This Reference Design showcases a 200kW "entry-level data center" with some design add-ons to improve overall availability. Though its primary focus is on low first cost, the architecture utilizes additional hardware in a modular approach to minimize downtime. This strategy increases the validated availability for the entire data center. This bare-bones architecture illustrates the primary requirements for electrical, mechanical and whitespace assets that provide a path toward the target availabilities while maintaining recommended best practices in data center design.

This architecture is also best suited to environments where change is constant, processes are less structured, flexibility is a requirement, and budgets are tight. With a low density profile, this design would fit well into smaller retail, educational (schools, community colleges, etc) and smaller healthcare environments. Additionally, isolated high density zones may be incorporated into this flexible design to best fit business needs. With a relatively small footprint, this architecture can be integrated well into a mixed-use building that houses other departments or offices.

Schneider Electric’s architects, engineers and data center managers developed this design after significant design inputs and discussion. The expertise of these individuals spans the breadth of electrical, mechanical, whitespace, controls and systems domains. The unification of the domains has forced realistic thinking on the design that is intended to deliver value to our joint customers.

The end-to-end data center management suite, which acts like a layer over the entire data center, provides optimized monitoring, reporting, and control functionality within the individual spaces. Schneider Electric provides intelligent devices such as sensors, meters and controllers as well as the expertise to implement management through out the data center.
Benefits

Whitespace

The Data Center Whitespace which is typically the crown jewel within the entire building. Built using the innovative InfraStruXure architecture, the whitespace, also referred to as the IT room, has been instantiated within the Reference Design to be a low power density environment. It supports a total power capacity of about 200KW. This design showcases all the components that are typically housed on the data center floor like Racks, Coolers, Power Distribution Units, Cooling Distribution Units supporting functional areas dedicated to IT, networking and storage.

Each row within the whitespace has been designed to its simplest form such that it is repeatable in a standardized and predictable manner. This enables customers to deploy data centers in a fraction of the time and facilitates removal of "e-waste" associated with over-sizing.

Each low density "zone" within the whitespace has been designed to support a "high availability" design requirement. A zone consists of two rows of racks with integrated power and cooling distribution. Each row has been designed with Chilled Water-based close-coupled InRow RC air conditioners that enhance the efficiency of the overall space. Coolant is supplied to these InRow RCs by a set of Cooling Distribution Units located along the walls. These intelligent air conditioners ensure that the critical IT equipment within the space receives the adequate supply of cool air necessary for smooth operation by monitoring temperature at each rack. The power is handled by a high efficiency UPS located in the Electrical room. Power is distributed by stationary power distribution units at the end of each row. These units are placed in a modular fashion to prevent downtime and distribute power along and across rows, by ladders and cables, to rack mount PDUs located within each rack. All rack mount PDUs in the design are of the metered variety in support of a high-availability design requirement. Metering also enables remote monitoring of the units for efficiency tracking.

The security of the room is maintained at multiple points. At the rack level, access is controlled inexpensively by a door lock and sensor. The sensor enables alerting when a rack is physically accessed thereby reducing manual control of keying hardware. Maintaining security at the rack level is considered a best practice as well as a basic level requirement. At the room level, basic level security cameras are utilized for monitoring.

The glue that holds the whitespace infrastructure equipment together is the management layer. The whitespace management appliance of choice in this design is InfraStruXure Central. This appliance contains software that monitors everything that is located within the data center. Using a variety of protocols, InfraStruXure Central is able to communicate with whitespace equipment as well as other components located off the whitespace. With the ability to monitor, manage as well as automate, InfraStruXure Central has become the preferred portal for data center management for many IT and Data Center managers. Advanced reporting and visibility features further enhance the tool.

Overall, this whitespace design steps up the value of this data center designed for customers looking to minimize first costs without sacrificing performance.
The mechanical space is the thermal vein that runs through the entire data center. This space is comprised of multiple rooms housing different types of equipment, all engineered to optimize energy efficiency, reliability, ease of maintenance and control. The rooms include a variety of components including chillers, economizers, heat rejection and piping loops to provide a complete cooling solution for today’s mission critical data center. The mechanical space integrates with the electrical space and whitespace to provide the necessary cooling and heat rejection for those spaces. Conversely, the electrical space provides the critical power to keep the mechanical plant up and running.

The mechanical space provides thermal support to a 200KW data center. It is designed with a single chilled water loop and no redundancy. This design utilizes a simple, convenient and efficient heat rejection methodology by utilizing a packaged air-cooled chiller and an outdoor economizer in the form of a dry cooler. The economizer has multiple fans to provide staging to utilize either all six fans or a portion of those depending upon the current environmental conditions and desired results. An economizer can cut energy cost and provide a significant savings over the life of the data center depending upon the amount of available free cooling days.

An N+1 pump configuration was implemented to provide better control, fault tolerance and efficiency. All pumps are fixed speed and sized to peak cooling demands. Wall mounted ultrasonic humidifiers are installed throughout the whitespace to regulate humidity levels. Cooling distribution units and InRow cooling units are configured in the whitespace using a close coupled cooling architecture.

Schneider Electric has strong relationships with global mechanical equipment OEMs, which allow us to recommend and source industry recognized cooling and heat rejection components that make up today’s most robust and energy efficient mechanical plants. To complement these relationships, Schneider Electric offers today’s leading building and HVAC control and automation solutions that make energy efficiency within the mechanical plant transparent. APC by Schneider Electric also offers a line of highly efficient, intelligent and variable speed InRow and InRoom cooling units for data centers deploying low and high density racks and zones.

This electrical space supplies power to all of the critical and non-critical components of the data center. It is a combination of multiple rooms housing a variety of different types of electrical equipment including UPS, switchboard, batteries, PDUs, all engineered to provide the highest levels of reliability and performance. Additionally, the electrical space is outfitted with mechanical equipment in order to maintain optimal ambient operating conditions. These critical pieces of the data center are integrated to provide a high level of availability to the design without compromising on efficiency.

This electrical space supports a 200kW data center designed to be the low first cost architecture offering a high quality infrastructure. This electrical architecture has been dictated based on UPS and distribution characteristics. The UPS choices for this design include the worlds most efficient Symmetra® PX modular scalable UPS and the reliable MGE Galaxy 5000 UPS which have been deployed in support of the whitespace and mechanical loads. The Symmetra® PX UPS has been configured to be an N+1 redundant unit. This UPS provides reliable and conditioned power to downstream APC InfraStruXure power distribution units (PDU) that in turn power the IT load. The MGE Galaxy 5000 UPS allows equipment like the chilled water pumps to have an extended ride-through time for the cooling system. Also, the Square D switchboards have been designed primarily around criticality. The QED switchboard allows access for ease of maintenance.

A network of intelligent devices and power meters has been applied across the electrical space. These management devices with a seamless communication platform facilitate power quality monitoring and predictive maintenance of the entire electrical asset as a whole.

Every component in this design is built and tested to the applicable ANSI, NEMA, UL or IEEE standards. For additional detailed design information, please click on the One Line Schematics associated with the space.
Power Usage Effectiveness (PUE)

How is data center efficiency defined?
Power usage effectiveness (PUE)\(^*\) is an industry standard metric for measuring efficiency in the data center. PUE ratio is the total power coming into the data center divided by the power going to the IT equipment. For example, if it takes 1.5 times as much energy in total (IT load plus supporting load) to operate a data center than is required for just the IT equipment, the PUE would be 1.5. Smaller PUE values indicate a more efficient data center.

Why is the PUE presented as an annualized average here?
A PUE ratio, as any other indexes, can be shown as either an instantaneous or average value. A collection of instantaneous data over a period of time can be very helpful in displaying a trend of efficiency performance of a data center at the operation stage. Hence, such information helps an IT manager decide on load shifting and a facility manager plan for the peak usage. Together, they can maximize the energy bill saving according to the electricity contract with the utility company.

On the other hand, an annualized PUE ratio considers the average weather conditions throughout the year which has a direct impact on the performance of both power and cooling systems during a yearly cycle. The validated model takes into account the differences in equipment configurations, individual equipment efficiency, and the estimated free-cooling hours per year. In this case, an average weather in Chicago, IL was selected, which has about 2,400 hours per year for 100% free cooling. The annualized PUE can best help a data center manager make trade offs between the efficiency and systems architecture, at the design evaluation and planning stage.

Why is the PUE a curve against the IT load, rather a fixed value?
The PUE ratio is a simplified system performance index based on aggregated performance results from dozens of electrical and mechanical equipments. PUE is calculated based on measuring power used for primary functions as well as efficiency losses while equipment is operating. Furthermore, the efficiency loss on both types of equipments is not a constant value along the operation load. Schneider Electric has engineered the reference design architecture to operate at the optimal performance at 100% designed load, with the provision of at least 20% buffer capacity in all electrical equipments. Even at the 80% load, the efficiency performance is still considered to be in the top 10% among all new data centers until 2015, according to APC’s forecast.

For more information about the PUE estimation model, please consult the APC Whitepaper #113.

\(^*\)Data center infrastructure efficiency (DCiE) is another well-known industry standard metric. DCiE is represented as a percentage of IT load power divided by total data center power, and is the inverse of PUE or 1/PUE. Higher DCiE values indicate a more efficient data center.
### Reference Design Quicktour

#### System Planning Sequence

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<td>Generate Detailed Design</td>
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### What is a reference design?

Given the IT parameters of criticality, capacity, and growth plan, there are potentially thousands of ways the physical infrastructure system could be designed, but there is a much smaller number of “good” designs. A library of these optimal – i.e., recommended and proven – designs can be used to quickly narrow down the possibilities. Much like a catalog of kitchen designs at a home improvement store, reference designs provide a choice of general architecture for the design of the system. Reference designs can help in zeroing in or ruling out, by presenting designs that may be hard to articulate or perhaps haven’t been thought of. Reference designs have most of the system engineering built in, but with enough variability to satisfy the specific requirements of a range of user projects.

A reference design is an actual system design that is a prototype or “shorthand” representation of a collection of key attributes of a hypothetical user design. A reference design embodies a specific combination of attributes including criticality features, power density, scalability features, and instrumentation level. Reference designs have a practical range of power capacity for which they are suited.

The great power of reference designs is they provide a shortcut to effective evaluation of alternative designs without the time-consuming process of actual specification and design (tasks #4 and #5 in this planning sequence). High quality decisions can be made quickly and effectively.

### Choosing the physical room

Selection of the physical room where the system will be installed allows for consideration of room characteristics that might constrain the choice of reference design. Examples of possible constraints are room size, location of doors, location of support columns, floor strength, and ceiling height. For example, suppose a reference design is not an exact physical fit in the user’s room – racks may need to be added or removed. Such a reference design might have a cost attribute allowing estimation of the cost adjustment needed to scale the design to fit a specific floor space.

### Choosing a reference design

The reference design is chosen to support the criticality, power capacity, and growth plan that have been determined in task #1 of the planning sequence. A reference design will have characteristics that make it more or less adaptable in each of these areas. For example, a reference design may be designed for one criticality level, or it may allow modifications to adjust the criticality up or down. A reference design may be able to support a range of power loads. A reference design may be scalable or not. Scalability of the reference design determines how well it can support the phase-in steps of a growth plan. Scalable reference designs may differ in the granularity (step size) of their scalability, making them more or less adaptable to a specific growth plan. The IT load profile (constructed from the four parameters of the growth plan) will suggest a rough idea of phase-in steps. The reference design is then chosen to have a scalability that supports that general phase-in concept. Since the actual phase-in steps will be row-based, the row-by-row details of the phase-in plan will be finalized later in the planning sequence, after the row layout of the room has been determined.

A library of reference designs will be particularly useful if it has a software tool to assist in selecting an appropriate reference design. Input to such a “reference design selector” would be the foundational IT parameters established in the previous Determine IT Parameters task – criticality, capacity, and growth plan. Other essential requirements may also need to be included to further narrow down the possible reference designs, such as type of cooling or power density. The automatically selected reference design(s) can then be reviewed for additional considerations that may not be handled by the selector tool, such as location of doorways, support columns, or other significant constraints.

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Your Next Steps

CHECK OUT… APC online resources
APC has developed a wealth of online tools to help you clarify your requirements and explore your options:

- Data Center Reference Design Selector
  The Schneider Electric Data Center Reference Design Selector cut right to the chase to present a wide spectrum of data center architecture that best meet your needs, saving you time and hassle.

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- Ten Cooling Solutions to Support High-Density Server Deployment (#42)
- Rack Powering Options for High Density (#29)

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