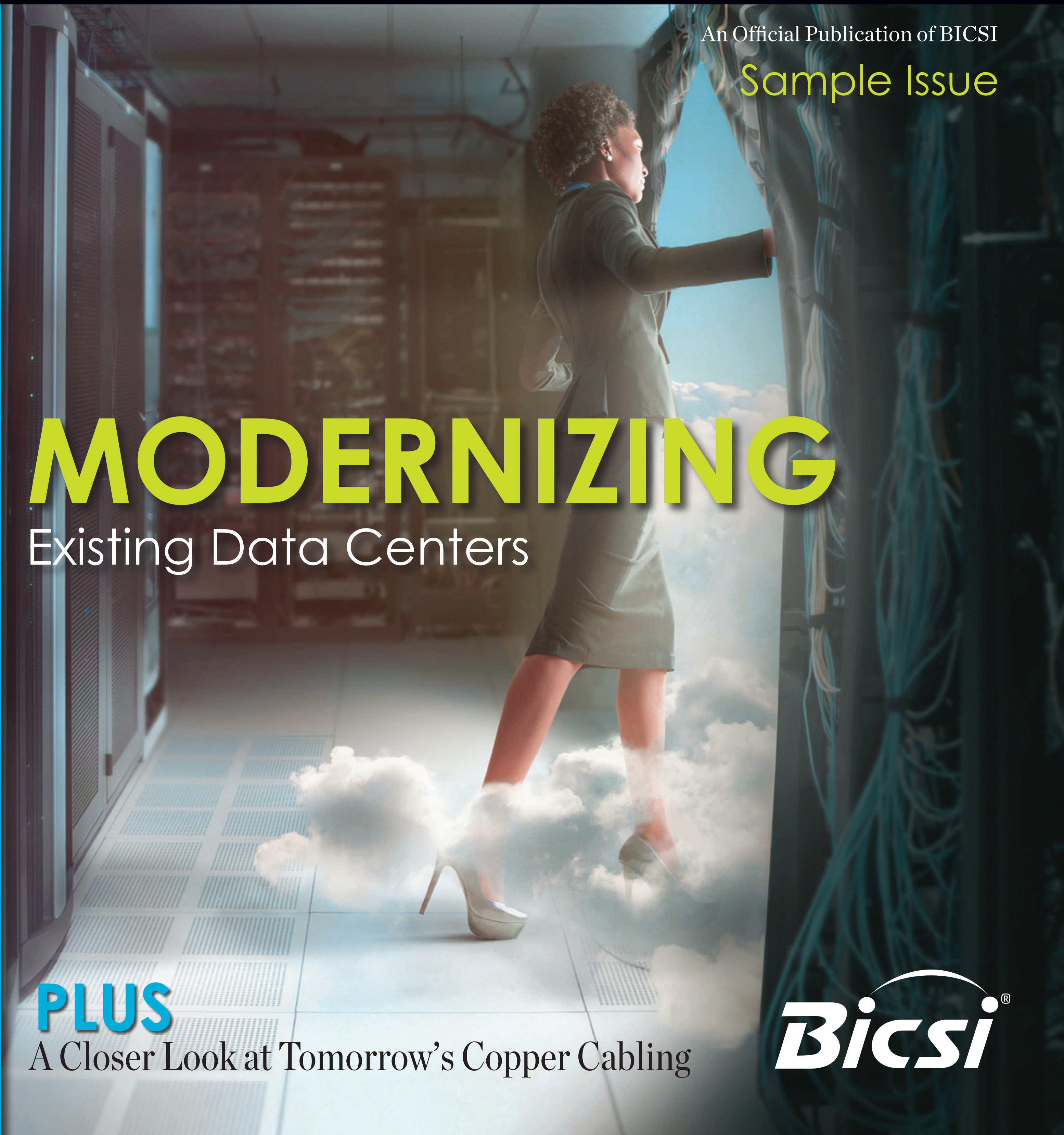

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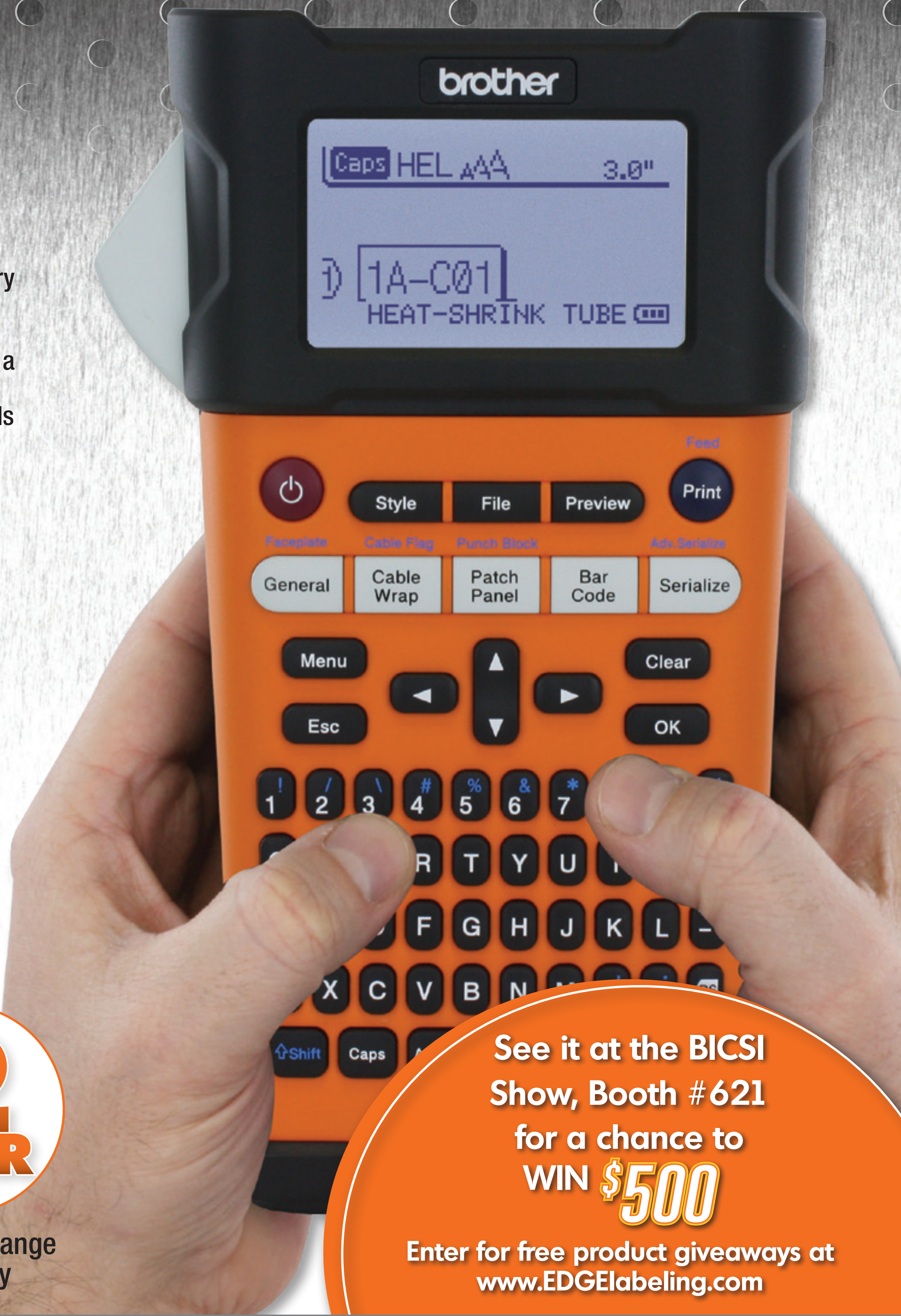

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THE JOURNAL OF INFORMATION TECHNOLOGY SYSTEMS

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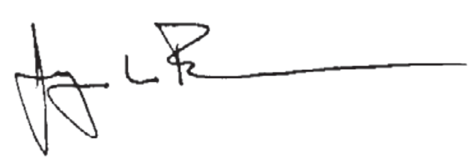
More Than a Name Change

The Journal of Information Technology Systems (ITS) is but one more piece of evidence that BICSI is evolving to meet the needs of today's ITS professional. Over the years, scientists have discovered a wealth of evidence concerning human evolution. This evidence comes in many forms, but fossils are by far the best known. Human fossils have enabled researchers and students to study the changes that occurred in the human race since our origin, including physiological changes and many other aspects regarding the way of life of our species. Millions of stone tools, figurines, paintings, footprints and other traces of human behavior in the prehistoric record tell where and how early humans lived and when certain technological innovations were invented.

What will future generations learn about us from reading old issues of *BICSI News Magazine*? I can only imagine the surprise of our members who, 30 years from today, unearth a copy of our beloved *BICSI News Magazine* and compare it to *The Journal of ITS*. By then, the "fossils" of BICSI will likely include Executive Director and Chief Executive Officer John D. Clark Jr., CAE, President-Elect Michael Collins, RCDD, RTPM, CCDA, NCE, and yours truly, along with some old issues of *BICSI News Magazine* found in someone's attic.

It is important to note that this isn't just a name change—articles in journals are assessed by an editorial review board and allowed publication only if they have substantial information and conform to the requirements of the journal. Furthermore, one can cite articles from journals as an authentic piece of information. Almost a year ago, I provided John Clark with three names of industry leaders from very different backgrounds who will serve as the Editorial Review Board for *The Journal of ITS*. These BICSI members and subject matter experts will create history as they work with the editor and BICSI staff to qualify articles for publication.

The Journal of ITS will elevate our industry publishing efforts to a new level. *BICSI News Magazine* has already evolved significantly from the newsletter format of early years into the magazine format of today. There has been a tremendous amount of work on behalf of staff and members to get ready to publish *The Journal of ITS*. As you read this sample issue, you are taking part in another evolution in the history of BICSI. Happy reading!



By Todd Boucher, RCDD, DCEP

MODERNIZING EXISTING DATA CENTERS

Strategies and Considerations for Extending the Lifecycle of Your Facility

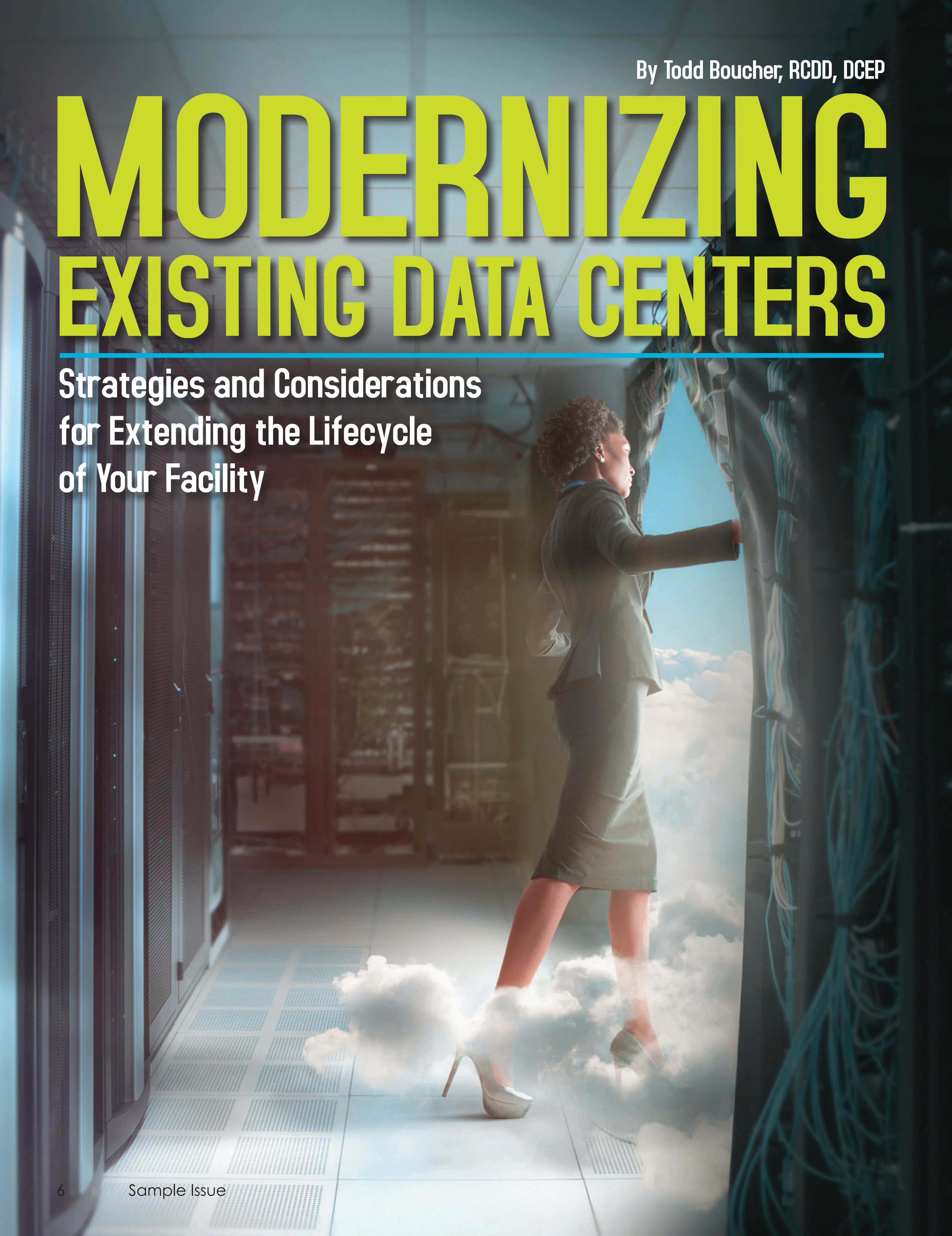


FIGURE 1: A typical legacy data center with raised floor, perimeter CRAC units and underfloor power and telecommunications distribution.

With the rapid proliferation in public cloud services, many organizations have engaged in a "build vs. buy" comparison for their data center facilities where they evaluate the benefits of building their own data center against outsourcing through colocation providers, public cloud services, or a combination of both. This effort is a complex evaluation that is unique to each customer and involves considerations for the financial, security, risk and customer service implications of the decision, among many others.

In data center deployments, a greenfield facility is one that did not exist before and is purpose-built from the ground up. In contrast, a brownfield deployment is an upgrade or addition to an existing data center that likely uses some legacy components. These terms come from the building industry, where undeveloped, unpolluted land is described as "greenfield," and previously developed (often polluted and abandoned) land is described as "brownfield." While building a greenfield facility and outsourcing are possible options, most legacy data centers can benefit significantly from modernization efforts that increase capacity and energy efficiency to extend the lifecycle of the existing space. Every project includes an element of risk, and modernizing an existing data center is no exception. However, remaining in your existing facility eliminates the risk and cost of the major technology migration effort that would be required to move into a new space. Many organizations find this factor alone to be a major substantiation of a renovation initiative.

Every data center will require an individualized project plan and strategy for its renovation.

Each data center has its own unique needs, and the motivation to renovate an existing facility will vary based on adding capacity, extending lifecycle, improving efficiency and increasing redundancy. With careful planning, a data center modernization effort can achieve all of the above.

Capacity Challenges

As IT organizations continue to leverage technologies such as virtualization, the profile of their data center changes. The challenge is that legacy data center infrastructures were not designed to respond dynamically to IT equipment refresh cycles. This presents the dichotomy of a data center—the facility is designed to last 20 years,

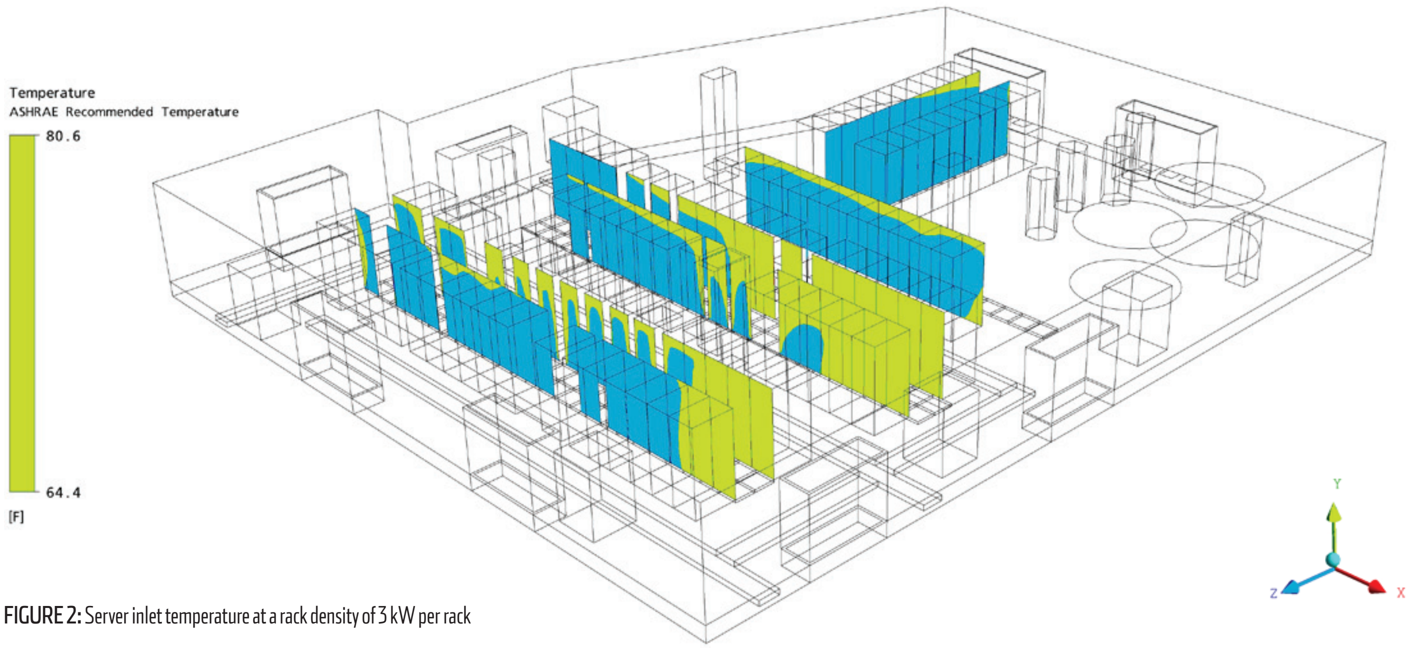


FIGURE 2: Server inlet temperature at a rack density of 3 kW per rack

A recommended strategy for optimizing the use of existing CRAC units is to implement air containment systems.

but the IT equipment installed in that facility changes every two to three years. A data center designed as little as five years ago might be designed to support average rack densities of 2 to 3 kilowatts (kW) per rack, whereas virtualized environments can average 7 to 10 kW per rack and beyond. For a typical legacy data center design with a raised floor, perimeter downflow computer room air conditioner (CRAC) units and underfloor power and telecommunications distribution, this density change presents several challenges (see Figure 1).

Figures 2 and 3 illustrate what happens to server inlet temperatures in a legacy data center facility when rack densities are increased from 3 kW per rack to 6 kW per rack. By performing this analysis using computational fluid dynamics (CFD) software, we can determine how the incremental difference of 3 kW in IT load will impact the data center's conformance with the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) recommended range of 18 degrees Celsius (°C [64 degrees Fahrenheit (°F)]) to 27°C (81°F) for server inlet temperatures.[1]

By reviewing the screenshots of the CFD analysis, we see that a rack density of 3 kW per rack produces server inlet temperatures within the recommended ASHRAE ranges. However, when the load is increased to 6 kW per rack, there is a notable deviation in server inlet temperatures through the data center, resulting in numerous sever inlet conditions that are outside of the recommended ASHRAE range. This condition would likely cause on-board environmental monitoring of the server equipment to alarm.

A typical owner response to increased server inlet temperatures shown in Figure 3 has been to add cooling capacity. Over time, this practice has left many data centers with excess cooling capacity compared to IT loads and significant inefficiencies in energy consumption. In a recent independent survey of data center operators, the average power usage effectiveness (PUE) for the facilities surveyed was 2.8.[2] This indicates that for every kilowatt of power consumed by IT equipment, 2.8 kW are used for supporting infrastructures like cooling and power (see Figure 4).

The good news for owners is that this inefficiency presents an opportunity to regain data center capacity through a modernization effort. The most successful modernization projects balance the reclamation of existing data center capacity with the addition to or upgrade of existing systems.

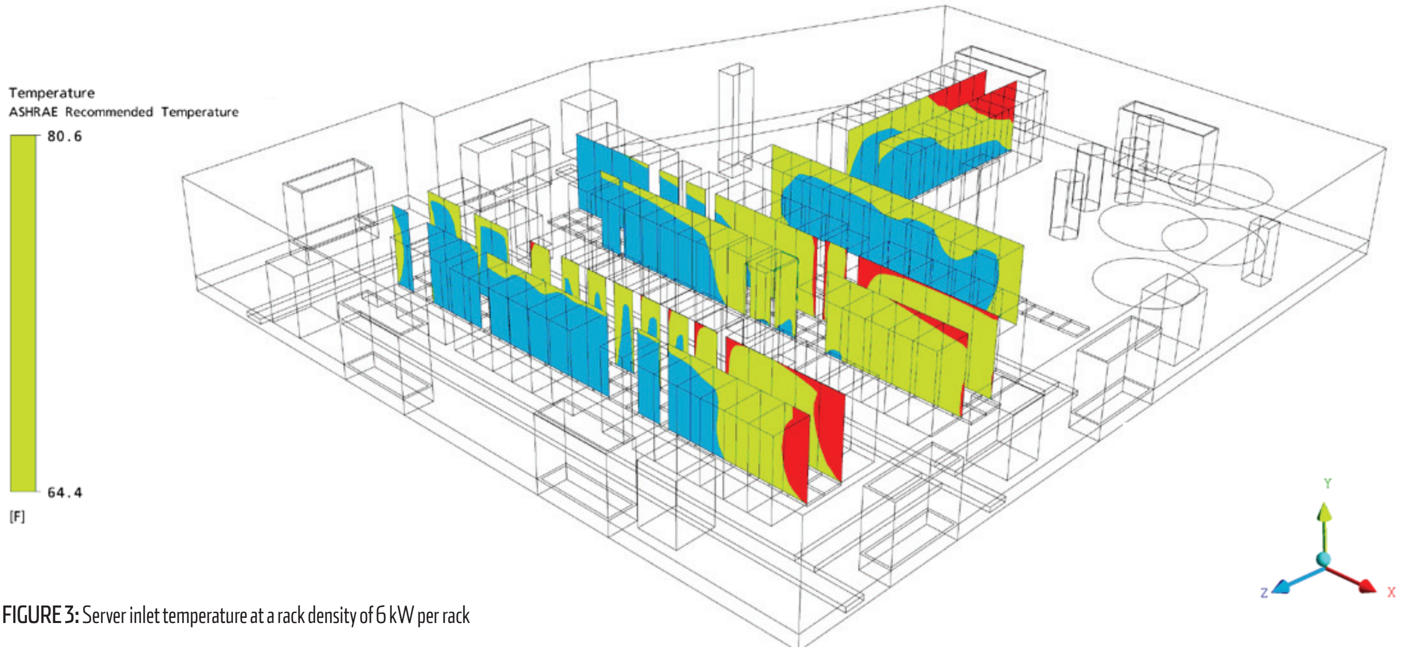


FIGURE 3: Server inlet temperature at a rack density of 6 kW per rack

The Gap Analysis

It is important to begin any data center modernization effort with two critical activities:

1. **Create a master plan for IT equipment, technology and services**. The IT plan will identify the growth requirements of IT operations and the associated technologies required to support the long-term goals of the organization.

2. **Complete an assessment of the existing data center infrastructure.** The physical infrastructure assessment should include a detailed review of what you currently operate in your facility, including systems like uninterruptible power supplies (UPS), cooling infrastructure, emergency power, fire protection, telecommunications and power distribution.

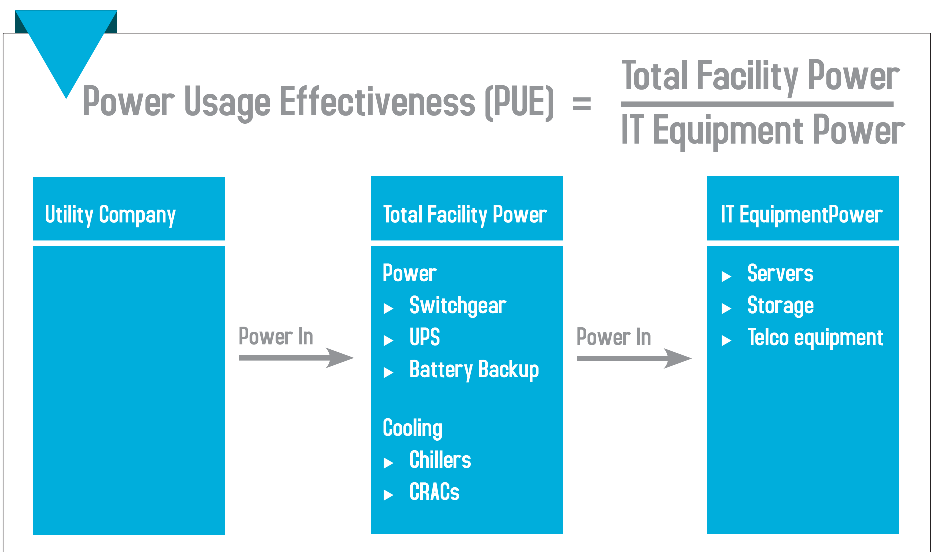


FIGURE 4: Power Usage Effectiveness. Source: Green Grid

By reviewing these detailed assessments, a gap analysis can be created that identifies how your existing infrastructure needs to be augmented to support the organization's ongoing IT operations in both the short and long term. More importantly, a thorough gap analysis will become the baseline for your data center modernization project plan.

A successful renovation project requires careful collaboration between the owner, design team

Design Conditions		Sensible Cooling Capacity
Return Air Temperature	Relative Humidity	
24°C (75°F)	45%	132.3 kW
22°C (72°F)	45%	122.6 kW

FIGURE 5: Capacity Data of Perimeter CRAC[2]

and contractor/integrator. It is important for the owner to understand that the lifecycle of most renovation projects extends beyond that of a greenfield build due to the planned shutdowns required for the project. Customers typically have several constraints that impact when a planned shutdown can occur, and these considerations should be identified at project inception so the timeline can be appropriately coordinated. In addition, a modernization project needs to be performed in phases—executing the work incrementally allows the owner to balance risk and sequence the migration of IT loads onto the new infrastructure.

Modernization Strategies

Every data center will require an individualized project plan and strategy for its renovation. However, an owner can begin their planning efforts with consideration of some common strategies employed for data center modernization.

Cooling Infrastructure

Improvements to cooling infrastructure in a legacy data center are extremely impactful and can involve both optimizing existing infrastructure and supplementing with new equipment and systems. Understanding the per-rack density needs outlined in your IT master plan will help your design team identify the most effective means of neutralizing the heat generated by IT equipment. A typical data center like the one shown in Figure 1 often operates inefficiently, with cool supply air mixing with exhaust air from IT equipment as it returns to the CRAC unit. Most owners do not realize that the impact of this air mixing is a reduction in return air temperature to the CRAC unit. This decreases the unit's sensible cooling capacity. An examination of the technical performance data of a CRAC unit illustrates this in more detail.

A normal design condition for a perimeter CRAC unit in a legacy data center may be to assume a return air temperature of 24°C (75°F) with 45 percent relative humidity.[3] In this condition, the unit would yield a sensible cooling capacity of 132.3 kW. However, if the return air temperature to the CRAC unit is reduced as a result of air mixing, the sensible cooling capacity is reduced proportionally.

Figure 5 demonstrates how a 2°C (3°F) reduction in return air temperature creates a 10 kW reduction in sensible cooling capacity. Given that it is not uncommon for return air temperature values measured during onsite assessments to reach 21°C (70°F) or less, it is easy to see why data centers become strained for cooling capacity.

Air Containment

A recommended strategy for optimizing the use of existing CRAC units is to implement air containment systems. A containment solution includes physical barriers that separate hot and cold aisles in a data center, eliminating the mixing of cool supply air and hot exhaust air from IT equipment. The choice between implementing a hot aisle containment system (HACS) or a cold aisle containment system (CACS) will be dictated by the existing data center environment, but both yield significant benefits.

According to ENERGY STAR, containment systems can reduce energy consumption by 5 to 10 percent in addition to reducing fan energy by up to 25 percent.[4] More importantly, physically segregating the supply and exhaust air streams in your data center will increase the return air temperatures to your CRAC units, helping you reclaim the capacity lost due to inefficiencies outlined in Figure 5. This serves as an excellent example of how a modernization effort can increase both capacity and energy efficiency.

Cooling Technologies

Improving the performance of existing cooling systems may not always be sufficient. As rack densities continue to increase, it is worth considering the implementation of newer cooling technologies such as in-row cooling, rear-door heat exchangers or overhead cooling. Once again, existing site conditions and expected rack densities will dictate the best technology for the project. For example, a low ceiling height in an existing data center

Any changes to a data center, especially those that include the installation of air

may prevent implementing overhead cooling systems. Similarly, if the data center does not have available floor space, and space cannot be created through consolidation, in-row cooling may not be a feasible option.

There are several advantages to utilizing cooling technologies. Most notably, these technologies locate cooling systems close to IT equipment, shortening the distance air has to travel to the server inlet (i.e., supply air) and back to the cooling unit (i.e., return air). This ensures that the exhaust air from IT equipment is captured and returned to the cooling unit at a higher temperature, improving the efficiency and capacity of the system. Shortening the distance of the supply air path significantly reduces fan power requirements. Combining this improved airflow distribution with the variable speed fan capacity of these cooling technologies can yield significant energy savings and an improvement in the data center's ability to support high-density IT loads.

Overhead Power Distribution

For an existing data center, any obstruction in the underfloor plenum space will impact the effectiveness of the cooling system. Unfortunately, for many legacy data centers, ongoing moves, adds and changes (MACs) associated with IT equipment refresh processes have led to raised floors with cabling conditions similar to those shown in Figure 6.

To rectify these challenges, a recommended modernization strategy is to implement power distribution that routes cabling overhead to IT equipment instead of under the floor. This can be achieved through several methodologies, with the most common being overhead busway distribution systems such as those shown in Figure 7 and in-row power distribution units (PDUs) that distribute power overhead via flexible tray cable. Leveraging these overhead strategies for power distribution can provide many functional benefits for existing data centers, including:

- **Agility—**Most data centers are not homogeneous, and operators need the flexibility to accommodate ongoing MACs of IT equipment in the facility. Overhead power distribution strategies enable owners to respond to these changes with a more "just-in-time" strategy. For example, most bus plug configurations required for today's IT equipment are standard factory items. With proper alignment between IT and facilities staffs, an upcoming equipment implementation can be easily coordinated through the procurement and installation of the necessary busway connections prior to the equipment implementation date. Without the requirement of working under the raised floor, an overhead power distribution system will improve meantime-to-deploy and reduce the risk of working around a growing accumulation of power circuits under the raised floor.

- **Monitoring and Data Center Infrastructure Management (DCIM) Integration—** Improving visibility into the power consumption at the rack or branch circuit level is an important step for any data center owner. Depending on the existing environment, this can be a difficult feature to retrofit. By upgrading the power distribution system, the ability to select and implement the level of power monitoring desired in the data center is achieved, as well as the integration of this monitoring with the DCIM system.

- **Energy Efficiency—**Some owners desire the ability to use high-voltage distribution (i.e., 240V) systems in the data center. The implementation of a new power distribution system provides the option of choosing this strategy, which yields a more efficient use of power in the data center, reduces wire size requirements and reduces electrical transformation (and associated cooling requirements) in the power distribution system. There are numerous implications to consider when evaluating this strategy, and owners should coordinate closely with the design professionals to determine if it is feasible for the facility.

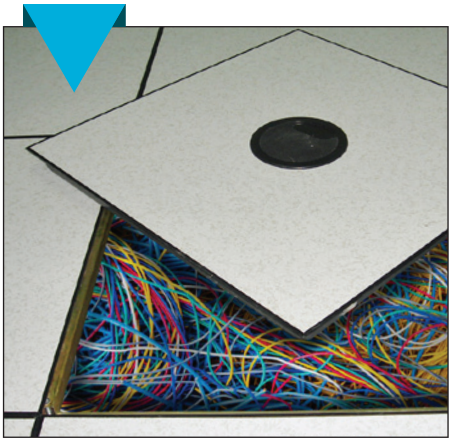


FIGURE 6: Ongoing MACs can lead to poor underfloor cabling conditions.

containment systems, could necessitate augmentations to the existing fire protection system.

FIGURE 7: Overhead power distribution systems

Additional Considerations

Modernizing existing data center space through the strategies outlined here can be complex and requires extensive planning and coordination. Following are some additional considerations that may impact a data center modernization effort:

- **Fire Protection—**Any changes to a data center, especially those that include the installation of air containment systems, could necessitate augmentations to the existing fire protection system. It is critical to review these implications with the design professionals and local authorities so any associated costs are included in the initial project plan.
- **Space Beyond the Whitespace—**Adding to the overall capacity of a data center may require use of space beyond the boundaries of existing data center whitespace. For example, increasing UPS capacity requires additional real estate and associated cooling as compared to the existing system, and the availability and location of that space will impact the project significantly. In addition, any changes to overall power capacity will require a thorough review of the power distribution system (beginning at the utility service size) and can create time delays and added cost.
- **Contingency Planning—**The renovation effort in an existing data center space will likely require a planned shutdown of equipment, during which several critical project activities will be completed. As the complexity of tasks to be completed during a shutdown increases, it becomes critical that owners work with their construction team to develop a contingency plan that outlines the shutdown milestones and the means by which service will be restored to the data center if any challenges occur during the shutdown process.
- **Structural & Architectural Concerns—**The ability to implement changes in the data center may be impacted by structural and architectural items such as the load bearing capacity of the floor or the existing ceiling height of the data center space. These considerations should be identified in advance through a gap analysis and reviewed for their impacts on cost and feasibility.

Conclusion

A recent survey of data center owners indicated that 82 percent of respondents expect to increase density in their data center in the upcoming year.[1] Many owners recognize the strain this increase could place on the data center physical infrastructure, and reviewing modernization strategies for the facility may prove to be a cost-effective alternative to constructing a greenfield data center or outsourcing data center services.

The strategies presented in this article are not meant to be inclusive of all options, and owners should spend adequate time reviewing their gap analysis to determine their specific needs and potential constraints that exist in their data center facility. However, most legacy data centers have the potential to benefit substantially from a well-planned modernization effort. With creativity and careful planning, an existing, constrained data center can be transformed into an agile, next-generation facility.

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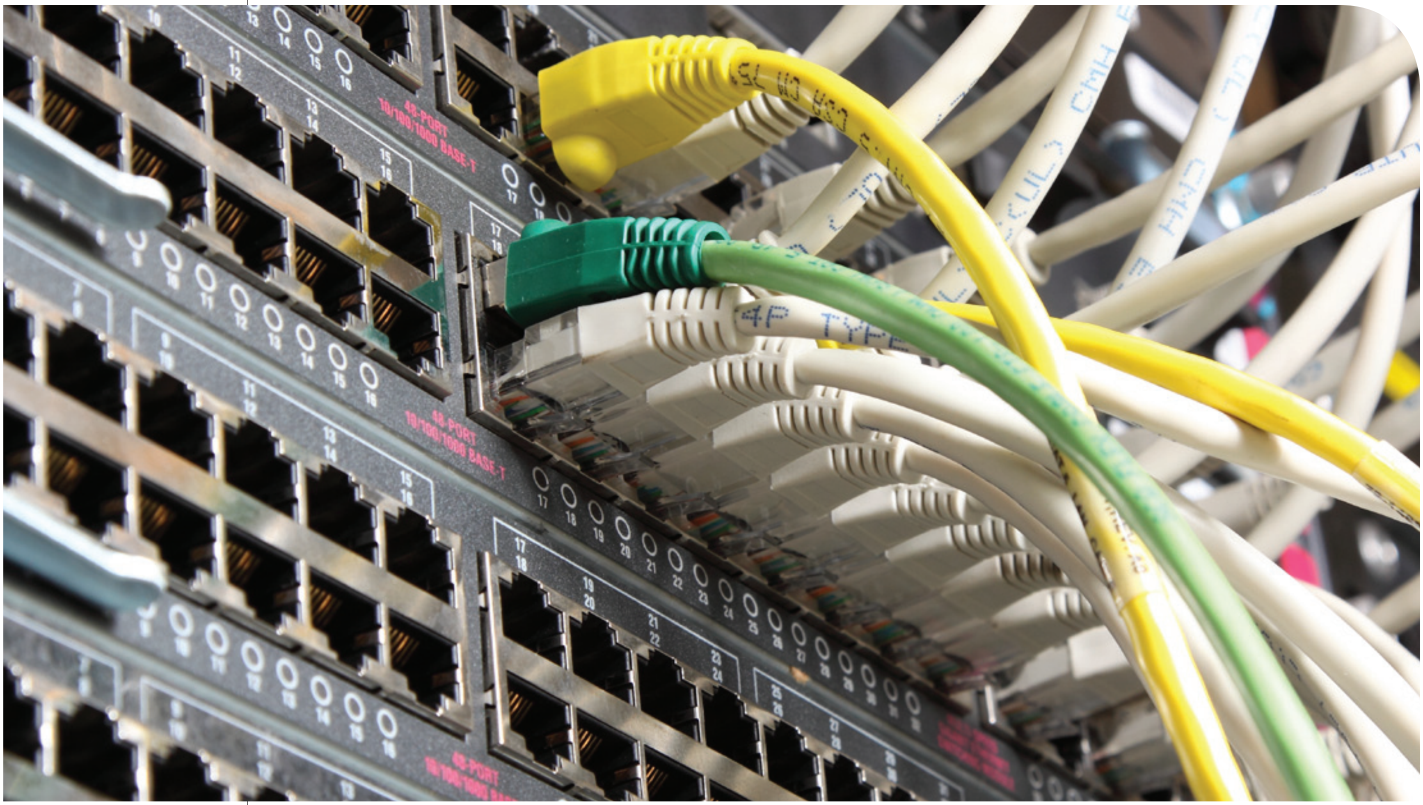

A Closer Look at Tomorrow's Copper Cabling:

What Do We Really Know About Category 8, and Will it Be the End for Copper?

In 2012, standards bodies identified the need for a 40GBASE-T application in data center sever-to-switch connections, and the IEEE 802.3 working group quickly approved a new project to extend the 40 gigabit per second (Gb/s) data rate standard to twisted-pair copper media. As with all prior Ethernet generations, there is a corresponding new twisted-pair cabling standards project. The Telecommunications Industry Association (TIA®) has designated category 8 as the next generation twisted-pair cabling that is currently under development for 40GBASE-T applications.

Driven by higher density data center connectivity and the fact that the 8-position, 8-contact (8P8C) RJ45 connector profile still holds the position as having the smallest practical dimension for data center equipment and faceplate port density, the 40GBASE-T application offers quadruple density over 10GBASE-T. The widely-recognized advantages of copper twisted-pair Ethernet cabling for this application also come from support for two unique capabilities—the inter-generational interoperability achieved by autonegotiation, which enables the best

The primary application for 40GBASE-T is very specific, and the market is clearly defined—data center interconnection from servers to edge switches.

available common speed between two different connected ports, and Energy Efficient Ethernet (EEE), which affords significant savings via power management by enabling a link sleep mode.

Most of the discussion for the new category 8 cabling is not focused on the traditional LAN model. The objective is set for two-connector channels up to 30 meters (m [98 feet (ft)]). Accordingly, short-reach data center interconnection interfaces will be the first applications supported by 40GBASE-T.

In the development of category 8 cabling, the current upper two levels of cabling performance, extended category 6A and category 7A technologies, have both survived the past year of preliminary discussions. The category 6A-based cabling technology offers fully backwards compatible connectivity for short-reach applications. The category 7A-based cabling technology offers higher bandwidth LAN connectivity for supporting extended reach to future multimedia applications. This article explores the potential cable and connector technologies under consideration for the category 8 standards, their impact on the information technology systems (ITS) industry and what the future holds for twisted-pair cabling beyond category 8.

What Will it Look Like?

The TIA standard for category 8 is being developed as a seamless upgrade from category 6A. The application provides an important relaxation from the traditional 100 m (328 ft) four-connector reference channel implementation to 30 m (98 ft) with two connectors. The designated frequency for category 8 twisted-pair cabling media is 2000 megahertz (MHz). The proposed two-connector channel will use two backward-compatible RJ45 connectors, and the cable will likely be an unshielded twisted-pair (UTP) core with overall shielding that will appear to be similar to screened category 6A (i.e., F/UTP). These shielded cables will be necessary for structured cabling; however, very short channels might still be possible with UTP cable. Making shield terminations more efficient and robust is an immediate, serious and worthwhile challenge to category 8 component designers. The good news is that for category 6A and up, shielded F/UTP cables are inherently smaller than UTP cables. Furthermore, with the RJ45 remaining as one of the smallest connectors used in the data center environment, 40GBASE-T offers quadruple the density over 10GBASE-T—pathways and faceplates will get four times more capacity from the same connector.

The International Organization for Standardization (ISO)/International Electrotechnical Commission (IEC) standard is spawning two versions of category 8—category 8.1 and category 8.2. Derived from category 6A, category 8.1 is essentially equivalent to the category 8 standard. On the other hand, category 8.2 is derived from fully-shielded category 7A technology. The most important feature of a category is its frequency. Since category 6A and category 7A technologies are both being upgraded to 2000 MHz, the respective new component sets for ISO/IEC category 8.1 and 8.2 will work together to enable more channel implementation options.

TIA uses the category name to identify components, links and channels, whereas the ISO/IEC standard designates channels and links as "classes," which are built from IEC component "categories." For example, Class EA channels are normally built from category 6A components. ISO/IEC will therefore define two new channel classes—Class-I and Class-II—to be built from category 8.1 and category 8.2 components respectively.

While category 7A (Class FA) suppliers might be expected to be already well on their way to making category 8.1 components, that is not necessarily the case. Category 7 has been available since 1996 and category 7A since 2006, but they have not been standardized beyond 1200 MHz. Nevertheless, most manufacturers are aware of category 7 and 7A international standards and have adopted portions of the technology into their products.

Both category 8.1 and category 8.2 cables will use the same gauge wire. The key distinction setting category 8.2 apart is the use of individually-shielded twisted-pair cables (F/FTP), traditionally used for category 7 and 7A. Like category 8, the designated connector for ISO/IEC category 8.1 is the RJ45. Category 8.2 will use upgraded non-RJ45 category 7A-type connectors.

What Are the Key Challenges?

The biggest challenge for category 8 is in the area of measurements technology required to assess and verify the required component, link and channel performance up to 2000 MHz. The fundamental problem of measurements and testing twisted-pair cabling components and channels at much higher frequencies presents the following issues:

- The new 1000 to 2000 MHz range is well beyond category 6A's 500 MHz range, reaching well into the microwave region. As is typical with everything else involving signaling, when the frequency is doubled, the power, complexity and cost quadruple. Therefore, new more precise and sensitive test equipment will be required.

- To date, twisted-pair cabling has been defined according to two-port models and measurements—starting with original IBM cabling system in the early 1980s. Twisted-pair cabling systems have long been measured using a balun, and categories and performance continue to be defined that way. At 2000 MHz, it is practically impossible to make baluns small and balanced enough. Therefore, four-port models and measurements are now being introduced. The result is subtle but amounts to reinventing the cabling standards.

Actually, a pair of wires is a 4-port passive network. Each end of each wire represents a port. A balun (balanced-to-unbalanced) transformer is commonly used to adapt the two ports at one end of a balanced twisted-pair to a single unbalanced port, such as a coax port normally found on the front of a measurement instrument.

What Will the Impact Be on Other Technologies?

The Ethernet upgrade from 1 Gb/s to 10 Gb/s established the pattern that determined the objectives for 40GBASE-T. Following the optical 10 Gb/s Ethernet development, the 10 Gb/s copper development was split and done sequentially over three projects—backplane printed-circuit, interconnect twinax and the network twisted-pair copper cabling. The IEEE 802.3 has adopted and strictly adheres to this technology roadmap principle.

After 10 Gb/s was completed, an Ethernet aggregation layer was developed for grouping 10 Gb/s channels to transport larger optical core rates. At the onset of the 100 Gb/s optical standard development, the 40 Gb/s rate "speed bump" was inserted between 10 and 100 Gb/s to accommodate the divergence in the edge and core link rate development timelines. Following IEEE's technology roadmap, the combined 40 Gb/s copper backplane and interconnect twinax standard started soon after the basic optical 40 Gb/s links were finished. With the 40 Gb/s over twinax standard nearly finished, it became time to start the 40 Gb/s over twisted-pair standard.

The primary application for 40GBASE-T is very specific and the market is clearly defined—data center interconnection from servers to edge switches. The first application for 40 Gb/s over twisted-pair will therefore be in server-to-switch links. For 10 Gb/s Ethernet, 10GBASE-T is beginning to replace direct attach copper (DAC) twinax technology for this application. From an equipment interface standpoint, DAC refers to very short interconnections made directly from transmitter to receiver using high-frequency signals over high-precision twinax connectors and cables. From a cabling technology standpoint, DAC refers to any single cable plugged directly from one piece of equipment to another. Therefore, DAC technology does not use intermediate standard structured cabling components (e.g. patch cords, patch panels or horizontal and backbone cables).

A short 10GBASE-T link consisting of two transceivers (i.e., integrated circuits [ICs]), two category 6A jacks and a category 6A patch cord can replace a DAC twinax SFP+ link. It is just a matter of time before the cost of the 10GBASE-T transceivers drops below the high-precision SFP+ DAC connectors and cables. Moreover, 10GBASE-T will likely use less power and motherboard real estate for further savings. The RJ45 connectors also offer the same density as SFP+ connectors. In fact, the RJ45 profile was the density benchmark for the SFP+ design. 40GBASE-T essentially extends the RJ45 capacity to the equivalence of the QSFP+ connector specified for 40 Gb/s over twinax.

10GBASE-T and 40GBASE-T do not necessarily predict the end for traditional DAC twinax solutions. A follow-on optical 100 Gb/s project is underway in IEEE. This future backplane and interconnect standard will consist of aggregated 25 Gb/s links, which is the next challenge for twinax.

A third definition for DAC refers to using a twinax cable plugged between two optical transceiver ports instead of an extremely short optical fiber link. The signal level needed to drive the optical transceivers is enough to reach about 2 meters (m [7 feet (ft)] over twinax. A few more meters can be gained by using active copper cable assemblies that include built-in ICs for amplification. However, even more distance is gained from using 10GBASE-T twisted-pair transceivers over optical transceivers. We can therefore expect 40GBASE-T to eventually replace extremely short 40G optical fiber links. While the practicality of this application is limited to very short reach, it is effective for a significant portion of the market. However, 40GBASE-T is not a threat to multimode optical fiber—the follow-on optical 100 Gb/s project using the aggregated 25 Gb/s links is also the next big challenge for multimode optical fiber.

What Will the Impact Be on the Industry?

The two main implementations for 40 Gb/s over category 8 will be upgrades to current applications using 10 Gb/s over category 6A, providing a quadruple data rate improvement to current technology. The first implementation will be twisted-pair patch cords that replace DAC twinax in top-of-rack switch-to-server interconnections. The second is twisted-pair structured cabling configured in a minimal implementation to support end-of-row or middle-of-row switch-to-server links. The top-of-rack implementation provides a switch for each cabinet, so the copper server-to-switch interconnects will be limited to inside cabinets or within pods. The end-of-row and middle-of-row implementations use patch panels for each cabinet, so server-to-switch links run between cabinets over horizontal channels using structured cabling. The end-of-row and middle-of-row server-to-switch links will be constructed from two-connector channels reaching up to 30 m (98 ft).

Unlike prior upgrades that provided 10 times more capacity (i.e., 1 Gb/s to 10 Gb/s), 40GBASE-T over category 8 offers four times the capacity over current 10GBASE-T using category 6A. Much of the new technology will take place inside the transceivers to enable them to transmit four times faster. However, think of 40GBASE-T as the technology that enables quadruple density over 10GBASE-T. Many industry professionals, including myself, believe that a major return on investment (ROI) will be realized from the four times improvement in interface density over 10 Gb/s. Even if only part of the potential 400 percent improve-ment in data center real estate is gained, it will make adoption of this technology early and fast.

Using fully compatible RJ45 connector technology with category 8 also means that the change in the connectors will be imperceptible to most in the field. Some of the new cabling technology can also be adopted from current category 7A, which already provides twice the bandwidth of category 6A. It therefore does not appear as if any new installation practices will be introduced with category 8—the new practices introduced with 10GBASE-T will continue to be improved for 40GBASE-T. Given the short reach required for category 8, preterminated cable assemblies and implementations are likely to be deployed first, but field termination is bound to be needed soon thereafter.

Does a Cat Really Have Nine Lives?

A few commercially available category 7A components already offer excellent performance far beyond 2000 MHz. In fact, many presentations have shown good performance data up to 3000 MHz, with a few up to 5000 MHz. Today, mainstream twinax technology runs at 5000 MHz.

The objectives have been agreed and the standards projects surrounding 40GBASE-T are essentially approved. Category 8 connectivity will eventually occupy the prime market segment for Ethernet links over twisted-pair cabling. It is, therefore, reasonable to begin considering what might be needed for a category 9. In fact, the preliminary IEEE study leading to 40GBASE-T considered the outlook to 100GBASE-T to accommodate future needs. It therefore does seem that "cats" may indeed have nine lives.

The current IEEE 802.3 copper project supports 25 Gb/s signaling over one lane (pair), albeit for 1 m (3 ft) backplane and 3 m (10 ft) interconnect links over twinax. However, just as 40GBASE-T grew out of electronic infrastructure standards using 10 Gb/s speeds per lane to support long-haul optical fiber, eventually there will be a demand for somewhat longer reach and lower-cost connectivity emerging from the 25 Gb/s copper technology now in development. ◀

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