DATA CENTER KNOWLEDGE

THE INFORMATION SOURCE FOR THE DATA CENTER INDUSTRY

Data Center Knowledge Guide to

Modular Data Centers

Second Edition

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Executive Summary

The data center infrastructure has evolved far beyond a centralized solution. Now, with cloud computing, more data demands, and distributed environments — there is a greater than ever need for agility. In creating a more flexible data center solution, organizations are seeing the direct benefits in working with modular designs. A modular data center is an approach that implies a prefabricated module or a method for delivering data center infrastructure in a modular fashion. A modular solution takes the best ideas for design, reliability and efficiency and packages everything into a prefabricated, repeatable and operationally optimized module. Now data centers can grow and expand while using efficient modular technologies.

Exploring the modular product and provider markets, as well as the benefits that a modular approach can provide will allow any company to better align their IT infrastructure with the needs of an evolving business environment.

The design landscape of the traditional data center has truly shifted. In looking at previous designs, the architectural, mechanical and electrical schematics for data centers have typically been an open book. Data center engineers were tasked with designing environments which were capable of supporting business needs both now, and in the future. There was a true drive to anticipate what requirements will be for the next 10 to 15 years.

Fast forward to those 10–15 years later and we have a data center environment which is forced to work with cloud computing, big data and serious user distribution. A 2012 Uptime Institute[1] survey asked people if their organization has deployed or considered moving to a private cloud. How did the participants respond? Almost 50% said that they have already deployed a cloud solution and another 37% were looking into the solution this year. Combine those two together and there is the potential to see numerous data center environments adopting the cloud computing architecture. When looking at cloud computing, 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. There are also many providers that offer a modular data center approach for their customers, taking advantage of modular while not having to commit 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 which is capable of scale. As the organization moves to adopt more cloud-based distributed technologies — a modular architecture can be there to immediately support additional workload and business demands.

CONTENTS

[1] http://www.uptimeinstitute.com/2012-survey-results

What Is Modular?

The concept of a modular data center solution has eluded definition, if not comprehension. Through the short history of modular solutions and vendor marketing, a definition and categorization of solutions has emerged.

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 to a fledgling market of vendors that produce everything from containers to a variety of modular designed products and solutions for IT, power and cooling.

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

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 like it to create different shapes or designs.

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.

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 the data center it is the ability to match capital expenditures with IT forecasts and requirements.

Modular – The First Generation

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 went so far as to plan offshore barges with IT containers that would use the ocean to provide power and cooling for their "water-based data center".

APC took an early approach to modularizing 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 own solutions into a modular data center design. In 2008 Microsoft announced that their new Chicago data center would house up to 220 shipping containers.

Container vs. Modular

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 deployment method for delivering data center infrastructure in a modular, quick and flexible method.

The primary confusion in terms stems from container versus modular. A data center container is a particular package that is engineered and delivered as such — in an ISO shipping container. A container is not the same thing as modular, 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, pre-fabricated solutions that enable scalability and a rapid delivery schedule.

After the early development of containers, theories evolved 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 own engineered solution.

Modular – The Second Generation

While there are still modular solutions that are in ISO shipping containers, the second generation of modular solutions thought outside the box (literally). These solutions kept the attributes and advantages of being modular, but did not conform to just a container. A primary difference between generations was how cooling was supplied. First generation containers were simply a container full of IT and relied on additional infrastructure to operate. Second generation modular solutions had integrated cooling technology and came as a complete data center solution. Many of these solutions used advanced cooling technology, implementing evaporative cooling and making use of outside air efficiently.

The second generation of modular solutions also coincides with the idea of IT 2.0. This is true expansion of the information technology area to include more WAN technologies, greater 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. Pre-fabricated solutions designed to help off-set big workloads can help organizations move more easily into 2.0 technologies. This includes better handling of big data, cloud computing and a distributed global environment.

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 both 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. Taking 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.

Why Modular?

The initial black eye for containers and the modular concept was mobility. The Sun Blackbox was seen on oil rigs, war zones and places a data center is typically not found. As an industry of large brick and mortar facilities that went to all extremes to protect the IT within, the notion of this *data center in a box* being mobile was not only unattractive, but laughable as a viable solution. What it did do however, was start a conversation around how the very idea of a data center could benefit from a new level of standardizing components and delivering IT in a modular fashion around innovative ideas.

Mobile vs. Quick Provisioning

Referring to a modular solution as mobile takes on different connotations. The ability to quickly place or move a container somewhere is truly a mobile data center. The early APC trucks were intended to be a mobile solution — a data center on wheels. A modular, manufactured data center that is constructed and quickly provisioned is mobile in that it is built in modules made to ship, however the intent is not to be mobile.

Faced with economic down-turn and credit crunches, business took to modular approaches as a way to get funding approved in smaller amounts and mitigate the implied risk of building a data center. 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.

Design

- **Speed of Deployment:** Modular solutions have incredibly quick timeframes from order to deployment. As a standardized solution it is manufactured and able to be 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 recent Market Insight survey by Data Center Knowledge, 64 percent indicated an interest in modular data centers. Furthermore, 44 percent responded that DC scalability was one of their top challenges. The top four topics of interest in the survey are items that modular solutions address: data center design, power and cooling, efficiency and DCIM (Data Center Infrastructure Management).

- **Scalability:** With a repeatable, standardized design, it is easy to match demand and scale infrastructure quickly. The only limitations on scale for a modular data center are the supporting infrastructure at the data center site and available land. Another characteristic of scalability is the flexibility it grants 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.

Where some organizations build their modular environment for the purposes of capacity planning; other organizations leverage modular data centers for their highly effecitve disaster recovery operations.

- **Agility:** Being able to quickly build a data center environment doesn't only revolve around the ability to scale. Being agile with data center platforms means being able to quickly meet the needs of an evolving business. Whether that means providing a new service or reducing downtime — modular data centers are directly designed around business and infrastructure agility. Where some organizations build their modular environment for the purposes of capacity planning; other organizations leverage modular data centers for their highly effecitve disaster recovery operations.
- **Mobility and Placement:** A modular data center can be delivered where ever it is desired by the end user. A container can claim ultimate mobility, as an ISO approved method for international transportation. A modular solution is mobile in the sense that it can be transported in pieces and re-assembled quickly on-site. 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. In a modular solution the space is used very efficiently and features densities as much as 20 kilowatts per cabinet. 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 a great gauge of data center green efficiency. Look for a provider that strives to break the 1.25 –1.3 barrier or at least one that's in the +/- 1.2 range.

- **Efficiency:** The fact that modules are engineered products means that internal subsystems are tightly integrated which results in efficiency gains in power and cooling in the module. First generation and pure IT modules will most likely not have efficiency gains other than those enjoyed from a similar containment solution inside of a traditional data center. Having a modular power plant in close proximity 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 as well, with all subsystems being engineered as a whole.
- **Disaster Recovery:** Part of the reason to design a modular data center is for resiliency. A recent Market Insights Report [2] conducted by Data Center Knowledge points to the fact that almost 50% of the surveyed organizations are looking at disaster recovery solutions as part of their purchasing plans over the next 12 months. 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. For those organizations that have to keep maximum amounts of uptime, a modular architecture may be the right solution.
- **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.
- **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 the true brick and mortar of a data center, placing modules in an outdoor park, connected by supporting infrastructure and protected only by a perimeter fence. Some modular solutions offer stacking also — putting twice the capacity in the same footprint.

Financial

Deferred Capital Cost:

As a large 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 large capital expense for a building that will only hopefully keep pace with technology demands. Modular solutions can be seen as a way to intelligently apply capital to the data center in line with changing technology and IT requirements. Instead of a $50 million project day one, ten $5 million modules can be built as they are needed. It enables the ability to incrementally add capacity to the data center.

Operating Expense:

The engineering in modular solutions has proven, known efficiency throughout subsystems which allow regular operating expenses to be optimized. Optimized power and cooling built-in to modules equate to a lower overall operating expense.

[2] http://www.datacenterknowledge.com/archives/2011/09/28/2012-data-center-market-insights-report/

Operations

- **Standardization:** Seen as a part of the industrialization of data centers the modular solution is a standardized approach to build a data center, much like Henry Ford took towards building cars. 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 enable 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.
- **DCIM** (Data Center Infrastructure Management): Management of the module and components within is where a modular approach can take advantage of the engineering and integration that was 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 IT equipment, infrastructure, environmental conditions and security of the module. The other important aspect 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.
- **Beyond DCIM – The Data Center Operating System (DCOS):** As the modular data center market matures and new technologies are introduced, data center administrators will need a new way to truly manage their infrastructure. There will be a direct 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. DCOS looks to remove the many challenges which face administrators when it comes to creating a road map and building around efficiencies. In working with a data center operating system, 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.
  - DCOS can be delivered as a self-service automation solution or provided as a managed service.

Over or under provisioning of data center resources can be extremely pricey — and difficult to correct.

Enterprise Alignment

- **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 needed quickly 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 the implementation of a supply chain process at the data center level. As a means of optimizing deployment, the IT manager directs vendors and controls costs throughout the supply chain.
- **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 months.
  - **Operations:** Standardized components to support and modules are engineered for extreme-efficiency.
  - **Maintenance:** Standardized components enable universal maintenance programs.

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.

The Modular Market

With the modular market developing in the industry, there has been some tremendous innovation and engineering design efforts put into solutions. The modular market is maturing with even more large enterprises actively deploying the modular data center platform. To further illustrate the traction in the modular industry, a recent Uptime Institute [3] survey showed that 41% of their respondents are already considering modular, pre-fab data centers or their components.

Industry Adoption

Large Internet companies and cloud providers were early adopters because of their need for optimizing 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 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.

Federal agencies are facing mandates to improve IT efficiency and offer citizens greater transparency into their operations. The 2012 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 finance industry has been seen as an early adopter for 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.

Modular Products

Many of the major server vendors have modular data center products and while they are optimized to work with their hardware, will typically support anything a standard rack supports. Vendors worldwide have engineered their own version of a container or module and incorporated a variety of unique capabilities into their solution. Having one vendor supply all components for and within the rack for a module enables them to engineer it as a complete solution that can then have modular power and cooling products complement the IT module. Modular data center products, including containers, are available from: IO, HP, IBM, SGI, Dell, Cisco, Cirrascale, Google, Elliptical Mobile Solutions, IPSIP, Toshiba, Bull, AST, Schneider Electric, PDI (acquired by Smiths Interconnect), Emerson Network Power, Silver Linings, and Telenetix.

Modular Providers

Within the everything-as-a-Service model, a modular provider is able to offer the entire data center as a service, by quickly adding a module of IT with all supporting power and cooling infrastructure. The idea is to deliver a data center-in-a-box solution. Quickly built-out and provisioned, the data center can be made operational far faster than a standard bricks-and-mortar solution.

The entire module is available as a package, integrating all aspects of the IT within and subsystems through DCIM or other management tools, such as DCOS (data center operating systems). Modular data center Providers include: IO, NxGen Modular, mSun Modular Data centers, IBM, COLT, Toshiba, Cannon, Pacific Voice and Data, BladeRoom, Pelio & Associates, Dock IT, Lee Technologies (acquired by Schneider Electric), Datapod and Turbine Air Systems (TAS)/ Celestica (CLS).

[3] http://www.uptimeinstitute.com/2012-survey-results

Due Diligence

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 a vital part of 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 local or state codes may be applicable to bringing this type of device to your site?
- Will you need additional protection for the module? While many of the modular solutions are able to withstand a great deal of outside conditions, there are security factors to consider as well as how to optimally fit the modules into the structure or site you have.
- On-site integration — can your facility/site accommodate modules and the overall power requirements?
- What voltage distribution is required to the module and how will you provide it?
- Do you require true mobility in a modular solution?
- Does disaster recovery play a major role within your organization?
- Integrated modular data center or separate power and cooling modules?

While predicting future IT requirements can be more guessing than science, it is still a vital part of the larger strategy.

Modular Providers

- Where do you need the modular solution provided? On-site, dedicated site or colocated 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 or DCOS option capable of spanning multiple data center modules?
- Are there provisions for future management technologies such as DCOS?

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 pertinent parties to the table to select the best fit for a holistic, optimized data center strategy.

Summary

In some regards the decision about modular mirrors that of build vs. buy. The choice is to put a lot of up-front capital into constructing a facility that you estimate will fulfill IT requirements for the next decade or so, or to build (and expense) modularly in increments that will match IT needs in years to come. Similarly there are cost analysis exercises to look at between the operational costs of running a large facility with matching infrastructure, or the cost per module or modules deployed and the efficiencies in both. Modular data centers are somewhat of a disruptor to the traditional build vs. buy decision, as it offers an alternative approach to building that can save significant capital expense and operational expense over the constructed data center.

Although modular data center solutions are relatively new; cloud computing and the power of distributed technologies have made this type of platform a viable option. Managers are able to quickly understand the cost of a solution and deploy a data center which can directly integrate with the needs of the organization. Second generation modular designs are purpose built around today's IT 2.0 environment.

While modular solutions are increasingly taking market share, they are still not a perfect fit for every need. Like all other aspects of a data center strategy, it requires knowing what IT needs are now and in the future, and what the specific requirements are for efficiently optimizing the supporting data center infrastructure. In many cases the modular product or provider are a perfect fit for a retrofit, expansion or new data center project. Finding the right modular solution means knowing which one will benefit your needs the best. Taking a modular approach toward data center design is an innovative way to tightly integrate IT and facilities, and deliver it with extreme agility.

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