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Covers

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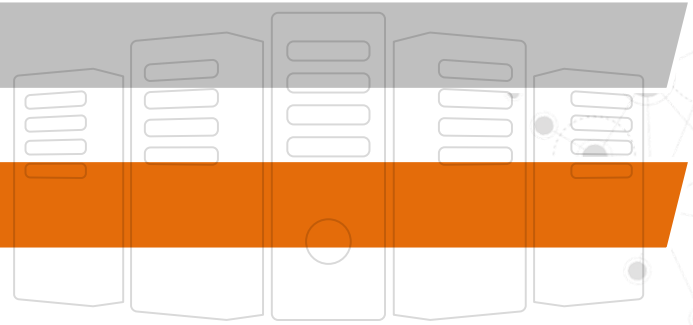
- Emerging Trends
- Impacts of emerging trends
- Rack Power Density Trends
- ASHRAE guidelines
- Server failure data
- Impact on IT hardware & data Centre form factor
- Road map for cloud , colocation , enterprise , Edge & HPC data centre
- Current power & cooling equipment landscape & future move
- Liquid cooling & Lithium ion battery- game changer
- Future DCIM tool



EMERGING TRENDS

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Year	Population, billion	IOT's, billion
2015	7.35	4.5
2018	7.5	13.5
2020	7.64	20.5

Smart Data Center of the Future

A confluence of mega-trends in technology that together finally provide cost and scale opportunities

- Sensing and data gathering
- Internet of Things (IoT), IP based smart lightings & cameras, mobiles
- Industrial IoT
- Smart building , Campus , city ,

- Data transport , high band with & low latency
- Large storage of data.

- Data analysis
- Big Data analytics
- Application of cognitive technology.

- Eservices, e commerce
- 5 G services, video streaming, content delivery
- Cloud services

IMPACT OF EMERGING TRENDS ON DATA CENTERS

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Need for **multi-layered operational security**
Secure perimeters, bio-metrics, visual identification and video surveillance

Network cabling becoming more critical
Fibre cabling, connectors, interconnects and switches

CIOs under cost pressure
Maintaining existing DCs leads to reduced budget allocations for New facilities
(More than 75% allocated to maintenance)

Data Center Infrastructure needs to be planned for Technological changes occurring every 3 years

Emphasis on renewables & energy savings
3.5% of global emission by 2020.
More focus on solar & wind
More innovations on cooling & power - high ambient & liquid cooled server.

Increasing Bandwidth Requirement
Leading to Data Center consolidation

Workloads getting cloud enabled
Hyper scale data centre & Shrinking enterprise class data centre , more workloads per rack.

Edge computation to reduce latency, connectivity & cloud outages
Application of hyper converged physical infrastructure for video streaming , autonomous cars , 5 G services.

Average Rack KW & Trends

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International trends- colocation

INDIA	3.5 KW / Rack
AUSTRALIA	4.6 KW / Rack
JAPAN	5.3 KW / Rack
UK	4.22 KW / Rack
USA	5.32 KW / Rack

Sector-wise trends

INDIA

BFSI	6 KW / Rack
Telecom	3 KW / Rack
Co-location	3.5 KW / Rack
Cloud	10-15 KW / Rack

Cloud

Medium loading
4 to 8 kW / rack

High loading
8 to 15 kW / rack

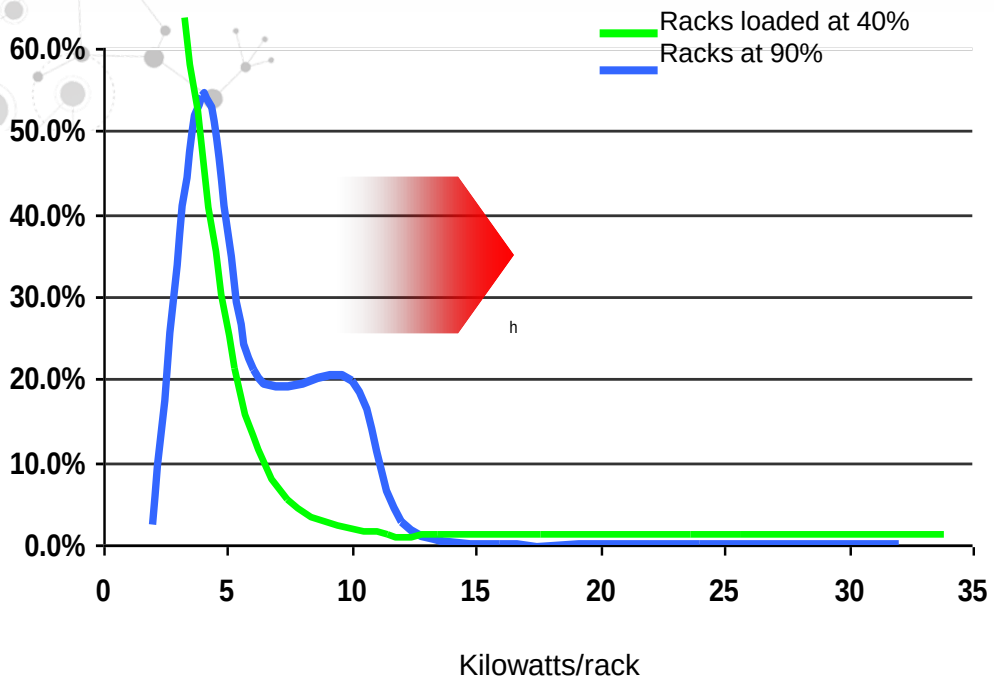
- So in the case of cloud computing, that portion of the DC should be between the Medium and the High loading
- If we lean more towards high loading, loading should be between 8 - 15 kW / rack
- Increasing practice of virtualization of racks allows some consolidation, as a result, number of racks may reduce

Key to success is to plan for unpredictability to manage the lifecycle of a data center

Plan to avoid the next 2-3 retrofits by smart planning

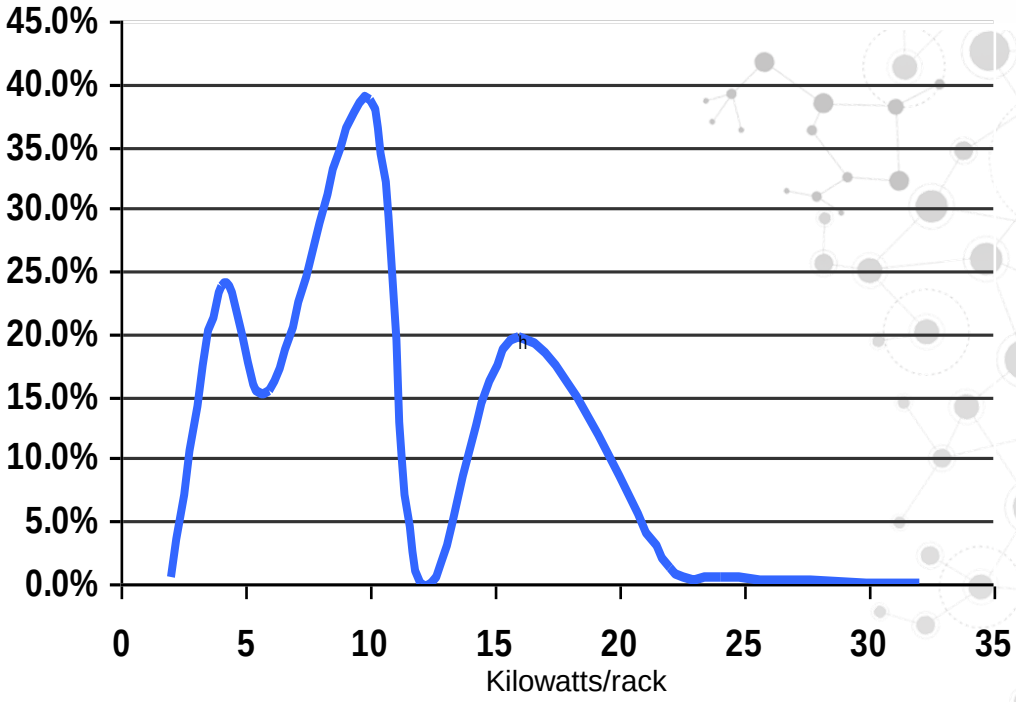
Today

50% of server density is < 5 kw/Rack or less



2020

60% of server density is > 10 kw/rack



ASHRAE TC 9.9 2011 added two additional classes, A3 & A4

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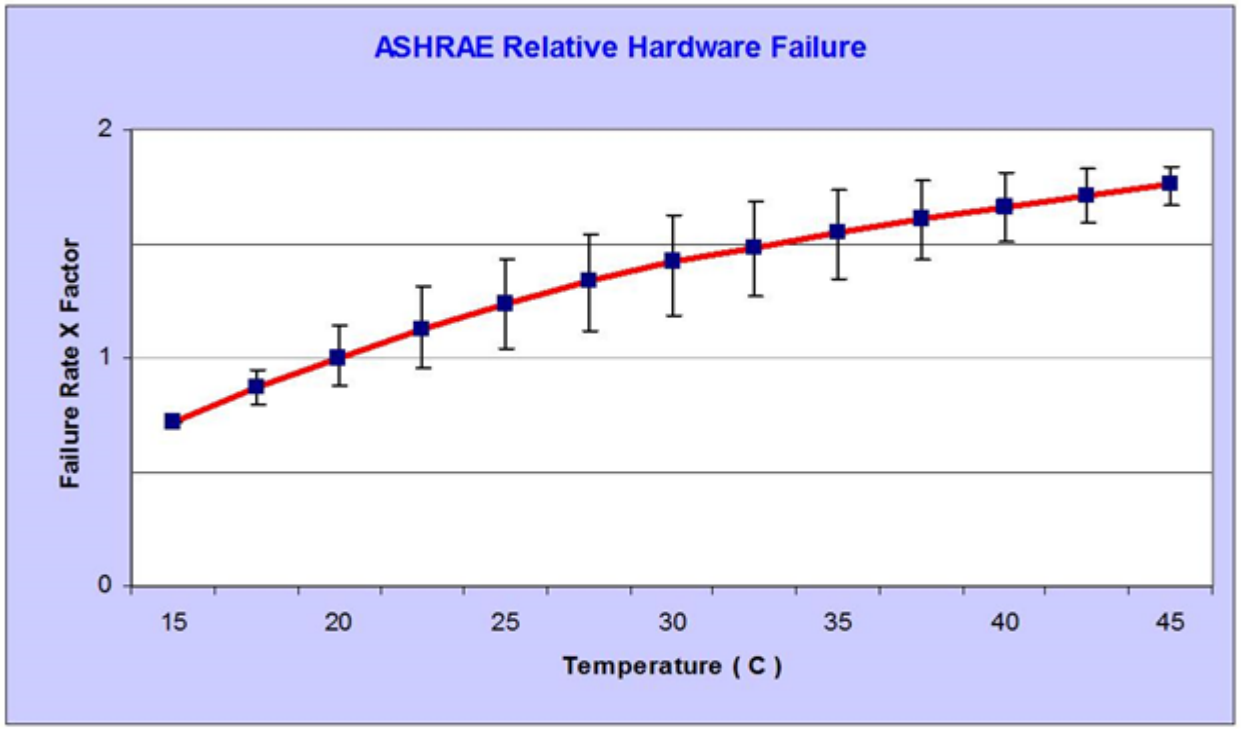
Classes	ASHRAE Equipment Environmental Specifications							
	Product Operations					Product Power Off		
	Dry-Bulb Temperature (˚C)	Humidity Range, non-Condensing	Maximum Dew Point (˚C)	Maximum Elevation (m)	Maximum Rate of Change(˚C/ hr)	Dry-Bulb Temperature (˚C)	Relative Humidity (%)	Maximum Dew Point (˚C)
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

ASHRAE - Relative Hardware Failure



DB Temp		Average Failure Rate X-Factor
C	F	
15.0	59.0	0.72
17.5	63.5	0.87
20.0	68.0	1.00
22.5	72.5	1.13
25.0	77.0	1.24
27.5	81.5	1.34
30.0	86.0	1.42
32.5	90.5	1.48
35.0	95.0	1.55
37.5	99.5	1.61
40.0	104.0	1.66
42.5	108.5	1.71
45.0	113.0	1.76

- Intel study: Traditional DC with supply temperatures of approximately 20°C resulted in a failure rate of 2.5% to 3.8% over twelve months

Failure Rate @ 20°C Inlet Temperature	Base	2.5%	3.8%
Failure Rate @ 35°C Inlet Temperature	X-Factor 1.55	3.9%	5.9%
Failure Rate @ 40°C Inlet Temperature	X-Factor 1.66	4.2%	6.3%

ASHRAE - Relative Hardware Failure

Effect of increasing server inlet temperature to the allowable A3 zone

- Benefits of A3 operating environment
  - Optimal operating temperature is 25°C with improvement depending on location
  - **More efficient operation by extending free cooling hours –**
  - **May allows for chiller free design environment**
  - **Can reduce operating complexity by eliminating the chiller component**

- Operational considerations
  - **May drive the need for DCIM (air flow and temperature management with equipment load)**
  - **Increase in hot aisle temperature (OSHA standards)**
  - **Potential increase in server failure rates and safety zone (thermal runaway)**
  - **Increase in server fan power and server noise**
  - Potential increase in silicon leakage current at higher temperature

Impact on IT active components & data center form factor

- **Shrinking enterprise class data center due to adoption of cloud.**
- **Hyper scale & mega scale colocation data center requiring large power demand, like 150 MW , requiring factory like landscape & facilities.**
- **Appearance of edge data center for distributed computing & low latency. Increased use of remote mini & micro data center, like modular & container data center.**
- **Public Cloud providers are using less OEM servers & more ODM servers**.
- Use of OEM hyper converged IT hardware's in private cloud for space , power efficiency & reliability.

Worldwide Server Vendor Revenue, Second Quarter of 2017

- HPE / New H3C Group – $3.3 billion.
- Dell – $2.7 billion.
- IBM – $1 billion.
- Cisco – $875 million.
- Lenovo – $834 million.
- **ODM** – $3.5 billion.
- Others – $3.2 billion.

Impact on IT active components & data center form factor

- Cloud providers are packing more servers in a rack, increasing rack KW
- **Increasing use of bigger height racks like 52 U size in cloud & colocation space, Increased door height & ceiling height**
- Hard floor design for server area
- **Provision of HT substation in master plan**

Cloud data center Road map

Amazon , Google, Microsoft , Facebook

- Do yourself hardware.
- High automation.
- **More Focus on energy .**
- **Ware house design.**
- **Conventional brick & mortar design , often with modular structures**.
- Horizontal modular expansion.
- Generally hard floor design.
- Ducted design.
- Hot aisle containment.
- **Customized racks & customized IT hardware.**
- Customized cooling equipment
- **Aggressive on temperature. Inlet air temperature = 104 degree F.**

Cloud data center Road map

Amazon , Google, Microsoft , Facebook

- **Extensive use of free cooling , Direct outside air for economizers , many a times chiller less design.**
- **Various Innovations.**
- Use of three phase AC mainly.
- Overhead cabling.
- **Tier level , flexible based on business model.**
- Data center modularity, modular build out with demand. Also container considered.
- Certifications , EU COC , LEED , Energy star rating.
- PUE = 1.1 (Chiller less design)
- Maximum use of renewable energy.

Colocation data center Road map

Digital reality , Equinix & NTT

- Design guided by client requirement
- Conventional brick & mortar design
- Vertical modular expansion
- Generally false floor
- Generally under floor air distribution
- Cold aisle/Hot aisle containment
- Standardized racks & heterogeneous IT hardware
- Generally chilled water precision unit
- Conservative approach on innovations

Colocation data center Road map

Digital reality , Equinix & NTT

- Use of three phase AC mainly.
- Overhead cabling.
- Tier level , Tier-III & IV based on TIA & UTI
- Civil construction in first phase for all modules . No container considered.
- PUE = 1.5

Enterprise data center Road map

- **More Focus on Reliability , followed by energy efficiency**
- **Brick & mortar design /Room in room solution.**
- Vertical/Horizontal modular expansion
- **Generally false floor design.**
- **Cold aisle containment. Hot aisle for purpose built data centers**.
- Standardized racks & OEM hardware, moving towards converged IT infrastructure.
- **Type of Cooling equipment based on rack load.**
- **Environment within recommended temperature environment**
- **Use of indirect free cooling ,**
- **Various Innovations, Focus on energy saving**

Enterprise data center Road map

- Use of three phase AC mainly
- Overhead & under floor cabling
- Tier level –III & IV based on business model
- **Generally container not considered**
- Certifications , EU COC , LEED , Energy star rating
- PUE = 1.4

Edge data center Road map

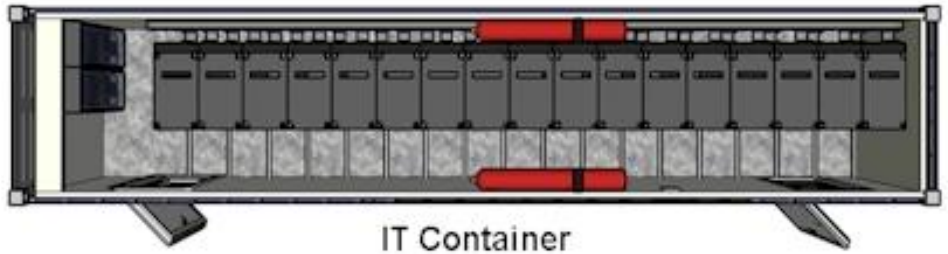
- Focus on space efficiency , reliability & security
- **Room in room solution/ Containerized solution/ Rack based solution**
- Generally false floor design.
- Cold aisle containment.
- **Converged IT infrastructure.**
- **Type of Cooling equipment based on rack load.**
- **Environment within recommended temperature ASHRAE environment**
- Overhead & under floor cabling.
- Tier level – III & IV based on business model

HPC Road map

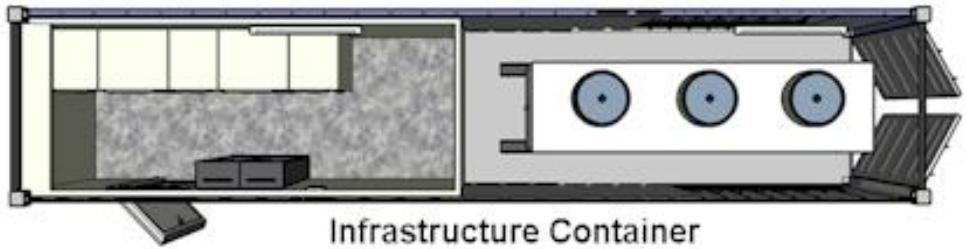
- Focus on efficiency
- Brick & Mortar
- Generally false floor design.
- High end hardware , combination of CPU & GPU
- Cooling innovations , rear door, warm water cooled
- Environment within recommended temperature ASHRAE environment
- Generally Overhead cabling.
- Tier level –Not a requirement.

Containerised Data Centres for Edge applications

"All-in-One" Design (example layout)



IT Container



Infrastructure Container

Multi-container Design (example layout)

Current cooling Equipment landscape

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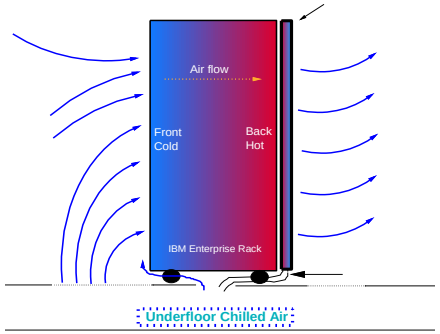
Precision units

Direct Expansion
Chilled Water
Dual-Fluid
Free-cooling

In row cooling units

Direct Expansion
Chilled Water

Rear door heat exchange



Chilled Water

Closed loop cooling

Direct Expansion
Chilled Water

Chillers

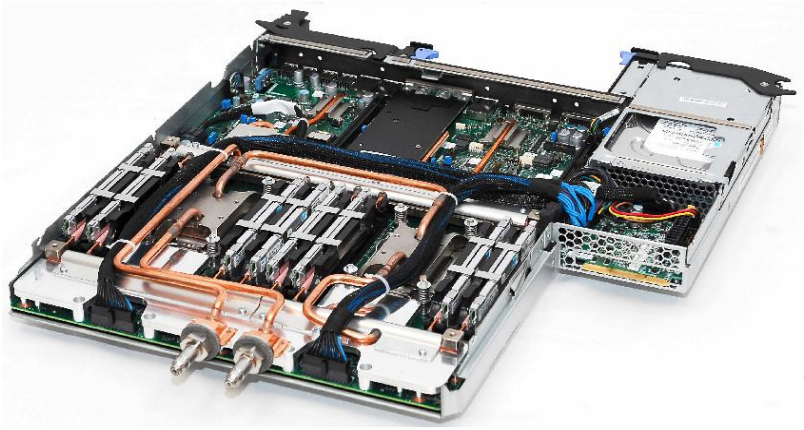
Air cooled
Water cooled

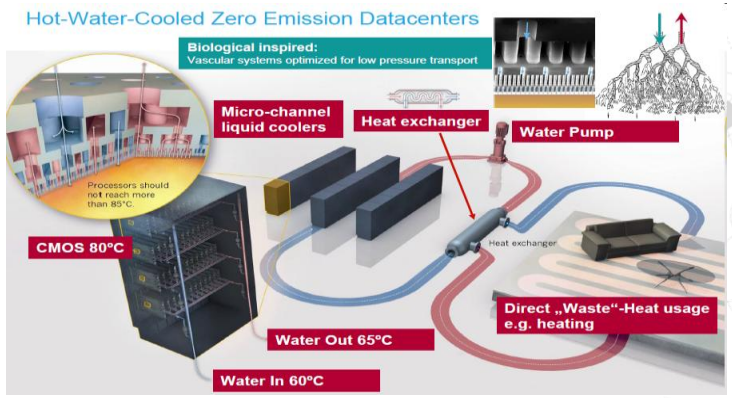
Current trends & future move - Cooling

- Generally false floor distribution with CRAC.
- Some DC user prefers hard floor distribution.
- Hot aisle containment for purpose built data center
- Chilled water based units. Scope for DX based units shrinking. New F gas rules in Europe. Within last 15 years three changes in refrigerants. New refrigerant R-1234 Ze is flammable
- Variable speed chiller/pumps/ EC fans.
- Move towards primary variable chilled water distribution.
- Customized chilled water based AHUs preferred by cloud providers.
- Localized/ close loop/ rear door for enterprise/ HPC/ Edge data center for high density racks
- High chilled water temperature being increasingly adopted.
- Application of warm water cooled server for HPC/ Edge environment. Increased scope of free cooling.
- Some use of high temperature hardware where probably liquid cooled can not be adopted.

Liquid cooling will rule HPC & the edge- A game changer

- Liquid cooling applications in high performance computation.
- It is perfectly match for high density , high power server modes and are much less prone to failure than air cooled servers.
- Hot water can be used for District heating system.
- SUPERMUC -LRZ facility of IBM at Germany uses hot water cooled servers to achieve PUE of 1.1.
- IBM employs microchannel based heat sink and water is supplied at 60 degree C.
- Russia's RSC employed hot water cooled server.
- Googles machine learning chip to use liquid cooled.
- 3 D chip stacks (ICE cool) is a reality





Liquid cooling will rule HPC & the edge- A game changer

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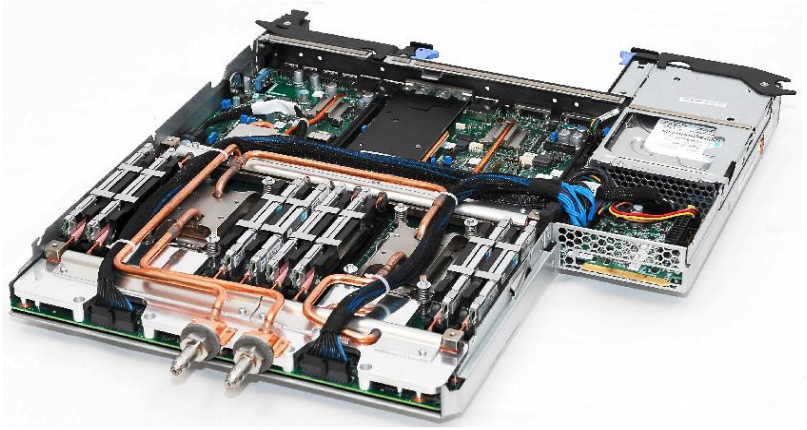
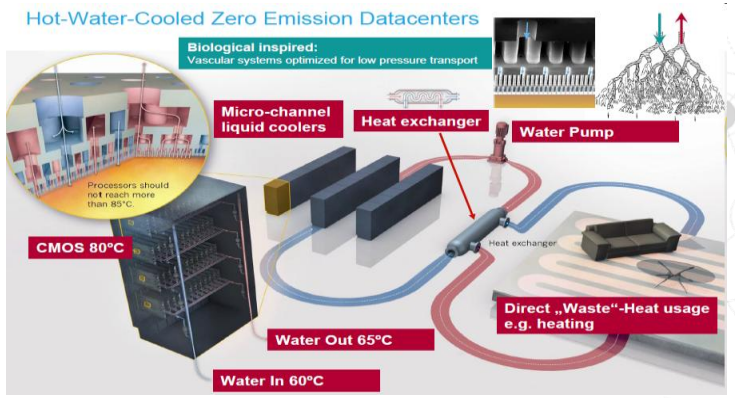
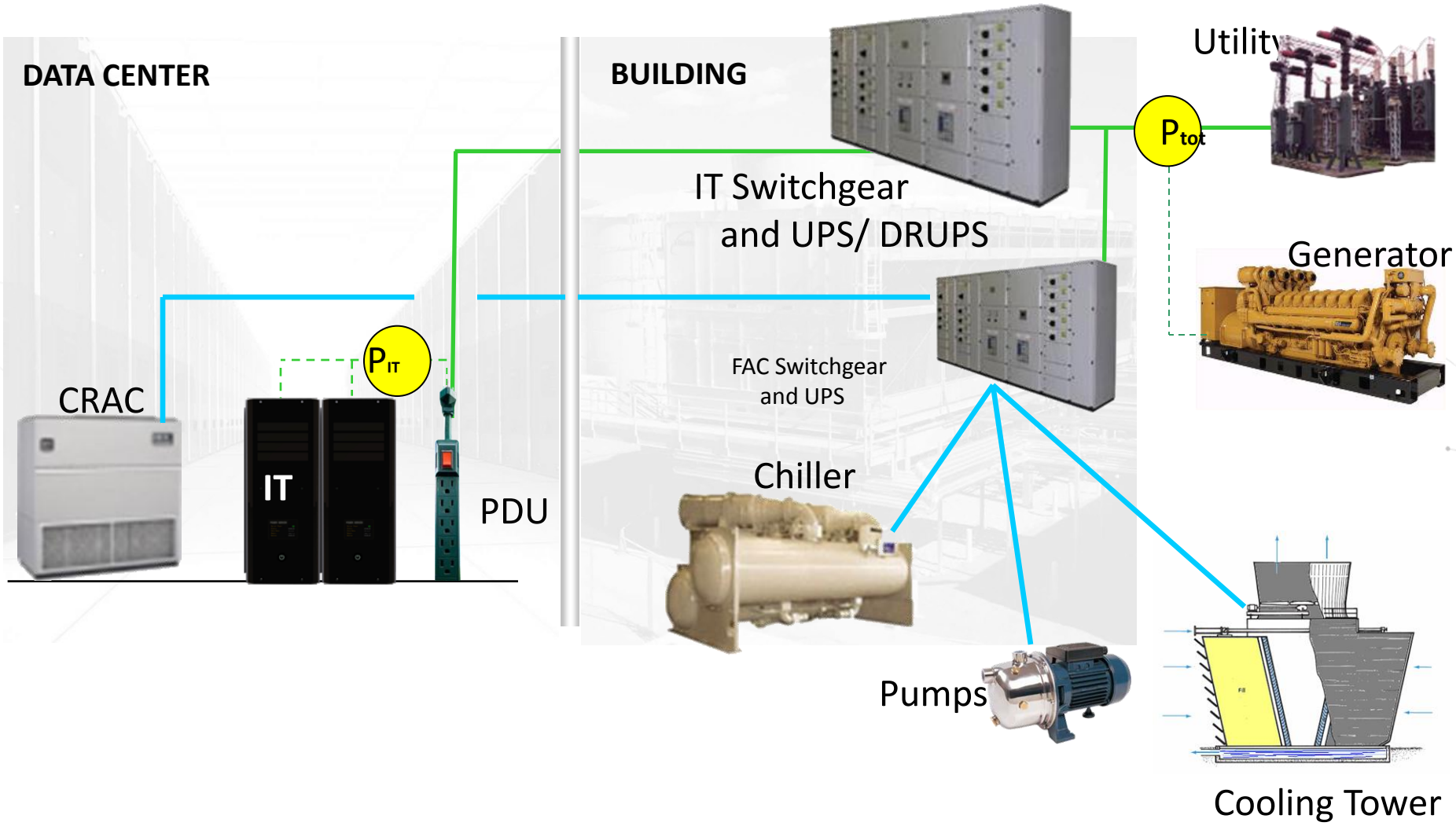
Benefits

- Space efficiency.
- Reliability.
- Energy efficiency.
- Quiet.
- New EU regulations to cut green gas emissions. New F gas rules.
- New refrigerants may be way forward . Another approach will be doing away from refrigerant and use hot water cooled server.





Typical Power distribution in the data center

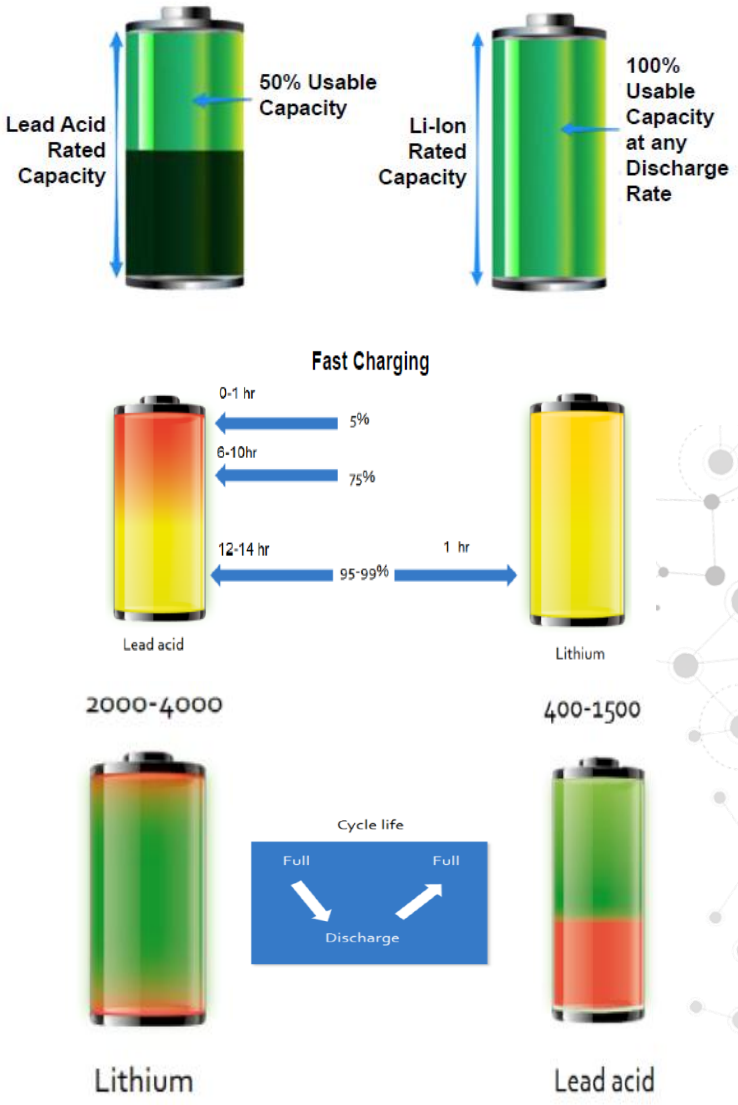


Current trends & future move - Power

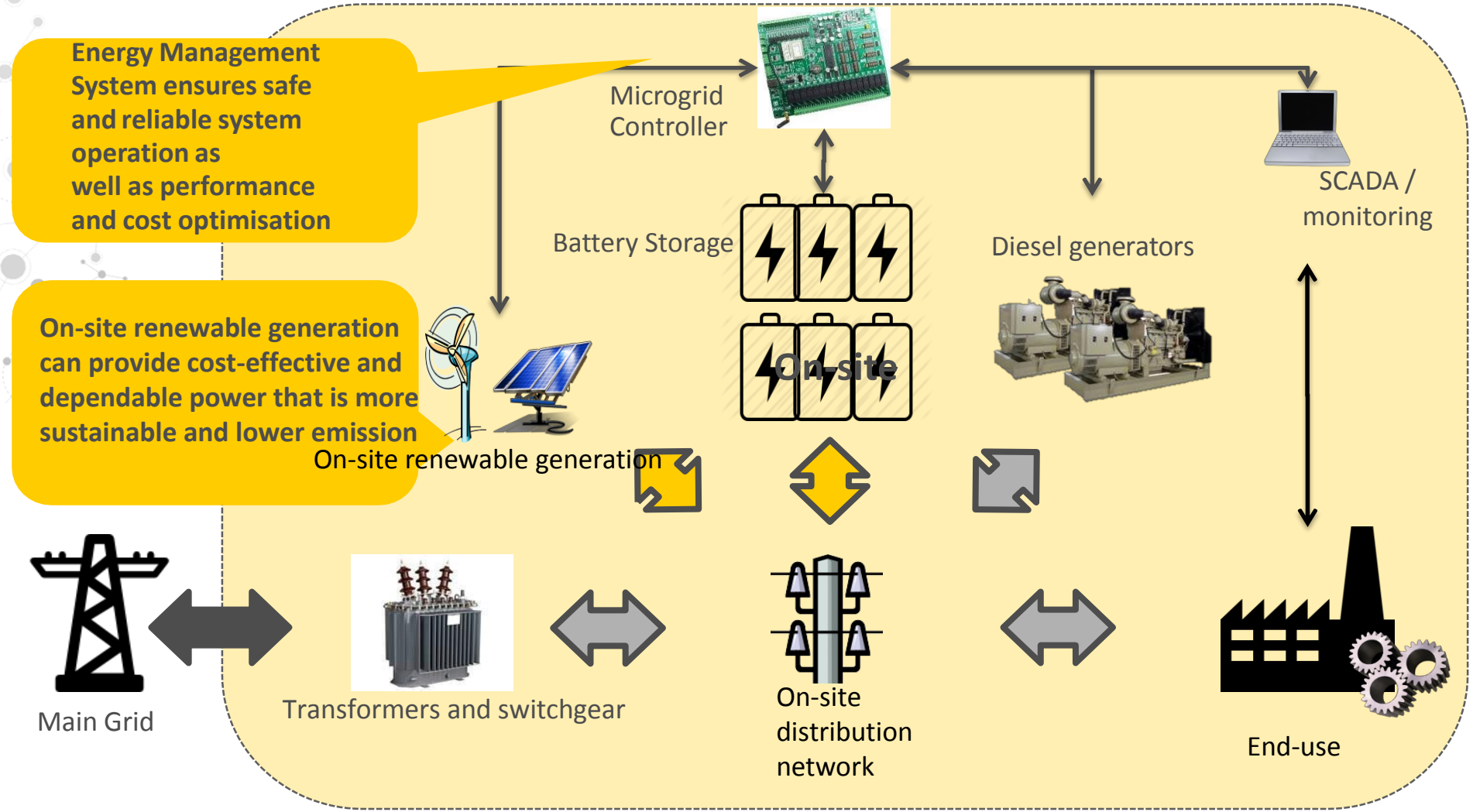
- Using UPS with Eco-mode that give 98.5% efficiency.
- Use PDUs with high efficiency transformer.
- Overhead BBT for power distribution to reduce transmission losses
- Power rating of individual facilities to be selected at optimum level.
- Power/ energy measurement as a part of equipment/ device.
- Lights off data center to be planned, LED lights with occupancy sensors can be planned
- Lithium ion battery
- Low harmonics system to be designed with no capacitor panels.
- Generation of clean power through renewable source /COGEN system.
- There could be move doing away from UPS , LRZ facility of IBM

In power distribution, Li-Ion Batteries could be a game changer

- Increased Life/ High Reliability: Fewer battery replacements
- High Energy Density: About three times less weight
- High Cycle Life: Up to ten times more discharge cycles
- Low Self Discharge: About four times less self-discharge
- Improved Efficiency: Four or more times faster charging
- This will open up the avenue for using the lithium ion batteries in data center for multiple use.
- The resources can be utilized for grid stabilization .



Used of Li-Ion batteries in Grids :



Future of DCIM tool

- Todays hyper scale data centers are fully chocked up with sensors & probe and create a plethora of data and need to be more intelligent to analyze.
- To make a DCIM a reality , DCIM will require to incorporate AI , big data analytics.
- Future DCIM need to provide cost information to enable CFO & CIO to decide . It need to manage environmental control to reduce PUE.
- This is probably possible when DCIM can be provided as a service, not as a tool , to make it completely holistic to meet hyper scale data centers both for Mega , mini & micro data center.

ONE STOP SOLUTION FOR YOUR DATA CENTER NEEDS

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