legrand®

DATA CENTER SOLUTIONS

How Intelligent Data Centre Infrastructures Help Manage Resources, Services and Costs.

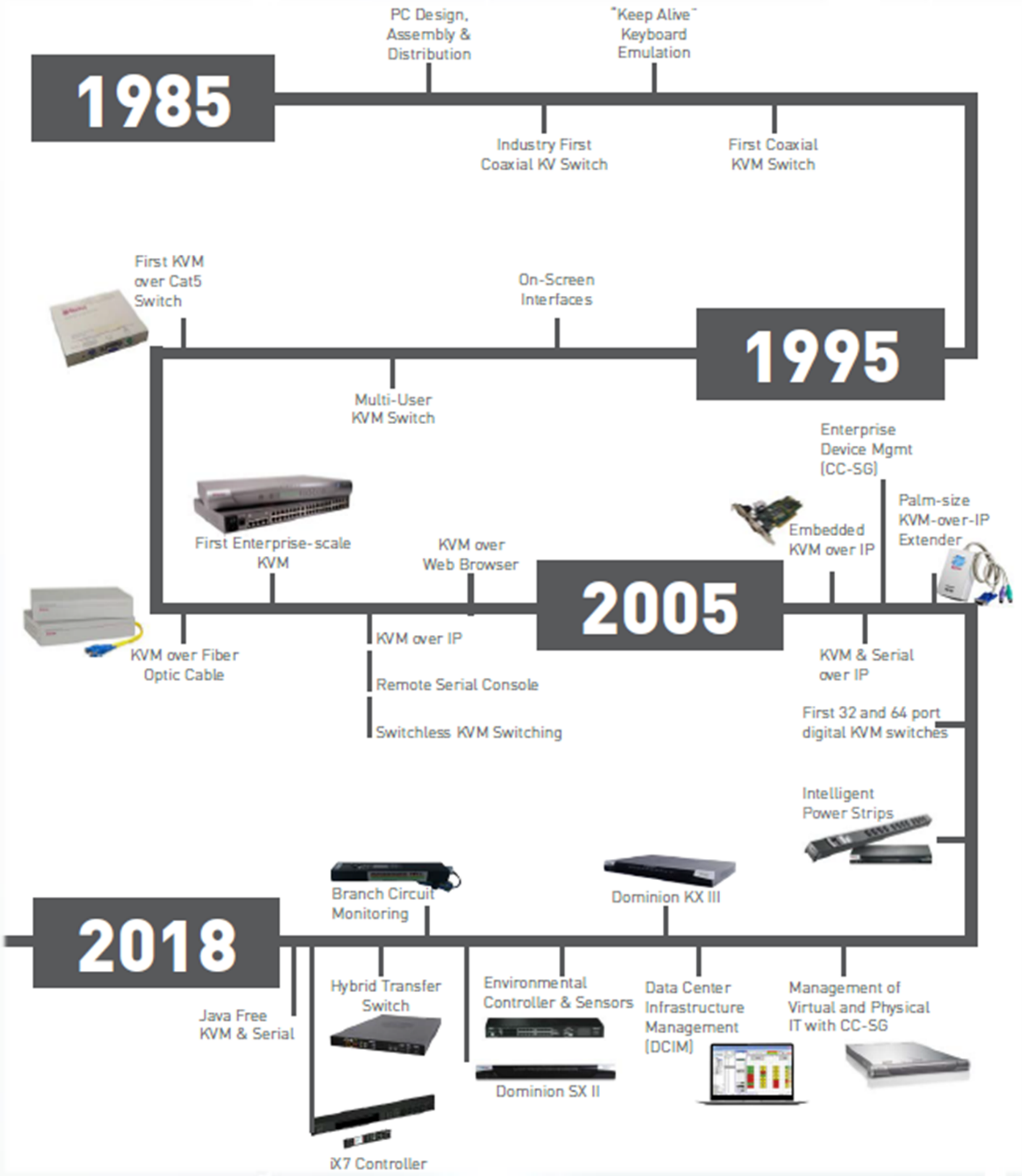
BICSI MIDDLE EAST & AFRICA

Who is Raritan?
A global leader in data center management solutions

Raritan
A brand of legrand

- Founded in 1985 in Somerset, NJ USA (HQ)
- Acquired by Legrand in Sept 2015
- Offices in Australia, Canada, China, France, Germany, India, Japan, Netherlands, Singapore, Taiwan, UK
- Products sold and supported in over 76 countries and installed in over 50,000 critical data centers

BICSI MIDDLE EAST & AFRICA



History of Innovation

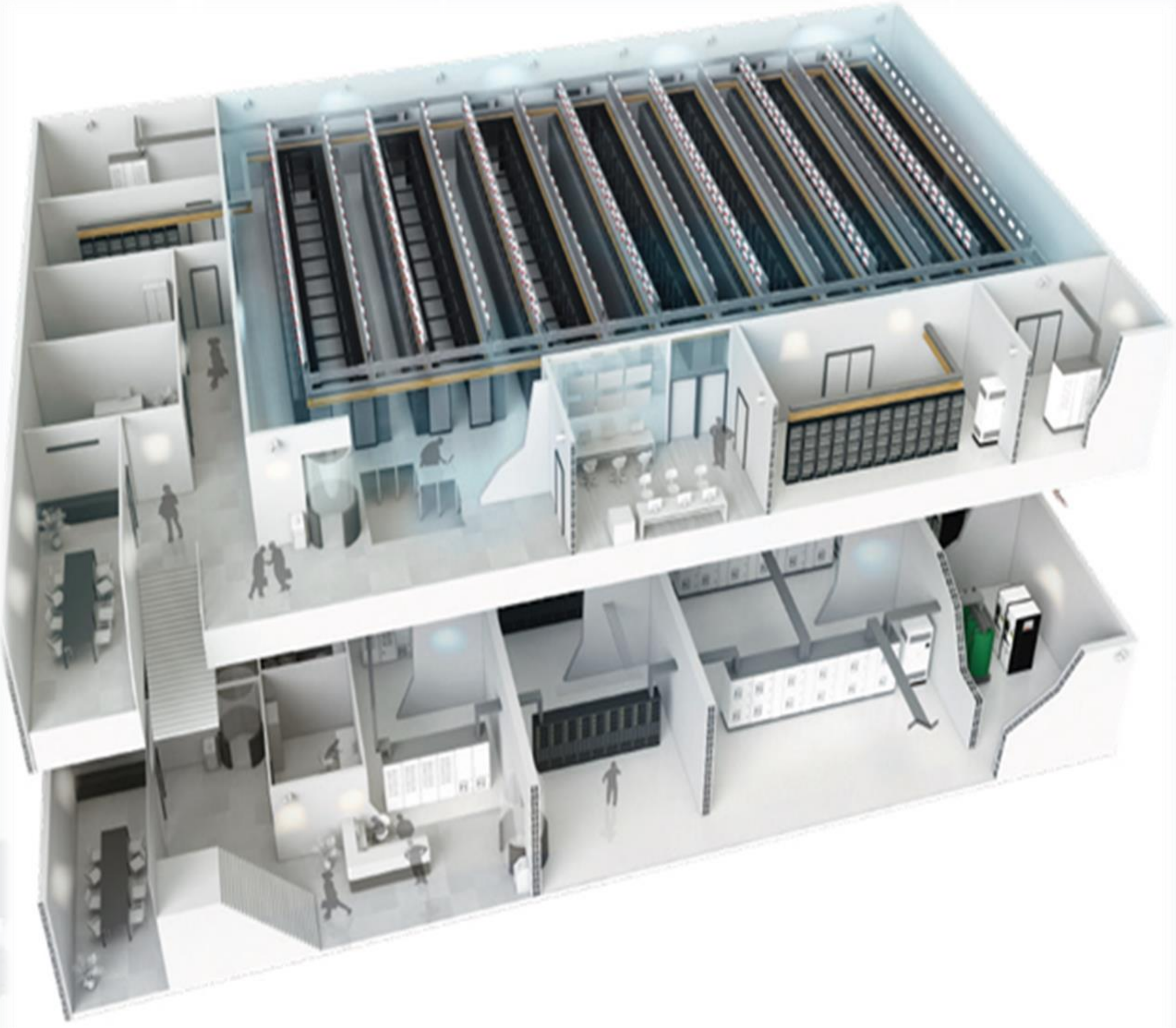
Our solutions help IT professionals gain more insight into data center operations and manage smarter in more than one way.

We help maximize uptime, optimize efficiency and allow for strategic decision-making based on reliable data points.

Raritan is always looking to push technology further and innovation is at our core.
With 47 patents granted and 30 more applications pending, we make sure you always have the latest and future-proof technology.

“Last Mile” Example Issues:

LEGRAND GROUP: The last mile



- Dry transformers
- Capacitor banks
- Switch boards
- UPS
- Cable management
- Structured cabling
- Busbar systems
- Aisle containment
- Patch & server racks
- Co-Location cabinets
- Row based cooling
- Power distribution
- KVM / Serial
- Monitoring

BICSI MIDDLE EAST & AFRICA

Today's Agenda

"Last Mile" Example Issues:

PDU:

1/ Circuit Breaker Trip Coordination
- 2/ Sufficient Circuit Breaker Trip Detection and Alarming Overlooked in Design
- 3/ Improper Feed Sizing for Blade Servers and Chassis-Based Networking Gear
- 4/ Residual Current Monitoring
- 5/ Outlet malfunction - trip Analyzation
- 6/ Human error minimization
- 7/ Equipment failure & redundancy
- 8/Outlet switching benefit and risk

UPDATE!

ATS:

- 9/ Application

  10/ Technologies
- 11/ Insufficient Switching Time
- Summary learnings & best practices

Connectivity considerations

Plug basics

Power Rating

- C19

C13

Connectivity	Type
10A 1ph	Schuko/ C13/ BS1363
16A 1ph	Schuko / C19/ Blue IEC60309
32A 1ph	Blue IEC60309
16A & 32A 3ph	Red IEC60309

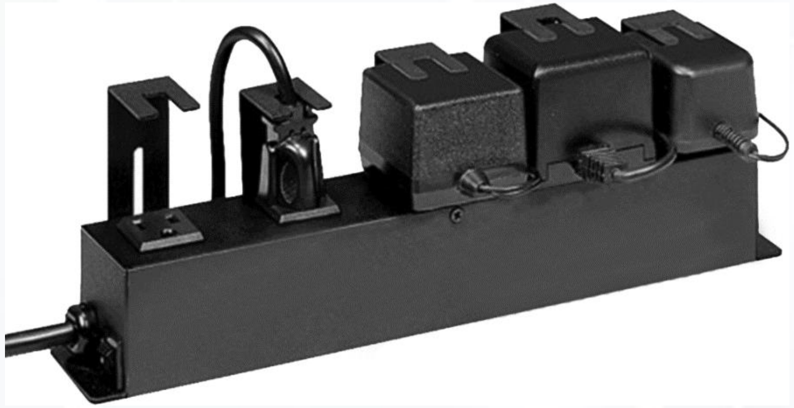
Schuko

IP44 / IP65

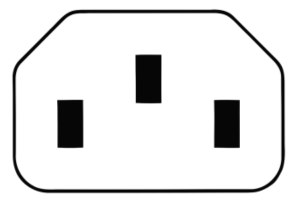
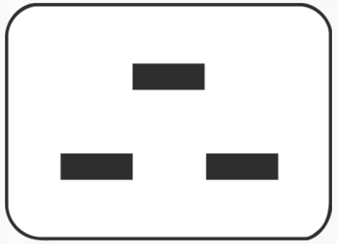
- Water-cooled CRAC/ CRAH
- Below sea level
- Seismic areas

Bicsi MIDDLE EAST & AFRICA

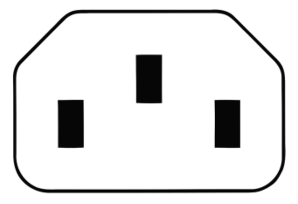
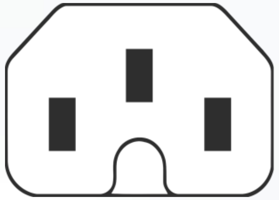
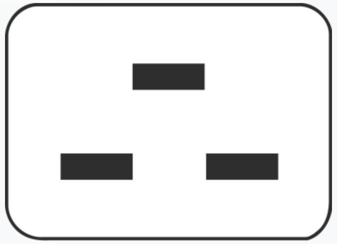
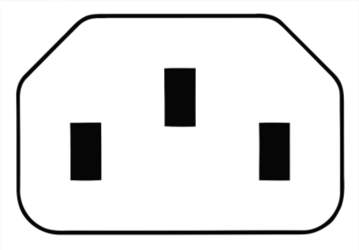
Locking



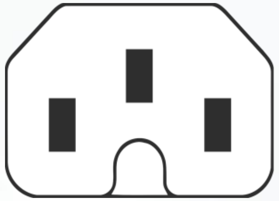
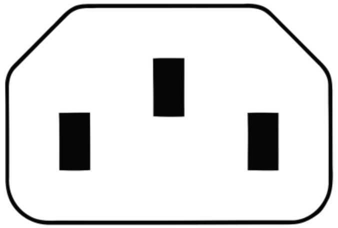
Temperature rating

- C13  70℃
- C19  70°C

Temperature rating

- C13  70℃
- C15  120°C
- C19  70°C
- C21  120°C

Temperature rating

- C15 
- C21 

Cisco MDS9500

HP Procurve

Temperature rating

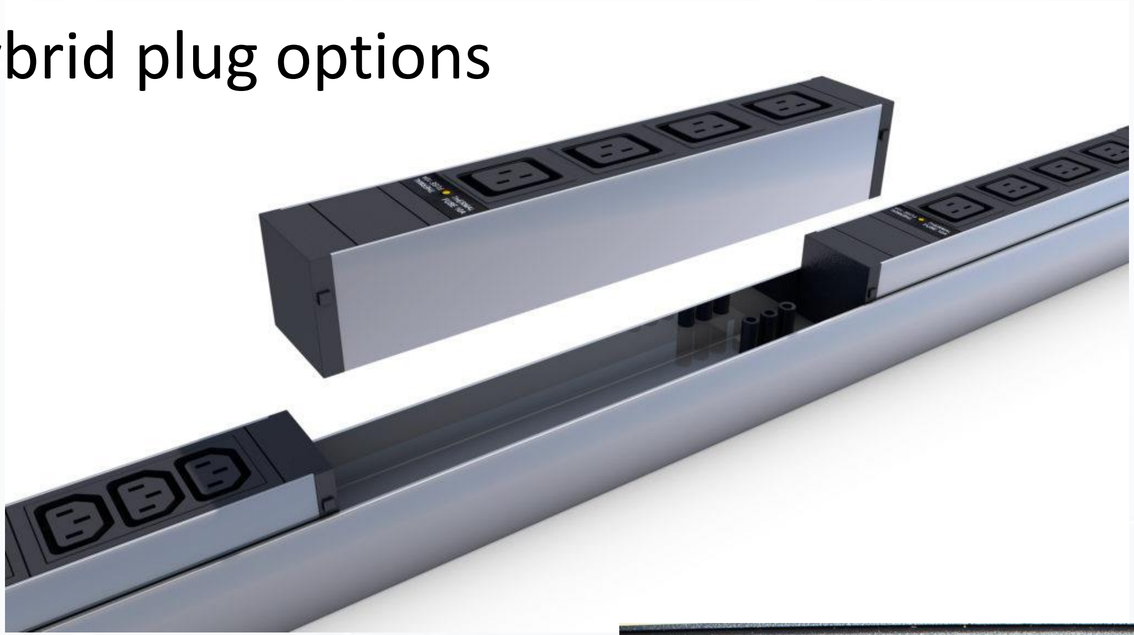
Cisco MDS9500

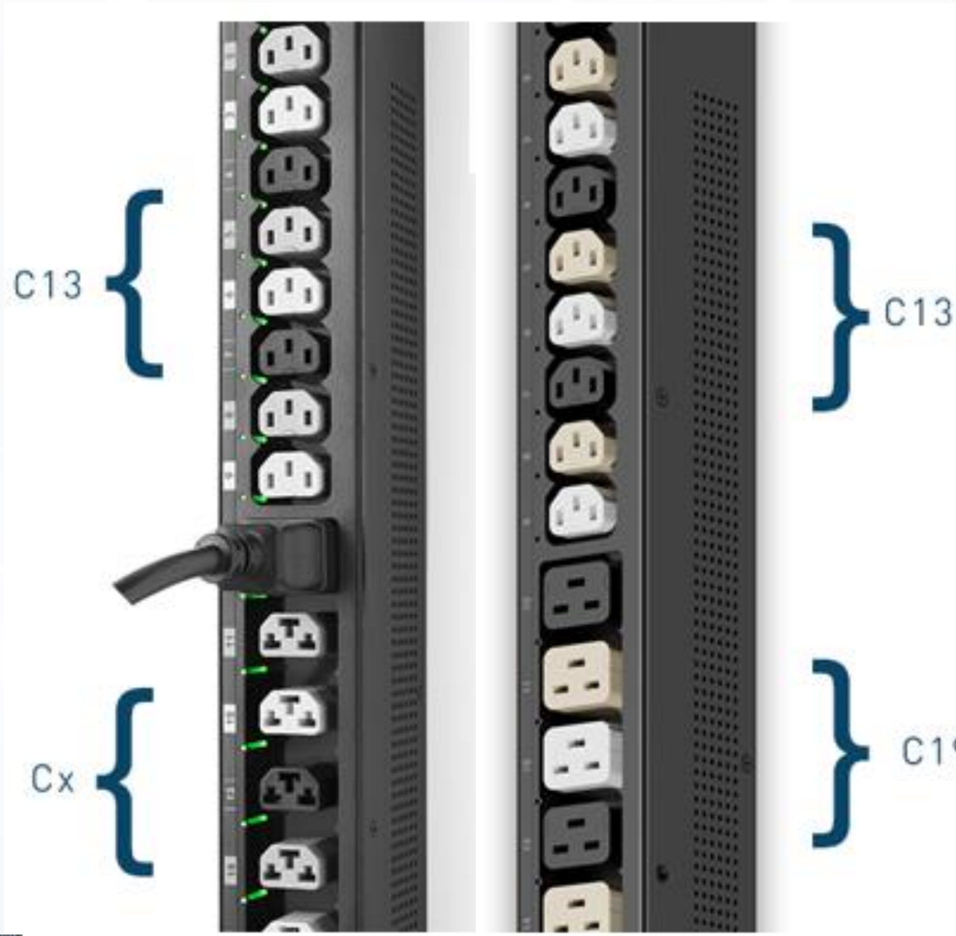
HP Procurve

XBOX 360

Outlet flexibility and density

- Customized solutions
- Modular
- Hybrid plug options





Power Cabling

Type:

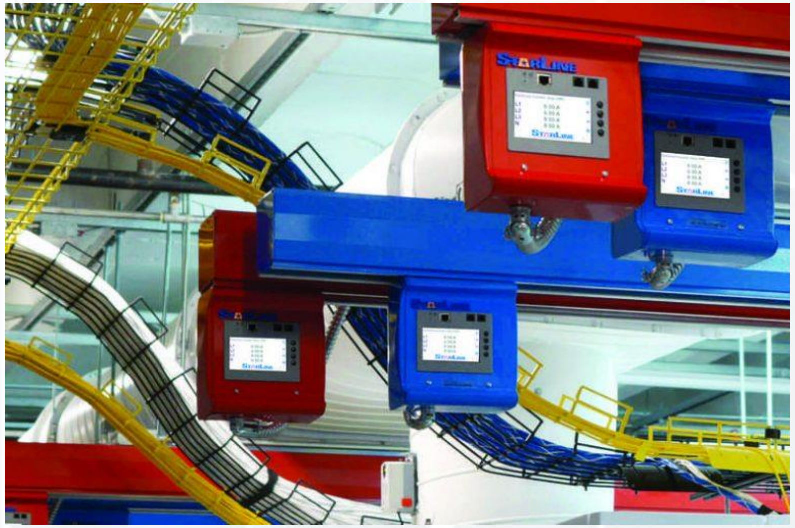
- PVC
- Rubber
- LS0H, Low Smoke Zer0 Halogen
  - EN 60332-1 (fire retardant requirements)
  - EN 61034-1 (low smoke requirements)
  - EN 50267/EN60754 (zero halogen)
  - 5G2.5 Cable Non Shielded

Power Cabling

Considerations:

- Cable length
- Hard wiring benefits
- Shipping cost, weight and dimensions

- On average US$1000 savings / rack



Safety considerations

Metering ?

The “Buckaroo Effect”

Avoid inefficiencies based on fear & uncertainty

Avoid over/under capacity with accurate data!

Ghost servers

- Mergers
- Personnel change
- Excel management
- Legacy application server left after transition/upgrade

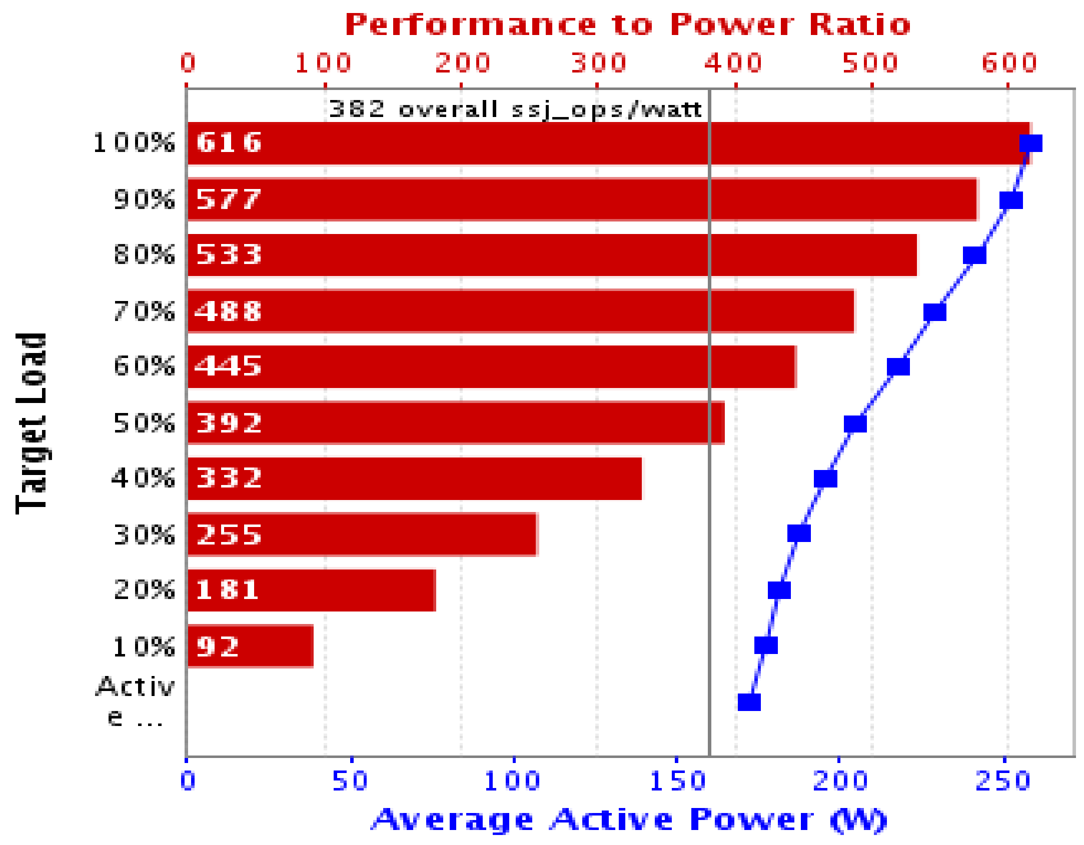
- 0W to 5W consumption eating away power capacity!

BICSI MIDDLE EAST & AFRICA

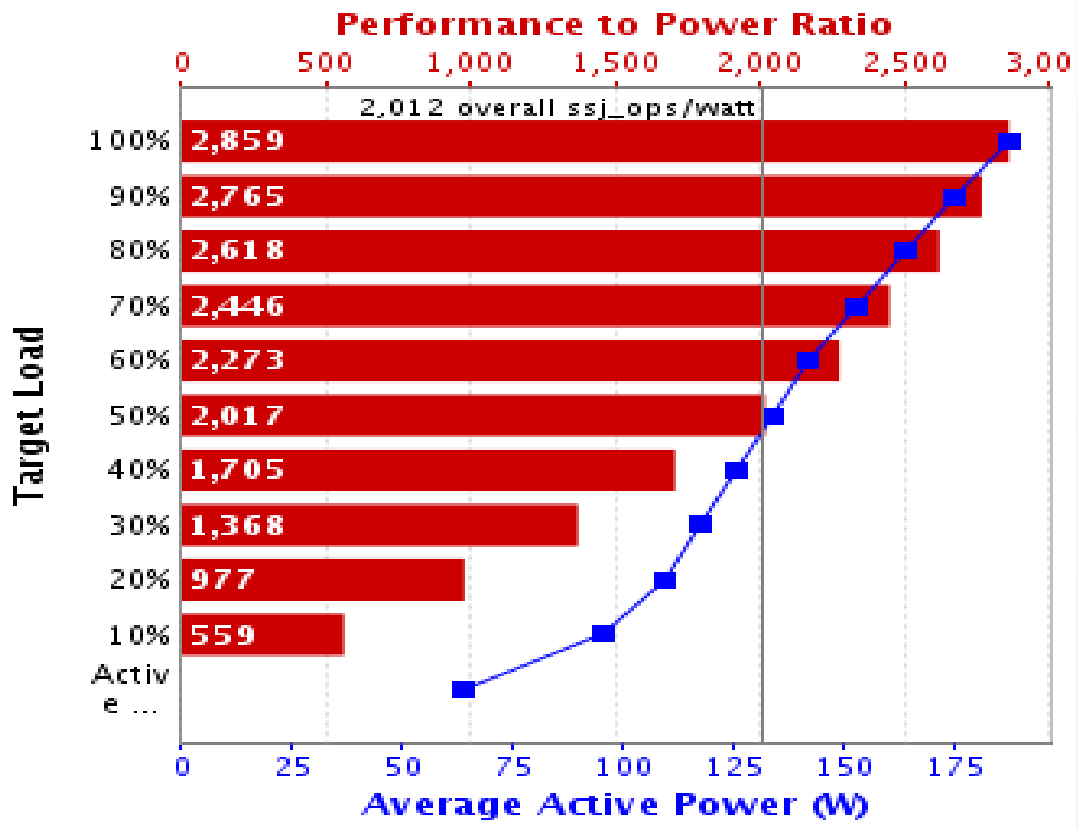
Reasons for metering

- Billing
- Enterprise DC as a service
- Divide kWh per department, create awareness
- Make informed decisions
- Am I at risk of blowing a fuse or tripping a breaker in case power source A fails?
- What is the power consumption in evenings and at weekends?
  Can we shut down equipment (Cisco labs)
- Is there a correlation between temperature and power consumption?
- How many racks do I have left in terms of capacity before I have to change/grow my facility?
- Identify power hungry devices, potentially replace

Capacity Planning



HP Proliant DL380G5
Name plate 700 Watt



HP Proliant DL380G6
Name plate 500 Watt

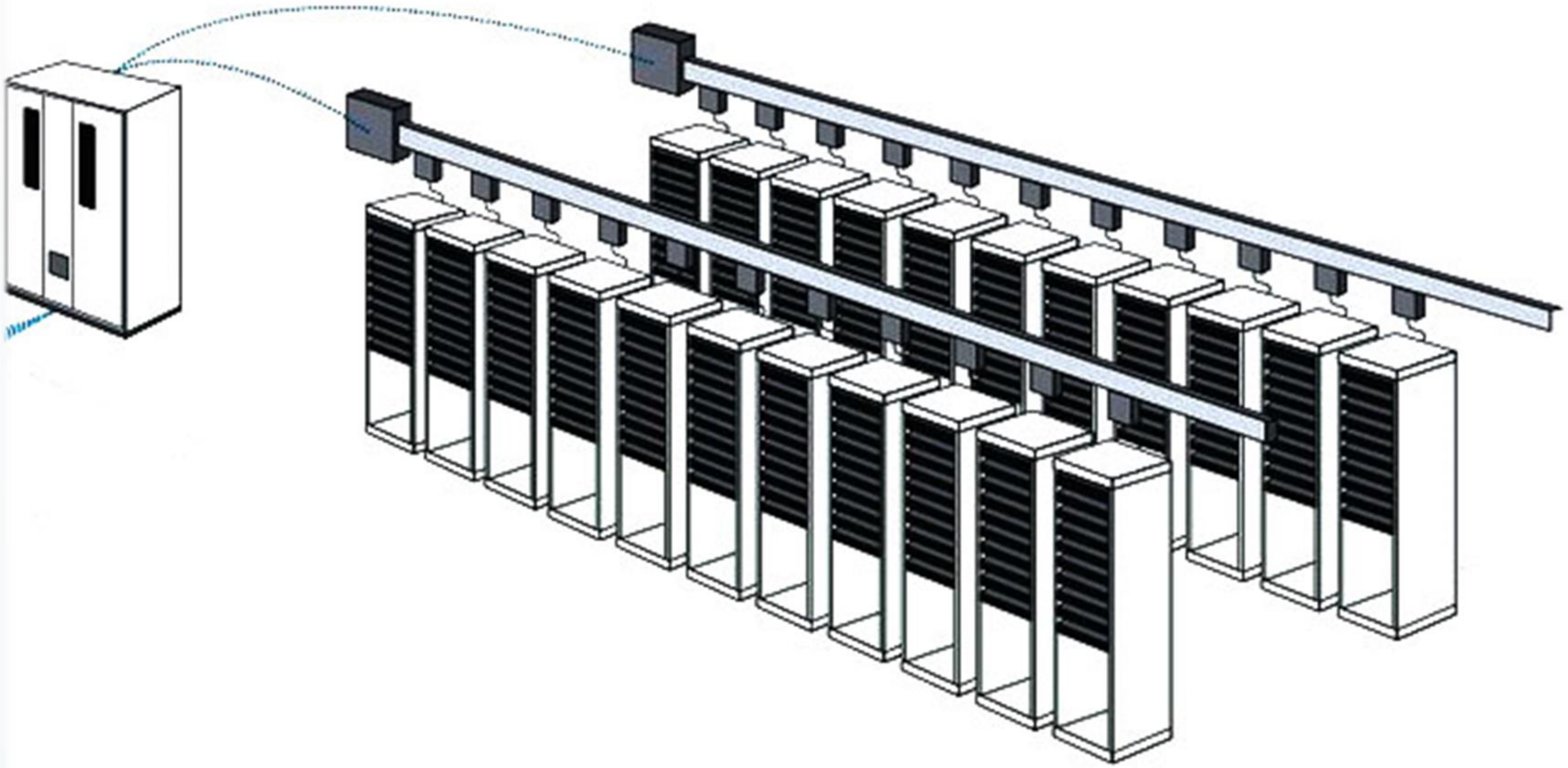
Source: http://www.spec.org/power_ssj2008/

Circuit Breaker Trip Coordination

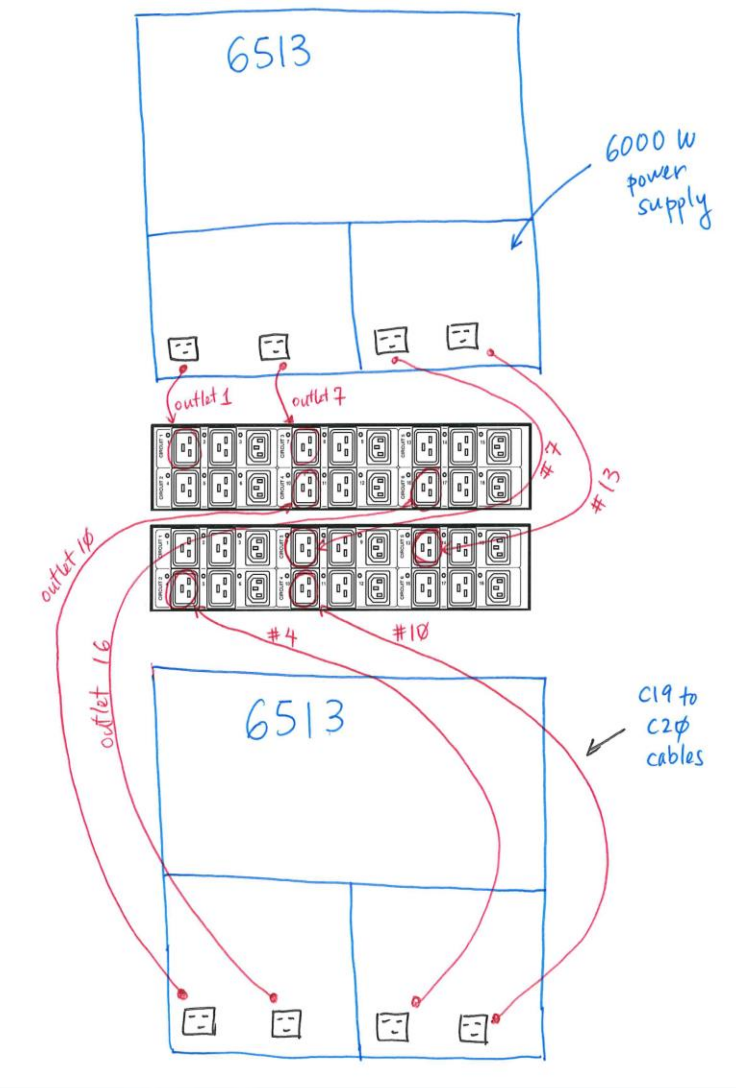
Breaker Coordination Must Extend into the Rack

EXAMPLE 1

Common scope of breaker coordination protects against cascading failure…



Critical Facility Design Scope: End-to-End



As IT loads become more sophisticated…

… the “last mile” of the power chain:
from the distribution board,
to the cabinet, to the equipment…

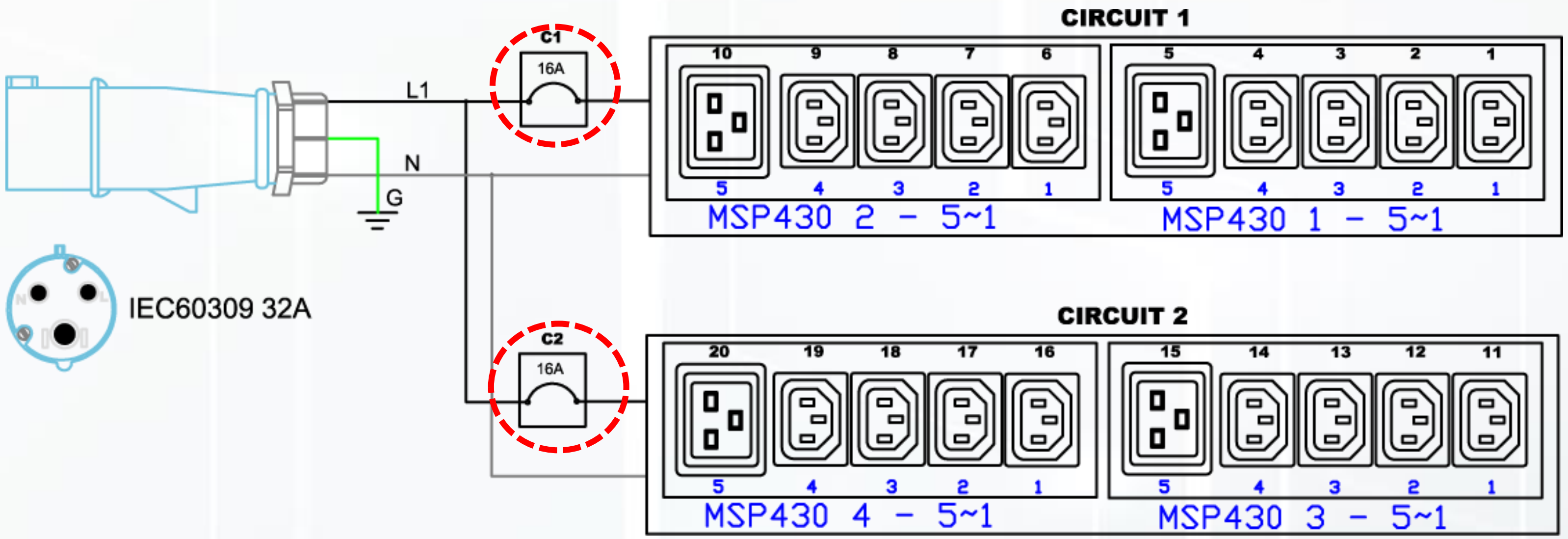
… pose new challenges for clients

Breaker Coordination Must Extend into the Rack

EXAMPLE 1

… but must consider cabinet components to be fully effective!

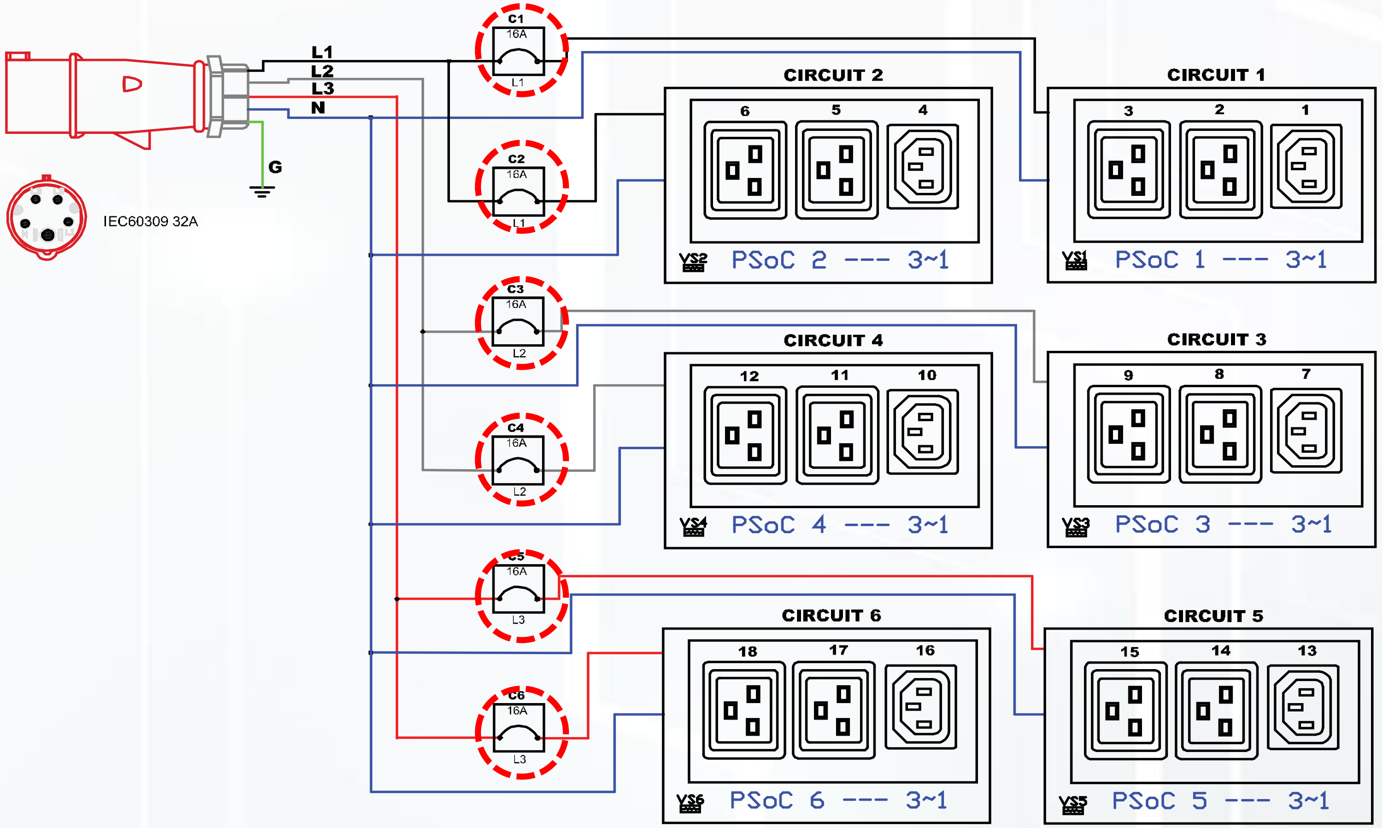
Derating 16A vs 20A



Breaker Coordination Must Extend into the Rack

EXAMPLE 1

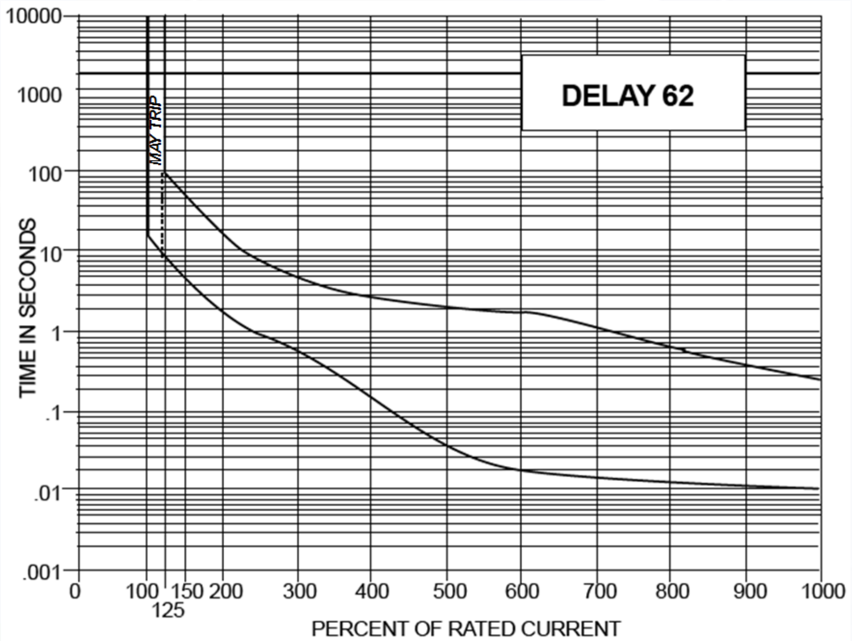
Most common trip event = faulty server power supply.



Breaker Coordination Must Extend into the Rack

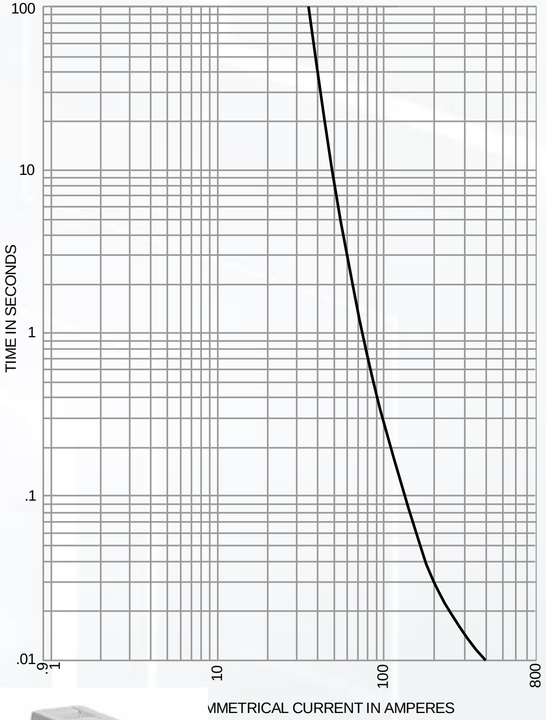
EXAMPLE 1

MCCB Trip Curve



5kAIC typical;

Fuse Melt Curve



Finger-safe cylindrical fuse holder;
Typical 20kAIC+

Circuit Breakers types

- IEC 60950-1 Safety Standard requires use overcurrent protectors (OCP)
  - Thermal-Magnetic Breakers
  - Hydraulic-Magnetic Breakers
  - Fast-blow fuses per branch or per outlet

Standardized trip delay curves: Type B (fastest), C or D (slowest).

Recommended are Type D
to manage inrush current and because of temperature derating / harsh environment

2 Pole for UL Models and 1 Pole Breakers (For EU / VDE)

BICSI MIDDLE EAST & AFRICA

Regulatory Approved OCP

Approved Circuit Breakers

- UL-489 (USA)
- CSA C22.2 #5 (Canada)
- EN 60934 VDE 0642 (Europe/International)

Approved Fuses

- UL-248 (USA)
- CSA C22.2 #248 (Canada)
- IEC 60127-1 (International)

NOT Approved Devices

- UL-1077
  (“supplemental” button breakers found on multi-outlet tap boxes)
- UL-489A
  (DC rated for communication circuits)

Circuit Breaker Mechanism Types

Thermal Magnetic

- Most common type. Used in all commercial/residential panelboards.
- Standardized trip delay curves.
- Thermal element (bimetallic strip) handles time delayed trips (currents <=600% breaker rating).
- Magnetic element (iron core coil) handles instantaneous trip short circuits.
- Must be derated if used at high ambient temperature (i.e. rack PDU)

Hydraulic Magnetic

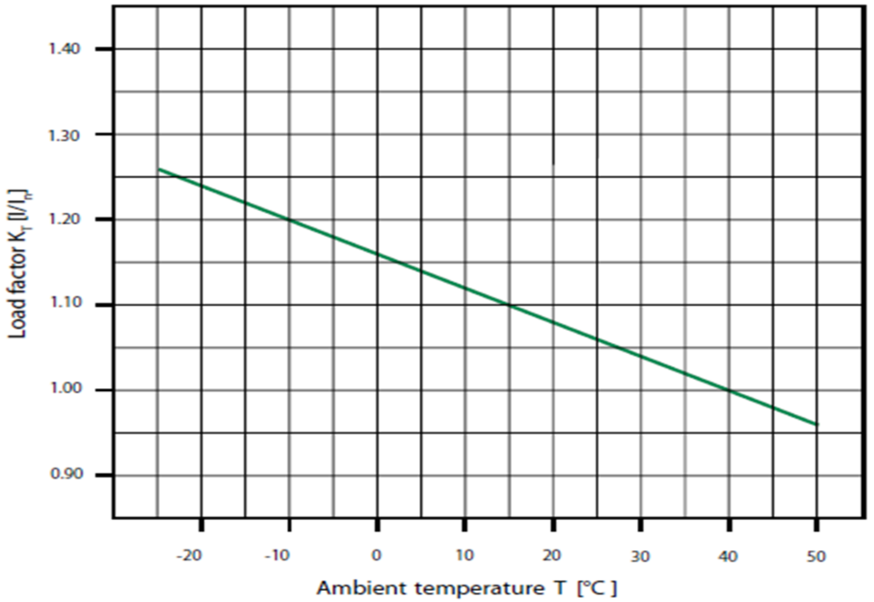
- Used where high ambient temperature is concern (rack PDU)
- Non-standardized vendor specific trip delay curves.
- Variable magnetic element. An air coil core containing a movable, viscous damped spring loaded iron slug.
- No derating at high ambient temperature.
- Slower to trip compared to thermal magnetic for short circuits.

Derating of Thermal Magnetic Breakers

- All thermal magnetic breakers must be derated when operated at high (>40°C) temperatures.

- Graph shows in a Moeller thermal magnetic breaker must be derated to 95% at 50°C (20A breaker = 19A @ 50°C) and cannot be used in a 60°C rated PDU.

Influence of ambient temperature T on load carrying capacity



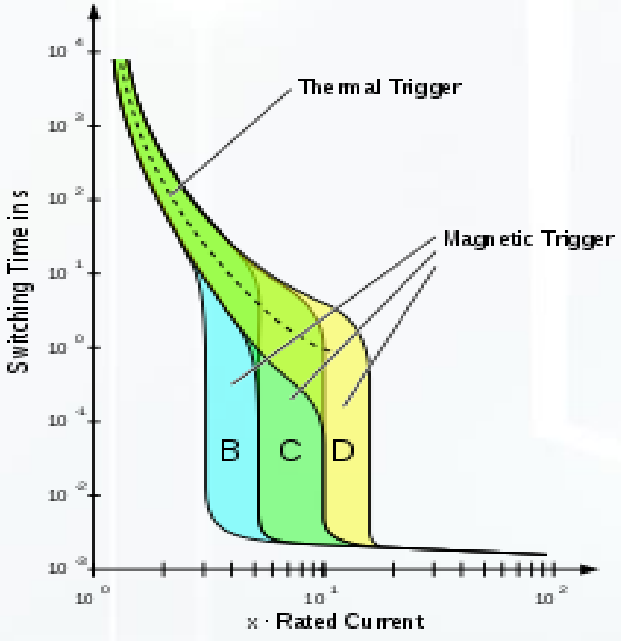
Maximum load I_L at ambient temperature T:
$I_L (T) = I_n K_T (T)$

Circuit Breaker Trip Delays

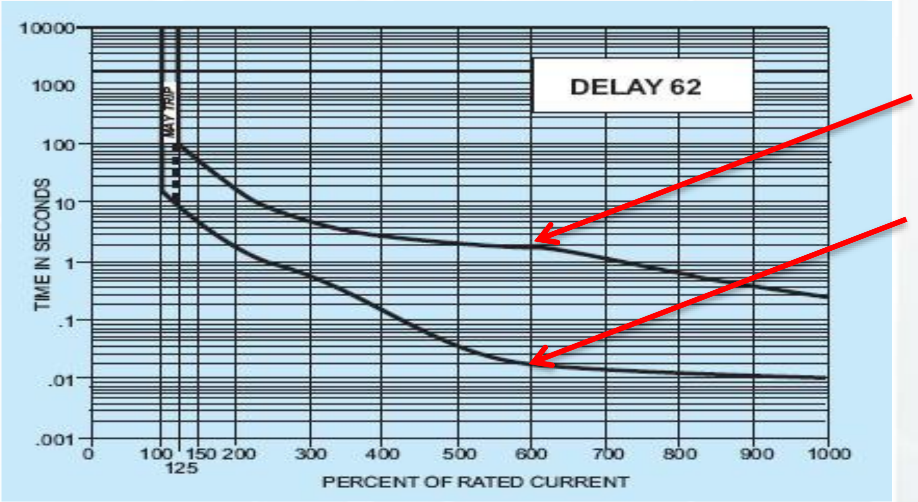
For data centers, type D is used.

Hydraulic magnetic trip delays are not standardized. Type 62 are used by most vendors

Thermal Magnetic Delay



Sensata Type 62 Delay

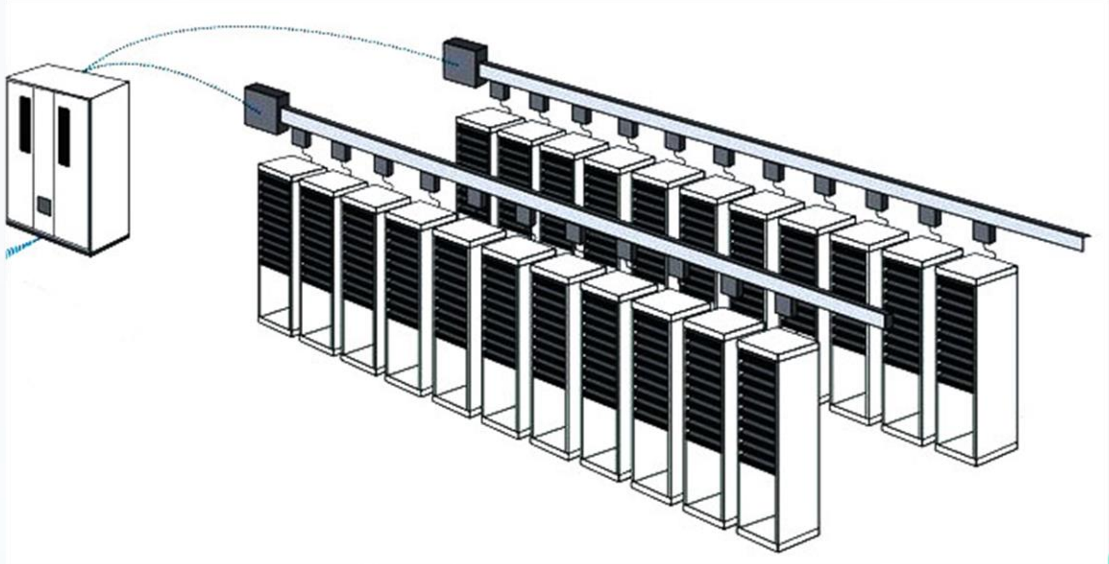


At 600% delay is 0.02 to 2 seconds.

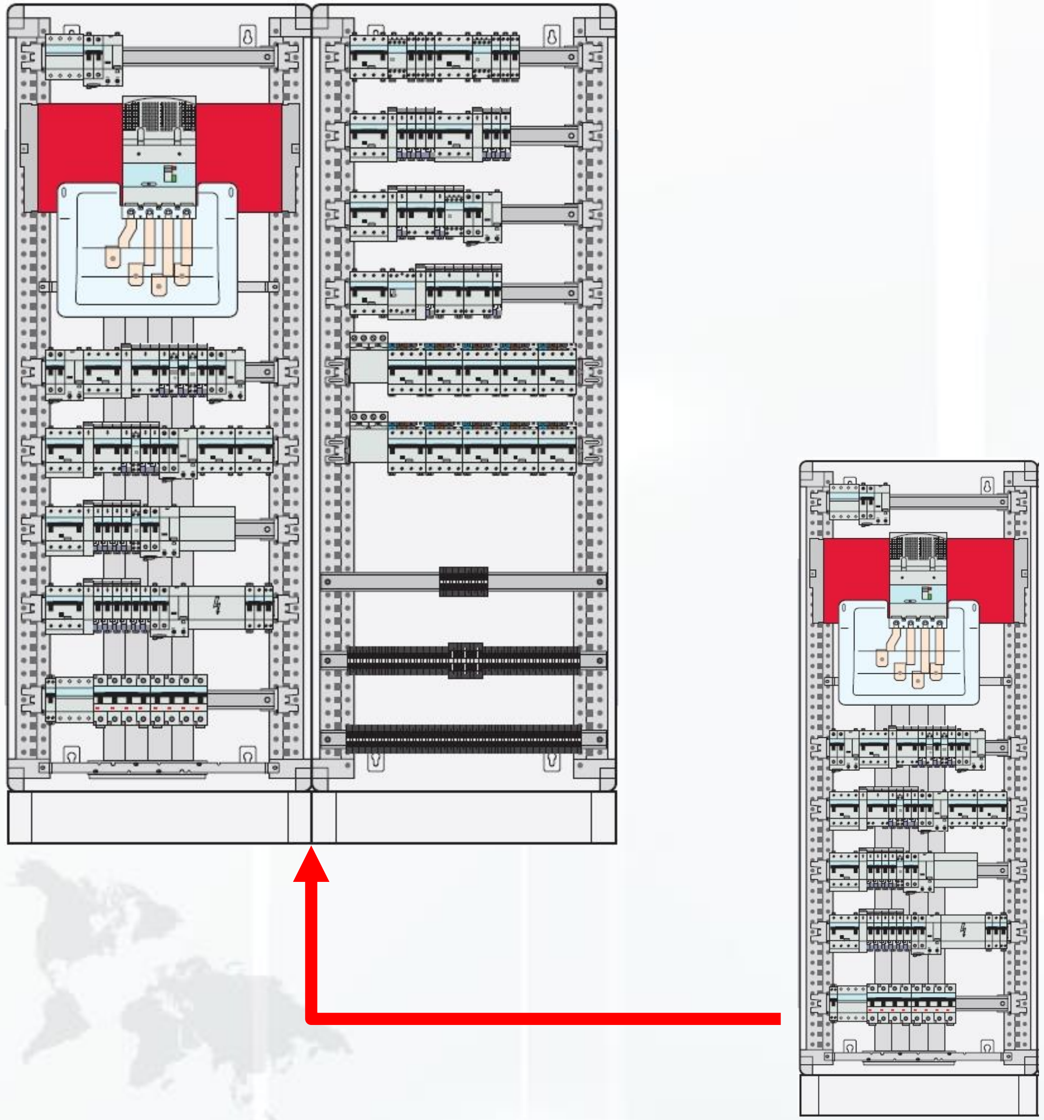
Circuit Breaker Trip Coordination

When a short occurs, only the closest up-stream breaker should trip.
Short in rack should trip PDU breaker - not panel breaker protecting the PDU.

- Panel main & branch CB manufacturer/type.
- PDU and panel breakers are different manufacturer & type.
  Current ratings are close (PDU 16A, panel 32A).
  PDU hydraulic-magnetic are slower than
  panel thermal-magnetic.
- Some customers test and complain
  panel trips before PDU breaker.
  Highly dependent on panel breaker
  manufacturer and current capacity of circuit.

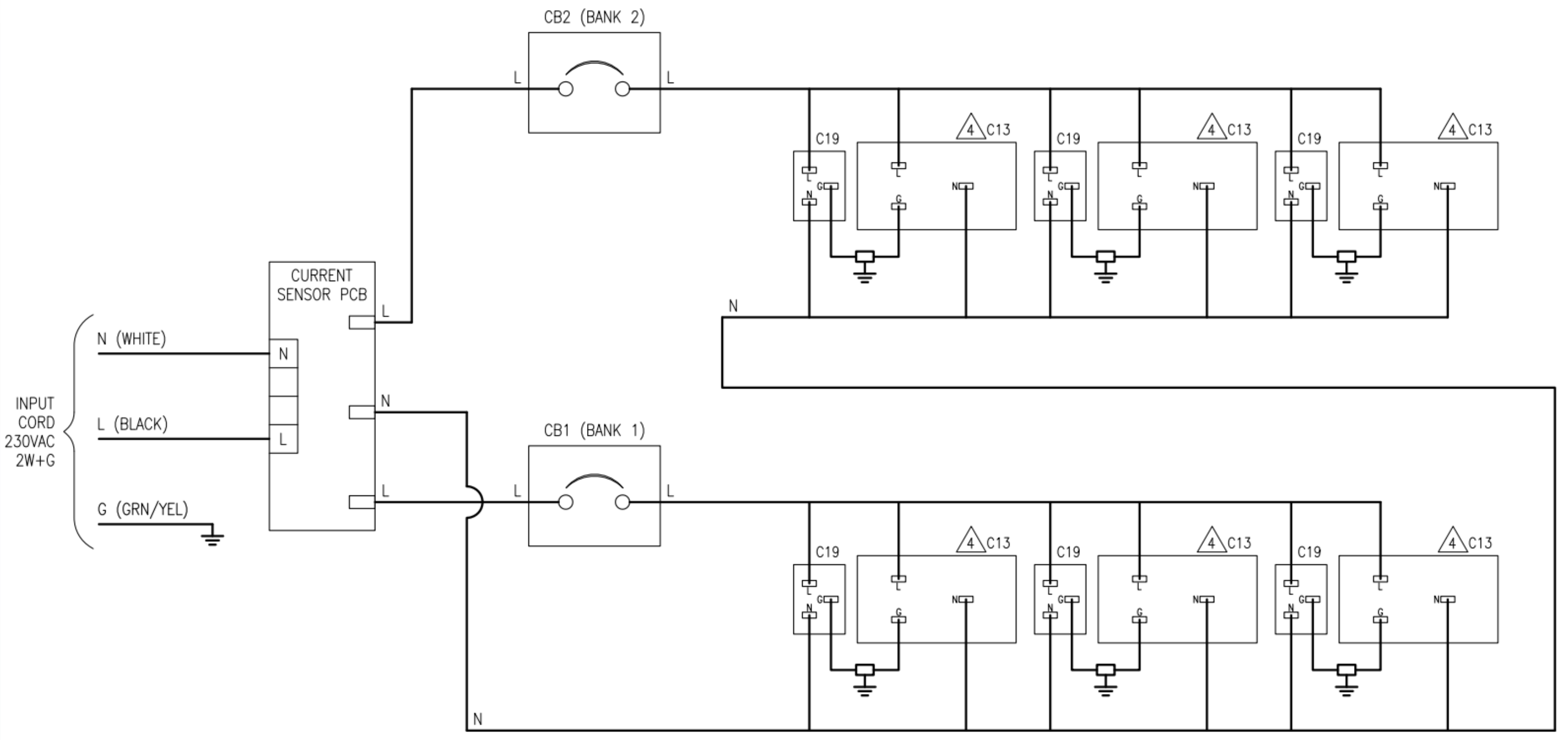


Insufficient Trip Breaker Alerting in Power Chain

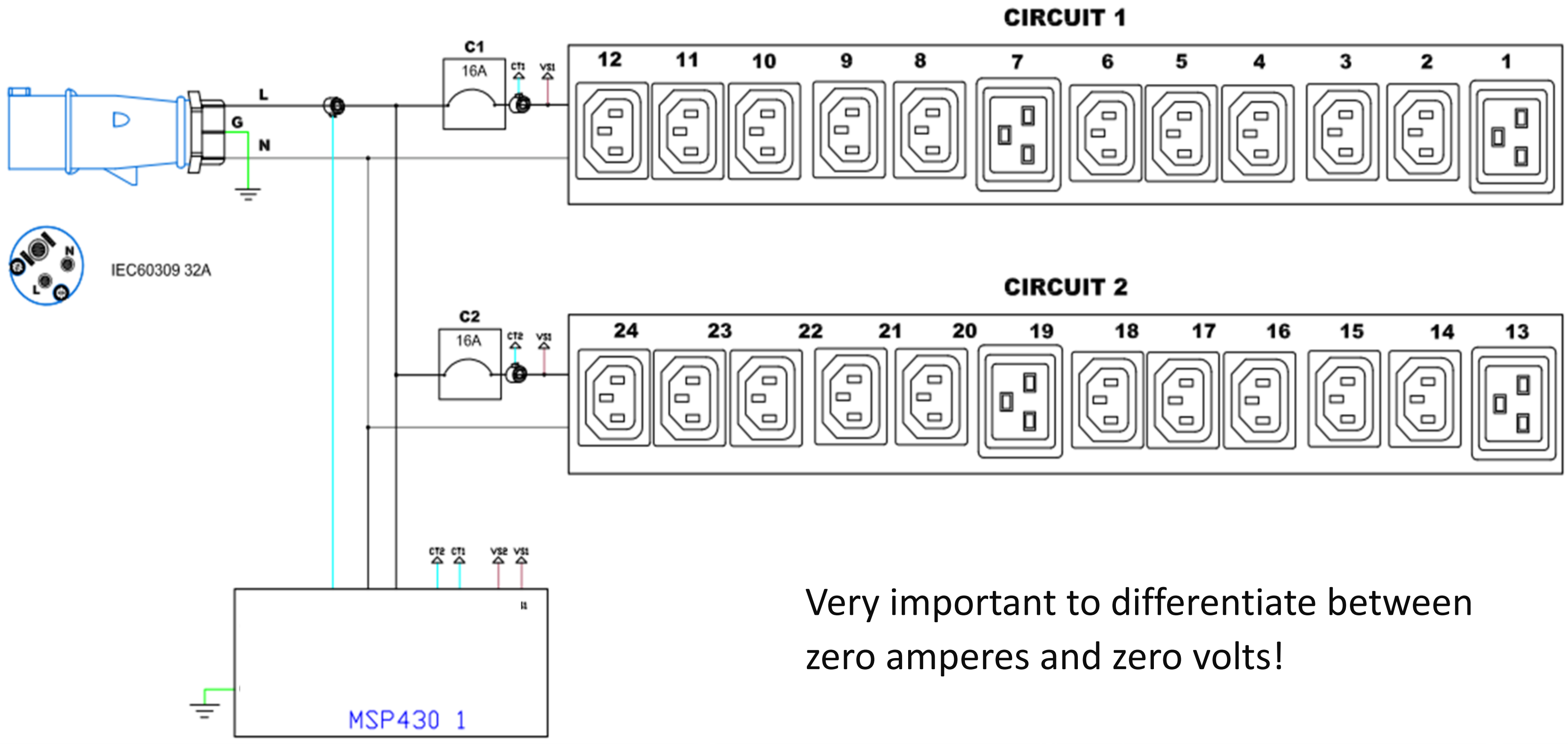


- Most modern data center builds equipped with branch circuit monitoring per pole;
- For same reasons as in previous example, granularity is insufficient;
- Clients often do not realize until too late;

Insufficient Trip Breaker Alerting in Power Chain

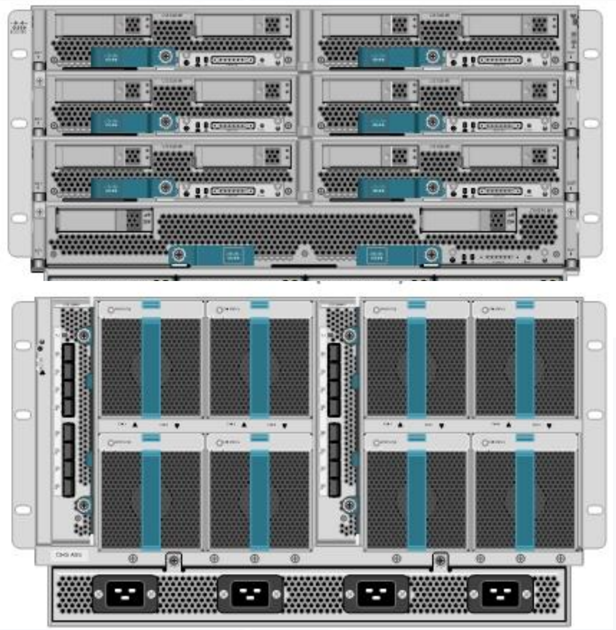


Insufficient Trip Breaker Alerting in Power Chain



Very important to differentiate between zero amperes and zero volts!

Proper Feed Sizing for High Density Blade Chassis



- Prevalence of blade servers increasing every year;
- Increased confusion regarding power interconnects required to maintain true 2N;
- Issue compounded when clients solely consider power capacity guidelines of RPP / distribution panel feed;

e.g. Cisco UCS 5108

- 6U height;
- ~1800W typical;
 ~2300W peak;
- 4x Power Supplies, up to 2500W each;

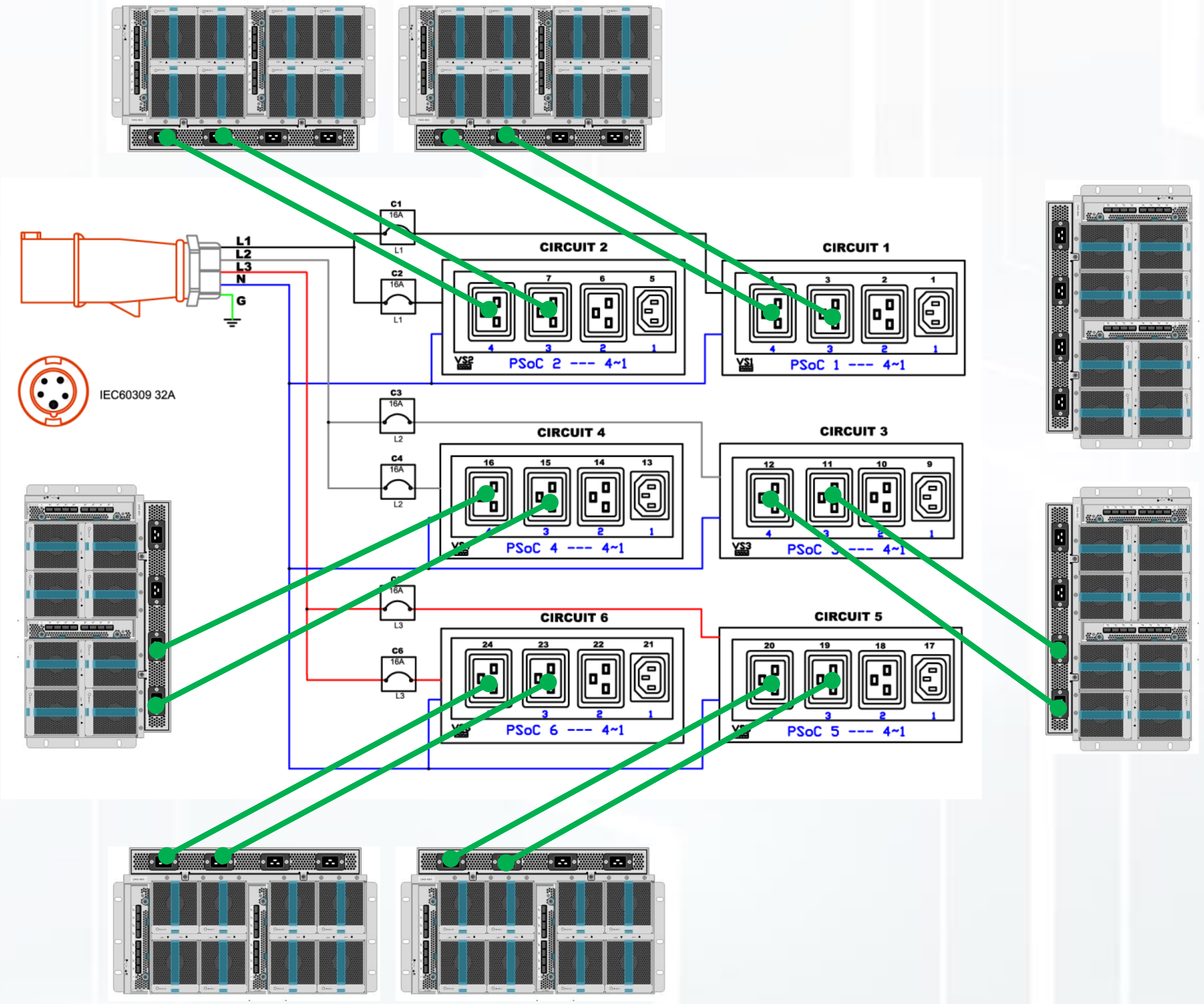
e.g. 415V, 3phase WYE; 32a Supply

- 23,000VA / ~22,400 Watts;
- In theory, should support up to (22400 ÷ 2300) = 9 chassis;

Let's try seven (48U rack)…

BICSI MIDDLE EAST & AFRICA

Proper Feed Sizing for High Density Blade Chassis

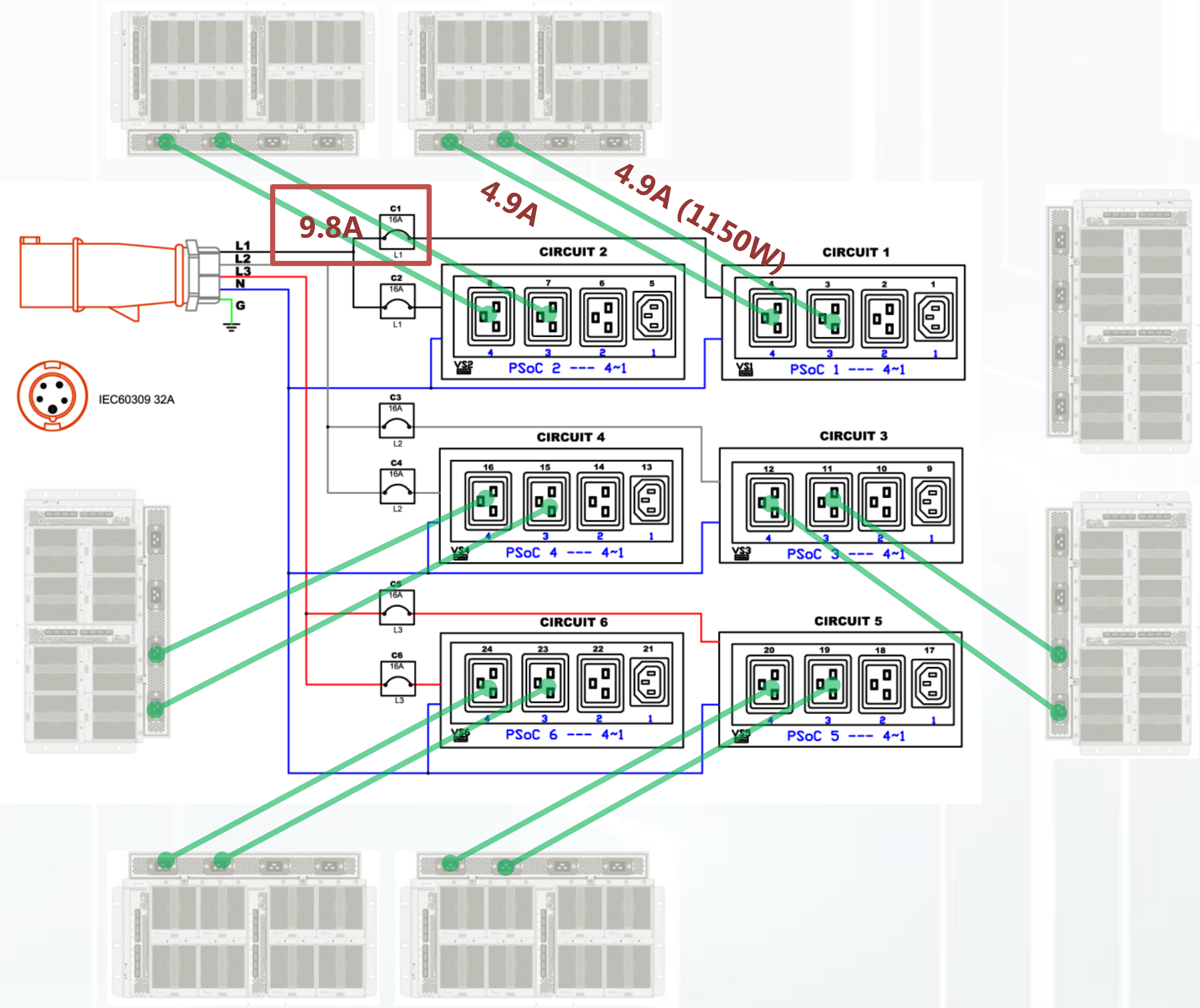


First Connect
Six Chassis
(14.2kVA)

Peak = 4.9A per connection;

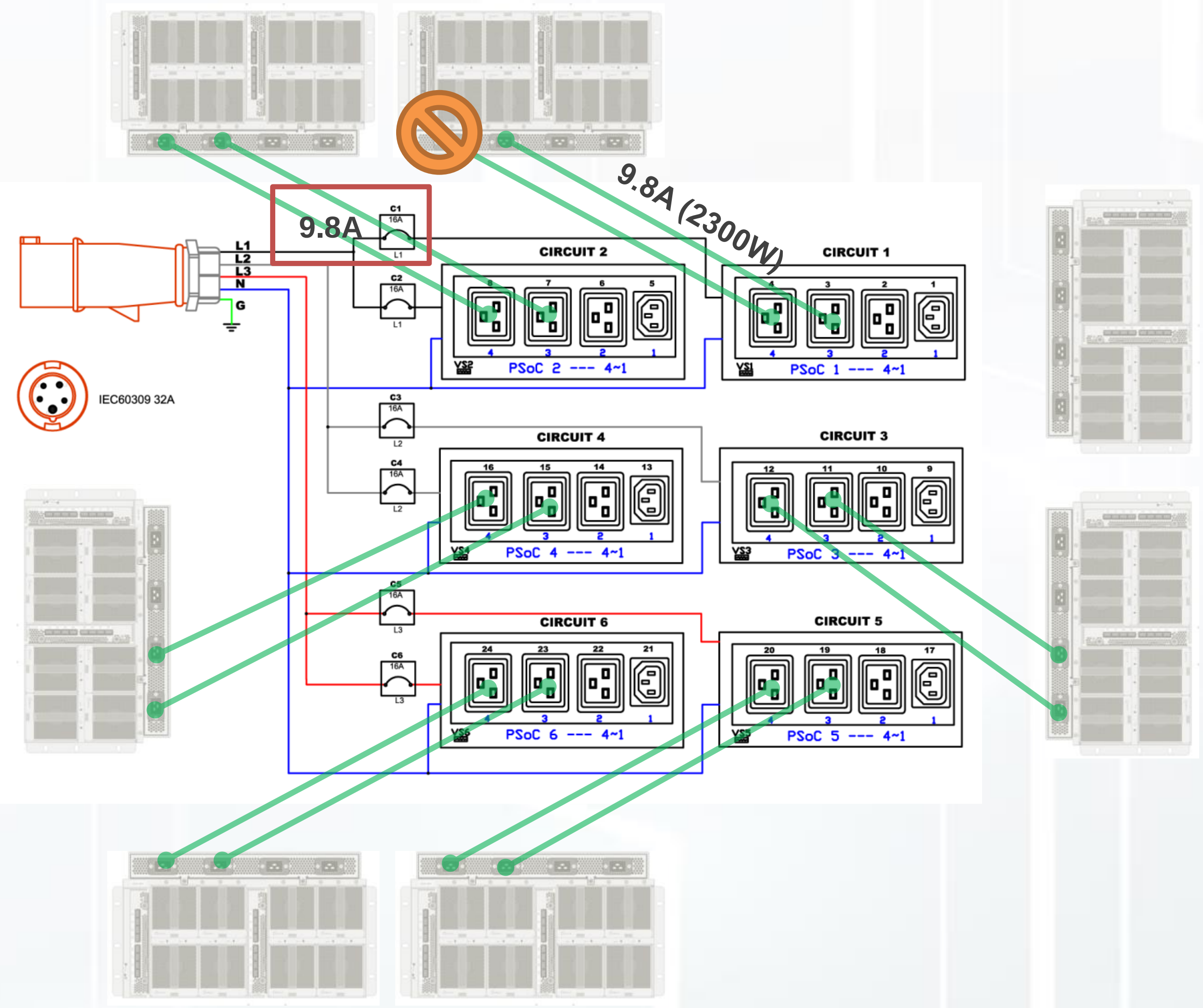
Peak (Failure Mode) = 9.8A on one plug

Proper Feed Sizing for High Density Blade Chassis



Even with
B-side down,
each circuit breaker at
61% load.
Very safe.

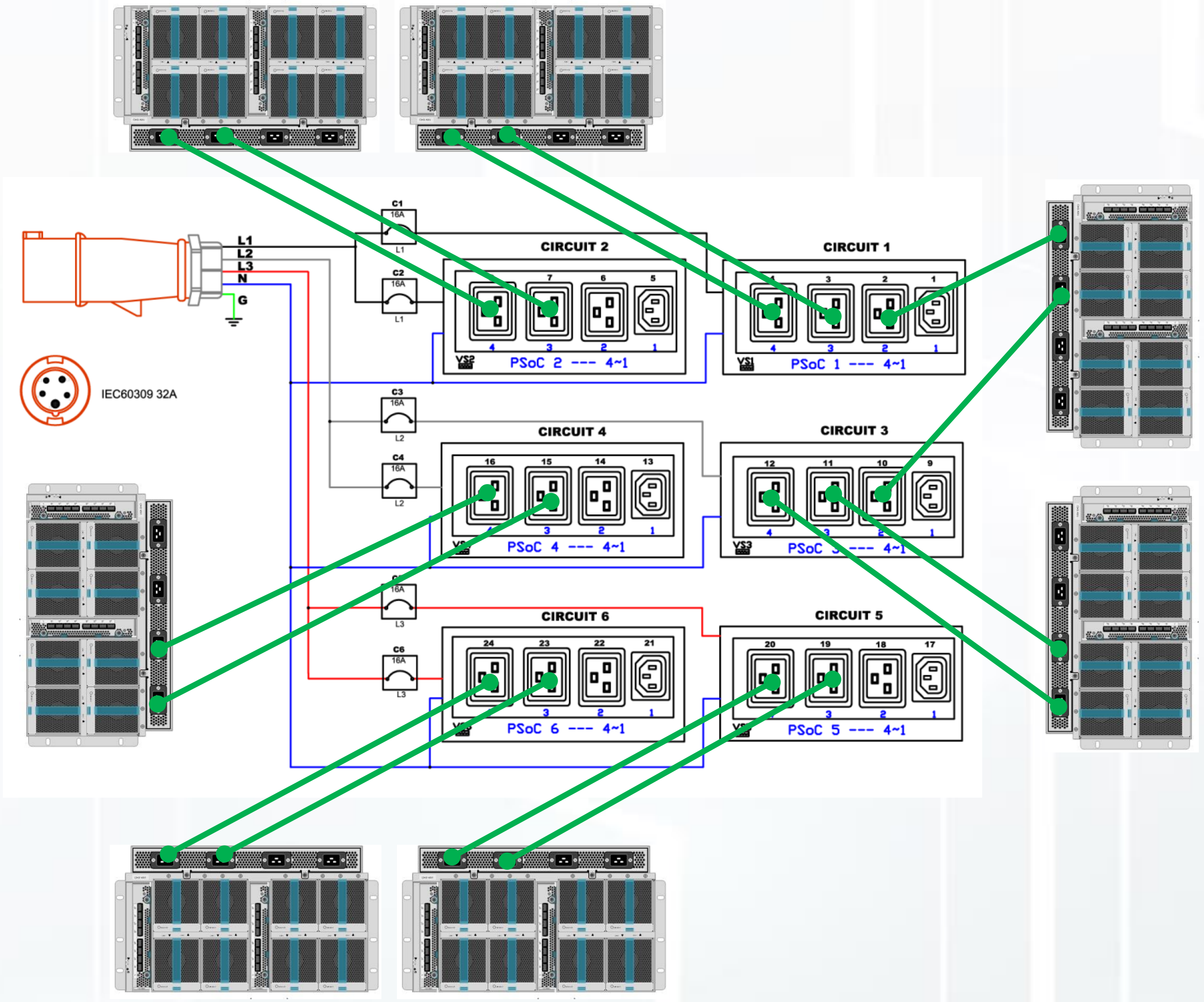
Proper Feed Sizing for High Density Blade Chassis



Failure Mode:

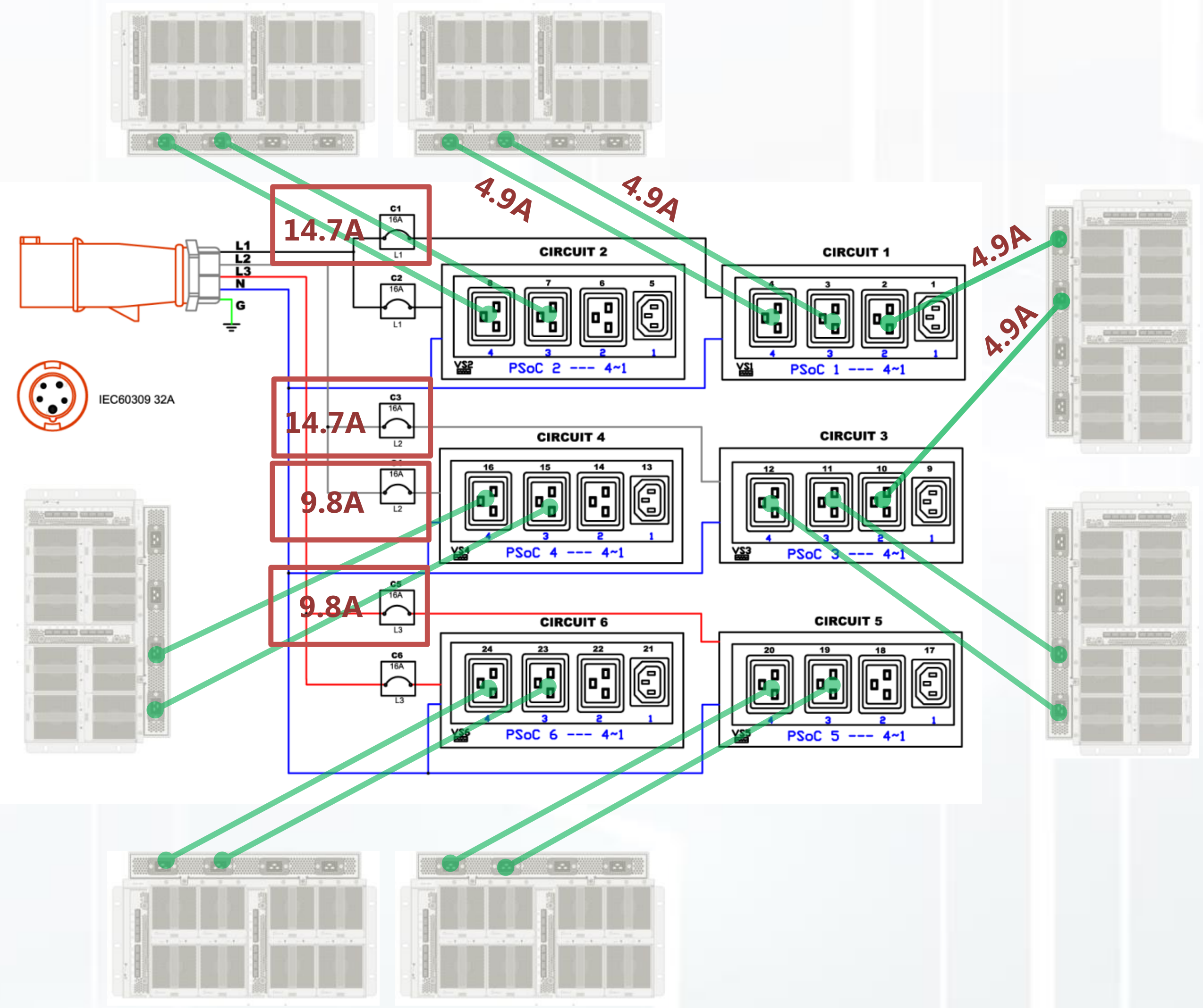
B-Side power down and some A-side power supplies fail. Still safe.

Proper Feed Sizing for High Density Blade Chassis



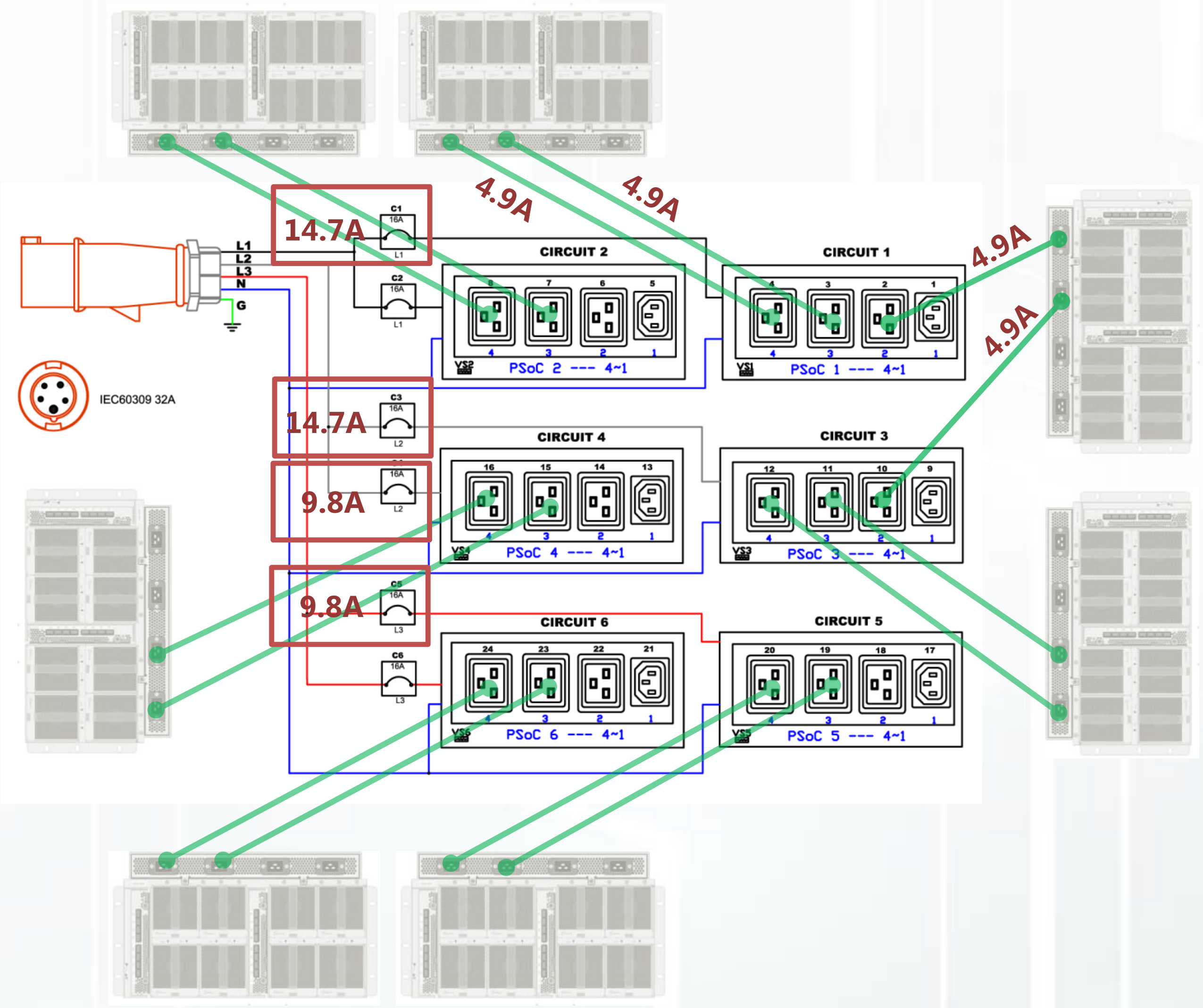
Add 7th Chassis.
Need to share breakers.

Proper Feed Sizing for High Density Blade Chassis



Still safe so far.
Two breakers
load to 14.7A
if B-side power down.

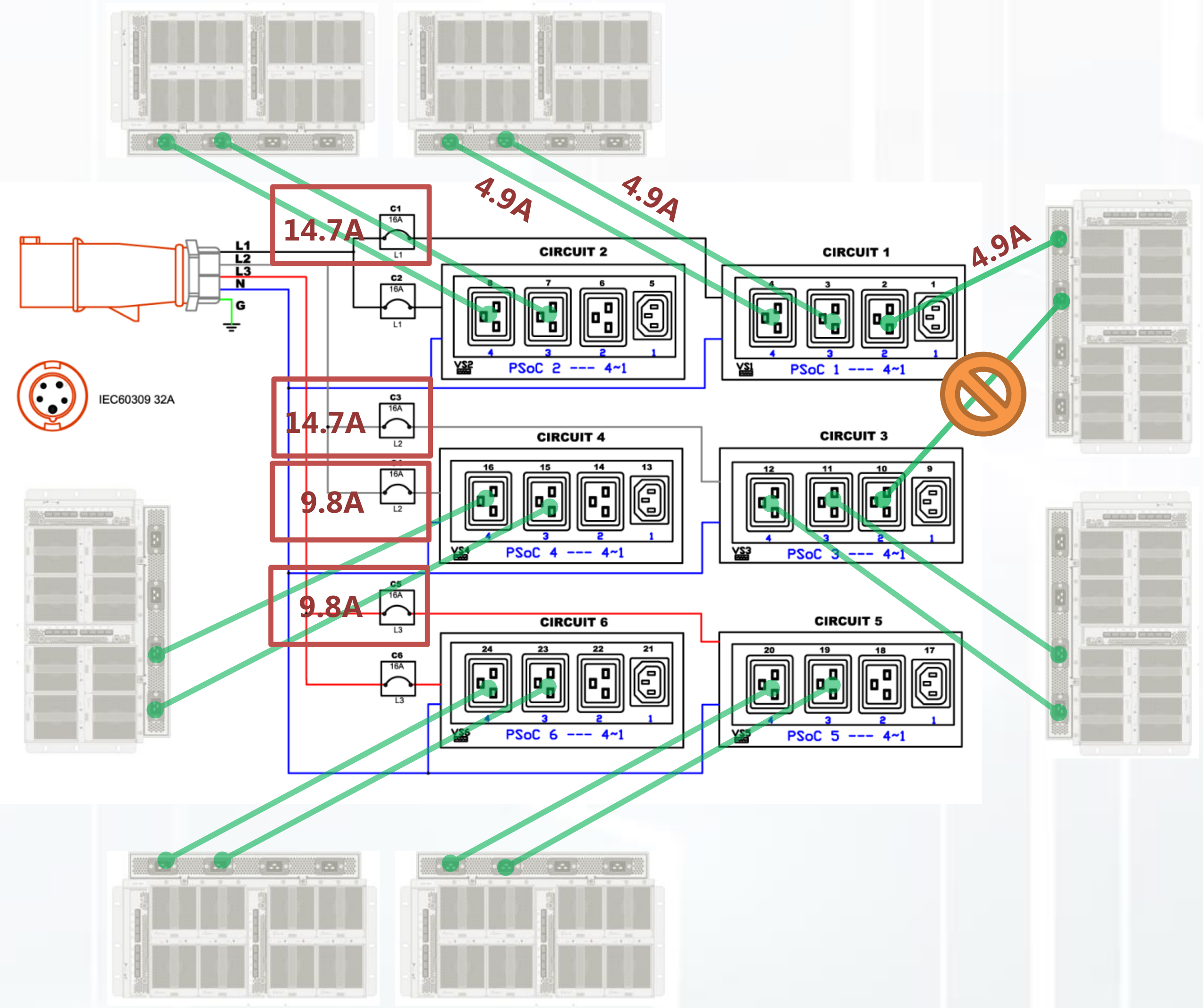
Proper Feed Sizing for High Density Blade Chassis



Not truly redundant!

One bad power supply (during B-side maintenance) can shut down 3 chassis

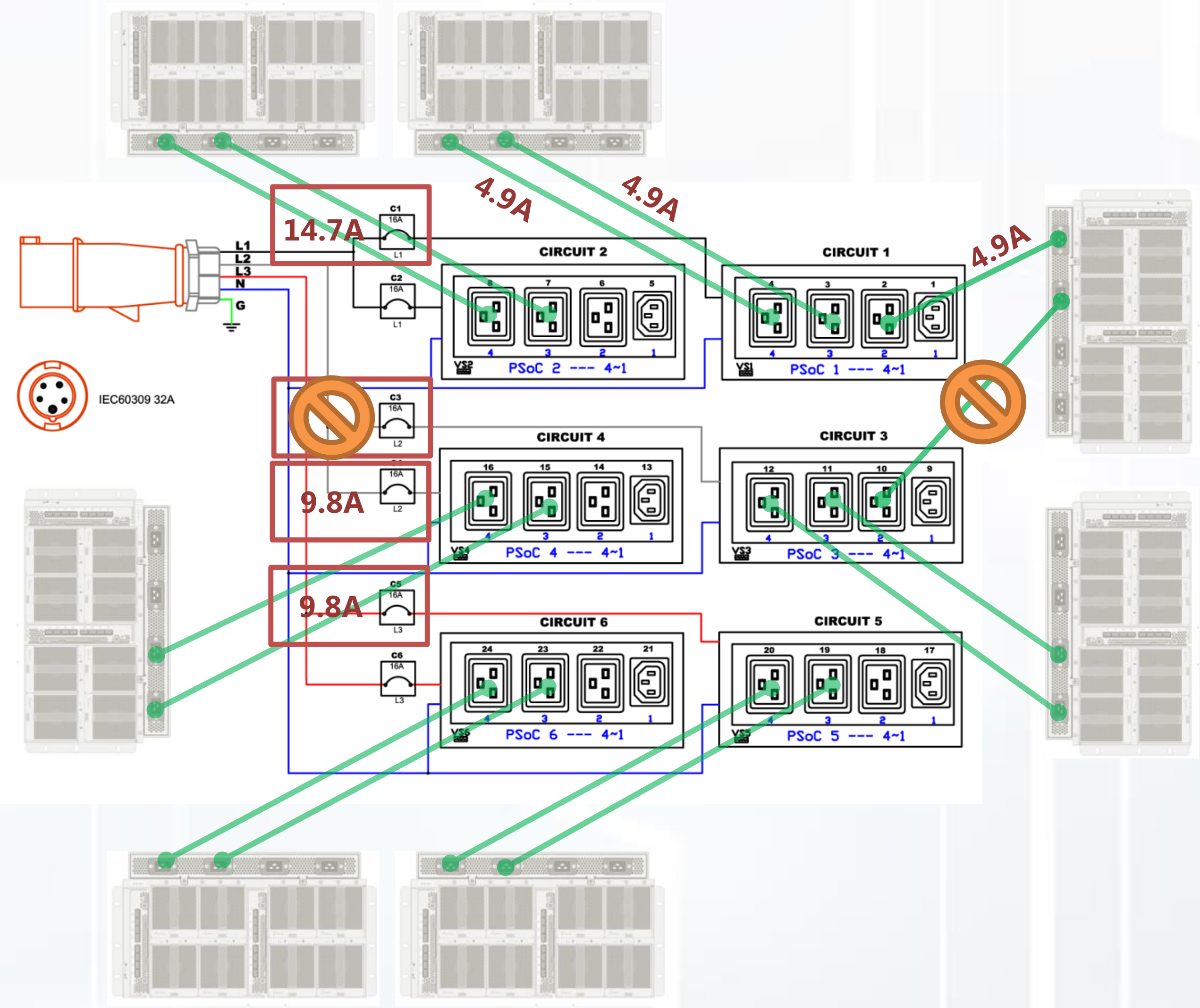
Proper Feed Sizing for High Density Blade Chassis



Not truly redundant!

One bad power supply (during B-side maintenance) can shut down 3 chassis

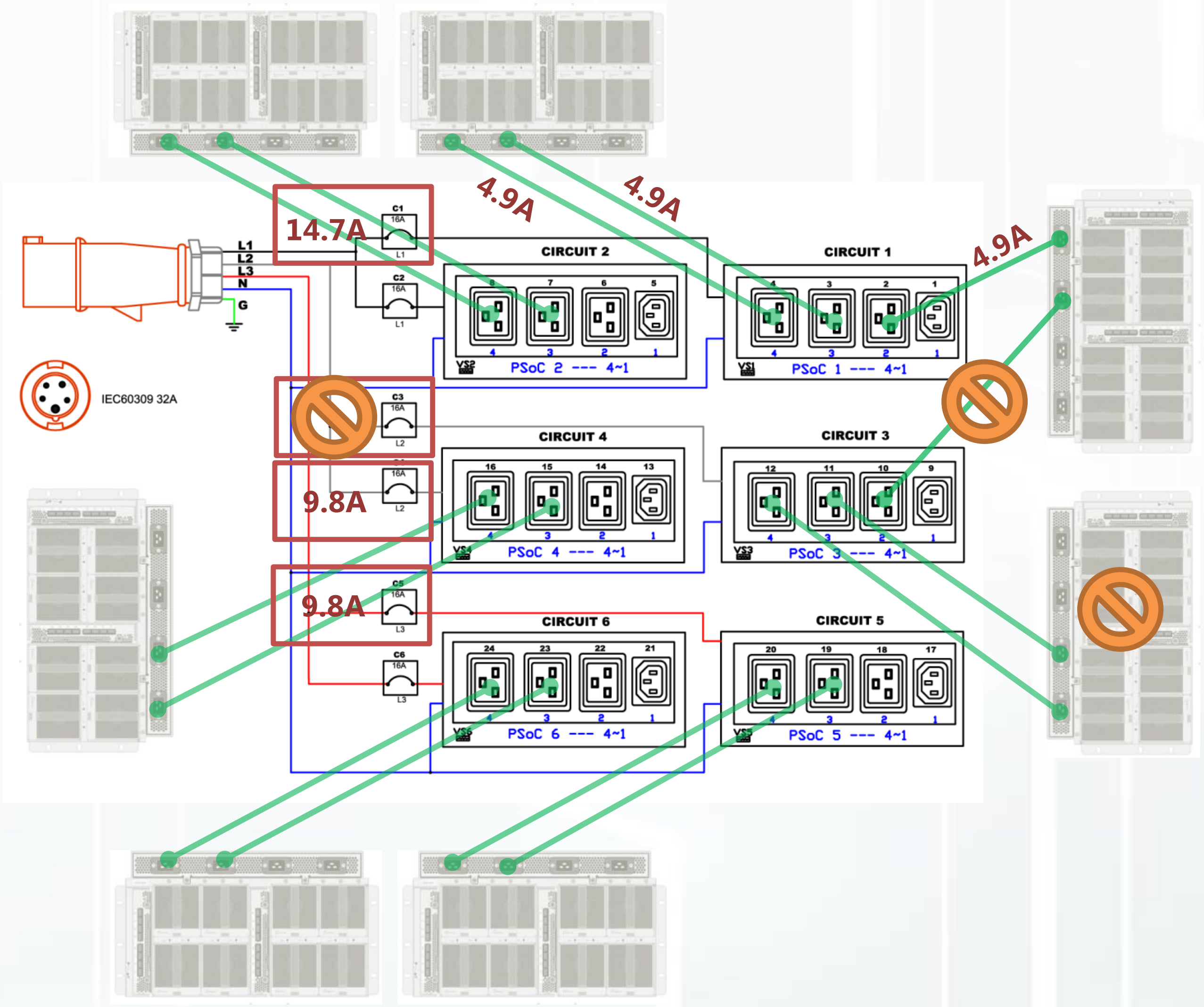
Proper Feed Sizing for High Density Blade Chassis



Not truly redundant!

One bad power supply (during B-side maintenance) can shut down 3 chassis

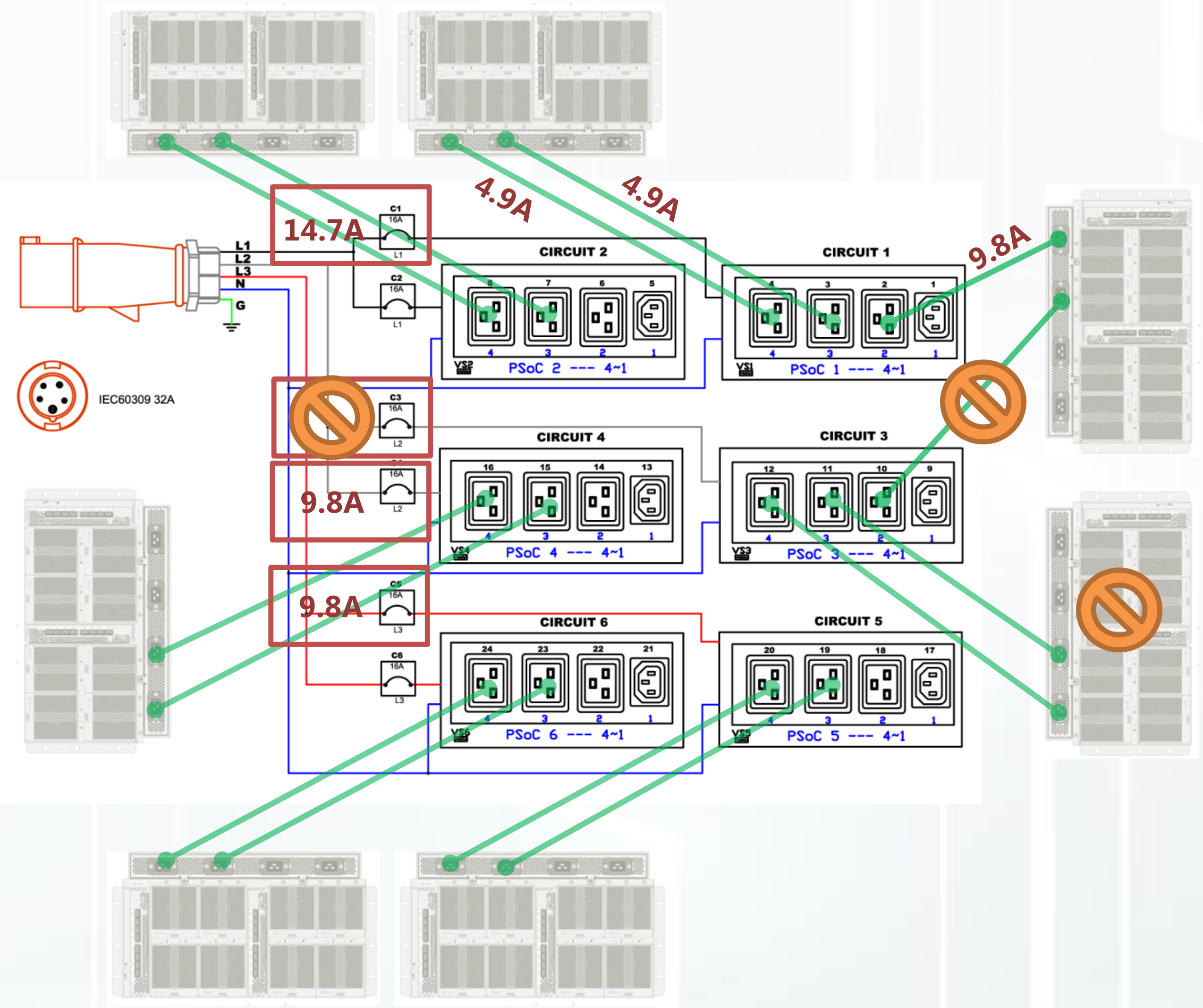
Proper Feed Sizing for High Density Blade Chassis



Not truly redundant!

One bad power supply (during B-side maintenance) can shut down 3 chassis

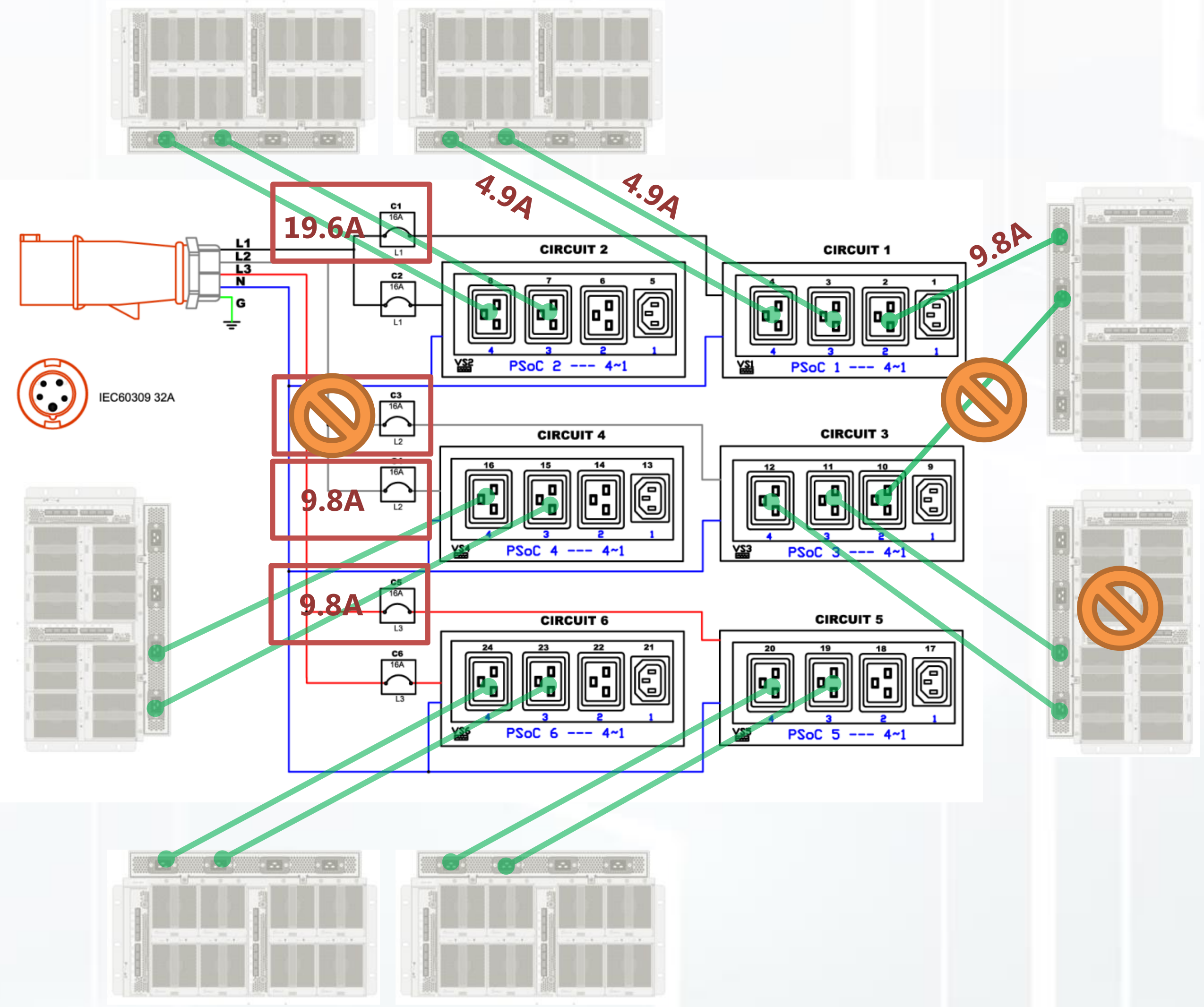
Proper Feed Sizing for High Density Blade Chassis



Not truly redundant!

One bad power supply (during B-side maintenance) can shut down 3 chassis

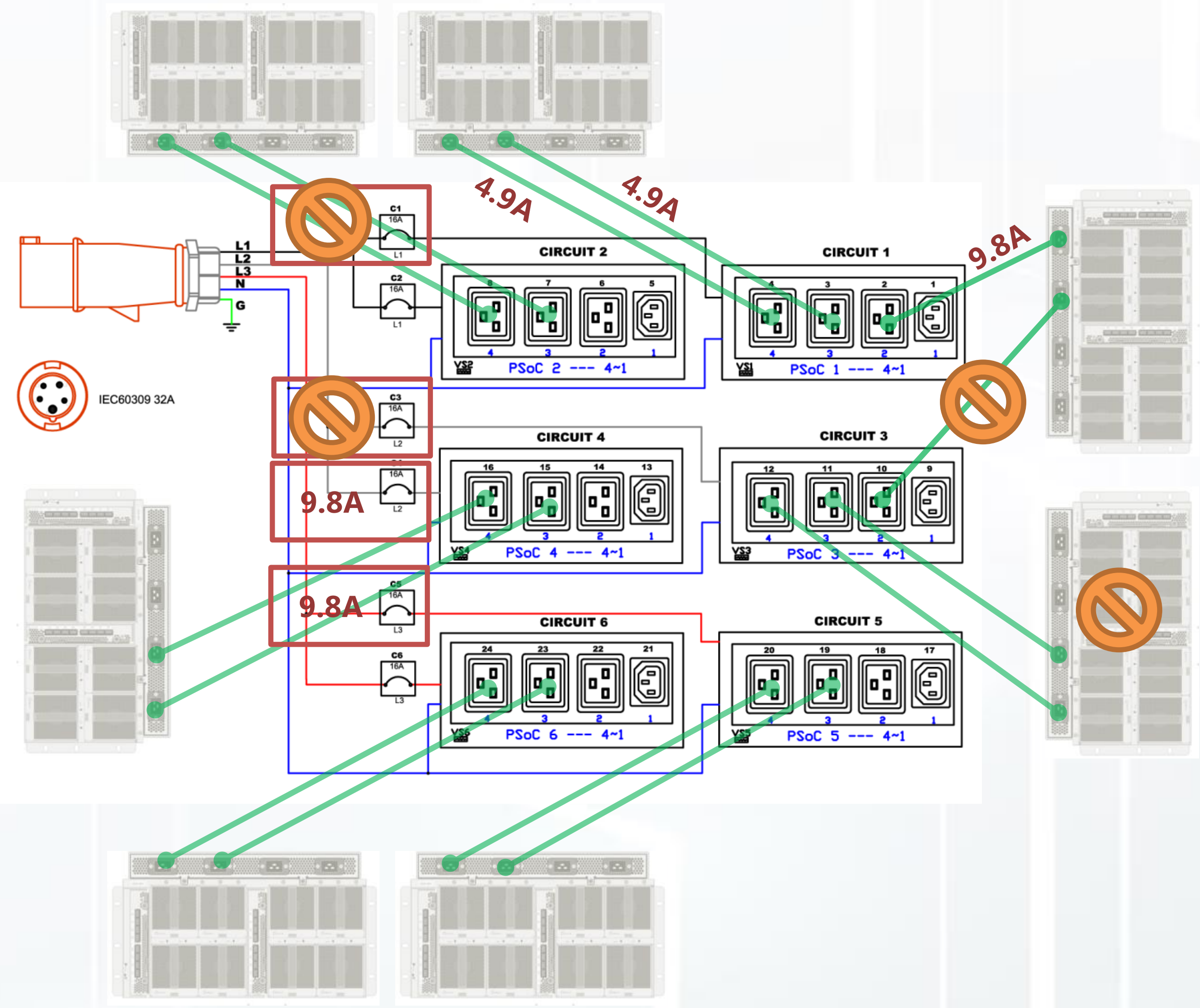
Proper Feed Sizing for High Density Blade Chassis



Not truly redundant!

One bad power supply (during B-side maintenance) can shut down 3 chassis

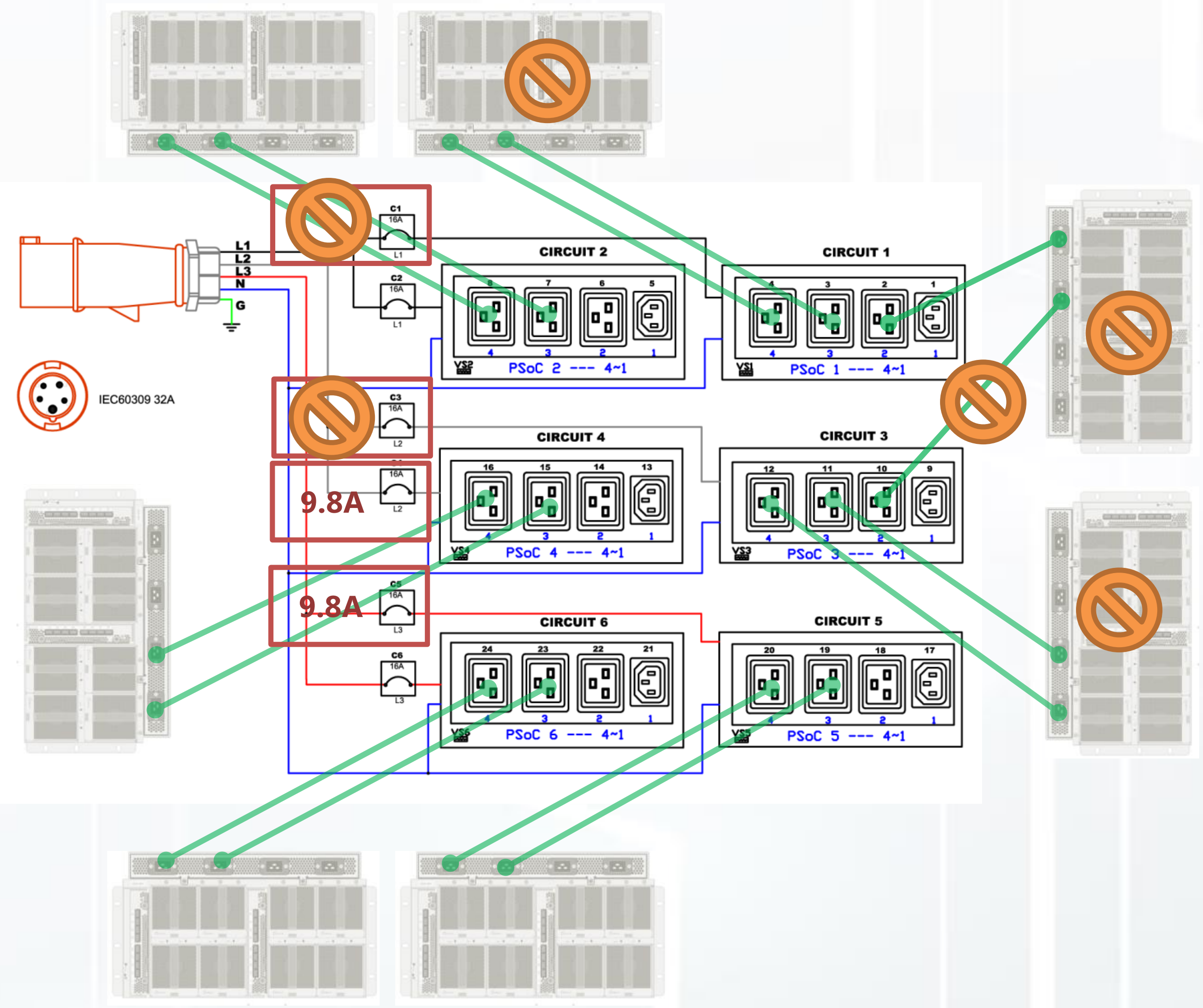
Proper Feed Sizing for High Density Blade Chassis



Not truly redundant!

One bad power supply (during B-side maintenance) can shut down 3 chassis

Proper Feed Sizing for High Density Blade Chassis



Not truly redundant!

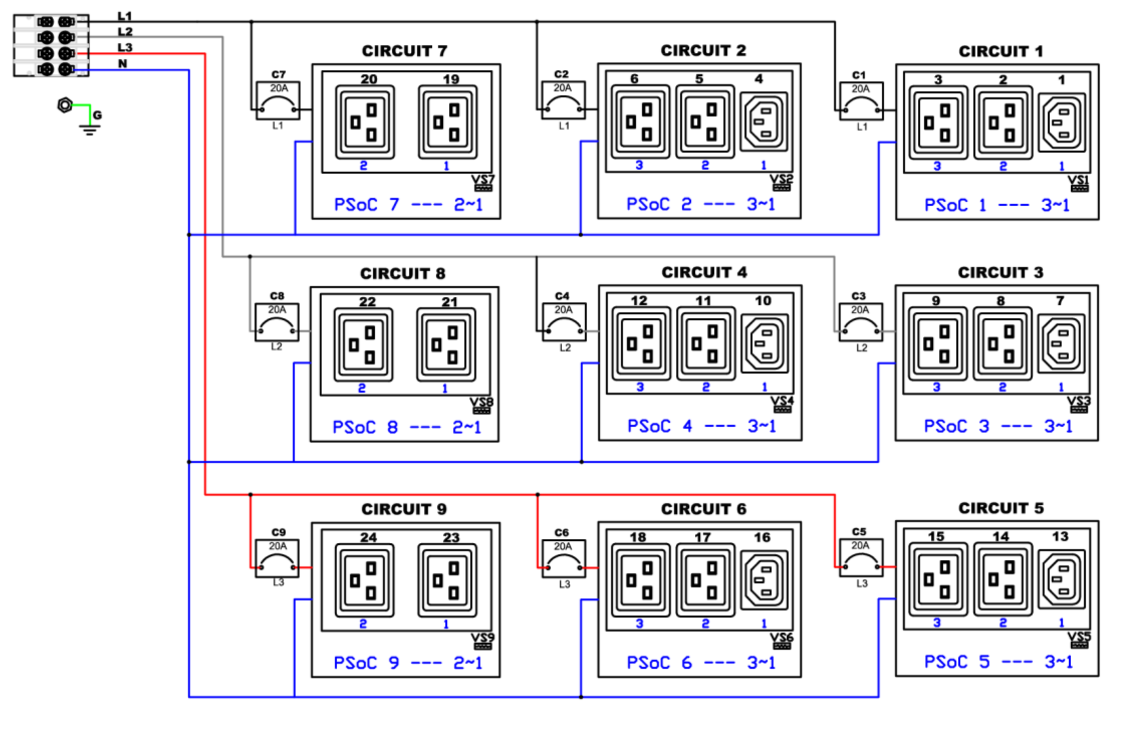
One bad power supply (during B-side maintenance) can shut down 3 chassis

Violates best practice concept of isolated failure domains.

Proper Feed Sizing for High Density Blade Chassis

- "This cabinet provides two redundant 23kVA power feeds."
- Does not necessarily translate into, "Can implement 23kVA of load."
- 7 chassis @ ~16.5kVA did not work!
- Apparent maximum = 6 chassis @ 36U (14.1kVA);
    - Wastes 40% of power capacity;
    - Wastes 25% of rack space (assuming 48U cabinet);

(One Possible Solution)



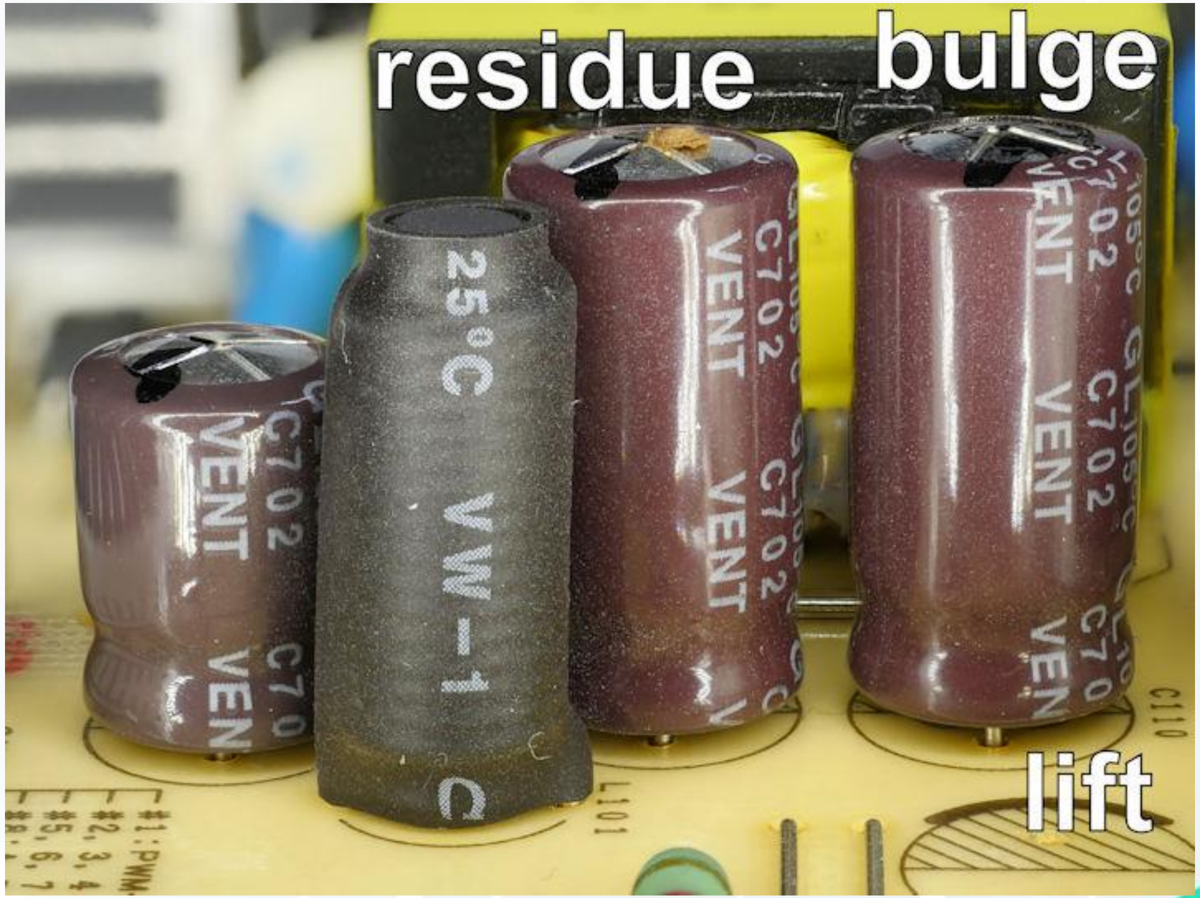
Residual Current Monitoring

Residual Current Monitoring (RCM)
Residual Current Device (RCD)

Residual current is the difference between the outer conductor (L1 or L1-L3) and the neutral conductor (N) flowing stream. This is known as current leakage and resulting an alarm to identify the presence of residual current

Residual Current: causes?

- Old or damaged cable isolation
- Leaking capacitators
- Failing power supplies
- IEC-60950-1 compliance



Detecting and Protecting against Residual Current

RCDs
Residual Current Devices

Legrand RCD

- **Will Disconnect** Power above a certain threshold ($I\Delta_N$30mA) of Residual Current
- Used in Household or similar applications, when operated by unskilled personal.
- Not Suitable for Data Center application because of Power Disconnect
- Standard: IEC 60755 General requirements for residual current operated protective devices

Both RCDs and RCMs require periodic and repetitive examination on unpowered equipment = Downtime (DIN-VDE-0701/0702)

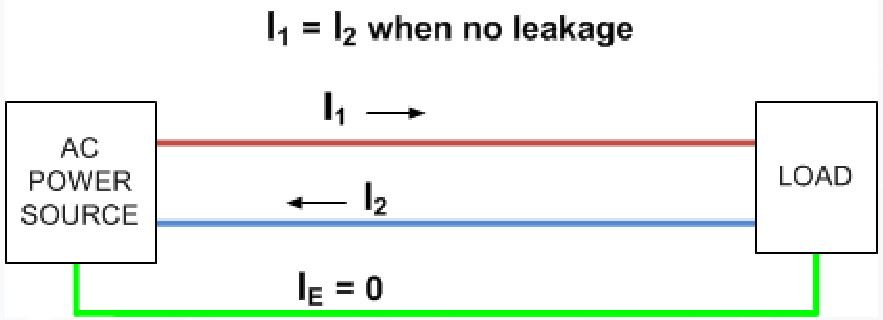
RCMs
Residual Current Monitoring

Bender Din RCM module

- Monitoring of Residual Current only, **No disconnect**
- Ideal to detect insulation errors at an early stage
- Constantly monitor the state of leakage current from the IT equipment
- In Data Centers, it is usage to observe 0.2 to 0.3% of leakage current (ex: 20A (4.6kW)*0.2% = 40mA)
- Standard: IEC/EN 62020-AMD2Ed1 – Residual current monitoring devices for household and similar uses

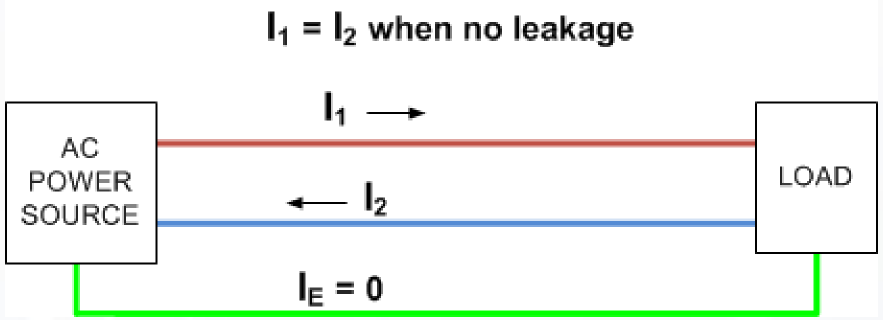
Residual Current Monitoring

Basic electric theory says sum of currents in a closed loop = zero.

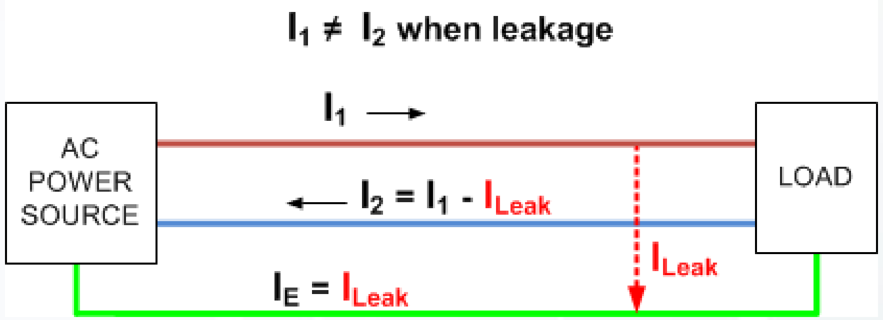


Residual Current Monitoring

Basic electric theory says sum of currents in a closed loop = zero.

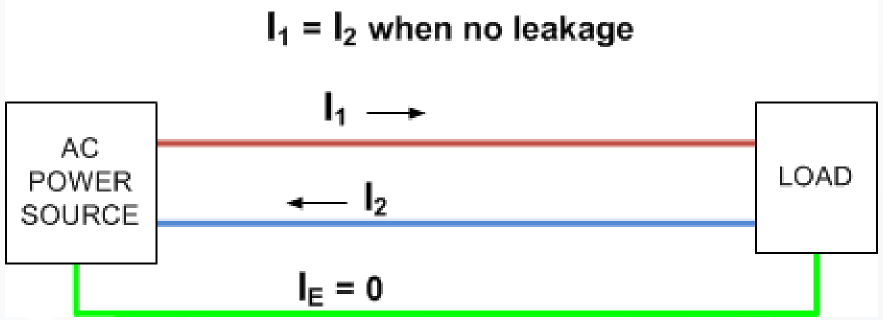


When leakage occurs sum of currents does not equal 0.

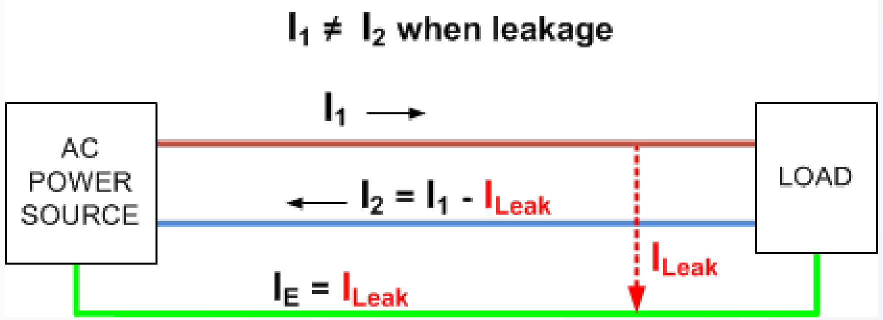


Residual Current Monitoring

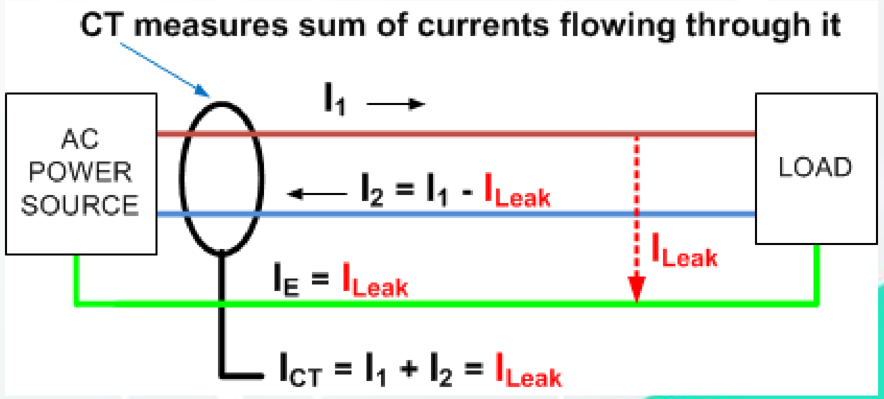
Basic electric theory says sum of currents in a closed loop = zero.



When leakage occurs sum of currents does not equal 0.



Sensor is a current transformer with inlet phase & neutral wires passing through it.



Operational reliability

- DGUV requires that “electrical systems and fixed operating equipment” are tested every 4 years

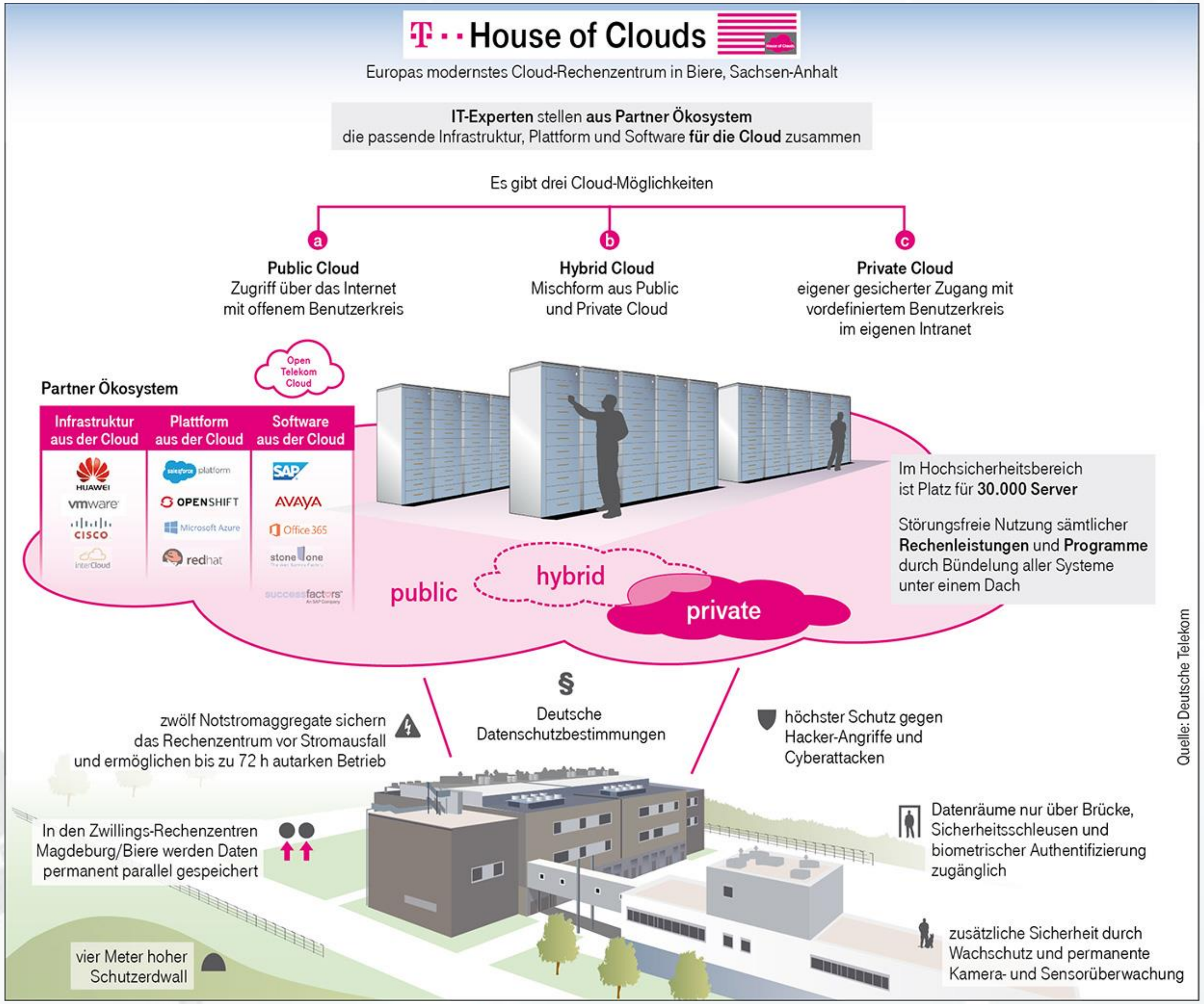
Prevent against electrical shock caused by residual current

Reduce the risk of fire caused by leakage and fault current by alerting in time

Facilitate Preventative maintenance and detect insulation errors

Increase Overall performance of the Data Center

T-Systems



Biere, Germany Data Centers

Advanced Predicative analysis from Correct Power Institute

Tracking RCM Type B evolution and behavior to identify failing server PS

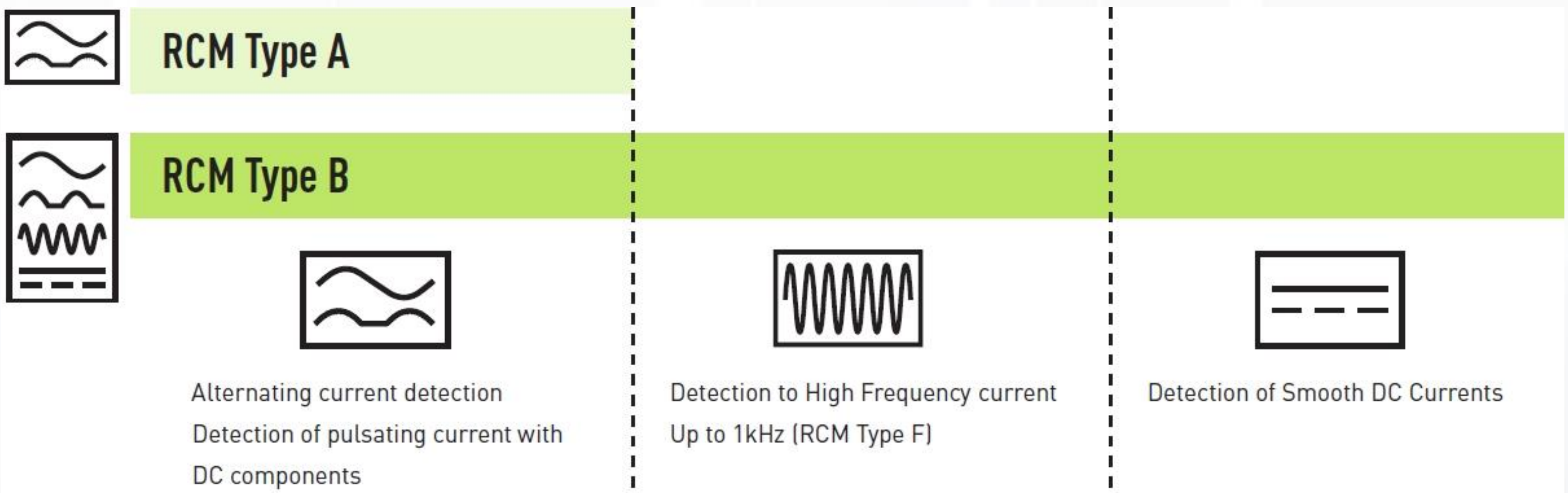
legrand® SYSTEMS

Operational reliability

Important criteria for an RCM solution:

- EN62020 (VDE 0663)
- Configurable threshold and configurable alert system
- Test the residual-current sensors (self-test)
- Avoid overload or overheating of the neutral wire (EN 50600: 8.2.1): neutral-wire current monitoring
- Residual current type A or B

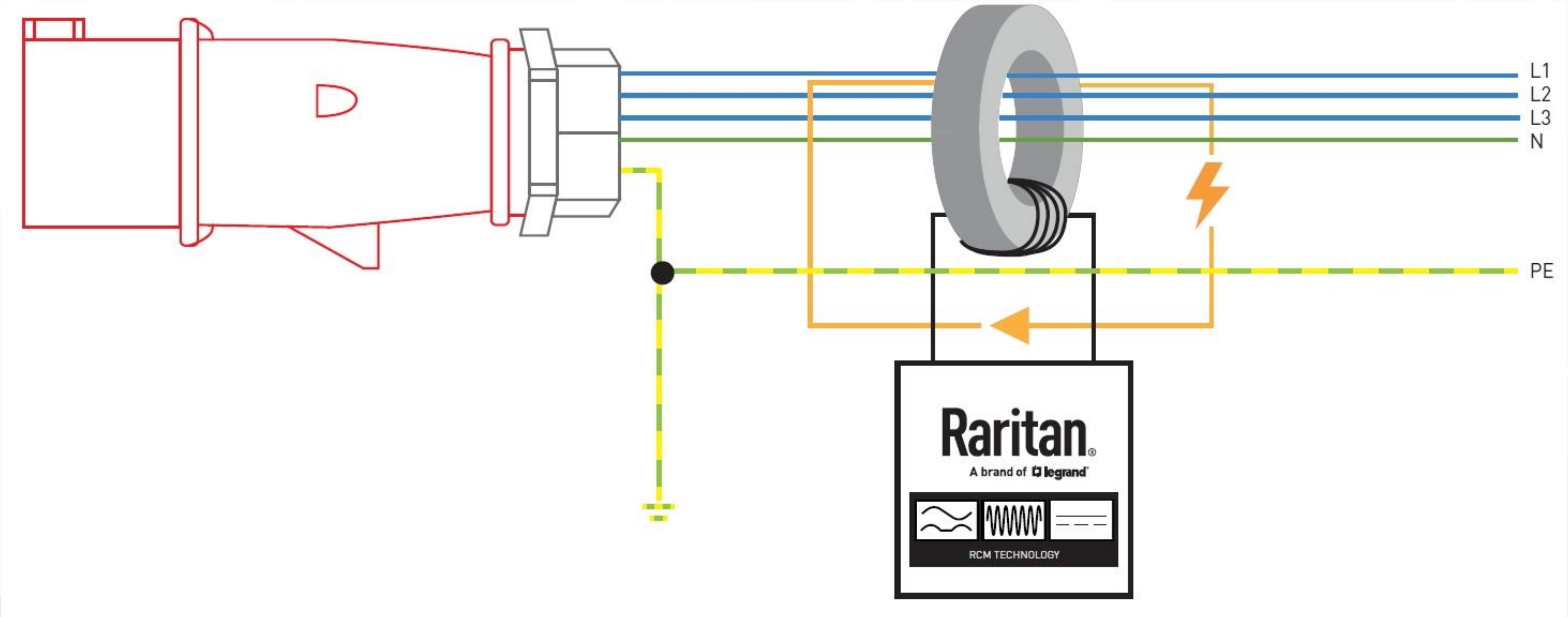
Residual Current: options



RCM types A and Type B Supported by Raritan

RCD type	Symbols	Sensitivity to residual current	Properties	Standards
AC		Alternating	Sinusoidal AC with rated frequency	IEC / EN 61008 IEC / EN 61009
A		Alternating and pulsating direct current	Sinusoidal AC and pulsating DC up to 6 mA	IEC / EN 61008 IEC / EN 61009
F		Alternating and pulsating direct current	Sinusoidal AC and pulsating DC up to 10 mA	IEC / EN 62423
B		Alternating and pulsating direct current and flat direct current	All kinds of current up to 1 kHz	IEC /TR 60755 IEC / EN 62423

Residual Current: options



Surge protection

The case for considering Surge Protection

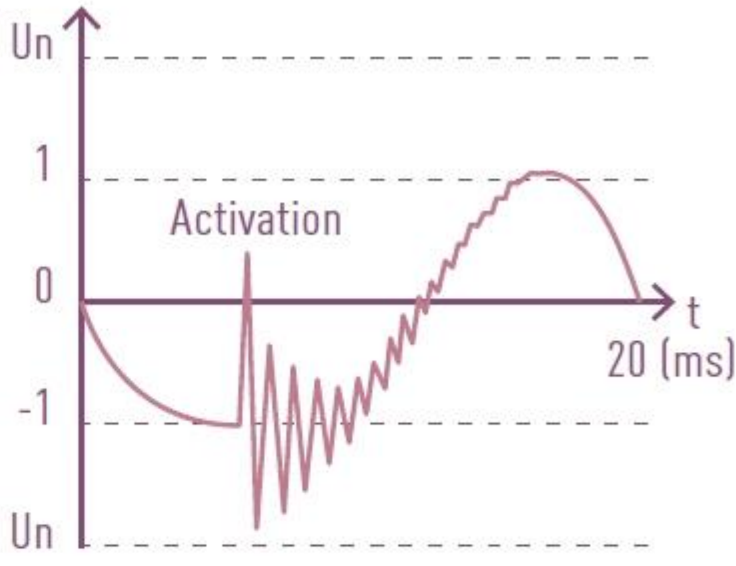
Over-voltages caused by lightning are responsible for 25% to 40% of all damage to equipment.

If the transient over-voltages caused by other phenomena are added to this, close to 60% of all electrical damage could be avoided by installing surge protective devices (SPDs)*.

SPDS… NOT JUST PROTECTION AGAINST THE EFFECTS OF LIGHTNING

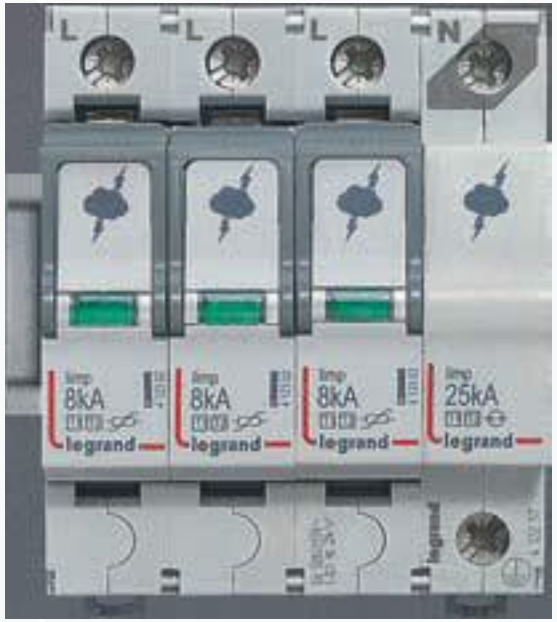
The operation of distribution networks, installations and equipment can cause very harmful transient over voltages.

As well as providing protection against the effects of lightning, installing SPDs also protects sensitive equipment against this type of disturbance



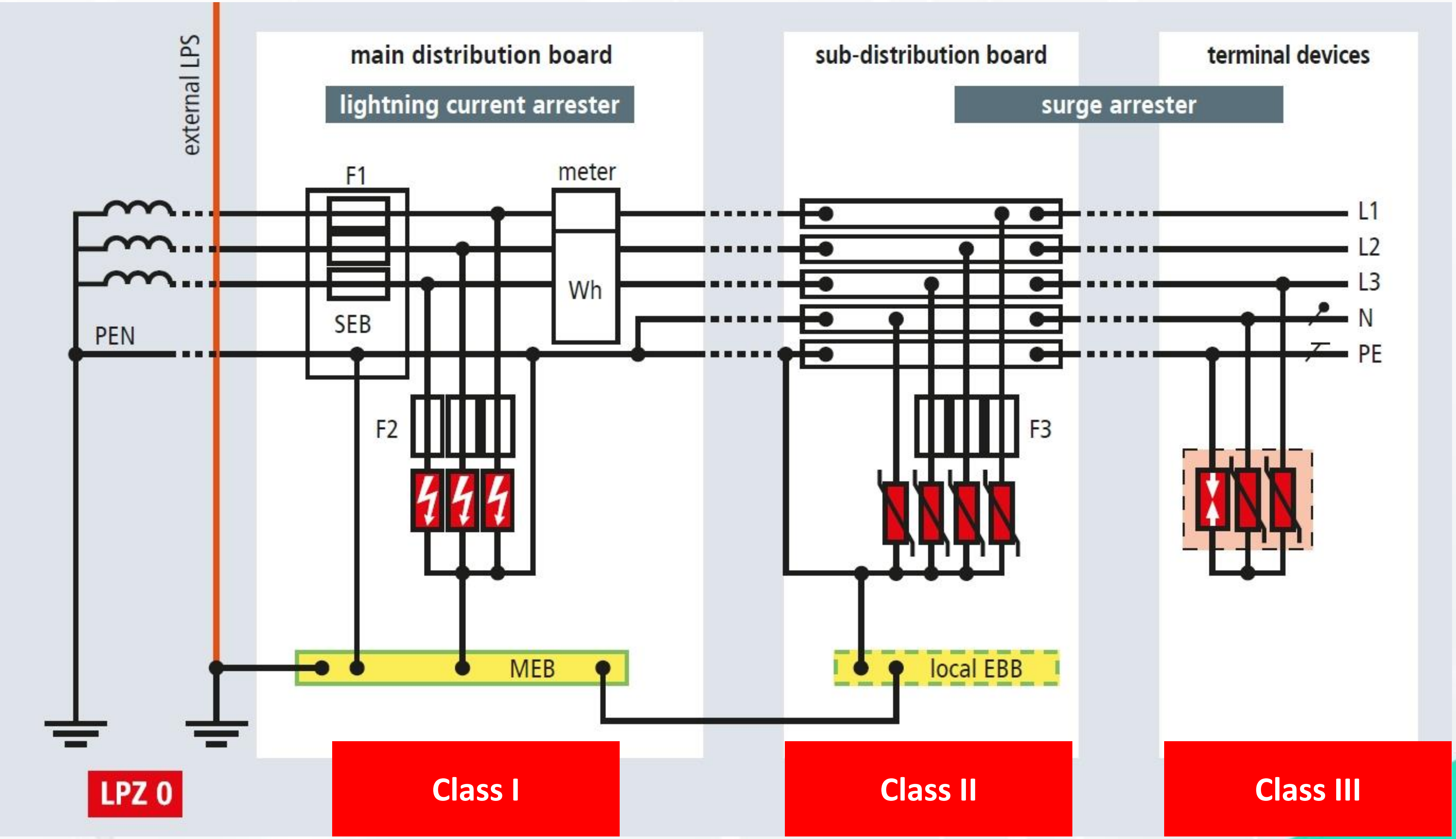
Typical switching overvoltage

How does a SPD Work?



The 1P+N and 3P+N SPDs with dedicated protection of the neutral pole discharge the common and differential mode over voltages that may occur in installations with TT and TNS systems, when there is a lightning strike.

Different classes of SPDs in the data center:



SPD Deployment

- Choice Number 1: Deployment inside the Tap-off Box:

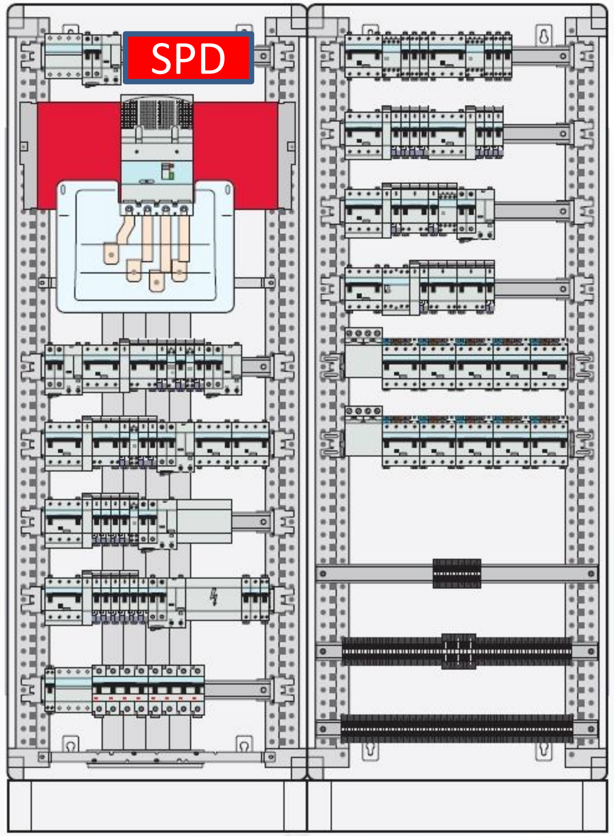
- **Requires Electrician to Install (150$ to 300$ in average)**
- **Requires Electrician intervention to replace catridge in the case of a surge or overvoltage**
- **Need Electrician during periodic inspections**
- **Price of the SPD itself (standard 60$ to 90$ depending on the power configuration)**
- **Lack of monitoring capabilities**
- **SPD not accessible (height concern)**
- **One time use**

Not Optimal

BICSI MIDDLE EAST & AFRICA

SPD Deployment

- Choice Number 2: Deployment inside the Panel Board or floor RPP:

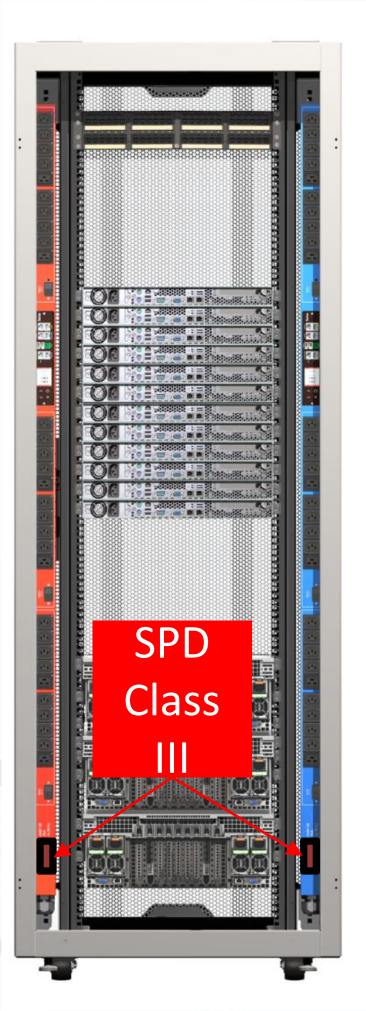


- Class III specs might be too small
- Requires Electrician to Install (150$ to 300$ in average)
- Requires Electrician intervention to replace catridge in the case of a surge or overvoltage (one time use)
- Need Electrician during periodic ins pections
- Price of the SPD itself (standard 60$ to 90$ depending on the power configuration)
- Lack of monitoring capabilities
- SPD not accessible (Closed Panels)

Not Optimal

SPD Deployment

- Choice Number 3: Deployment inside the rack PDU:

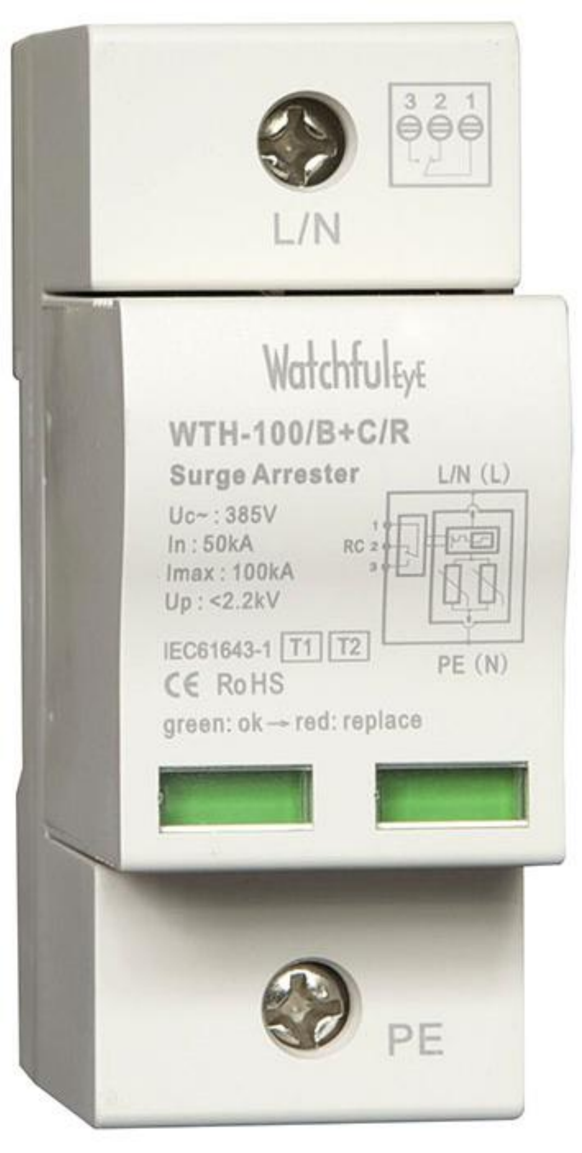


- Perfect for Class III specs
- No Electrician required to instal, inspect, or maintain the SPDs
- Price of the SPD itself integrated to PDU (150$ to 250$ depending on Power Configuration)
- Full monitoring capabilities + Alerting in case of surges
- SPD is accessible directly inside the Rack

Best Solution

Embedded Class3 SPD

- Resettable
- No-break
- HD/ IEC 60364



metal-oxide varistor

Metering Accuracy

Metering Accuracy

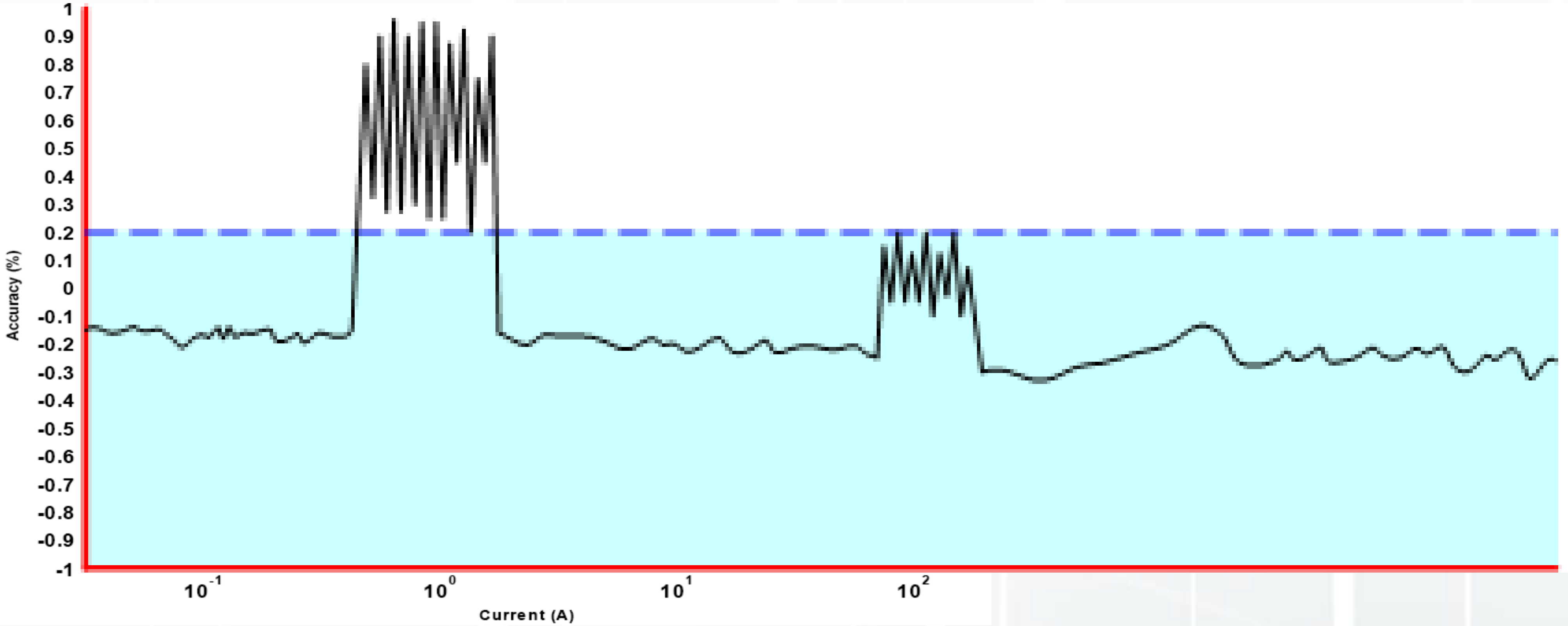
ISO/IEC 62053-21 = +/-1%

for billing purposes: Class 0,2 (±0,2 %) of EN60044-1:1999;
for non-billing purposes: Class 1 (±1 %) of EN60044-1:1999.

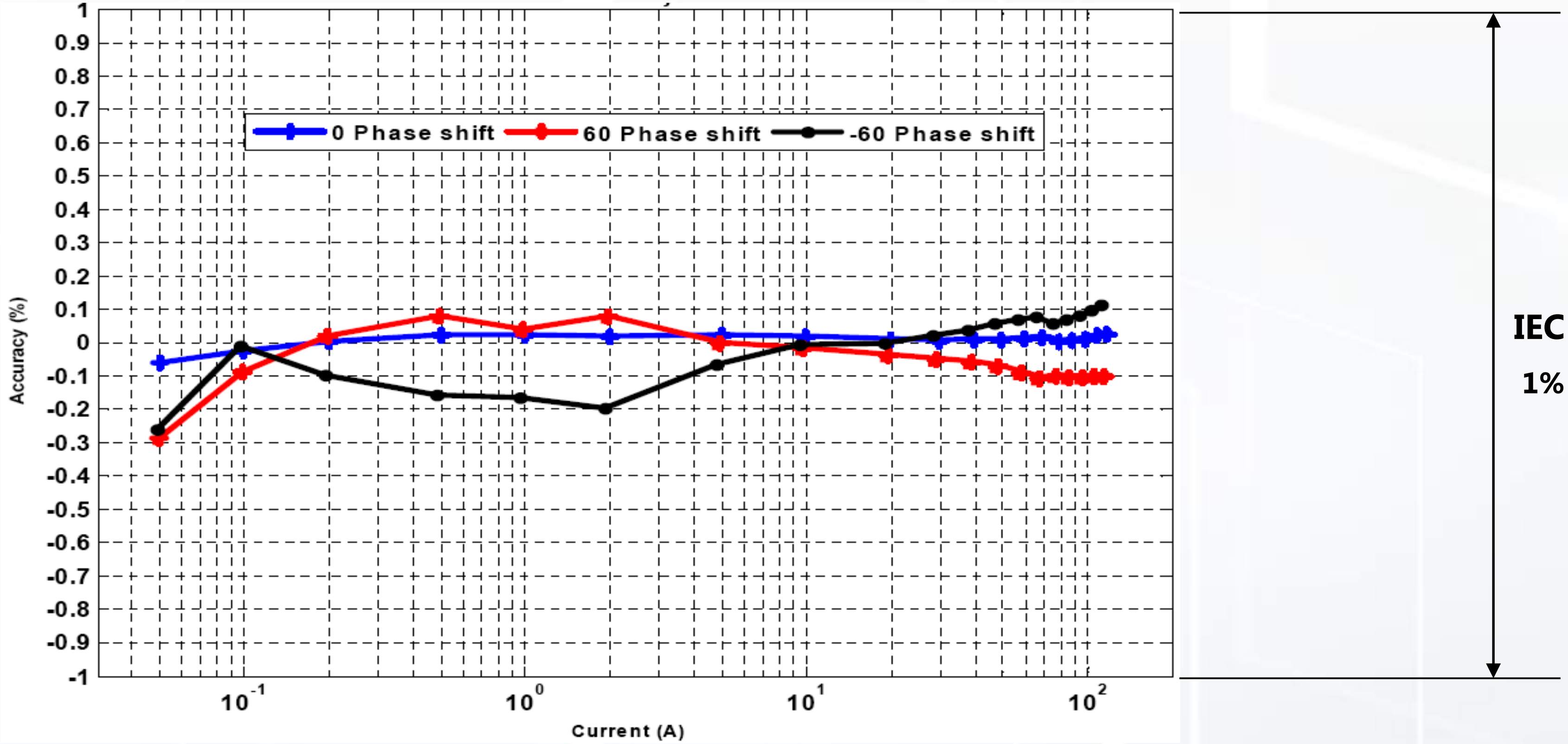
MID?

BICSI MIDDLE EAST & AFRICA

Metering Accuracy - Squelch



Metering Accuracy – Phase shift



IEC 62053

1% - Class 1

You Can’t Beat Real World data

Peak power usage in watts	Calculated peak power usage	Actual peak power usage	Percentage difference
1U servers			
Cisco UCS C200 M2 SFF	451	362.7	-24.3%
HP ProLiant DL360 G7	334	377.2	11.5%
2U servers			
Cisco UCS C210 M2	451	355.4	-26.9%
HP ProLiant DL380 G7	306	368.2	16.9%

EN 50600:

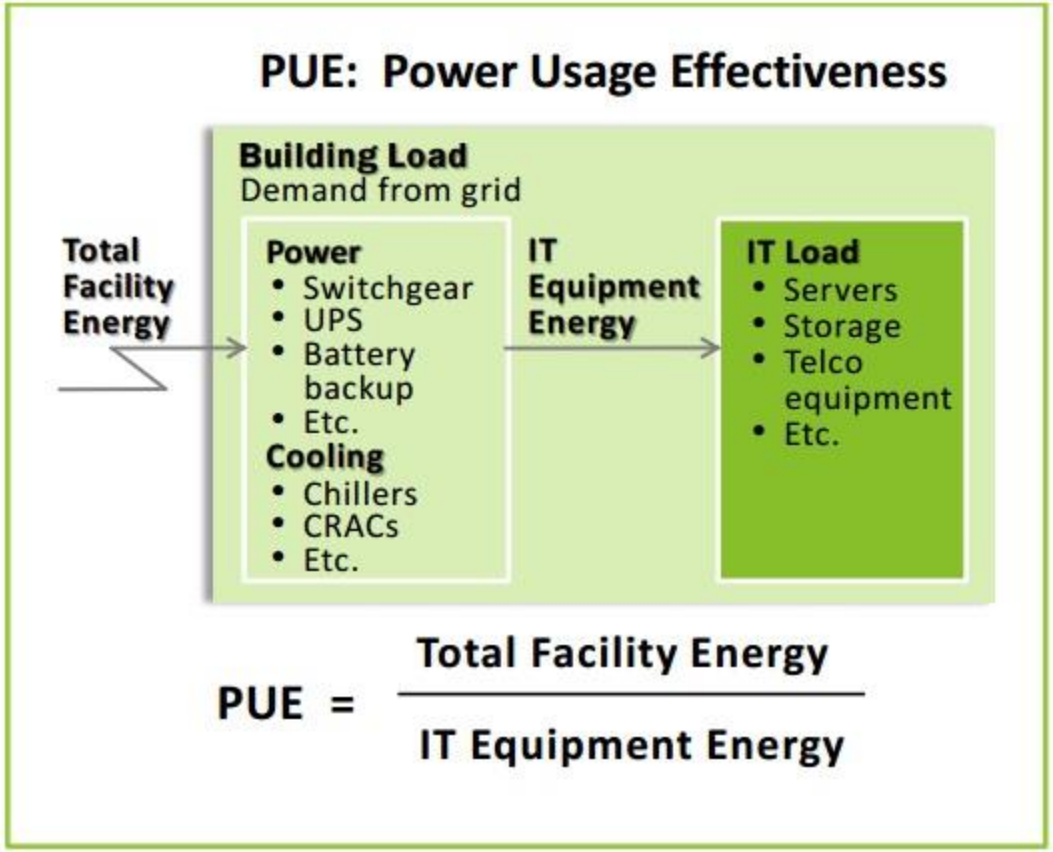
Include energy efficiency performance as a high priority criterion when choosing new ICT equipment. The power consumption of the device in normal operating circumstances should be considered in addition to peak performance per Watt.

Source: Principled Technologies Test Report
Calculators: HP Power Advisor & Cisco UCS Power Calculator

Power Usage Effectiveness

EN 50600:
Report periodically, as a minimum (via written or automated means), the following:

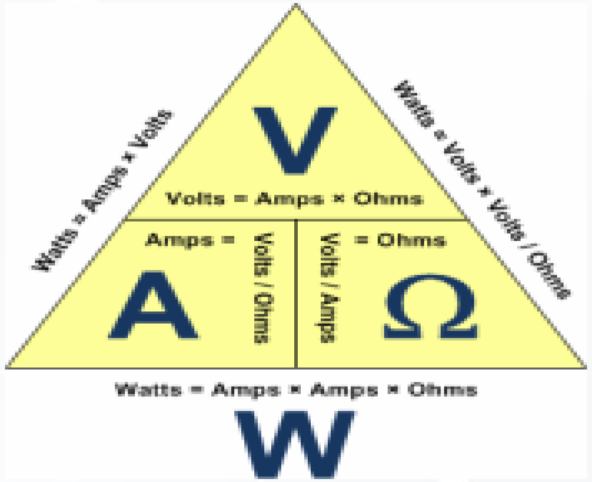
- *Energy consumption;*
- *Power Usage Effectiveness (PUE) in accordance with EN 50600–4–2 or Data Centre Infrastructure Efficiency (DCIE)*



Why 3 Phase at the rack?

When to consider – 3Phase

- Reduced Costs on Installation
- Increased Phase balancing
- Higher Operating Capacity
- Future Proofing
- 3 x The Power
- Speed of Deployment
- 50% increase Cost of Unit

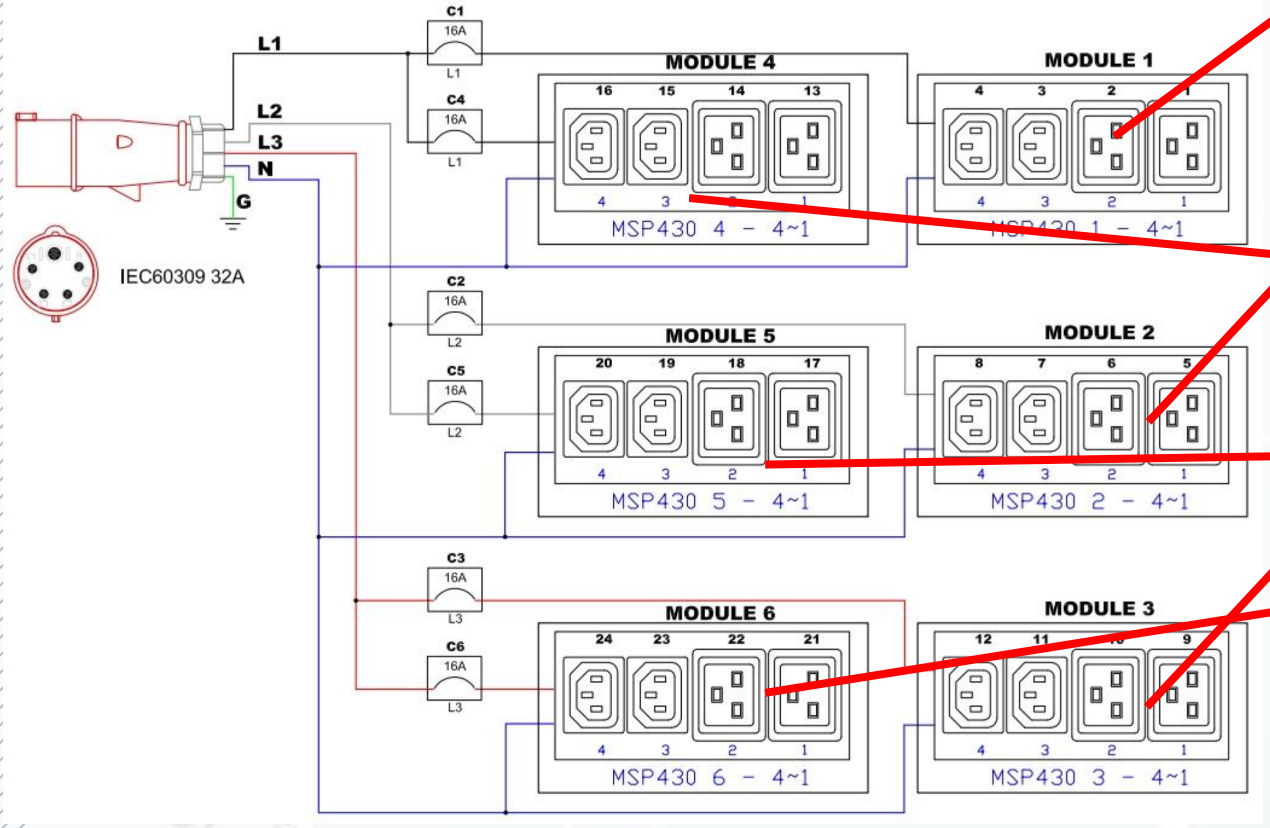


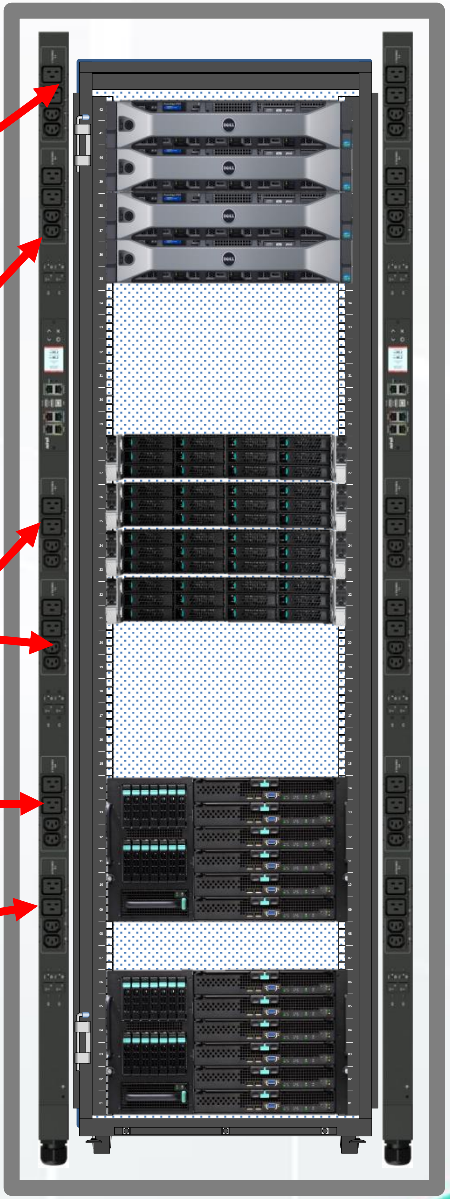
Power Density Level	Equipment Protected	Power in the Rack
Standard density	5 to 15 1U servers	2 to 4 kW
Medium density	15 to 30 1U servers	4 to 8 kW
High density	42 - 1U, or 2-3 blades	8 to 15 kW
Ultra High density	4 to 6 blade servers	15 to 30 kW

Redundancy requirements

Example of Implementation

400V, 3Φ Wye, 22.2kVA, 32A
6 X 16A rated MCBs





200W
200W
200W
200W

500W
500W
500W
500W

700W 3A
700W 3A

700W 3A
700W 3A

400/1.732=230V
per circuit

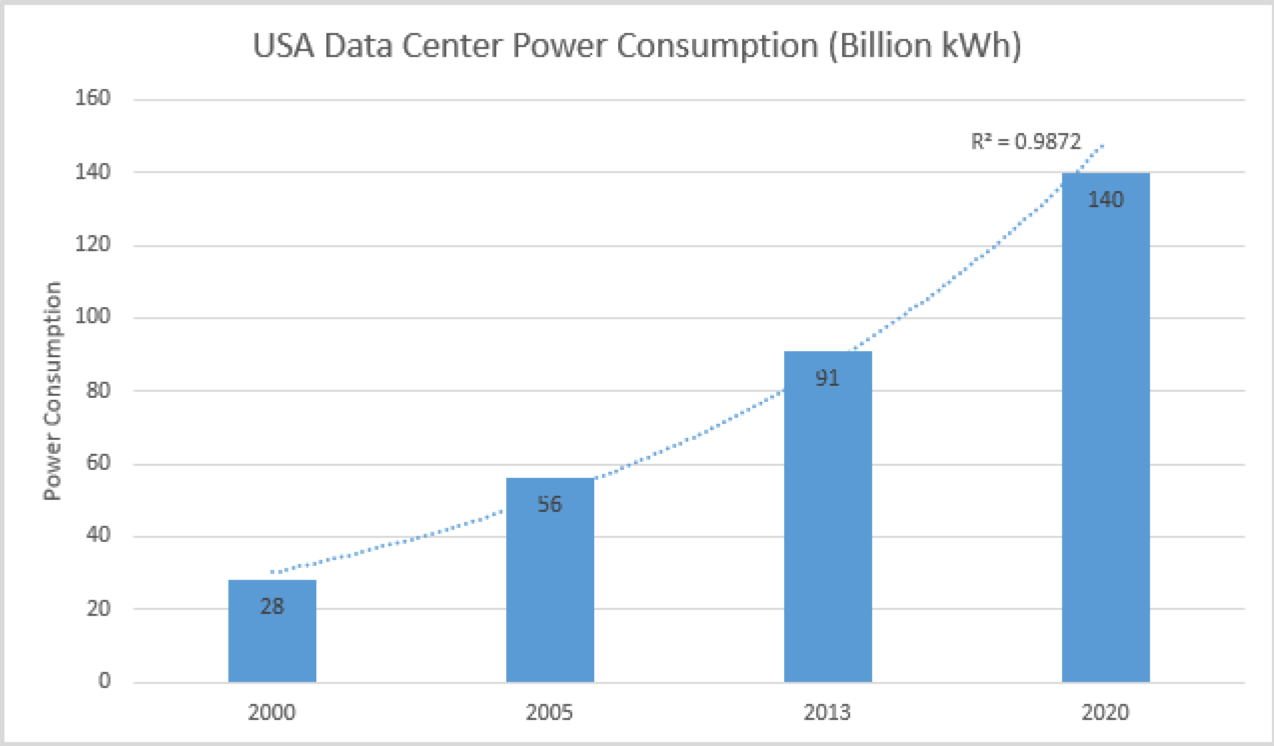
230X16A=
3.7kVA/Branch

3.7 X 6 = 22.2kVA

Load Max reccomended per breaker:
16A X 40%= 6.4A

When to consider – 3Phase

- Raritan's best seller 32A 1ph
- IHS average load <5kW
- 40% load recommendation
- 3 Phase cheaper at high density
- Allows for load disaggregation and convenience outlet circuits (120V in NA)
- 3 Phase allows 73.2% more power than single phase with the same footprint.



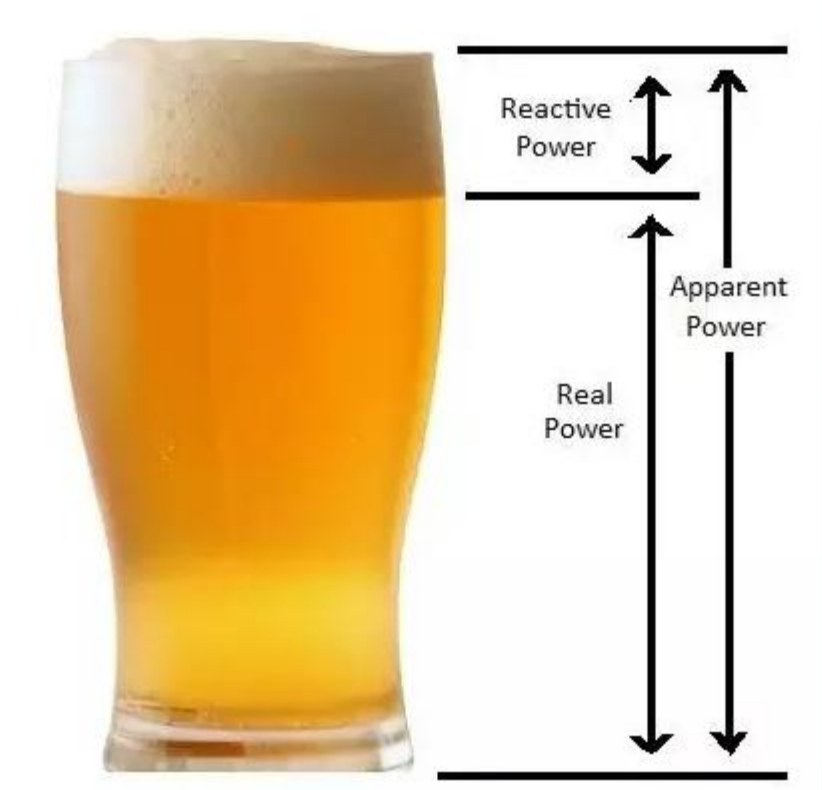
Savings Calculation – 3 Phase Option

Single Phase		**Three Phase**	
16 Amp	32 Amp	16Amp	32 Amp
3.2 Kw	7.2 Kw	11 Kw	23 Kw
$359	$478	$615	$956
12.8 Kw	21.6 Kw	Savings	
$1436	$1434	$821	$478

ASHRAE: *“Server lifetime varies widely: 3 to 8 years”*
“Rack PDU & Rack ATS Typical Usage Lifetime: 8-12 years”.
“The life of a typical data center is 15 to 20 years”

BICSI MIDDLE EAST & AFRICA

Powerfactor considerations



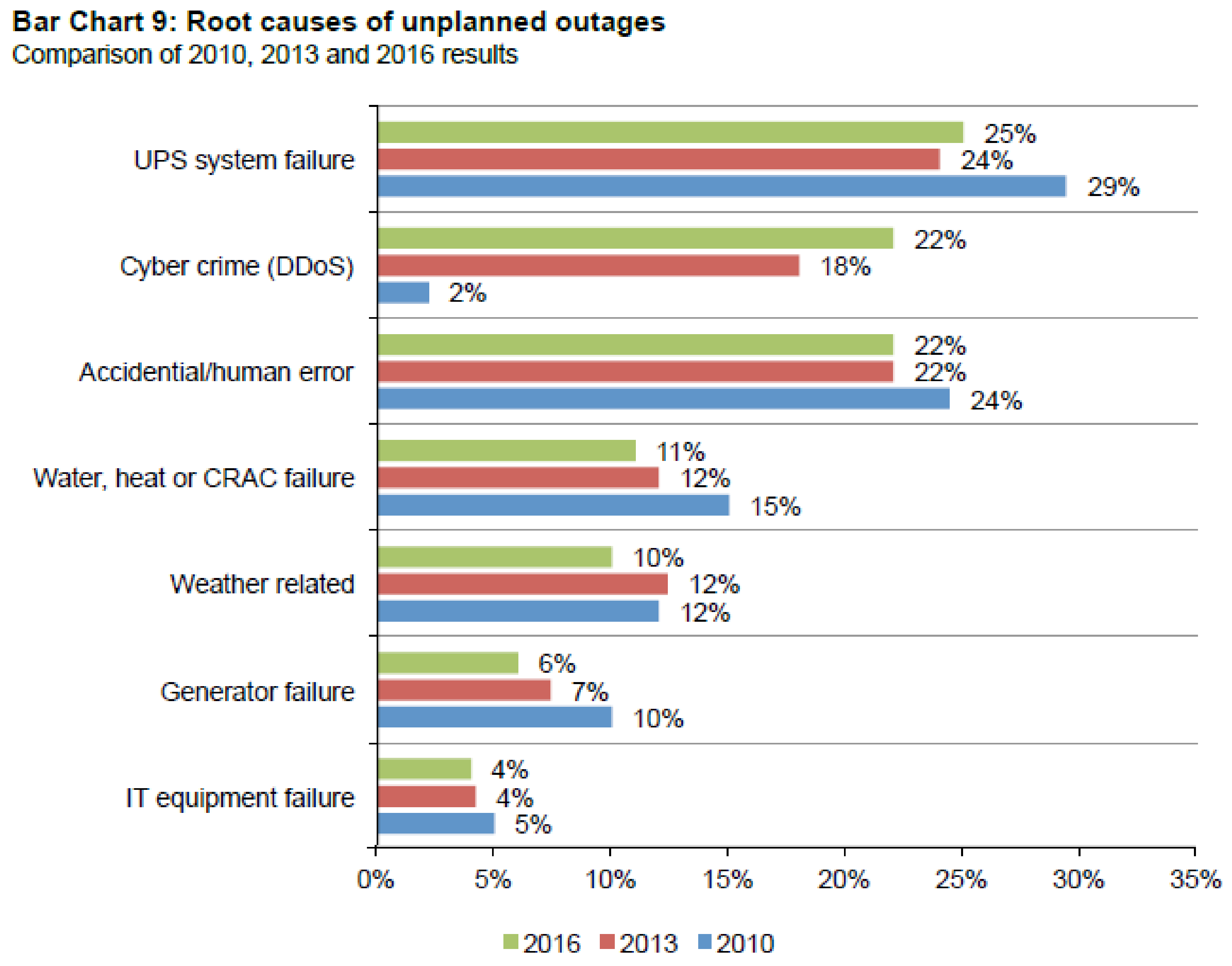
7360VA is the Apparent Power , this value is ALWAYS the same (230Volt x 32 Amps = 7360 VA).

Scenario 1 , connecting purely resistive circuit :
In this case the Power Factor = 1
The power factor is defined as: Power Factor = P(Real Power) / S(Apparent Power) = cos(ϕ)
In this case the Real Power is the same as the Apparent Power :
(Apparent Power 7360VA) x (Power Factor 1) = Real Power 7360 Watt

Scenario 2 , connecting a capacitive or inductive load :
In this case the Power Factor is lower than 1 (e.g. Power Factor = 0.5)
In this case the Real Power is NOT the same as the Apparent Power :
(Apparent Power 7360VA) x (Power Factor 0.5) = Real Power 3680 Watt

Minimize Human Error

Human Error: Data



- CNET 22%
- Uptime Institute 70%

Human Error: Color

- Easily Identify Power Feeds
- Critical and non-critical Feeds
- Corporate identity
- Phase Marking
- Alternating Load Balancing Circuits
  (L1/L2, L2/L3, L3/L1)

BICSI: *"Class F2 or above, Equipment color coded Recommended"*

BICSI MIDDLE EAST & AFRICA

Colored cabling/ units

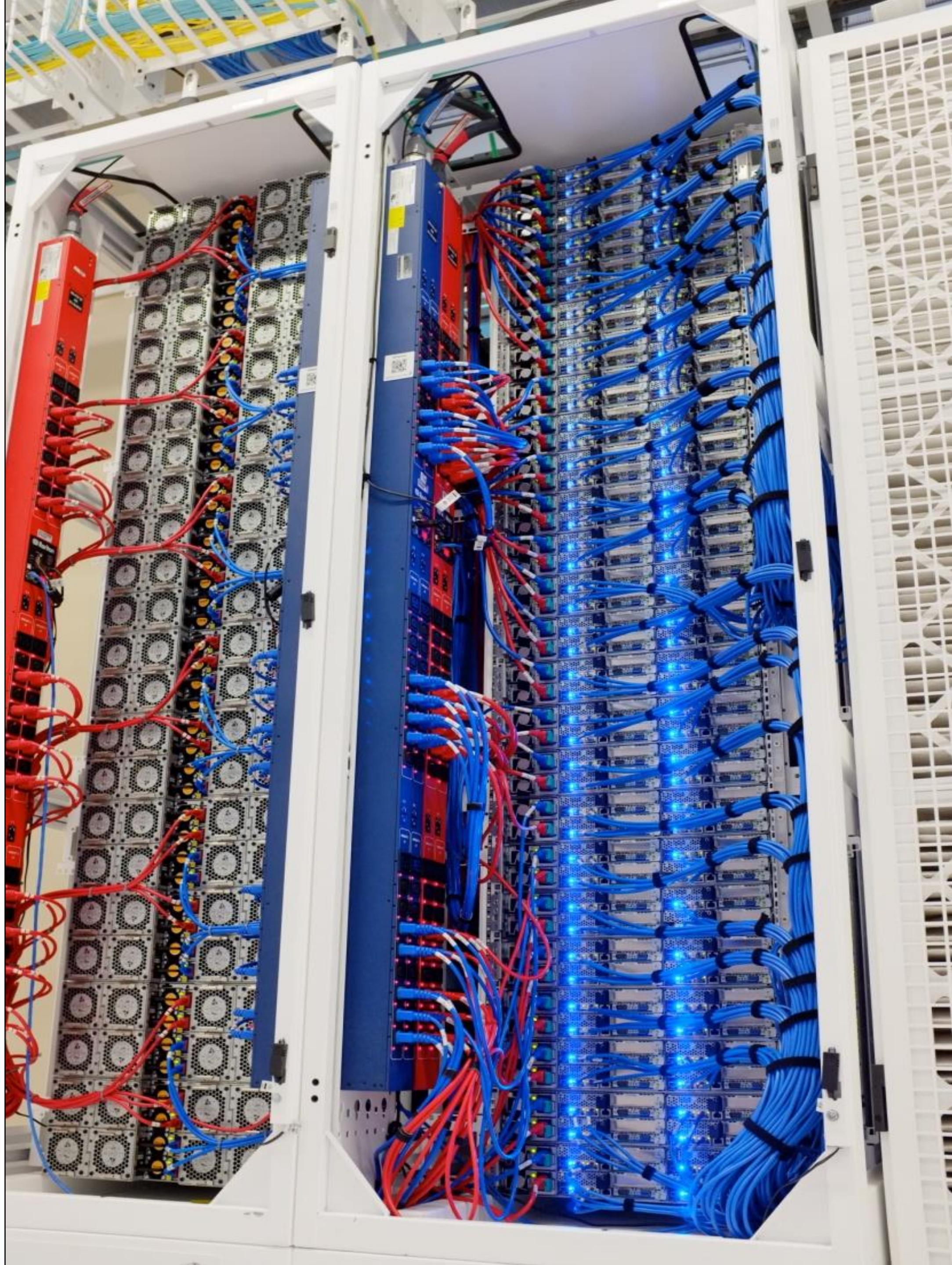
- Alternating Load Balancing Circuits
- L1/ L2
- L2/ L3
- L3/ L1

UPS Battery time+

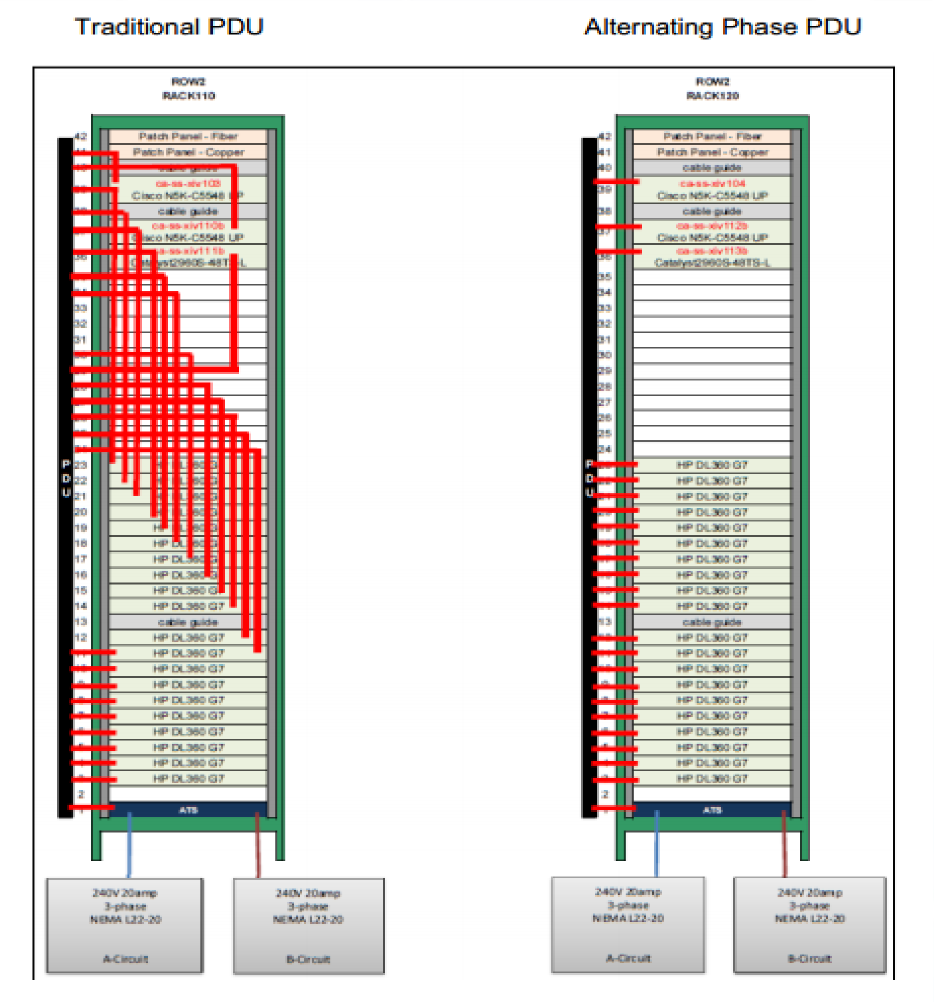
Colored cabling/ units

- Alternating Load Balancing Circuits
- L1/ L2
- L2/ L3
- L3/ L1

UPS Battery time+



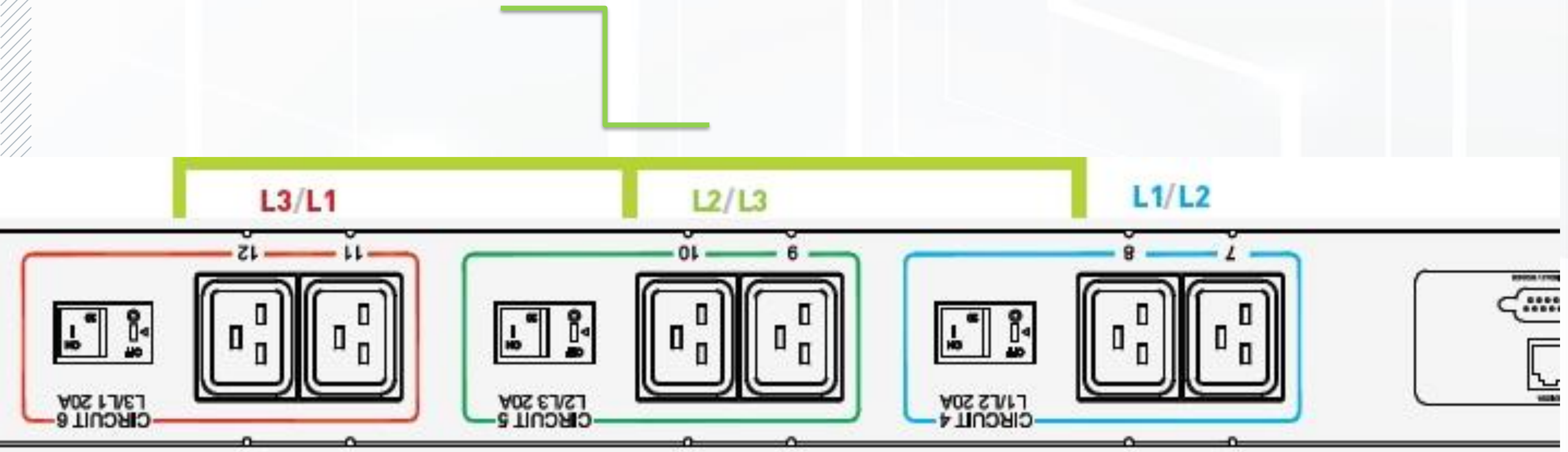
Alternating Phase in the Rack



- Simplifies load balancing
- Speeds up deployment
- Shorter cable runs
- Improves air flow

Colored cabling/ units

- Alternating Load Balancing Circuits



Equipment failure and redundancy

@Marketing
Add a picture highlighting that the PDU is not just a powerstrip, but a gateway for multiple facets. Ie. environmental gateway, doorlock, cctv etc .

PDU redundancy: Power Sharing

Feed A

In case of a feed outage, your PX controller stays powered and sends alerts

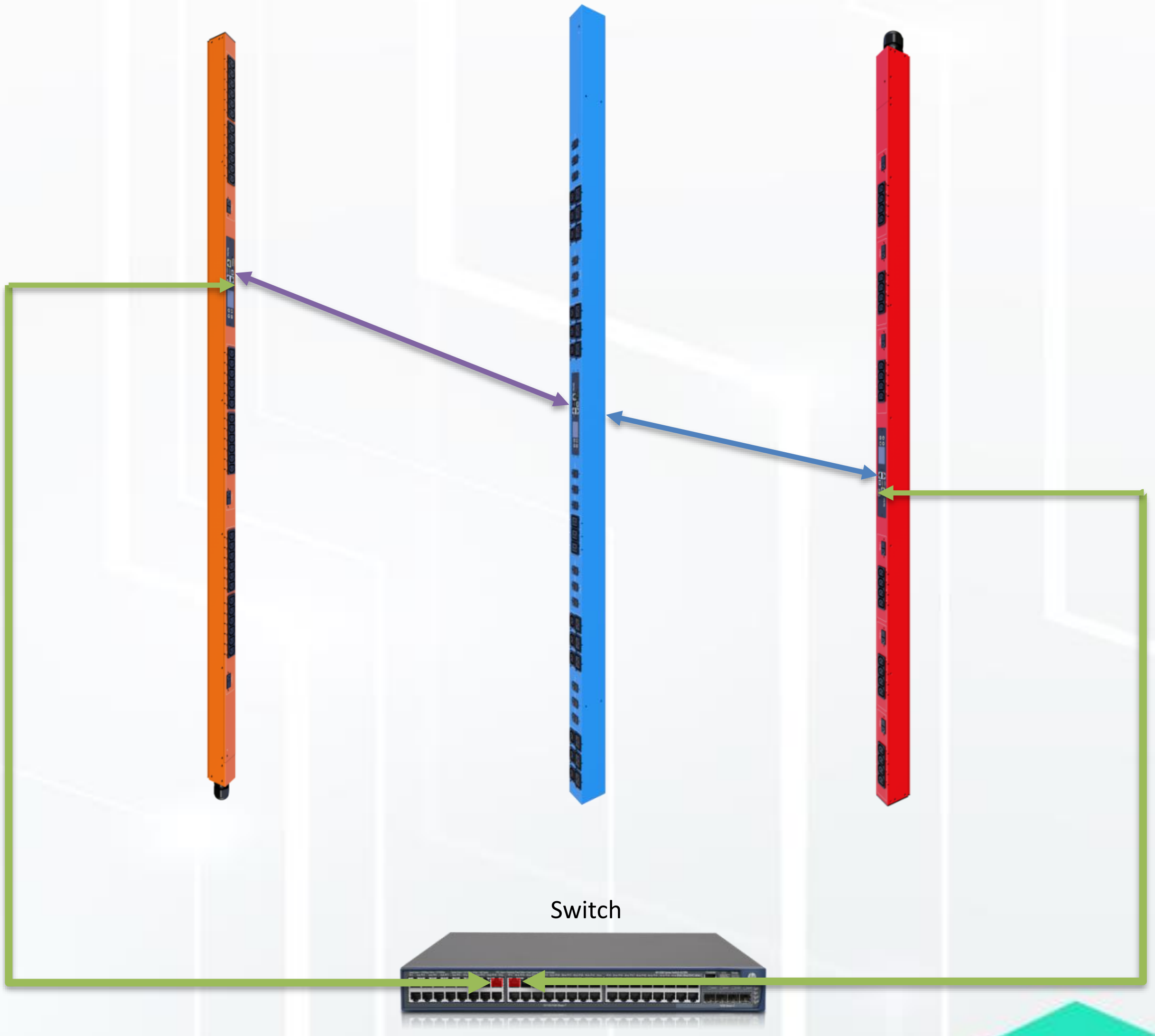
~~**Feed B**~~

Networking Cascading

Eliminate daisy-chains single points of failure

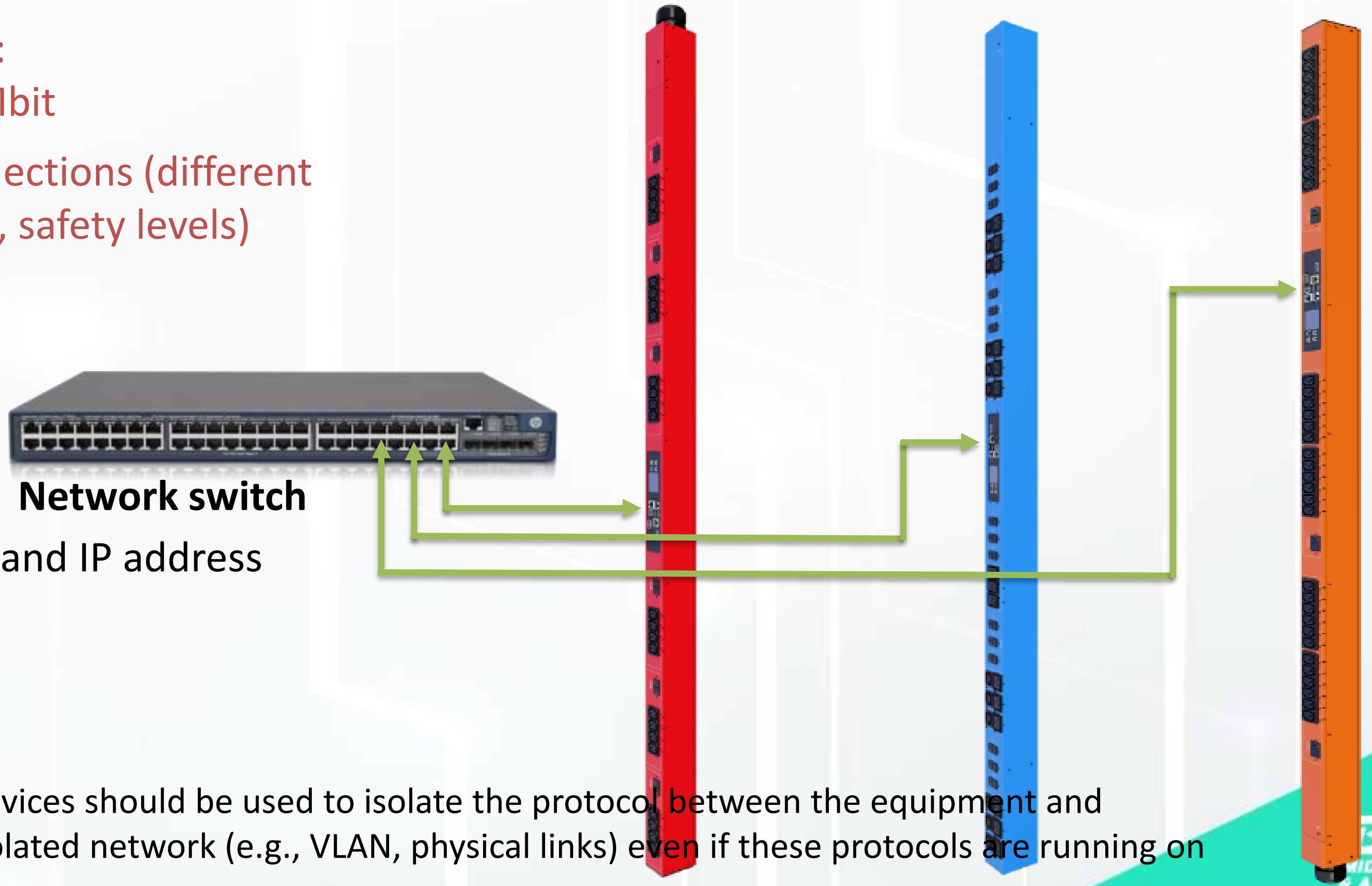
Protocols / Options

- Modbus daisy chain
- Modbus ring
- Master / Slave setup
- SNMP



Integration to the enterprise network

- Network standard:
  1000 Mbit / 100 Mbit
- Two network connections (different subsections, users, safety levels)



- Costs: switch port and IP address (CapEx+OpEx)
- Colocation

BICSI: " -Modbus, gateway devices should be used to isolate the protocol between the equipment and gateway on a separate and isolated network (e.g., VLAN, physical links) even if these protocols are running on TCP/IP.

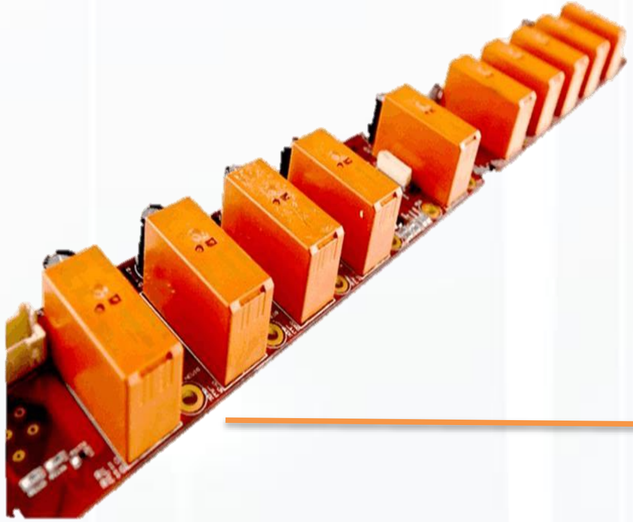
Replaceable controllers

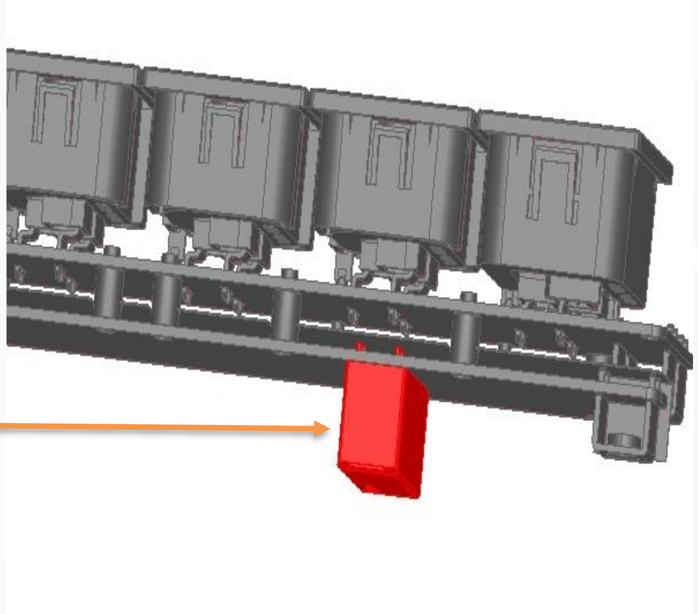
Outlet switching benefit and risk

Why outlet switching

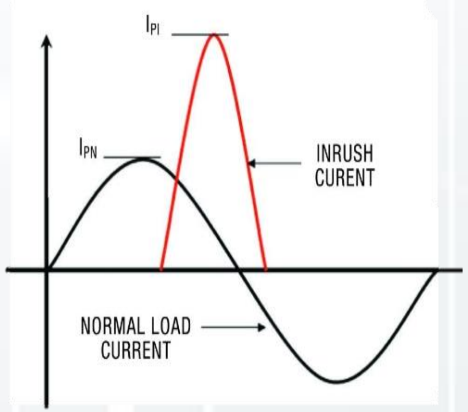
- Remote reboot / Lights out
- Outlet sequencing
- Load Shedding, UPS
- Security
- In-rush current
- Graceful shutdown

Outlet switching: Relays



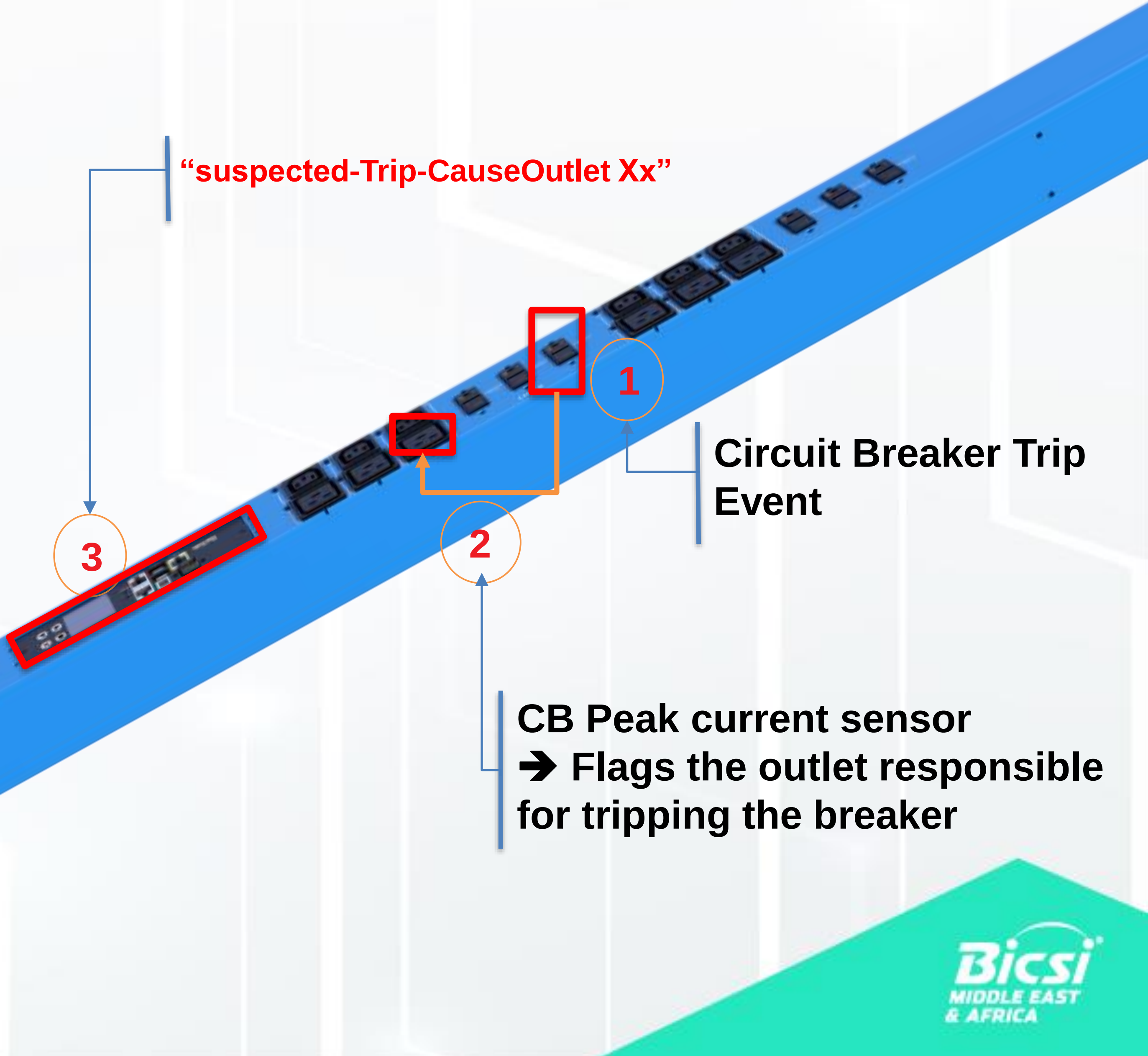


- Non-latching
  - 0.5W – 1.0W ON status
  - Default state generally ON
  - Non configurable power-on
- Latching
  - 0.0W ON status, only consumes when changing state
  - User configurable power-on relay: pre-outage state or power cycle



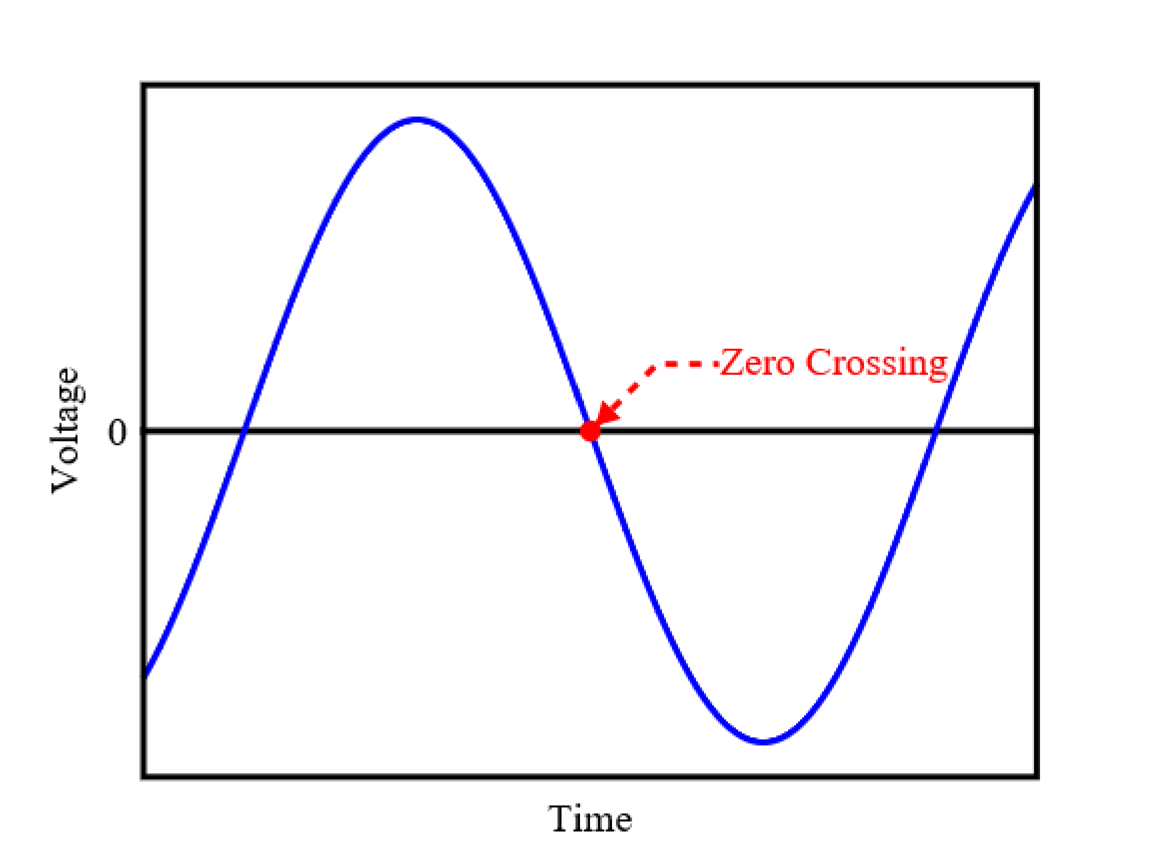
Metering Accuracy icw. Circuit Breakers

- Detect the Root-cause of unplanned outages per branch
- Gain time on device testing in case of circuit breaker trip event
- Leverage instant alerting to limit
- business impact and improve MTTR



Relays: (near) Zero-Crossing

Synchronize relay switching > Cheap components



Automatic Transfer Switch (ATS)

When do you need an ATS

- Single power supply units

Bicsi MIDDLE EAST & AFRICA

Switching times

Switching power supplies (SMPS) frequently cited with 15ms+ holdup time (one cycle at 50Hz);

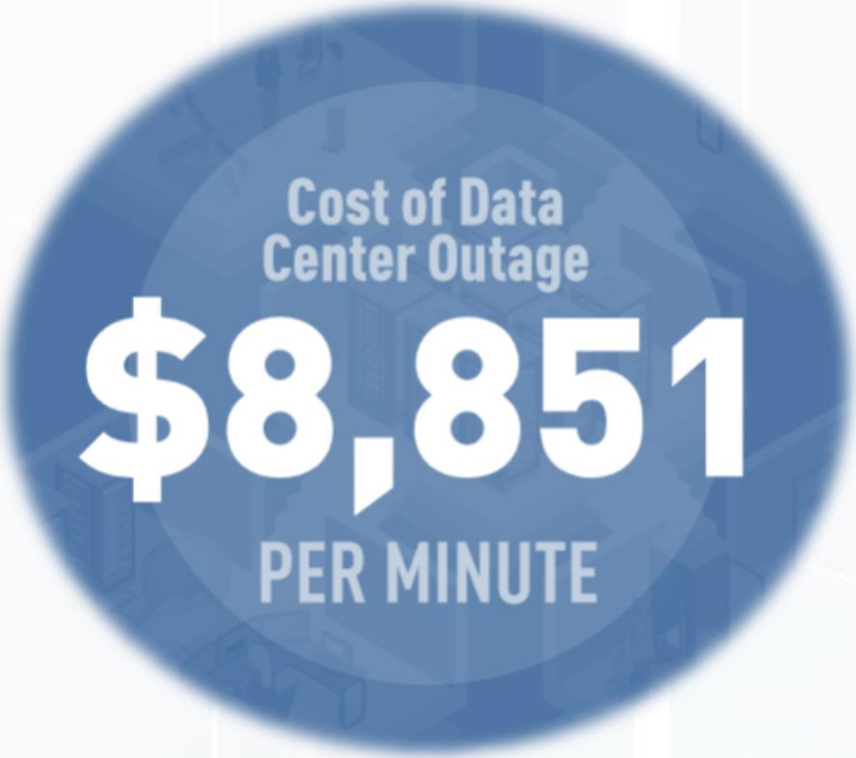
Example: HP DL360 G9 Power Supply

But reality is not deterministic.

- Can depend on load, capacitance, ambient heat, AC power curve, etc.;
- Real-world experience: switchover for ~12ms – non-zero probability of server reboot;

ASHRAE: *“ATS will seamlessly switch – within ½ of an AC Cycle”* = 10ms

Cost of outage



Avg. cost of downtime:

2010: $5.617

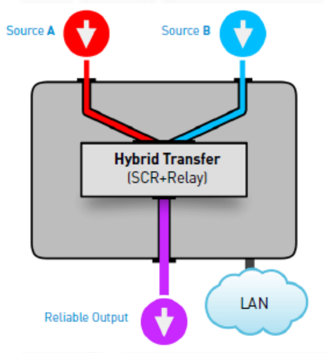
2016: $8.851 (+57%)

Avg. downtime:

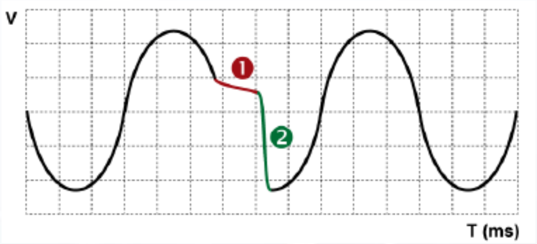
84 minutes

Transfer Switch
Technical considerations

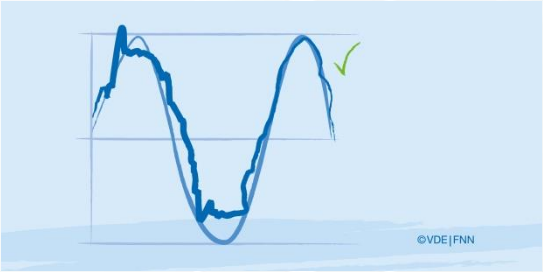
Switch Technology



Switch point



Power Quality



Technical considerations

ATS (Automatic Transfer Switch)

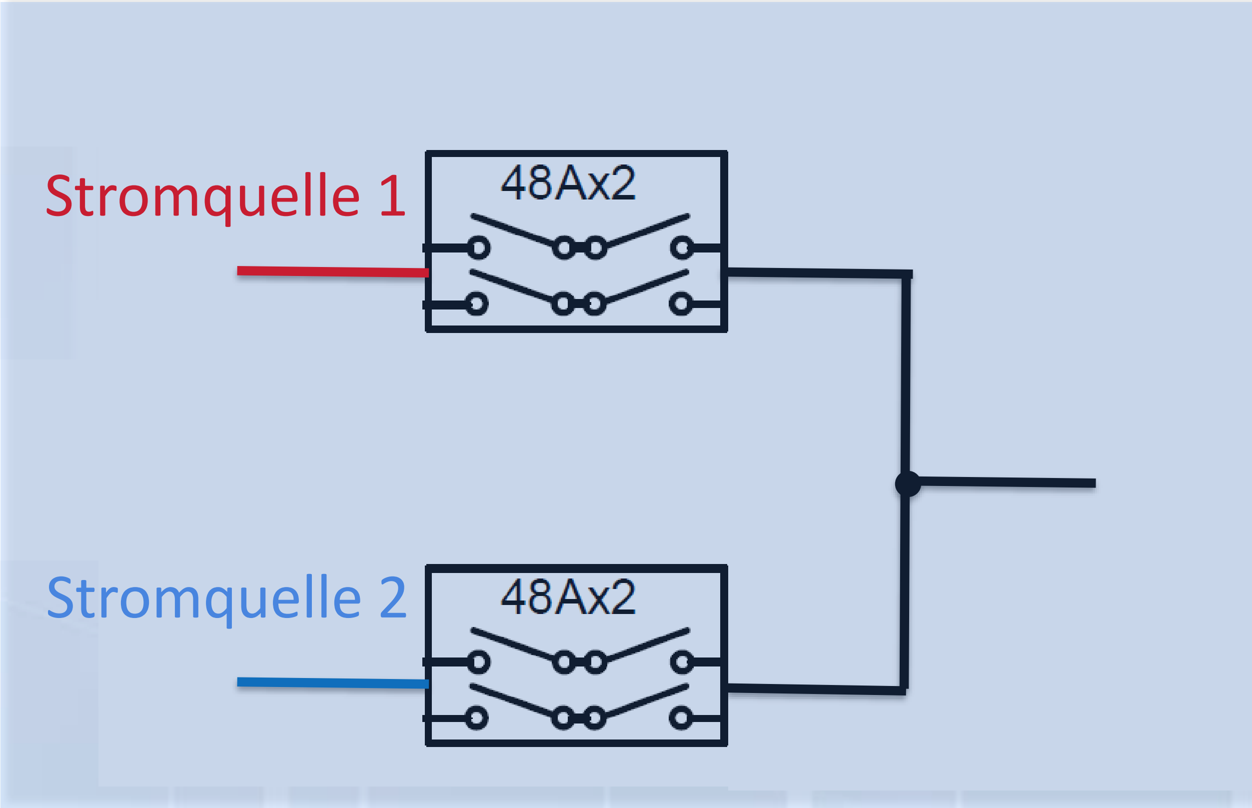
– Electromechanical Relay

– Advantage:

- Power loss free transfers

– Disadvantage

- Risk of Arc Welding
- Slow

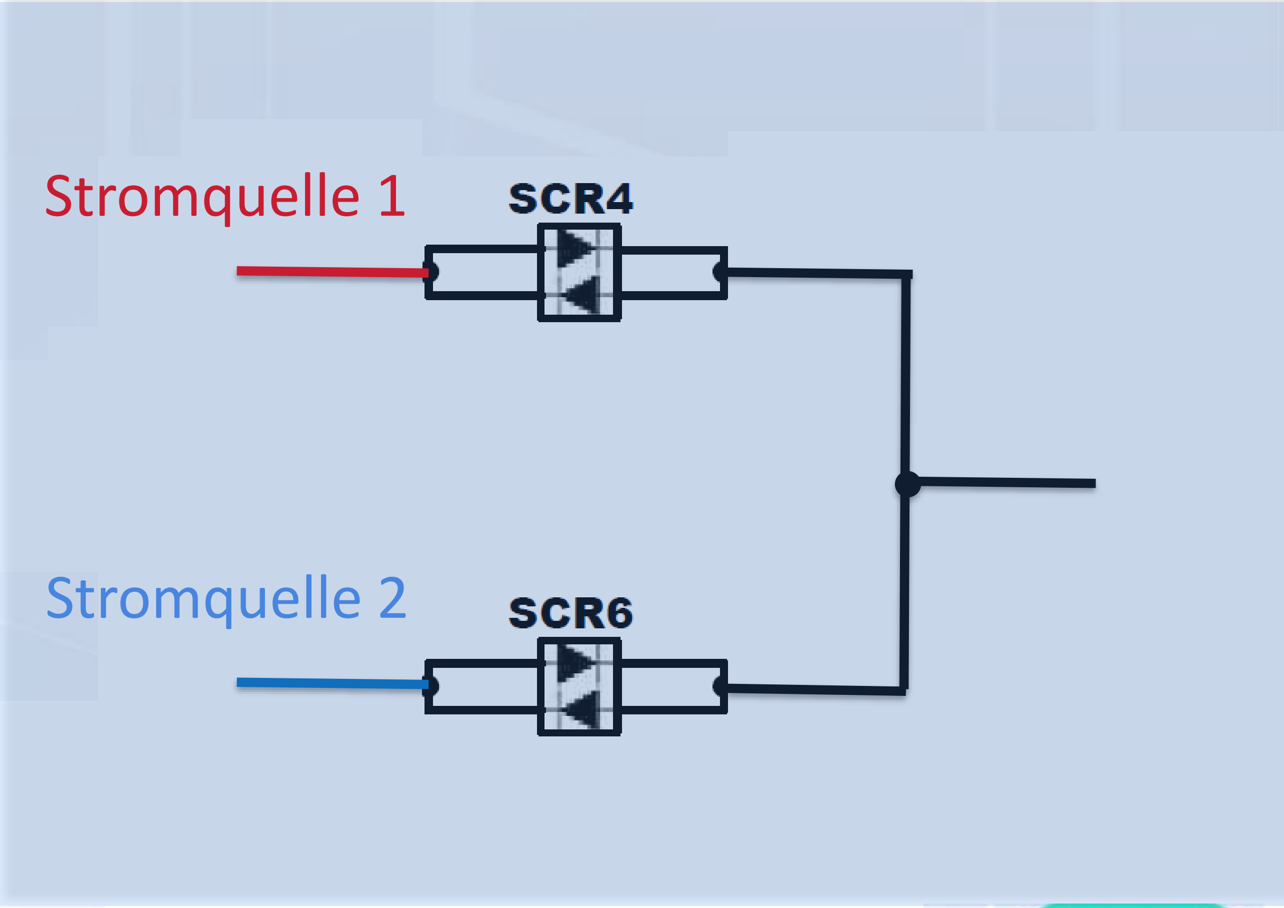


Technical considerations

STS (Static Transfer Switch)

- Thyristor / SCR

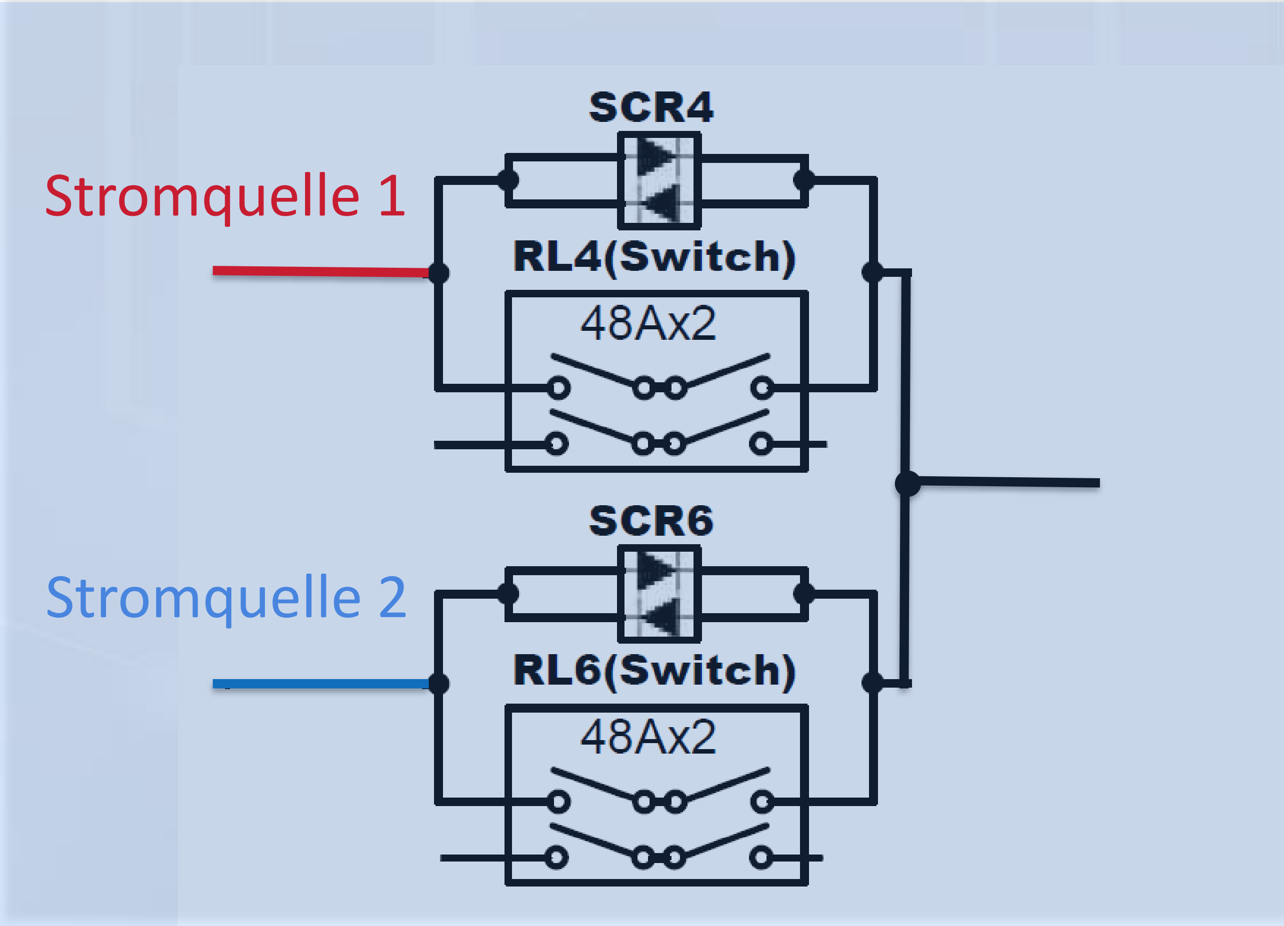
- Advantage
  - Very Fast switching
- Disadvantage
  - Energy consuming transfer



Technical considerations

HTS (Hybrid Transfer Switch)

- Thyristor / SCR + Relay
- Advantage: Fast Switching

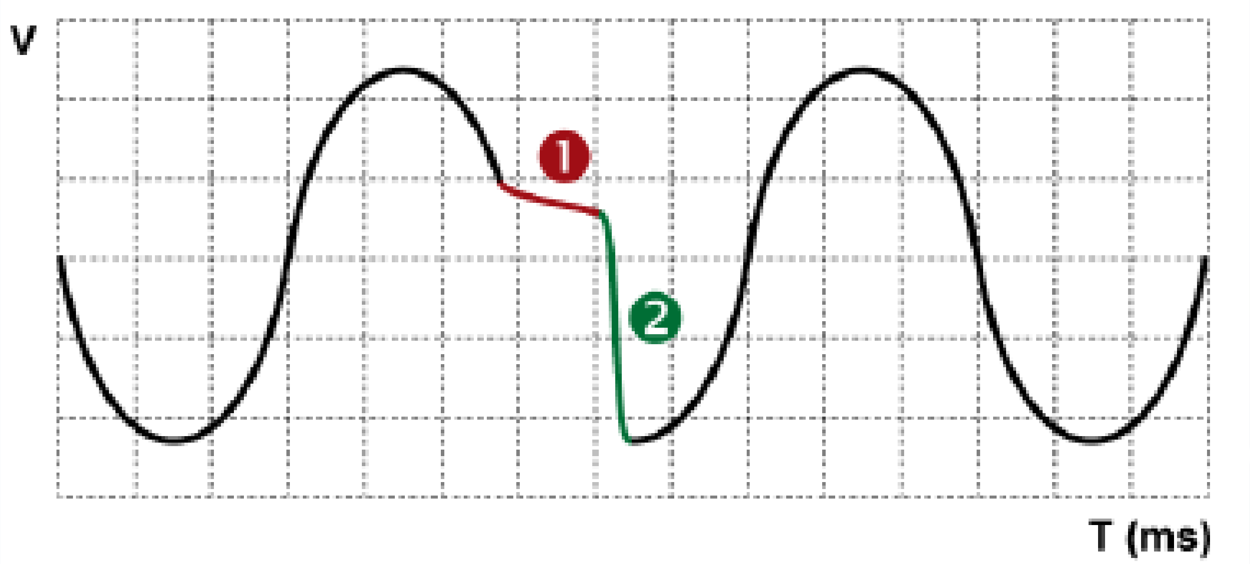


Technical considerations

Switch Point

- Make-before-Break
  Closed transition

- Break-before-Make
  Open transition

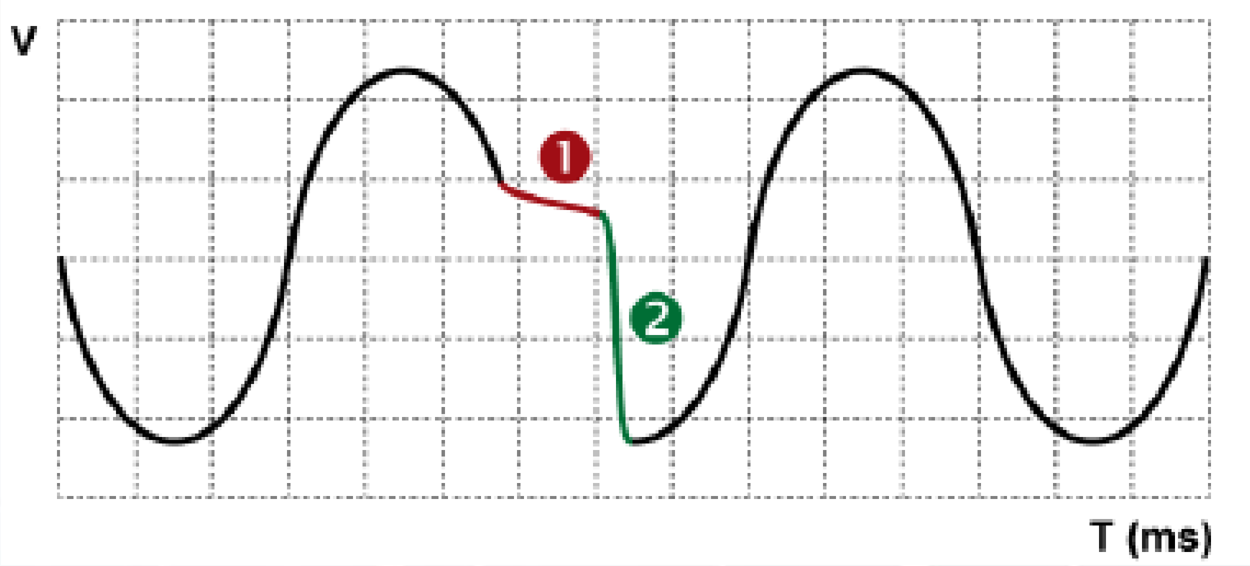


Technical considerations

Power Quality

EN50600: Power Quality according to EN50160

- Voltage tolerance +-10%
- Frequency tolerance +-0,5Hz
- Unbalance
  - Voltage
  - Phase
- Harmonic Distorsion



Technical considerations

Power Quality

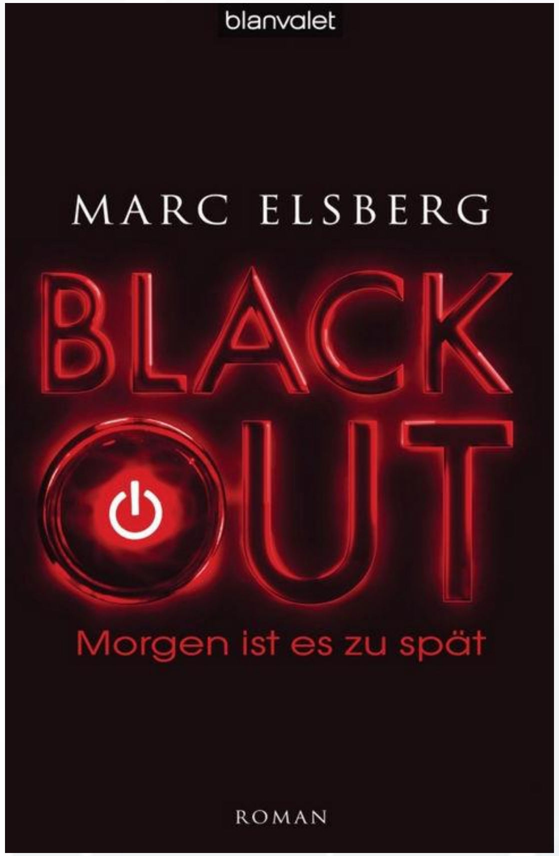
Causes of downtime

1% < U < 90%

- Short downtime (1ms – 1min)

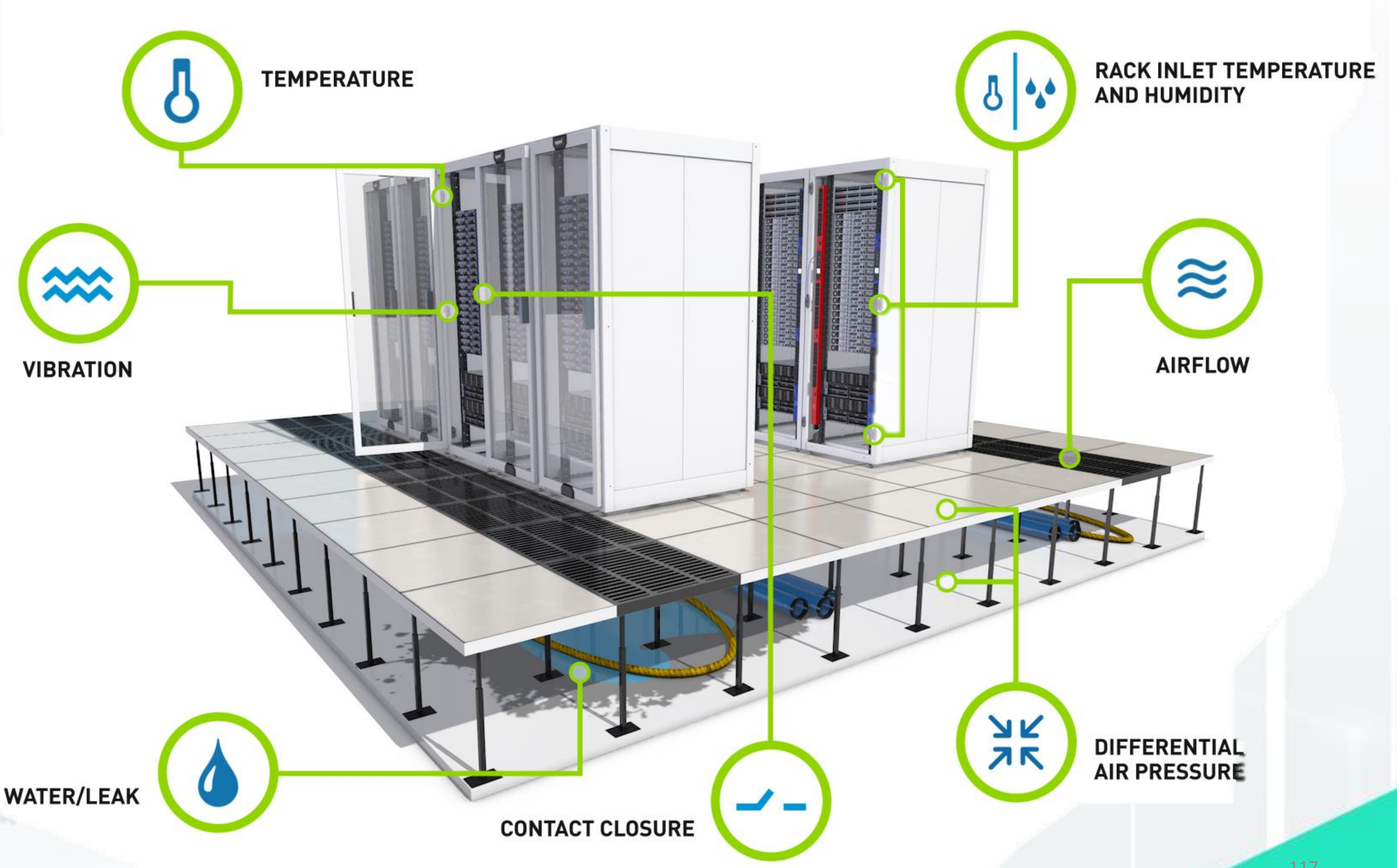
Lightning, failing breakers, Arc flashes

- Black Out – planned or unplanned
  - Voltage drop
  - Longterm failure >3 minutes
- Brown Out
  - Ie. Overload
  - Rare in the region due to UPS/ Gen.set



Environmental considerations

Demanding


TEMPERATURE
RACK INLET TEMPERATURE
AND HUMIDITY
VIBRATION
AIRFLOW
WATER/LEAK
CONTACT CLOSURE
DIFFERENTIAL
AIR PRESSURE

TIA-942 –

Telecommunications Industry Association

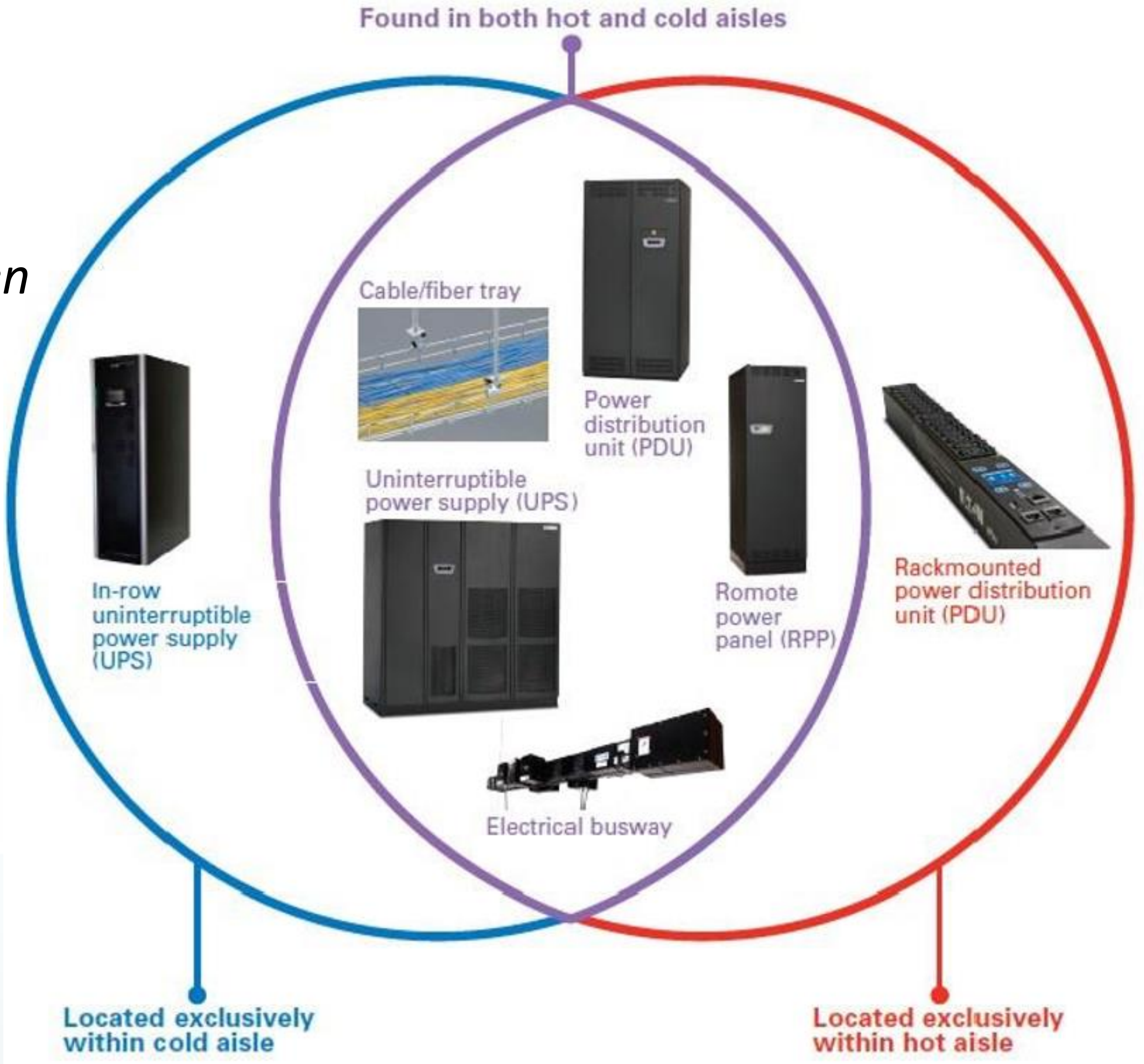
Rack server ΔT: 6-8℃

Blade server ΔT: 10-12℃

2011 Class Range	Low	High
Recommended	*18 °C*	*27°C*

PDU placement

ASHRAE: *"-HVAC failures – when they do, a temperature rise in the cold aisle air temperature of 30'C in as little as 5 minutes is not uncommon".*



ASHRAE guidelines

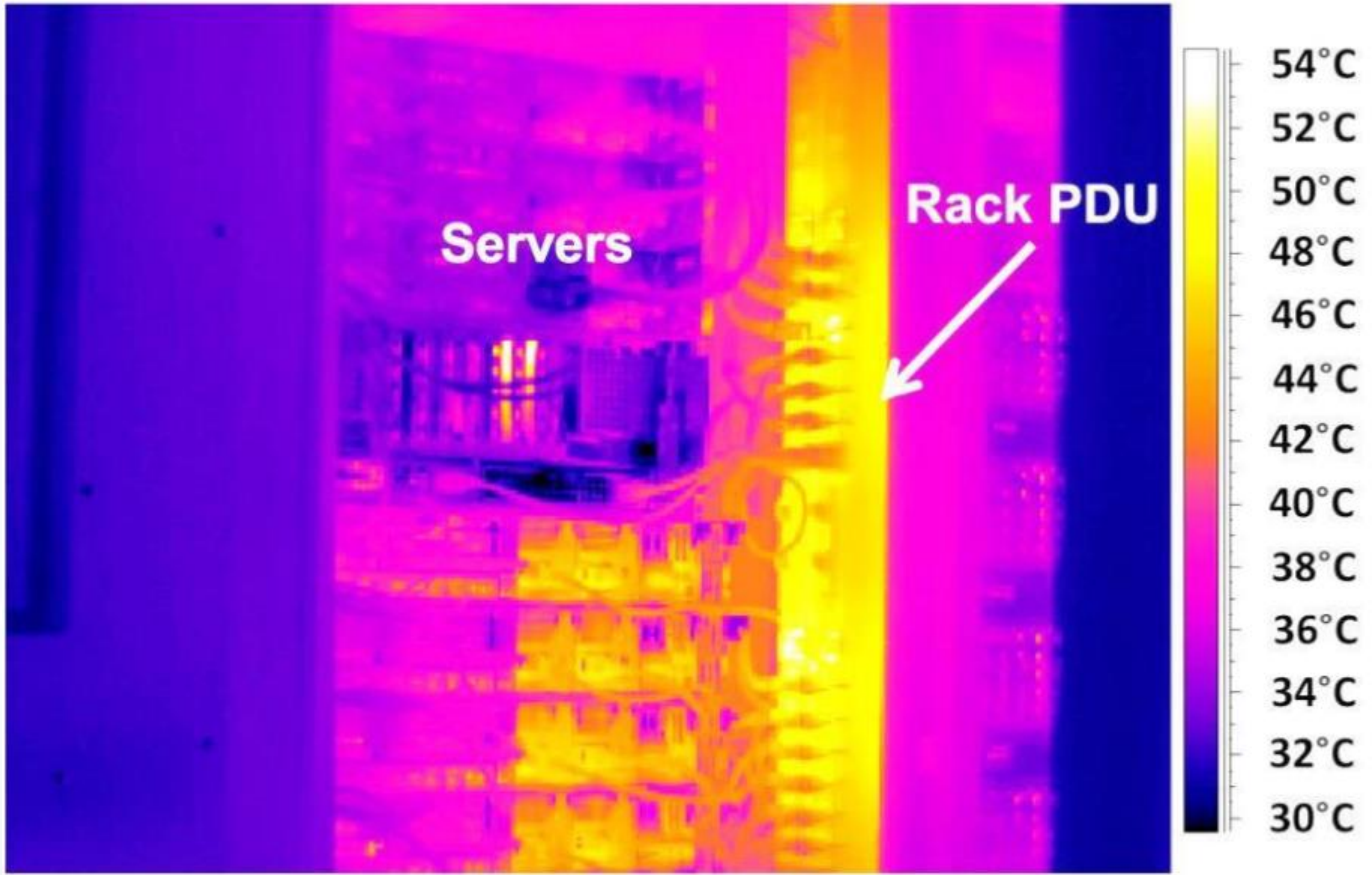
American Society of Heating Refrigerating and Air-conditioning Engineers.

2011 Class Range	Low	High
Recommended	18 ℃	27℃
Allowable A1	15℃	32℃
Allowable A2	10℃	35℃
Allowable A3	5℃	40℃
Allowable A4	5℃	45℃

High temperature ratings importance

ASHRAE: *"Most rack PDUs are passively cooled –*- have to be designed for much higher temperature operation than the IT equipment that connects them"*

ASHRAE: *"Recommends all new rack PDU products be designed to at least 60'C"*



High temperature ratings importance

ASHRAE: *"The original ASHRAE air temperature recommended envelop for datacenters (2004) 20-25'C. This was a conservative statement-.. "*

ASHRAE: *"Rack PDU & Rack ATS Typical Usage Lifetime: 8-12 years".*

ASHRAE: *"Higher temperatures can impact equipment reliability. Exposure to warmer temperatures, coupled with the fact that usuable life cycle of power equipment is typically longer than IT equipment, increases the importance of this topic"*

ASHRAE: *"As the inlet air temperature rises to 35'C and 45'C, most servers reach a maximum exhaust air temperature somewhere between 58 and 60'C"*

ASHRAE: *"Recommends all new rack PDU products be designed to at least 60'C"*

BICSI MIDDLE EAST & AFRICA

ASHRAE & TIA-942

Demands metering at 3 levels in the front of the cabinet. 3x Temperature & 1 Humidity

BICSI: *"Class F2 and above required - One sensor in cold- and one in hot aisles"*

"Class F3 and above Required in open aisle configuration - Two sensors in cold and two in hot aisles at different heights"

ASHRAE:

"Temperatures above 50'C will adversely affect the service life of a battery".

"Tape products require a stable and more restrictive environment – rate of change of temperature is less than 5'C/hour."

Humidity sensor decay

- Cooling = Taking away water

- High humidity leads to condensation/ corrosion
- Low humidity leads to Electrostatic Discharge (ESD)

- Rule of thumb, replace Humidity sensors every 2 years!

ASHRAE: 30 – 60% RH

Relative Humidity

Parameter	Condition	Value	Units
Resolution[1]	12 bit	0.04	%RH
	8 bit	0.7	%RH
Accuracy tolerance[2]	typ	±1.8	%RH
	max	see Figure 2	%RH
Repeatability		±0.1	%RH
Hysteresis		±1	%RH
Nonlinearity		<0.1	%RH
Response time[3]	τ 63%	8	s
Operating Range	extended[4]	0 to 100	%RH
Long Term Drift[5]	Typ.	< 0.25	%RH/yr

Field replaceable sensor heads

- Facilitate MTTR in case of failed probes
- Eliminate standard fixed cords
- Cheaper deployment and elegant cable management


QUESTIONS?

THANK YOU