BREAK **THROUGH** Data Center design

NetApp Bangalore Campus

Murali Naidu

NetApp

Agenda

1) Background
2) PUE
3) NetApp Bangalore Campus
4) Free cooling
5) DRUPS
6) Conclusion

NetApp

Background

Data Center Design Evolution

Data Center Design Evolution

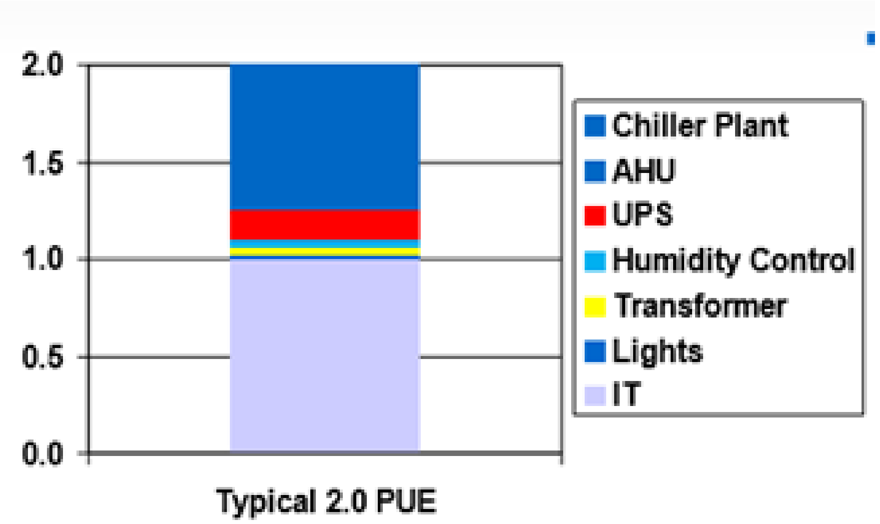
	Capacity mW	Build Cost $/kW	Configuration year	Density kW/rack power & cooling	PUE >1
Generation 1	Multiple Smaller 1-3	n/a	Hot / Cold Aisle Prior to 2006	<4	1.65
Generation 2	3	1.8	Cold Aisle Containment 2006	8	1.55
Generation 3	25	2 / 8	Gen 2 w/ Economizer 2007 (Delivered 2009)	12	**1.16**
Generation 4	25 (scalable)	2.6	Gen 3 Plus Refinement 2014	4 to 12	**1.12**

* Estimated annual

Power Usage Effectiveness (PUE)

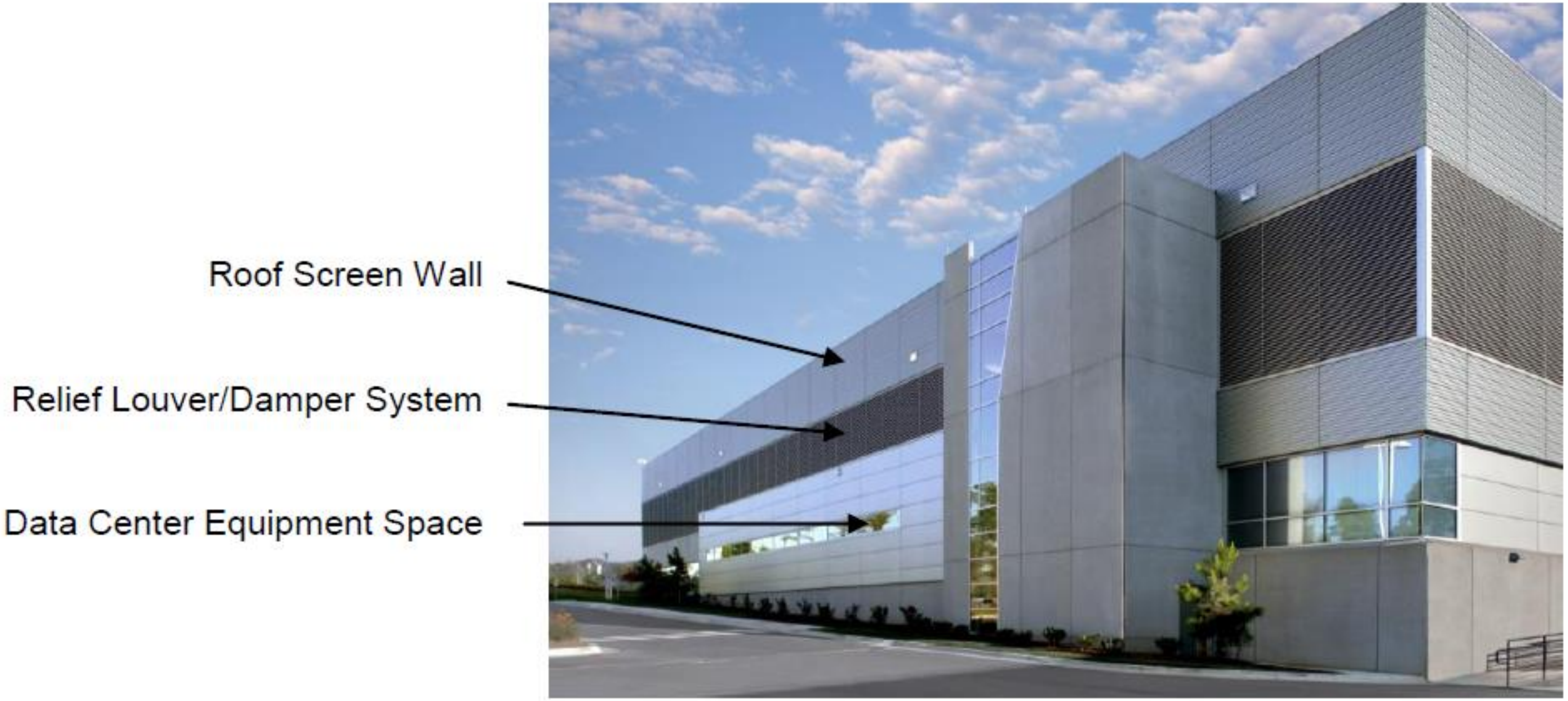
Power Usage Effectiveness (PUE) ratio cited as the data center infrastructure efficiency metric:

- Total power / IT equipment power
- Infrastructure systems account for half of total energy in data centers
- Typical data center PUE = 2.0
- Lower the number the more efficient



Global Dynamic Lab 1 (GDL 1)

https://www.youtube.com/watch?v=QogbhdOlbtM&spfreload=1



NetApp

Global Dynamic Lab 2 (GDL 2)

https://www.youtube.com/watch?v=ZY9BoaapsOI

NetApp

Free Cooling

NetApp

NetApp Bangalore Campus

- Objective: Design and Build a data center inline with GDL1/2 in terms of **Performance** and **Quality**
- Challenges:
  - Data Center needs to be accommodated within the office building without compromising architectural intent
  - Design innovations – Economizers, DRUPS
  - Meeting Quality standards
  - End-user acceptance
- Solution:
  - Structural steel building and integrated façade design
  - Adopted Air Side Economizer
  - Used DRUPS - UNIBLOCK UBTD+ (n+1 redundancy adopted, however n+n reliability available)
  - BIM and Lean Construction Principles
- Results: Successfully delivered India's most energy efficient data center with PUE 1.4 with high quality

Free Cooling

Depending on the climate, the steady, 24-hours cooling load of a data center is well suited to take advantage of seasonal and night-time temperature variations to cool the space by Airside & Waterside Economizers

Airside Economizer (ASE)

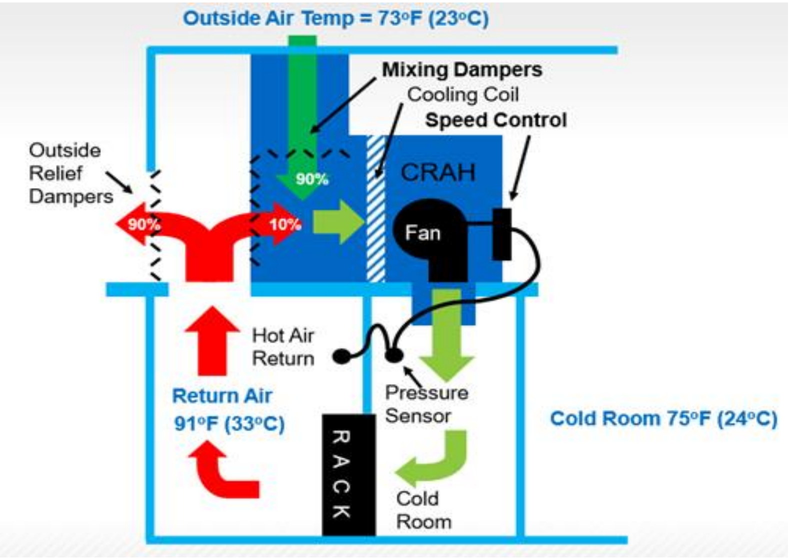
When the outside air is cooler than the return air, hot return air is exhausted and replaced with cooler, filtered outside air.

Waterside Economizer

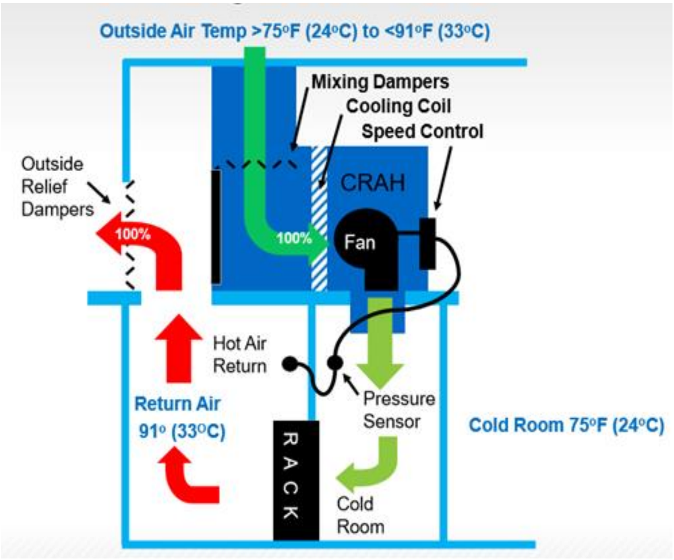
Waterside economizer uses the evaporative cooling capacity of a cooling tower to indirectly produce chilled water to cool the data center during mild outdoor conditions (particularly at night in hot climates). Free cooling reduces or eliminates chiller power consumption while efficiently maintaining strict temperature and humidity requirements.

Free Cooling

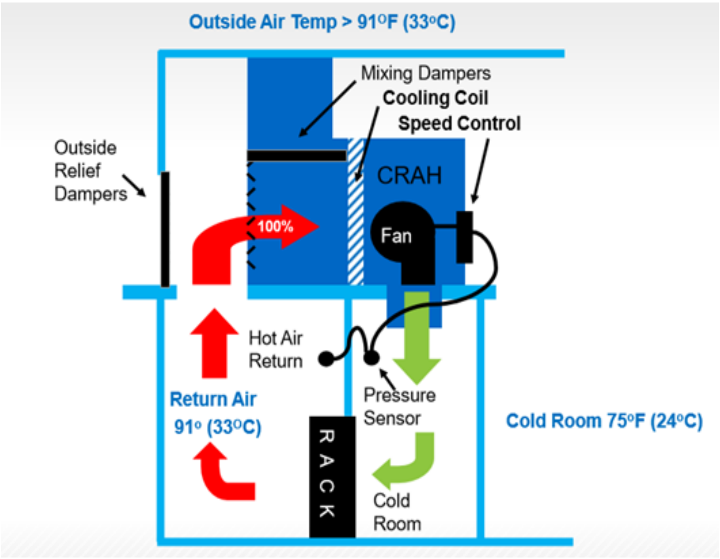
Air-side Economizer



Full Free Cooling



Partial Free Cooling



Full Pay Cooling

NetApp

Free Cooling

Waterside Economizer

Two types: Air Handler WSE & Chiller Plant WSE

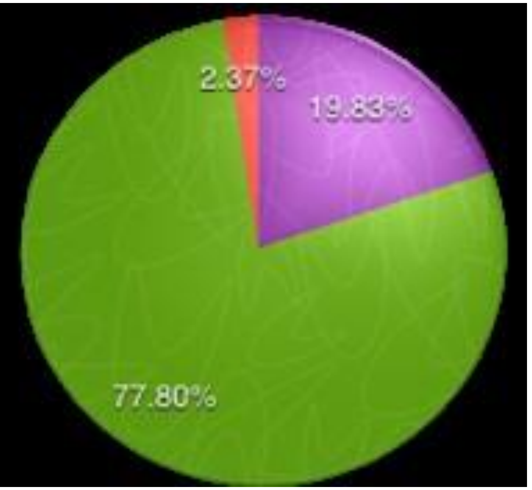
- Air Handler WSE – Climate at Bangalore, humidity level swing between 40% ~ 60%. Adiabatic humidification could reduce OA DB temperature by about 5 ~ 7^0F
- Chiller plant WSE operates to reduce chilled water return temperature in series configuration. At Bangalore, only Partial Pre-cooling is available

NetApp

Free Cooling

Air-side Economizer

S. No	Outside Air Conditions	Type of Cooling	Number of Hours Available
1	DBT < 75 F and RH < 80%	100% Free Cooling	1735 Hrs
2	DBT < 75 F and RH > 80%	Partial Free Cooling	3236 Hrs
3	75 F < DBT < 91 F	Partial Free Cooling	3582 Hrs
4	DBT > 91 F	No Free Cooling	207 Hrs

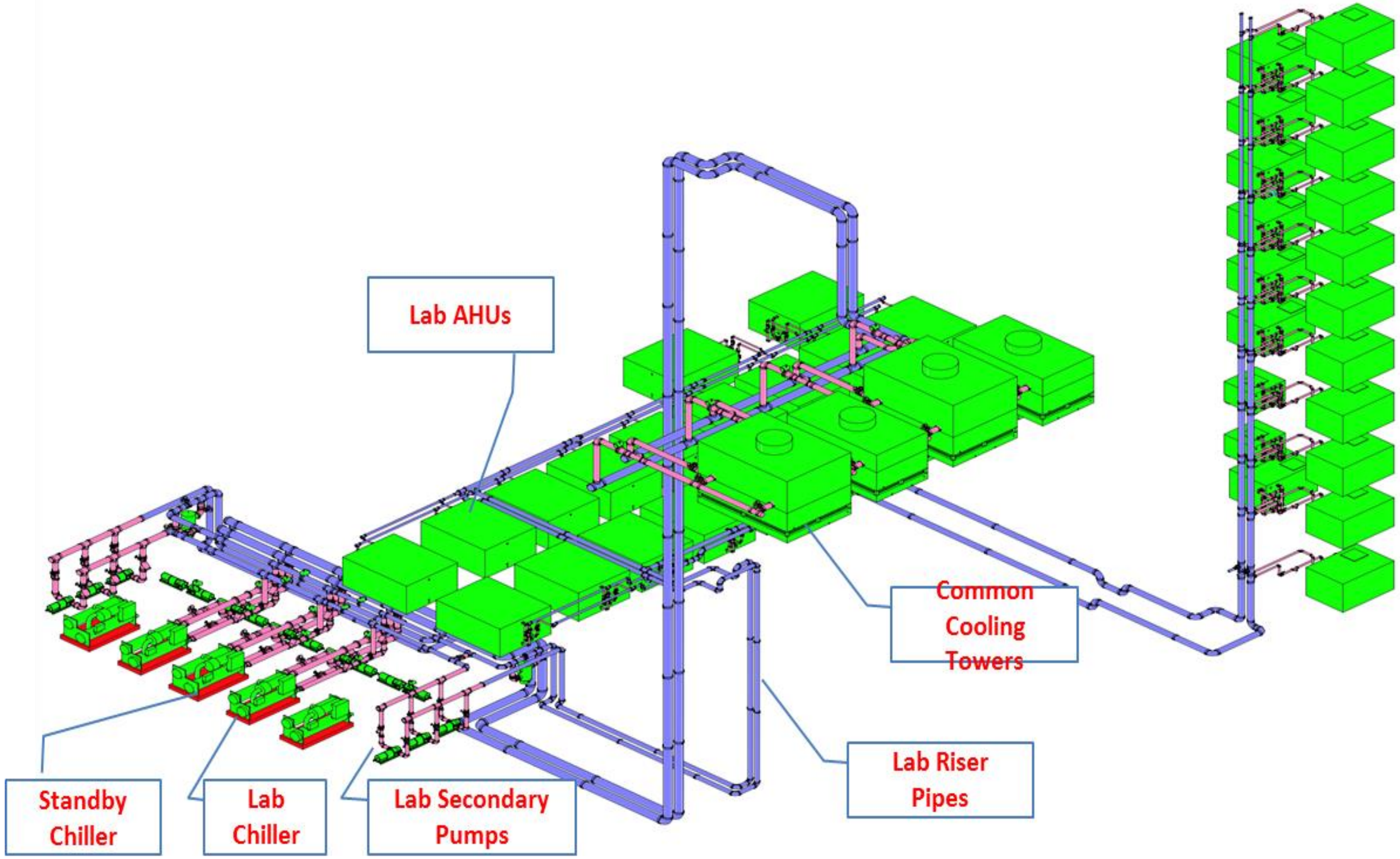


NetApp

NetApp Bangalore Campus

NetApp Bangalore Campus

Schematic Design



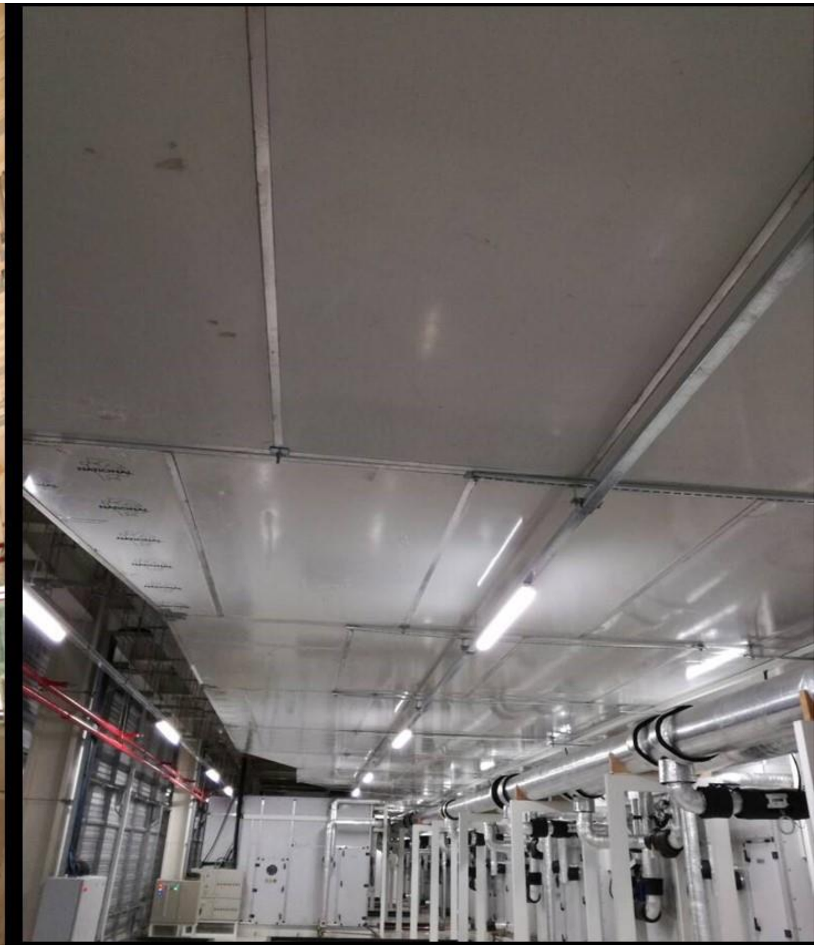
Airside Economizer

System design highlights

- Fresh Air Intake through Motorized Dampers and Plenum
- Fresh Air Distribution through Double Skin Plenum (10.5m wide x 1.1m High x 50m Long x 2 Sets)
- Exhaust Air Discharge through Motorized Dampers (46m Long x 3.6m High)
- Return Air Intake to AHU room through Floor Gratings (186 Sqm)
- Return Air Intake to AHUs through Motorized Dampers in AHUs
- 20 Nos (18W + 2 S) Air Handling Units of 75 TR / 50000 CFM capacity Each with EC Fans (8 EC fans per AHU)

Airside Economizer

Fresh air Intake Plenum



Airside Economizer

Exhaust Air Dampers

NetApp

Airside Economizer

Fresh air and Return air intake

NetApp

DRUPS

“Standard” UPS configuration

Diesel Engine

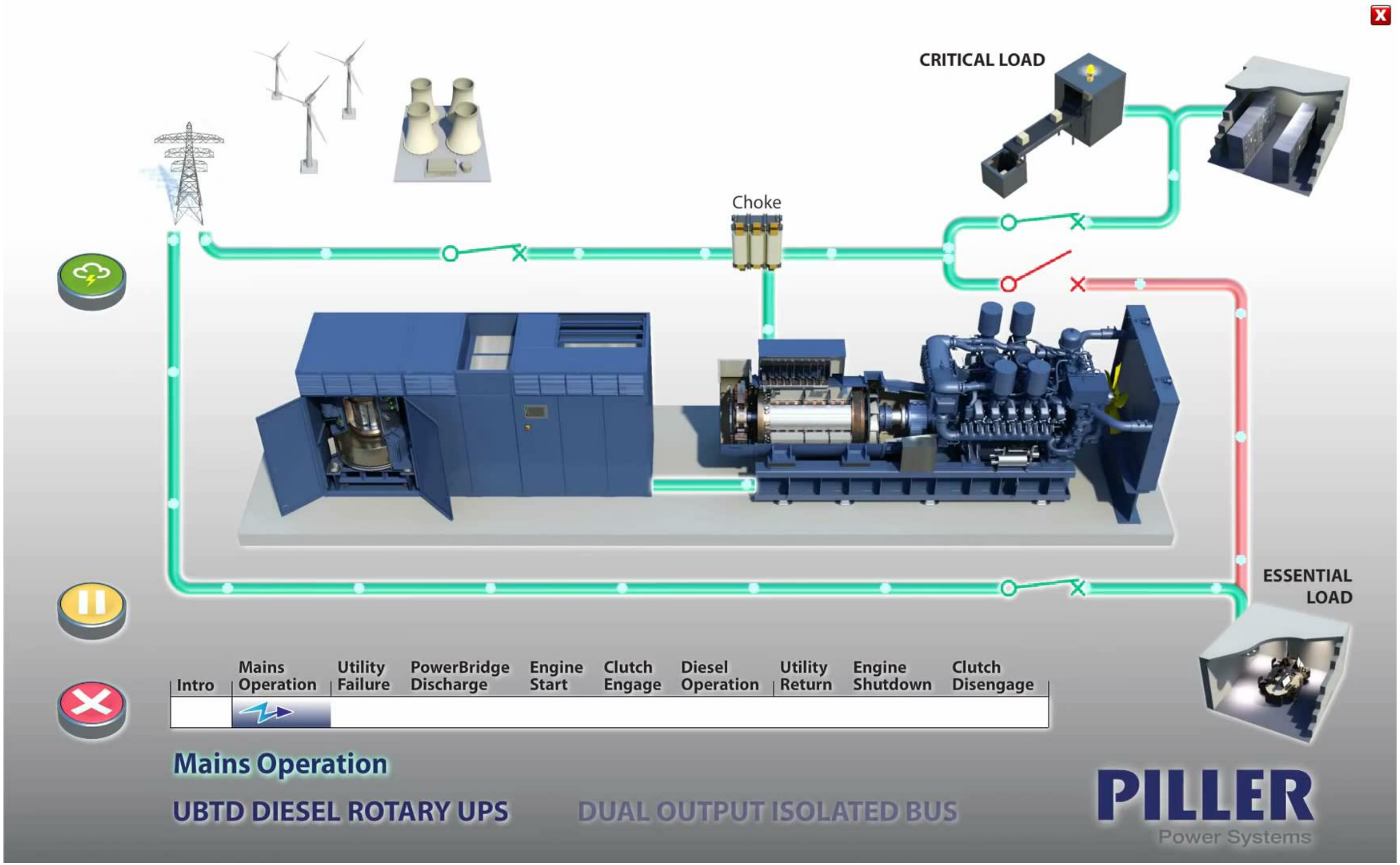
Alternator

\+

Space comparison with Battery UPS

=

DRUPS saves approx 50%-75% Space



CRITICAL LOAD
Choke
ESSENTIAL LOAD
Intro
Mains Operation
Utility Failure
PowerBridge Discharge
Engine Start
Clutch Engage
Diesel Operation
Utility Return
Engine Shutdown
Clutch Disengage
Mains Operation
UBTD DIESEL ROTARY UPS
DUAL OUTPUT ISOLATED BUS
PILLER
Power Systems

NetApp

Merits of DRUPS

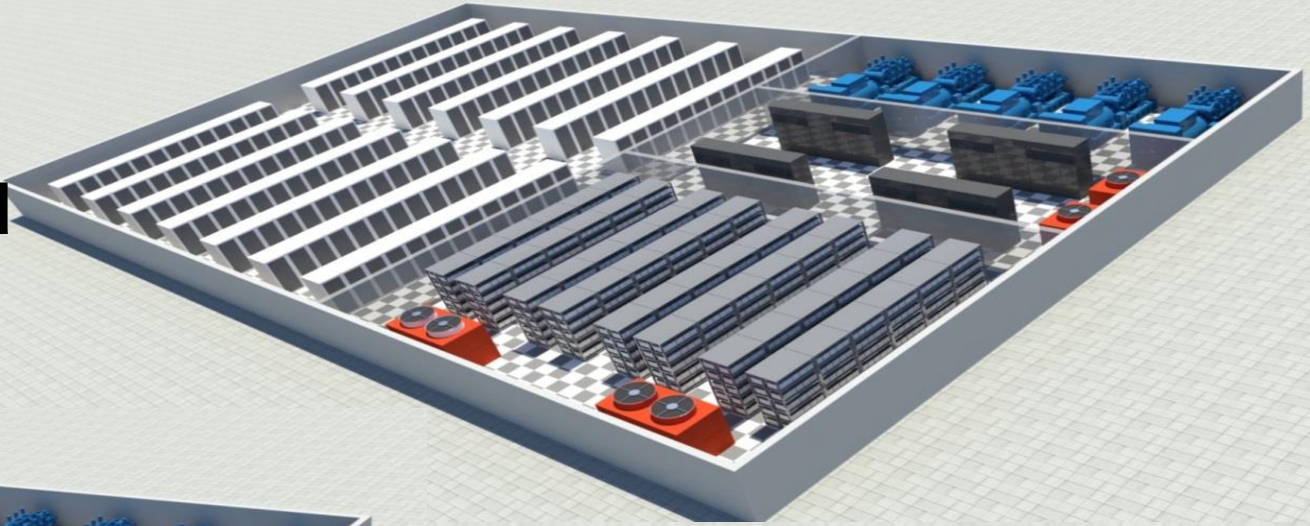
- Day-1 DRUPS Capital Costs can be higher with Static + Battery , but lower if holistic costs of the solution are considered.
  Switchgear, Installation, Cabling, Air conditioning, Capacitor and battery Replacement, Footprint/Maximized whitespace

- If the Total Cost of Ownership (5-10 years) is considered, then DRUPS offers significant cost savings

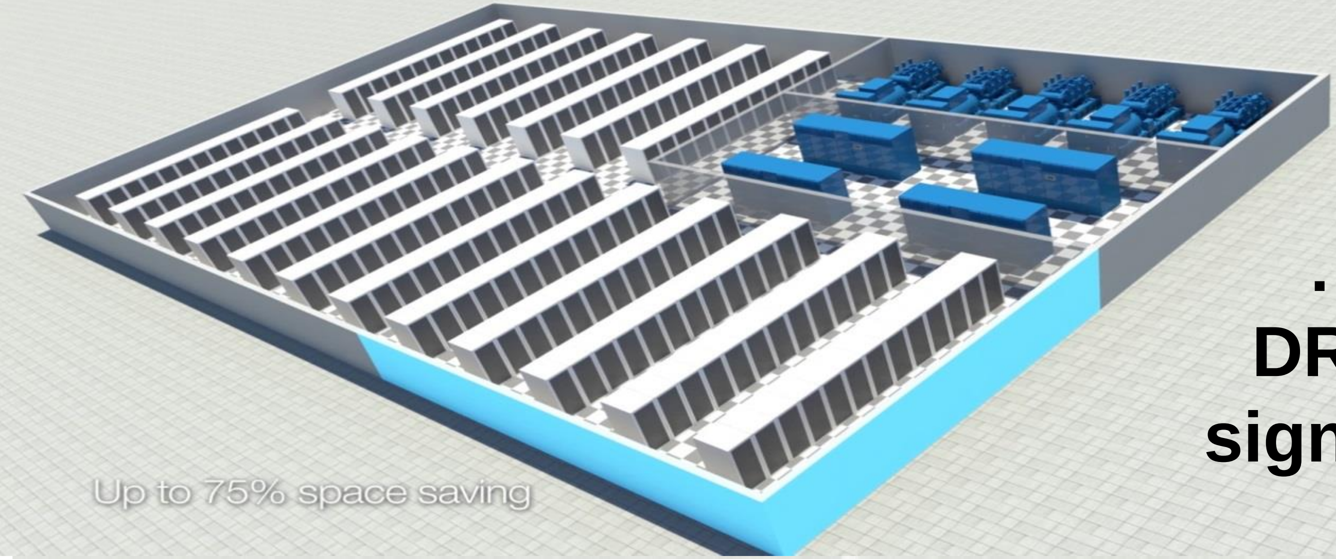
	Static + Batteries	DRUPS
Gensets	**Comparable Capex and Opex**	
UPS	**Lower Capex**	**Lower Opex (IP-Bus)**
Air Conditioning	**Required**	**Naturally cooled**
Maintenance Costs	**Year 6 – replace fans Year 7 – replace cap’s Year 3/5 – replace batteries**	**Year 5 – Flywheel PB degrease**

NetApp

Merits



Consider a Multi MW Data Centre with Static UPS and 15 min Battery backup…



…adopting a battery-less DRUPS solution generates a significant space advantage up to 75%.

NetApp

Innovative Redundancy

Isolated Parallel UPS-System

NetApp

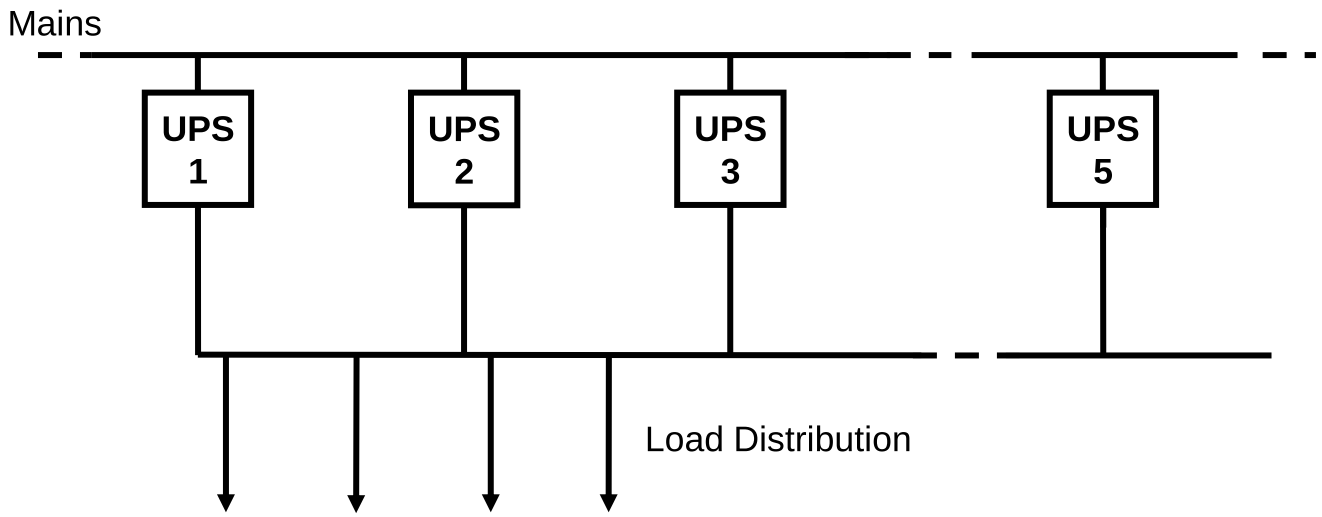
Conventional Parallel System configuration N+1

- In a parallel System all outputs of the UPS´s are hard connected to one load bus.
  The load sharing is realized by the regulation of the UPS software. A parallel communication between the UPS´s is necessary

- In a case of a failure of only one load distribution path, all other loads are affected, Independently of the redundancies of the UPS´s.

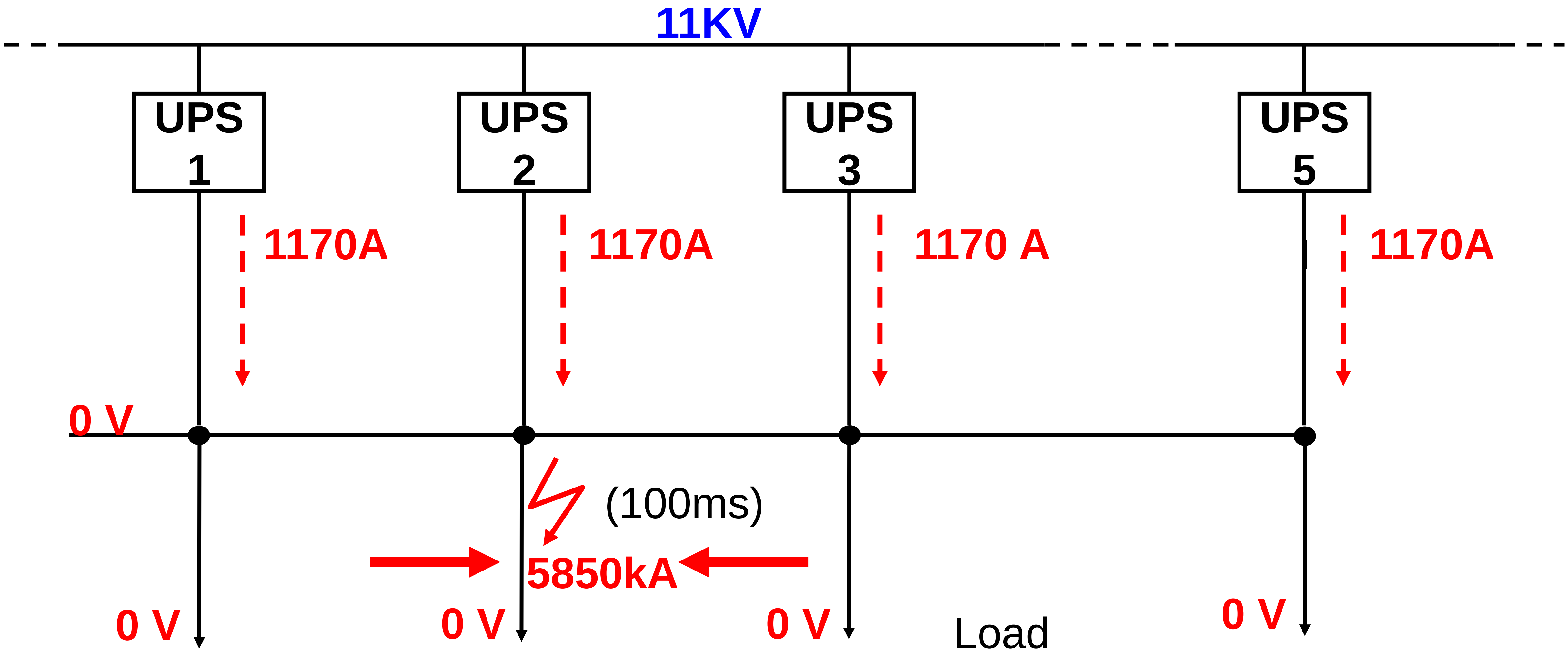
- It means there is a single point of failure !

- In case of a short circuit at a load the voltage drops to 0V. Because of the hard parallel system the voltage drops to 0V at each load !



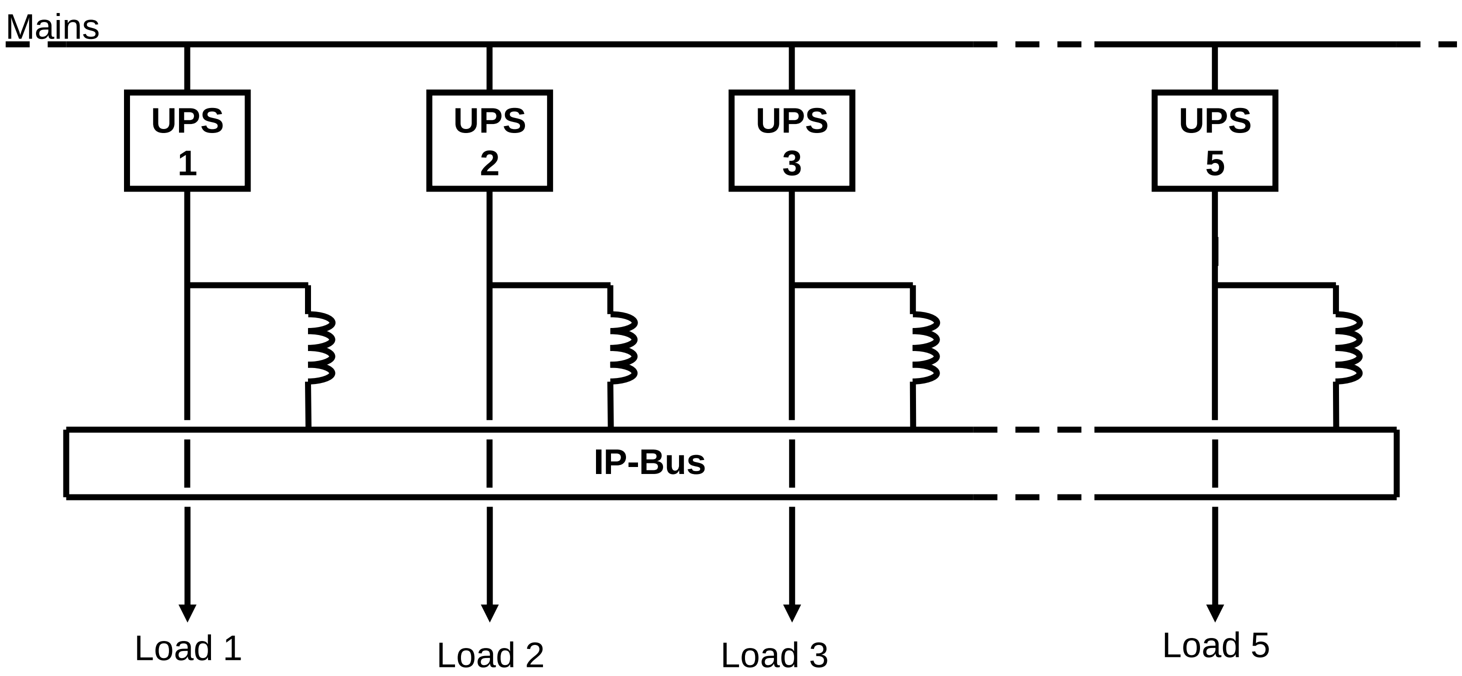
NetApp

Example for the current flow in case of a short circuit in parallel configuration



NetApp

IP Bus configuration

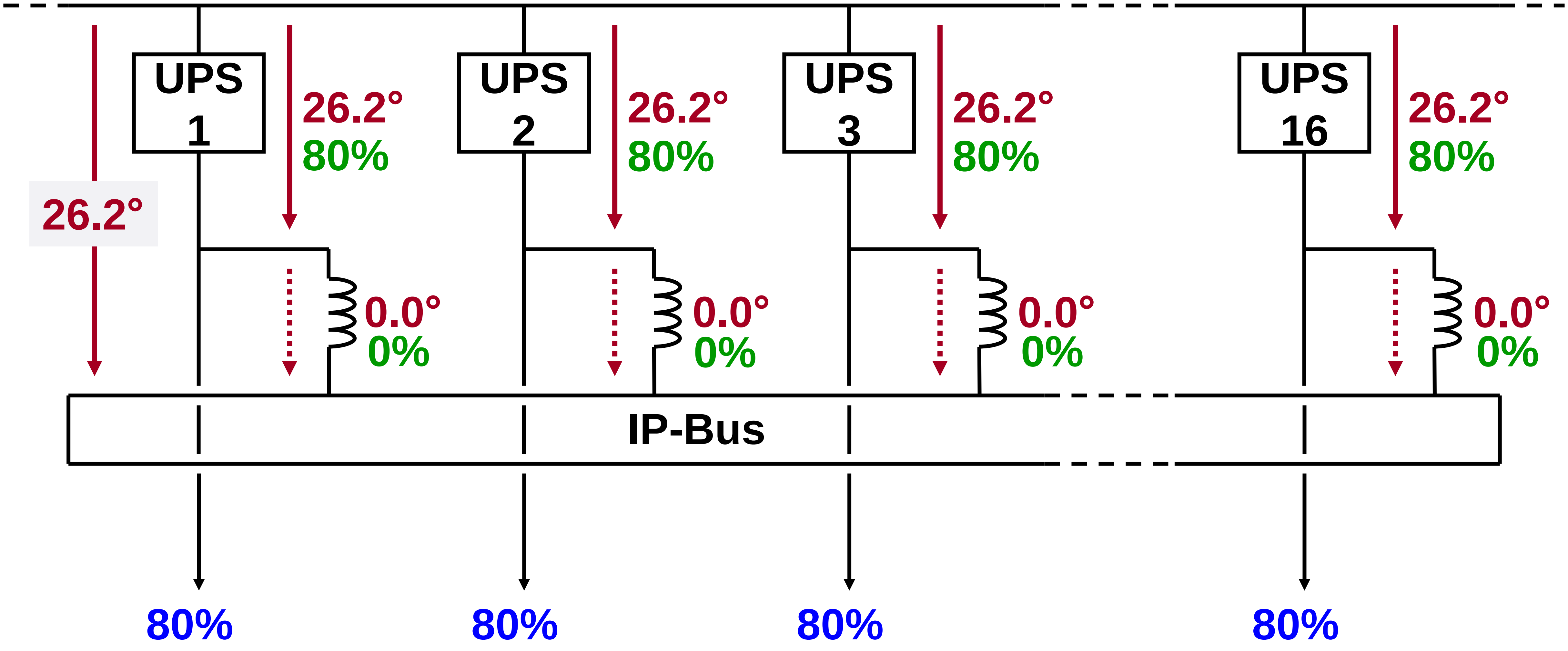


- In an IP Bus configuration each UPS supplies one load
- To reach a redundancy, the loads are connected via an IP choke and connected to an IP ring
- In case one UPS fails the load will automatically supplied via the IP choke
- No parallel regulation is necessary!

Characteristics of the IP-System

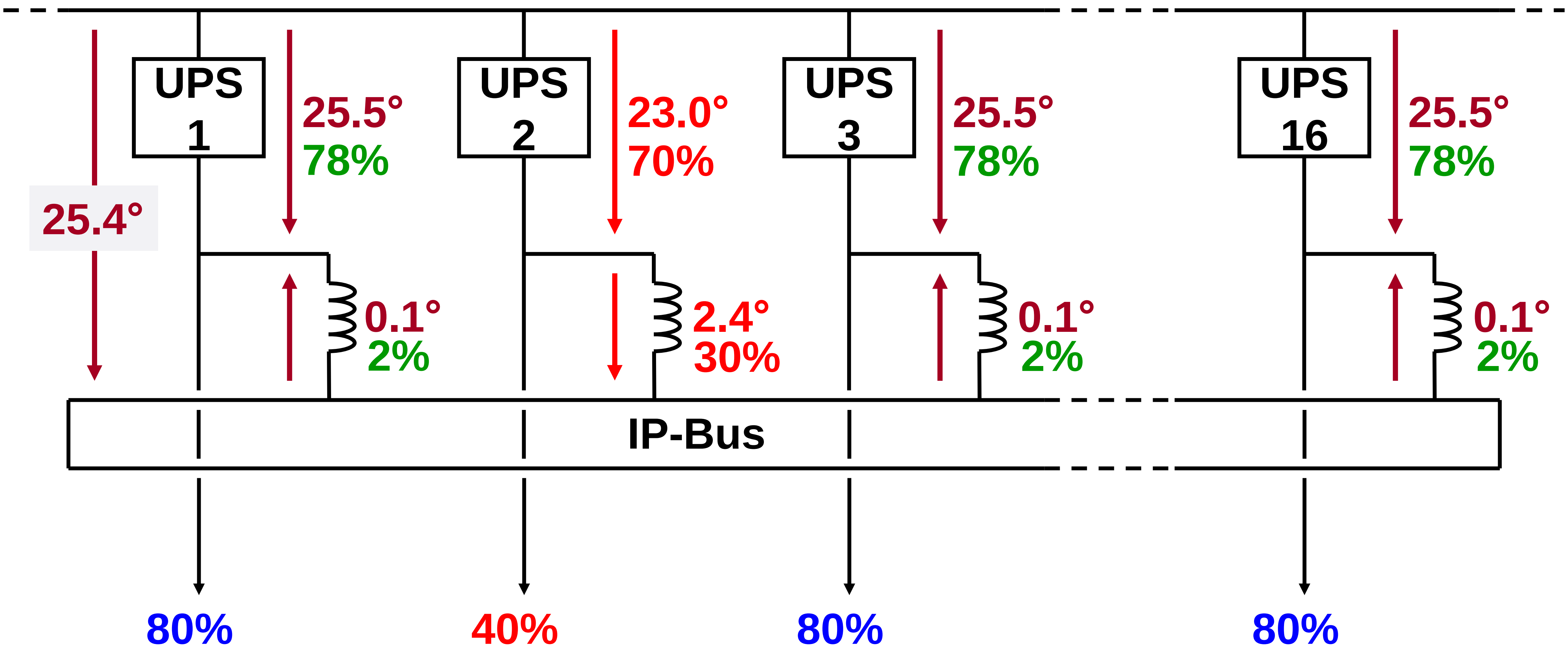
- Possible short circuit currents are limited (isolated) by the chokes
- A failure in a load distribution does almost have no influence on the non affected loads
- All units share the load, paralleled via the IP-Bus
- In case of a serious UPS failure the corresponding load is automatically supplied by the remaining UPS units without relying on any switching devices.

Load sharing in an IP-System under balanced load conditions



NetApp

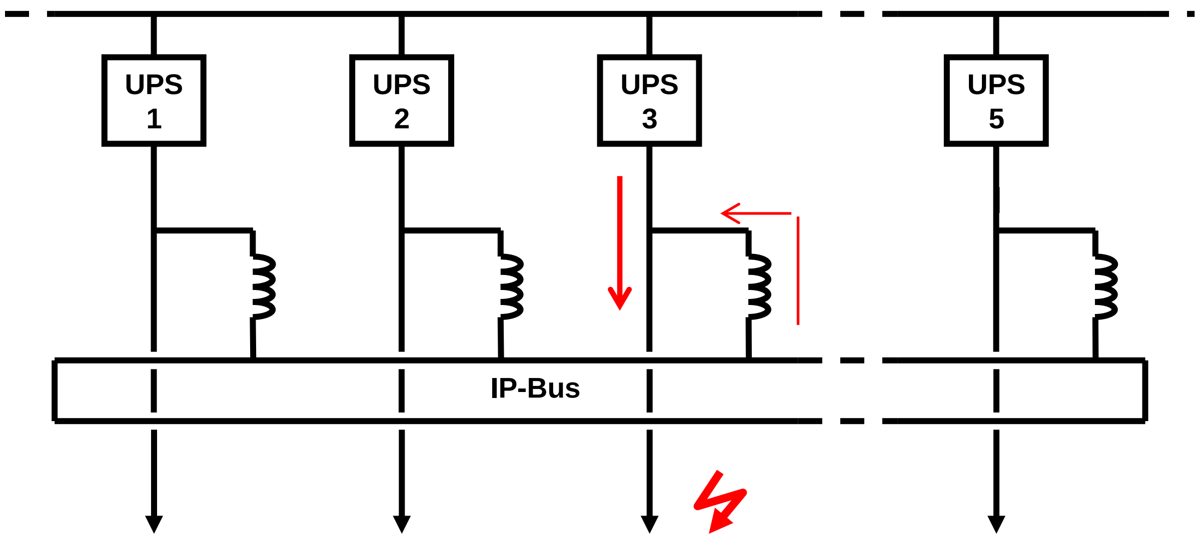
Load sharing in an IP-System under unbalanced load conditions



NetApp

Short circuit in IP-Bus configuration

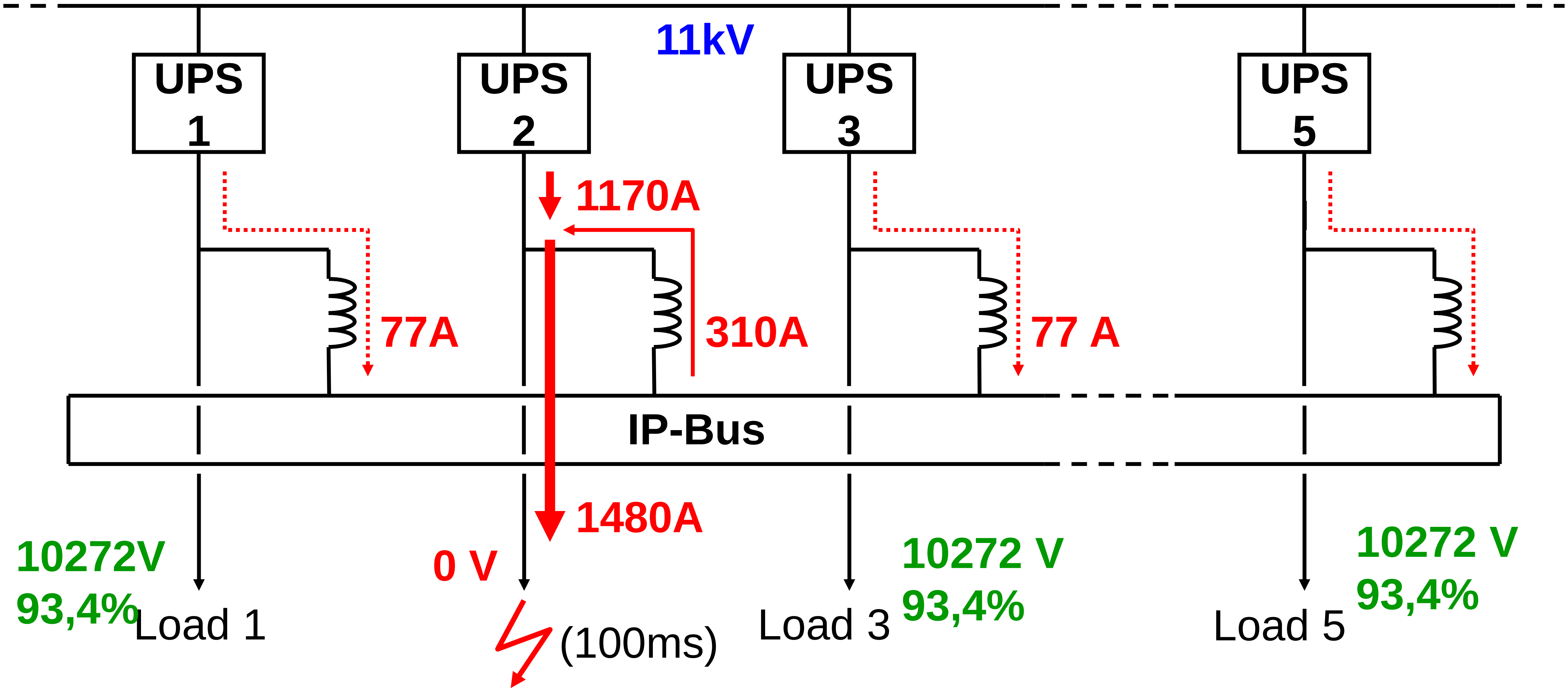
- In case of a short circuit at a load (shown in this slide) the voltage of the affected load drops to 0V.



- The major fault current fed into a short circuit in a load distribution is coming from the directly connected UPS.
- Driven by the voltage difference the none affected UPSs will also drive currents into the fault.
- Due to the impedance of the IP-Chokes these currents are significantly lower than the one coming from the affected UPS.
- As these currents are in a range below the nominal currents of the UPS, the resulting voltage drop at the output of the none affected UPS does normally not have any influence on their loads.

NetApp

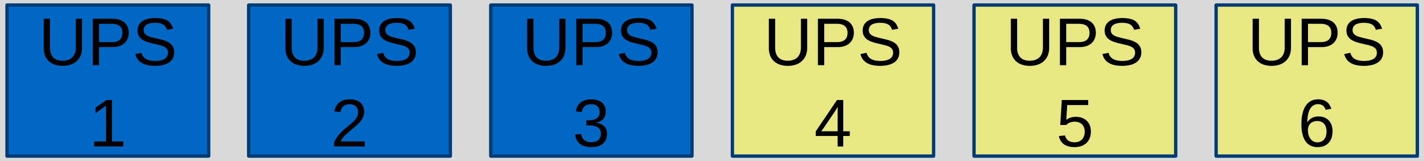
Example for the current flow in case of a short circuit in the load distribution



NetApp

Reliability of UPS Systems
Example calculation

Parallel low voltage system with a summary power of 5MVA



Dynamic UPS modul
Power = **1670 kVA**
MTBF = **1.000.00h**
of single unit

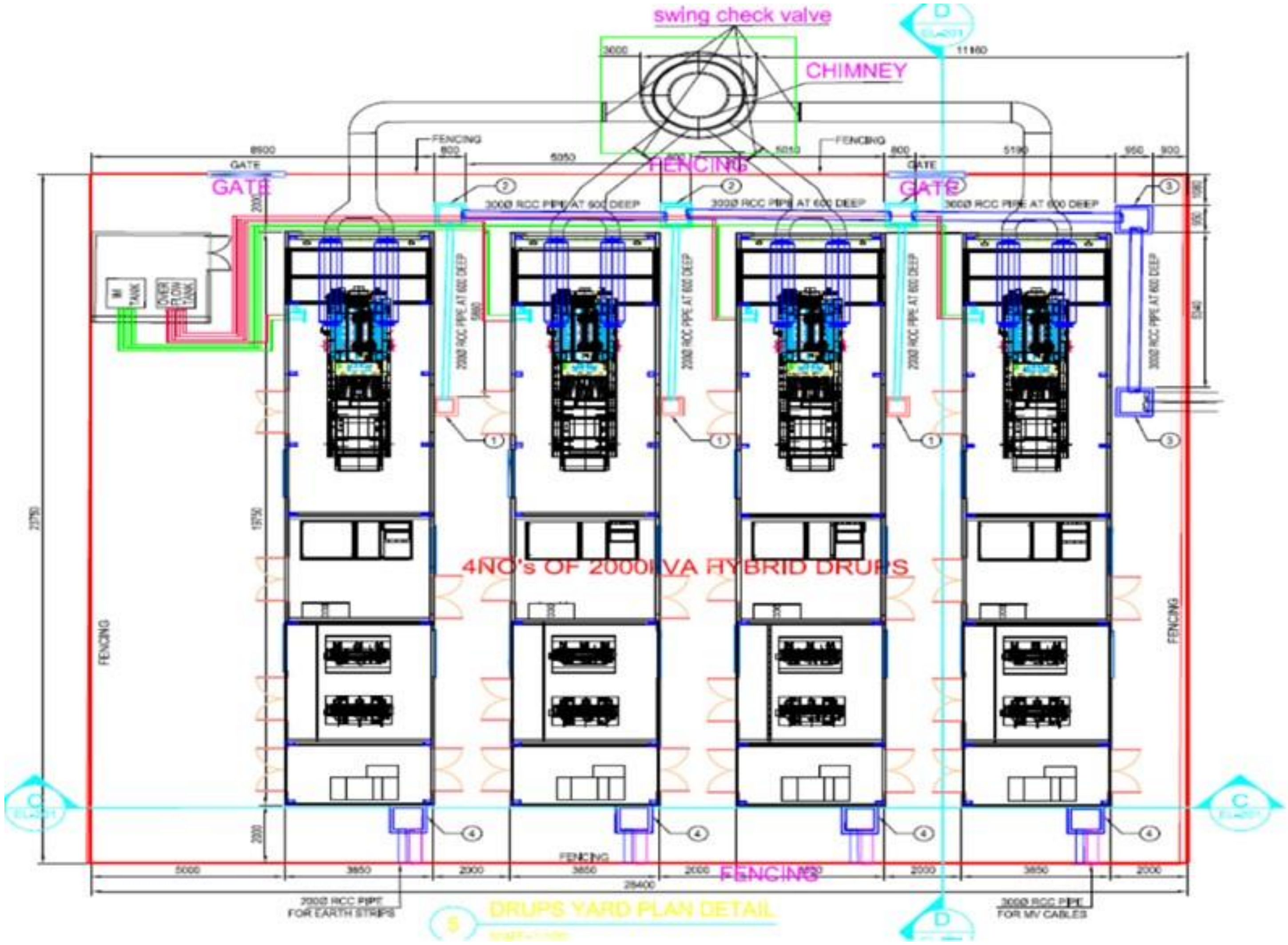
configaration	redundency	System MTBF
Parallel redundency	3+1	12,5 mil. h
System redundency	3+3	2315 mil. h
IP Bus system	3+1	3290 mil. h

NetApp Bangalore Campus

First IP Hybrid DRUPS Project in India
4x 2000kVA, scalable to 6x2000kVA

DRUPS yard

4x1800kW/2000kVA, scalable to 6x1800kW/2000kVA



IP Switchgear room

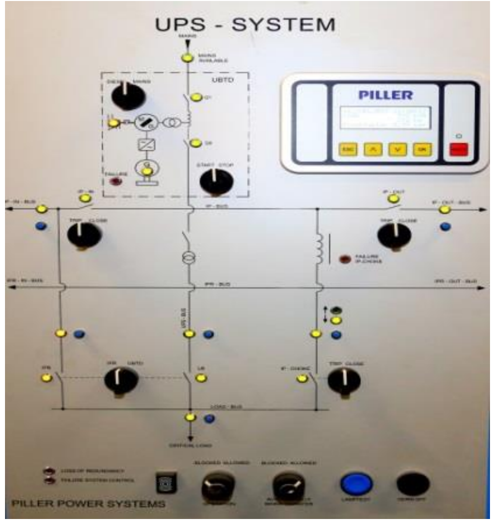
MV Transformer room

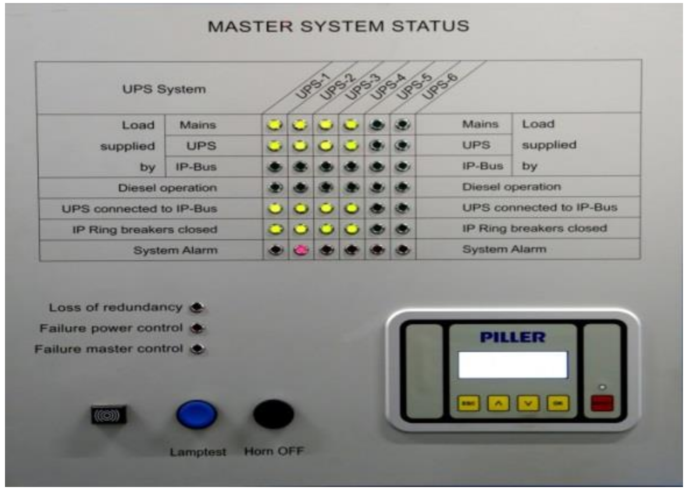
Inside view (PB cabinet Canopy)

Inside view (Genset Canopy)

NetApp

IP System & Master control, mimic display





NetApp

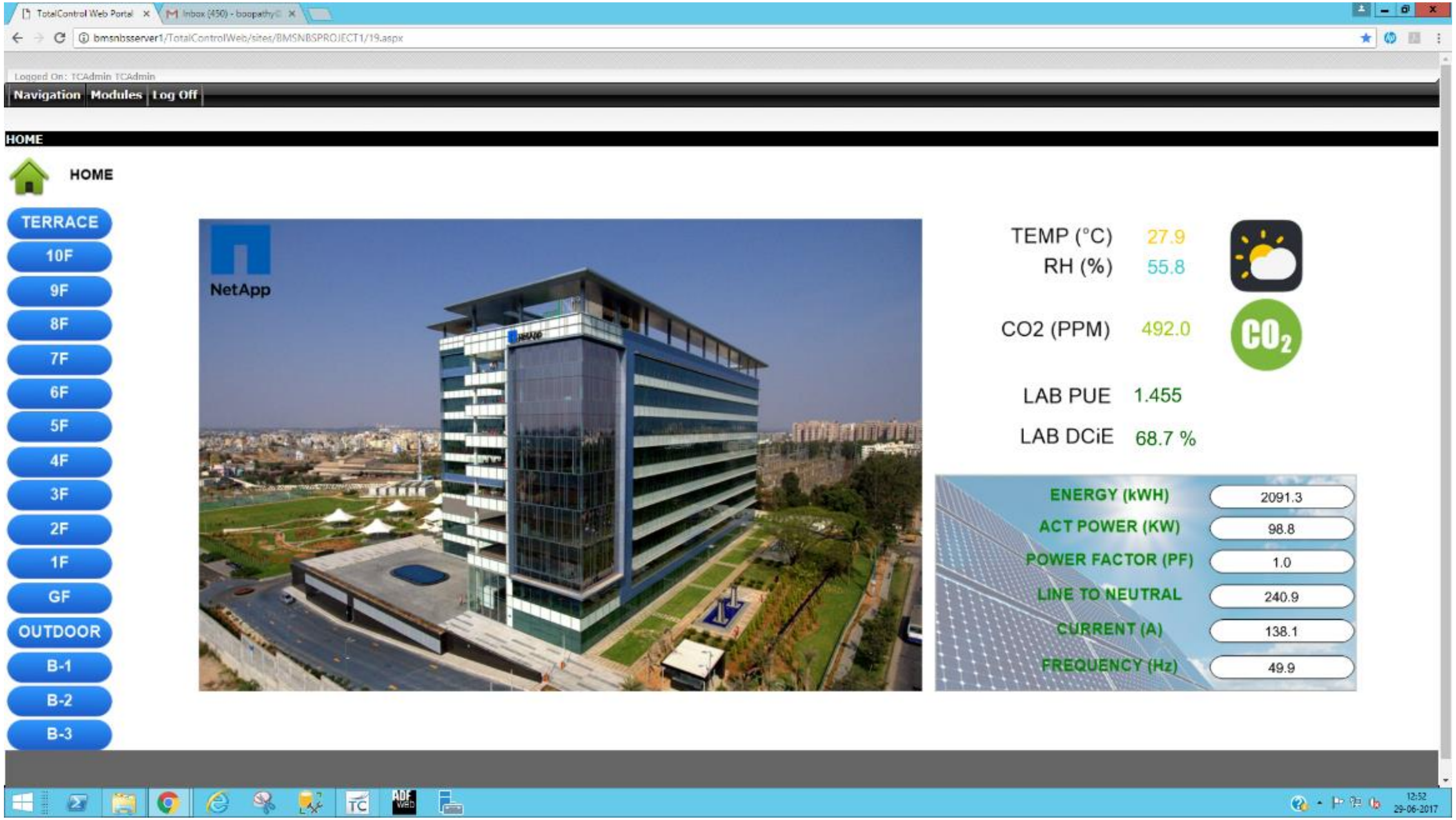
Conclusion

- NetApp Bangalore Campus Lab/Data Center has been built to the quality and performance standards of Global Dynamic Labs in the USA
- This is the first ever data center delivered in India with Containment w/ pressure control allowing high density (and low construction cost)
- This is the first data center in India adopted DRUPS UNIBLOCK UBTD+
- Target to meet the PUE of 1.3

NetApp

Screen shot of IBMS

PUE ~1.4



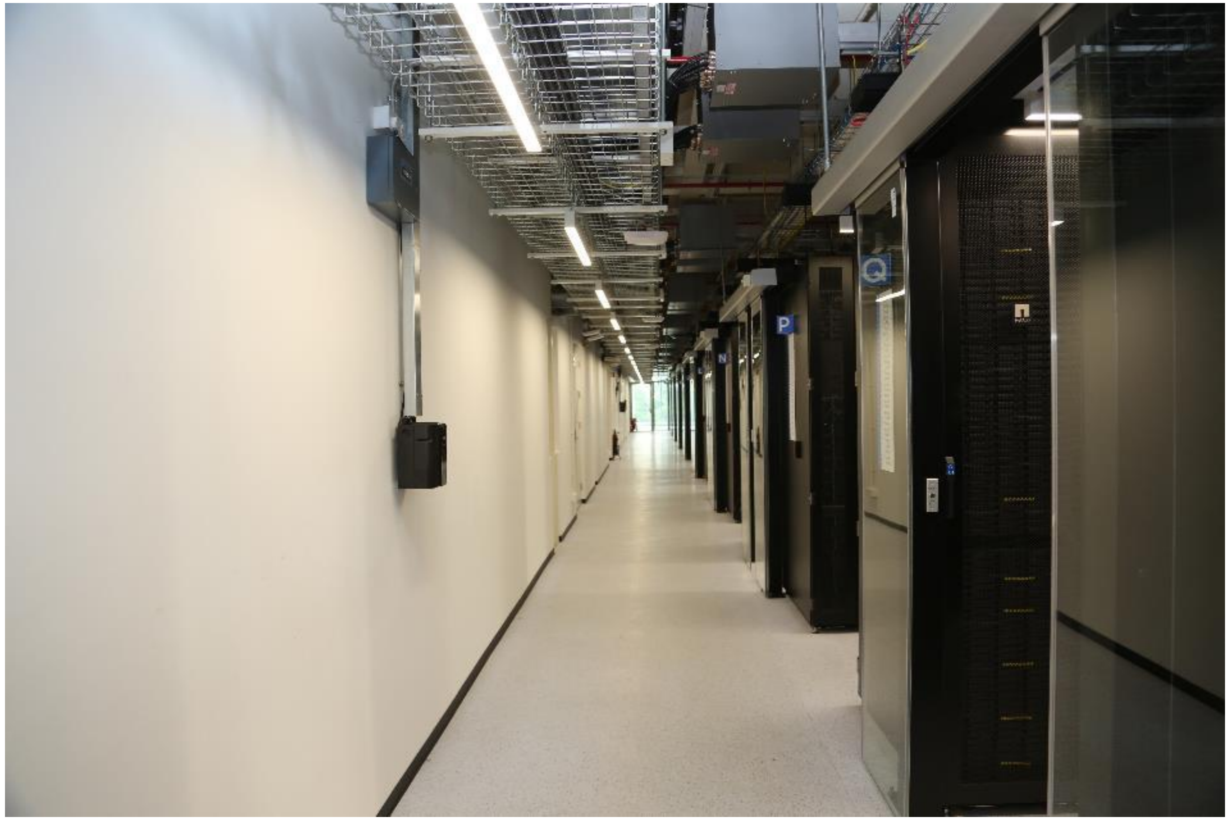
NetApp

Screen shot of IBMS

PUE ~1.4

NetApp

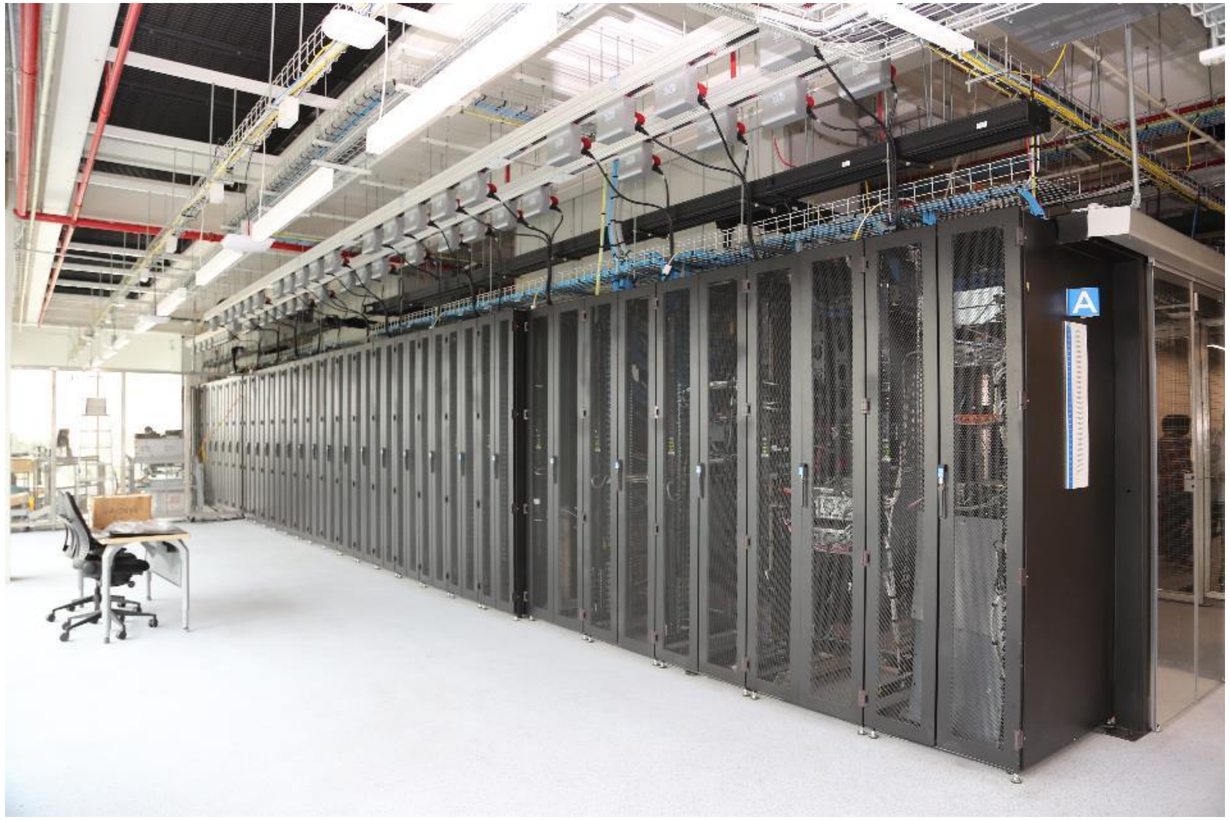
Level 2 - LAB

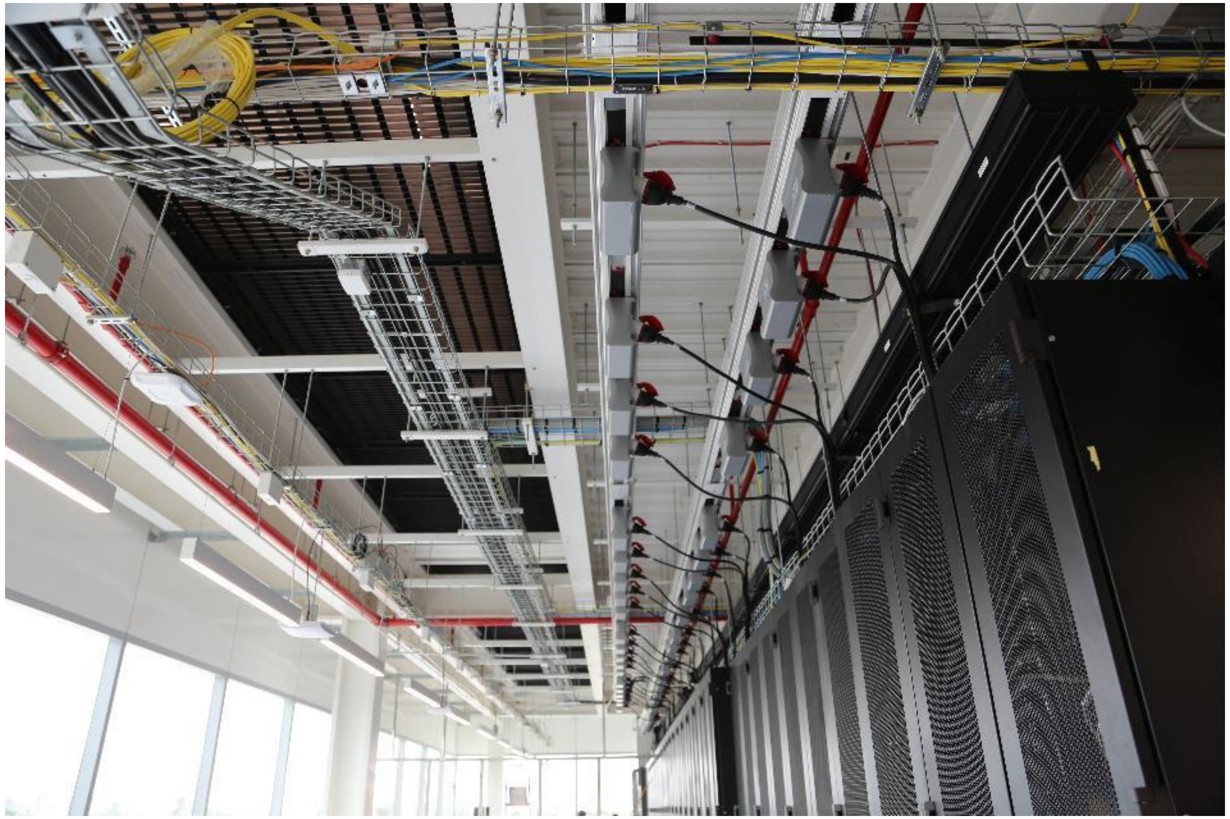


NetApp

Level 2 - LAB

Level 2 - LAB





Level 2 - LAB

NetApp

Thank You.

NetApp