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Avoiding the Five Bottlenecks of Data Center Planning and Management

Data Center Knowledge™

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Executive Summary

A data center is, for all practical purposes, a factory. It consumes resources, applies human labor, produces exhaust, requires continual attention, and is replenished by fresh inventory. We've embraced the modern metaphors of data center revolution and digital transformation to the extent that we forget a data center is an engine in a complex supply chain – just like any other factory.

The growth of a data center or data center network is too often constrained by its own design, management practices, production objectives, and resource priorities. When we treat the data center more as an organic entity rather than a human endeavor, we constrain its evolution, to the detriment of both its operators and its customers.
In this report, we call your attention to five such constraints that may be commonly found in data center growth plans, which we call bottlenecks:

1. Unsuitable location
2. Limited connectivity
3. Shortage of skilled human resources
4. Scarce water and natural resources
5. Lack of available clean power

Every data center construction project requires investors. When they evaluate a prospective operator's growth plan, they look for evidence of these bottlenecks in your service delivery channels. They will typically reject an investment opportunity if there is evidence of two of these five.

This report also suggests a response plan that addresses, stage by stage, the constraints and inefficiencies that these bottlenecks impose.

Bottleneck #1: Unsuitable Location

The typical data center growth plan is fundamentally based on electricity consumption. The power of a data center is usually measured in megawatts, and the health of a data center market in a given region is referred to as absorption rather than production. Data centers may be the only type of factory whose operators are more concerned about what they ingest than what they yield.

The deregulation of the European energy market has completely decoupled the electricity generation market from the electricity distribution market. The result is a bewildering assortment of private interests, each of which does business in relegated areas ranging in size from an entire country to a few city blocks. Each one competes for your choice of project site location.

Transmission system operators (TSO) are delegated responsibility for producing power. Under EU law, TSOs must make arrangements with distribution system operators (DSO) to deliver power to customers. Thus, customers' relationships with electricity is typically through their DSOs. Although the law specifies that TSOs and DSOs must be independent from one another, there are waivers in place for DSOs that serve fewer than 100,000 customers. As one can imagine, this creates incentives for DSOs to remain small. The nation

Map representing the quantity and ownership alignments of Distribution System Operators (DSO) among member nations in the European Union. [Courtesy Eurelectric.org]

where deregulation has run rampant is Germany, where there are four private, competitive TSOs and some 805 DSOs as of 2018. Only 75 of those DSOs, according to a 2018 European Commission report, serve 100,000 customers or more.

In the United States — where the rule of thumb is that a Tier-4 project costs $1,000 per square foot to build — electricity markets are regulated at the state level rather than national. Some 17 of 50 states have deregulated their electricity markets to some extent, including California, Texas, Georgia, Virginia, and New York.

Data centers are among the largest electricity consumers on the planet. Competition for customers there is both fiercely competitive and highly regulated. While deregulation has introduced competition into markets that had historically been monopolies, on the flip side, it has cast global electricity markets in a state of flux.

Siemens Response #1: Frame Agreements

Eliminating bottlenecks in your data center growth plan requires a sequence of layered responses. You may have been told once or 100 times that every data center growth plan starts with location. Whether you're making that decision now or inheriting an older one, site location is not just about geography and the physics of connectivity. It's about jurisdictions and authority. Location determines with whom your organization will be dealing for building permits, construction labor, and energy.

Frame agreements establish medium- to long-term relationships between your data center and its suppliers. Such an agreement:

- Protects you as the operator from the effects of fluctuating power market rates.
- Protects resource suppliers by establishing norms for power and resource consumption.
- Establishes in advance the parties with whom you'll be dealing for building permits, construction labor, energy, natural resources, and connectivity, and ensures their continued participation and presence.
- Lowers underwriters' fees and spurs investment from financial institutions by minimizing risk and uncertainty.

Bottleneck #2: Limited Connectivity

We tend to think of a data center's "footprint" in terms of megawatts and consumed electricity. More and more, the resource that its customers demand is connectivity.

When the number of "hops" (handoff points, junction stations, and router connections over a network) become too great for quality-of-service (QoS) to become normalized, connectivity becomes a pain point for a data center's end customers. More customers today rely on data centers for high-performance computing (HPC) and artificial intelligence (AI) tasks, both classes of which use high quantities of data. For these tasks to be efficient, customers require determinism — unwavering performance levels and connectivity stability.

Siemens Response #2: Interconnectivity Planning

The applications and services hosted by a data center are becoming more data and resource intensive by the month. As a result, their connectivity requirements are scaling up faster than the facility's electricity requirements. Meeting customer demands requires a connectivity strategy that links multiple connections into one system.

Interconnectivity refers to a facility's capability to link all the components in the worldwide computing process into a cohesive, orchestrated unit. It effectively diversifies an organization's IT infrastructure by distributing it across multiple facilities and assets, delegating some services to public cloud providers strategically and selectively. Data centers need infrastructure-level, Layer 2 network connections to enable links to:

- Other data centers through protocols such as Data Center Interconnect (DCI).
- Network-neutral facilities and carrier hotels that access CSPs directly, bypassing the Internet.
- Private content distribution networks (CDN) that bring high-volume data closer to customers. Today, more operators look to content delivery networks to reduce the number of hops and achieve measurable stability.

An interwoven network of IT facilities, including assets in the public cloud, actually simplifies the routes any one workload must traverse from server to customer. This directly translates into higher QoS.

Bottleneck #3: Shortage of Skilled Human Resources

While a data center doesn't require a large staff of professionals to be maintained properly and efficiently, it cannot operate in a vacuum. According to a 2018 Uptime Institute survey of IT professionals whose organizations operated their own assets, some 64% of over 500 respondents said their organizations were experiencing some struggles in attracting and maintaining qualified data center staff . This despite reliable estimates that, for the average enterprise, data center IT staff positions may be as much as two-thirds unfilled.

Siemens Response #3: Human Investment

With a radically simplified data center design, incorporating a pay-as-you-grow development model, it becomes feasible for you to enter into agreements with third parties you might never have considered could be useful, including:

- Aggregators, or "buying groups" comprised of multiple tenants in their respective regions, collectively representing power purchasers.
- Brokers, serving as intermediaries who can negotiate fixed prices for long-term purchasing agreements.
- Consultants, hired to help operators construct growth plans for energy consumption, often incorporating renewable resources.
- Suppliers, who purchase contracts in advance from energy producers and resell them to operators.

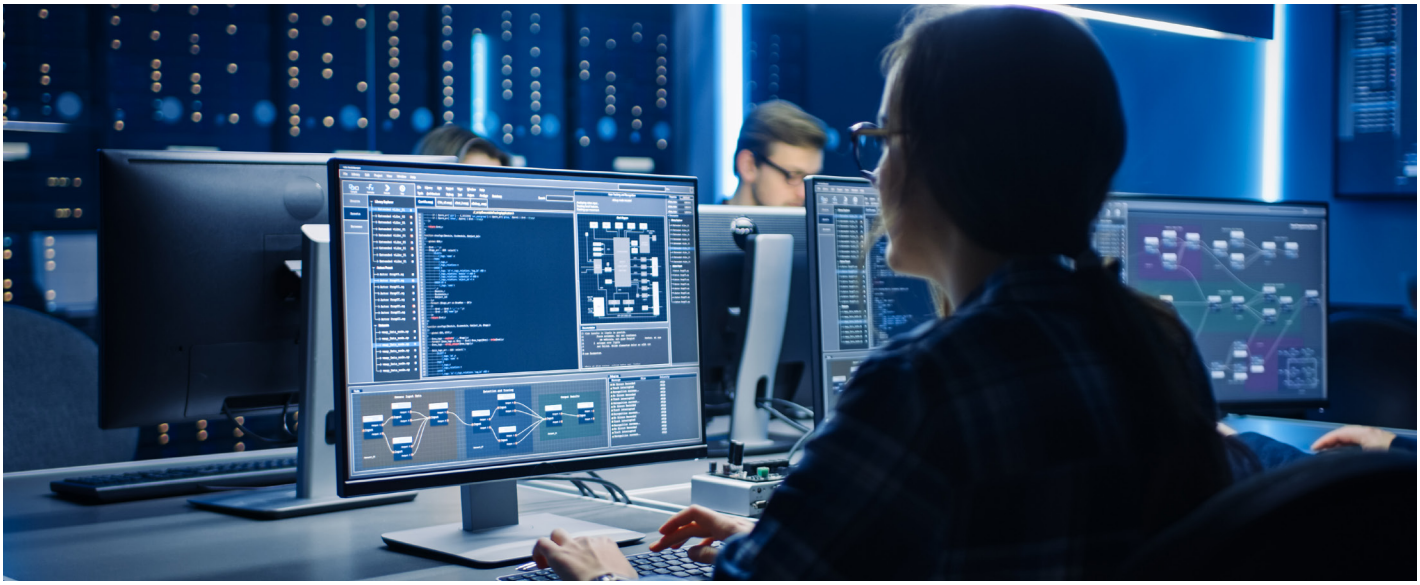
- Civil workers, operating in cooperation with cities and municipalities, who can lay slab foundations and attach support structures for facilities as they're being constructed or extended.

Leveraging these outside resources for site procurement, development, and construction gives an operator greater leeway to invest in renewing the skills and growth potential of its own internal IT staff. Human resources are not byproducts of their environments. Their experience alone is not enough to sustain the engine of their businesses. Investing in certification and renewed education ensures that IT staff have the problem-solving skills to respond to situations they've never encountered before, and to put the appreciation of their own jobs and service to their employers to beneficial use.

Bottleneck #4: Scarce Water and Natural Resources

For many data centers, especially those addressing high availability workloads and customers with critical needs, water may be at least as precious as electricity, if not more so. And with water comes cooling. Many facilities devote more than half of their operational expenditures to cooling. Climate and location play roles in determining how much water may be necessary, if any, but those locales where passive cooling is an option are limited.

At the start of 2019, Amsterdam had been marketing itself as the fastest growing digital hub in Europe. By some estimates, as much as 30% of the continent's data centers were located in the Amsterdam and neighboring municipalities. Then in July, the local government placed a one-year halt to permits for new data center construction, citing unanticipated strains on the region's power infrastructure and natural resources .



Builders of large hyperscale facilities are working to avoid this bottleneck by building closed-loop fluid distribution systems – each filled only once with just a truckload of water. That may solve the cooling problem for some. But a Tier-3 or Tier-4 builder may still need to make minimum water consumption guarantees with municipalities.

Siemens Response #4: Modular Deployment

The ultimate objective of a data center growth plan should be to establish manageable utilization rates over a sustained period of time, and maintain those rates through careful, incremental implementations. Utilization rates are not consumption rates, so they're not measured in megawatts or gigabits. Instead, they measure:

- How well you've provisioned your processing capacity to meet customer demand.
- How strategically you've planned for growing connectivity needs.
- How well you've allocated your cooling and support infrastructure to facilitate your processing capacity.

One way to ensure sustainable, scalable resource utilization is with a pay-as-you-grow plan that incorporates flexible building design with componentized infrastructure. A skid solution is a group of prefabricated, transportable sections that incorporate power and power management components. For example, Siemens Energy produces a 37,500 kilogram skid solution comprised of two sections, combining low-voltage switchgear, uninterruptible power systems, battery racks, control cabinets and panels, along with the power monitoring system, plus the interfaces that link them all together. Skids are delivered in a form that makes them ready for integration on the same day as delivery.

A building designed to house skid solutions can have a radically simplified design, almost like an aircraft hangar. Such simpler buildings can be constructed in partnership with civil engineers, which saves on construction expenses. Installations are made easier through the use of entry doors big enough to enable transport vehicles to drop each skid within feet of where it needs to be. And if you're flexible enough to allow your building space to serve multiple purposes, then the unused portion — the part that waits for future scalability — doesn't have to sit empty and unutilized.

The skid's modular form factor enables facility design to be decoupled from resource architecture. Put another way: think of the building as a big room, and the power system as a staged deployment with scalability built in. Modularity reduces initial costs during the construction phase, and distributes maintenance and upgrade costs throughout the implementation phase. Components of a skid can be assembled and prepared in minimal time in a production hall without a crane, then essentially forklifted into place and interfaced into control systems. By eliminating many of the activities involved in installing new racks, upscaling can be scheduled in parallel with everyday operations, reducing downtime to zero.

Integrated, modular power solutions from Siemens enable maximum uptime, the highest energy efficiency, full scalability, and optimum physical and cyber security capability.

Bottleneck #5: Lack of Available Clean Power

Ironically, one contributor to greater demand for clean power sources, especially in the near-term, has been recent moves by Germany and other governments to shut down lignite-fired coal power plants on an accelerated timetable . This leads to a near-term power availability bottleneck for energy across the board. In global hotspots such as Amsterdam, Frankfurt, and Dublin, free capacities for produced energy are already completely utilized. Were they to follow suit and shut down their coal-fired plants sooner, these cities may be able to compensate partially with renewable sources. But data centers there may be compelled to consider alternatives that may have seemed drastic just a few years ago, such as upgrading onsite power generation from backup status to a full-time supplement.

Many large data centers today have onsite generators. However, due to a multitude of factors — including local zoning laws, building codes, municipal ordinances, state and city laws and regulations — those facilities are restricted or even prohibited from using these generators except during an outage event or power emergency.

Siemens Response #5: Power Management Systems

A power management system enables a data center operator to manage multiple power sources in parallel. Where local regulations permit, this means an operator could conceivably source its power from multiple DSOs. In certain circumstances, an operator could conceivably locate its site adjacent to a TSO, and source its power directly from the transmission station, bypassing the distribution network altogether.

Such a system also opens up a wealth of capabilities, including:

- Switching directly to cleaner sources of power, including as main sources.
- Utilizing onsite power generation, including from an adjacent green power source, not just as backup but supplemental power.
- Making just-in-time judgment calls about how much or how long to rely upon backup sources or UPS batteries.
- Taking responsibility for maintaining uptime and assuring QoS levels during unanticipated power events.

Siemens' modular skid and smaller kiosk solutions feature power management systems built-in. A data center growth plan that incorporates these modular form factors will be better prepared to adopt future smart grid power delivery options as they become available. Paired with frame agreements, these options will enable operators to lock in power purchases in advance, with one or another competing provider, ensuring that a facility is always powered by the most cost-effective option.

In Conclusion

Siemens' out-of-the-box thinking for power generation, delivery, and management solutions, gives data center operators new options for responding to growth bottlenecks. You can concentrate your supplies of natural and human resources where they make the most sense, or distribute them among multiple sources. But these options are only feasible when you plan from the outset to give yourself the management tools and infrastructure architectures your data center needs to keep your options open. To learn more about Siemens data center solutions, visit siemens.com/datacenters.