Data Center Design:
From Rack Row to Rack Space

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RACK SPACE

Components of Rack

- Rack
- Cable management
- Power
- Environmental and security
- Software management
- IT devices

RACK

Rack

- Wall mount enclosure
- Vertical wall mount enclosure
- Open frame network rack
- High density networking rack
- Rack enclosure

Wall Mount Enclosure

- Ideal for remote environments
- Mounts to wall

Vertical Wall Mount Enclosure

- Equipment hangs vertical
- Space saving design
- One person install

Vertical Wall Mount Enclosure

Key features and benefits

Save time

- **Modular design** guarantees installation can be performed by one technician, reducing installation costs and time to deploy
- **Unsurpassed weight capacity** allows up to 400 lbs. of critical equipment to be installed

Save space

- **Large cable access openings** on the top, bottom, and sides of the backplate provide increased cable and conduit routing flexibility
- **50 percent smaller footprint** makes the MiniRaQ an ideal solution for network closets and other small, non-traditional applications

Reduce risk

- **The optional high-velocity, multi-fan module** ensures critical networking equipment stays cool

Vertical Wall Mount Options

Vertical Wall Mount Options

Configuration options

Open rack

Sturdy, low-profile, open frame wallmount rack

Convertible rack

Rugged, low-profile design capable of being upgrade to MiniRaQ securre

Secure rack

Locking lid wallmount rack with heat removal, air filtering, equipment mounting and data/cable management accessories

Open Frame Rack

- 2 or 4 post
- Ideal for network
- Bolts to floor

High Density Networking Rack (HDNR)

Designed for handling high capacity of cables

HDNR High Capacity Cable Manager

Four Post Adjustable Rack
(Tapped & square holed rails)

Cable Management Rack

High Capacity
Vertical Cable Manager

Cable Management

- Vertical and horizonal
- Attach to two and four post racks

RCM+ Vertical Cable Manager

RCM+ Vertical Cable Managers Plastic Gate

RCM+ Extended Horizontal Cable Manager

Rack Enclosure

- White reflects light better
- Different U heights, widths or depths

RS Rack Enclosure

Power mounting

Tool-less configuration

Application-specific

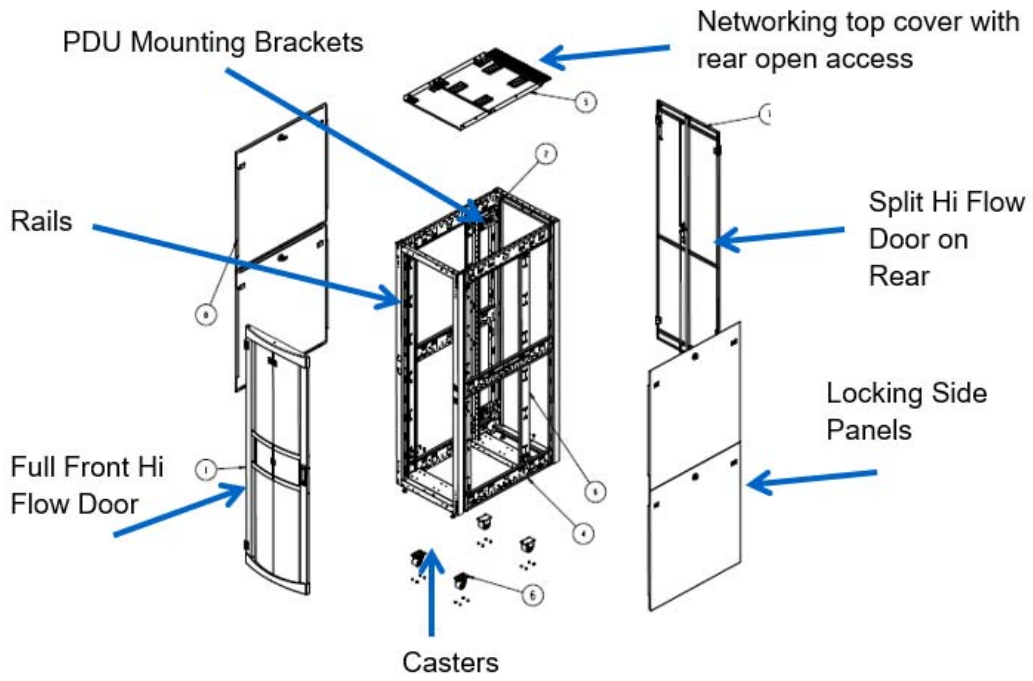
PDU Mounting is Critical

Key hole slot for tool-less mounting

PDU Cable Routing

- Top exit for overhead busway
- Bottom exit for raised floor

Configuring a Rack Enclosure

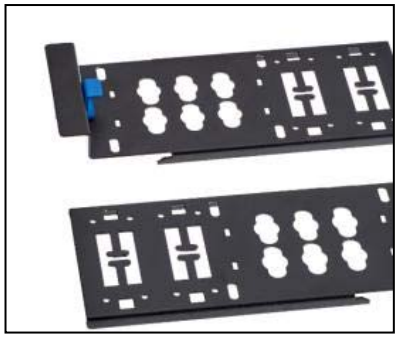


Tool-less Cable Management

Vertical cable management

Flex tray

Overhead troughs



Cable management brackets

RACK POWER DISTRIBUTION

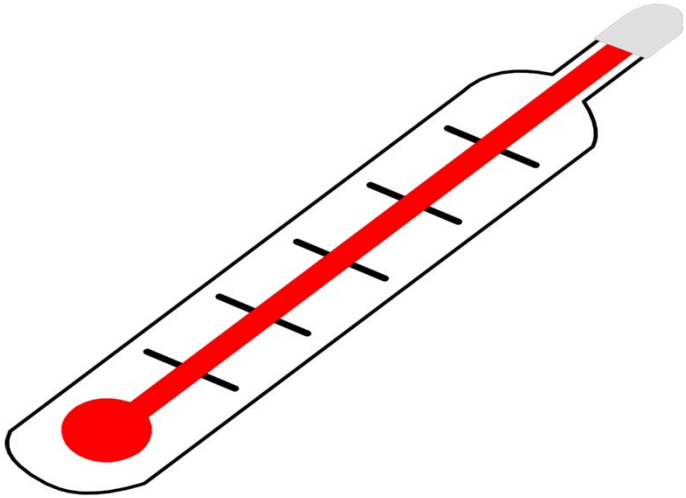
RPDU Form Factors

Installation

- Mounting buttons are pre-installed to save installation time
- Double-sided buttons accommodate different variations of metal thickness
- Optional side mounting for 90-degree rotation in the rack

Operating Temperature

- Full load UL tested rating
- Required for containment or other hot environments
- Reduces energy cooling costs



Warranty and Packaging

- Standard 3 years
  - 5 year extended warranty
- Environmentally friendly packaging reduces disposal costs
  - 100% recyclable cardboard

Locking Outlets and Cords

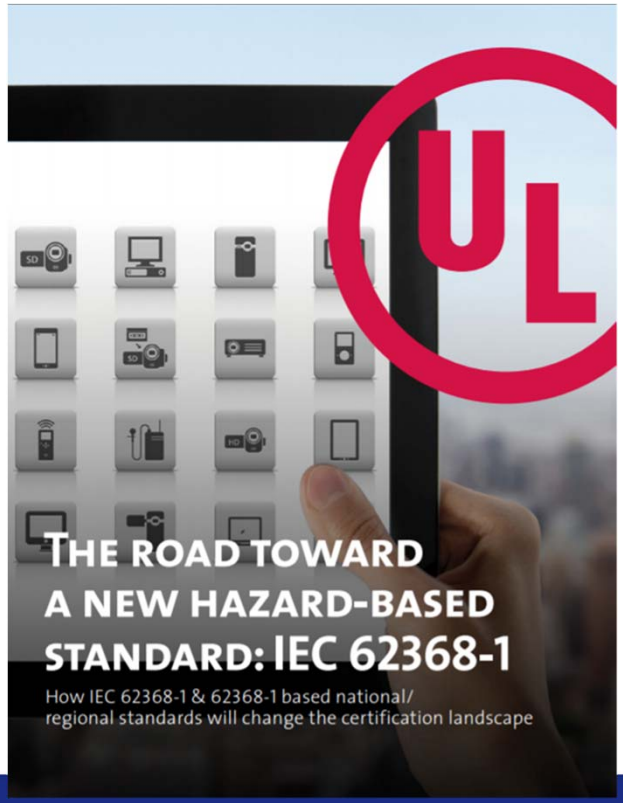
- Lever actuated grip outlet using standard power cord
- Now supports P-Lock locking cables
  - Same locking plug used by other major vendors (Servertech and Raritan)

Color Coding PDU to Source

- Easily identify A and B power feeds, common:
  - Red and Blue
  - Red and Black
  - 11 options
- Power cables to IT equipment to trace power chain

New UL Safety Standards

- UL 62368-1 will be mandatory in 2020
  - Hazard based safety engineering
- Replaces UL 60950-1 withdrawn 12-2020



Alternating Phase Outlets

- Simplify load balancing
- Reduce cable clutter with shorter cable runs

Understanding RPDU Terminology

Basic

Reliable, cost-effective power distribution solution providing branch circuit protection for all connected equipment in your rack. Slim form factor and pre-installed mounting buttons ease set up.

Metered Outlet

Provides outlet-level monitoring without control of individual outlets. Increased monitoring capabilities to the outlet level allow you to calculate Level 3 power usage effectiveness (PUE) for the most accurate view of your power utilization.

Metered Input

Remote monitoring capabilities provide access to your power data whenever you want it, wherever you are. Monitor your critical equipment within each color-coded outlet section from a single interface.

Managed

Remote management, outlet-level control and monitoring make this our most advanced rack PDU. Benefit from remotely rebooting connected equipment, turning off unused outlets to prevent unauthorized use and measuring the most accurate Level 3 PUE.

High density

With all the features you have come to expect from Managed PDUs, the HE rack PDU offers the additional benefits of configurability, improved outlet counts and color chassis options. Designed with data center customers in mind, the HD rack PDU offers up to 54 outlets in 32U and alternating phase outlets.

Basic (BA)

- Distributes power to multiple outlets
- May have circuit breakers or surge protection
- No network connectivity

Metering Input (MI)

- Three phase systems require phase balancing
  - Meter display on PDU allows for phase balancing
- Circuit breaker metering
  - Overload metering
  - Trip detection alarming

Metered Outlet (MO)

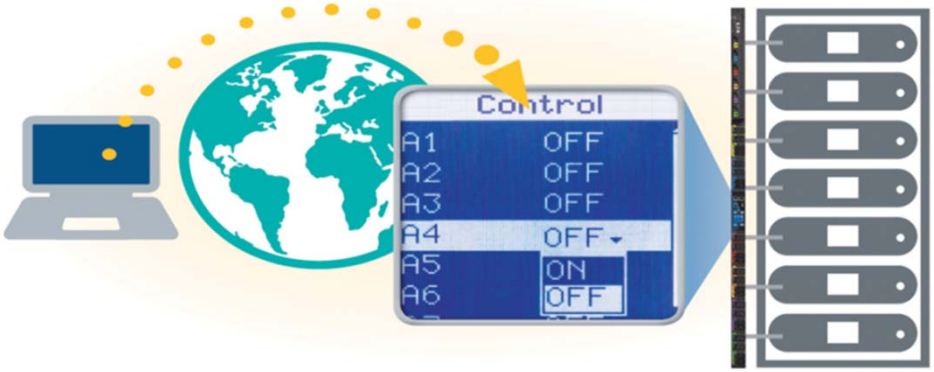
- Measure power uptime at the outlet for QOS metrics
- Alarm for lost power connection

Switched (SW)

- Outlet level power control
- Full Metered Input measurement

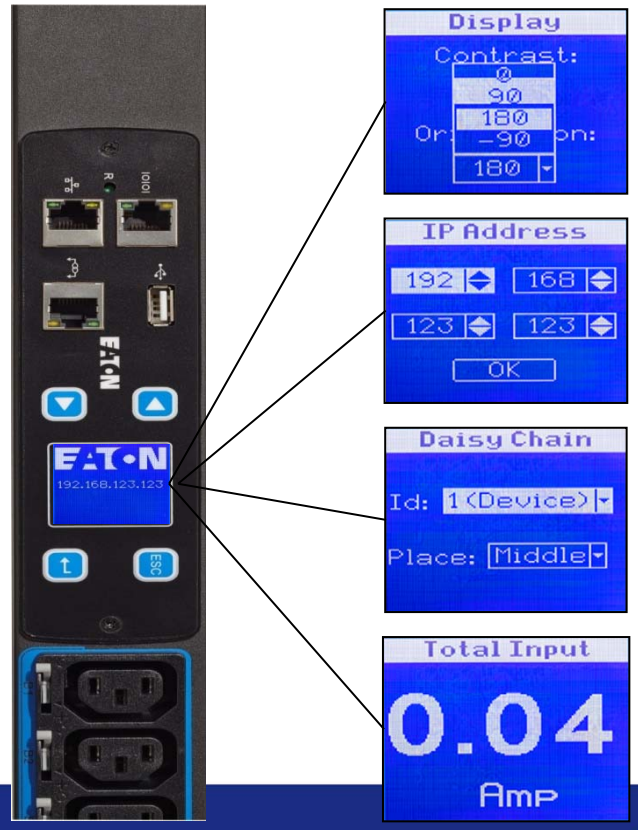
Managed (MA) Switched with Outlet Control

- Control inrush through sequenced power after outage
- Remotely power cycle locked equipment
- Securely power off unused outlets



Local Display

- Advanced pixel LCD display with menu system
- Rotate display
- Set IP address
- Read current, voltage, power, energy and more
- Communications
  - SNMP V1,2,3
  - Telnet / CLI
  - Web browser



Replaceable Network Card

- Common point of failure
- Should be hot swap and touch safe
- Reduces down time

Daisy Chain

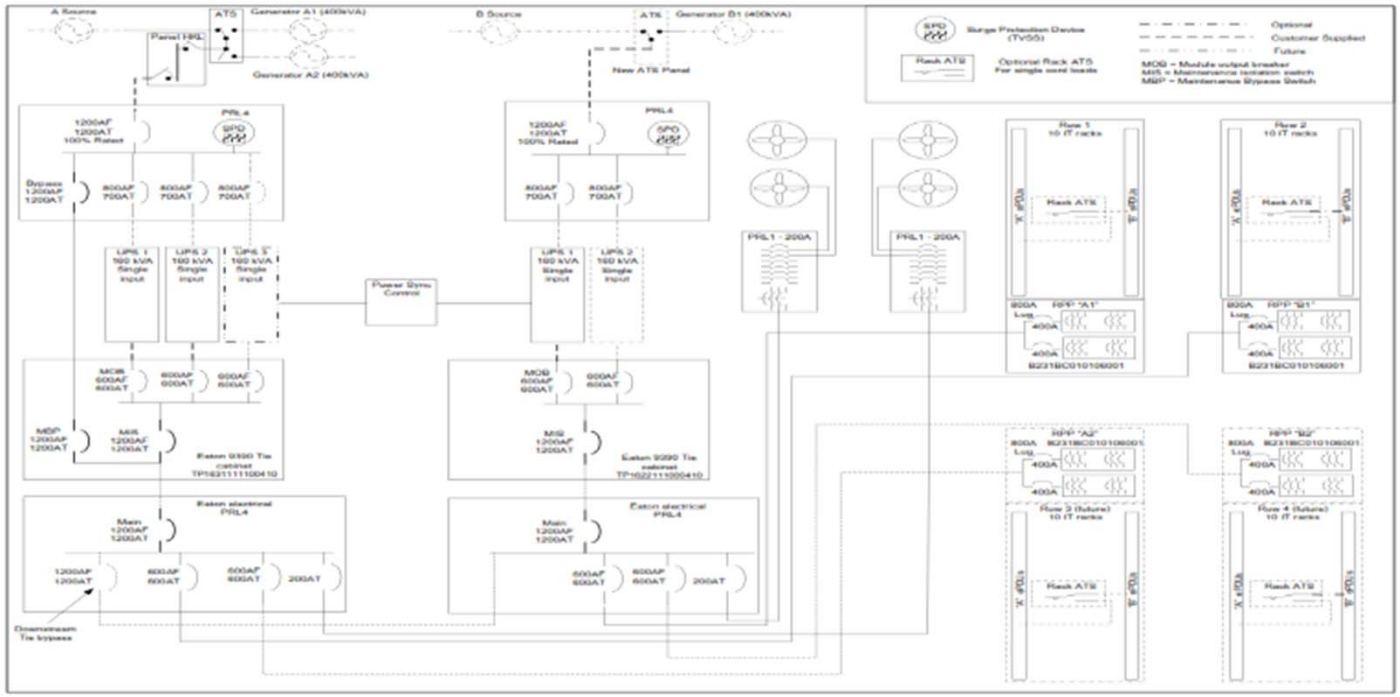
- Daisy chain to reduce network connections
- Ideal to link all the PDU in a network closet or for A feed B feed

BID SPECIFICATION RACK AND PDU

Bid Specification

- Review sample bid spec here

Facility Schematic

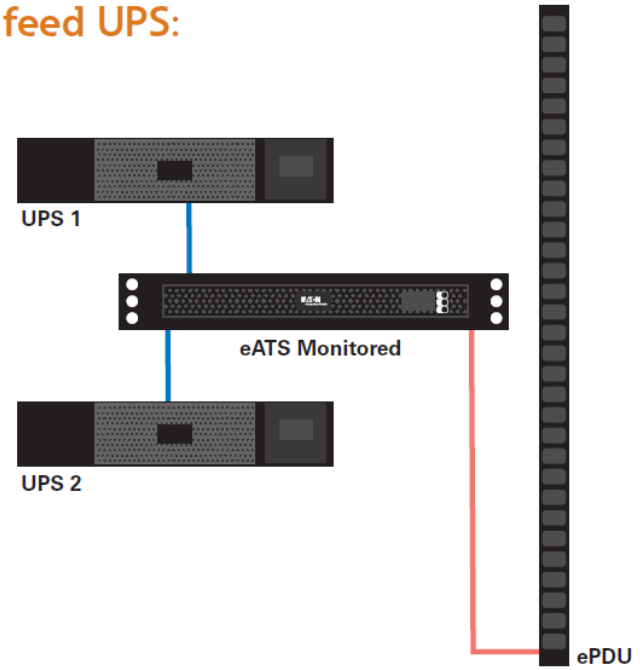


RACK ATS

Application – Dual-feed UPS

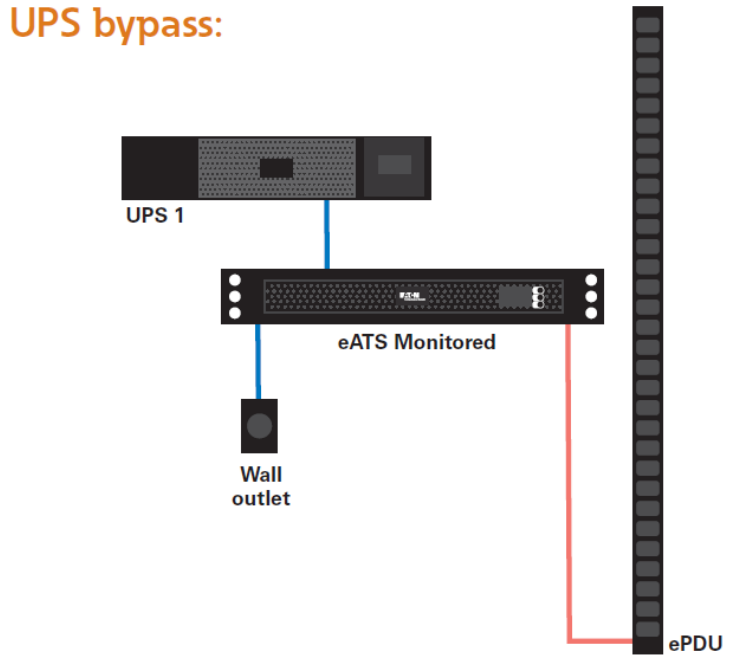
- Dual UPS feed for higher level of redundancy
- Manual or automatic transfer between UPS
- The ATS provides dual feed redundancy to single cord devices

Dual-feed UPS:



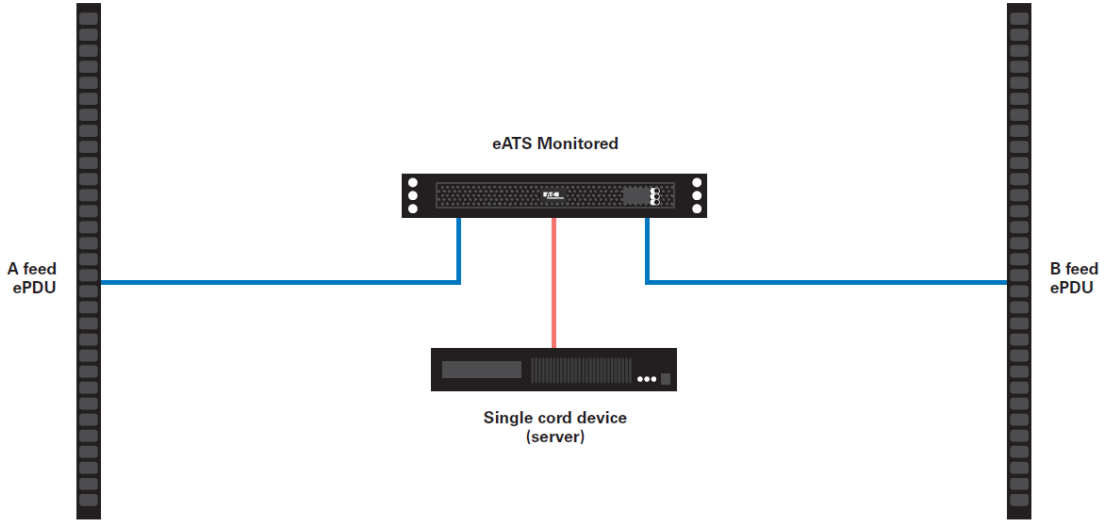
Application – UPS Bypass

- Normal operation UPS power is output to rack PDU
- In event of UPS failure, rack ATS acts as bypass to wall
- UPS can be replaced without loss of power



Application – Dual Feed PDU

Dual-feed PDU:

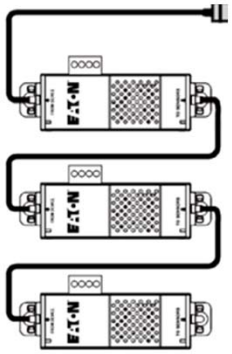


- Typical data center dual feed facility level UPS
- Deploy rack ATS to add dual corded redundancy to single corded devices

ENVIRONMENTAL AND SECURITY

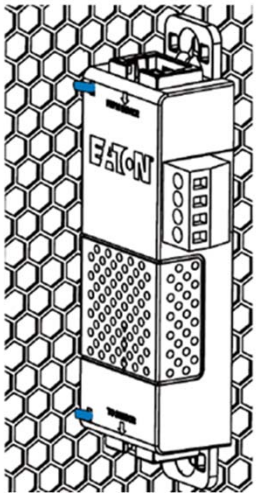
Accessory Environmental Probe

ASHRE recommends top, middle, bottom of rack temperature monitoring Increase data center efficiency with higher inlet temperatures



Environmental Probe Mounting

Ideally in the path of cold air

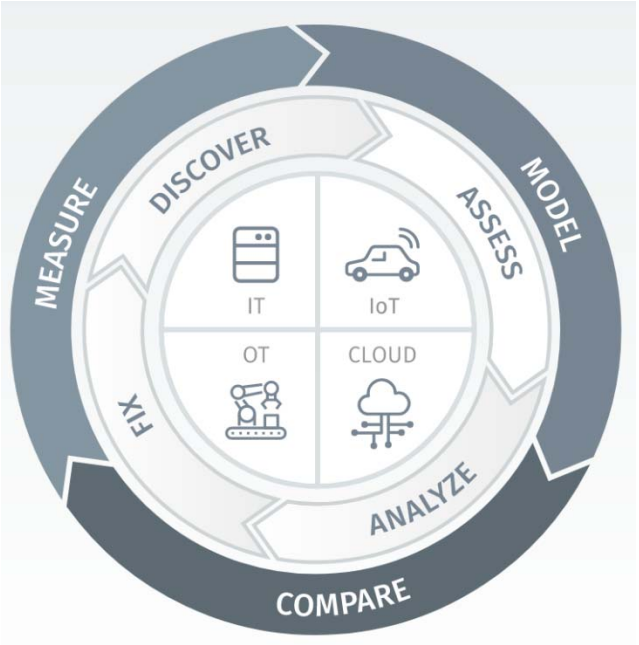
Bottom mounting	Side mounting
	

Environmental Accessories

- Fire and smoke
- Water detector
- Vibration sensor
- Door open/close sensor
- Camera

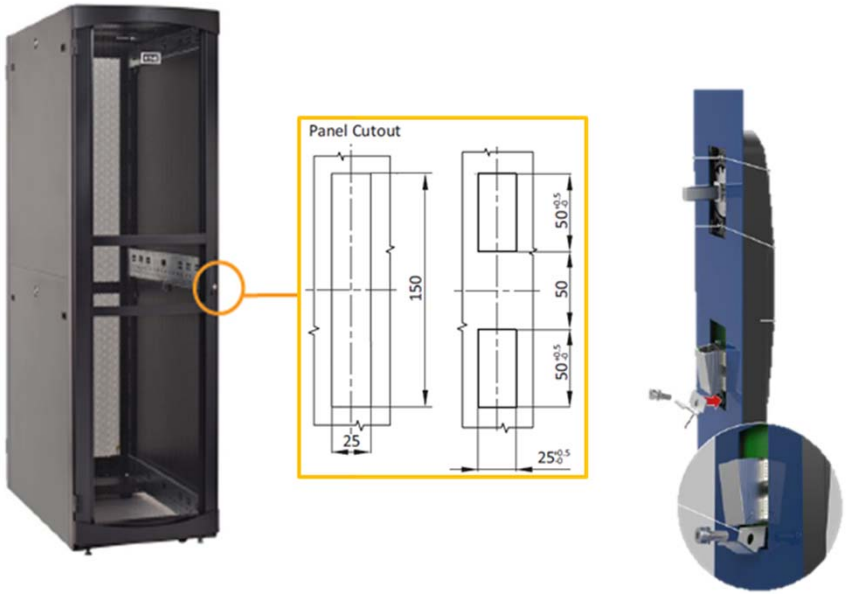
Security Intrusion

- Network cards should be cyber security tested
- Monitor for physical intrusion



Lock Options

- Key lock
- Combination lock
- Electronic lock



Electronic Locks DC or POE Powered

- Powered by geared motors
- Master Emergency Key
- Connection to SPS

- HTTPS
- Syslog
- MS Active Directory, LDAP, RESTful API
- Web API
- Two-factor Authentication
- SNMP

Electronic Lock Access Options

PIN pad

- PIN input
- Through RFID combinable for two-factor authentication

Hand vein scanner

- Highest security level through hand vein detection

RFID (radio-frequency identification)

- 125 KHz frequency band
- 13,56 MHz frequency band
- HID, Mifare, Desfire

Finger print scan

- Biometric procedure protects from abuse

Touch display

- Authentication through entry at the touch display
- Displays operation parameters like temperature, humidity

Remote

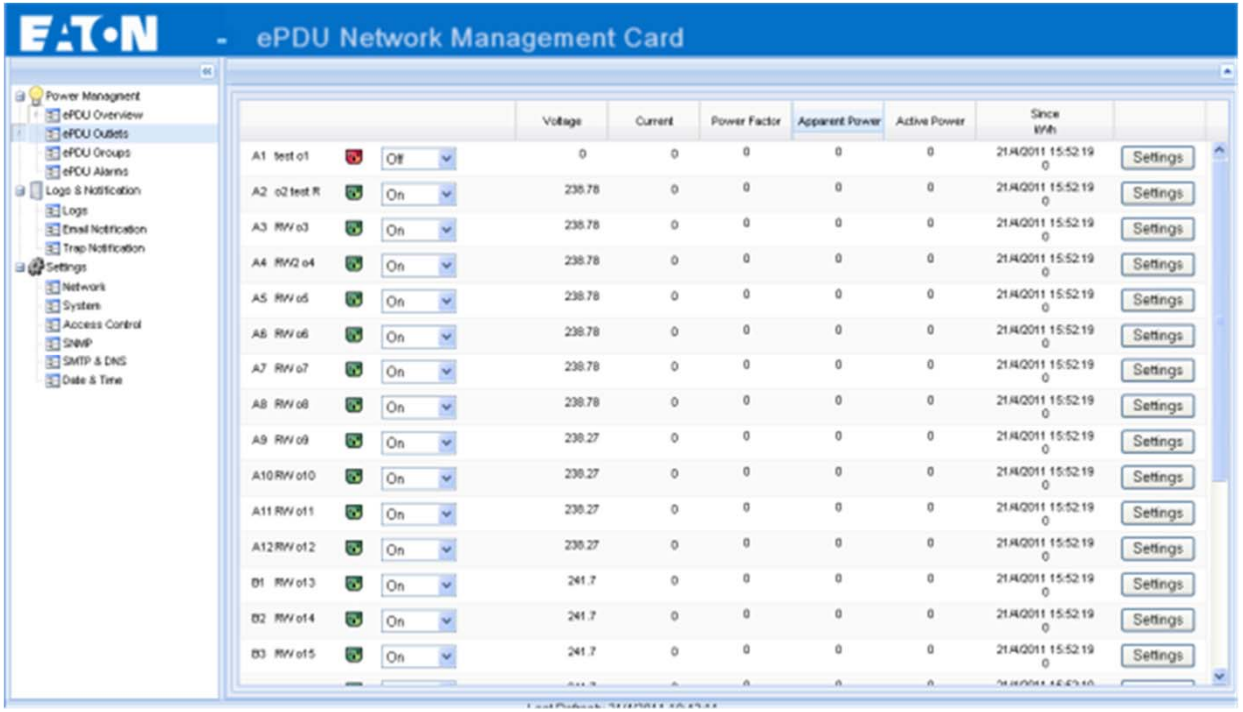
- Access over remote control
- Versatile access possibilities
- 5 V, 12 V, 24 V

SOFTWARE MANAGEMENT

Managing with Software

- Internal software
  - Web browser, command line
- Branch monitoring
- Building management software (BMS)
- Data center infrastructure management (DCIM)
- Remote monitoring services (cloud based)

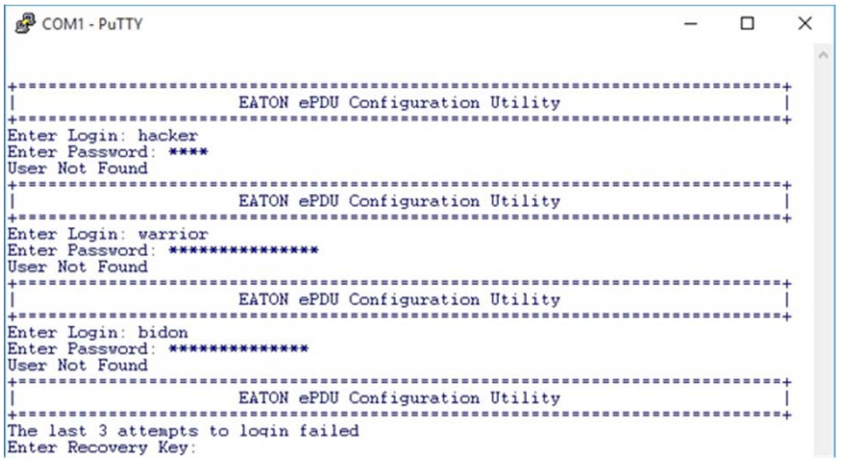
Internal Web



- Web GUI
- Great for small number
- Limited reporting
- Email alarms

Internal Command Line

- Know as CLI (command line interface)
- Serial RS232
- Network Telnet / SSH
- Putty or SecureShell



Branch Monitoring

- Communicates over SNMP
- Power monitoring
- Alarms
- Phase balancing
- Reporting
- Trending

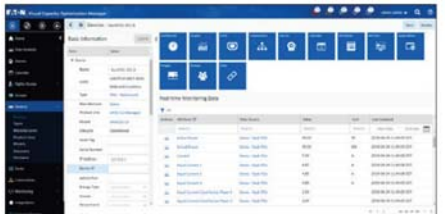
Trend your data points over configurable periods of time to identify changes and irregularities in your power infrastructure

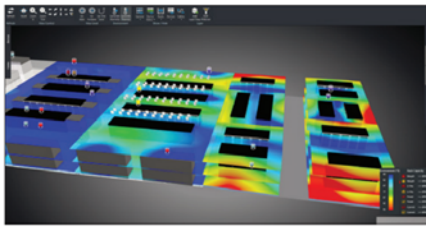
Building Management System (BMS)

- Monitor and control building systems
- HVAC, security, entry, fire, etc.
- Can tie in IT monitoring
- BACNET or SNMP

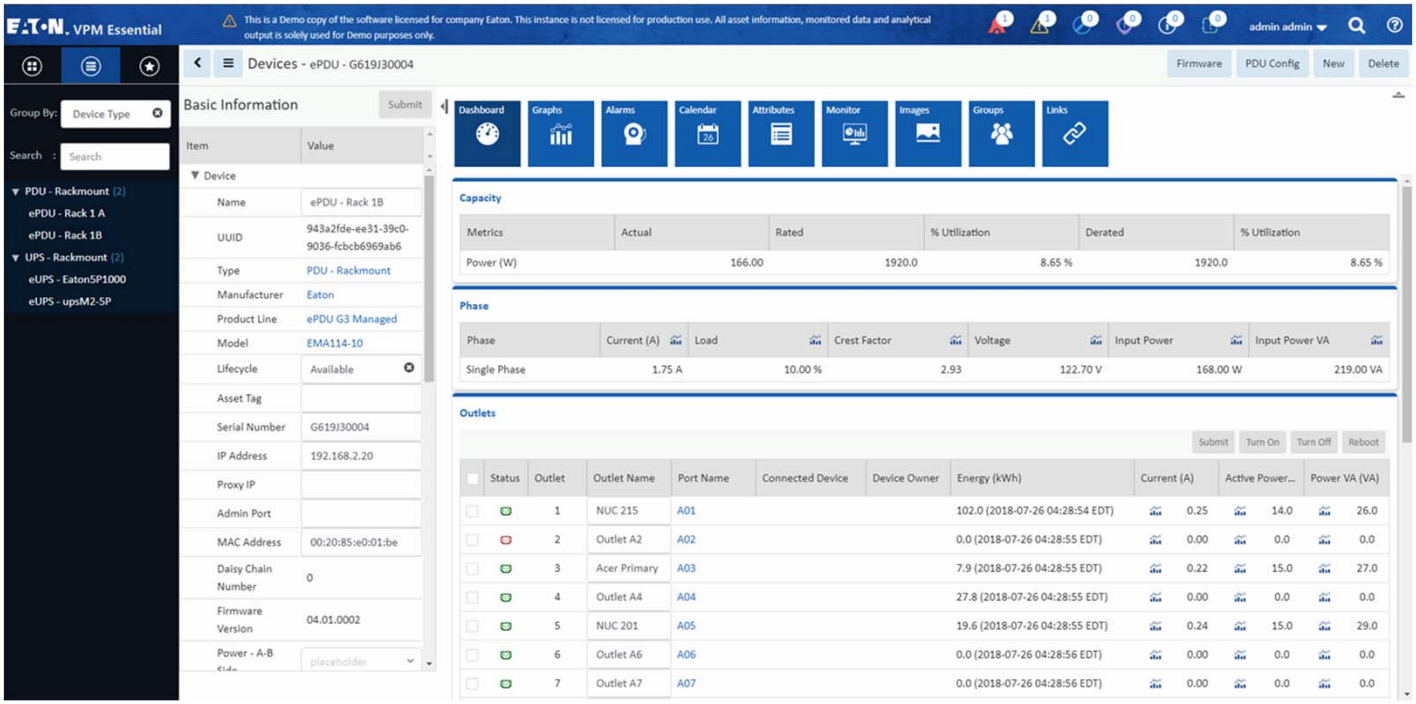
DCIM Overview

- Monitoring
- Port mapping
- Asset management
- Reporting and dashboard
- Capacity planning
- Change/workflow management

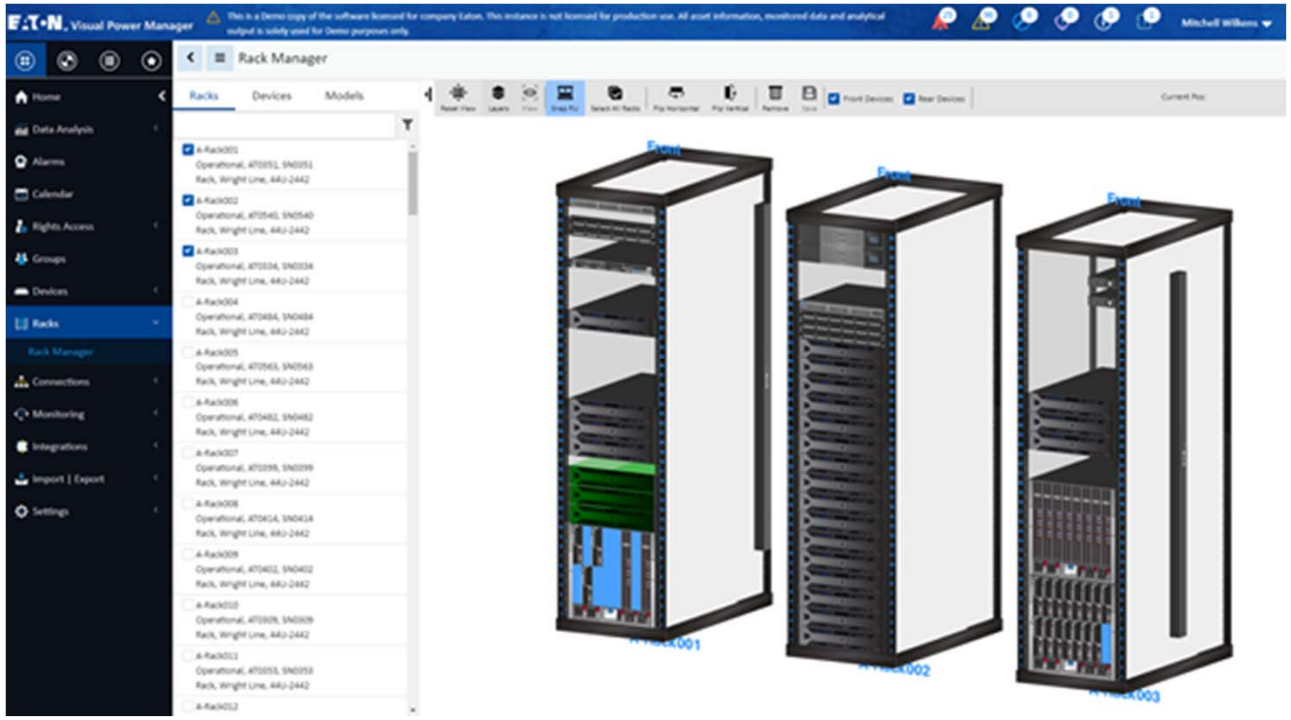




DCIM - RPDU Outlet View



DCIM - Rack Elevations



Remote Monitoring Service

- Cloud based
- Remote monitoring team
- Ideal for remote office / branch office rollouts with lack of technical expertise
- Monthly reports, dashboards and analytics
- Self install

POWER

Power

- Backup power (UPS)
  - Battery backup for power outages
  - Ensures power quality
  - Rack level or centralized
- Rack power distribution (RPDU)
  - Distributes power to equipment
  - Meters power
  - Controls power to devices

Determining Power Density

- Often referred to as KW of rack
- Could be identified as input plug type
- Calculated by adding total power draw of IT equipment + expansion capacity

Example: 3 phase 50 amp plug 14.4KW

How much power do I need?

- Power supply label rating
- Manufacturer spec sheet
- Measured rating use peak

Current (A) or Power (W)?

- Power supplies have current and watts ratings
- Current changes with voltage
- Simplified example: 480W power supply draws 4 amps at 120 volts or 2 amps at 240 volts
- Either can be used to size the load

Single Phase or Three Phase Power

- Usually determined ahead of time
- Three phase is generally used for higher power

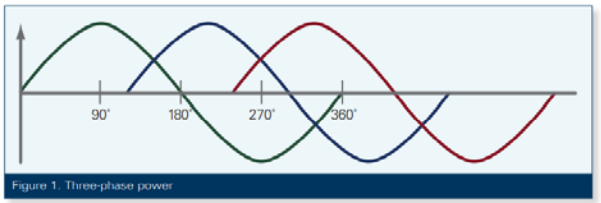


Figure 1. Three-phase power

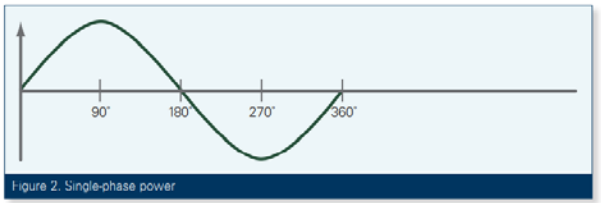


Figure 2. Single-phase power

BACKUP POWER (UPS)

Ten UPS Selection Criteria

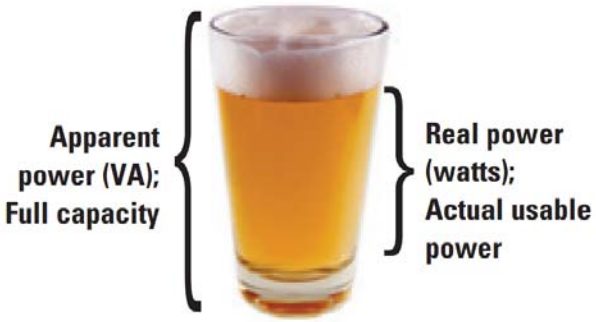
1. Power environment: single and three-phase
2. Installation environment
3. Power load
4. Availability and battery runtime
5. Form factor
6. Scalability
7. Power distribution
8. Manageability
9. Operation and maintenance
10. Budget

UPS Form Factors

1. Desktop and tower
2. Wall-mount UPS
3. Rackmount Compact UPS
4. Rackmount UPS
5. Two-in-one rackmount / tower UPS
6. Scalable UPS
7. Large tower UPS

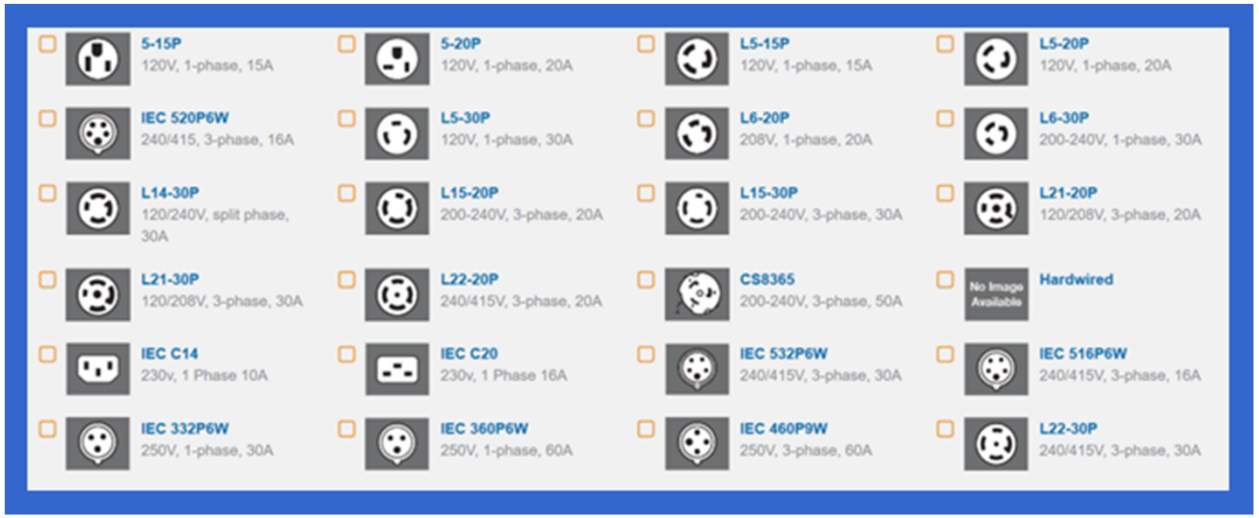
Difference Between VA and Watts

- Watts is related to apparent power (VA) using a ratio referred to as power factor (PF)
- Watts = VA * PF
- VA = Watts / PF
- Consider power supply power factor when sizing UPS



Plug Types

Select plug



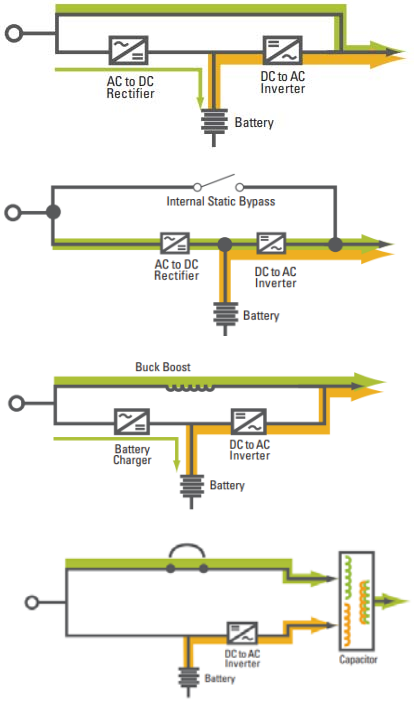
Nine Major Power Problems

- Higher quality UPS address more problems
- Understand power quality concerns at location

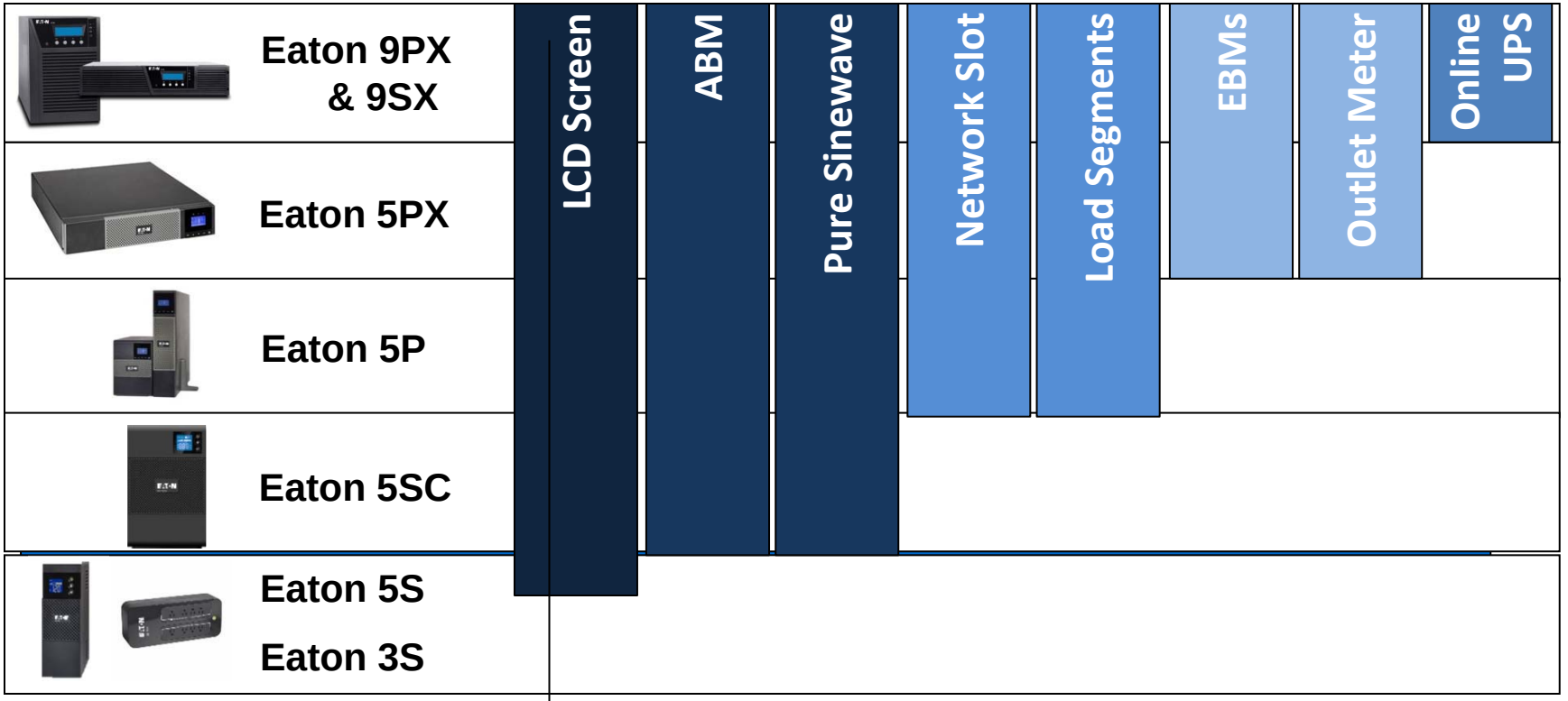
Power Problem		Definition
1 Power failure		When a superhero loses his ability to fly or **a total loss of utility power.**
2 Power sag		Post-lunch sleepiness or **short-term low voltage.**
3 Power surge (spike)		Rush of energy following a double shot of espresso or **short-term high voltage more than 110 percent of normal.**
4 Under-voltage (brownout)		When your amp's too wimpy to handle the bass line or **reduced line voltage for an extended period of a few minutes to a few days. Often happens during the summer months when everyone is cranking up their air conditioners.**
5 Over-voltage		Inhuman cheerfulness exuded by aerobics instructors or **increased line voltage for an extended period of a few minutes to a few days.**
6 Electrical line noise		Excuse you use to get off the phone quickly or **a high power frequency power wave caused by radio frequency interference (RFI) or electromagnetic interference (EMI).**
7 Frequency variation		Fluctuation in how often you do laundry from week to week or **a loss of stability in the power supply's normal frequency of 50 or 60 Hz.**
8 Switching transient		Breaking up with your significant other only to get back together every six months or **instantaneous under-voltage in the range of nanoseconds.**
9 Harmonic distortion		"Music" blaring from your nephew's headphones or **the distortion of the normal power wave, generally transmitted by unequal loads.**

Types of UPS Topology

- Standby
- Online
- Line-interactive
- Ferro resonant



0-3 kVA UPS


Eaton 9PX & 9SX
Eaton 5PX
Eaton 5P
Eaton 5SC
Eaton 5S
Eaton 3S
LCD Screen
ABM
Pure Sinewave
Network Slot
Load Segments
EBMs
Outlet Meter
Online UPS

5-6kVA UPS (208V output)

- **0.9 power factor**
- **93% efficiency**
- **5000/6000 VA models**
- **3U rack/tower form factor**

9PX 5 & 6 kVA Components

6 kVA EBM

- Extended battery module increases runtime by hours.

6 kVA PPDM

- PowerPass Distribution Module allows a step-down voltage to 120V to accommodate a variety of IT equipment. The PPDM also provides a maintenance bypass, which allows you to service or replace the entire UPS without powering down IT equipment.

5 kVA Transformer

- Provides 120V output through receptacles.

9PX 8 & 11 kVA UPS (208V output)

- 0.9 power factor
- 94% efficiency
- 8000/11000 VA models
- 6U rack height
- 28 percent more power versus competition
- Includes power module and EBM

New Battery Technology

Safety benefits

- Lithium phosphate battery chemistry is stable and safe
- Battery management system (BMS) actively monitors temperature and charge cycles
- Common vendor for battery and BMS improves integration and safety

Installation benefits

- Save money on battery replacement costs
- 40% weight reduction eases installation
- Shift your refresh cycle to be in line with your IT equipment

Performance benefits

- 2-3X longer life allows you to set it and forget it
- 6X faster charge improves recovery
- BMS provides up-to-date insight into battery performance

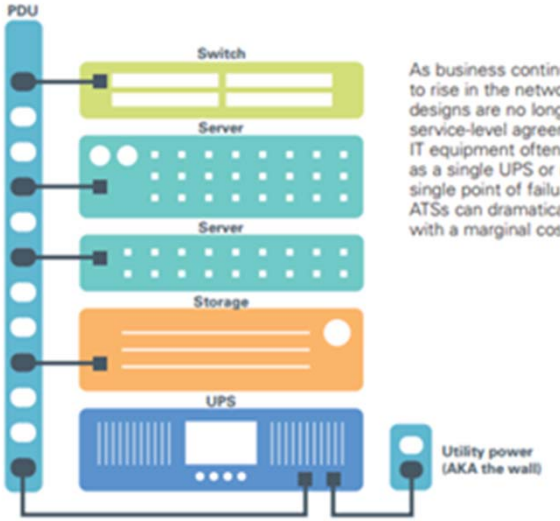
Eaton 5P UPS with lithium-ion battery

By the numbers: 5P 1U 1500 VA UPS

Characteristic	VRLA battery	Lithium-ion battery	Lithium-ion benefit
Battery life span	3-4 years	8 years	2-3X longer life
Recharge time (from 0% to 90% runtime capacity	24 hours	4 hours	6X faster recovery
Battery weight	19 lb.	11 lb.	40% lighter weight
Battery replacement cost	$600*	$0	$0 OpEx expenditure
Warranty	3 years	5 years	2X warranty coverage

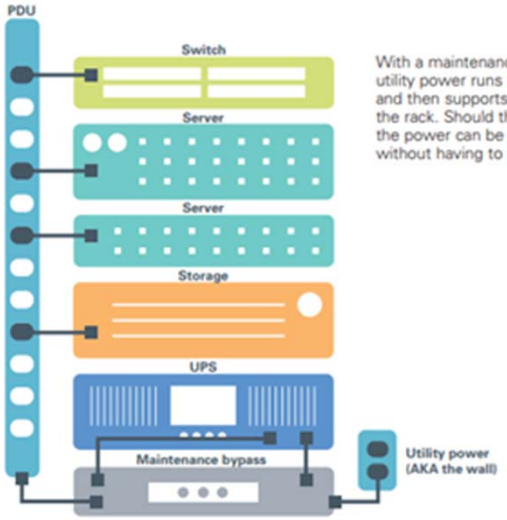
**Battery and labor cost for two replacements*

Typical UPS Configuration



As business continuity requirements continue to rise in the network closet, traditional power designs are no longer adequate to meet IT service-level agreements. However, single-corded IT equipment often complicates system design, as a single UPS or rack PDU may represent a single point of failure. Maintenance bypass or ATSs can dramatically improve system reliability with a marginal cost impact.

Traditional installation



With a maintenance bypass (MBP) for example, utility power runs through the MBP via the UPS and then supports the rest of the equipment in the rack. Should the UPS need to be replaced, the power can be switched away from the UPS without having to shut down your equipment.

Maintenance bypass

UPS Bid Specification

ROW OR POD DEPLOYMENT

Deploying Multiple Racks

- Row various lengths
  - Back or front of racks face each other
- Pod is a cluster
  - Often uses containment

Rows of Racks in a Data Center

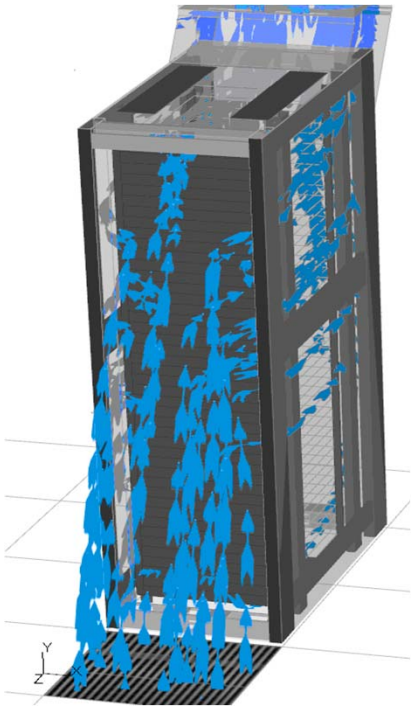
THERMAL MANAGEMENT

Rack is the Key Point to Control Air Flow

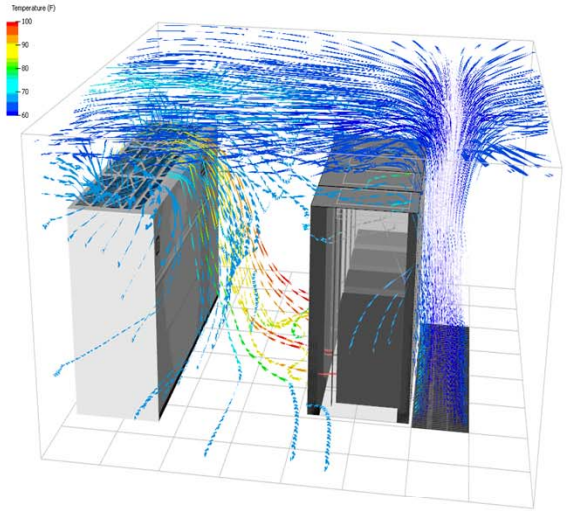
Rack Hygiene – Determines the containment capability of the rack outside the u-space

Five Airflow Fault Areas

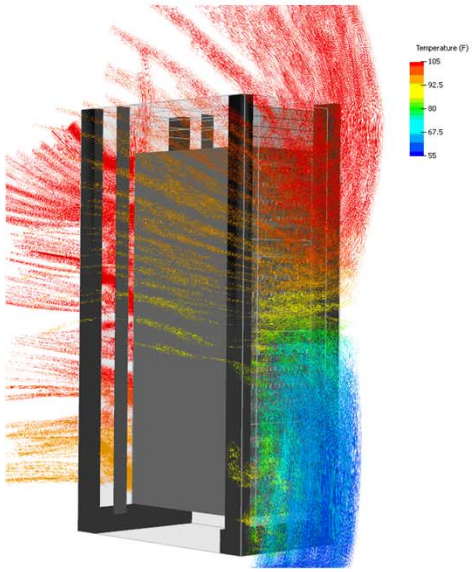
1. Under the rack
2. Left side of left 19" rail
3. Right side of right 19" rail
4. Above top U rack-mount space
5. Below bottom U rack-mount space



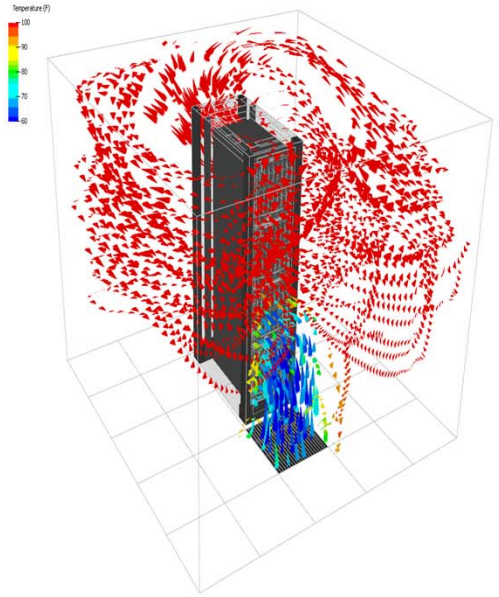
Key Challenges in Legacy Data Centers



Bypass Airflow



Temperature Stratification



Re-Circulation

Thermal Management

High-flow doors and
maximized surface area

Air dams

Brushes, grommets, vertical blanking

Blanking panels

Three Types of Containment

- Rack Based Containment
- Hot Aisle Containment
- Cold Aisle Containment

Real World Challenges -Lighting, Cabling and Power

- Rack-based containment allows for standard cable and wiring best practices
- Can be retrofitted in the field without interruption of processing equipment

POWER DISTRIBUTION

Distribution Schemes

- Panel board
- Floor standing power distribution unit
- Remote power panel (RPP)
- Busway

PANEL BOARD

Panel Board Distribution

- Mounted on wall
- Distributes power to PDU in racks
- Generally under raised floor or conduit overhead

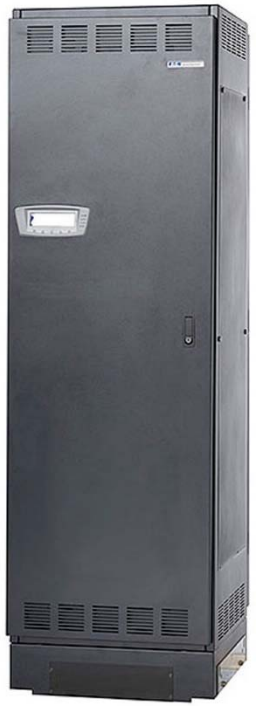
FLOOR STANDING PDU AND RPP

Floor Standing PDU

- Located around data center
- Can feed power to more than one row
- Typically raised floor but can support conduit over head

Remote Power Panel

- Located at the end of the row
- Typically features two or four 42 position circuit breaker panels
- May include branch monitoring



Bid Specification

- Sample bid spec

BUSWAY

Busway

- Overhead power distribution
- Bus plugs twist into busway
- Easy to reconfigure

Summary

- Physical and power infrastructure is just as critical as cabling
- Increasing demands are being placed on data center professionals to understand all aspects of the data center
- Using guide specs combined with general knowledge will ensure an efficient design