Enhanced Energy Efficiency in Indian Green Data Centers

Energy Efficiency challenges and way forward

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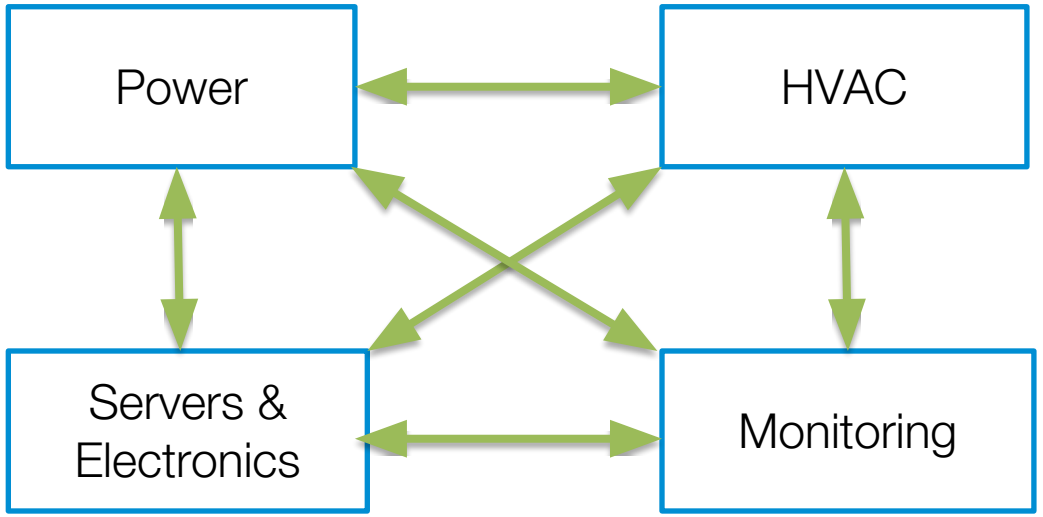
Agenda

	Energy efficiency challenges in Data Center
	Way Forward to meet challenges
	Conclusion

Energy efficiency challenges in Data Center

Components of Data Center:

- Power
- HVAC
- Servers & Electronics
- Monitoring



Energy efficiency challenges in Data Center:

Challenges :

- System working in team mode rather than in isolation
- Efficient and reliable operation
- Life cycle cost

Energy efficiency challenges in Data Center:

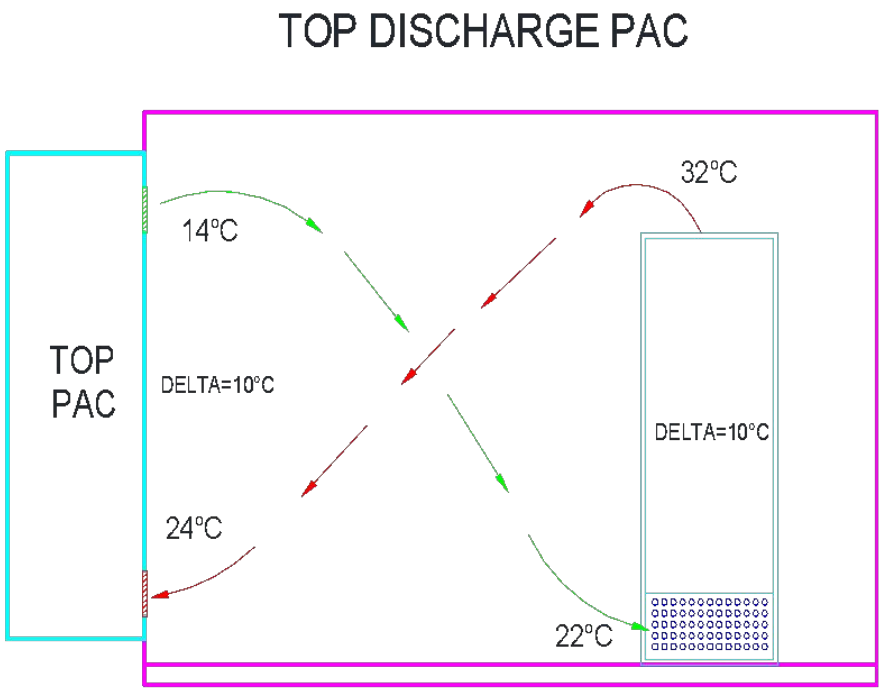
Team Mode Operation between HVAC & Servers:

	Rack
(a)Operating envelope	Rack Inlet Air Temp 18-27°C
	Rack Inlet RH 20%-80%
(b)Airflow Direction	
	- Front Suction /Back exhaust
	-front Suction / top exhaust
	- left suction/right exhaust
	- right suction/left exhaust
	- bottom suction /top exhaust
(c) Delta T	3-20°C
(d) Operating Philosophy	Variable Flow
(e)Containment	

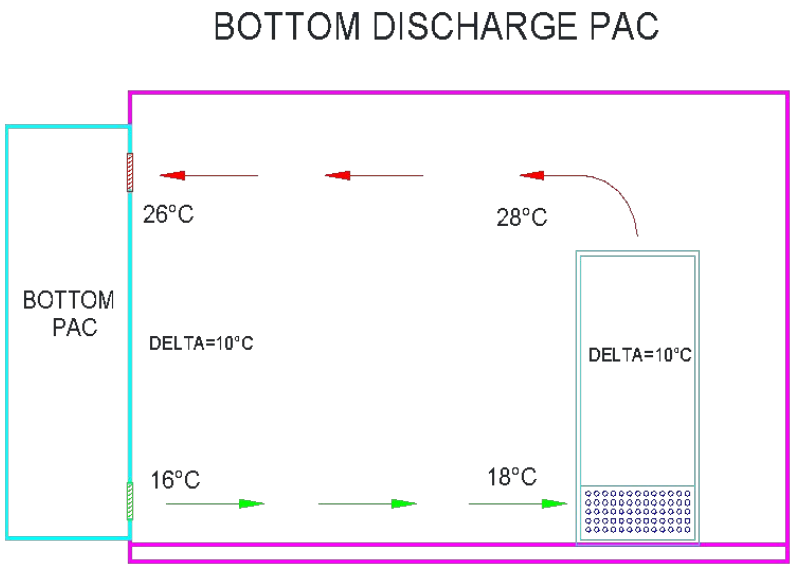
	PAC
(a)Operating condition	Inlet Air Temp 39°C
	Outlet Air Temp 27°C
	Airflow Variale to meet Server Load
(b)Airflow Direction	
	Top IN/ Bottom Out
	Top IN/ Front Out
	Back IN/ Front OUT
	Front IN/ Top Out
(c) Delta T	Designed to meet rack high Delta T
(d) Operating Philosophy	Variable Flow
(e)Containment	
(f)Spare capacity	Spare capacity in PAC to meet the extra load requirement(temp increase during power failure) after power resumption
(g)Quick Start Facility	PAC to have quick start facility to start very fast after power resumption
(h)Operating Load	

Energy efficiency challenges in Data Center:

Team Mode Operation between HVAC & Servers:



AMB 33°C 70%RH
DEWPOINT = 26.94°C

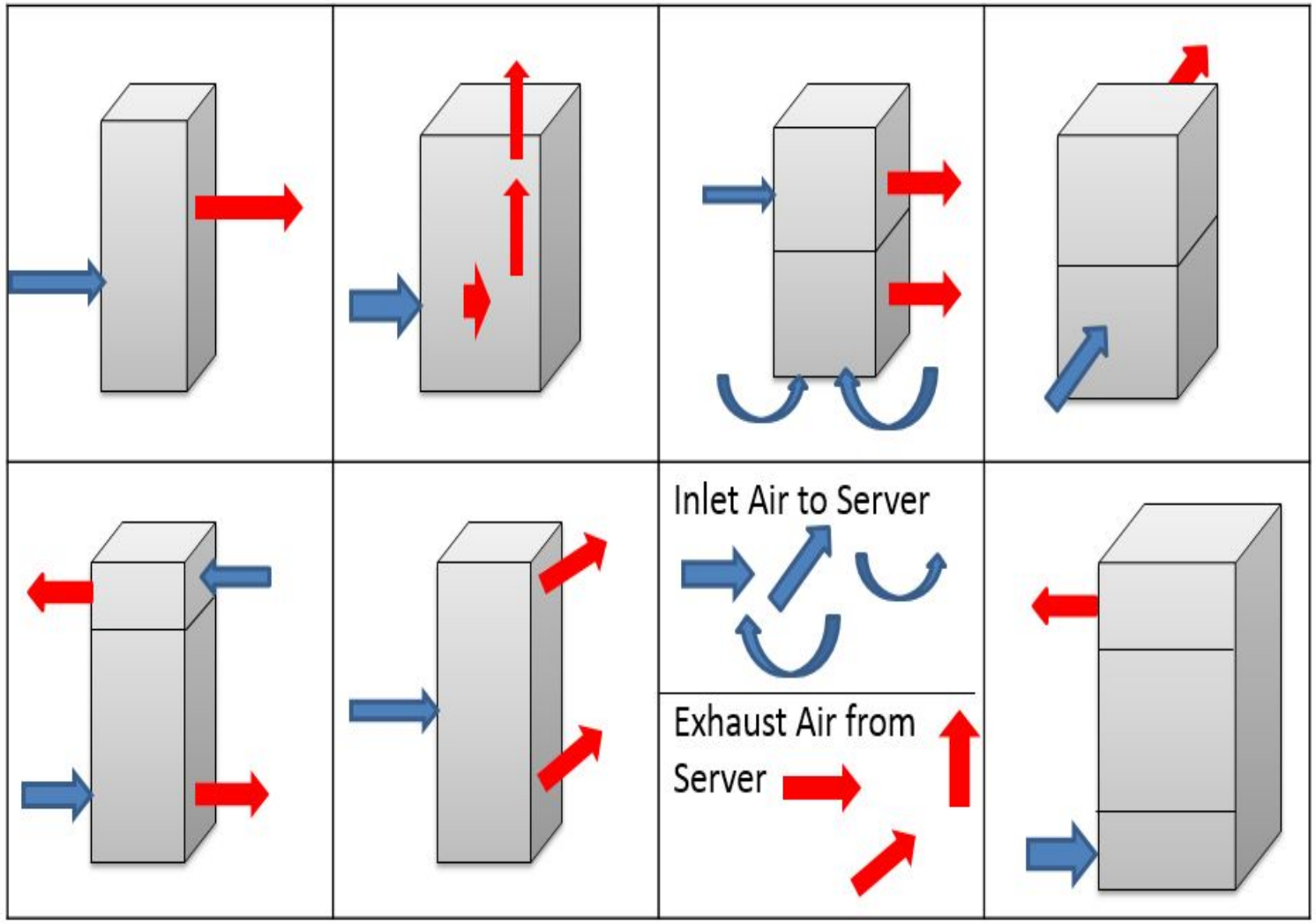


AMB 33°C 70%RH
DEWPOINT = 26.94°C

Inefficiency of Top throw PAC vs Bottom throw PAC

Energy efficiency challenges in Data Center:

Different Airflow Directions in Racks:



Eradicating inefficiencies in Rack design:

- blanking plate
- cable closure
- front to back isolation
- air flow direction
- required server clearances
- filters cleaning
- rack spacing
- rack exhaust fan static pressure and air flow

Energy efficiency challenges in Data Center:

Intake and exhaust air port in the same side of server:

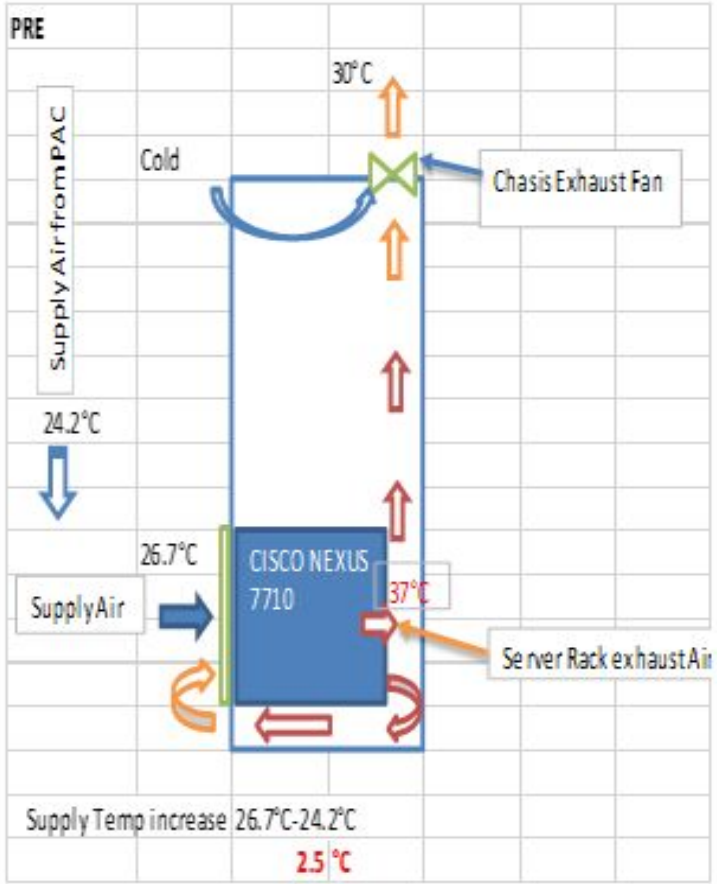
Some Servers have supply air Intake and exhaust air out on the same side.

So there are mixing of cold air and hot air found.

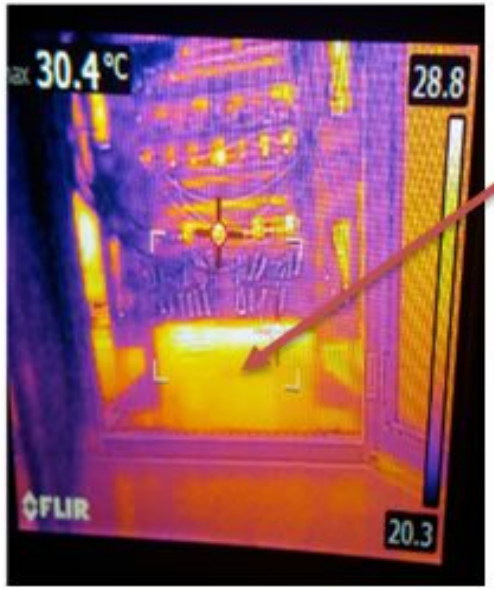
Slanted extension plates in front of exhausts to be put to divert the hot air to the top.

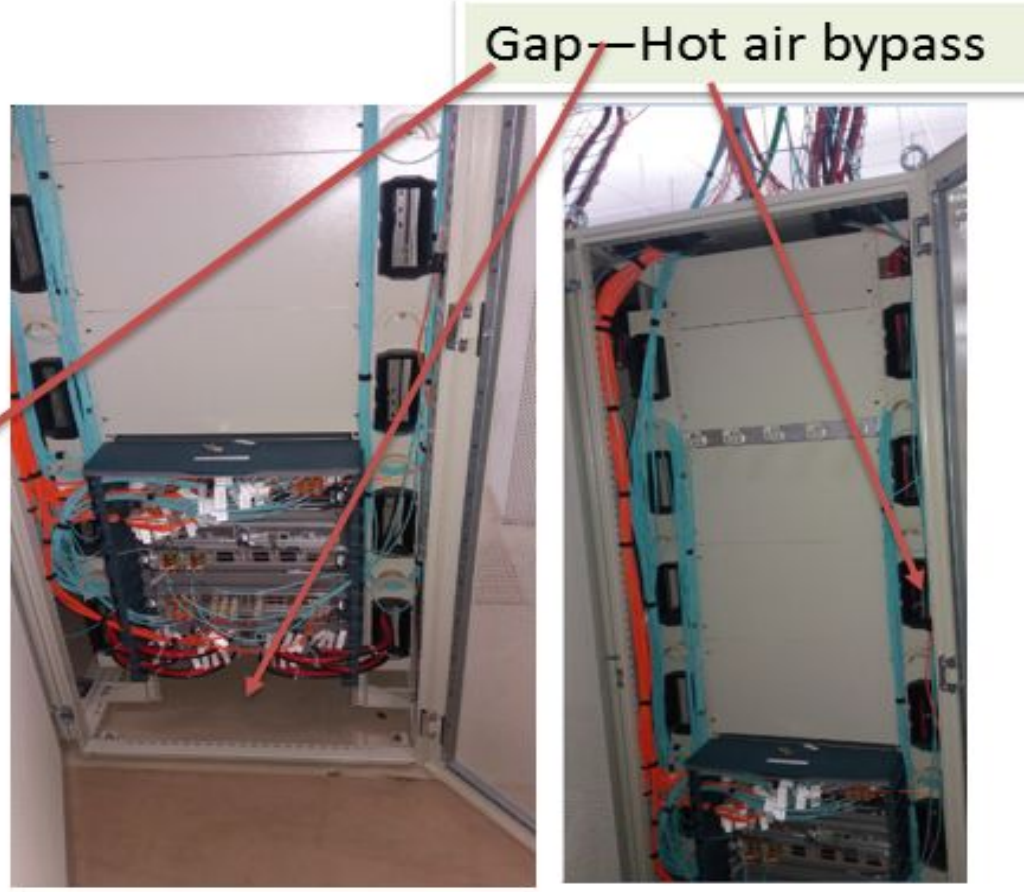
Energy efficiency challenges in Data Center:

Hot Air bypass Gaps:



Before: No blank Off Plates.
Hot air bypassing from bottom
(Thermal Imaging)





Supply air temperature to this rack was getting increased due to hot air short circulation from back through bottom opening.

Energy efficiency challenges in Data Center:

Server Intake Air Temperature:

Table 4.2011 ASHRAE Thermal Guidelines (I-P version in Appendix E)

The 2008 recommended ranges as shown here and in Table 2 can still be used for data centers. For potentially greater energy savings, refer to the section 'Guide for the Use and Application of the ASHRAE Data Center Classes' and the detailed flowchart in Appendix F for the process needed to account for multiple server metrics that impact overall TCO.

Classes (a)	Equipment Environmental Specifications							
	Product Operations (b)(c)					Product Power Off (c) (d)		
	Dry-Bulb Temperature (°C) (e) (g)	Humidity Range, non-Condensing (h) (i)	Maximum Dew Point (°C)	Maximum Elevation (m)	Maximum Rate of Change(°C/hr) (f)	Dry-Bulb Temperature (°C)	Relative Humidity (%)	Maximum Dew Point (°C)
Recommended (Applies to all A classes; individual data centers can choose to expand this range based upon the analysis described in this document)								
A1 to A4	18 to 27	5.5ºC DP to 60% RH and 15ºC DP						
Allowable								
A1	15 to 32	20% to 80% RH	17	3050	5/20	5 to 45	8 to 80	27
A2	10 to 35	20% to 80% RH	21	3050	5/20	5 to 45	8 to 80	27
A3	5 to 40	-12°C DP & 8% RH to 85% RH	24	3050	5/20	5 to 45	8 to 85	27
A4	5 to 45	-12°C DP & 8% RH to 90% RH	24	3050	5/20	5 to 45	8 to 90	27
B	5 to 35	8% RH to 80% RH	28	3050	NA	5 to 45	8 to 80	29
C	5 to 40	8% RH to 80% RH	28	3050	NA	5 to 45	8 to 80	29

Extended Ambient Operating Support Specification	Dry bulb temp range (°C)	Relative humidity range (% RH)	Dew point limits (°C)	Maximum altitude	Altitude de-rating*
Hewlett Packard Enterprise Standard Operating Support	10°C to 35°C (50°F to 95°F)	8% to 90%	-12°C (min) to 24°C (max)	3050 meters	1.0°C/305m above sea level
Hewlett Packard Enterprise Extended Ambient 40°C Operating Support (ASHRAE Class A3 compliant)	5°C to 40°C (41°F to 104°F)	8% to 90%	-12°C (min) to 24°C (max)	3050 meters	1.0°C/175m above 900m
Hewlett Packard Enterprise Extended Ambient 45°C Operating Support (ASHRAE Class A4 compliant)	5°C to 45°C (41°F to 113°F)	8% to 90%	-12°C (min) to 24°C (max)	3050 meters	1.0°C/125m above 900m

* Altitude de-rating assumes no direct sustained sunlight.

Energy efficiency challenges in Data Center:

Team Mode Operation between HVAC and power:

HVAC

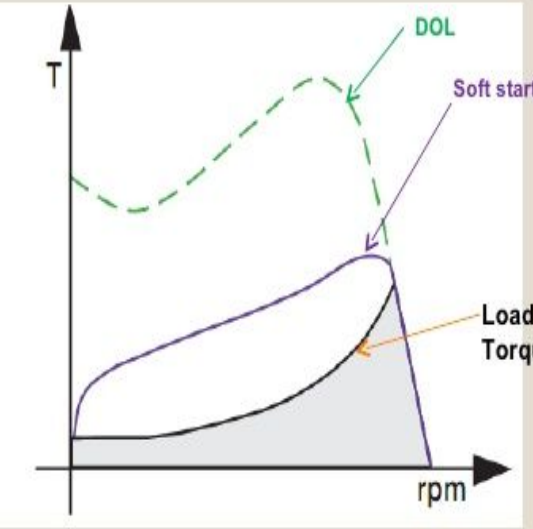
- DOL Start/ Soft Start
- Quick Start
- Efficient Part Load Operation
- Auto start
- Spare Capacity to meet power failure

Power

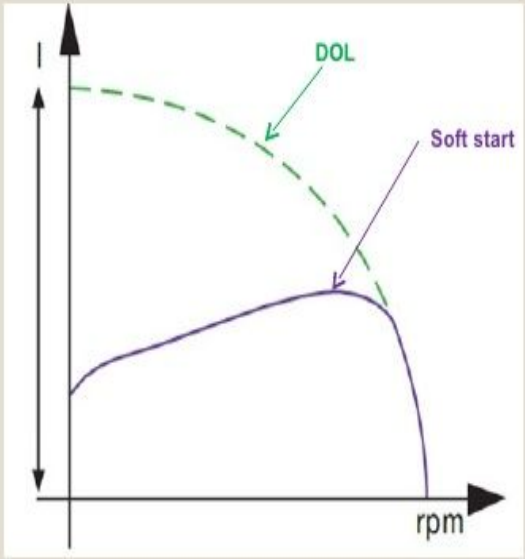
- MD
- DG Capacity
- UPS Capacity
- PF, Harmonics
- Change over Time
- Efficiency at variable load
- Auto Supply

Energy efficiency challenges in Data Center:

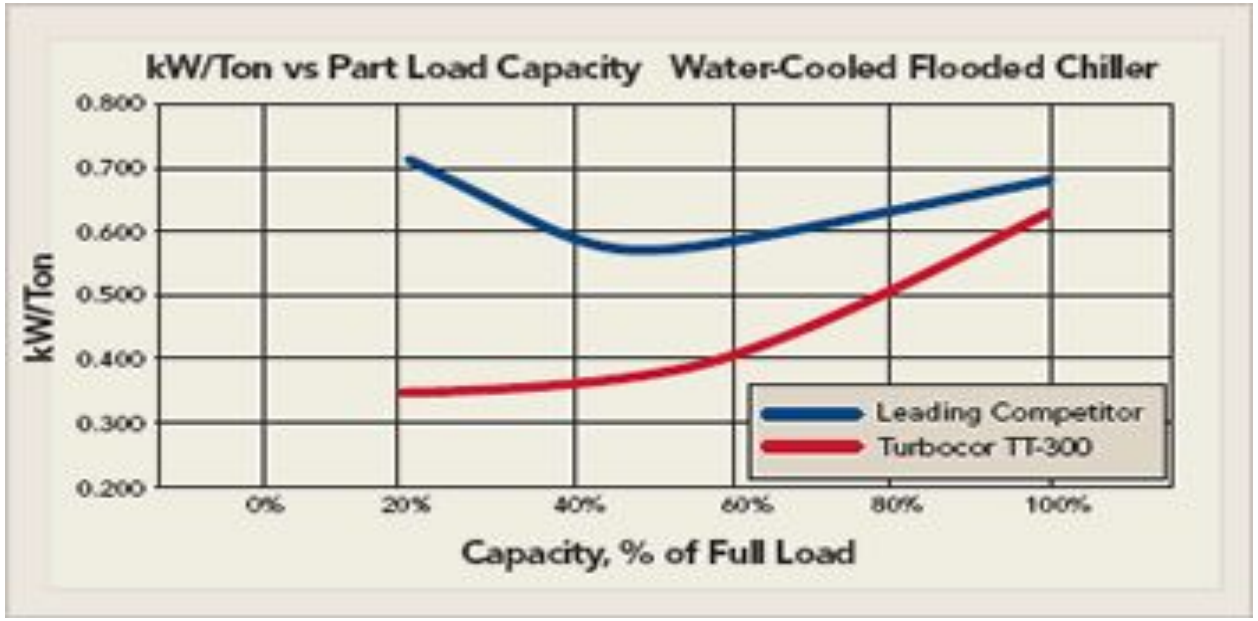
Characteristics of soft starter

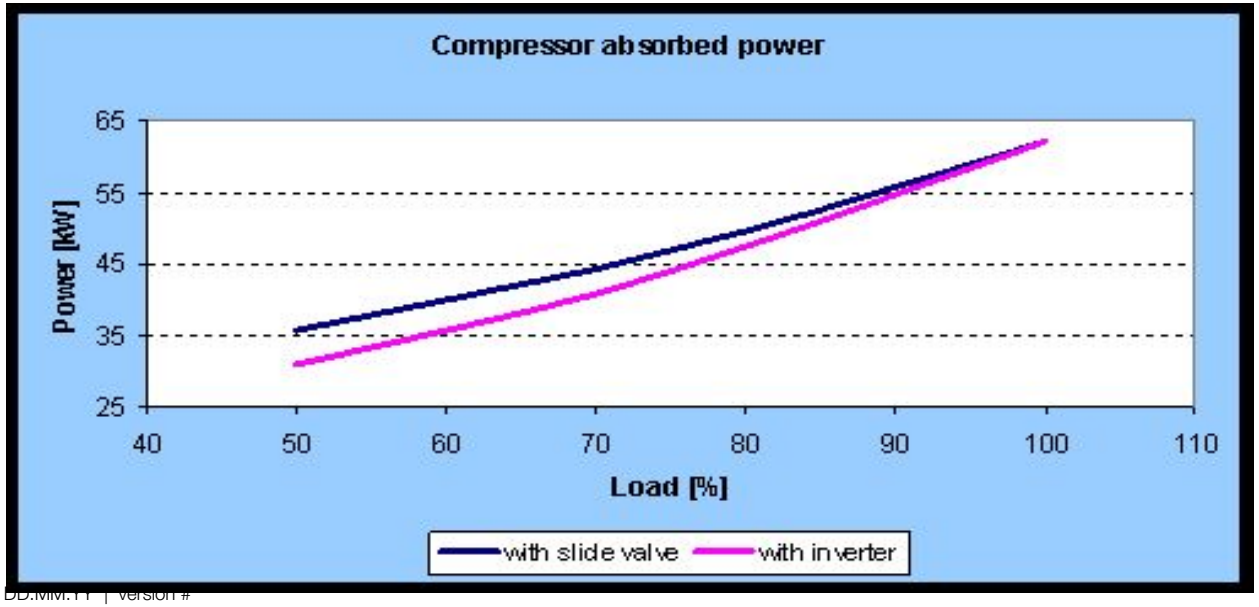


Torque/speed curve with Soft start



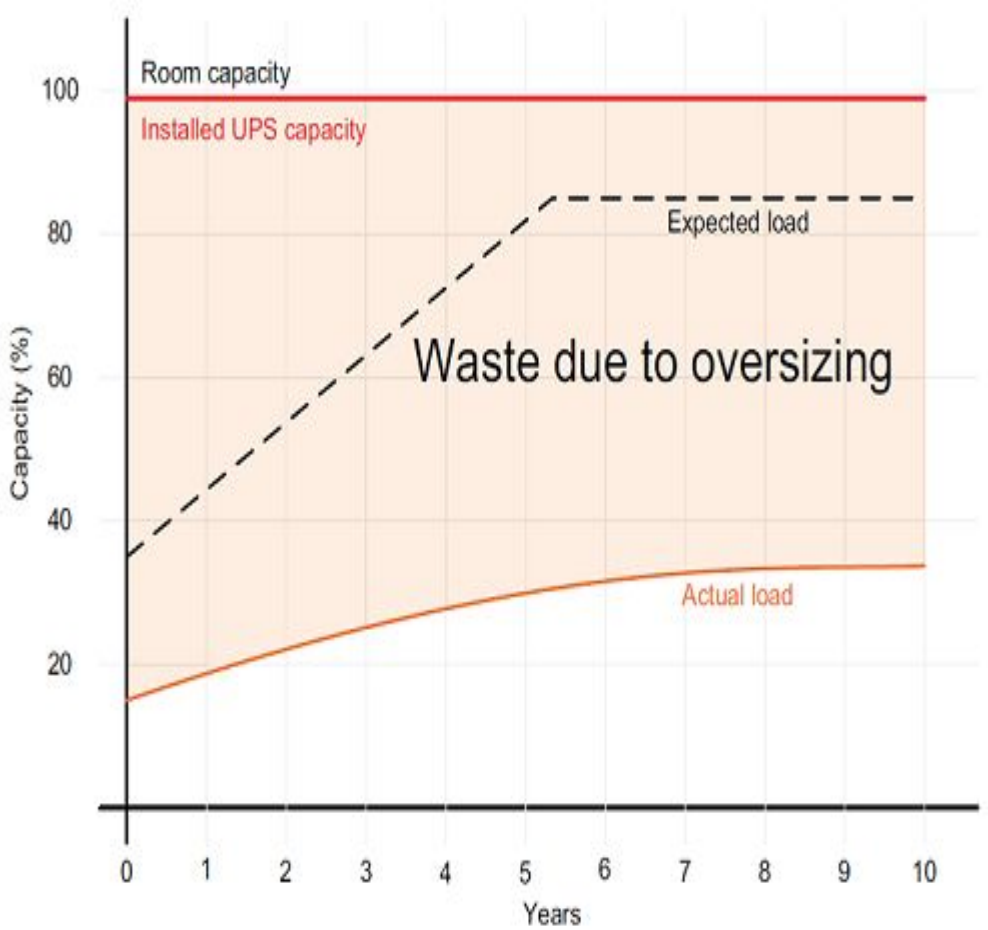
Current/speed curve with Soft start

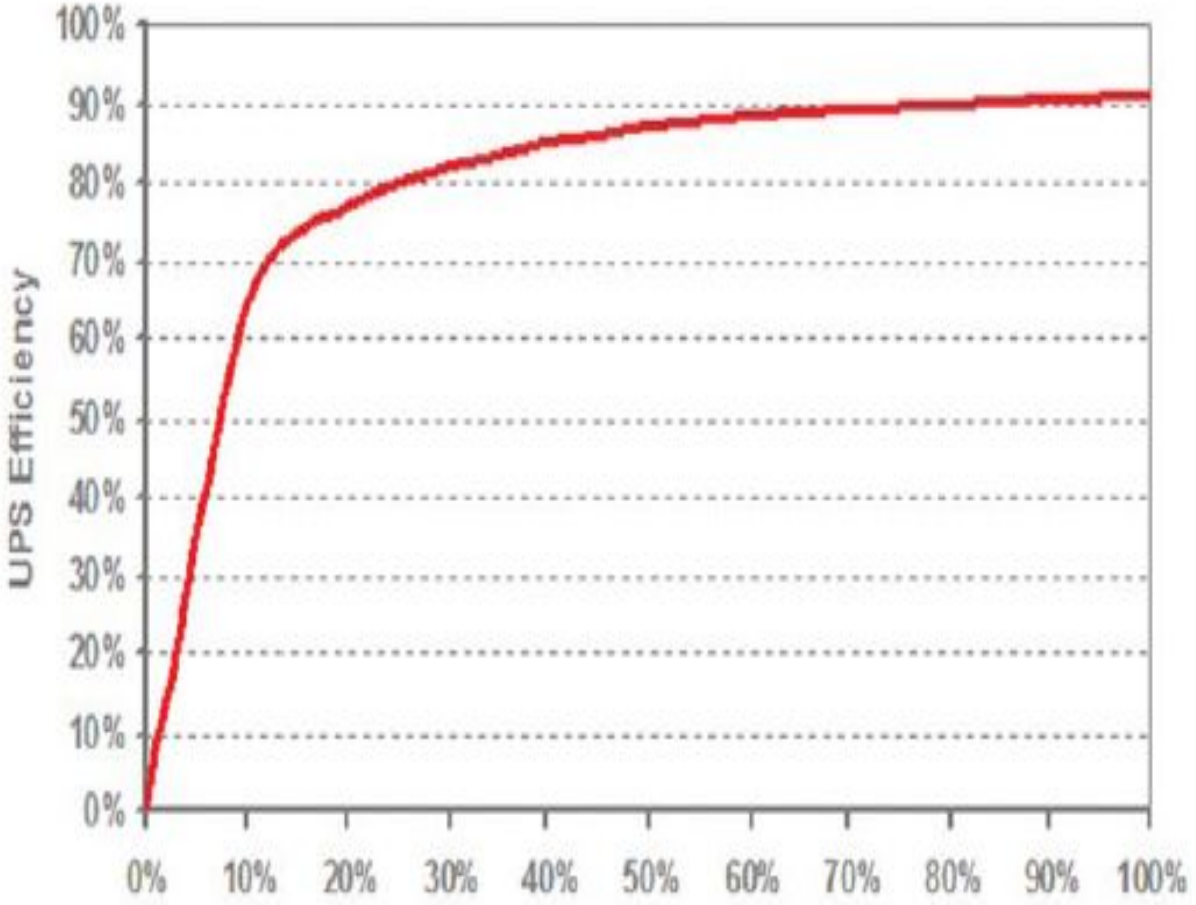




Energy efficiency challenges in Data Center:

UPS Capacity





Energy efficiency challenges in Data Center:

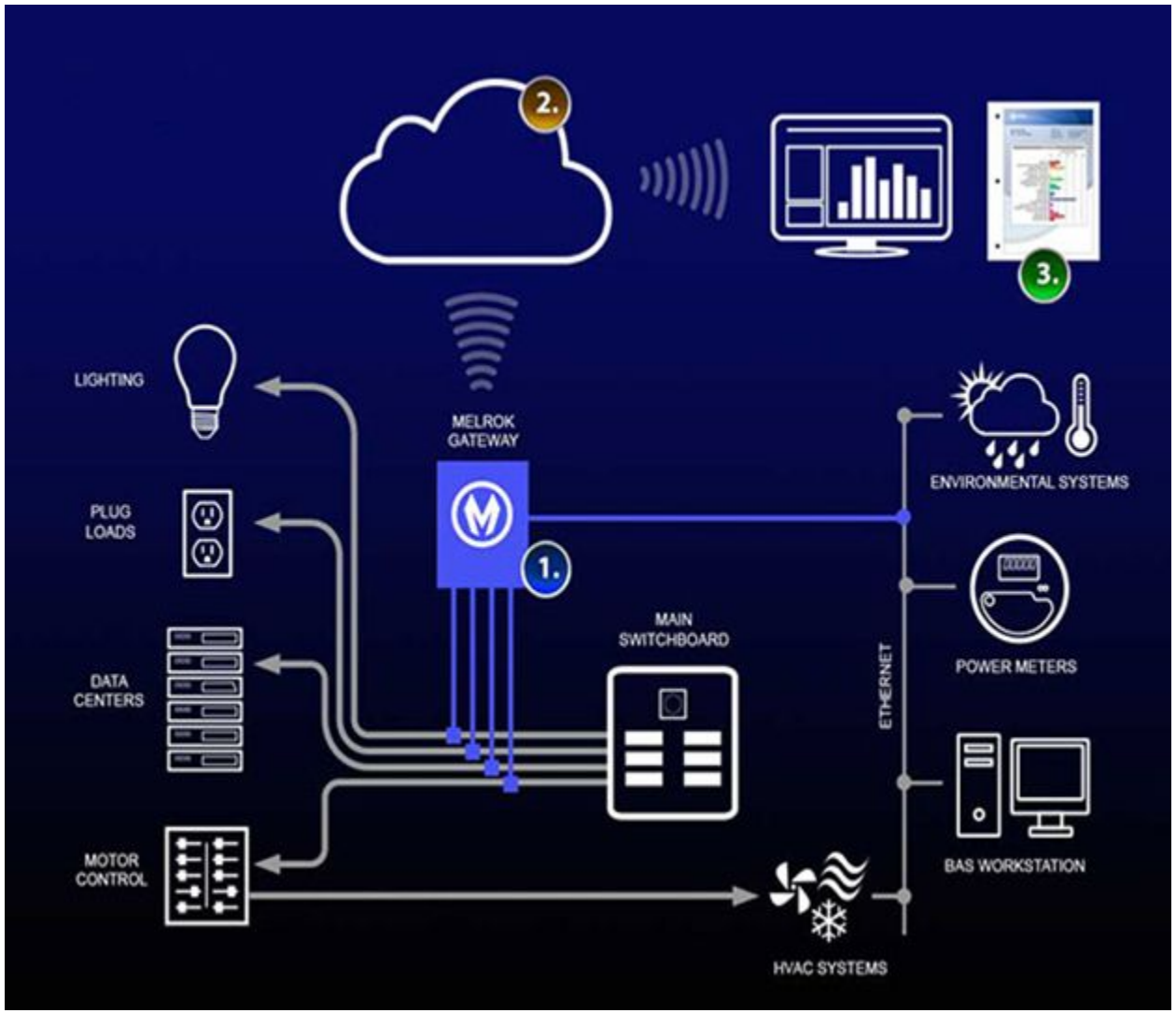
Team Mode Operation between HVAC and Automation:

Whether operation algorithm of server operation matches with HVAC.

Whether all variable operation for part load efficiency optimization is being carried out by BMS

Auto optimizing HVAC system performance using BMS data analysis & analytics

Energy efficiency challenges in Data Center:



PUE Monitoring over time period:

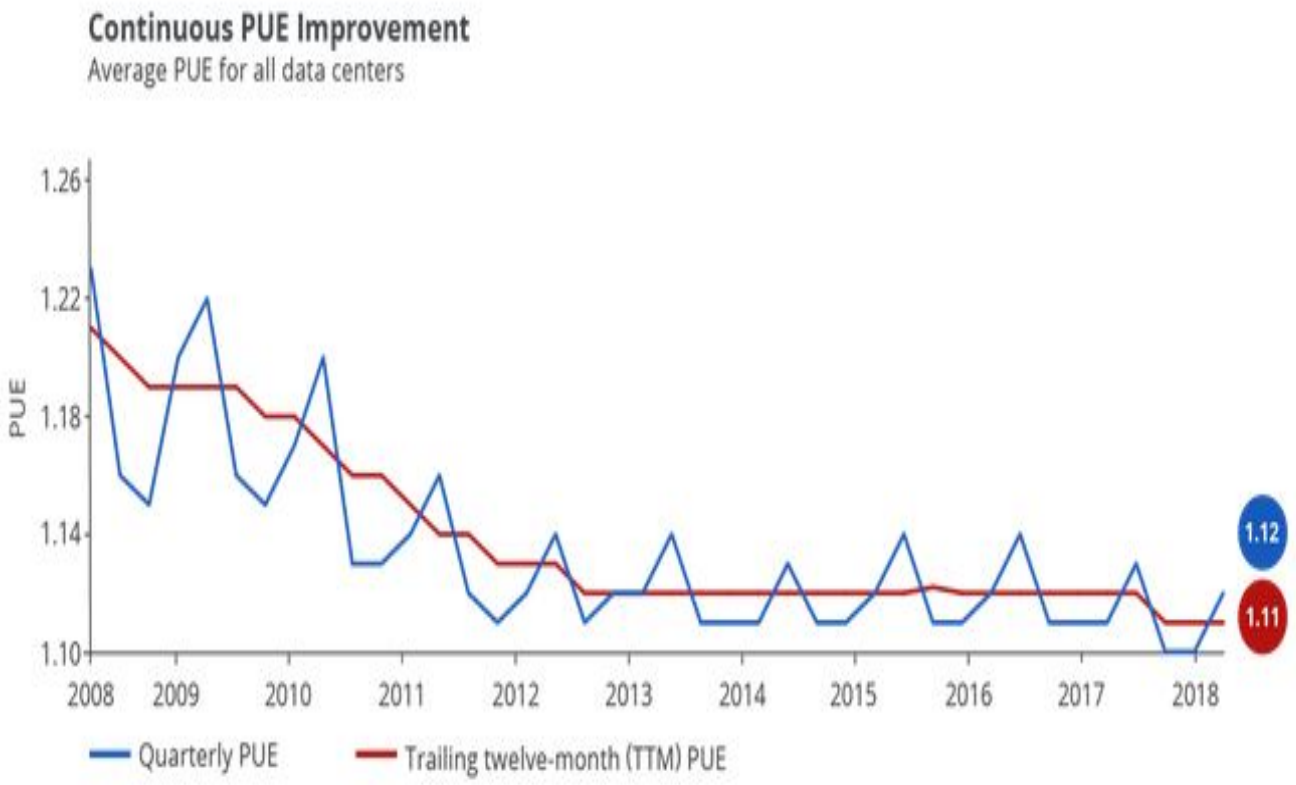
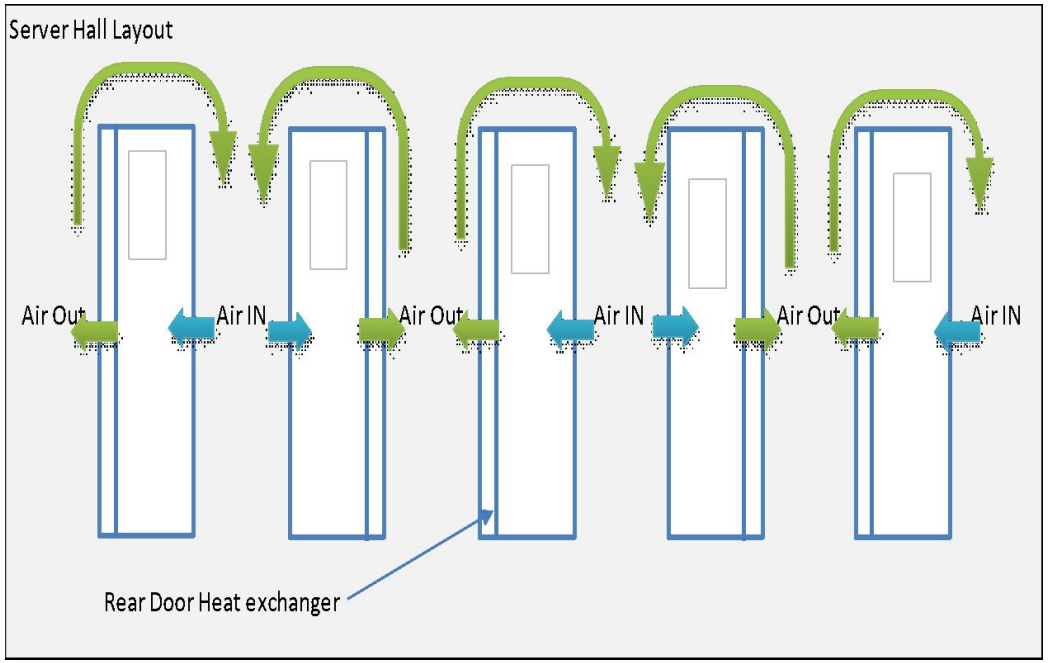
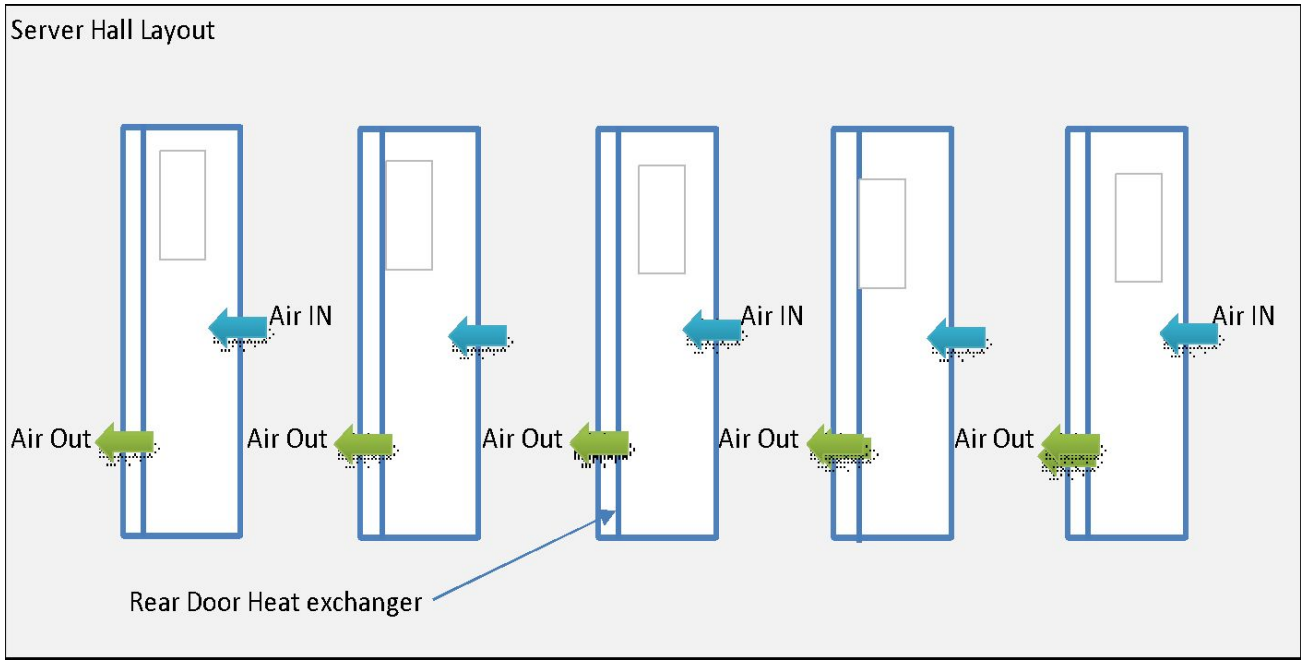


Figure 2: PUE data for all large-scale Google data centers

Way Forward for HVAC/ Rack

- Racks to be complete with isolation, in terms of front cold side isolation to back hot side isolation.
- Server fan should be having static pressure and filters for air filtration
- Air IN/OUT in PAC to meet Air IN/OUT in RACK
- PAC Variable flow to meet rack load
- Part load thermal performance





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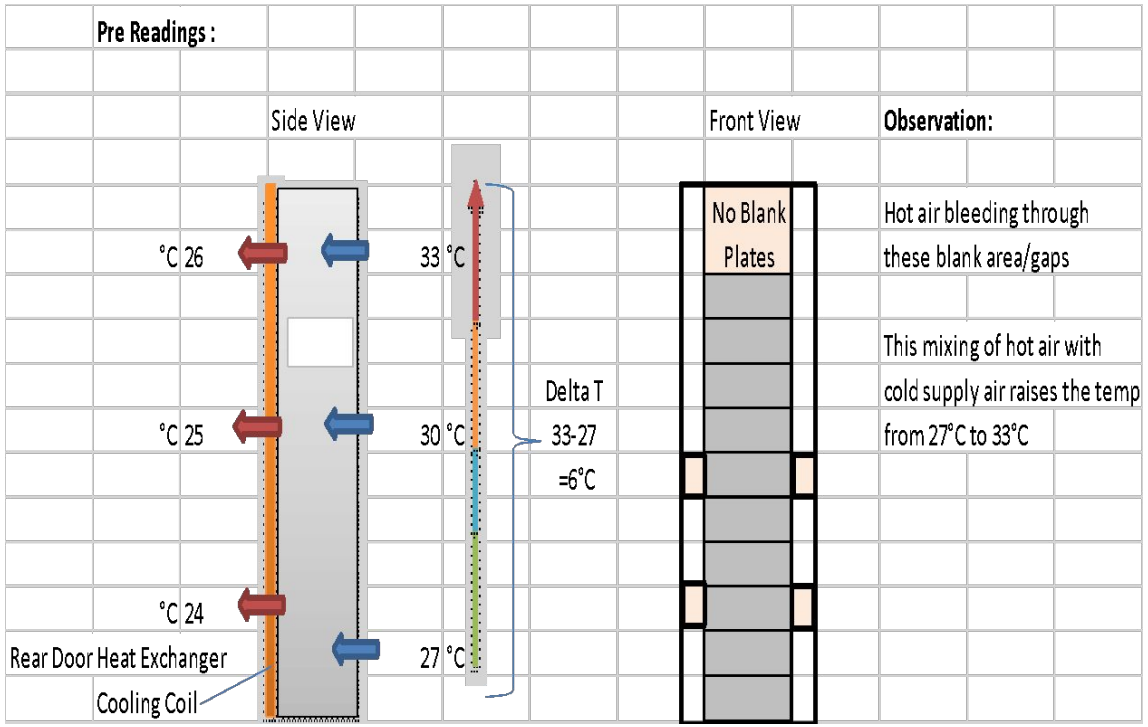
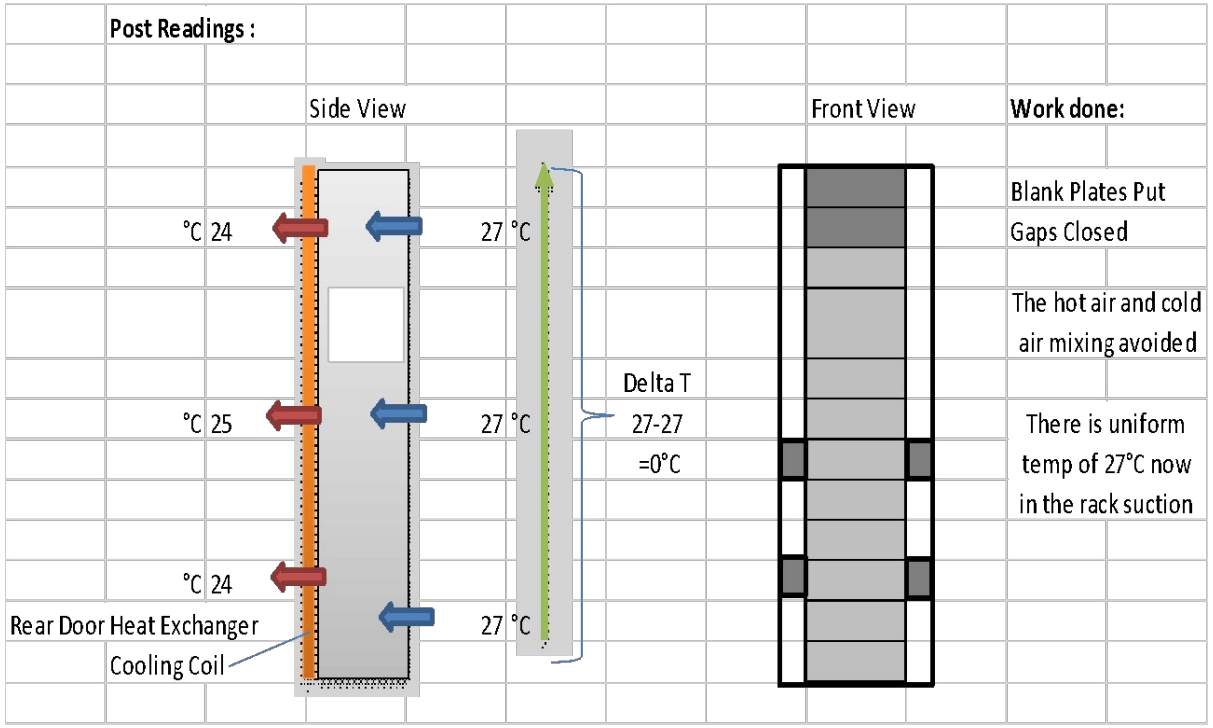
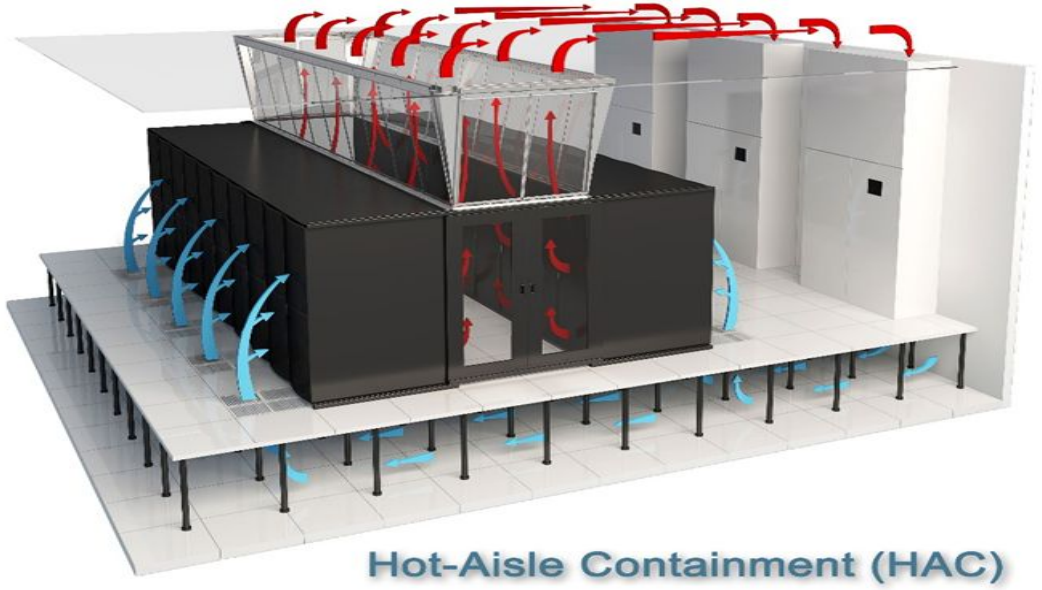
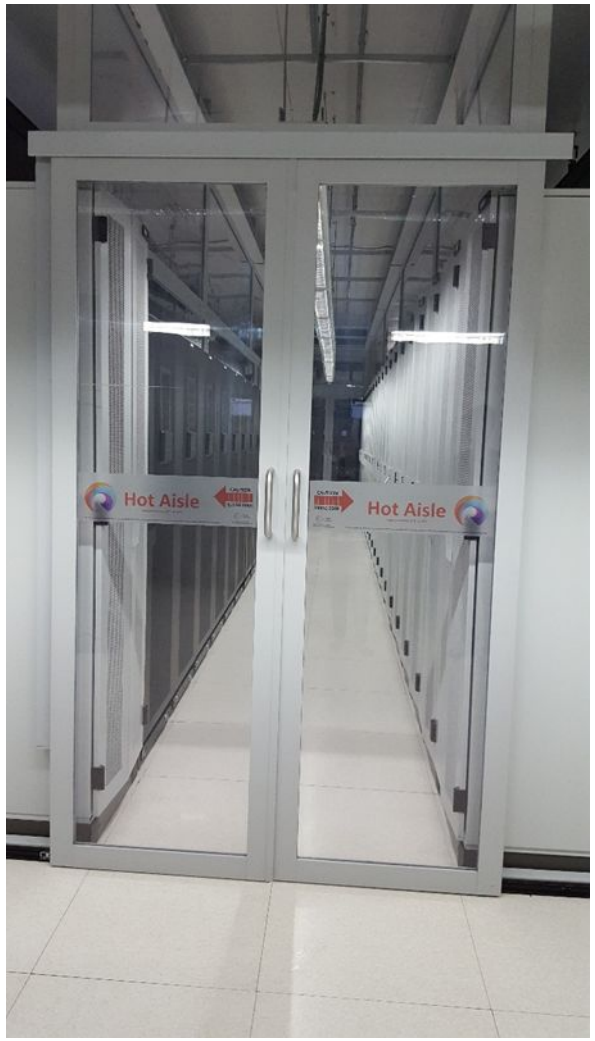


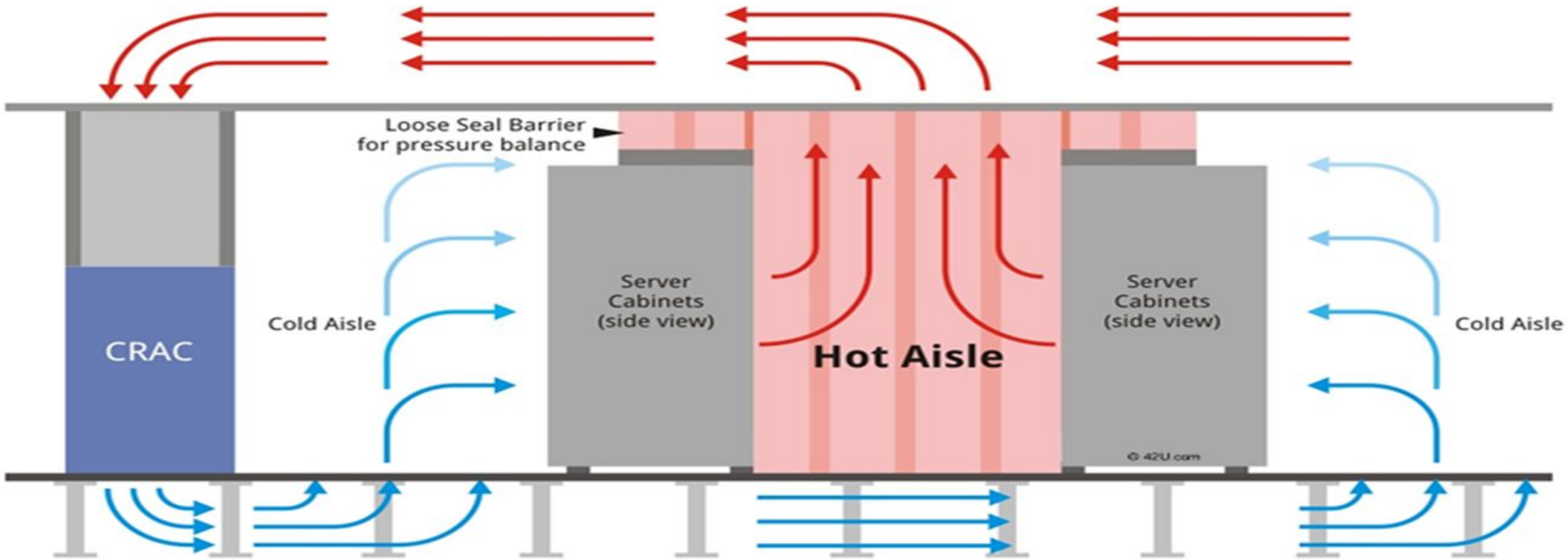


Way Forward for HVAC/ Rack





Way Forward for HVAC/ Rack



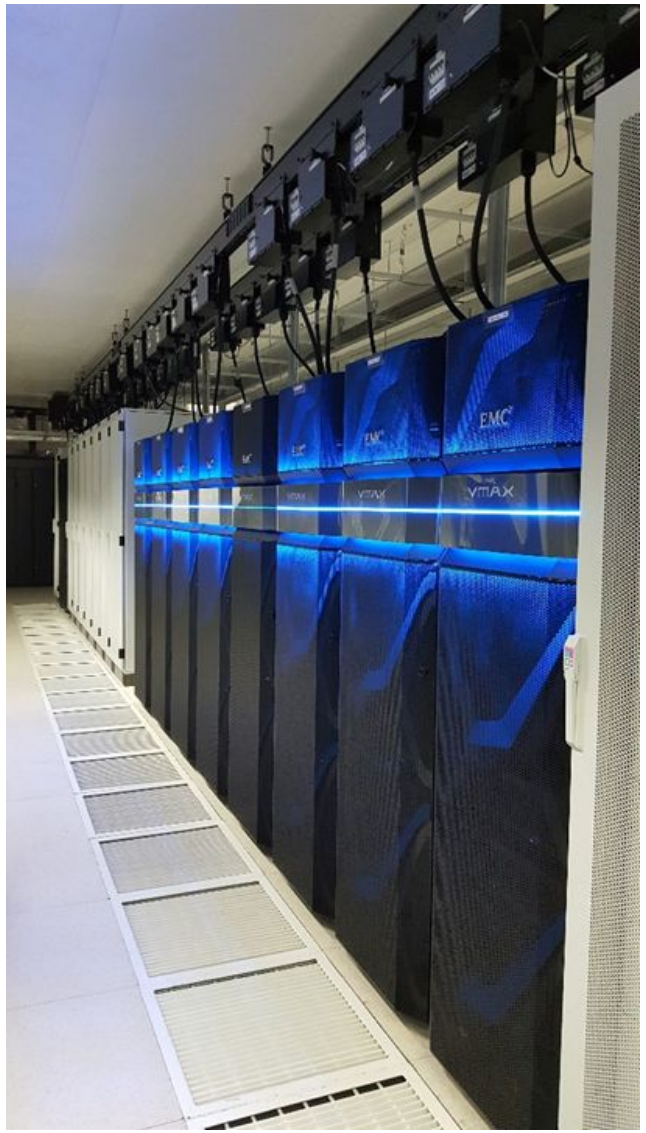
The cold aisle provides cold air directly to the front of all the racks and hence to the servers, while the hot aisle receives the warm air discharged by the servers after completing its cooling purpose.

Way Forward for HVAC/ Power

- HVAC system to have Auto/ Quick start
- Low ingress current
- Part Load Performance
- PAC Variable flow to meet rack load & turn down capabilities
- Thermal storage for power change over
- PF, Harmonics corrections

Way Forward for HVAC/ Power

- Adoption of UPS Tribus Technology Configuration
- Overhead DC bus bar power distribution
- DG Set power back up
- Motion sensor controlled lighting
- UPS with power factor as Unity



Way Forward for HVAC/ Monitoring

- Share all operating data
- Variable flow to meet part load
- Quick/Auto start
- Computation of all consumptions and comparison with bench marking
- Fault prediction and indicative of maintenance requirement

Thank You for patience hearing