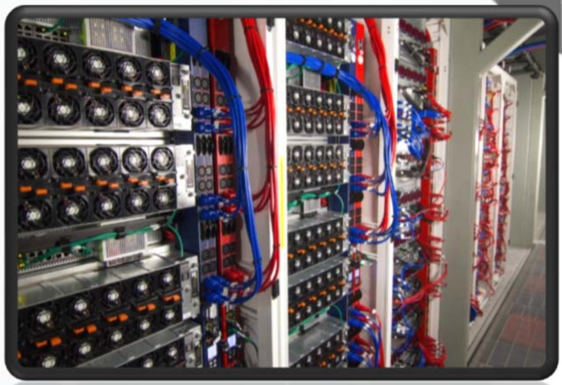
DATA CENTER SOLUTIONS

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

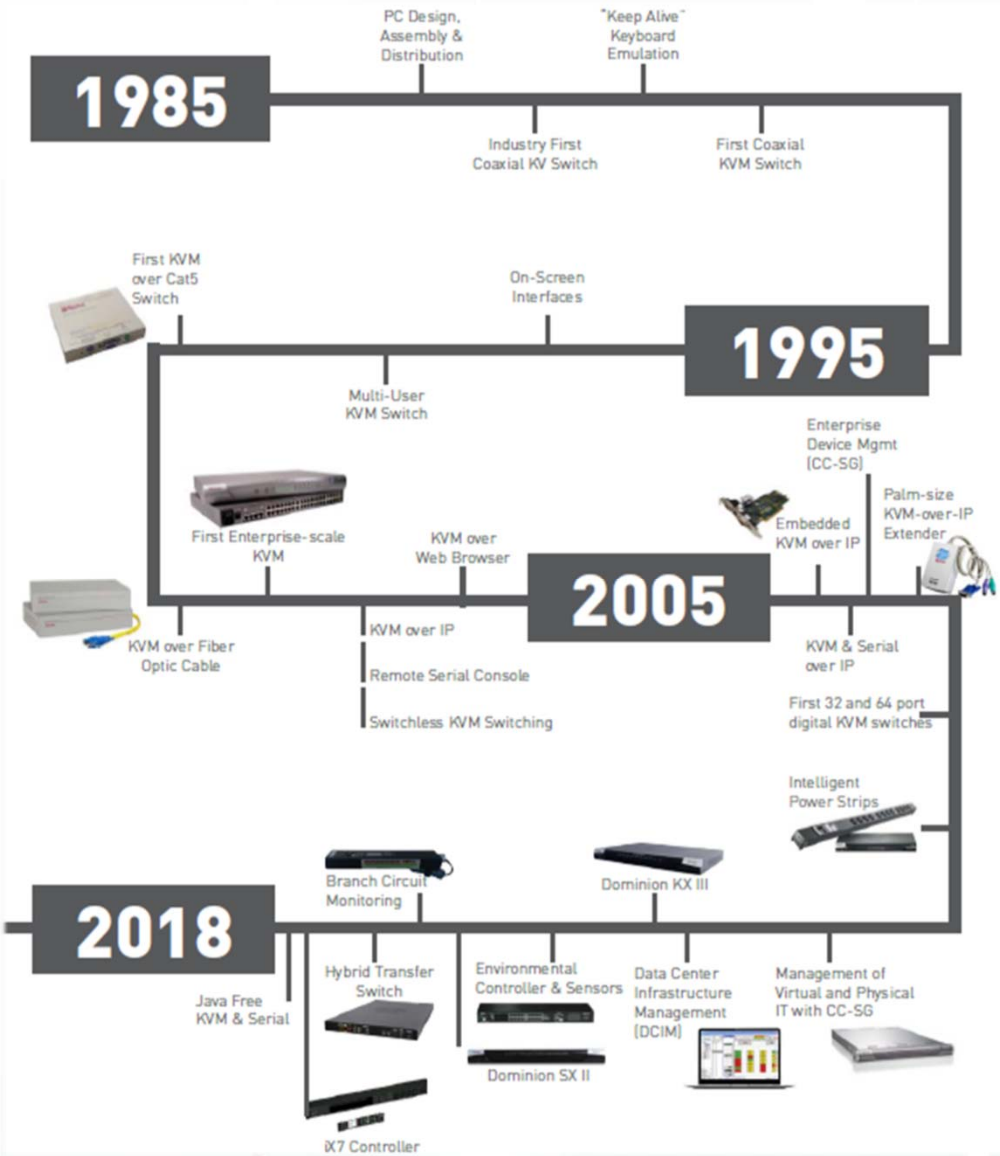
Who is Raritan?
A global leader in data center management solutions

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

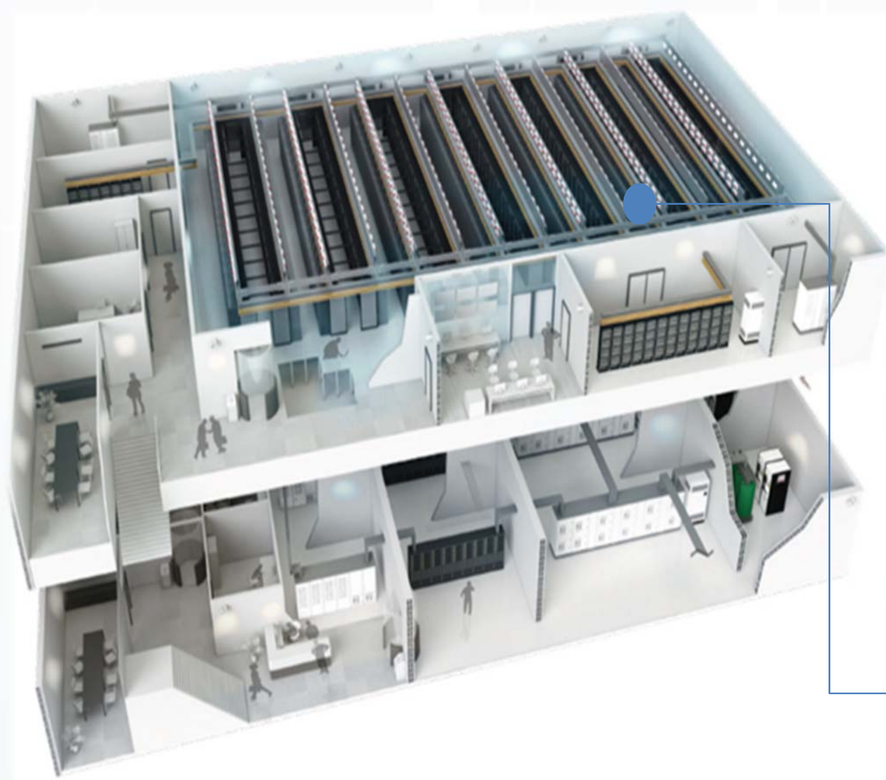
Our solutions help IT professionals gain more insight into data center operations and manage smarter in more than one way.

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

Agenda of today's Seminar

"Last Mile" Example Issues:

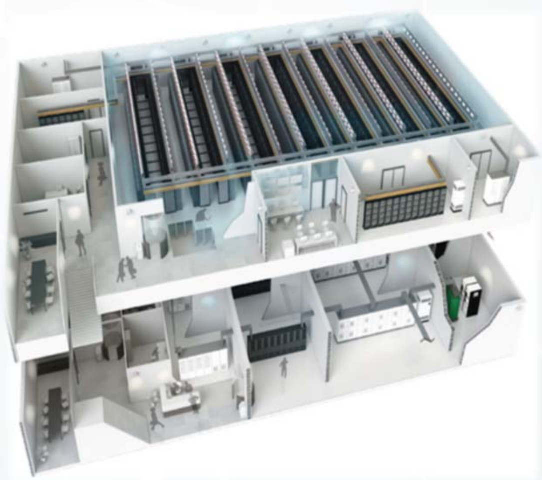
PDU:

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

ATS:

- 9/ Application
  10/ Technologies
- 11/ Insufficient Switching Time



Circuit Breaker Trip Coordination

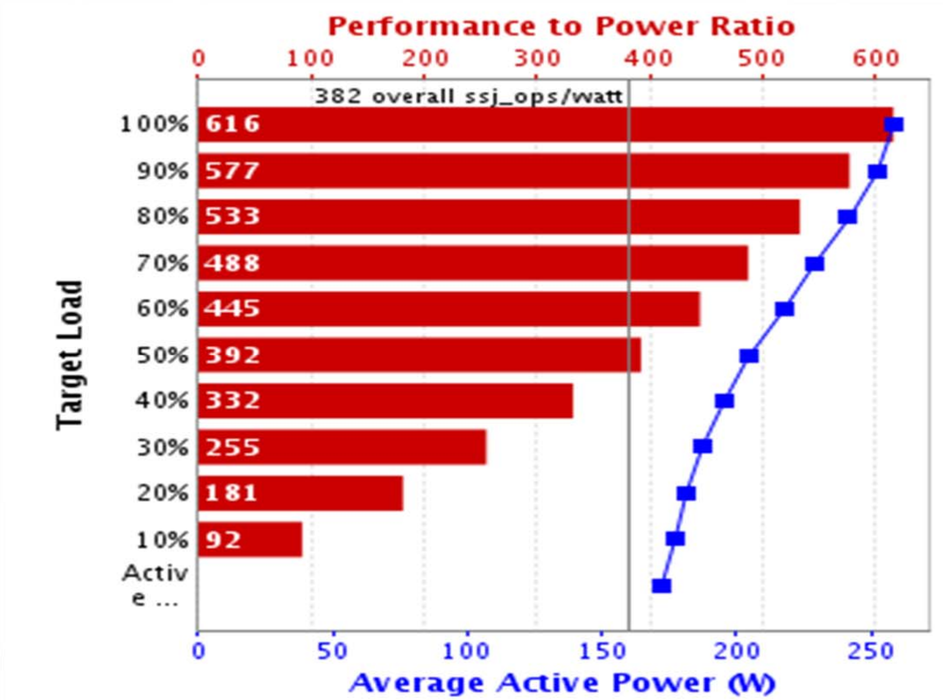
Why metering ?

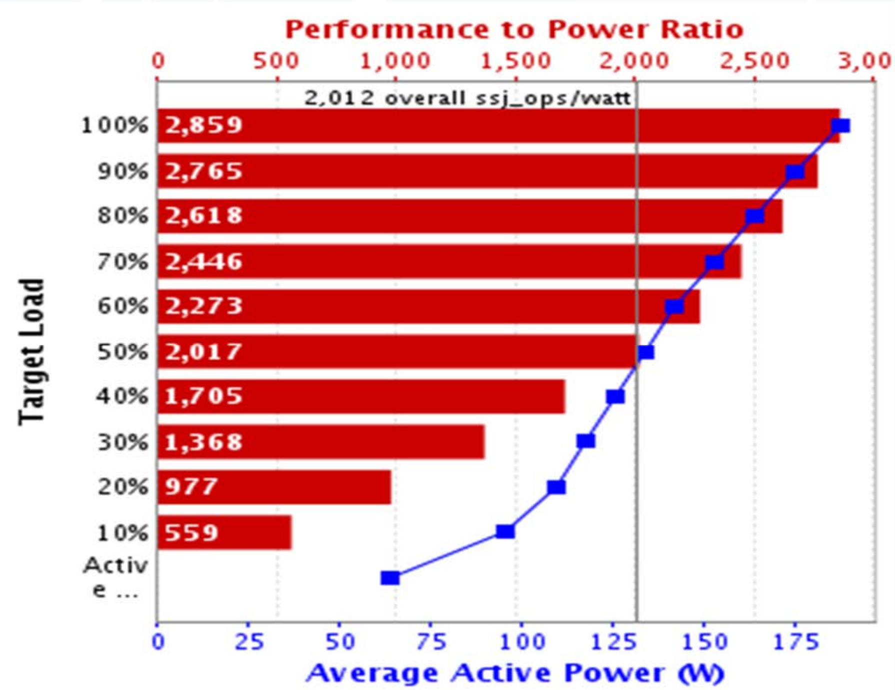
The “Buckaroo Effect”

Avoid inefficiencies based on fear & uncertainty

Avoid over/under capacity with accurate data!

Capacity Planning





HP Proliant DL380G5
Name plate 700 Watt

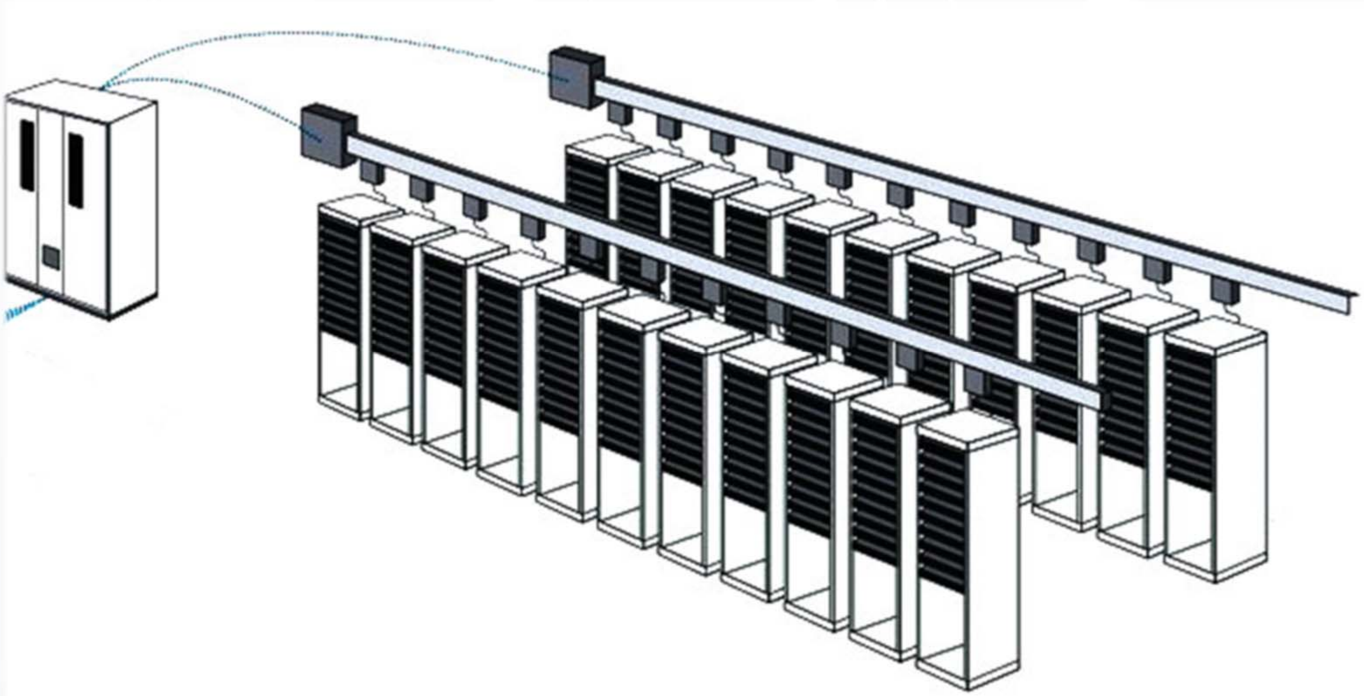
HP Proliant DL380G6
Name plate 500 Watt

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

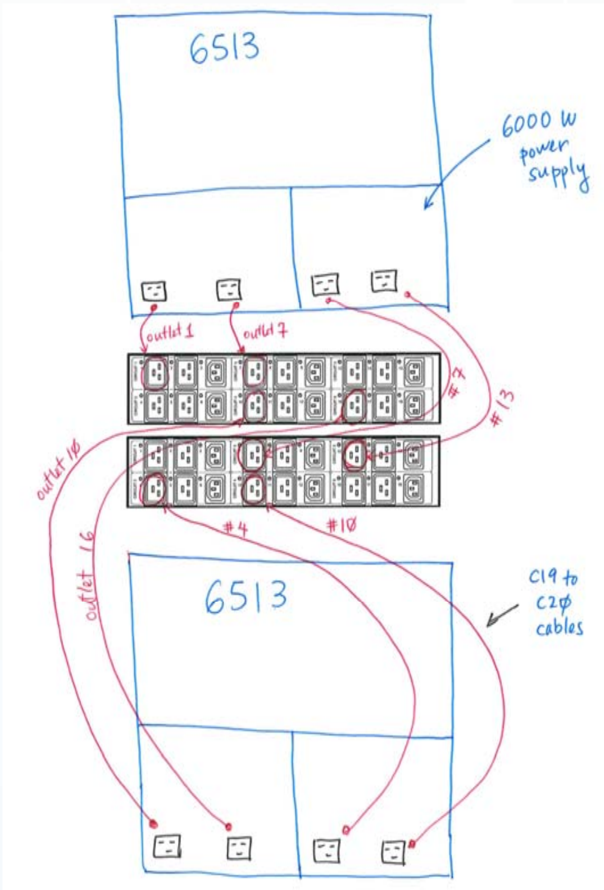
Breaker Coordination Must Extend into the Rack

EXAMPLE 1

Common scope of breaker coordination protects against cascading failure…



Critical Facility Design Scope: End-to-End



As IT loads become more sophisticated…

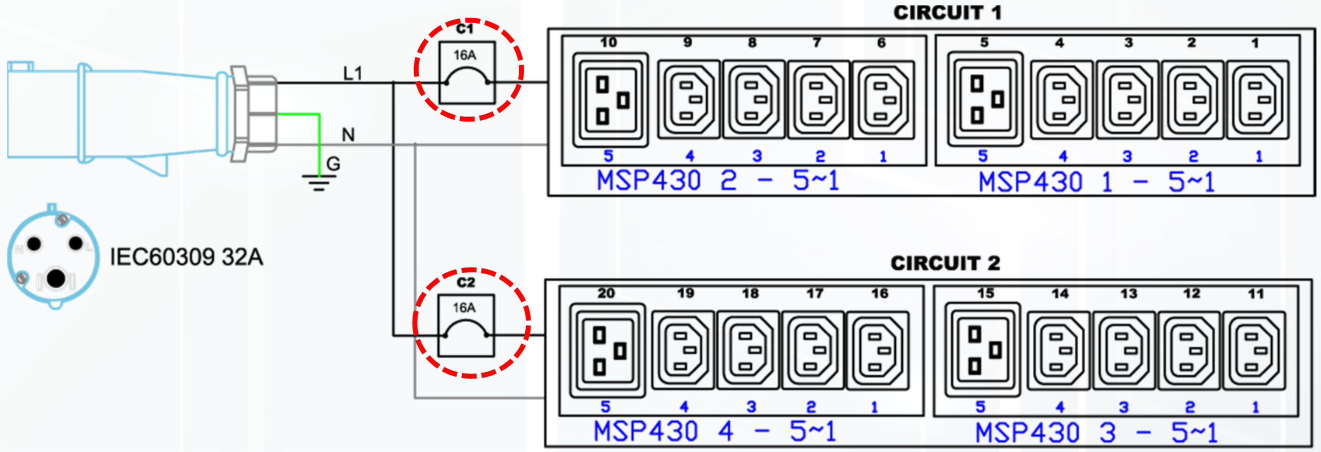
… the "last mile" of the power chain:
from the distribution board,
to the cabinet, to the equipment…

… pose new challenges for clients

Breaker Coordination Must Extend into the Rack

EXAMPLE 1

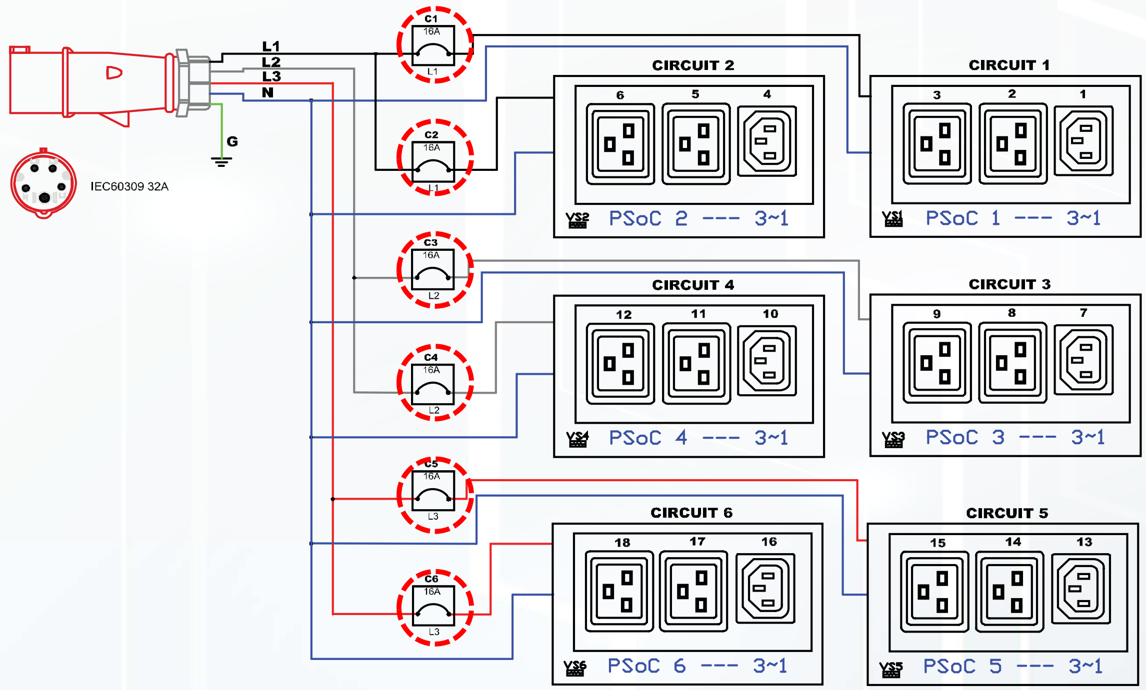
… but must consider cabinet components to be fully effective!



Breaker Coordination Must Extend into the Rack

EXAMPLE 1

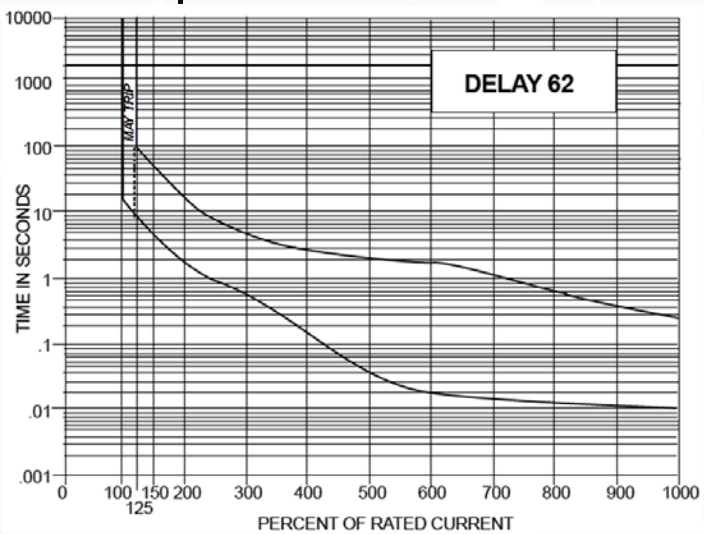
Most common trip event = faulty server power supply.



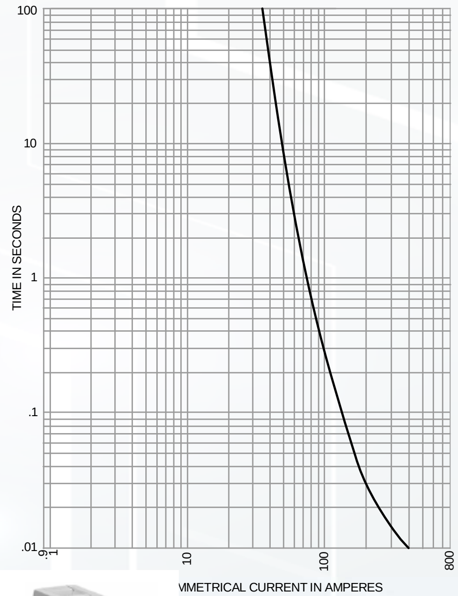
Breaker Coordination Must Extend into the Rack

EXAMPLE 1

MCCB Trip Curve



Fuse Melt Curve



5kAIC typical;

Finger-safe cylindrical fuse holder;
Typical 20kAIC+

Circuit Breakers types

- IEC 60950-1 Safety Standard requires use overcurrent protectors (OCP)
  - Thermal-Magnetic Breakers
  - Magnetic-Hydraulic 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)

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)

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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)

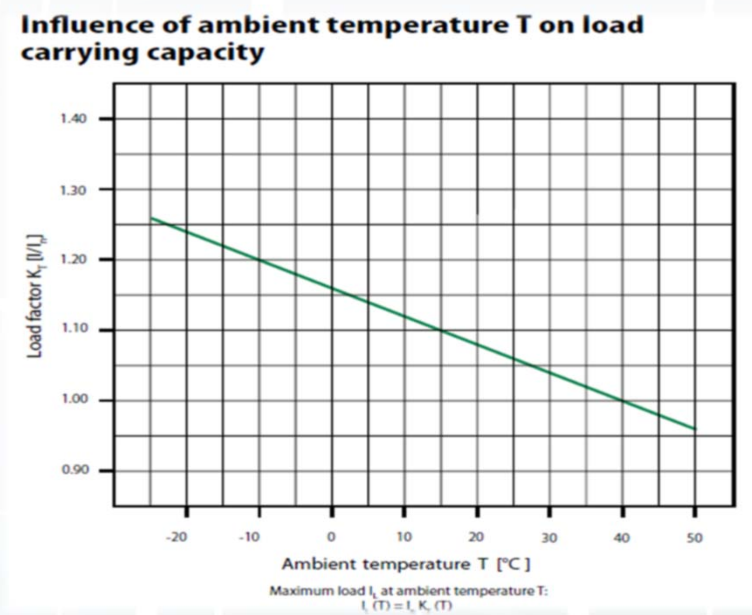
Hydraulic Magnetic

- 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 our 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.

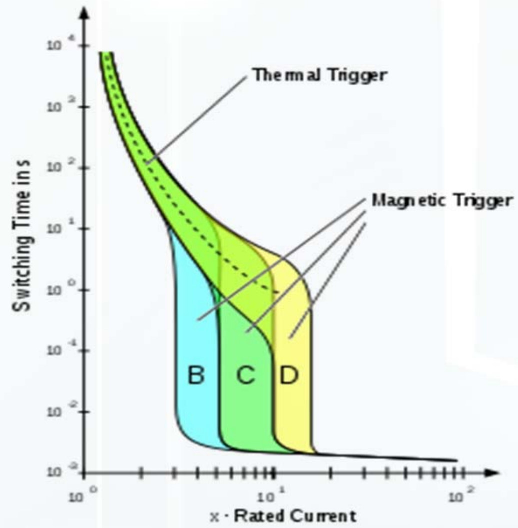


Circuit Breaker Trip Delays

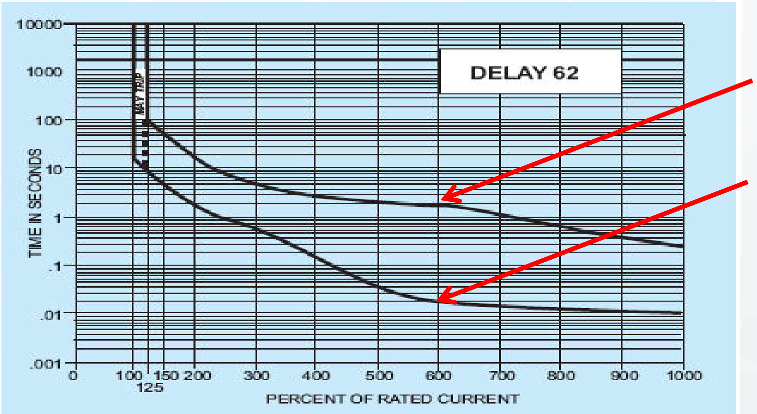
Thermal magnetic delays are standardized: A,B,C, or D. For data centers, type D is used.

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.

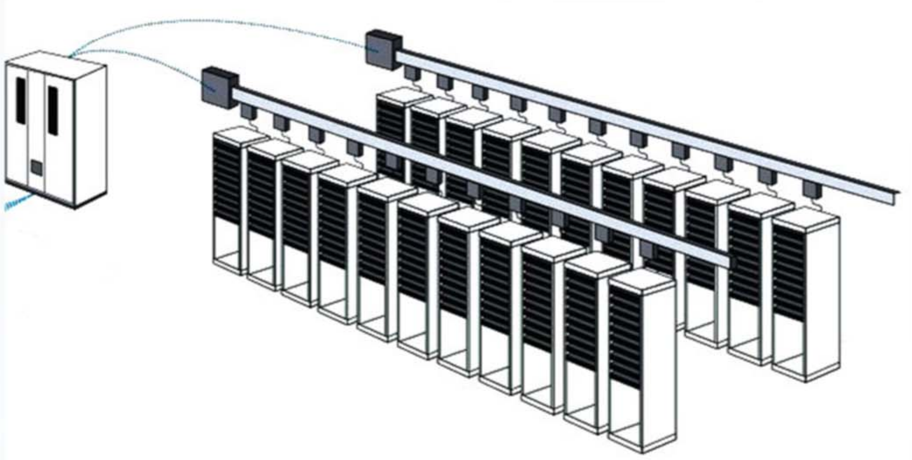
Circuit Breaker Trip Coordination

When short occurs, only 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.



BICSI MIDDLE EAST & AFRICA

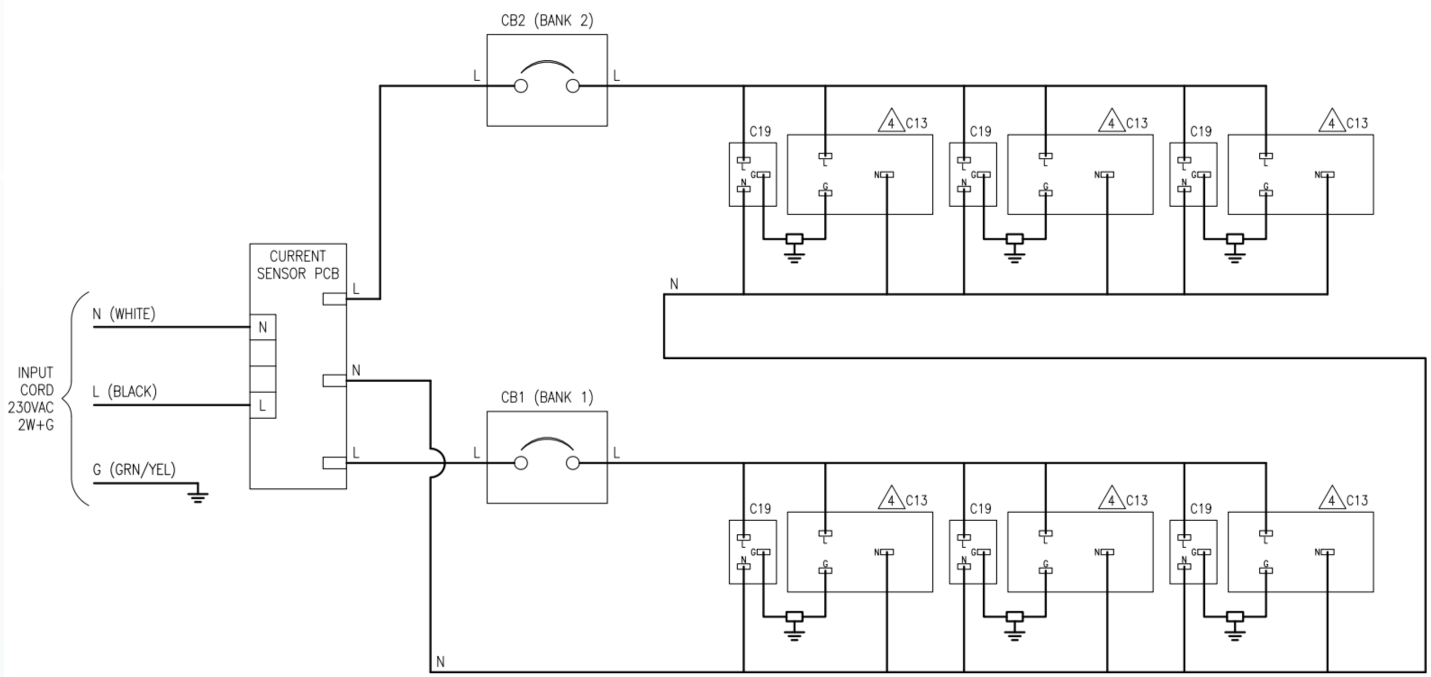
Insufficient Trip Breaker Alerting in Power Chain

EXAMPLE 2

- Most modern data centre 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;

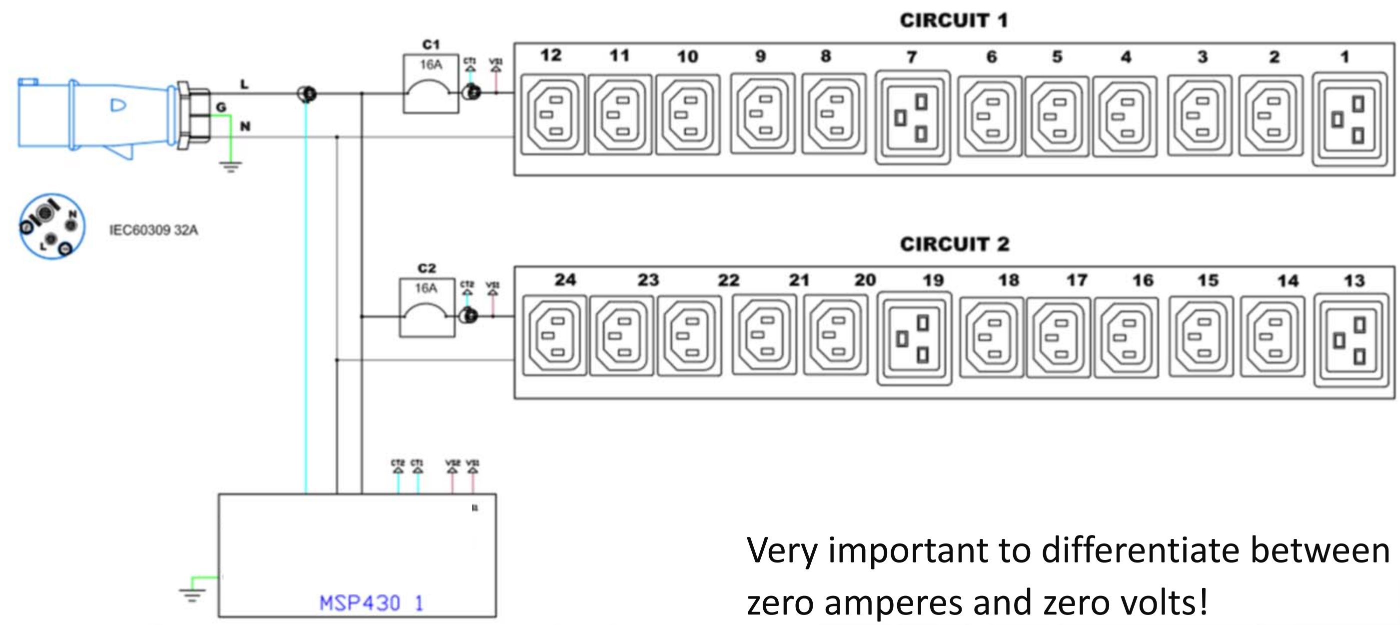
Insufficient Trip Breaker Alerting in Power Chain

EXAMPLE 2



Insufficient Trip Breaker Alerting in Power Chain

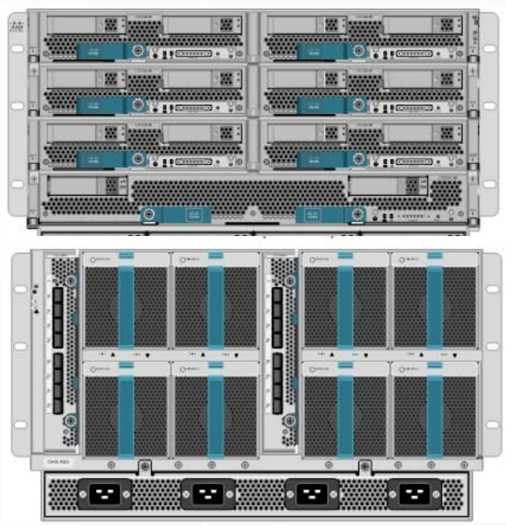
EXAMPLE 2



Very important to differentiate between zero amperes and zero volts!

Proper Feed Sizing for High Density Blade Chassis

EXAMPLE 3



- 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;

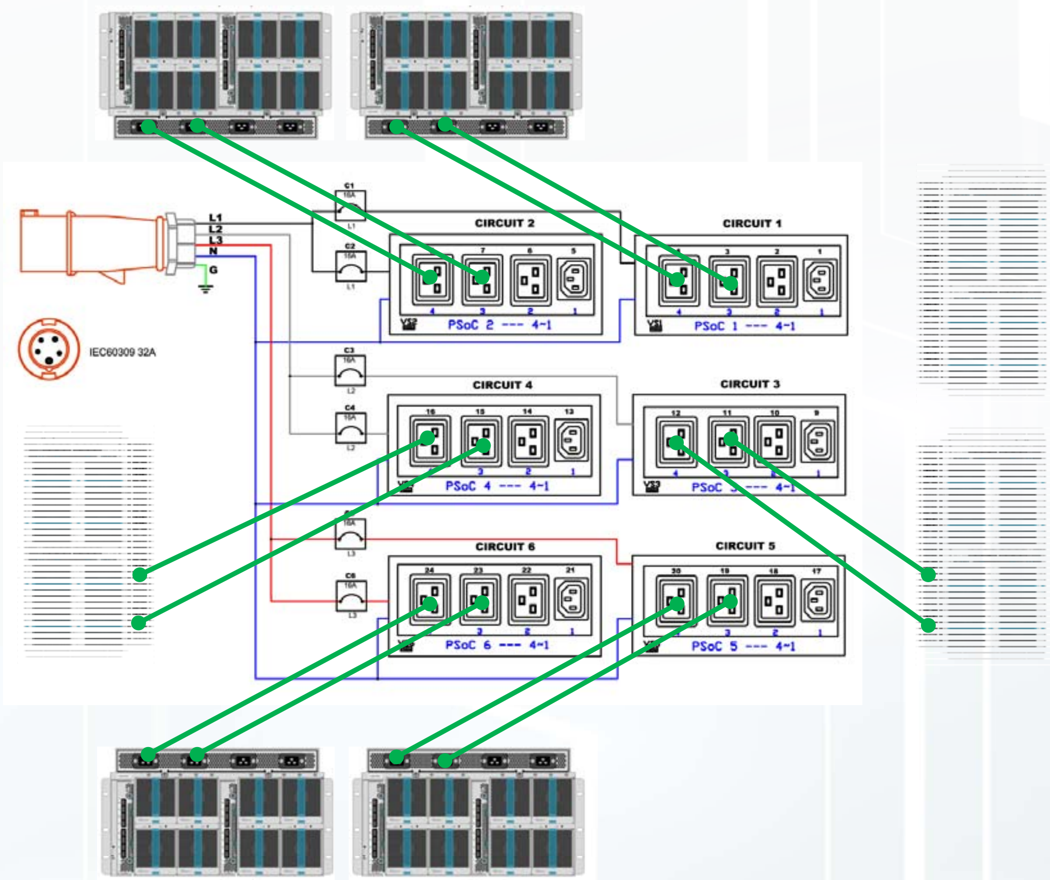
e.g. 415V, 3phase WYE; 32a Supply

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

Let's try seven (48U rack)…

Proper Feed Sizing for High Density Blade Chassis

EXAMPLE 3



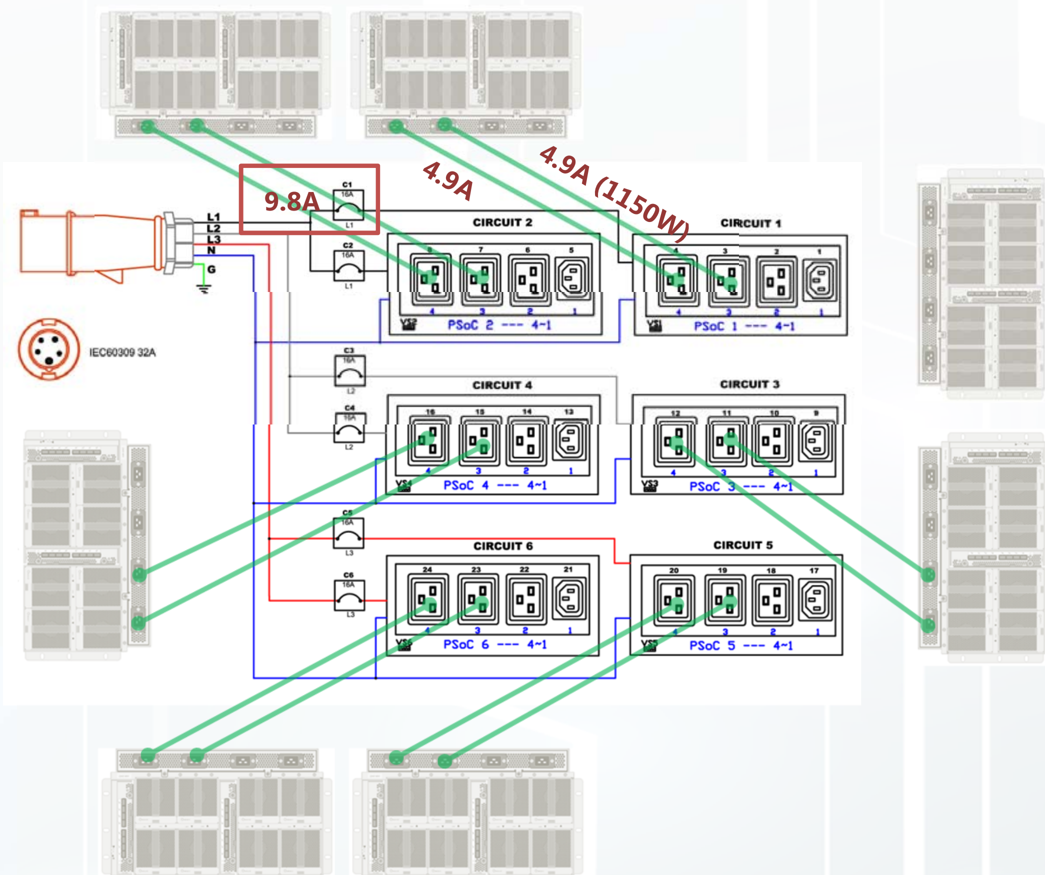
First Connect
Six Chassis
(14.2kVA)

Peak = 4.9A per connection;

Peak (Failure Mode) = 9.8A on one plug

Proper Feed Sizing for High Density Blade Chassis

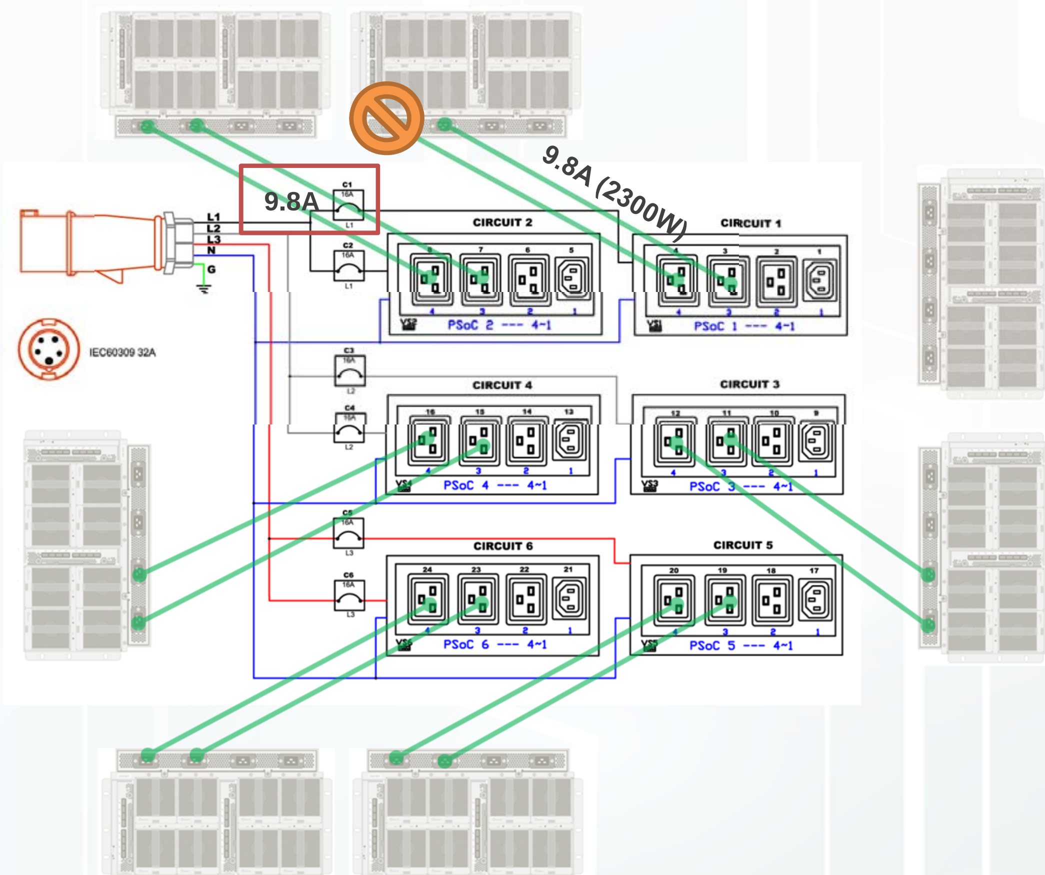
EXAMPLE 3



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

Proper Feed Sizing for High Density Blade Chassis

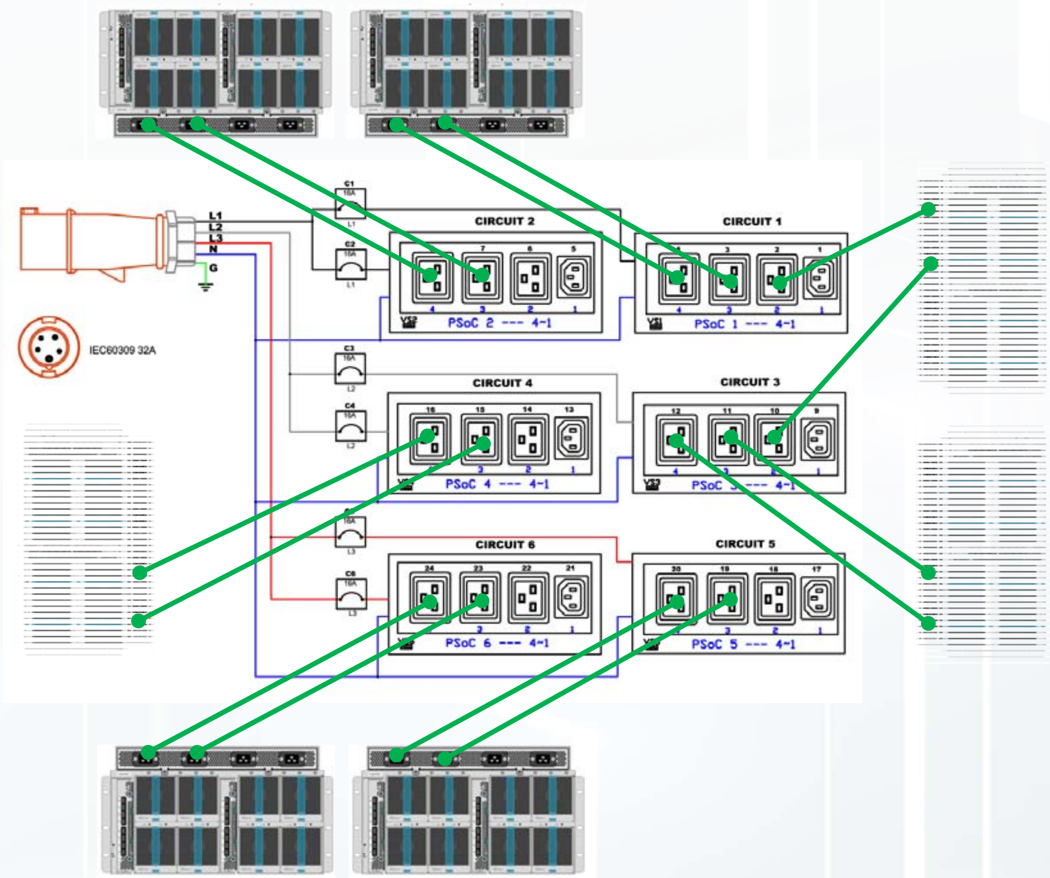
EXAMPLE 3



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

Proper Feed Sizing for High Density Blade Chassis

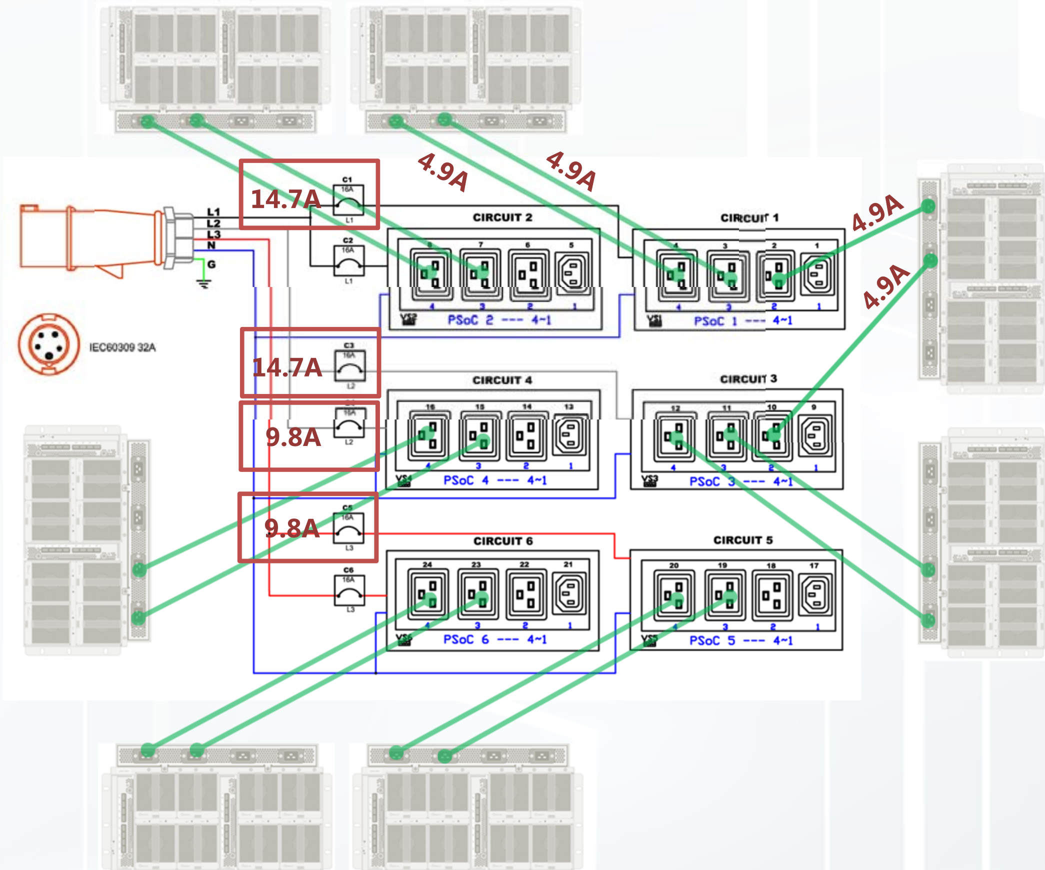
EXAMPLE 3



Add 7th Chassis.
Need to share
breakers.

Proper Feed Sizing for High Density Blade Chassis

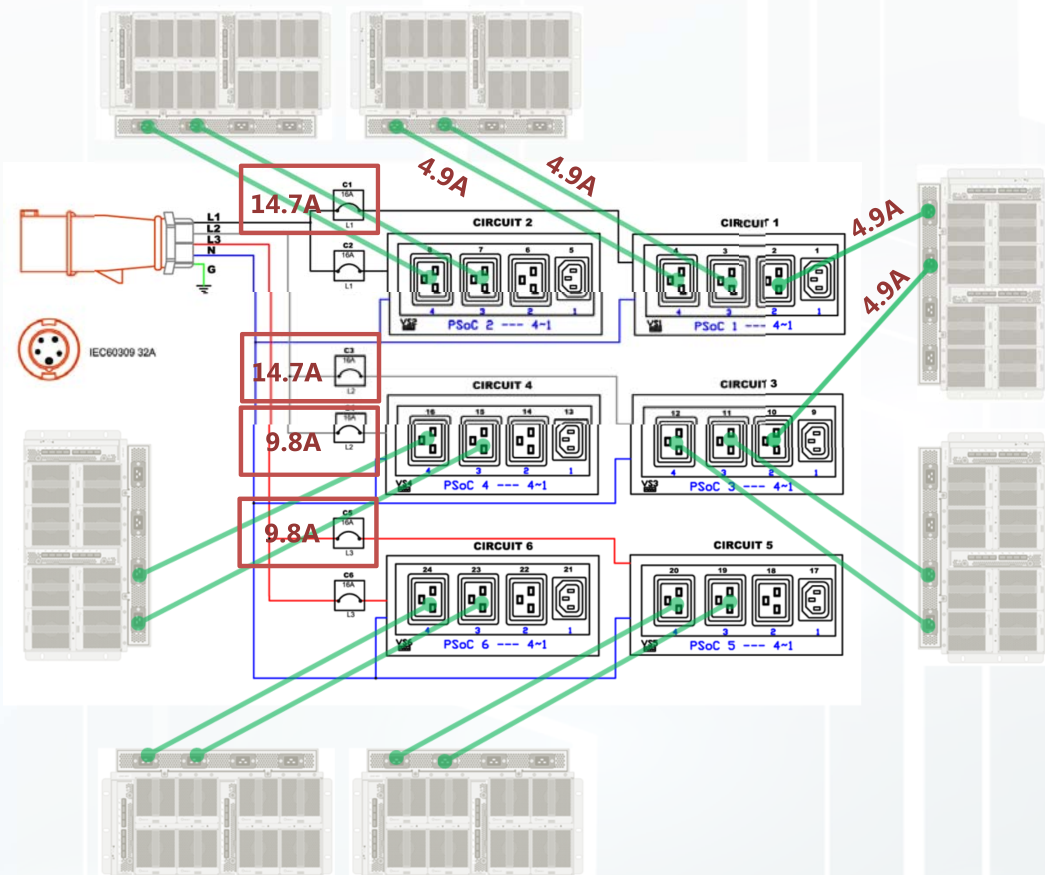
EXAMPLE 3



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

Proper Feed Sizing for High Density Blade Chassis

EXAMPLE 3

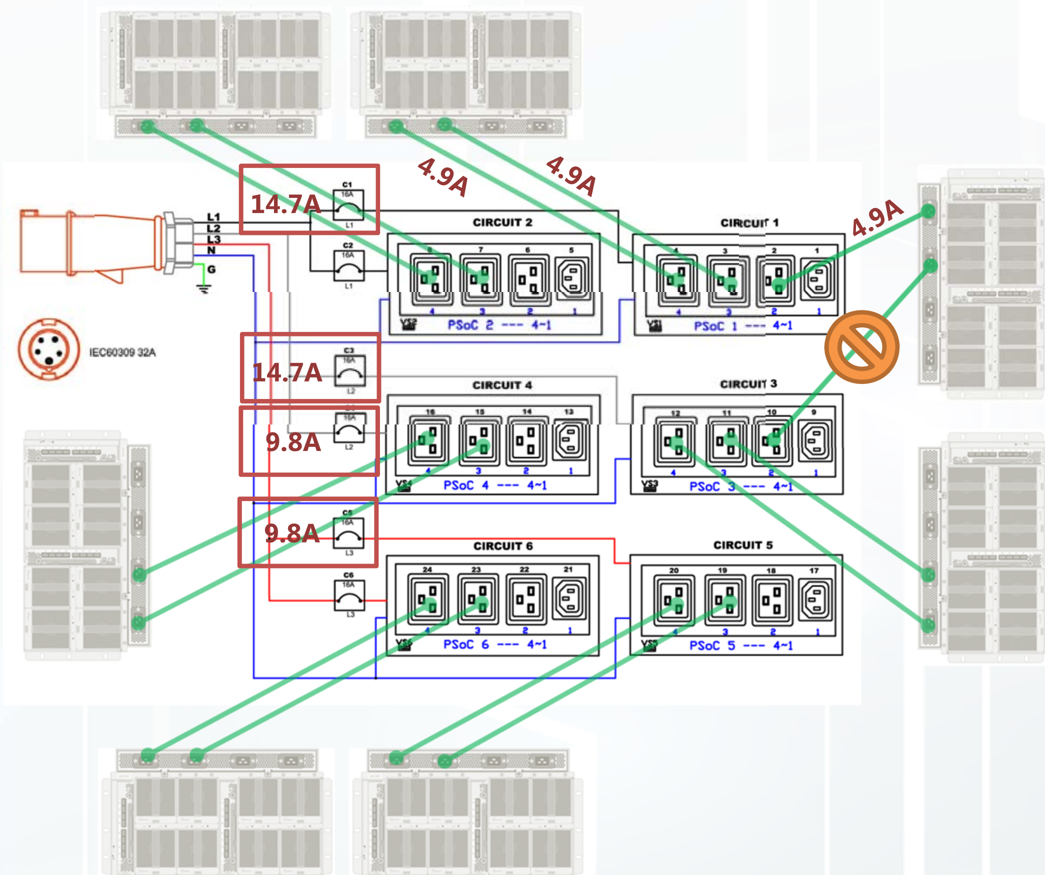


Not truly redundant!

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

Proper Feed Sizing for High Density Blade Chassis

EXAMPLE 3



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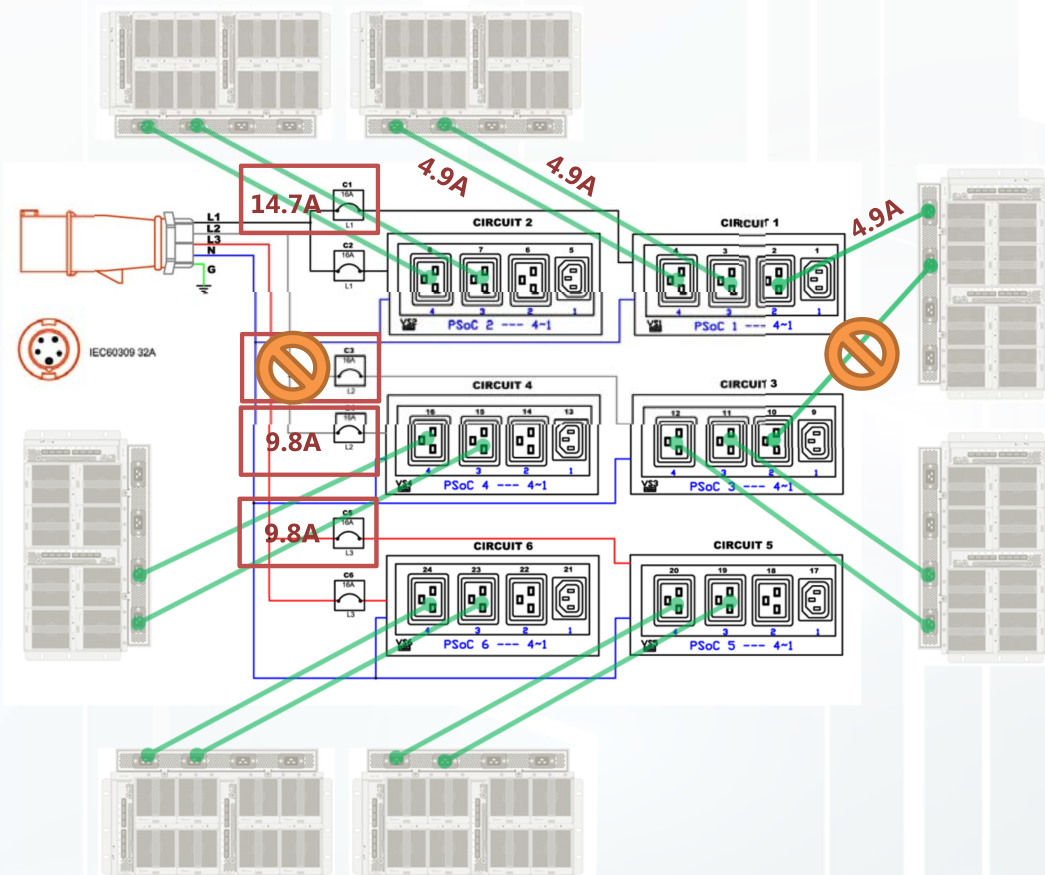

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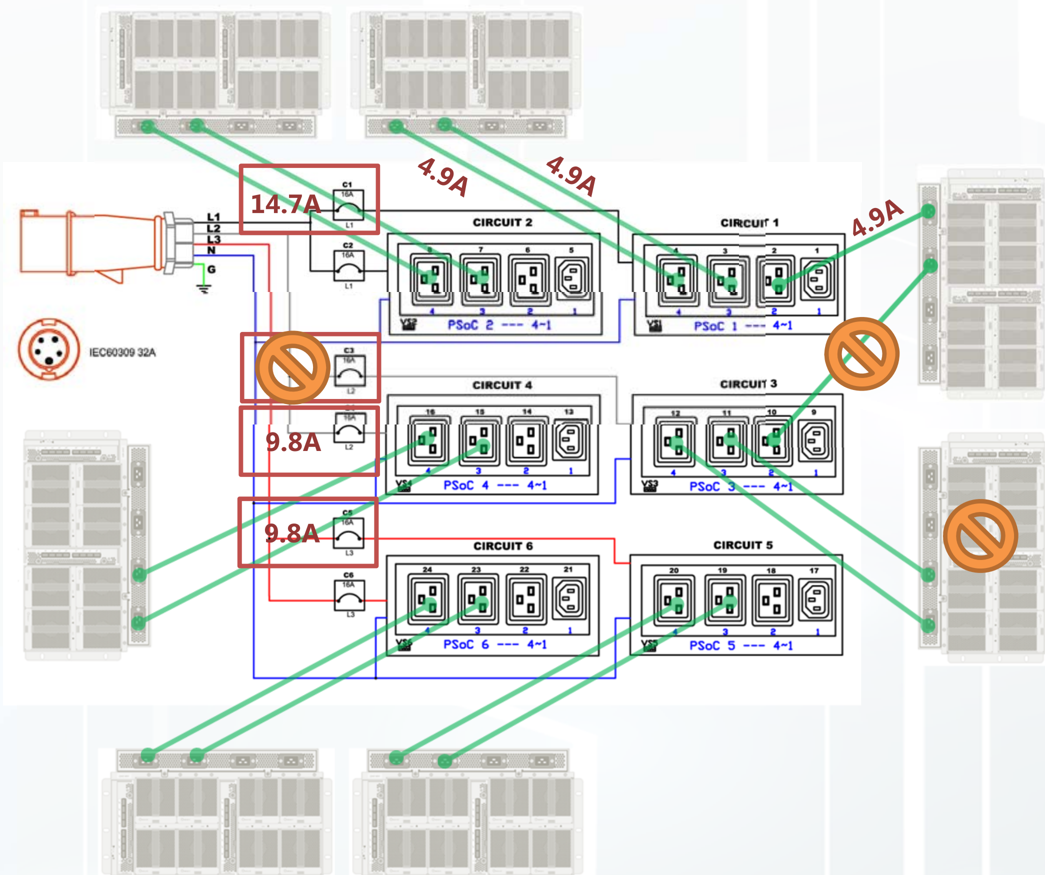

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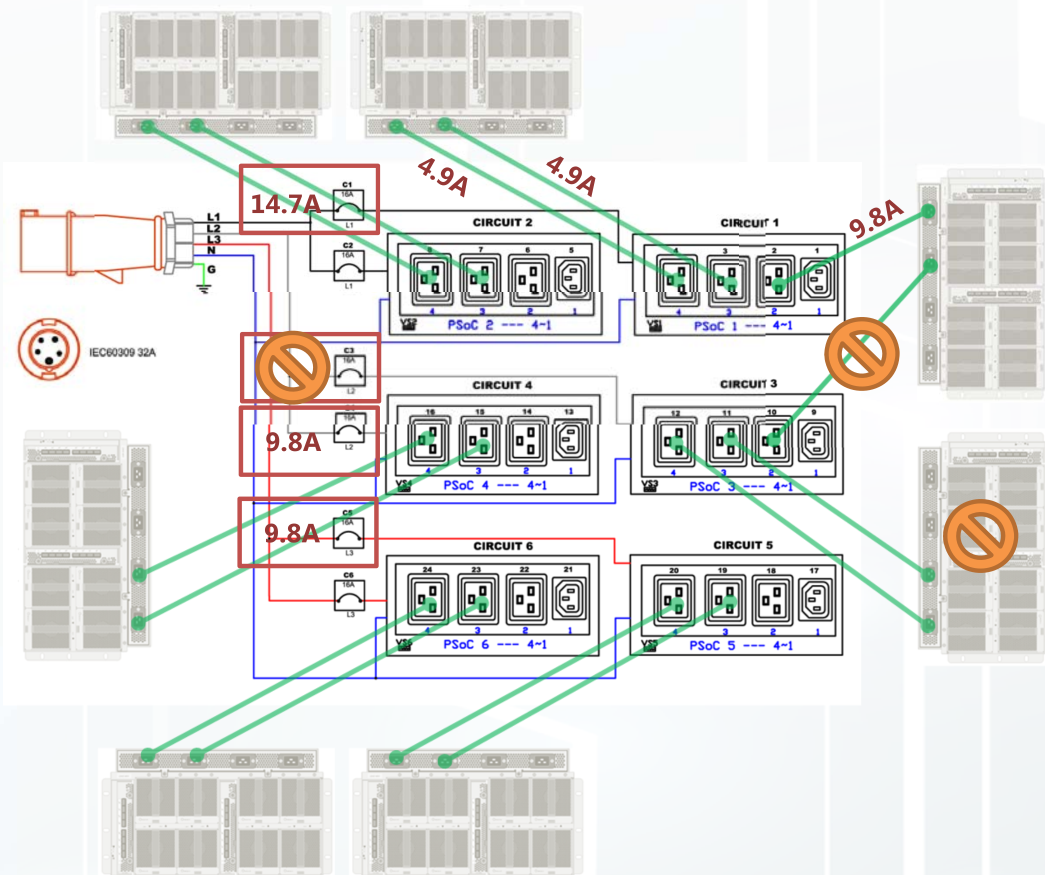

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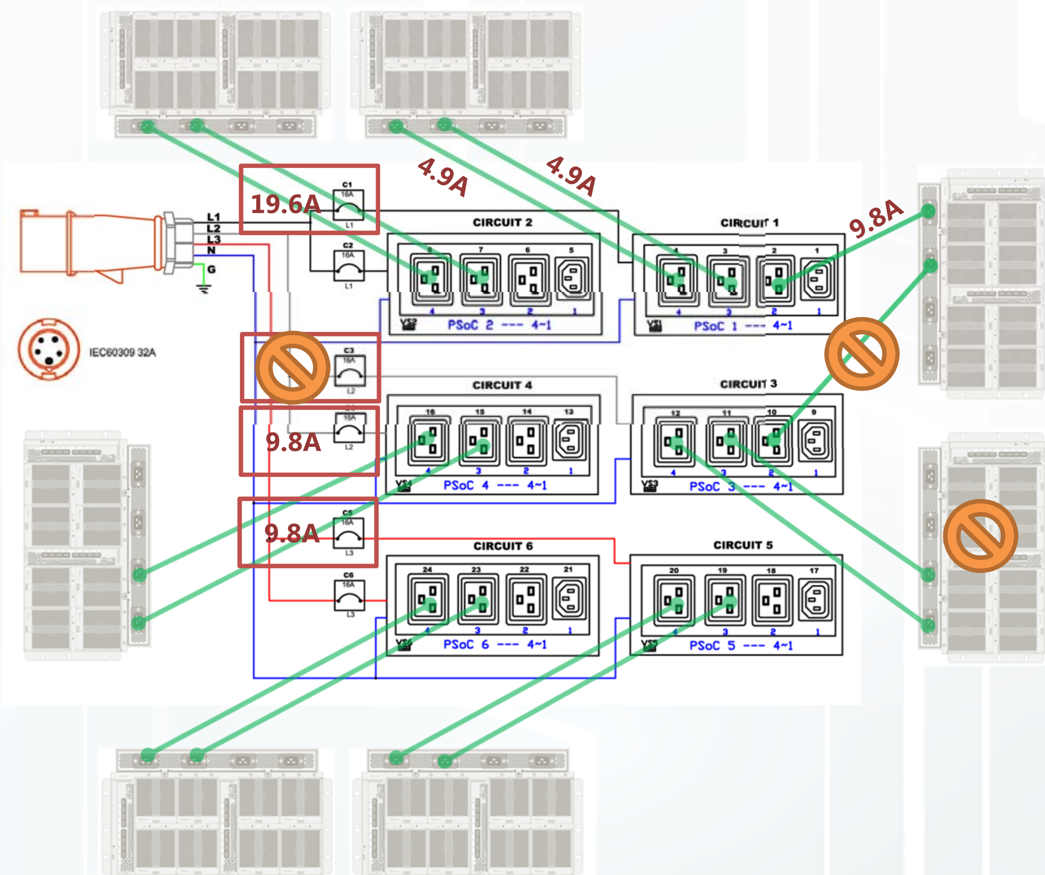

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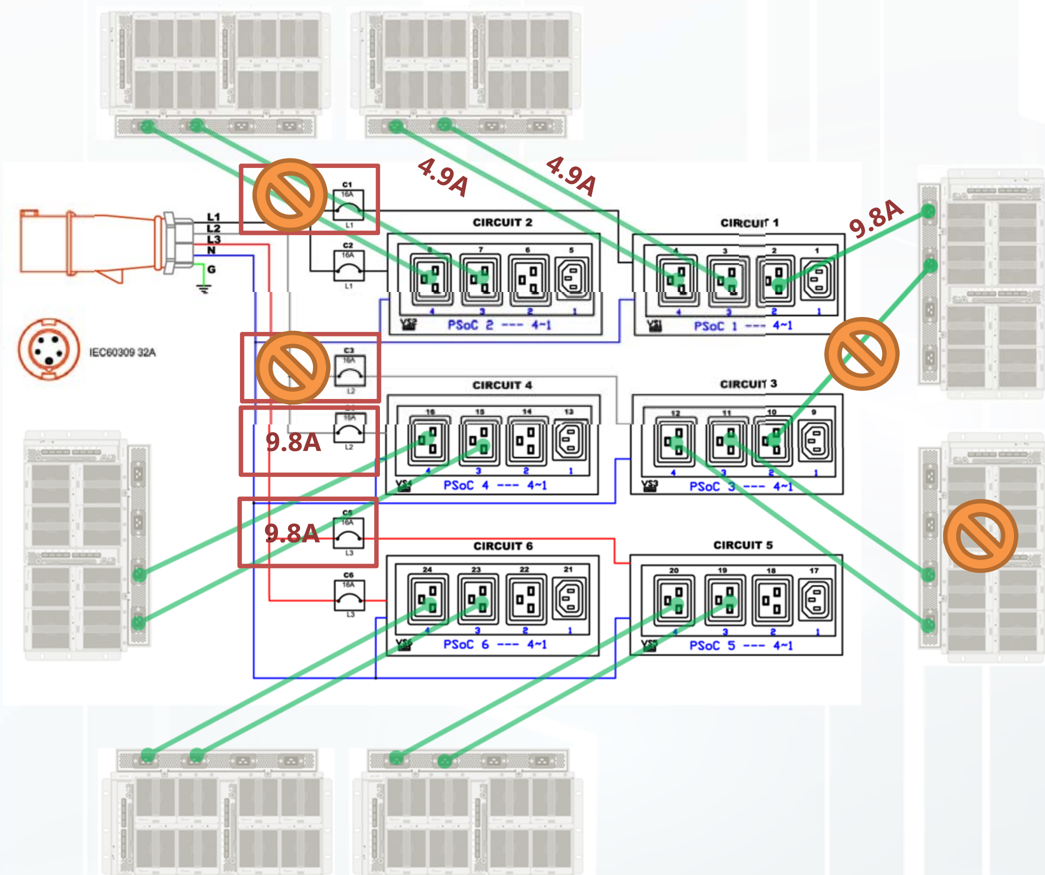

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Proper Feed Sizing for High Density Blade Chassis

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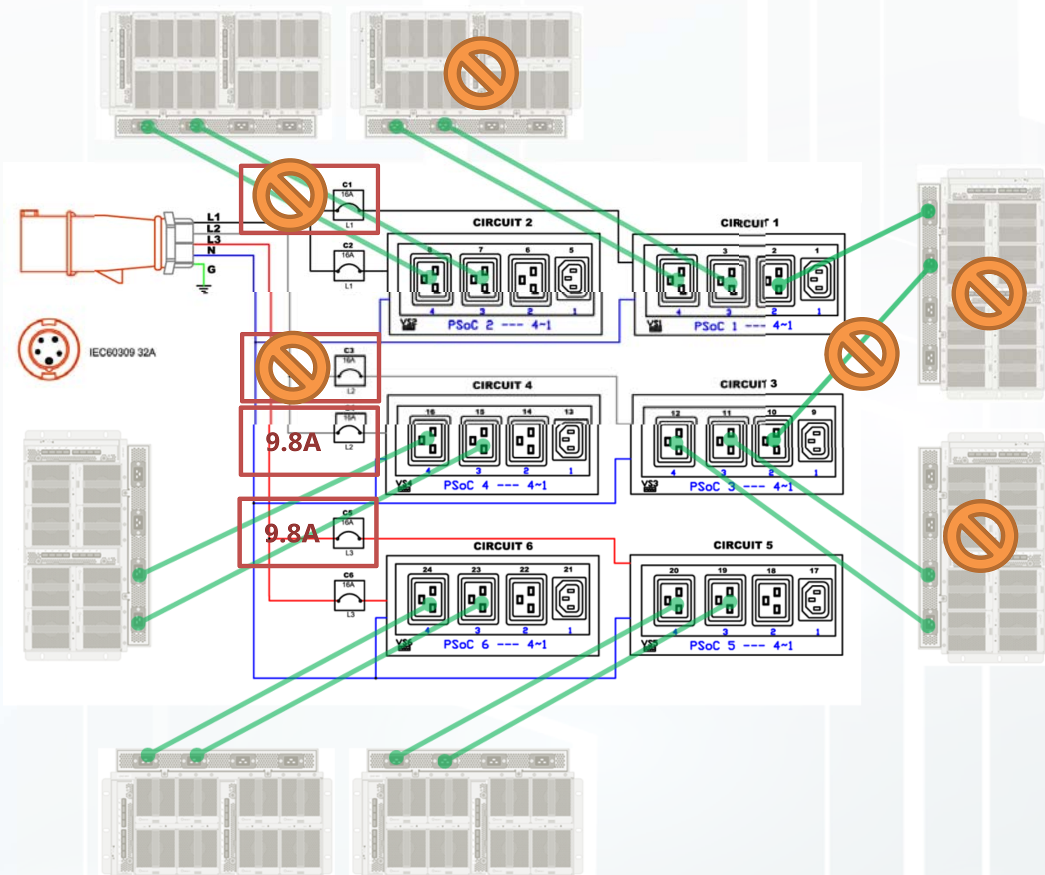


Not truly redundant!

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

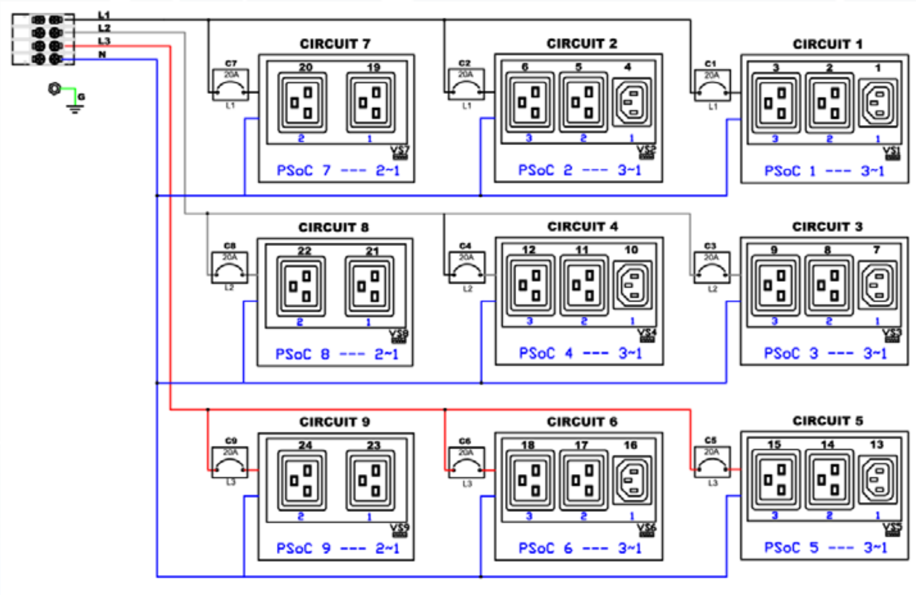
Violates best practice concept of isolated failure domains.

Proper Feed Sizing for High Density Blade Chassis

EXAMPLE 3

- "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)



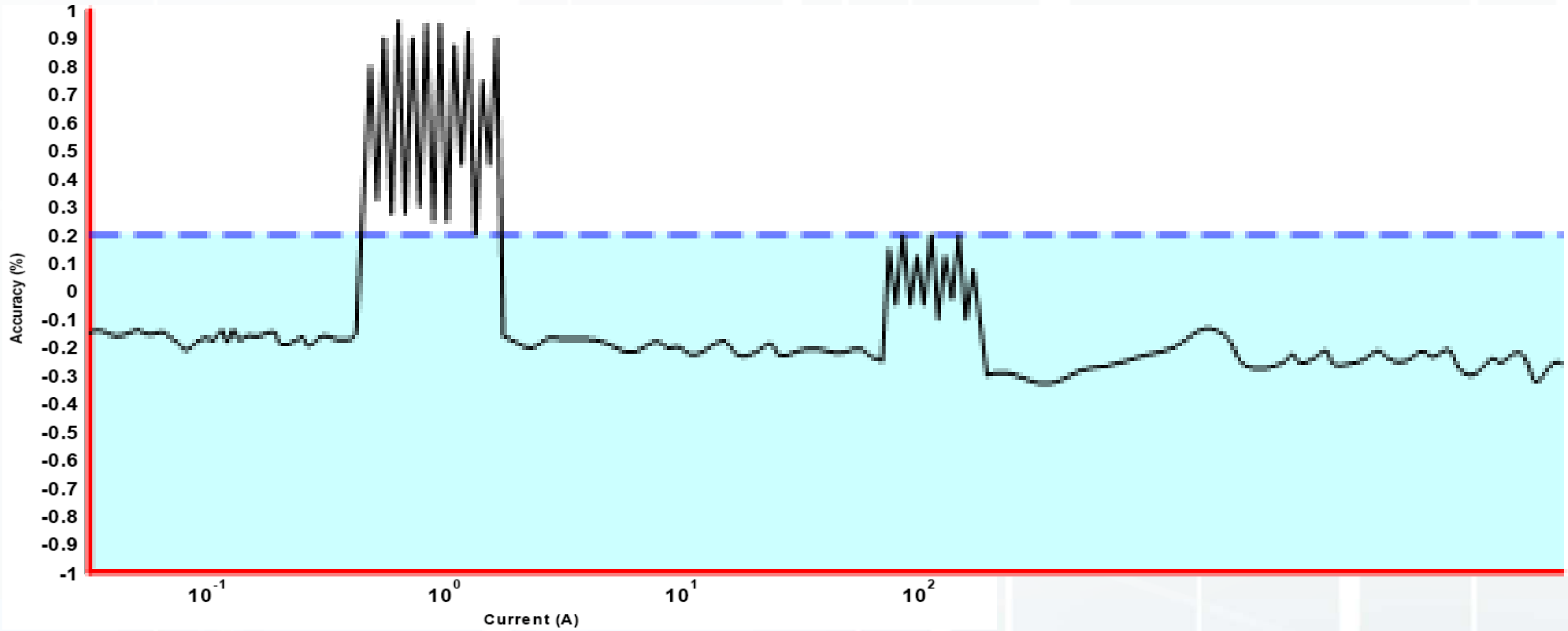
Metering Accuracy

Metering Accuracy

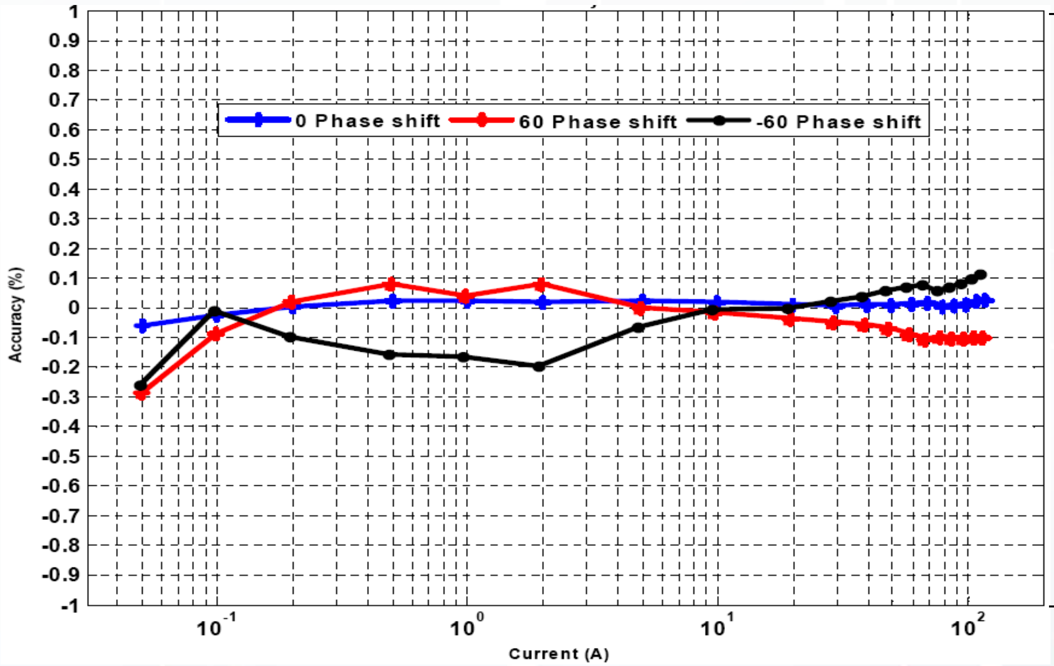
ISO/IEC 62053-21 = +/-1%

Outlet Metering	Circuit Breaker Status Monitoring	Inlet level Metering	Residual Current Monitoring

Metering Accuracy - Squelch



Metering Accuracy – Phase shift

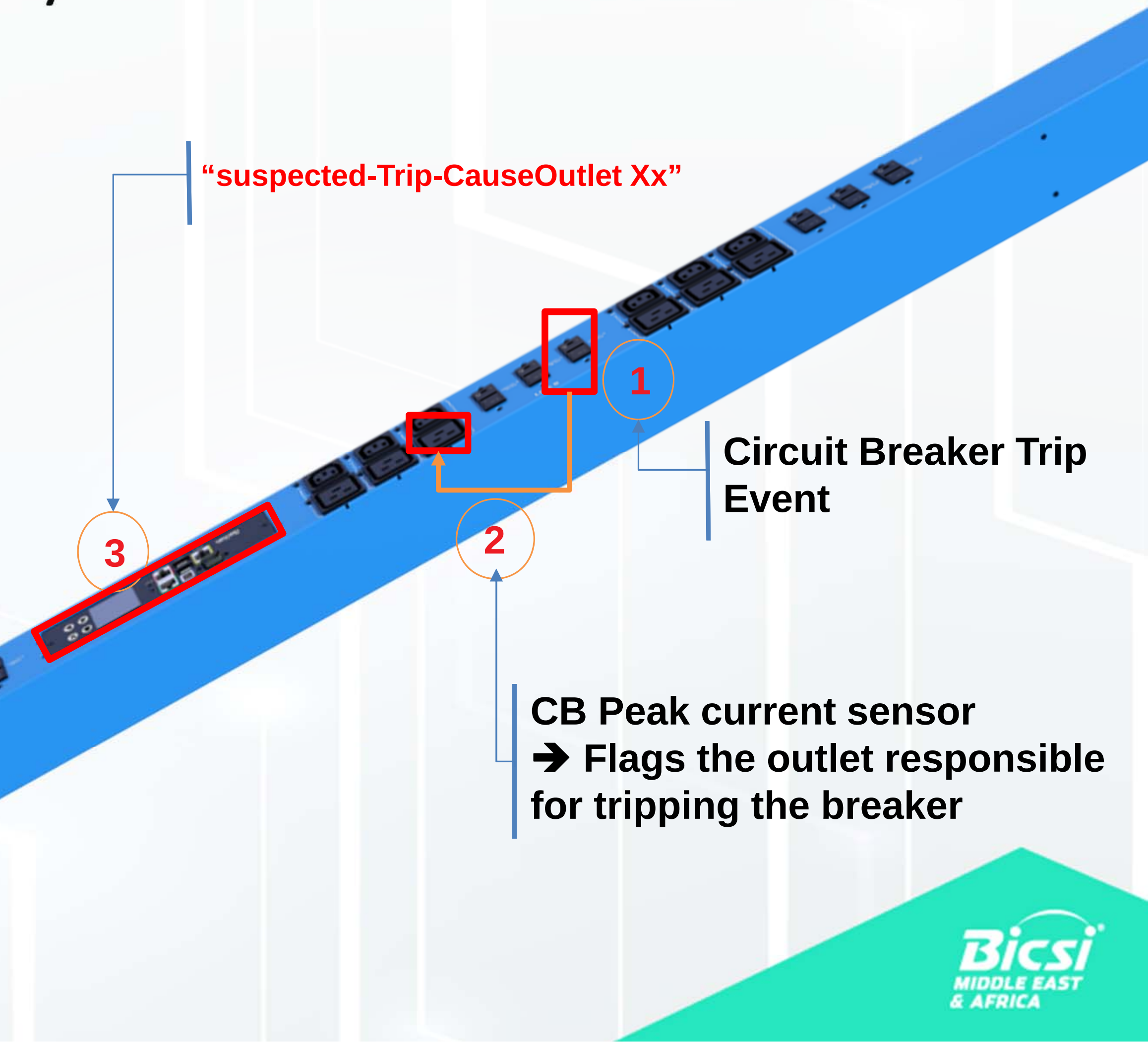


IEC 62053

1% - Class 1

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



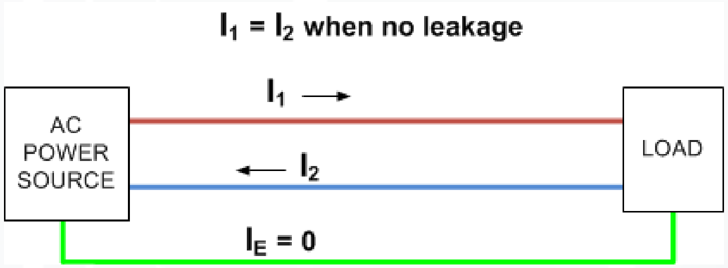
Residual Current Metering

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

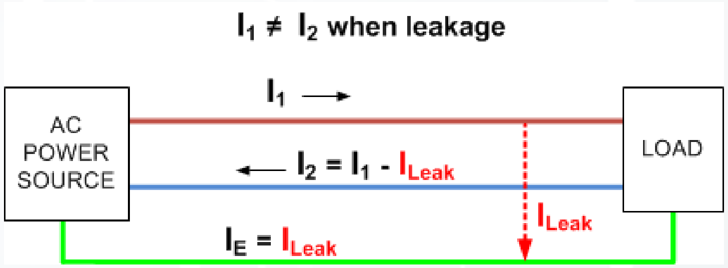
Residual current is the difference between the outer conductor (L1 or L1-L3) and the neutral conductor (N) flowing stream. This is known as current leakage and resulting an alarm to identify the presence of residual current

Residual Current Monitoring

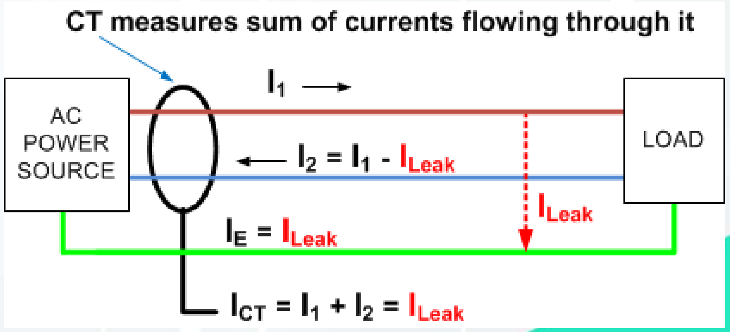
Basic electric theory says sum of currents in a closed loop = zero.



When leakage occurs sum of currents does not equal 0.



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

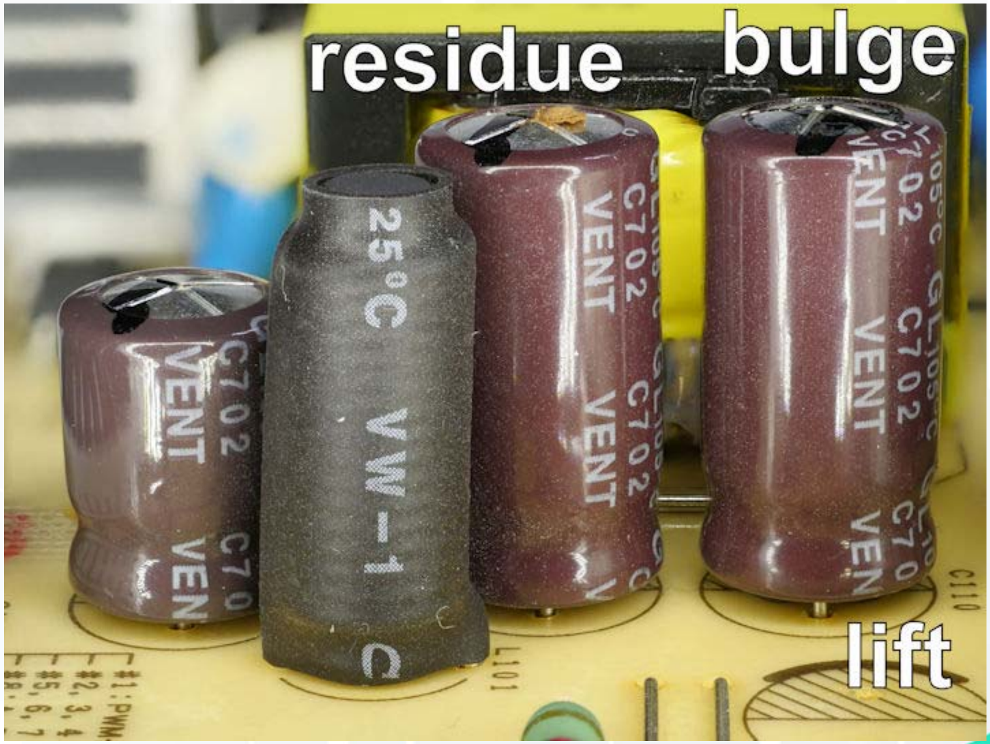


Risks of current leakage: avoid downtime

- Proactive detection of a leakage current in high-availability facility.
- Regulatory testing required by law in some regions
  Germany, Austria, UK moving towards EN 50600
- Permanent monitoring, automated saves cost

Residual Current: causes?

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



Residual Current: Sensor options

RCM Type A

Detects AC leakage and is sensitive down to 6mA leakage.

RCM Type B

Detects AC and DC leakage and is sensitive down to 30mA.

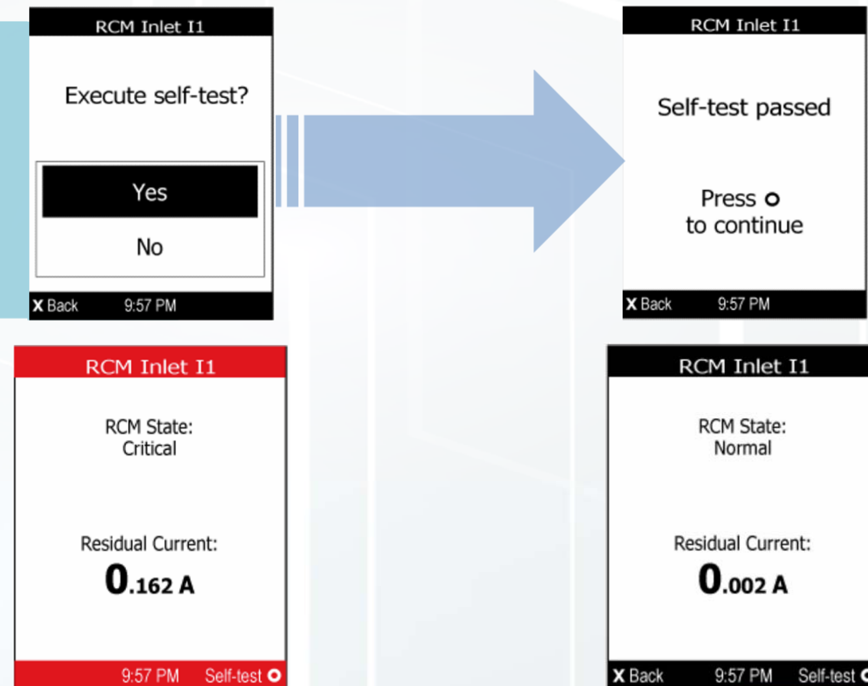
Neutral Monitoring

UL/IEC 60950-1 + IEC 62020 standard Compliance tolerates leakage up to 3mA (Type A) and 30mA (Type B)

Residual Current: Testing

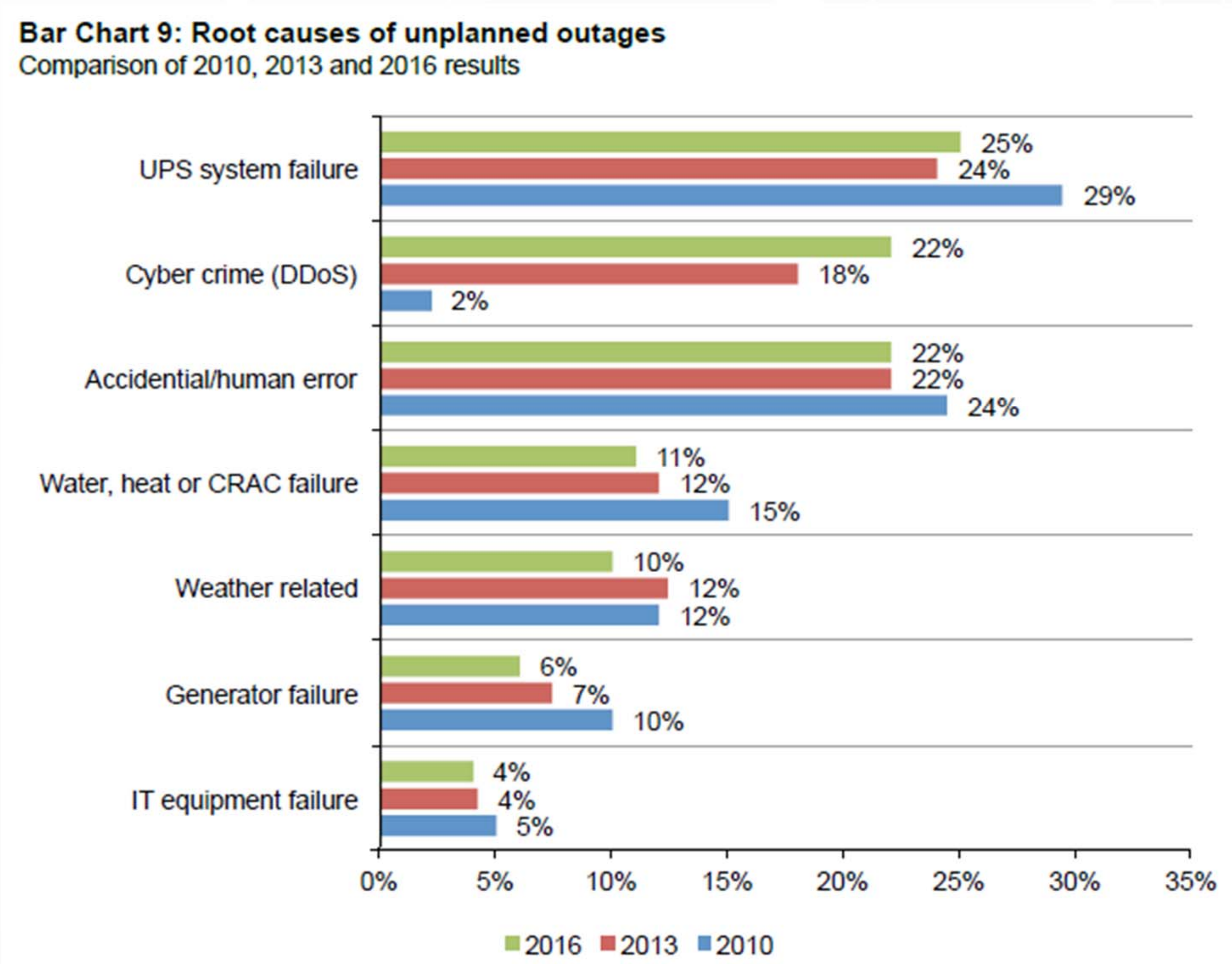
Avoid false positive/negative readings, ignore current measured under 3mA

- ➔ Useful for testing the alerting system
- ➔ Ensures Sensor Readings reliability



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)

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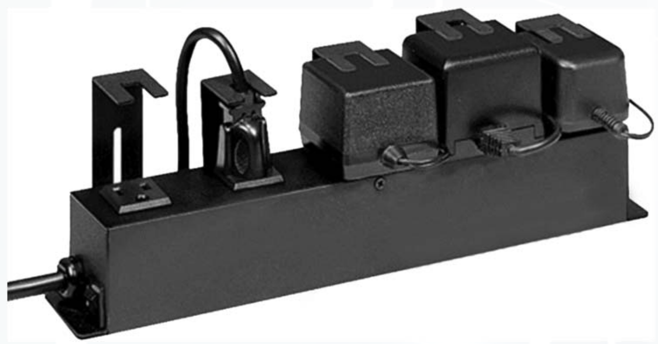
Human Error: Locking

Outlet locking

- PDU side
- Server side

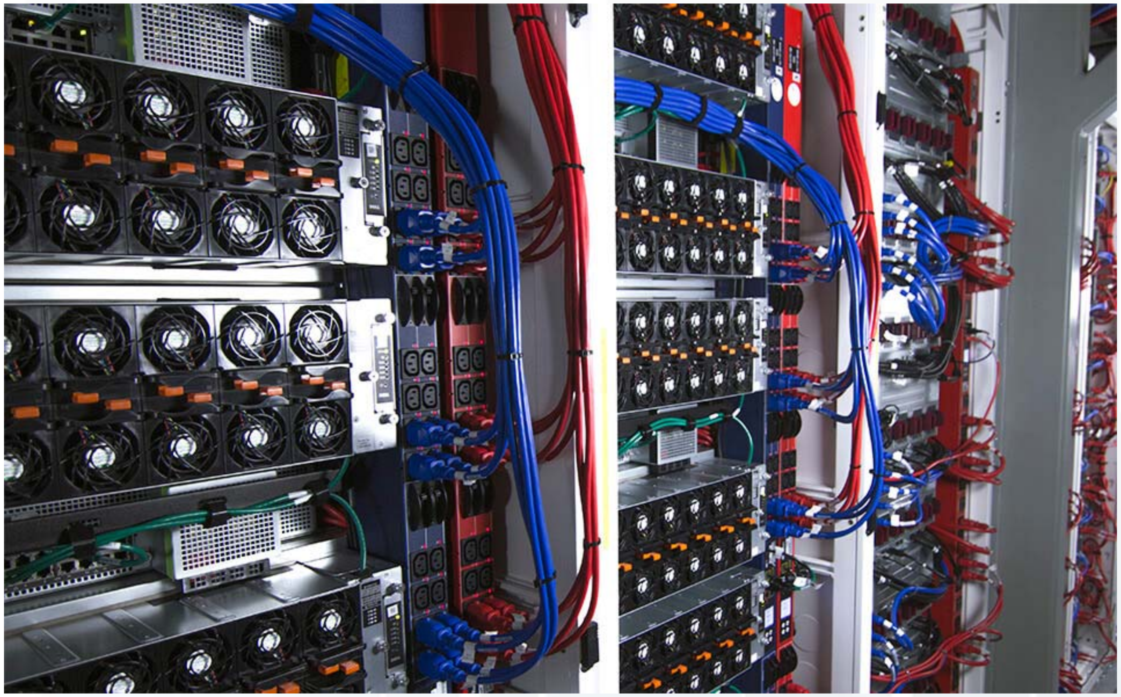


Equipment failure and redundancy

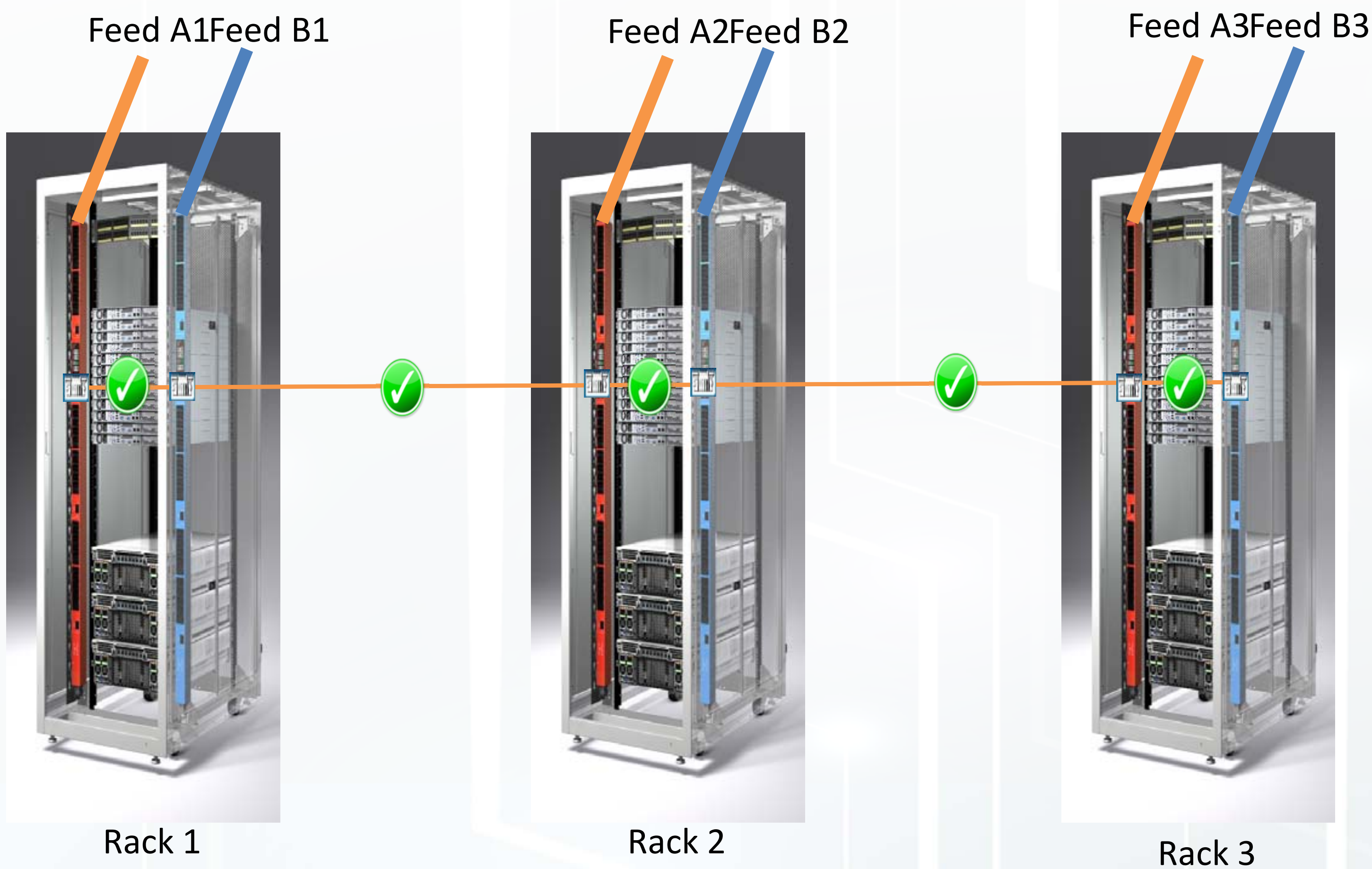
PDU redundancy

Additional features

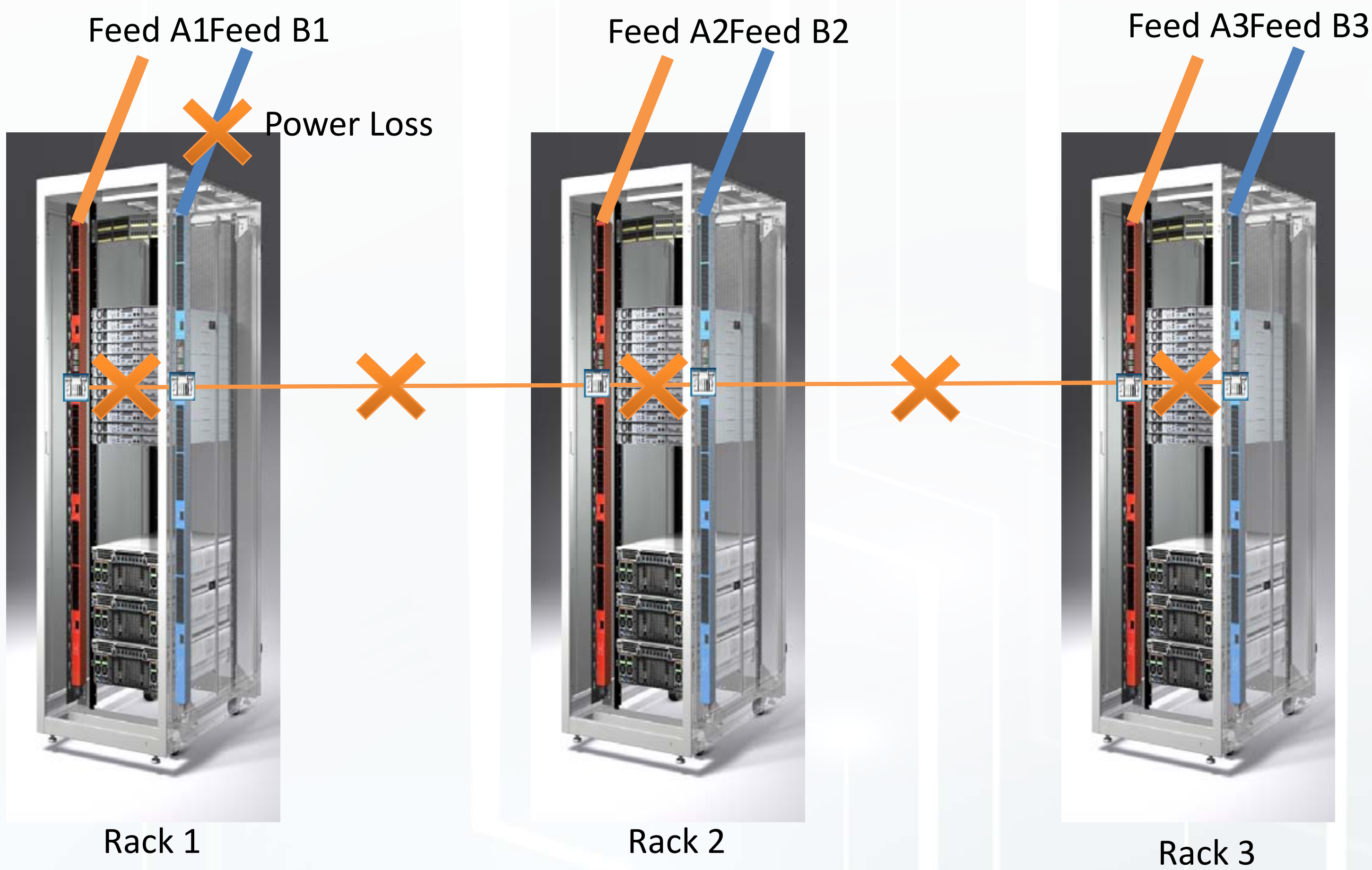
- Temperature sensors
- Smoke detection
- Door-lock solutions
- USB webcam security
- Cascading/ Daisy chain
- Modem/ SMS notification



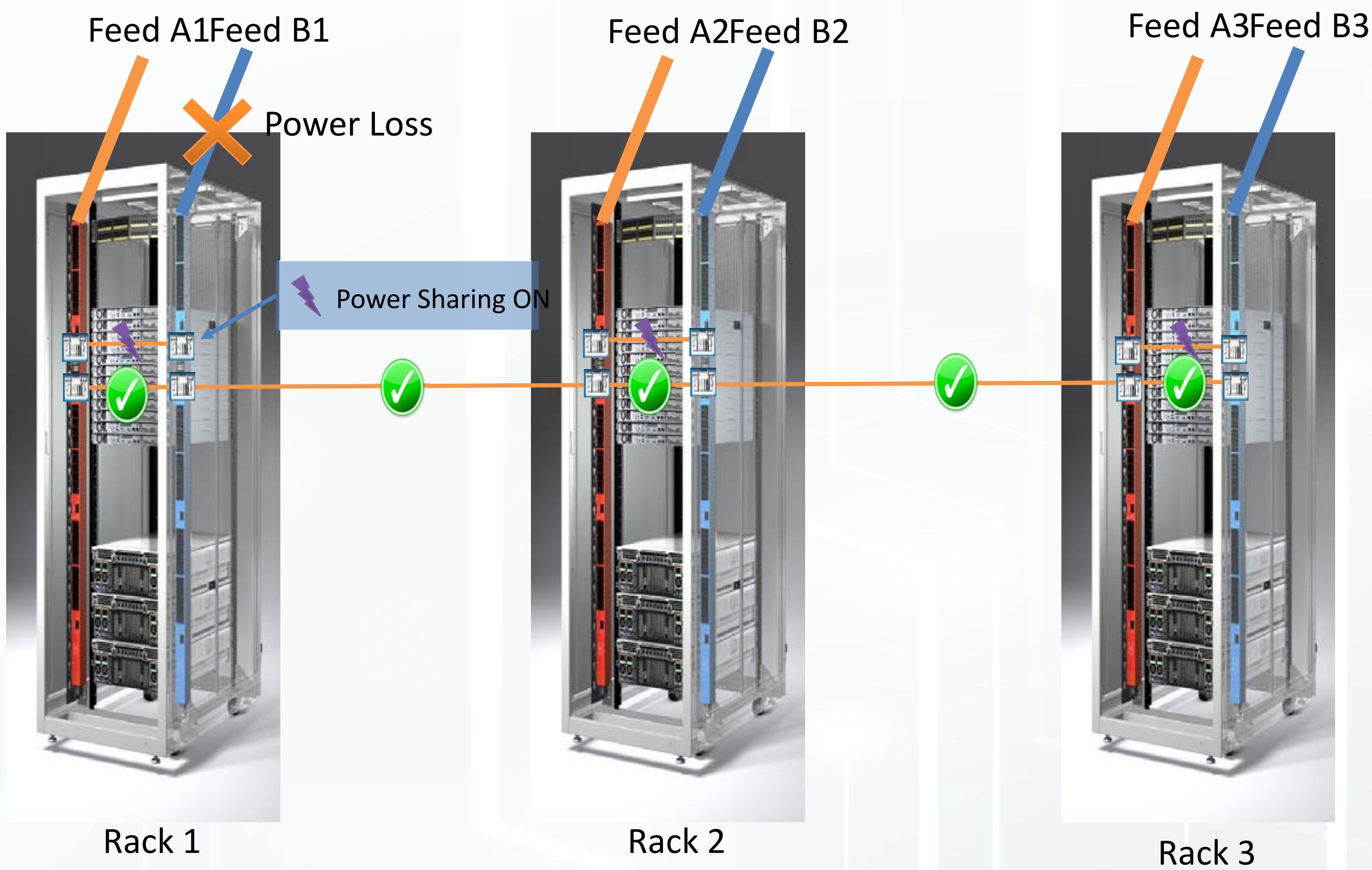
PDU redundancy: Power Sharing



Regular Cascading



Regular Cascading With Power Sharing



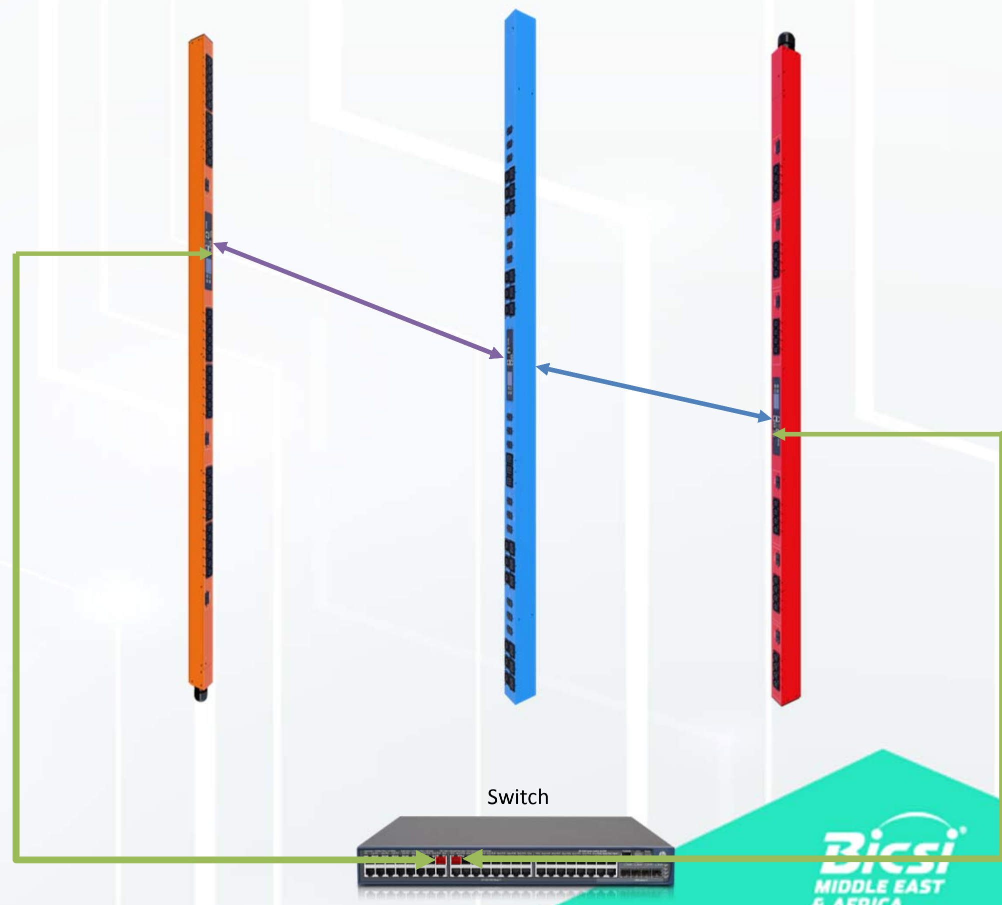
Regular Cascading With Power Sharing

Networking Cascading

Eliminate daisy-chains single points of failure

Protocols / Options

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

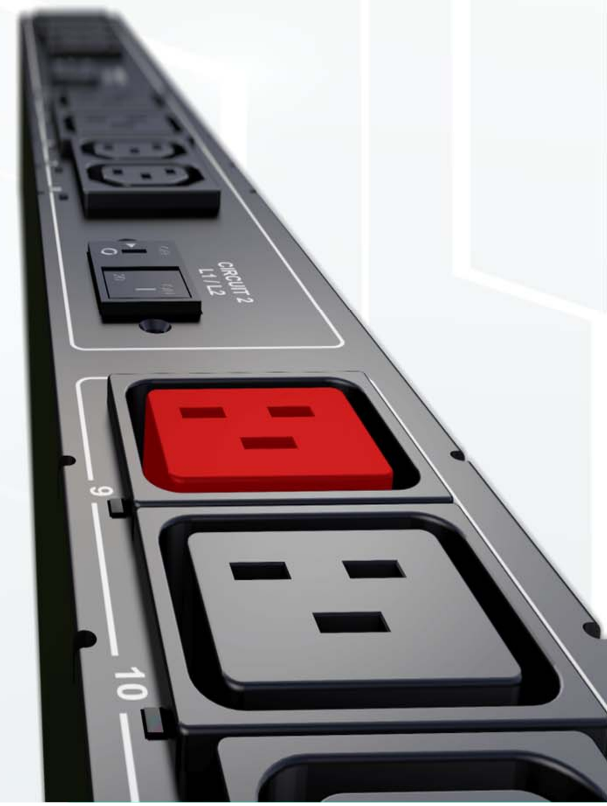


PDU redundancy: Replaceable controllers

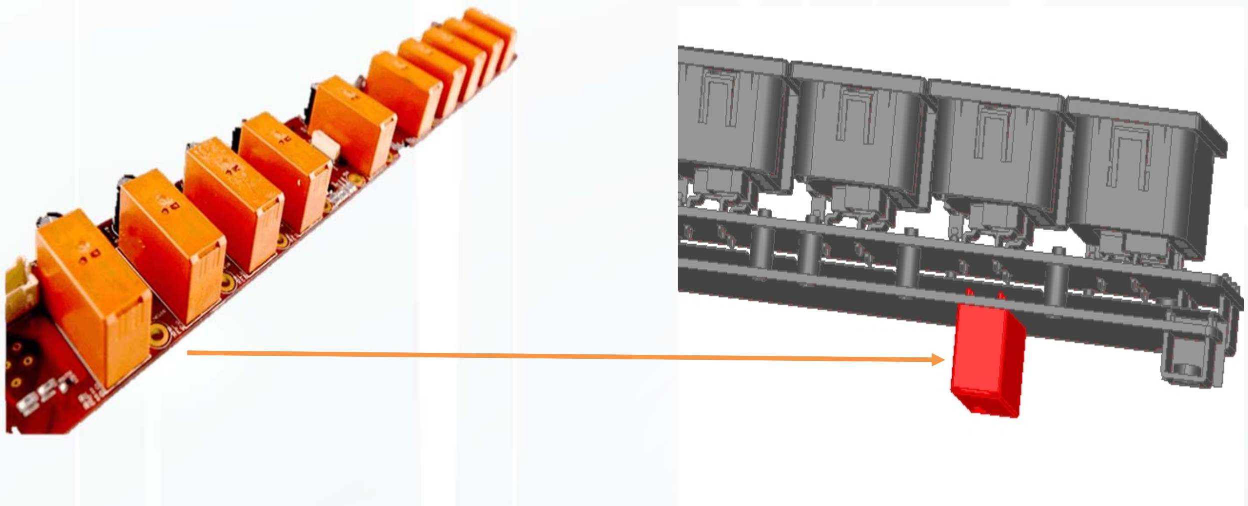
Outlet switching benefit and risk

Why outlet switching

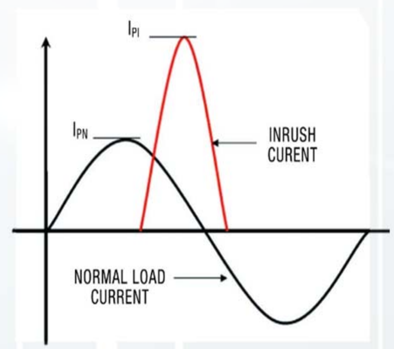
- Remote reboot / Lights out
- Outlet sequencing
- Load Shedding, UPS
- Security
- In-rush current
- Graceful shutdown



Outlet switching: Relays

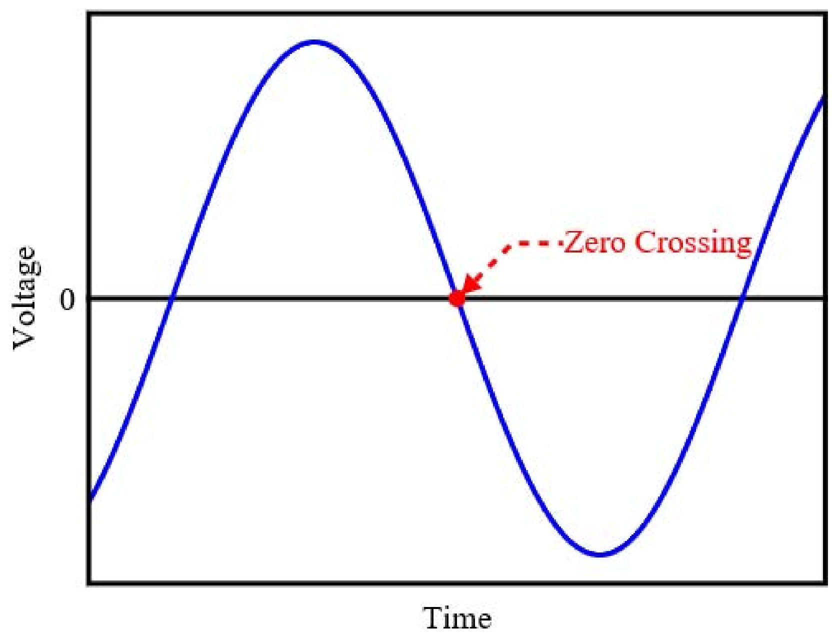


- Non-latching
  - 0.5W – 1.0W ON status
  - Default state generally ON
  - Non configurable power-on
- Latching
  - 0.0W ON status, only consumes when changing state
  - User configurable power-on relay: pre-outage state or power cycle



Relays: (near) Zero-Crossing

Synchronize relay switching > Cheap components



Automatic Transfer Switch (ATS)

When do you need an ATS

- Single power supply units

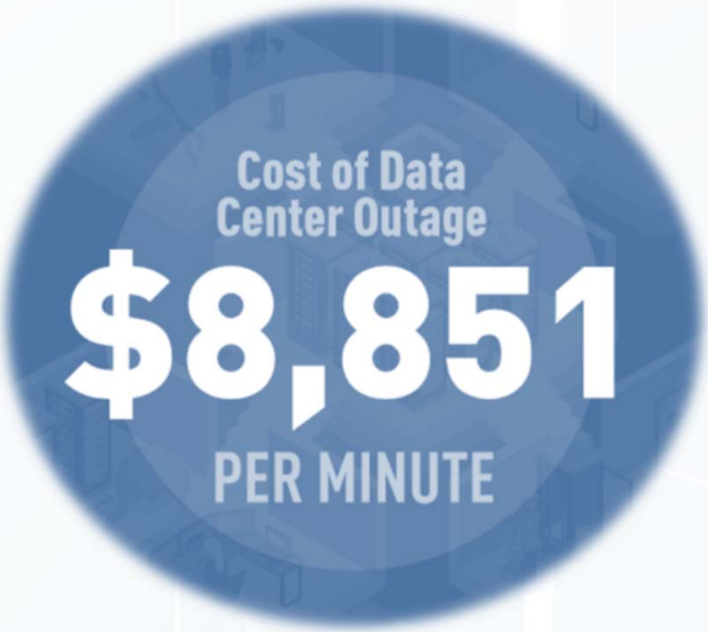
Switching times

- 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;

Cost of outage



Avg. cost of downtime:

2010: $5.617

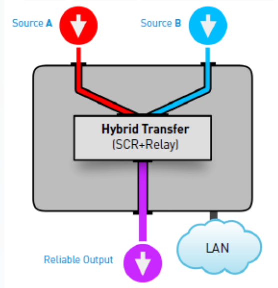
2016: $8.851 (+57%)

Avg. downtime:

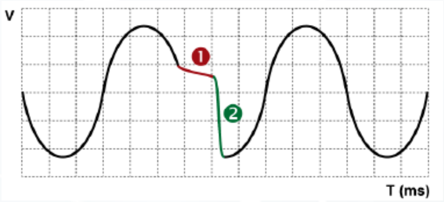
84 minutes

Transfer Switch
Technical considerations

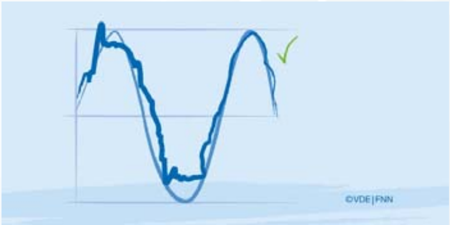
Switch Technology



Switch point



Power Quality

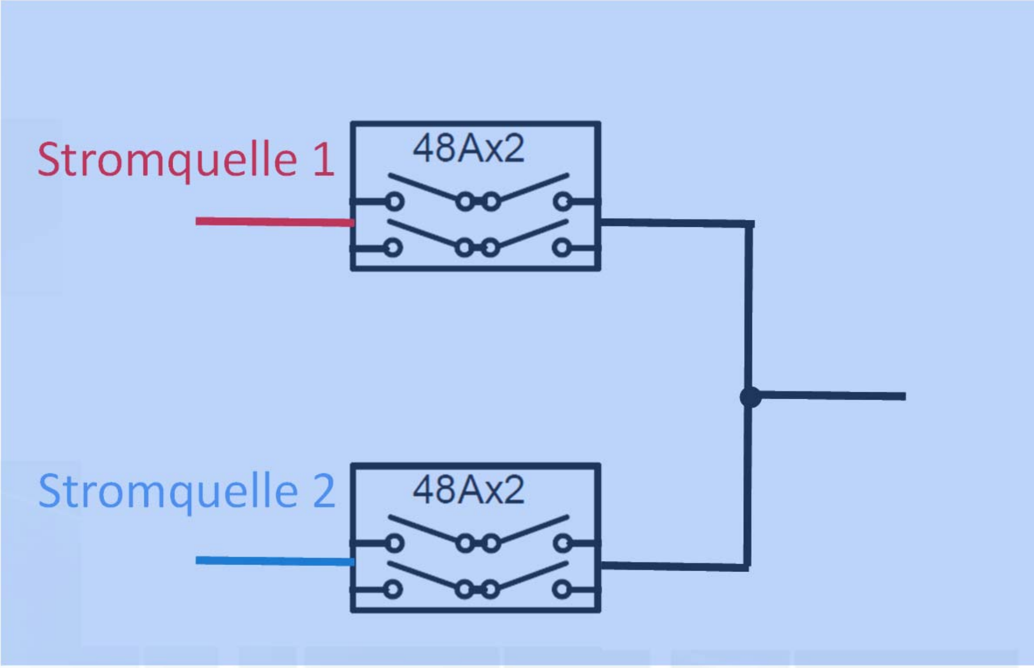


Technical considerations

ATS (Automatic Transfer Switch)

- Electromechanical Relay

- Advantage:
  - Power loss free transfers
- Disadvantage
  - Risk of Arc Welding
  - Slow

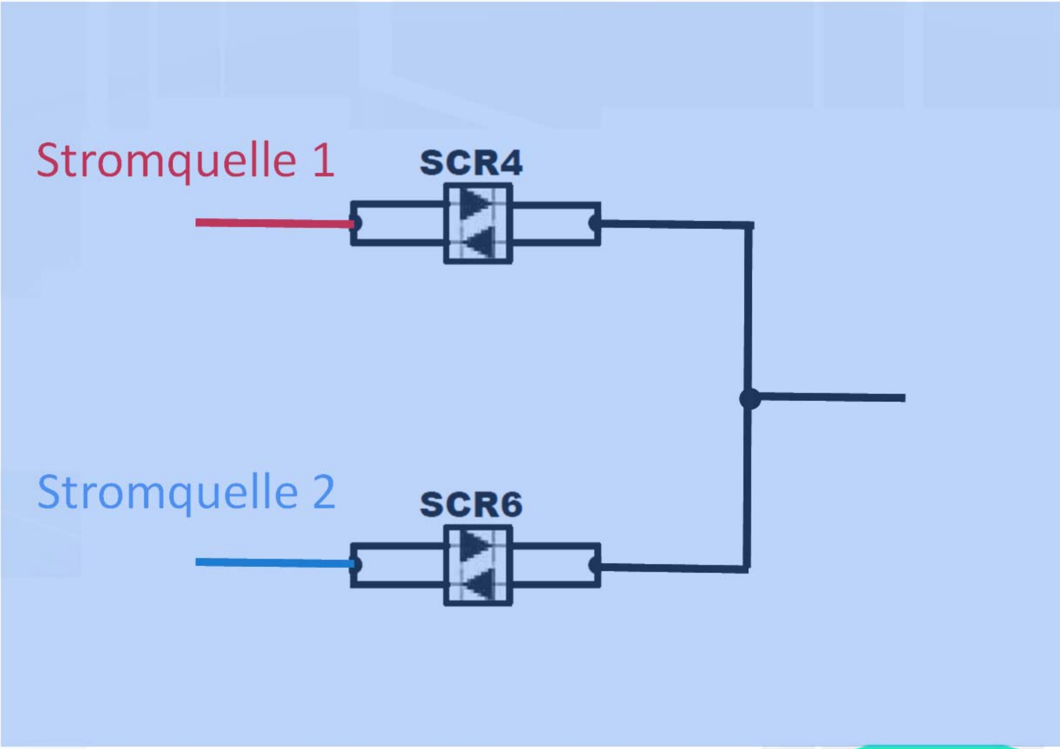


Technical considerations

STS (Static Transfer Switch)

- Thyristor / SCR

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

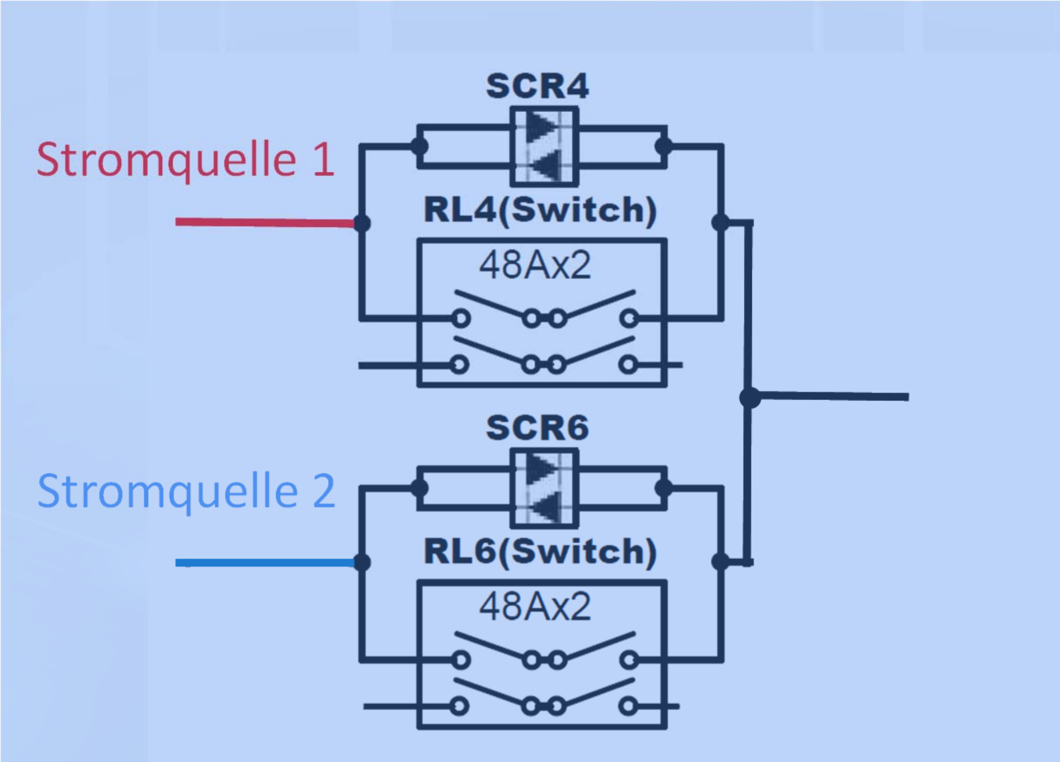


Technical considerations

HTS (Hybrid Transfer Switch)

– Thyristor / SCR + Relay

– Advantage: Fast Switching

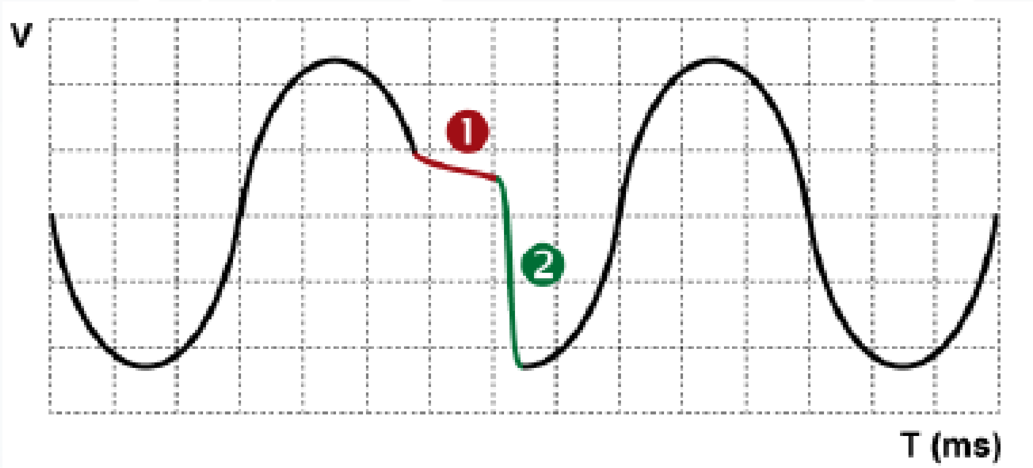


Technical considerations

Switch Point

- Make-before-Break
  Closed transition

- Break-before-Make
  Open transition

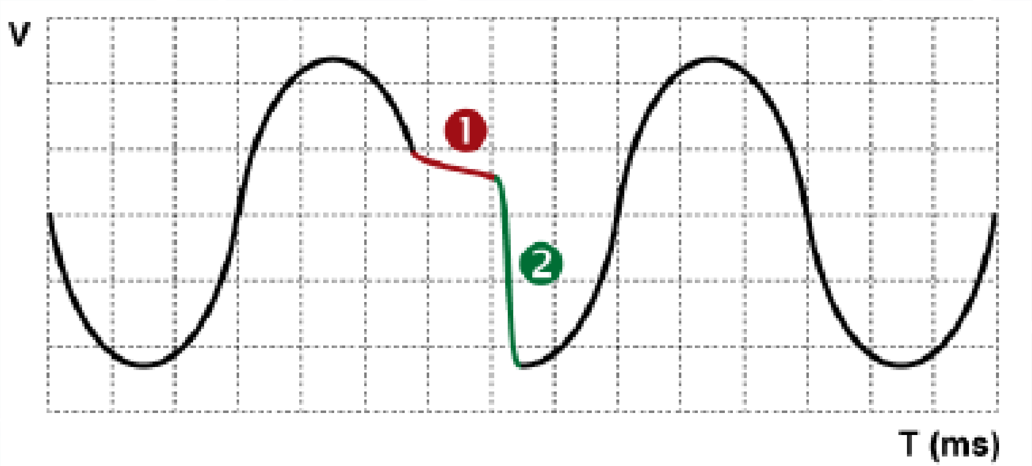


Technical considerations

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


QUESTIONS?

THANK YOU
Shukran Jazilan
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Backup: Environmental

- "Goal Posts are Moving"
- Demand for Increased Capacity
- Governed by the ASHRAE Standards
- Q = Consider Operating Temp, back of rack?

(@ Equipment Intake)	Recommended	Allowable
Temperature Data Centers ASHRAE	18-27 °C	15-32 °C
Humidity (RH) Data Centers ASHRAE	40% RH 5,5 °C DP	60% RH 15 °C