DATA CENTER
Frontier Special Report

Cloud and the Data Center: How Digital Modernization is Impacting Physical Modular Infrastructure

With digital modernization in full swing, learn how physical infrastructure, the data center, and the cloud are keeping up with new modular solutionsdelivery, and streamlined operational support.

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Executive Summary

2020 was an eye-opening moment for nearly everyone. Cloud and data center leaders raced to ensure that users had the digital tools they needed to succeed in the technology space. The result? More modernization efforts, reliance on digital infrastructure, colocation deployments, hyperscale, and even cloud architecture.

But unlike digital booms in the past, something feels different today. A recent report from ReportLinker indicates that the global data center market size has witnessed a significant boost since the outbreak of the COVID-19 pandemic across the globe. The demand for data centers has increased because of the reliance on internet-related services aided by nationwide lockdowns imposed by governments worldwide. The COVID-19 pandemic has dramatically increased internet traffic between 25% and 30% during the initial lockdown period (March-April) worldwide, which is 10X times than average growth (~3% per month). Cloud-based services have observed a spike as organizations, including government bodies, require transferring, storing, and securing confidential data and information.

2021 and beyond will be hitting the accelerator as it relates to digital solutions.

Outside of the growth in data center and cloud services, the method by which these are being deployed is truly evolving. A report from Fortune Business Insights tells us that companies' expanding utilization of data centers amid the COVID-19 pandemic further fueled this market's growth.

> "COVID-19 took the wind from the sails of the data center network market during the middle part of 2020, but long-term growth prospects remain relatively bright, driven by continued demand from hyperscalers and other cloud customers and by enterprises modernizing and extending their datacenter networks for hybrid IT and multi-cloud. IDC expects multi-cloud networking to benefit as enterprises, reeling from COVID-19, adopt infrastructure that enables viable business resiliency and continuity."
> *— Brad Casemore, research vice president, IDC's Datacenter Networks*

Furthermore, the rapidly evolving competitiveness in the global market and advanced technologies such as cloud computing and Big Data have made it **simpler and cheaper for enterprises to shift their workload to self-contained data centers.**

Organizations are looking at solutions that will make it easier for them to address the market and improve their speed to deployment. With these design considerations come challenges as well. How do you ensure reliability as well as efficiency during an era of unprecedented digital modernization? How do you ensure that things like latency don't slow down your digital platform? Most of all, how can new, modular designs help data center and cloud providers become more secure, improve standardization, and create a far more scalable ecosystem?

This special report dives into some of the latest trends around:

- Cloud
- Data center solutions
- Digital modernization
- Where physical infrastructure is being impacted

Further, we'll examine real-world modular solutions that help companies reduce their time to deployment while supporting the future of cloud, edge, and emerging data center solutions.

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Introduction

Welcome to the digital era where you are the digital citizen. Our reliance on new forms of communication, interaction, and doing business has evolved over the past decade. However, that evolution hit the accelerator over the past year.

In 2012, we crossed into the zettabyte era. That is, the amount of data in our digital ecosystem for the first time exceeded a zettabyte. Today, that number continues to increase, with estimates pointing to around 175 zettabytes by 2025.

BREAKING THE THRESHOLD INTO THE ZETTABYTE ERA

175 ZETTABYTES

The global datasphere will grow from 33 zettabytes in 2018 to 175 zettabytes by 2025. IoT devices are expected to create over 90 zettabytes of data in 2025.

30%

In 2025 nearly 30% of the world's data will need real-time processing as the role of the edge continues to grow.

Source: IDC & Seagate Data Age 2025

At the heart of all this is your data center. However, there has been a fundamental shift in deploying technology solutions and where digital modernization impacts physical infrastructure. Too often, we look at modernization efforts as server upgrades and new pieces of software.

However, the digital evolution is happening on the data center and cloud infrastructure front.

The New Cloud and Data Center Balance

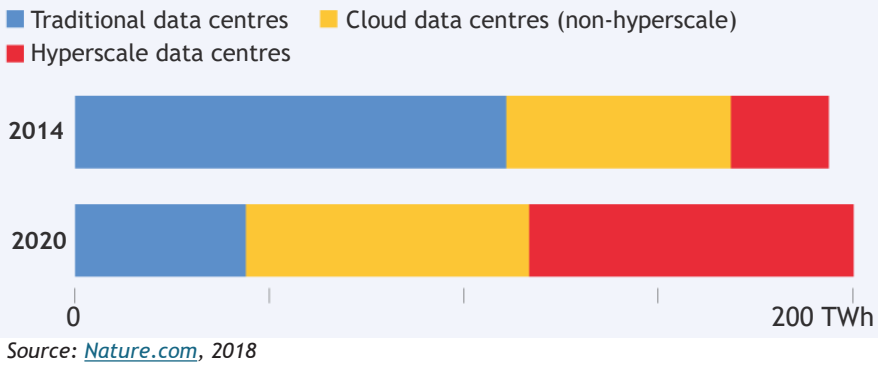
Before we dive in, it's essential to very quickly understand the various types of data center models.

- ***Traditional/Enterprise Data Centers:*** These are your traditional facilities designed to support one customer or client. They're often built at a corporate campus.
- ***Colocation:*** This is a multi-tenant data center provider. These data center models can range in size from just a few thousand square feet to campuses that are well over a million square feet. The largest colocation providers are known as hyperscale data centers.
- ***Cloud (Public):*** This defines sizeable public cloud services like AWS, Azure, and GCP. Public cloud providers will usually have their own data centers, often as large as the hyperscale providers in the colocation space. It's important to note that public cloud providers do not exclusively build their own data centers. They will often partner with colocation and hyperscale colocation providers to extend their services.
- ***Edge:*** This class of data centers is designed to be smaller and often modular in architecture. Their purpose is to help bridge the connectivity gap, reduce latency, and facilitate the faster delivery of applications, data, and services closer to businesses, cities, users, and physical devices like cars, phones, and other IoT devices.

With this in mind, there has been a shift in how traditional data centers and hyperscale providers have impacted the industry. In a recent article from Nature, we learned that in a 2016 report, the Lawrence Berkeley National Laboratory estimated that if 80% of servers in small US data centers were moved over to hyperscale facilities, this would result in a 25% drop in energy use. If you look at the data center and hyperscale market today, you'd see that this is very much already underway. Per the graph below, you'll see that traditional data centers are going away. They're being replaced with more efficient, larger, and often modular hyperscale data centers.

HYPERSCALE SHIFT

Efficient 'hyperscale' data centres are predicted to swallow up half of data-centre electricity demand by 2020, as smaller, less-efficient centres shut down.



Source: Nature.com, 2018

Today, **the world has around 600 hyperscale** data centers, many of them mopping up services for small corporations or universities that would have previously had their servers. And, there are **approximately 6,600+ colocation and wholesale data center facilities** across North America, EMEA, Asia-Pacific, and Latin America.

Here's another final point, there have been proven trends in repatriating workloads from cloud computing back to the data center. For the past two years, the AFCOM State of the Data Center report indicated a significant trend in how organizations view cloud solutions. Definitions are blurred as the cloud takes on a broader meaning where it's not just public cloud solutions.

Per the latest report, *nearly 60% report noticing a trend for organizations to move away from the public cloud and looking to colocation or private data centers*. Last year, the majority of respondents also indicated this cloud repatriation trend.

With this in mind, it's important to note that it is certainly not the end of cloud computing. Cloud computing isn't going anywhere. *So, what's changed? And how are data centers creating a better cost equation?*

Our understanding of cloud workloads, where specific resources should live, and how we can plan for the future are vital considerations. The fun part is that we see a better balance between the cloud and the data center.

The other key point is **how** we're deploying these cloud and data center solutions. With digital modernization impacting digital infrastructure, it's essential to explore how our physical components are affected. This means looking more closely at modular infrastructure, ensuring we leverage resources properly while improving ROI and a company's speed-to-market.

In this paper, we'll explore:

- How modular solutions are driven by digital modernization
- How new solutions are impacting speed-to-market and standardization
- Where modular and new data center solutions will influence edge, cloud, and data centers
- Replacing manual and legacy infrastructure components with emerging digital solutions
- The 'Race to ROI' and where modular makes a difference
- Cloud, data centers, and modernization efforts— how to find the right balance.
- "Pay-as-you-grow" design considerations to create sustainable, profitable growth for hyperscale, cloud, and colocation providers

Finally, this paper will look at real-world use-cases around modular and scalable data center design and ask the right questions to support modernization efforts, digital infrastructure, and new physical design considerations.

Section 1
How Digital Transformation is Impacting Physical Infrastructure

The design landscape of the traditional data center has genuinely shifted. Data centers' architectural, mechanical and electrical schematics have typically been an open book looking at previous designs. Data center engineers were tasked with designing environments that could support business needs both now and in the future. There was a genuine drive to anticipate what requirements would be for the next 10 to 15 years.

Fast forward to those 10-15 years later, and we have a data center environment that is forced to work with cloud computing, big data, and vast user distribution.

As the world moves through the COVID-19 pandemic, organizations across industries are accelerating their digital transformations and looking toward technology to help them adapt to a new normal where disruption could be around every corner.

Modular construction methods have been evolving in data center projects for some time, but the impact of COVID-19 will undoubtedly put this at the forefront.

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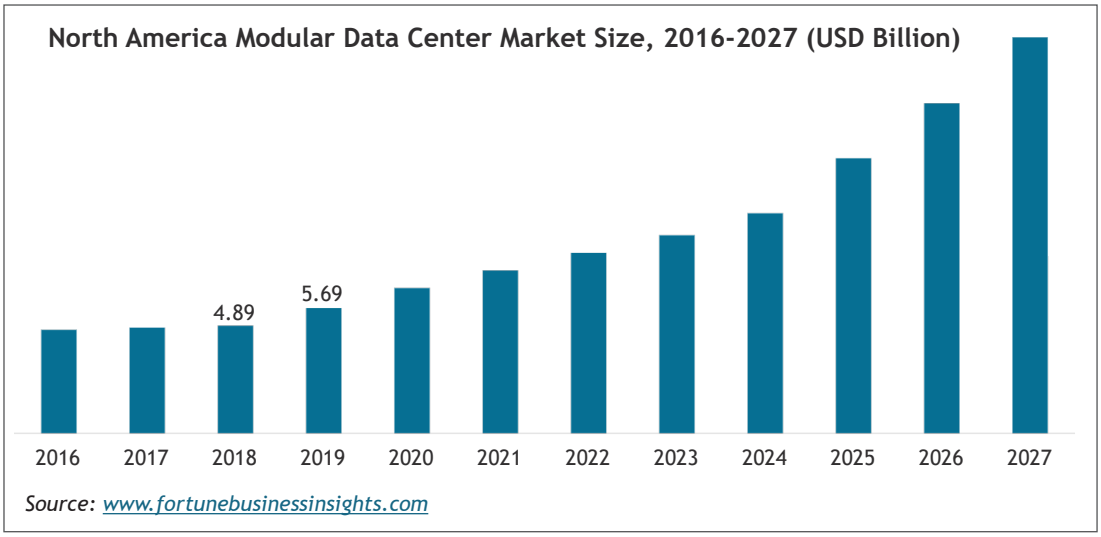

A recent report from Fortune Business Insights indicates that the global modular data center market size was $16.56 billion in 2019 and is projected to reach $65.55 billion by 2027.

Apart from cost savings, modular constructions benefit from reducing the number of people required onsite during the construction phase. Due to the COVID-19 pandemic, there is a fresh surge in the already brisk demand for online services, and more capacity is needed. Consider this from a recent Allied Market Research report:

The spread of COVID-19 has considerably augmented the data traffic. In addition, the surge in storage volume requirement is due to the pandemic driven by the proliferation of emerging technologies such as artificial intelligence (AI), big data, and the Internet of things (IoT). This will continue to drive modular data center investments across the globe.

This shift into a more modular design is a direct result of digital modernization efforts impacting physical infrastructure.

When looking at emerging solutions like edge, cloud computing, and new designs around colocation and hyperscale ecosystems, the modular approach to data centers addresses many of the same concerns and offers similar benefits. A modular data center also factors into both sides of the traditional build versus buy equation. When deciding to build, the modular data center approach and products have tremendous benefits for making the ownership of a data center very attractive. Many providers offer a modular data center approach for their customers, taking advantage of modular while not committing the capital.

A modular solution takes the best ideas for design, reliability, and efficiency and packages everything into a prefabricated, repeatable, and operationally optimized module. This translates to a truly agile data center environment that is capable of scale. As the organization adopts more cloud-based distributed technologies, a modular architecture can immediately support additional workload and business demands.

Beyond the cloud, modular solutions are also impacting future designs around 5G, edge, IoT, and emerging cloud solutions.

How Cloud, Edge, and Connectivity are Impacting Modular Solutions

A lot is changing in how leaders are deploying digital infrastructure. They need to find ways to deliver critical pieces of infrastructure faster and more efficiently. It's a big reason why designs around modular solutions are so popular. A recent report from Business Wire indicates even further growth around modular solutions in how they impact emerging technologies like cloud, edge, 5G, and more. Consider these findings:

- To optimize their networks and the digital services running on them, the telecom providers will need more compute and storage capacity to be deployed across carrier networks. Additionally, the increasing 4G penetration and the upcoming 5G wave further motivate telecom vendors to invest in the modular data center market for more network functionality and a much higher ability to manage networks around the edges due to increased data traffic.

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- As carriers can be benefitted in terms of network service optimization, edge computing has become almost a common practice in the telecom industry. Telecom operators are estimated to deploy micro modular data centers and 5G cell towers to provide enterprises with better network connectivity across industries.

Let's dive a little deeper into the world of 5G, edge computing, and today's user and workload distribution level.

A recent report from Nokia indicated that over three-quarters (77%) of respondents found the use case of connected equipment and cloud-connected robotics appealing, as they are vital enablers of Industry 4.0.

Distributing Computing: Edge, 5G, IoT, and More

As the potential next iteration of connectivity, 5G solutions have been marketed and talked about quite a lot. But is this just a marketing fad? Will these technologies hit the mainstream? The short answer is yes. Beyond 4G LTE solutions, evolution is needed to connect and share rich content and critical workloads. So, since the first 5G network went live in April 2019, there have been quite a few advancements and updates already.

According to Ericsson, towards the end of 2020, 5G numbers were already pouring in:

- 92 commercial networks in 38 countries
- 150 million 5G subscribers in China
- 320 million 5G subscribers forecasted in the US by the end of 2025
- 8 million 5G subscribers in South Korea—with close to 30 percent of the country's mobile 5G data traffic in July 2020 being generated by only 11.3 percent of subscribers
- Six times higher 5G data usage compared to 4G subscribers in South Korea

According to Gartner, 5G was one of the main drivers for mobility in 2020, with the market for 5G infrastructure hitting more than $4 billion, with two-thirds of companies deploying 5G in 2020.

As far as real-world adoption, there have already been some pretty unique use-cases. 5G is poised to change how we game, work, and enjoy life outside of new and emerging edge solutions. For example, innovative startups find ways to leverage 5G connectivity and create diverse new use cases. This includes immersive Multiview eSports streaming to the world's first 5G VR headset.

Here's another vital point: A recent report from Nokia indicated that over three-quarters (77%) of respondents found the use case of connected equipment and cloud-connected robotics appealing, as they are vital enablers of Industry 4.0.

Responding companies noted that leveraging 5G alongside connected IIOT allows them to "readily visualize the benefits of 5G for real-time monitoring and remote control of machines they can't currently control remotely."

All of these new trends bring to light emerging considerations around the cloud and data center balance. They also bring up new latency challenges and ensure that workloads are delivered as efficiently and resiliently as possible. This is where we get to our next point: working with partners who see this evolution and balance level.

The Edge Predictions

According to Gartner, around 10% of enterprise-generated data is created and processed outside a traditional centralized data center or cloud. By 2025, Gartner predicts this figure will reach 50%. This means that services around the edge will continue to evolve and grow. This is also why you need to work with a partner to help you address common issues like consistency between deployments, reliability, remote installation, connectivity, monitoring and management, and security. Furthermore, the edge will require a broader focus on connectivity, telecommunications, and modular design to ensure the best possible experience.

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Keeping Pace with Modular Solutions

To keep pace with this level of adoption, leaders are turning to new designs to help them stay ahead in a digital market. Mainly, they are trying to improve their speed-to-deployment to ensure they have the resources needed to keep the business ahead. The Business Wire report points out that modular data centers are at least 60% faster to deploy and provide 13% or more cost savings than traditional data center power and cooling infrastructure. Hence, modular is also helping in overcoming the rising energy crises due to growing data and data center infrastructure. This is important because North America accounts for a significant market share of data centers and is expanding its capacity with more than 411 MW, which is currently under construction or near completion.

Before we go too much further, let's explore the new concepts around modular and why so many are leveraging this design.

What is Modular?

For the longest time, the concept of a modular data center solution has eluded definition, if not comprehension. A description and categorization of solutions have emerged through the short history of modular solutions and vendor marketing.

A dictionary definition hints at the data center adaptation of modular:

A self-contained, fast-scaling unit or item that can be combined or interchanged with others to create different shapes or designs.

A modular data center can be defined as more of an approach to data center design that incorporates contained units, many times in the form of prefabricated modules. The modular market started with an international standard approach in the shape of an ISO (International Standards Organization) shipping container and has evolved into a market of vendors that produce everything from containers to various modular designed products and solutions for IT, power, and cooling.

In some ways, the shift in IT, such as cloud computing and edge, has been in parallel with modular data center approaches. Modular elements for both IT and the data center exist in:

Modular Deployment

- For IT this exists in PaaS (Platform as a Service) and IaaS (Infrastructure as a Service)—combined with virtualization they package IT into deployable units and present what were disparate parts into a module. The only infrastructure that is deployed is what is needed.
- In the data center it is capacity management that benefits by having the ability to deploy a module of IT, power or cooling as a single unit of measure, instead of a large brick and mortar project.

Modular Consumption

- For IT this exists in SaaS (Software as a Service), consuming the service only as needed.
- In the data center it is not having facility infrastructure that was over-provisioned and not needed. Data center capacity can be measured and consumed by power instead of space.
- Using modular systems, replicatable and standardized topologies and scalable digital technologies, colocation providers can expand in smaller blocks, repeating the process many times as demand continues to grow.

Modular Finance

- For IT this is all of the 'as a service' approaches, paying only for what is used, instead of large, complex and expensive licensing agreements. In a pay-as-you-grow model, you leverage a strategic growth path which requires less upfront cost and can generate faster revenues.
- In the data center it is the ability to match capital expenditures with IT forecasts and requirements.

Modular Planning

- Installing vast data centers from the ground up or adding large scale extensions to existing locations requires considerable upfront costs.
- Often, the space built is not leased straight away and this building for tomorrow' mentality can result in delayed revenues and ongoing running and maintenance costs for empty server rooms.
- Modular solutions ensure you have what you need right now, while still planning for the future.

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Now that we understand what modular represents, it's essential to look at the journey modular solutions have taken to get to this point.

Understanding the Modular Evolution

Although modular solutions haven't been around for a long time, they have gone through some iterative advancements. Let's look at the first and now second generations of modular designs.

Modular: Gen 1

The current definition of a modular data center evolved from that brief history of iterations that fall under the category of what consists of a modular solution. The idea of a modular data center is an aggregate term for the many facets that make up modular components and solutions. Some of the earliest mentions of modular solutions focused on mobility and the container.

The container data center used the foundation of an ISO standard for a shipping container and customized it to accommodate data center infrastructure. Around 2002 Google began experimenting with a container full of IT parked in an underground parking garage. Google even planned offshore barges with IT containers to use the ocean to provide power and cooling for their "water-based data center."

APC took an early approach to modularize the data center in 2004 with the InfraStruXure Express—an on-demand, mobile data center truck with integrated power, cooling, and racks. It was primarily used for disaster recovery and temporary or transitional IT projects.

In January 2007, Sun Microsystems introduced the Blackbox data center container solution and truly kick-started the notion of a modular data center. Google and Microsoft have continued to innovate their solutions into a modular data center design. In 2008 Microsoft announced that their new Chicago data center would house up to 220 shipping containers.

This is where we pause for a second. It's important to note that containers are not the same as modular solutions.

Container vs. Modular

The primary confusion in terms stems from container versus modular. A data center container is a particular package that is engineered and delivered in an ISO shipping container. A container is not the same as a modular system, but a container can be a part of a modular data center. A modular data center references a deployment method and engineered solution for assembling a data center out of modular components in, many times, prefabricated solutions that enable scalability and a rapid delivery schedule.

Theories evolved after the early development of containers, and the hype cycle played out for a data center in a box. Numerous hardware vendors, independent companies, and data center providers embraced the modular concept and presented their engineered solutions.

Container:

A data center product incorporating customized infrastructure to support power or cooling infrastructure, or racks of IT equipment. Containers are built using an ISO (International Standards Organization) intermodal shipping container.

Modular:

An approach to data center design that implies either a prefabricated data center module or a depolyment method for delivering data center infrastructure in a modular, quick and flexible method.

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Modular: Gen 2

While there are modular solutions in ISO shipping containers, the second generation of modular solutions thought outside the box (literally). These solutions kept the attributes and advantages of modularity but did not conform to just a container. A primary difference between generations was how cooling, power, and density were supplied. First-generation containers were simply a container full of IT and relied on additional infrastructure to operate. Second-generation modular solutions had integrated solutions like cooling and power and came as a complete data center solution.

Many of these solutions used advanced cooling technology, implementing evaporative cooling and efficiently using outside air.

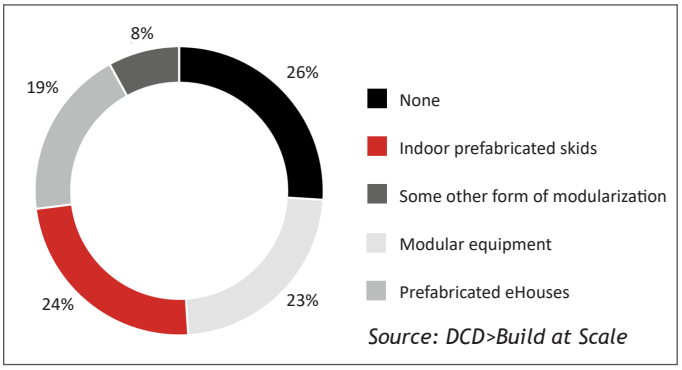
The second generation of modular solutions also coincides with the idea of IT 2.0. This is a true expansion of the information technology area to include more WAN technologies, edge computing, IoT, more significant amounts of user density, and more data utilization. In creating a modular design, organizations are seeking not only to create a sound data center solution—they're looking to stay agile. Prefabricated solutions designed to help off-set big workloads can help organizations move more quickly into 2.0 technologies. This includes better handling of big data, cloud computing, and a distributed global environment.

Shifting the Paradigm: All Things Modular

The idea of a modular IT solution quickly spread to the supporting infrastructure for a data center. Product manufacturers for power and cooling equipment began making modular solutions to complement modular IT deployments and act as a quick, easy and standardized way to deliver their product for traditional data centers.

UPS, flywheels, generators, and chillers—all turnkey and containerized. A modular approach to supplying power and cooling presents many of the same benefits of a modularized IT solution. While not required to be in any particular form factor, many are delivered in a containerized solution.

Consider this, a recent taken during the DCD Building at Scale conference also showed that 74 percent of data center professionals are already dealing with some type of modularization:



With all of this in mind, it's time to shift the focus and examine some new designs considerations when looking at modular solutions.

Section 2
From Modernization to Modular: New Design Considerations

The key to sustainable and profitable growth for colocation providers is to open and lease each phase of the data center as quickly as possible to start leveraging their investment and generating revenue.

For that reason, many colocation providers are building their data centers in smaller blocks to open one section while they begin building the next. This limits the upfront investment and the time before revenue generation begins. It also allows providers to secure tenants earlier, which is essential in competitive, fast-paced environments.

On that note, it's not always easy to keep pace with a digital market. Two of the biggest reasons typically listed for the problem with data centers are capital and speed of deployment. The traditional brick-and-mortar data center takes a lot of money and time to build. Furthermore, the quick evolution of supporting technologies further entices organizations to work with fast and scalable modular designs.

Outside of those two primary drivers, there are many benefits and reasons listed for why a modular data center approach is selected.

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Modular Data Center Key Considerations

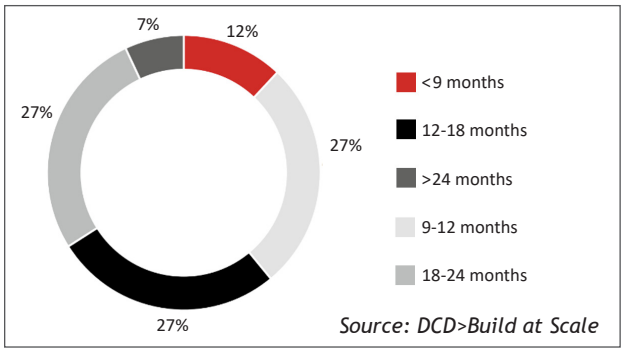
In a world driven by digital solutions, ensuring that you can meet the market's demands has become more complicated. Leaders in the edge, cloud, and data center space have looked to modular designs to ensure that they can meet emerging requirements. Let's examine some of the key benefits and considerations as it relates to a modular architecture.

Key Modular Design Concepts

SPEED OF DEPLOYMENT

Modular solutions have rapid timeframes from order to deployment. As a standardized solution, it is manufactured and ordered, customized, and delivered to the data center site in a matter of months (or less). Having a module manufactured also means that the site construction can progress in parallel instead of a linear, dependent transition. Remember, this isn't a container—rather a customizable solution capable of quickly being deployed within an environment.

In a study conducted during the DCD>Building at Scale conference in June of 2020, 39 percent of professionals working in the data center industry said that projects are being deployed in under a year, and 66 percent in under 18 months. To keep up with this demand, data center designers will have to select more scalable solutions.



Source: DCD>Build at Scale

These lead times are significantly shorter than a decade ago, where data center projects stretched well over two years, a build strategy that simply would not meet the data demand of today's rapidly growing market.

SCALABILITY

To ensure your data center design is modular and scalable, it is essential to select scalable equipment. With a repeatable, standardized design, it is easy to match demand and scale infrastructure quickly. The only limitations on the scale for a modular data center are the supporting infrastructure at the data center site and available land. Another characteristic of scalability is its flexibility by having modules that can be easily replaced when obsolete or if updated technology is needed.

This means organizations can forecast technological changes very few months in advance. So, a cloud data center solution doesn't have to take years to plan out.

AGILITY

Quickly building a data center environment doesn't only revolve around the ability to scale. Being agile with data center platforms means being able to meet the needs of an evolving business quickly. Whether that means providing a new service or reducing downtime—modular data centers are directly designed around business and infrastructure agility. Some organizations build their modular environment for the purposes of capacity planning; others leverage modular data centers for their highly effective disaster recovery operations.

MOBILITY AND PLACEMENT

A modular data center can be delivered wherever desired by the end-user. A container can claim ultimate mobility as an ISO-approved method for international transportation. A modular solution is mobile because it can be transported in pieces and reassembled quickly onsite. Mobility is an attractive feature for those looking at modular for disaster recovery, as it can be deployed to the recovery site and be up and running quickly. As data center providers look to take on new offerings, they will be tasked with staying as agile as possible. This may very well mean adding additional modular data centers to help support growing capacity needs.

DENSITY AND PUE

Density in a traditional data center is typically 100 watts per square foot. The space is used very efficiently in a modular solution and features densities of 20 kilowatts per cabinet or more. The PUE can be determined at commissioning, and because the module is pre-engineered and standardized, the PUE's can be as low as 1.1 – 1.4. The PUE metric has also become an excellent gauge of data center green efficiency. Look for a provider that strives to break the 1.25-1.3 barrier or at least one in the +/- 1.2 range.

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All pre-engineered solutions can be easily duplicated or modified to serve most data centers. These electrical power solutions typically include medium-voltage (MV) switchgear, transformers, low-voltage (LV) switchgear, LV switchboards, UPS systems, power distribution units (PDU), remote power panels (RPP), and IT busways—all of which can be combined into integrated skids or eHouses.

EFFICIENCY

The fact that modules are engineered products means that internal subsystems are tightly integrated, resulting in efficiency gains in power and cooling in the module. First-generation and pure IT modules will likely not have efficiency gains other than those enjoyed from a similar containment solution inside a traditional data center. Having a modular power plant close to the IT servers will save money in costly distribution gear and power loss from being so close. There are opportunities to use energy management platforms within modules, with all subsystems being engineered as a whole.

If a data center is built but not occupied, power losses and inefficiencies from equipment such as uninterruptable power supplies will have a negative impact on the site's energy efficiency.

By building in modules, data centers can secure tenants for each phase before building the next. If a data center is built but not occupied, power losses and inefficiencies from equipment such as uninterruptable power supplies will have a negative impact on the site's energy efficiency. Each modular building block should be around 80 percent capacity to optimize efficiencies. Once a module is approximately 80 percent utilized, planning for the next module can begin.

REDUNDANCY

There are a few redundancy architectures to consider. For example, block redundant topology, also known as catcher topology, utilizes a Static Transfer Switch (STS) to transfer the critical load from the primary or active system to the reserve or catcher system. Both hyperscale and colocation data centers use such a topology.

The reserve system can be larger than the active system. Block redundancy can be applied with single cord or dual corded IT loads. If single corded IT loads are used, the static transfer switch is a single point of failure.

For data centers with single corded loads, this topology is usually the most cost-efficient design. With the block redundant topology, an asset utilization of 80 percent is possible, and there is no need to constantly monitor loads to maintain redundancy. The primary disadvantage of this topology is the reliance on static transfer switches, increasing the design's cost and complexity.

Block redundant topology depends on the catcher or reserve UPS module (or modules) to handle a step load. The active UPS can be loaded to full capacity, and the reserve UPS has no load in normal operation. The reserve system can be larger than the active system. Block redundancy can be applied with single cord or dual corded IT loads. If single corded IT loads are used, the static transfer switch is a single point of failure.

DISASTER RECOVERY AND RELIABILITY

Using reliable and predictable processes delivers many benefits in such a fast-paced build environment. The consistency and standardization of repeatable designs reduce risk, maintain a tight build schedule, and result in reliable prefabricated systems in both performance and maintenance. Once scaled, modular designs are reliable, successfully built, commissioned, and used in previous stages. This build method takes the uncertainty out of a campus expansion plan or the rapid addition of new build centers to an expanding data center campus.

Part of the reason to design a modular data center is for resiliency. Organizations are looking at disaster recovery solutions to remain resilient over the next 12 months as part of their purchasing plans. This means creating a modular design makes sense. Quickly built and deployed, the modular data center can be built as a means for direct disaster recovery. A modular architecture may be the right solution for those organizations that have to keep maximum uptime.

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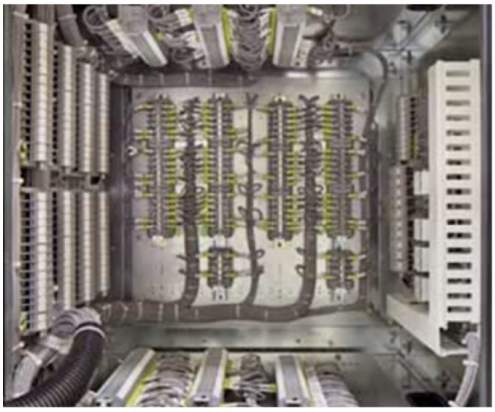
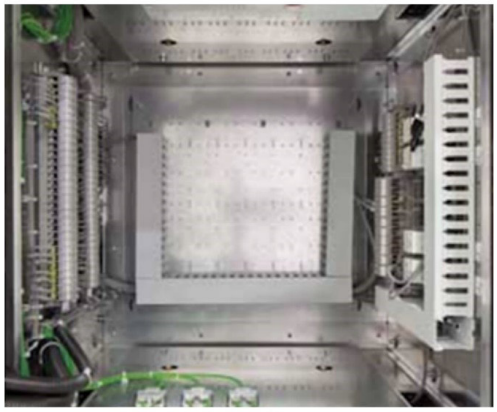
DIGITALIZATION

There are many benefits to adding intelligence to electrical equipment using open protocols (such as IEC 61850), but for scalability, the most crucial advantage is that it reduces wiring, minimizing installation and commissioning time.

IEC 61850 provides a standardized framework for substation integration that specifies communications requirements, functional characteristics, device data structure, naming conventions for the data, and more.



Manual switchgear



Digital switchgear *Source: ABB*

IEC 61850 is now being increasingly used across the smart grid, renewable, and process industry applications. It benefits equipment such as protection relays, circuit breakers, communication gateways, programmable logic controllers (PLCs), and supervisory control and data acquisition (SCADA) architectures. Together, these devices make it possible to design and operate a fully integrated protection and supervision system that spans the voltage ranges required. This comprehensive approach is made possible by exploiting IEC 61850 to create advanced logic selectivity based on device-to-device communication, real-time diagnostics, and integrated engineering.

COMMISSIONING

As an engineered, standardized solution, the data center module can be commissioned where it is built and require fewer steps to be performed once placed at the data center site.

Skid units and electrical house (eHouse) packages enable data centers to address speed to market challenges. Common to traditional construction methods, packaged solutions are typically supplied as individual components with installation and interconnections provided by third parties. Such a solution is an open frame-mounted, compact unit with factory-installed equipment and interconnections. Because they are pre-engineered, prefabricated, and pretested, indoor skid solutions can be built off-site parallel to other construction efforts, accelerating the construction schedule.

The eHouse is a prefabricated, pre-engineered, and pretested system; it is an environmentally controlled building with factory-installed equipment and interconnections. By testing all components before shipping, you ensure that risks in the field are minimized. These units are easy and cost-effective to install and can be placed close to the main loads. Although usually permanently installed, they can be relocated as a colocation center grows or a customer's IT equipment changes.

Skids units and eHouses can both be used to accelerate construction schedules and quickly expand existing capacity. These one-piece systems can be installed with limited impact on existing operations and reduce onsite work limiting the number of people onsite at an operational data center.

REAL ESTATE

Modules allow operators to build out in increments of power instead of space. Many second-generation modular products feature evaporative cooling, taking advantage of outside air. A radical shift in data center design takes away a data center's true brick and mortar, placing modules in an outdoor park, connected by supporting infrastructure and protected only by a perimeter fence. Some modular solutions offer stacking—putting twice the capacity in the same footprint.

Information technology complies with various internal and external standards. Why should the data center be any different? Modular data center deployment makes it possible to quickly deploy standardized modules that allow IT and facilities to finally be on the same page.

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Section 3
Modular Modernization: The Data Center Race to ROI

With the modular market developing in the industry, some tremendous innovation and engineering design efforts have been put into solutions. The modular market is maturing, with even more large enterprises actively deploying the modular data center platform.

To that extent, there is already quite a bit of industry adoption as it relates to modular solutions:

- ***Large Internet companies*** and cloud providers were early adopters because they needed to optimize deployment at utility-scale implementations. They need to scale infrastructure quickly and easily, deploying thousands of servers at a time and optimizing both operations and financial aspects of those deployments.

The speed of deployment and time to market provided by modular systems ensure that these digital infrastructure leaders deliver solutions when customers need them.

- ***Federal agencies*** are facing mandates to improve IT efficiency and offer citizens greater transparency into their operations. The National Defense Authorization Act (NDAA) was signed into law with a section on data centers, the IT industry, and cloud-hosting providers (Section 2867). The NDAA states that moving forward, a modular approach must be included when deploying new data centers.
- ***The enterprise*** has come on board as the modular industry graduated out of its early phases and matured a product into a more attractive option. Large enterprises have millions of square feet of data center space to manage and tremendous utility bills to match.
- ***The finance industry*** has been seen as an early adopter of the modular approach. Financial firms typically have single-tenant facilities with vast quantities of square feet of traditional data center space across their portfolio. The opportunity exists to standardize components of the data center, move that unit of measure from the rack to a module, and take advantage of the power and cooling efficiencies available in modular solutions.
- ***Cloud, edge, data center, and hyperscale leaders*** are also getting into the modular mix. With massive growth around digital requirements, leaders in infrastructure have struggled to ensure they deliver enough capacity to their market. The speed of deployment and time to market provided by modular systems ensure that these digital infrastructure leaders deliver solutions when customers need them. Further, they won't be wasting money or resources by over-building. A modular design ensures that the right resources are available and more can be added in a repeatable manner.

With all of this in mind, there are still some hesitations related to modular adoption. These 'modular myths' date back to the first generation of modular deployments. Let's examine some of these myths and where today's modular modernization and the race to data center ROI impact digital infrastructure.

Breaking Down Modular Myths and Improving Data Center ROI

Modular Myth #1: Modular solutions are too expensive.

MODULAR FACT

- ***Deferred Capital Cost:*** As a significant capital expense, building a data center is typically a large project that requires a lot of money upfront to anticipate forecasted IT needs for the next 10 to 15 years. Rapidly changing technology in the data center makes it difficult to justify such a considerable capital expense for a building that will hopefully keep pace with technology demands.

  Modular solutions can be seen as intelligently applying capital to the data center in line with changing technology and IT requirements. Instead of a $50 million project on day one, ten $5 million modules can be built as they are needed. It enables the ability to add capacity to the data center incrementally.

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- ***Operating Expense:*** The engineering in modular solutions has proven known efficiency throughout subsystems, allowing regular operational expenses to be optimized. Optimized power and cooling built-in to modules equate to a lower overall operating cost.
- ***Reduced Strain on Resource:*** Building for today's requirement using modular build methods allows colocation providers to only invest an amount that will deliver a fast return via rapid uptake of server space and a timely generation of revenue. By breaking down the upfront investment into smaller chunks, revenues can be generated on each investment before the next modular expansion begins. This allows data centers to be more flexible in their response to market changes. Furthermore, installing a modular building block is faster and more efficient onsite, requiring fewer resources. In turn, this translates into lower risk and further time and cost savings
- ***Modular Solutions are Classified Differently:*** Did you know that modular designs are considered equipment and not buildings? It's important to consider how, potentially, this can impact your finances and how depreciation happens against equipment. Because modular architectures are considered equipment and not buildings, you could substantially positively impact ROI.

Modular Myth #2: Operations become more complicated.

MODULAR FACT

- ***Standardization:*** Seen as a part of the industrialization of data centers, the modular solution is a standardized approach to build a data center. Manufactured data center modules are constructed against a set model of components at a different location instead of the data center site. Standardized infrastructure within the modules enables standard operating procedures to be used universally. Since the module is prefabricated, the operational procedures are identical and can be packaged together with the modular solution to provide standardized documentation for subsystems within the module.

  Here's another critical point: you don't have to worry about a lack of sub-contractors and trade professionals. Due to the nature of the design and standardized module architecture, you can have your equipment and facility up and running with minimal requirements for contractor support. The reason for this is that your equipment comes delivered as factory-built units. These modular units are pre-assembled, tested in a controlled factory environment, and delivered directly to the construction site. These efforts minimize the need for additional onsite construction and additional personnel.
- ***DCIM (Data Center Infrastructure Management) and Beyond:*** The module and components management within a modular approach can leverage the engineering and integration built into the product. Many, if not all of the modular products on the market will have DCIM or management software included that gives the operator visibility into every aspect of the module's IT equipment, infrastructure, environmental conditions, and security. The other important factor is that distributed modular data centers will now also be easier to manage. With DCIM solutions now capable of spanning the cloud—data center administrators can have direct visibility into multiple modular data center environments. This also brings up the question of what's next in data center management.

  As the modular data center market matures and new technologies are introduced, data center administrators will need a new way to manage their infrastructure. There will be an immediate need to transform complex data center operations into simplified plug & play delivery models. This means lights-out automation, rapid infrastructure assembly, and even further simplified management. The next iteration of DCIM aims to work more closely with modular ecosystems to remove the many challenges which face administrators when it comes to creating a road map and building around efficiencies. In working with the future of DCIM, expect the following:

  ✓ An integrated end-to-end automated solution to help control a distributed modular data center design.

  ✓ Granular centralized management of a localized or distributed data center infrastructure.

  ✓ Real-time—proactive—environment monitoring, analysis, and data center optimization.

  ✓ DCIM that can be delivered as a self-service automation solution or provided as a managed service.

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Modular Myth #3: Business and market alignment becomes more challenging with a new data center solution.

MODULAR FACT

- ***Rightsizing:*** Modular design ultimately enables an optimized delivery approach for matching IT needs. This ability to right-size infrastructure as IT needs grow enables enterprise alignment with IT and data center strategies. The module or container can also provide capacity when quickly required for projects or temporary capacity adjustments. Why is this important? Resources are expensive. Modular data centers can help right-size solutions so that resources are optimally utilized. Over or under-provisioning of data center resources can be extremely pricey—and difficult to correct.
- ***Supply Chain:*** Many of the attributes of a modular approach speak to implementing a supply chain process at the data center level. To optimize deployment, the IT manager directs vendors and controls costs throughout the supply chain.

  Another critical consideration is working with a modular partner that can support a healthy supply chain. When working with modular designs, make sure you have a partner that can think locally and deliver globally.

When working with modular designs, make sure you have a partner that can think locally and deliver globally.

- ***Total Cost of Ownership***
  - *Acquisition:* Underutilized infrastructure due to over-building a data center facility is eliminated by efficient use of modules deployed as needed.
  - *Installation:* Weeks and months instead of more than 12-36 months to stand up a traditional data center.
  - *Operations:* Standardized components to support and modules are engineered for extreme efficiency.
  - *Maintenance:* Standardized components enable universal maintenance programs.

Much like anything in the technology market, solutions continue to change and evolve. Many of the legacy perspectives on modular solutions revolve around an older generation of modular design. Today, modular data centers are more efficient, denser, and a lot easier to deploy. Let's examine some solution architectures for scalable, modular data center designs.

Section 4
Solution Architectures for Scalable Modular Data Center Design

To ensure your data center design is modular and scalable, it is essential to select scalable equipment. Switchgear, uninterruptible power supplies (UPS), power distribution units (PDU), and remote power panels (RPP) are all examples of scalable equipment. Get this right and specifying future expansions will be time and cost-efficient.

With this in mind, let's look at some emerging Gen 2 Modular Design considerations.

- ***MV GIS Switchgear:*** Selecting medium voltage Gas Insulated Switchgear (GIS) that can be scaled up without emptying the gas from the system makes scaling quicker and easier without disrupting service. Market-leading flexible switchgear designs can include a three-phase encapsulated, arc-resistant switchgear for single and double busbar applications with separate gas-filled busbar and circuit breaker compartments. Specifying equipment with plug-in technology enables safe, fast, and easy installation without the need for special tools.
- ***UPS that's built for flexibility:*** The UPS plays a vital role in ensuring clean and continuous power for the critical infrastructure. A modular UPS based on a decentralized parallel architecture (DPA) allows data center designers to scale the power on demand and lower upfront investment. Using the DPA design, every power module has its own fully independent entity, control, and required hardware for autonomous operation. A single point of failure is removed with DPA architecture, providing continuous uptime even during maintenance or system expansion.

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- ***Power distribution units (PDU) and remote power panels (RPP):*** Power distribution units (PDUs) and remote power panels (RPPs) help meet the demands of power-intensive applications, delivering unsurpassed power monitoring and distribution in a safe, reliable, space-saving footprint. PDUs/RRPs can be configured as needed, and they are scalable regarding the number of outputs and required output power, ensuring continuous power to critical applications. Furthermore, market-leading systems of this nature can help panel builders dramatically reduce the cost of certification and facilitate easy post-installation alterations, such as the ability to change or extend the number of connected servers.

The Digitalization of Modular Infrastructure

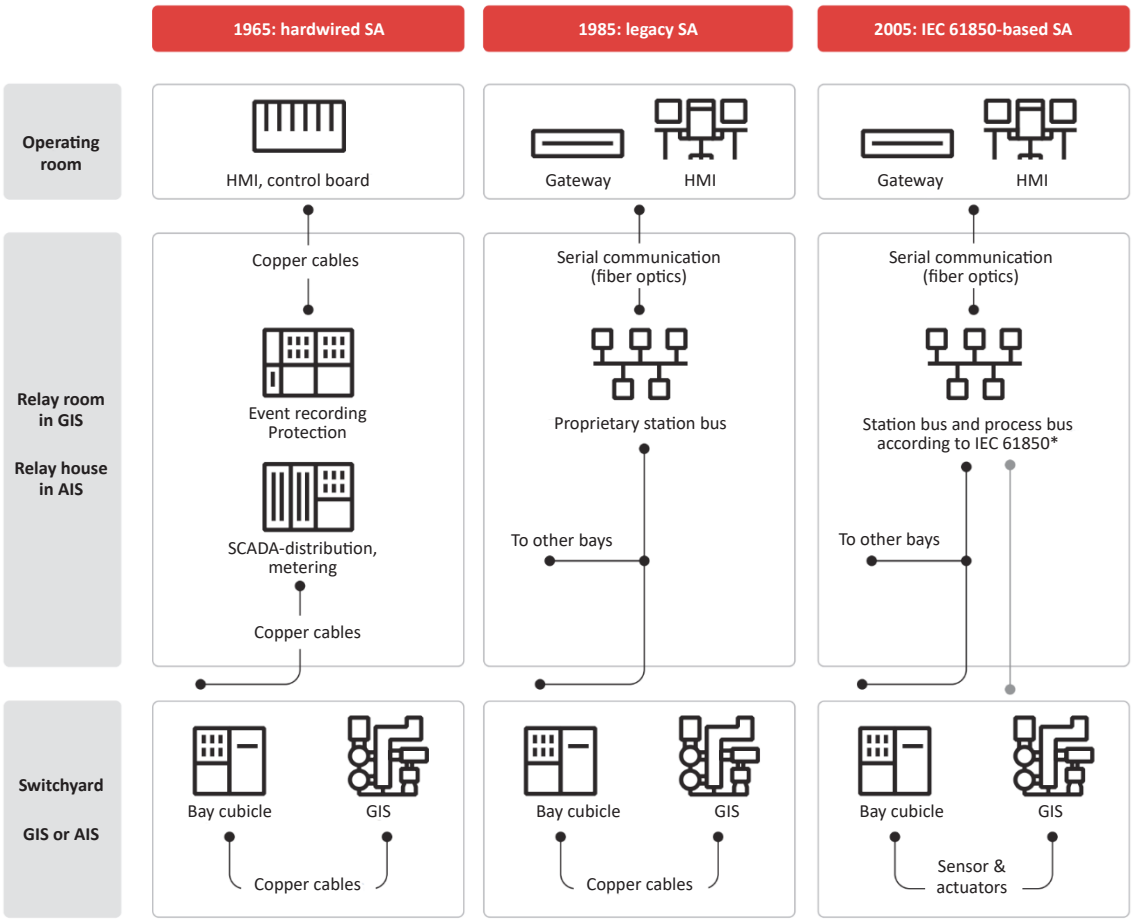
Digitalization within the modular industry is a significant design consideration for Gen 2 modular designs. Systems of this nature are much more scalable because changes to the configuration can be done remotely using software, as opposed to changing out hardware or reassembling wiring

IEC 61850 simplifies data center power infrastructure and automation

IEC 61850 is a well-established communications standard for substation automation. The high reliability, integrated diagnostics, fine selectivity, shorter fault reaction times, and better fault tolerance delivered by IEC 61850 make it ideal for data center power infrastructure.

IEC 61850 AND MODULAR DATA CENTERS

The world is experiencing a data explosion. Not only is the quantity of data increasing at a dizzying rate, but the extent to which society relies on that data is also growing by the day. These trends elevate the data center to the status of critical infrastructure in many countries. If a data center fails, chaos ensues, which makes a reliable power supply indispensable. Generally, data centers have well-thought-out power backup provisions—such as uninterruptible power supplies (UPSs), diesel generators, etc. By employing IEC 61850-enabled devices and IEC 61850-based GOOSE (generic object-oriented substation event) communication to automate the data center power infrastructure, significant improvements can be made: better power supply reliability, greater operational control, and reduced cost, for example.



* The process bus is not a must in IEC 61850 but only an option

Source: ABB


Source: ABB

GEN 2 MODULAR CONCEPTS AND AUTOMATION

Working with the next iteration of modular data center design means eliminating wasteful processes and operations. In many cases, this means adopting new solutions around infrastructure automation.

IEC 61850 is eminently suited to data center power infrastructure automation. Using just one protocol can form the bedrock of a complete electrical design concept that includes the full protection, control and supervision system, and cybersecurity. By using optical fiber instead of copper wire, wiring costs are lowered, space requirements are substantially reduced, and safety is increased. IEC 61850 also delivers the capability to monitor and control IEDs remotely. The convenience is that devices supplied by different manufacturers can communicate with each other without custom-designed gateways or other engineering-intensive complications.

Taking a broader perspective, the IEC 61850 standard allows digitalization of the data center power system in a way that opens it to collaboration with other digital entities in the data center, such as a building management system (BMS), power management system (PMS), data center infrastructure management (DCIM) or ABB Ability™ Data Center Automation.

These are all essential parts of the final goal: the "single plane of glass" that orchestrates the entire data center. Decathlon for Data Centers, for instance, gives power and cooling visibility, and IEC 61850's open protocols allow integration of existing equipment and systems. With IEC 61850 peer-to-peer communication capabilities in components like ABB's Relion relays and Emax circuit breakers, one can go from the DCIM system controlling or supervising software to having real-time interaction with the subsystem (such as a UPS breaker) itself.

The IEC 61850 architecture is the ideal standard for data centers, as it delivers increased reliability, finer selectivity, shorter fault reaction times, and the possibility to implement fault tolerance and integrated diagnostics, as well as a host of other advantages.

The Modular Journey: Getting Started

Data center owners and operators need to design data centers capable of responding to the needs of today's data demand and the data requirements mid to long-term. The potential for future expansion should be at the forefront of design, selecting technologies, and constructing new centers.

Adding standardization and modularity to planning, together with digitalization strategies, will ensure future-proof data centers are designed to meet global expansion standards in a cost and time-efficient way.

Ultimately, it is about using clever design and technology to ensure scalability and speed of build without compromising on future performance. On that note, let's explore some real-world use cases around Gen 2 modular solutions and how today's partners are impacting a digital ecosystem focusing on improved modular designs.

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Section 5
The Partners That Modernize Cloud and Data Center Solutions

Let's start here: Using prefabricated and modular construction techniques in data center design and the use of skids and eHouses allows a pay-as-you-grow approach to expansion that is faster, energy-efficient, and more cost-effective, with minimal disruption to the operation.

Furthermore, scaling in line with demand keeps the upfront cost low, and revenues are generated faster. This directly helps with the data center race to ROI as digital infrastructure deployment is simplified and accelerated.

The best way to understand the impacts of emerging modular data center solutions is to see them in action. Let's examine some modern modular designs and use cases.

Case Study

Solution Architectures for Scalable Data Center Design

The challenge

USA-based GIGA data centers had acquired a long, rectangular building in North Carolina suitable for conversion into a data center. Working with ABB, the brief was to create a critical power distribution design that was fully scalable to allow for further pay-as-you-grow expansions. The design needed to be scalable so that GIGA could offer flexible and modular data center technology at a competitive cost to all its customers

The solution

GIGA selected ABB as its design partner based on the expertise of its team in providing flexible, innovative technical electrification solutions within a challenging time frame. Together, GIGA and ABB worked to design a system that would support 60 MW of IT load. Amazingly, the first phase of the data center conversion was completed in less than six months. Subsequently, ABB collaborated with GIGA's mechanical, electrical, and plumbing consultants to design a flexible, scalable, and efficient packaged solution based on a system plus system topology. This design is scalable and has the capability of expanding in increments of 2 MW of IT load.

The result

ABB's electrification solution for GIGA Data Centers included TLE UPS modules (to support the IT server load) and a decentralized parallel architecture (DPA) UPS for the site server load. In addition to uninterruptable power supplies, the solution included UPS maintenance bypass cabinets, lithium-ion battery systems, lighting panel boards, and dry-type transformers. The DPA UPS was chosen for its effectiveness for lower power requirements and scalability.

ABB's packaged solution included all project management and field services from the startup and commissioning of all equipment to the commissioning of all systems. ABB's successful end-to-end solution is a compact and efficient data center that delivers the power distribution and protection performance GIGA needs today with the potential to expand in the future.

Diving a bit deeper into modular infrastructure use cases, we see how specific pieces of equipment help with repeatable designs and emerging modular architecture. Consider the following case study.

Case Study

The Importance of Scalable Equipment for Modular Infrastructure

The challenge

Scalability across all equipment specifications is critical in implementing a pay-as-you-grow data center design strategy. Suppose some of the equipment selected is not scalable. In that case, it can cause considerable cost and time delays in future expansions, as US Colocation Data Center, Volico discovered: Volico, like many progressive colocation providers, had a pay-as-you-grow strategy in place, but the UPS specified in the initial design was not scalable, and this posed a significant expansion roadblock. Even though all other equipment was scalable, this one specification error had put a stop to Volico's pay-as-you-grow plans.

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The solution

Needing a scalable and flexible UPS, Volico opted to replace its current UPS equipment with ABB's modular DPA UPS system, comprising two frames of 10 module sets delivering 1MW of power. The Conceptpower DPA 500 can scale vertically, up to 500 kW in a single frame, and horizontally by adding up to six parallel frames, to a total of 3 MW of power.

The result

This replacement UPS allows full system scalability, allowing designers to add more power every time Volico expands simply by inserting another module. The system is based on unique slide-in UPS module sets, each rated at 100 kW. Modules can be inserted or removed from the frame while the system is running securely in double conversion. Using online-swap modularity, combined with the system's full redundancy, helps data centers achieve six-nines availability (99.9999 percent). The DPA 500 provides total reliability with more than 96 percent energy efficiency, reducing the total cost of ownership compared to other UPS systems

The Technology: ABB modular DPA UPS

ABB offers a best-in-class modular UPS with an efficiency rating of 96 percent, a compact footprint, and low TCO. There is a range of options for scaling the ABB modular DPA UPS. These include the 250 S4, which is ideal for mid-size data centers with a single power capacity of 300kW based on power modules of 50kW. In addition, the new MegaFlex DPA offers a power capacity of up to 1500kW based on power modules of 250kW. For Volico, this modular design perfectly resolved the short-term need to replace a system that was a barrier to expansion while giving scope for future growth.

Getting Started on the Modular Journey: Asking the Right Questions

Modular solutions can benefit a variety of businesses and requirements—but not all. Similar to any data center project, proper planning is paramount. While predicting future IT requirements can be more guessing than science, it is still vital to the larger strategy. Investigating a modular approach means optimizing your research and making that perfect fit for realizing your objectives. Here are some items to consider when investigating modular products or providers.

MODULAR PRODUCTS

- Is the product UL and/or CE certified? What may local or state codes apply to bringing this type of device to your site?
- Will you need additional protection for the module? While many modular solutions can withstand many external conditions, there are security factors to consider and how to optimally fit the modules into the structure or site you have.
- Onsite integration—can your facility/site accommodate modules and the overall power requirements?
- What voltage distribution is required for the module, and how will you provide it?
- Do you require true mobility in a modular solution?
- Does disaster recovery play a significant role within your organization?
- Integrated modular data center or separate power and cooling modules?

MODULAR PROVIDERS

- Where do you need the modular solution provided? On-site, dedicated site, or in a colocation facility with the provider?
- What integration options are available to manage and automate IT and infrastructure within the module?
- What type of monitoring and security is required?
- What data needs to be collected and reported?
- Are you providing some type of distributed cloud solution?
- Does the modular solution have a solid DCIM option capable of spanning multiple data center modules? Or, do they work with partners that are integrated and can help?
- Are there provisions for future management technologies?

In both approaches, the foundational data for evaluation is power. Match the IT needs and forecasts for power consumption with the right-sized modular implementation in 100 – 500kW increments.

Additionally, any energy efficiency or environmental guidelines for the organization should be followed. Invite facilities, IT, and all relevant parties to the table to select the best fit for a holistic, optimized data center strategy.

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Final Thoughts and a Look into the Future

There are several important considerations when planning a scalable data center: topology, scalable technology, digitalization, and modular deployment. Leaders in the digital infrastructure space are tasked with ensuring that they can meet the demands of a persistently connected market.

A new breed of data centers focusing on modular designs ensures that you deploy on time to support a digital market without having to break the bank on the initial build.

To support growth around data, edge, cloud computing, and digital infrastructure, it's essential to work with partners who share your vision and help with design challenges. Solutions architectures can blueprint each expansion, maximizing investment, energy efficiency, and build speed. To get your architecture right, work with design partners that support a new generation of modular infrastructure. For example, ABB Data Center's team is highly skilled in designing scalable data centers and offers solutions architectures and a range of scalable technologies.

To get started, take a reflective look at your own business and technology landscape. Can you be deploying data centers more effectively? Do your legacy solutions simply take up space without offering a return on technology investment? A new breed of data centers focusing on modular designs ensures that you deploy on time to support a digital market without having to break the bank on the initial build.

Novel design considerations that already have a foothold in the industry can help with scalability, speed of deployment, time to market without compromising performance or user experiences. Furthermore, the new generation of modular designs helps add even more value to the technology piece of a digital-ready business.

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