

A simple but revolutionary concept: The modular approach to data center design



DIGITAL REALTY

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A DIGITAL REALTY WHITE PAPER



The simple but revolutionary idea behind the modular approach to assembling data centers is to prefabricate as much of the systems as possible offsite.

In response to customer demand, Digital Realty has developed and put into practice an offsite manufacturing solution that has become the industry-leading one for modular data center design.

The purpose of this paper is to introduce our modular approach and the benefits associated with it, as well as to demonstrate the success of our program thus far.

We are confident that global enterprises will continue to benefit from the advantages this model offers.

MANUFACTURING VERSUS CONSTRUCTION

Pod Architecture 2.0®, our proprietary modular approach to building data centers, was developed in Silicon Valley in 2010. In January 2013 we introduced the next iteration of the program, branded Pod Architecture 3.0®, which will allow us to deliver more IT capacity within the existing framework. Today, we have approximately 45 megawatts deployed in 11 buildings across North America and we are confident that global enterprises will continue to benefit from the advantages this model offers.

The simple but revolutionary idea behind the modular approach to assembling data centers is to prefabricate as much of the systems as possible offsite—away from the construction site of the facility that ultimately will house the data center(s).

We have implemented a process whereby we build-out and test the bulk of a data center’s electrical and cooling installations on transportable skids in offsite factories, as illustrated in Exhibit A. Each three-skid system supports approximately 1125 kilowatts of IT load.

Configurations can then be lifted onto trucks and delivered as-needed to their respective development sites. Skids are shrink-wrapped for shipping purposes, much like luxury yachts, as they are hauled to their final desti-

nations. On site, skids are unloaded for installation, with each one pre-wired for rapid assembly. It takes approximately 10 working days to manufacture a skid that quite often can be installed in less than one.

By delivering these key elements on a just-in-time basis, work on the shell and core of a facility can be performed in parallel, thereby significantly reducing the amount of time required for an overall project to be completed.

CUSTOMER WANTS VERSUS NEEDS

A colleague of mine recently attended a technology strategy and information conference where the topic of “customer wants versus customer needs” was broached. During one of the sessions, the Marketing head for an electric tool maker said, “Our customers do not want quarter-inch drill bits. They want quarter-inch holes.” His point was customers will tell you up front what they want (holes), but it takes a bit of analysis to figure out what they actually need (drill bits). In other words: You have to ask the right questions.

We know when it comes to data centers, enterprises with evolving needs are specific and consistent about their requirements: 1) availability has always topped the list; 2) the ability to multi-tier for redundancy purposes has become a close second in recent years; 3) cost savings and

Exhibit A: The bulk of a data center’s electrical and cooling installations can be built-out and tested offsite and moved on site for installation on transportable skids.





the financial flexibility inherent in an incremental deployment option have gained importance since the beginning of the global economic crisis; and, of course, 4) our customers appreciate rapid delivery of the finished product.

As you will see, each of these factors was taken into consideration as we developed our modular program with an eye toward exceeding our customers' needs.

AVAILABILITY IS ASSUMED

In the data center business, availability or the degree to which a system is operable and committable is the go-to metric. Everybody wants high availability, but the concept is rarely mentioned because it has become an "assumed" deliverable.

Our facilities have produced more than 100 million availability minutes over the last six years with proven reliability, as illustrated in Exhibit B. Data centers built, owned and operated by deployment option have gained importance

With the development of virtualization, new types of facility-aware software and more flexible operating systems, our customers are more interested in multi-tiering.

since the beginning of the global economic crisis; and, of course, 4) our customers appreciate rapid delivery of the finished product.

As you will see, each of these factors was taken into consideration as we developed our modular program with an eye toward exceeding our customers' needs. Digital Realty regularly achieve the benchmark of "five nines" in availability, which translates to a downtime of just more than five minutes per year¹. It is worth mentioning that there have been years during which we even reached "six nines."

The reliability of a data center can be further enhanced under the modular approach because we commission its individual components both at the factory and onsite at the conclusion of their assembly and installation, which ensures the highest level of performance.

However, today not all systems necessarily need to be highly available. With the development of virtualization, new types of facility-aware software and more flexible operating systems, our customers are more interested in multi-tiering.

MULTI-TIERING FOR REDUNDANCY

My team and I are convinced that for the next several years multi-tiering is going to be the most interesting challenge we face from a design and architecture perspective.

In short, multi-tiering is the ability to deploy a particular workload with varying tiers of availability—or the capacity to provide adequate back-up systems with different maintainability and reliability characteristics—in the same facility, campus or data hall.

Interestingly, the trend toward multi-tiering ties in very well with the modular approach that we are continuing to refine. Whether a customer requires one-megawatt or one-kilowatt increments, the ability to adjust capacity and to adapt it to a specific set of applications is invaluable in today's competitive environment.

One of the larger-scale methods to apply this architecture and then deploy it within our modular approach is to construct a building containing multiple, discrete data centers with variable tiers that share network, storage and monitoring services. With this setup a customer has the option to deploy on different dimensions, as illustrated in Exhibit C.

Exhibit B: Digital Realty Turn-Key Flex data centers have produced more than 100 million availability minutes over the last seven years.

Operations Reliability Analysis	2011	2010	2009	2008	2007	2006	2005
Total outage minutes	164	560	191	123	132	935	231
Total outage minutes (equipment)	164	500	181	45	82	718	124
Total outage minutes (human error)	0	60	10	78	50	217	107
Net outage minutes – service impacting	164	253	191	122	1	231	0
Total # of Turn-Key Flex (TKF)	143	117	96	73	55	42	26
Available minutes per TKF per year	525,600	525,600	525,600	525,600	525,600	525,600	525,600
Total available minutes for all TKFs	75,160,800	61,495,200	50,457,600	38,168,800	28,908,000	22,075,200	13,404,400
Average % uptime across all TKFs	99.999%	99.999%	99.999%	99.999%	99.999%	99.999%	99.999%
Average % uptime across all TKFs (equipment failure only)	99.999%	99.999%	99.999%	99.999%	99.999%	99.999%	99.999%
Average % uptime across all TKFs (less non-service impacting outages)	99.999%	99.999%	99.999%	99.999%	100%	99.999%	100%

LOWER COSTS, FINANCIAL FLEXIBILITY (AND STABILITY)

Data center development projects are capital intensive and have been receiving a heightened level of scrutiny since the onset of the global financial crisis in 2008. While increased attention can create challenges for commercial owners and operators in the data center sector, we believe it has encouraged the industry to take a prudent approach in the development of these high-cost projects.

The modular method to data center design has proven more cost effective for enterprises because it creates options that have value. For example, rather than making a \$100 million data center investment decision today, we can deploy capital incrementally and say, “Let’s make an initial \$20 million decision today, because at the end of the six months it takes to construct the building, we will have more visibility into demand and how many units we actually need—and at that we can point ramp up if necessary.”

Additionally, because of Digital Realty’s REIT² status, we provide an OpEx³ model that is an attractive alternative to the CapEx⁴ model for enterprises, because: 1) monthly lease rates are a fixed operational expense with Digital Realty carrying the “break fix” risk and associated variable costs; 2) data centers do not have to be carried as capital

A typical data center, if it is fully instrumented, might have 5,000 or 10,000 data points.

assets on an enterprise’s balance sheet; and 3) the need to commit capital for investment in real estate is eliminated—so capital can be deployed elsewhere.

RAPID DELIVERY

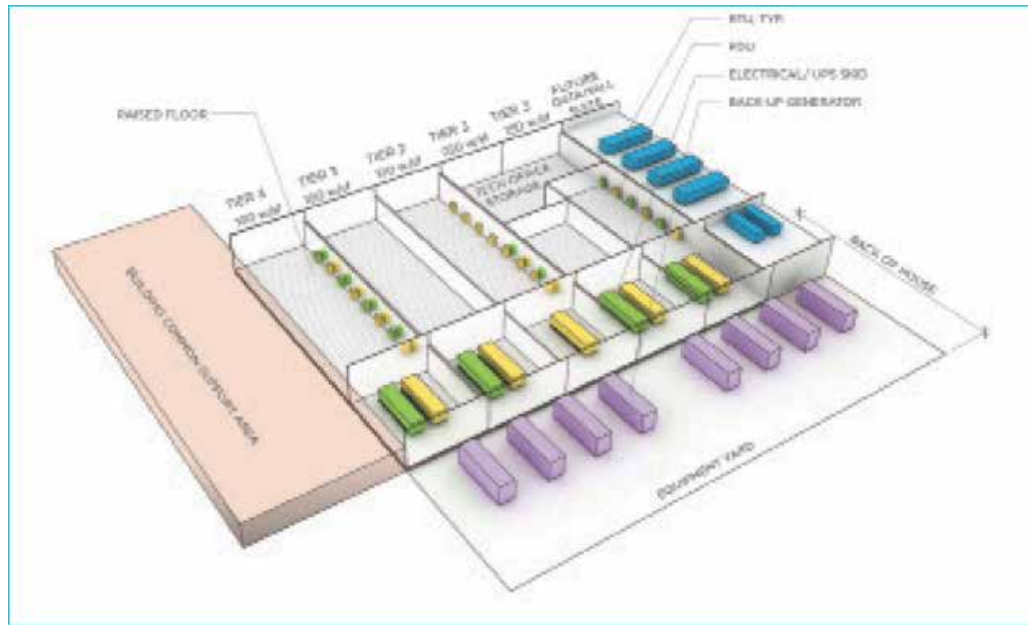
Again, each pre-fabricated skid contains a portion of the data center’s electrical and cooling components, and upon completion all the major components of each—including UPS (uninterruptable power supply), batteries and switch gear—are set in place and ready for full commission. Furthermore, Digital Realty’s use of modular components provides customers with an enhanced level of architectural flexibility. We can build-out an inventory with multiple power and cooling configurations, from chilled water to airside economization, which allows customers to hand-select the configurations based on location and climate or site conditions. Please see Exhibit D.

²REIT (Real Estate Investment Trust): A security that sells like a stock on the major exchanges and invests in real estate directly, either through properties or mortgages. REITs receive special tax considerations and typically offer investors high yields, as well as a highly liquid method of investing in real estate. Source: Investopedia (<http://www.investopedia.com/terms/r/reit.asp#axzz24wsLqXGY>).

³OpEx or Operating Expense is an ongoing cost for running a product, business or system. Source: Financial Dictionary (<http://financial-dictionary.thefreedictionary.com/OPEX>).

⁴CapEx or Capital Expenditure is the cost of developing or providing non-consumable parts for a product, business or system. Source: Financial Dictionary (<http://financial-dictionary.thefreedictionary.com/Capital+expenditures>).

Exhibit 3 - Data Displays Tailored to Operators



Flexibility can translate to rapid delivery of the final product—whether it is a brand new facility or a system upgrade. When asked in what increments they would prefer to scale-up their data centers’ IT capacities, more than 65 percent of our customers said that growing in increments of 250 kilowatts at a time would be ideal, which fits in well with our modular approach, as illustrated in Exhibit E.

It takes mere days to install a completed electrical skid that has been manufactured in two week’s time offsite, versus the several months it would take to build the same system onsite; on a recent project for an existing customer, we set up four rooms in two days. The end product of this modular design is an installation schedule as short as 12 weeks. It is worth noting that we can deliver a new data center in around the same amount of time it takes an IT department to deploy a new workload—and sometimes we are even faster.

FOCUS ON BACK OF HOUSE

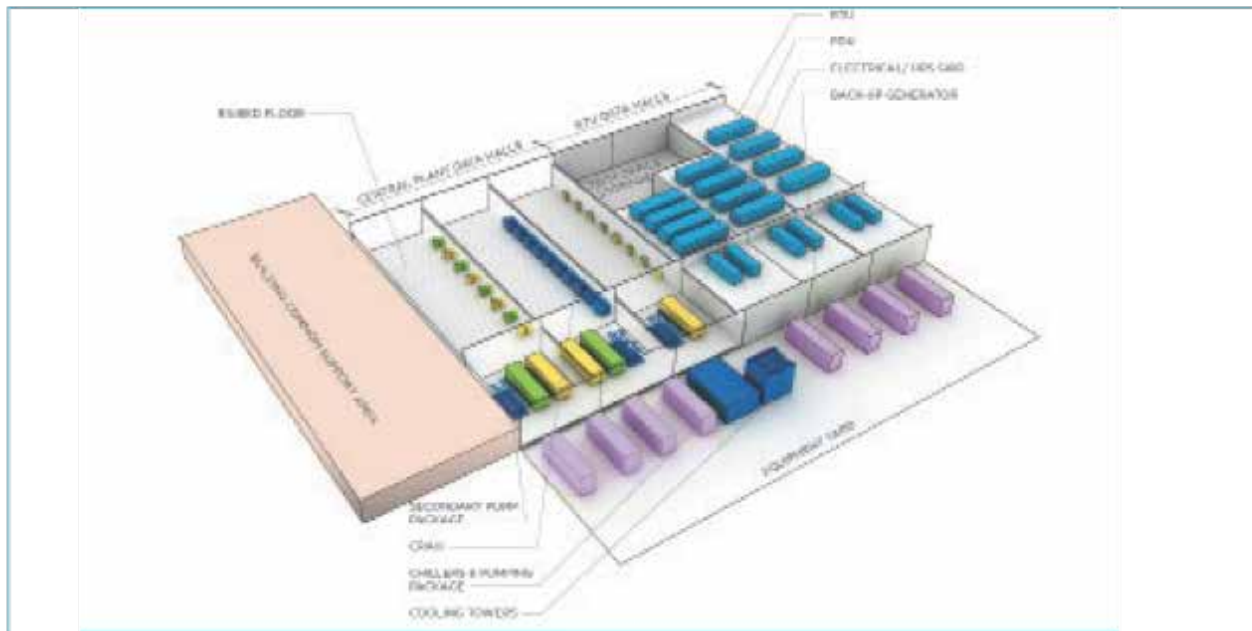
During the prefabrication phase of a project, our teams focus on the back of the house, indicated by the gray space in Exhibit C, which includes: the UPS and BMS (building management systems), as well as everything from generators, switchgear and fan controls to fuel enclosures, rooftop DX and chilled water systems. These assets tend to be the heavier, harder-to-install and longer-lived components of any data center.

An example of the front of the house, on the other hand, is the modern data hall. In our analysis of the costs associated with building data hall systems using the modular approach we have not uncovered any appreciable cost advantages over the traditional “stick build” method. In fact, stick-built data halls typically match the energy performance and cost of the majority of the modular data hall solutions out there.

The back-of-the-house approach is not conducive to the production of data halls because they need the power and cooling infrastructure to be in place before they can operate, and the rapid deployment of data hall capacity is dependent on existing power, fiber, security and cooling architectures. In other words, extensive real estate site work would be required. Our focus is on “entitling” the facility and readying the infrastructure and shell.

Rather than making a \$100 million data center investment decision today, we can deploy capital incrementally in environment—

Exhibit C: Customers can deploy on different dimensions for redundancy purposes.



In addition, existing market solutions for the front of the house tend to be highly specific to a particular deployment and will not “flex” with technology factors such as equipment footprints and cable and power distribution points. With more than 20 million square feet of data center real estate in our global portfolio, Digital Realty has experience re-configuring assets and we know that a traditional building has a higher degree of flexibility than a fixed-form aluminum- and steel-framed room with laminated panels for walls.

THE LIFECYCLE CONUNDRUM

The modular approach to building data centers provides our customers with options, which have more value in situations where you have high volatility and long duration.

Big enterprises with “old” data centers are often faced with the challenge of what to do at the end of a lifecycle. Thirty years from now, for example, an eight-pod data center that is running a business may have components that are at the end of life their lifecycles.

Using the modular approach, a customer would have the ability to shut down a section of its overall system and do a refresh—change the tiering, change the technology—it could make a number of changes without interrupting the rest of the system. Or the customer could elect to shut down and reconfigure the entire arrangement.

The ability to adjust capacity and to adapt it to a specific set of applications is invaluable in today’s competitive environment—

Lifecycle management is generally considered a sleepy issue in what has become a dynamic industry; very few customers want to talk about it during pre-sales even though nearly every enterprise has to manage the problem at some point. In fact, over the 10-plus years that Digital Realty has been operating data centers in a global portfolio, we have identified the end-of-life issue to be the one that our customers struggle with most.

Since we have real-world experience and a strong sense of the lifecycle challenges our customers will ultimately confront, we also understand the questions that need to be asked and answered early and often: Do you have a production data center near its end of life today? Is there a plan in place? Do you have a solution? The modular approach can be part of the solution.



SUMMARY

Digital Realty launched the modular Pod Architecture 2.0 program in 2010 and in the spirit of continuous improvement the company introduced Pod Architecture 3.0 in January 2013. At the time of this writing we have assembled and put into operation 11 buildings across North America based on our POD Architecture design, representing a financial commitment to the manufacturing process of nearly \$60 million. Our focus today is on optimizing buildings for the prefabricated components—basically integrating the ready made electrical and cooling rooms with the overall facilities—or as we like to say in the field, “Wrapping the buildings around the skids.”

Clearly, we remain confident that our customers will find the modular approach to building data centers to be the most efficient choice, and we plan to continue fine-tuning the program as well as expanding it along with our global footprint in the coming years.

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