Practical Guide to Preparing Edge Sites and Installing Micro Data Centers

White Paper 288

Version 1

by Victor Avelar and Paul Lin

Executive summary

IT departments with computing needs at the edge typically focus their attention on specifying the IT stack that meets business requirements. The physical infrastructure that supports this IT stack tends to get less attention, which increases risk of downtime, project delays, and cost overruns. This paper provides practical guidance on preparing your edge sites including how to assess the site's constraints as well as, power, cooling, and network connectivity needs. It also provides guidance on starting up the system. The focus of this paper is on small server rooms and branch offices with up to 10kW of IT load.

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Introduction

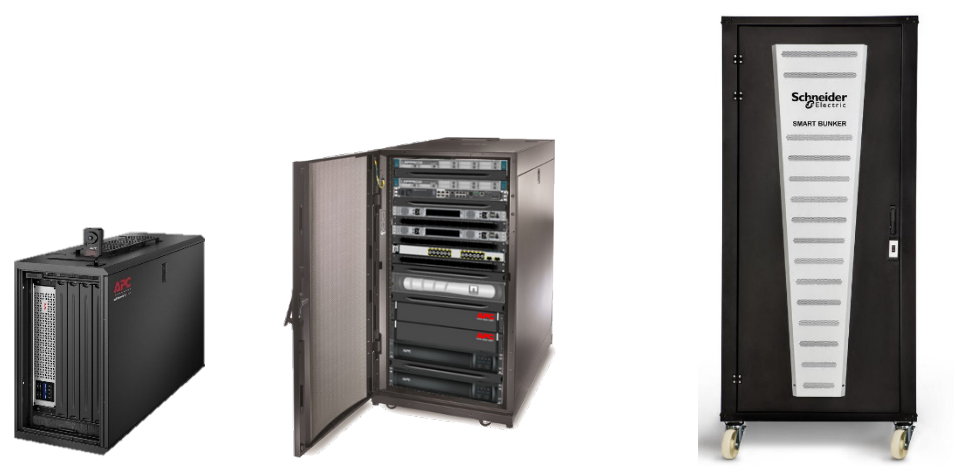
As businesses grow and rely more on edge computing applications, IT downtime has a greater impact on the business. For more information on edge computing, see White Paper 226, *The Drivers and Benefits of Edge Computing*. As with many businesses, it takes a downtime event or a series of close calls to finally invest in improving the availability of IT operations. In many cases, this spurs new IT upgrade projects. An upgrade project is the optimum opportunity to assess the physical infrastructure required to support IT, however, our research reveals that IT stakeholders often lack two things in this regard:

1. **Guidance on specifying improvements to edge IT availability at these sites** – There are numerous best practices to improve the availability of a site and the micro data center you intend to deploy, some of which are dependent on the configurations of the micro data center and also on constraints within your site. A site walk-through along with a checklist of best practices will help improve edge IT availability.
2. **Guidance on how to prepare edge sites for delivery and installation of micro data centers at one or more locations** – After availability improvements for the IT and site have been determined, you need to implement those improvements while anticipating potential issues that can risk IT availability, delay the project, and/or cause cost overruns.

This paper provides practical guidance for the second item, while White Paper 280, *Practical Guide to Ensuring Availability at Edge Computing Sites*, provides guidance for the first. We recommend that you read White Paper 280 **BEFORE** reading this paper, as the checklists in White Paper 280 help specify site work, location, and the configuration of the micro data center that will eventually be delivered and installed.

A micro data center is a self-contained, secure, computing environment that includes all the storage, processing, and networking necessary to run production applications. The micro data centers are best suited to support edge computing over other alternatives such as server rooms and traditional data centers. White Paper 223, *Cost Benefit Analysis of Edge Micro Data Center Deployments*, provides more information on the drivers and cost benefits of micro data centers for edge computing applications. The micro data centers are shipped in one enclosure and include all necessary power, cooling, security, and associated management tools. Micro data centers are assembled and tested in a factory environment. **Figure 1** shows three examples of micro data centers.

Figure 1
Examples of micro data centers



6U micro data center Haft-rack micro data center Single-rack micro data center

This paper deals with the deployment of a single-rack micro data center inside a building. In this paper we assume an IT integrator[1] has pre-configured the IT rack with all the IT equipment and the appropriate IT physical security, monitoring, cable management, etc., according to the items selected in White Paper 280's checklists. This integration is considered a best practice to reduce unexpected defects such as incompatible parts, missing parts, damaged components, incorrect parts, etc.

The following sections summarize the actions you must take to prepare edge sites and install a micro data center on time, on budget, and with no surprises:

- Assess site constraints
- Install power circuit
- Install cooling system
- Provide network connectivity
- Install micro data center
- Start up the system

Note that these actions are not meant to encompass all the detailed procedures that contractors must go through. They are meant to provide high-level guidance on work that must be completed in anticipation of a micro data center delivery and installation. Some of these actions must be completed before moving the IT rack into place because exposing the IT equipment to a construction environment will risk damage due to dust, falling debris, vibration, etc. The remaining actions should be completed after the micro data center is delivered to complete the installation.

Assess site constraints

After identifying the installation site within the building such as what floor, which room, etc. for the micro data center, a detailed assessment is required prior to delivery and installation. The assessment has two parts: room assessment and delivery path assessment:

- For floor-standing micro data center installation, assess floor area of the **room** (length and width), and available room height accounting for all service clearances and fire suppression requirements for sprinklers, for example, per local jurisdiction. Then, identify concentrated static floor loading capacity (lbf/ ft2 or kPa). If a raised floor is used, record the height of the floor, identify the floor's rolling weight capacity (lbs/kg) and concentrated static load capacity (lbf/ ft2 or kPa). For wall-mounted micro data center installations, assess the available area and strength of the wall.
- Walk the **delivery path** to assess if the pathway leading to the installation site, through all doors, can support the widest component specified for your micro data center. For example, if there is an elevator, you need to identify the elevator door's dimensions, interior area, and weight limitations (lbs/kg). If there is no elevator, check the dimensions of stairs required to deliver the equipment from the building entry to the room.

There are also other questions that serve as guidance in avoiding surprises on the day your micro data center is delivered.

- Is seismic bracing required for equipment proposed in this project?

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[1] For more information on this emerging model that involves an integrated ecosystem of cooperative partners see White Paper 277, *Solving Edge Computing Infrastructure Challenges*.

- Have you identified when all electrical/mechanical installation work will be completed?
- Have you identified the responsible party for rigging? Does the delivery truck need a liftgate?
- Have you identified responsible party for de-skidding/unpacking and placement of components into the room?
- Is a "staging area" available for deposit of all equipment prior to placement in room or will all equipment be placed in the final room upon arrival to site?
- Have you identified if a forklift is required?

Install power circuit

After the site assessment and before hiring an electrician to install the power circuit, you need to know the total IT load power. Your IT partner, or integrator should know this, as they typically estimate the IT load and specify the UPS or surge protection device that will power the IT stack. With this information, you can tell your electrical contractor:

1. You need a dedicated branch circuit installed to prevent other loads from tripping the micro data center breaker due to overloaded.
2. The voltage that will feed your micro data center (i.e. 100V, 120V, 230V).
3. The location and the receptacle type required (e.g. NEMA 5-20, SCHUKO CEE 7) – this is determined by the UPS input power cord length (or surge protection device) and input plug.
4. Which distribution panel should feed your dedicated circuit.
5. Install a dedicated maintenance circuit in the IT room to provide power for maintenance activities, lighting, etc. Follow steps 2-4 for this circuit.
6. If a generator is available, connect the dedicated micro data center circuit and maintenance circuit to the generator panel.

From the receptacle type, the electrical contractor should know the circuit breaker size required (e.g. 20 amps), however, they will likely need to assess your building to quote the job. Note that there may be other requirements as discussed in White Paper 280, such as color-coded power feeds, that the contractor should know about.

If your micro data center requires a UPS, (in almost all cases this is true), then the power circuit should be sized for the maximum UPS power draw. This will ensure that the circuit provides enough power to support the IT load and UPS losses, including battery charging. Most UPS specifications will indicate the input plug type. An example of this is shown in **Figure 2**. Note that the "P" in the "5-20P" means "plug" as opposed to 5-20R, where "R" means receptacle. The cord length should also appear in the specifications. You'll need this to ensure that the power cord of the UPS or surge device is long enough to reach the new receptacle.

Figure 2
An example of UPS input specifications showing type of input plug (NEMA 5-20P)

Input	
Nominal Input Voltage	120V
Input frequency	50/60 Hz +/- 3 Hz (auto sensing)
Input Connections	NEMA 5-20P
Cord Length	6ft (1.83meters)
Input voltage range for main operations	82 - 144V
Input voltage adjustable range for mains operation	75 - 154V
Number of Power Cords	1
Other Input Voltages	110, 127

UPSs for single-rack micro data centers are typically line-interactive for loads up to 5kVA and double-conversion for loads above 5kVA[2]. Note that UPS capacities greater than approximately 2.2kVA cannot be plugged into a standard U.S. receptacle (e.g. 5-20R). Standard receptacles in countries with 230VAC can support approximately 3kVA depending on the country. For example, in Europe, a 3kVA system typically requires an IEC C-19 receptacle and a 5kVA system typically requires an IEC C-19 receptacle. While in the U.S., a 3kVA system typically requires an L5-30 receptacle and a 5kVA system typically requires an L6-30 receptacle. The “L” represents a “locking” plug, the first number represents the voltage, and the second number represents the amp rating. UPS systems greater than approximately 6kVA are typically hardwired to the electrical panel. Installing a new receptacle or hardwiring requires an electrical contractor. If this is not a possibility, an alternative approach is to use multiple lower-capacity UPS systems which may require multiple dedicated circuits.

If your application doesn’t require a UPS, plug your IT equipment into a surge protection device like the one shown in **Figure 3**. Plugging your IT equipment into “raw” utility, may result in damaging the IT equipment due to impulse power transients. Note that rack PDUs typically do not protect equipment against voltage spikes. Rack PDUs are typically fed by a UPS which includes surge protection.

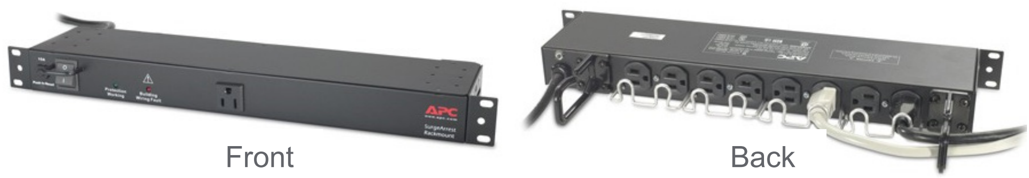


Figure 3
An example of a rack-mount surge protection device

Install cooling system

Preparing the site for the cooling system installation depends on which cooling system is required. White Paper 68, *Cooling Strategies for IT Wiring Closets and Smalls Rooms*, will help you determine which cooling strategy to use, based on IT equipment power and target room temperature. White paper 68 will direct you to one of these four cooling strategies:

- **Conduction** – No cooling system is required.
- **Passive ventilation** – Ventilation grilles in doors or walls, and no air moving device.
- **Fan assist** – Wall or ceiling-mounted fan system. This solution requires a construction contractor for installation but may also require an electrical contractor. As a best practice, the fan should be powered from the UPS in the micro data center, to ensure cooling during a power failure. In this case you don’t need an electrical contractor. However, if powering from a separate circuit, you may need a contractor to install the circuit. Some IT cabinets have integrated ventilation fans which do not require a construction contractor.
- **Dedicated cooling** – Dedicated air conditioner for the IT load. This solution requires a mechanical contractor and potentially an electrical contractor. The electrical contractor should be scheduled to install both the micro data center circuit and dedicated cooling circuit at the same time. Air-cooled, self-contained units are used when a return plenum is available, such as a dropped ceiling. Alternatively, if there’s access to the building’s chilled water, condenser water, or glycol loop, a dedicated system using one of these cooling fluids is possible. If an outside wall or roof is within about 30m (100ft) of the IT space,

[2] For information on UPS topologies see White Paper 79, *Technical Comparison of On-line vs. Line-interactive UPS designs*

an air-cooled system is recommended. This distance requirement can ensure the performance and reliability of the air-cooled system.

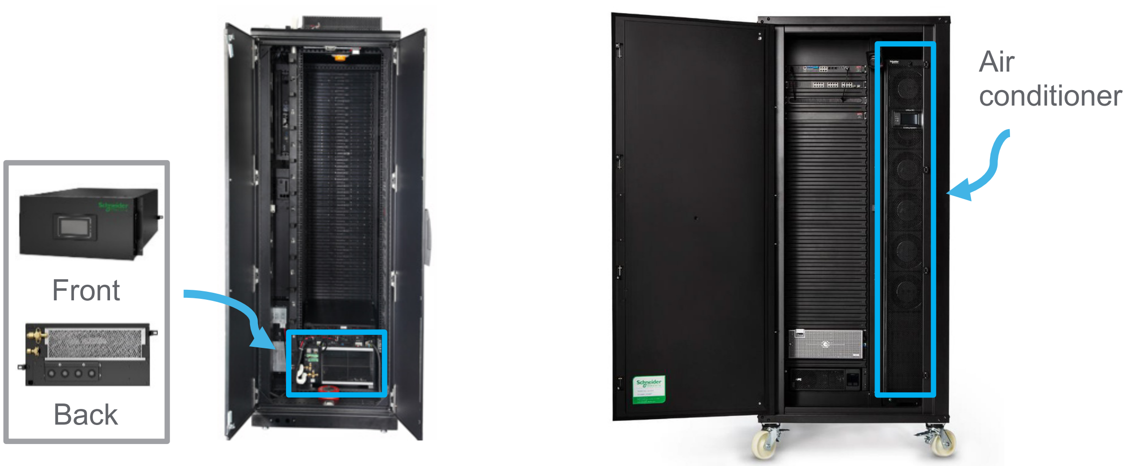
An air-cooled system has two parts and is known as a split system, the "cooling unit" that is usually hung high on the wall near the micro data center and the "condensing unit" that sits on the roof or on the side of the building. This type of installation requires drilling holes through walls for running refrigeration piping. There are distance limitations to using this solution but in most cases, it provides a lower-cost solution ranging from $0.30 to $0.40 per watt[3] for the unit. A rule of thumb for installation is that it costs about the same as the materials, therefore the total cost is about $0.60 to $0.80 per watt. **Figure 4** shows an example of an air-cooled split system. In cases where the refrigeration piping distance is exceeded, a glycol-cooled system is required. It can cool between 6kW and 12kW and are a common and effective solution for small rooms.

Figure 4
Example of an air-cooled split system

Indoor unit mounted on the ceiling or wall   Condensing unit located outdoors

For some applications with harsh environments, a best practice is to integrate a dedicated air conditioner within IT enclosure. **Figure 5 (a)** shows an example where the indoor unit is mounted inside of the IT enclosure with 3.5kW cooling capacity, and the mechanical contractor is required to install the outdoor condenser unit, while **Figure 5 (b)** shows an example of self-contained air conditioner (cooling capacity is 5kW) , and a mechanical contractor is not required.

Figure 5
Examples of embedded air conditioners



(a) Indoor unit integrated   (b) indoor and outdoor units integrated

Upon choosing a cooling system, ensure that the mechanical contractor communicates their electrical requirements to the electrical contractor, such as voltage, amperage, etc. The mechanical contractor should know the requirements for condenser placement, electrical code clearances for maintenance, etc.

There are instances when the only choice is to locate IT equipment in the occupied office space as is common in corporate branch offices. In these cases, the recommended solution is to install the IT equipment within a secure enclosure with

[3] Per Watt in this case means the rated cooling capacity of the cooling system (in Watts)

specially designed, integrated ventilation, noise dampening, and power distribution. These types of enclosures can ventilate equipment up to about 4kW while keeping the equipment safe and quiet. They are described further in White Paper 278, *Three Types of Edge Computing Environments and their Impact on Physical Infrastructure Selection*.

Consideration of the following questions will help avoid surprises on the day your micro data center is delivered.

- Have you determined where refrigerant, humidification, and condensate lines will be run?
- Have you reviewed the location of the power source feeding the cooling system?
- Have you identified the responsible party for receiving delivery of the cooling solution?
- Have you identified the responsible party for assembling and installing the cooling system?
- Have you identified the responsible party for installation of refrigerant, humidification, and condensate lines?

Provide network connectivity

Preparing the site for network connectivity includes determining the entry path, type, length, and number of the data cables required into the micro data center. There are two approaches to distribute data cables, overhead or under floor. Overhead cable management makes it easier to trace cables and mange moves while underfloor cable management makes it difficult to visually trace a cable. Check with your ISP providers and IT integrators as to what kind of data cable (such as Cat 5, Cat 6, Cat 7, etc.) is required given the network speed required, such as gigabits per second (Gbps) or megabits per second (Mbps). Check also that the router is matched with the cable type. **Table 1** lists characteristics of some different data cable categories[4].

Table 1
Characteristics of different data cable categories

Category	Shielding	Max transmission speed (at 100 meters)	Max bandwidth
Cat 5	Unshielded	100 Mbps	100 MHz
Cat 5e	Unshielded	1 Gbps	100 MHz
Cat 6	Shielded or unshielded	1 Gbps	250 MHz
Cat 6a	Shielded	10 Gbps	500 MHz
Cat 7	Shielded	10 Gbps	600 MHz
Cat 7a	Shielded	10 Gbps	1000 MHz

The following questions serve as guidance to avoid surprises on the day your micro data center is delivered.

- Have you identified the responsible party for installation of network cables?
- Have you identified the responsible party for providing a network connection to cooling unit(s), UPS/PUD(s), and rack-based accessories?

[4] https://www.electronics-notes.com/articles/connectivity/ethernet-ieee-802-3/cables-types-pinout-cat-5-5e-6.php

Install micro data center

After the micro data center(s) is delivered, the next step is to install it. There are also several best practices raised in White Paper 280 which can be implemented during this stage to confirm the installation. The following checklist provides these installation best practices to ensure high availability of micro data centers:

- Connect the UPS to the newly-installed dedicated electrical circuit.
- If the UPS has no integrated bypass, an external bypass module is recommended to prevent dropping the critical load in the event of a UPS fault.
- If a generator is available, connect the micro data center and cooling to the standby generator.
- If you're using dual-corded UPS and IT equipment, color code the A and B feed cables and rack PDUs with different colors to minimize human error.
- Bond all rack enclosure doors and panels.
- Use blanking panels in empty rack U-spaces for airflow management
- Bolt racks to seismic stands or directly to the slab for floor-stand enclosures. For wall-mount enclosures, bolt racks to the wall.
- Place physical security devices on the UPS to maintain security during power outages.
- Integrate video surveillance system with the building's CCTV (closed-circuit television) system to ensure that critical IT areas are also monitored by building security personnel.
- Remove flammable materials such as printer paper, hand towels, paint thinner, etc. from the IT space.
- Configure and locate fire sprinklers based on local fire codes.
- Organize, label, and color-code network cables for cable management to avoid human errors.
- Make sure the sensors and detectors such as temperature, humidity, dry contact, etc. are in right place and connected to the monitoring platform.

Start up the system

Once the micro data center is delivered and installed, the last step is to start up the system. This start up process is typically much simpler than larger multi-rack installations, however when a generator is connected, it is prudent to test the switching sequence to and from generator to ensure that the UPS and generator perform as expected during a power outage. Ensure the micro data center has been factory-tested before delivery. Your IT integrator can identify a responsible party that can perform the onsite start-up of the system. This also includes validating that the various physical infrastructure subsystems – cooling, security, physical infrastructure monitoring, and management systems (DCIM) – function as specified.

Conclusion

Our experience with thousands of edge sites at small businesses and branch offices reveals that most of them are unorganized, unsecure, hot, unmonitored, and space constrained. It is also clear that these situations often place your IT availability at risk. An upgrade project is the optimum opportunity to assess the physical infrastructure required to support IT, however, our research reveals that IT stakeholders often lack two things in this regard. Following the guidance in White Paper 280 and 288 will help prevent , delay your project, and overrun your cost. IT stakeholders in these environments often lack guidance for deploying micro data centers. This paper is written to comprehend these challenges and summarizes the most practical guidance to provisioning power, cooling, and network connections in these edge sites, as well as preparing for delivery and installation of micro data centers with up to 10kW of IT load.

About the authors

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