

# Data Center Physical Infrastructure for Enterprise Wireless LANs

## White Paper 84

Revision 1

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### > Executive summary

Wireless LAN (WLAN) deployments can result in unexpected or unplanned power, cooling, management and security requirements. Most wiring closets do not have uninterruptible power supplies (UPS), and they do not provide adequate ventilation or cooling required to prevent equipment overheating. Understanding the unique data center physical infrastructure (DCPI) requirements of WLAN equipment allows planning for a successful and cost effective deployment. This paper explains how to plan for DCPI while deploying indoor WLANs in small, medium or large enterprise, with emphasis on power and cooling. Simple, fast, reliable, and cost effective strategies for upgrading old facilities or building new facilities are described.

### Contents

*Click on a section to jump to it*

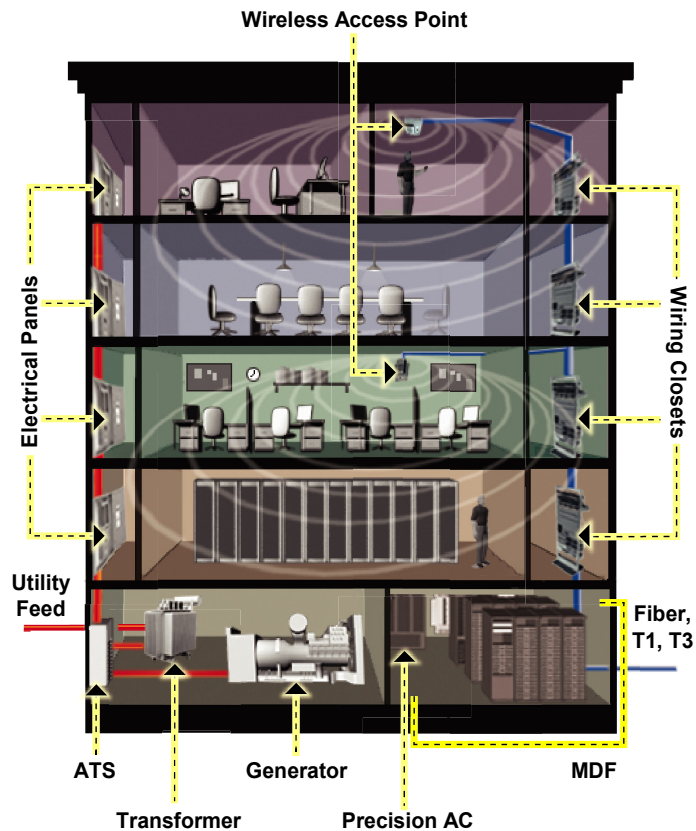
Introduction	2
Wireless access points	3
Intermediate distribution frame (IDF)	5
Main distribution frame (MDF)	8
Data center or server farm	10
Conclusion	12
Resources	13

## Introduction

Data center physical infrastructure (DCPI) is the foundation upon which all highly available networks reside but is often ignored. It has to be resilient, scalable, highly available, and manageable. DCPI consists of:

1. Power systems such as UPS, power distribution units (PDU), and generators to provide uninterrupted conditioned power to the critical loads.
2. Cooling systems that provide optimal environment by regulating temperature and humidity
3. Racks that house the critical network equipment like switches, routers, gateways, servers etc.
4. Security and fire protection systems
5. Cabling to interconnect equipment
6. Management systems that locally and remotely communicate with integrated services to ensure their satisfactory operation 7x24
7. Services to deliver, install, and commission equipment as well maintenance and diagnostics

This paper discusses and reviews the challenges imposed on DCPI while deploying indoor wireless LANs (WLANs) in a small, medium or large enterprise with a focus on power and cooling. There are various WLAN standards prevalent in the industry, however this paper refers to IEEE based standards 802.11a, b & g also known as Wi-Fi. A typical WLAN installed in an enterprise is show in **Figure 1** below.

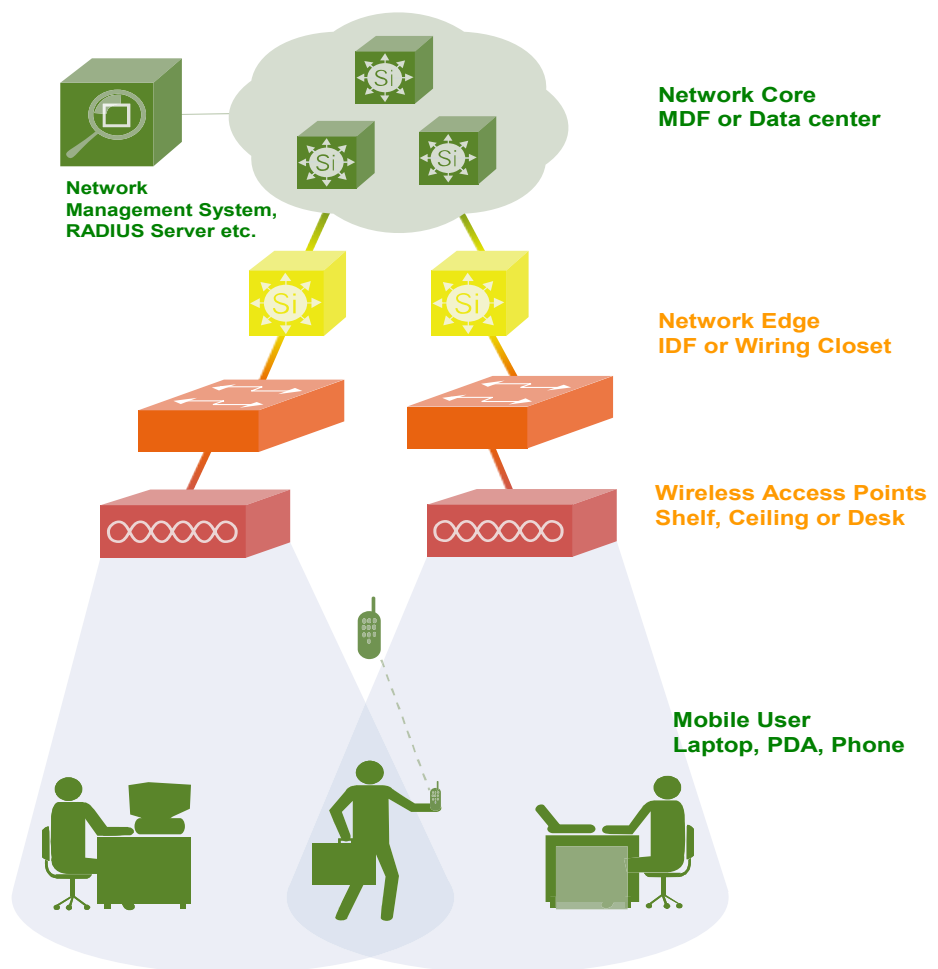


**Figure 1**

*Typical WLAN deployment in an enterprise*

The WLANs based on these IEEE standards are used to compliment, augment or substitute the wired LANs in enterprises, homes and public hot spots e.g. airports, hotels, restaurants etc. A successful deployment of WLANs ensures that the entire network including the wireless access points provide similar or higher levels of availability to the user, compared to wired LANs. With rapid popularity of power over the Ethernet (PoE) based on adoption of IEEE 802.3af, the legacy wiring closet, which used to house passive devices like patch panels and hubs, will now need to accommodate high power switches, routers and UPS with long runtimes. These closets that feed power and data to the wireless access points, IP phones, security cameras etc. now become very critical. Cooling and airflow in these wiring closets must be examined to ensure the continuous operation and high availability of these peripherals.

Typical WLANs are built in layers and each layer is made of components that reside in one of four physical locations (**Figure 2**). Newer modern networks and switches tend to have layer 2 and layer 3 capabilities often times combining the access and distribution layer in to one aggregation layer. DCPI for these four locations vary as described in the following sections.



**Figure 2**

*Typical WLANs architecture*

## Wireless access points

Wireless access points (APs) provide the mobile user connectivity to the network (**Figure 3**). These APs typically draw 6-7 Watts but some devices may draw more power. IEEE 802.3af limits the current drawn by such devices from data cables to 350 mA. Networks complying with this new standard will deliver a maximum 15 W of power up to a distance of 100 m (328 ft). For higher power consumption these devices will have to rely on other external power sources, like plug-in adaptors.

**Figure 3**

*Typical wireless access point (indoor use)*



### Environment

These APs are mounted in ceilings, or on shelves and are generally in an indoor office environment. Sometimes they are used in outdoor environments. For newly deployed or upgraded networks they will most likely be powered over the Ethernet. However, in some cases they are powered from the wall outlets.

### Problems

These APs need to be highly available and secure to ensure connectivity to a number of mobile users. The biggest challenge from a DCPI perspective is to ensure their continuous operation even during power outages.

### Best practices

PoE is the best way to solve the power availability problem. It also eliminates the problem of ensuring power to the remotest APs in the building without requiring an electrical outlet or an electrician. The power is now being fed to the APs by network switches located in the wiring closet supported by a UPS system with a long runtime. For those APs powered from wall outlets (not using PoE) a compact UPS system with a long battery back-up time (four or more hours) should be provided locally like the Schneider Electric Back-UPS HS. The UPS should be wall / shelf-mounted and easily installed near the AP. An example of a UPS that can provide power to APs is shown in **Figure 4**.

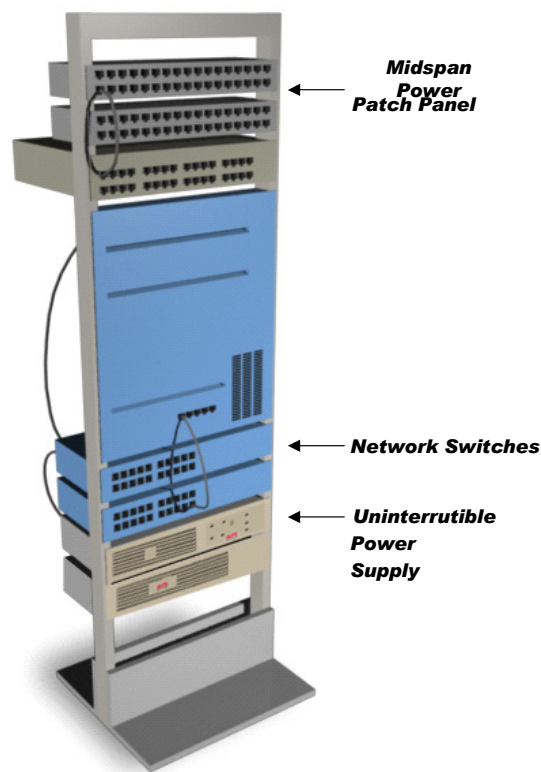
**Figure 4**

*Wall-mounted UPS*



## Intermediate distribution frame (IDF)

IDF or wiring closets are typically comprised of layer 2 & layer 3 access and distribution switches, hubs, routers, patch panels, UPS system with a battery back-up as well as any other miscellaneous telecommunications equipment mounted in a two post rack (**Figure 5**). Most new switches, stackable or chassis based, have built in capability to supply power over Ethernet (so-called 'end-span' power supplies) to feed power to the wireless access points. For switches without this capability, an appropriately sized external 'mid-span' power patch panel is used to inject PoE. Depending on the size of the enterprise and the network architecture there can be several IDFs located in the building and hundreds of them within the whole enterprise. These closets which are often ignored now become very critical in ensuring connectivity to the mobile users and hence their availability is very important.



**Figure 5**  
IDF (wiring closet)

### Environment

These IDFs or wiring closets are typically hidden in some remote location of the building with little or no ventilation, illumination and access control. Unless the customer is moving into a new building, they most likely will want to reuse these wiring closets. Legacy telecommunication and data networks typically used wiring closets for punch down blocks, patch panels, and a few small stackable hubs or switches, but most of the new access / distribution switches are designed to supply PoE. They draw and dissipate considerably more power. These new switches are generally 19" rack mount type and have varying air flow patterns depending on the manufacturers e.g. side to side, front to back etc. A typical IDF will house 1-3 racks worth of equipment, and draw 500 W to 4000 W of single phase AC power.

## Problems

While deploying WLANs these IDF's need the most attention in terms of their data center physical infrastructure particularly power, cooling, access control and management. They draw power in the range of 500 W to as high as 4000 W single phase at either 120 or 208 V or 230 VAC, depending on the network architecture and the type of switch used. In a wiring closet, ensuring the right type of receptacle (e.g. 5-15R, L5-20R, L6-20R, L6-30R, IEC320C13, and IEC320C19) and right amount of power with the right circuit breaker protection to all the network equipment, UPS and PDU is a challenge. Cooling, airflow, management and services are often a bigger problem but often ignored in these wiring closets.

## Best practices

All equipment in the IDF should be protected by a UPS system. The selection of the UPS system is based on:

- The total power required in Watts
- The run time required in minutes
- The level of redundancy or fault tolerance desired
- The voltages and receptacles required

The UPS system is sized to the sum of the Watt ratings of the loads. A common rack-mount UPS like the APC Smart-UPS (**Figure 6a**) will provide approximately four nines\* (99.99%) of power availability, while an N+1 redundant, UPS with built in bypass, like the APC Symmetra RM (**Figure 6b**), with one hour runtime will provide approximately five nines\* (99.999%), which may be sufficient for most applications. See White Paper 69, *Power and Cooling for VoIP & IP Telephony Applications* for details on availability analysis.

 Related resource  
**White Paper 69**

*Power and Cooling for VoIP  
& IP Telephony Applications*

### Figure 6a (left)

Rack mount UPS

### 6b (right)

Fault tolerant UPS



UPS products are available with battery packs to provide different durations of run time. Products of the type shown in **Figures 6a** and **6b** have optional battery packs, which can be used to extend run time.

Higher levels of availability e.g. six or seven nines\* may be needed for some critical applications like 911 service. Such requirements may be met by using dual network switches with dual power cords, dual UPS, and concurrently maintainable electrical architectures with generator back-up. Many companies like Schneider Electric have dedicated availability consulting services to evaluate individual customer sites, requirements and recommend high availability power infrastructures for such critical networks.

Finally, identify the plugs and receptacles required for all the equipment including the UPS in the wiring closet. Ideally all the equipment should be directly connected to the UPS or the transformer, and the use of additional outlet strips or rack PDUs should be avoided. However, depending on the amount of equipment it may not be practical and a rack PDU strip is required. In that case a high-grade rack PDU specifically designed for the purpose should be used. The PDU should have enough receptacles to plug all the current equipment with some spares for future needs. PDUs with a meter displaying the current power consumption are preferred as they reduce human errors like accidental overloading and resultant load drops.

The best criteria for selecting the appropriate UPS model includes, meeting the required power level, redundancy, voltage, and run time. This process is simplified by using a UPS selector such as the APC [UPS Selector](#). This tool has power data for all popular switches, servers and storage devices, which avoids the need to collect this data. In tools like this, various receptacle options are available when configuring a UPS.

To ensure continuous operation of the equipment in the wiring closet 7 x 24 x 365, cooling and airflow issues must be identified and addressed. Power dissipation in the wiring closet should be calculated to decide on a cost effective method to solve the problem (see **Table 1**). The most important thing to note here is that many network switches have a high power draw; however this does not mean that all the power is dissipated as heat inside the wiring closet. For example a layer 2/3 switch may draw 1800 W of power but it may be dissipating only 300-500 W in the closet. The rest of power is supplied over the network to the various devices like wireless access points, IP phones, security cameras scattered and is dissipated throughout the office area.

**Table 1**

*WLANs wiring closet heat output calculation worksheet*

Item	Data required	Heat output calculation	Heat output subtotal
Switches without in-line power, other IT equipment (except mid-span power units)	Sum of input rated power in Watts	Same as total IT load power in watts	_____ Watts
Switch with in-line power capability	Input rated power in Watts	0.6 x Input power rating	_____ Watts
Mid-span power units	Input rated power in Watts	0.4 x Input power rating	_____ Watts
Lighting	Power rating of any lighting devices permanently on in Watts	Power rating	_____ Watts
UPS system	Power rating of the UPS system (not the load) in Watts	0.09 x UPS power rating	_____ Watts
<b>Total</b>	Subtotals from above	Sum the above heat output subtotals	_____ Watts

Once power dissipated in the wiring closet is calculated follow the broad guidelines outlined in **Table 2**.

**Table 2**

WLANs wiring closet cooling solutions worksheet

Total heat load in closet	Condition	Analysis	Action
< 100 W	Balance of building is conditioned space	Wall conduction and infiltration will be sufficient	None
< 100 W	Balance of building is hostile space, no HVAC system	Any fresh air from outside the room cannot be considered safe to use due to temperature or contaminants	Install a self-contained computer air conditioner in the closet adjacent to the equipment
100 – 500 W	Dropped ceiling (overhead) HVAC system exists. Balance of building is conditioned space	Fresh air from outside closet will be sufficient if drawn through, but door may block air. Bring air in through door and exhaust to HVAC return	Place a return grille in overhead ventilation system in top of closet, and place a vent in bottom half of closet door.
100 – 500 W	No access from closet to any HVAC system. Balance of building is conditioned space	Fresh air from outside closet will be sufficient if drawn through, but door may block air. Bring air in bottom of door and exhaust out top of door	Place an exhaust grille in top of closet door, and place an intake vent in bottom half of closet door.
500 – 1000 W	Dropped ceiling (overhead) HVAC system exists, Balance of building is conditioned space	Fresh air from outside closet will be sufficient if drawn through continuously, but door may block air and continuous fan operation is required and not assured	Place a return grille with ventilation fan assist in top of closet, and place a vent in bottom half of closet door.
500 – 1000 W	No access from closet to any HVAC system. Balance of building is conditioned space	Fresh air from outside closet will be sufficient if drawn through continuously, but no way to get the air.	Place an exhaust grille with ventilation fan assist in top of door, and place a vent grille in the bottom half of closet door.
> 1000 W	Dropped ceiling (overhead) HVAC system exists and is accessible, Balance of building is conditioned space	Fresh air from outside closet will be sufficient if drawn directly through the equipment and no hot exhaust air from the equipment recirculates to the equipment intake	Put equipment in an enclosed rack with a hot exhaust air scavenging system and place a vent grille in bottom half of closet door.
> 1000 W	HVAC system is not accessible, Balance of building is conditioned space	Moving air through the door is insufficient, local cooling of the equipment exhaust air is required	Install a self-contained computer air conditioner in the closet adjacent to the equipment

Finally, all the equipment in the closet needs to be monitored and managed for continuous operation. This can help avoid unplanned downtime due to equipment aging caused by environmental conditions e.g. temperature and humidity or UPS batteries capacity reduction with time. Additionally, closets are often located in remote offices or areas where there is no IT support on staff. In such situations remote power reboot capability with PDUs and on-site service contracts from equipment manufacturers should be considered.

## Main distribution frame (MDF)

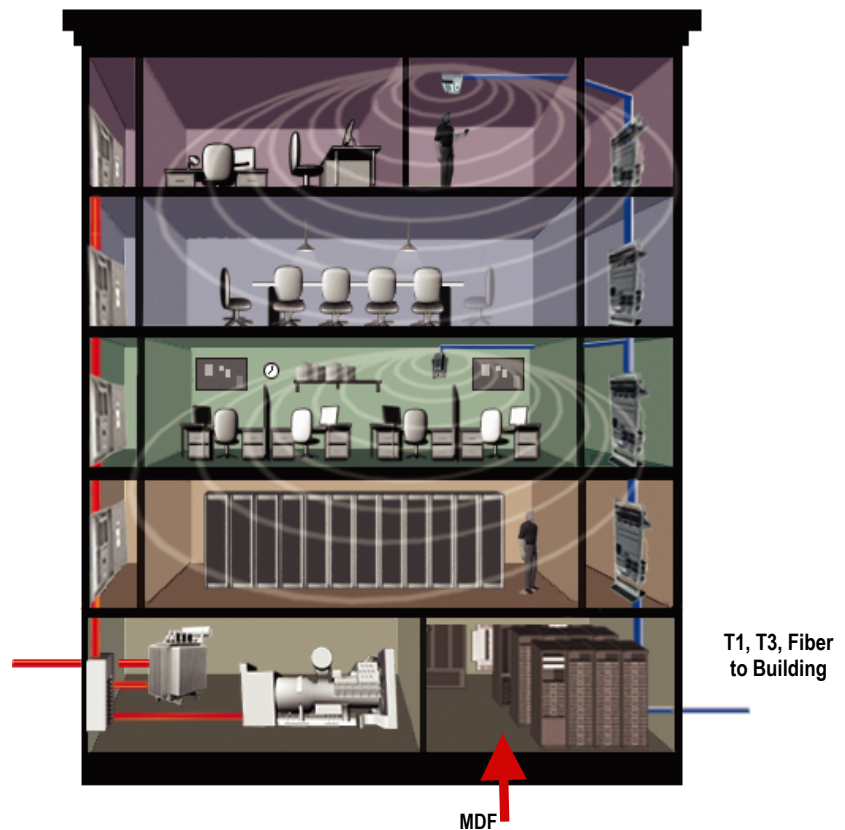
MDFs are also called MERs (main equipment rooms) or POP (point of ping or presence) rooms (**Figure 7**). They are the building service entrance for the IT and communications networks. The fiber to the building and the T1/E1, T3/E3 lines entering the building or campus, terminate into the MDFs providing connectivity to the internet backbone and central



office. They house the most critical network and communication equipment like layer 3 routers, switches, gateways, PBXes etc. The MDF is the most critical room as it supports and feeds all of the wiring closets within the building or campus which in turn feed the wireless access points and is often treated as a small computer / data room.

**Figure 7**

*Main distribution frame*



## Environment

MDFs are generally located in the basement or first floor of the building. They may have 4-12 racks of equipment and draw 4 kW to 40 kW single or three-phase at 208, 230, 400 or 480 VAC power. There may be some equipment requiring -48 VDC power. MDFs may have a mixture of two-post, four-post open and four-post enclosed racks used to mount a variety of networking, communications and IT equipment. This equipment may have different airflow patterns e.g. side to side, front to back etc. and can be 19" or 23" rack mount type. However, more and more new generation devices are 19" rack mount type with front to back airflow.

## Problems

Some MDF rooms do not have a UPS, many do not have adequate battery back-up time and often times may not have a dedicated precision air-cooling system.

## Best practices

These MDFs provide backbone connectivity to a central office and internet. They house a variety of critical network, telecommunications and IT equipment and should be treated like a small data center or a computer room. To provide five nines\* of power availability, the MDF room should be protected by modular, redundant UPS with internal bypass and at least thirty minutes of back-up time. Higher runtimes with higher levels of availability like six or seven nines\* can be provided by using dual switches with dual cords, dual UPS, and concurrently

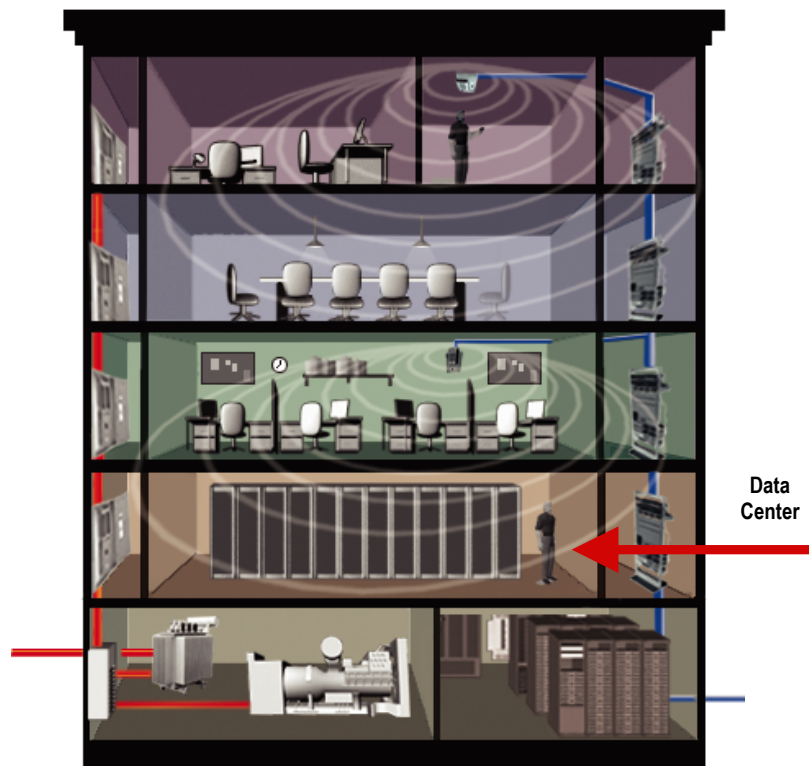
maintainable electrical architectures with generator back up. Companies like Schneider Electric have dedicated availability consulting services to evaluate and recommend high availability architecture for such critical network infrastructure.

To ensure continuous operation of all the equipment during power outages and optimum operation during normal conditions, MDFs should have their own precision air conditioning units with environmental monitoring. Redundant air conditioning units should be considered for critical applications needing higher availability. For high power density racks (> 3 kW/rack) additional air distribution and air removal units should be used to avoid hot spots. Unlike servers and storage devices, many switches utilize side-to-side airflow. This creates special issues when installing in an environment which uses enclosed racks. These issues are discussed in detail in White Paper 50, *Cooling Solutions for Rack Equipment with Side-to-Side Airflow*.

 Related resource  
**White Paper 50**  
*Cooling Solutions for Rack Equipment with Side-to-Side Airflow*

## Data center or server farm

The data center or server farm (**Figure 8**), houses the network management servers. These servers are used for operation, maintenance and management of WLANs e.g. authentication, billing, monitoring rogue users, rogue access point etc. In addition, based on the size of organization and the network architecture, it may house layer 2/3 switches and other enterprise IT equipment. Depending on their size (small, medium or large) a typical data center or server farm can house from tens to hundreds of racks, loaded with tens or hundreds of servers and a variety of IT, networking and computing systems running business critical applications like ERP, CRM and other web-based services.



**Figure 8**

*Typical data center or server farm*

### Environment

Data centers, generally located at corporate offices, can draw 10 kW single or three-phase 208 VAC power on the low side, to hundreds of kilowatts of 3-phase 480 VAC power on the high side. There can be some small -48 VDC power requirements for some telecommunica-

tions loads but predominantly it will be all AC power loads. The majority of data centers have a UPS with battery back-up, generator and precision air conditioning units.

## Problems

WLANs servers and switches are basically small incremental loads of a data center which may require a higher runtime, more redundancy and higher availability than other IT and networking equipment.

## Best practices

Even though the data center may have its own UPS and generator, many times it might be appropriate to provide for a separate, redundant UPS with longer battery back-up time for the WLAN equipment. Identify and group the WLAN gear (servers, switches etc.) requiring longer runtime and higher availability in a separate area, in separate racks within the data center. Provide them with a dedicated UPS with longer runtime and higher availability N+1, N+2 etc. as needed. This concept of “targeted availability” helps increase availability of critical WLAN equipment without having to incur a large capital expense for the entire data center. Higher levels of redundancy like dual feeds with dual generators and dual N+1 UPS with dual power paths all the way to the server and other critical equipment in the rack may be considered for highly available data centers and networks.

Ensure that the data center’s precision air conditioning equipment has enough cooling capacity for the new additional WLAN equipment. Redundant air conditioning units may be considered for higher availability. For high power density racks (> 3 kW/Rack) additional air distribution and air removal units should be used to avoid hot spots. Avoidable mistakes that are routinely made when installing cooling systems and racks in data centers or network rooms compromise availability and increase costs. For more information on this topic refer to White Paper 49, *Avoidable Mistakes that Compromise Cooling Performance in Data Centers and Network Rooms*.



Related resource  
**White Paper 49**

*Avoidable Mistakes that  
Compromise Cooling  
Performance in Data  
Centers and Network Rooms*

## Conclusion

To ensure high availability and security to WLANs, special attention must be paid to its data center physical infrastructure across all its layers from APs on the edge to IDFs, MDFs and data centers at the core. The biggest problems in terms of power and cooling lie within the wiring closets. Cooling is a special problem for wiring closets, in many cases ventilation alone is sufficient. In some cases targeted spot air conditioning is required. Small, dedicated UPS with extended runtime is a cost effective solution compared to one large centralized UPS powering all wiring closets. With MDFs there may be a limited problem with available run time, which can be solved by providing a generator or a larger battery back-up with UPS.



Related resource  
**White Paper 69**

*Power and Cooling for VoIP  
& IP Telephony Applications*

\* The availability levels stated in this paper are based on a comparative availability analysis described in the Appendix of White Paper 69, *Power & Cooling for VoIP & IP Telephony Applications*



## Acknowledgements

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