كلية الخوارزمي الدولية
KHAWARIZMI INTERNATIONAL COLLEGE

Report Title

Daman Abu Dhabi Data Centre Design, Operation & Management

A Research Project Presented in Partial Fulfilment of the Requirements for the Bachelor Degree in Information Technology at Al Khawarizmi International College on Fall 2016/2017

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Abstract

In this report we are going to explain what is a Data Centre, how business are relayed on the Data Centre and Data Centre best practices, designs according to site conditions.

Data Centre tiers certification and how it would support the business from crisis which will save money.

Building a Data Centre requires criteria's to be view from different angles such as Site Selection which contain Geographic information which needs further studies to avoid area that are prone to natural hazard and acceptable distance to DR site. According to site selection, Data Centre owner will start the study of the location to match the required Tier classification. Design phase will be implemented once the company completes the total computing of the new Data Centre, architecture team is been worked closely with different vendors to decide number of cores that the Data Centre is required to provide the company the best performance.

We as Data Centre Team were requested to design a Data Centre to serve 13000 Cores and future expansion up to 20000 cores for server racks and 6 dedicated rack for Storage and archive however Network & Security Team were requesting us to have 12 network racks to comply with architecture logical design

The Data Centre Team and I were closely involve on the design and implementation phase, I have made several site survey, contribution on equipment selection which lead to change on Design and Start the implementation, I and the Data Centre Team have decided on technology & technique that will be used such as InRow Cooling and Rack Containment, We have calculate power load per rack and the Data Centre total power consumption on Watt to ensure the cooling efficiency, calculate total weights of equipment, we have designed physical security and managing the construction while making sure personal health & safety is followed all the time with consideration of risk assessment in all major activity and be deeply understood.

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Once the Data Centre Fit-out is completed we are collecting all the documents and start the hardest task which is properly manage and operate the Data Centre.

Data Centre Management is essential therefore I and the Data Centre Team have reviewed each and every single document, we have reviewed the as built drawing to well understand the site condition for future troubleshooting and maintenance.

I and the Data Centre Team created our own Access Management, Maintenance Program, Monitoring and Induction Policies & Procedure that must be followed otherwise Tier 4 classification might have more downtime of Tier 1 because of poor management and operations procedure.

Data Centre management & operation is to keep the Data Centre maintained, monitored, documented, minimize human error, predict natural hazards and make sure the devices are in peak working conditions.

About Data Centre

Data Centre is the Company brain and where the all critical information and processes are stored, managed and distributed in line with the business requirement.

Therefore, the Data Centre is consist of a well-constructed, strong place that houses servers, storage devices, network and internet connection secured from any water source and fire hazards. Also, the Data Centre has a large amount of equipment associated with power, cooling, fire suppressions and access security systems.

Data Centre for Business

Data Centre is an infrastructure that is centralizing an organization's IT operation, services and equipment.

Data Centre is where the data is stored, managed, and distributed. It also houses the network's most critical systems and dynamic to the continuity of daily operation. Certainly, the reliability and security of data centre and the company information that hosted on the Data Centre is a top priority for any organization.

Business might lose their customer or partner or worse closing the company because of unsecure and improper maintenance that can affect the operation of Data Centre.

Medium to big business requires a Data Centre regardless if private Data Centre or cloud base.

Even though Data Centre designs are unique, it should be as simple as possible to be understood by the Data Centre Operation Team or any future handover.

Data Centre architectures and requirements are different meaningfully. Ex: Data Centre built for cloud service provider such as Google significantly have different facilities, infrastructure and security requirements than private Data Centre such as one built on the company premises which is dedicated to maintaining classified data.

Regardless of Tier classification, an effective Data Centre operation is achieved by balancing the investment in facility and equipment hosted. The elements of effected Data Centre are breaking down as follows:

Facility – the location of usable space for IT equipment "White space" and the location of Electric equipment that support the Data Centre "Grey space". All the time high importance are placed on the design to optimize white space and grey space environmental control to keep equipment within manufacturer-specified temperature/humidity range.

Support infrastructure – equipment are securely sustaining the highest level of availability as possible "Uptime Institute defined four tiers Data Centres can fall under the availability ranging from 99.671% - 99.995%" (What is a data center) with some components for supporting the Data Centre infrastructure including:

Uninterruptible power sources (UPS) – battery banks, generators, and redundant power sources

Environmental control – computer room air conditioners (CRAC), heating, ventilation, and air conditioning (HVAC) systems, and exhaust systems

Physical security systems – biometrics and CCTV systems

IT equipment – active equipment for IT operations, storage and network connectivity of the organization's data. This including Network, Servers, Storage hardware, Cabling, and Racks

Operations staff –Operate, Monitor and maintain IT infrastructure equipment around the clock, Well operation will manage the Data Centre effectively even if the Tier classification is low

Cost – Space of white and grey area, Support infrastructure to reduce the downtime to save cost, Virtualize IT equipment to optimize resources, Increase IT flexibility and reduce power consumption for green environment

Data Centre Tiers

Most Data Centres having Tier level of 1, 2, 3 or 4, and these levels serves as a figure for everything it is offer which is its physical infrastructure, it's cooling, power infrastructure, redundancy levels and promised uptime.

Data Centre infrastructure costs and operational complexities increasing with Tier Level, and upon to the Data Centre owner to design to approach the Tier Level that fits the business's need. A Tier 4 solution is not better than a Tier 2 solution if the Data Centre is not management and operate according to the policies and procedures. The Data Centre infrastructure needs to match the business approach, otherwise companies may overinvest on Data Centre or take huge risk. Even though Tier 2 can be more efficient than Tier 4 if they implement Data Centre Management and operation correctly on the other hand Tier 4 can be worst the Tier 2 if they have not followed and implement Data Centre Management and operation correctly as they will have spaghetti in network and power cables, no proper labelling, human error because of lack of physical security.

Tier 1

Tier 1 Data Centre is basic Capacity which secure separate site IT infrastructure hosting IT system that support the business. The compensation of Tier 1 including UPS to filter and provide the power due to power outage, Separate cooling unit which is note shared with other facilities. (Hector Diaz)

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- Single path of power and cooling

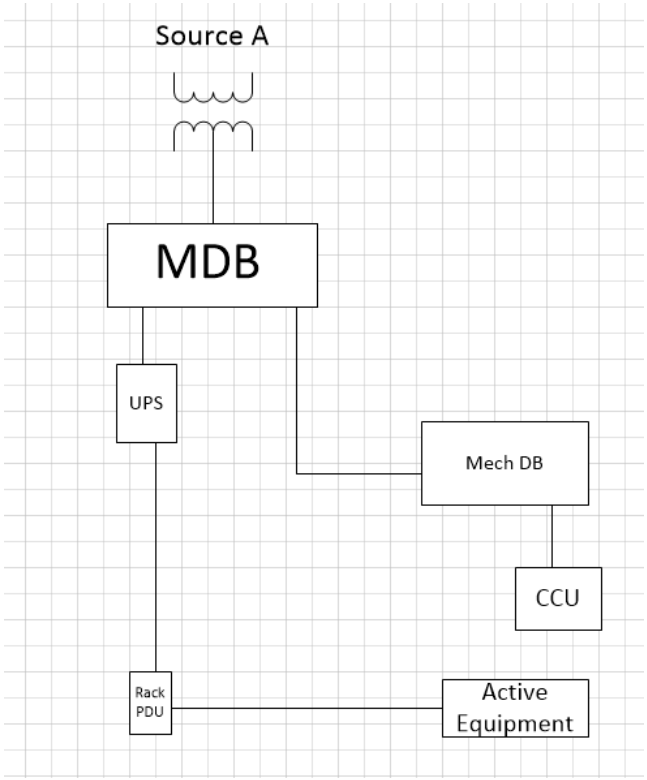

Figure 1 Data Centre Tier 1

Tier 2

Tier 2 Data Centre is Redundant Capacity Components facilities which secure separate site IT infrastructure hosting IT system that support the business. The compensation of Tier 2 including: (Hector Diaz)

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- Single path of power and cooling
  - Generator to provide power to UPS due to power outage
  - Redundant UPS to provide maintenance schedule that increase safety of equipment from failure
  - Redundant PDU that coming from each UPS to increase safety of equipment from failure
  - More than one cooling unit to share the load
- List and availability of critical spare parts

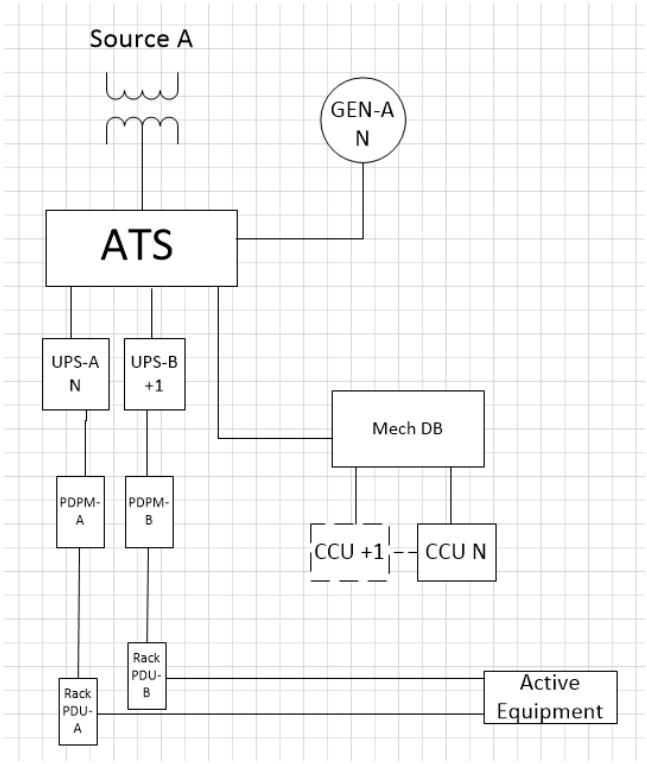


Figure 2 Data Centre Tier 2

Tier 3

Tier 3 Data Centre is Concurrently Maintainable Data Centre which have dedicated White and Grey area that have same as Tier 2 component but each power source is coming from different path which have dedicated generator.

No shutdown is required for equipment replacement or maintenance so each and every component needed to support the IT processing environment can be shut down and maintained without impact on the IT operation. (Hector Diaz)

- Multiple cooling and power path
- Fault tolerance (N+1)

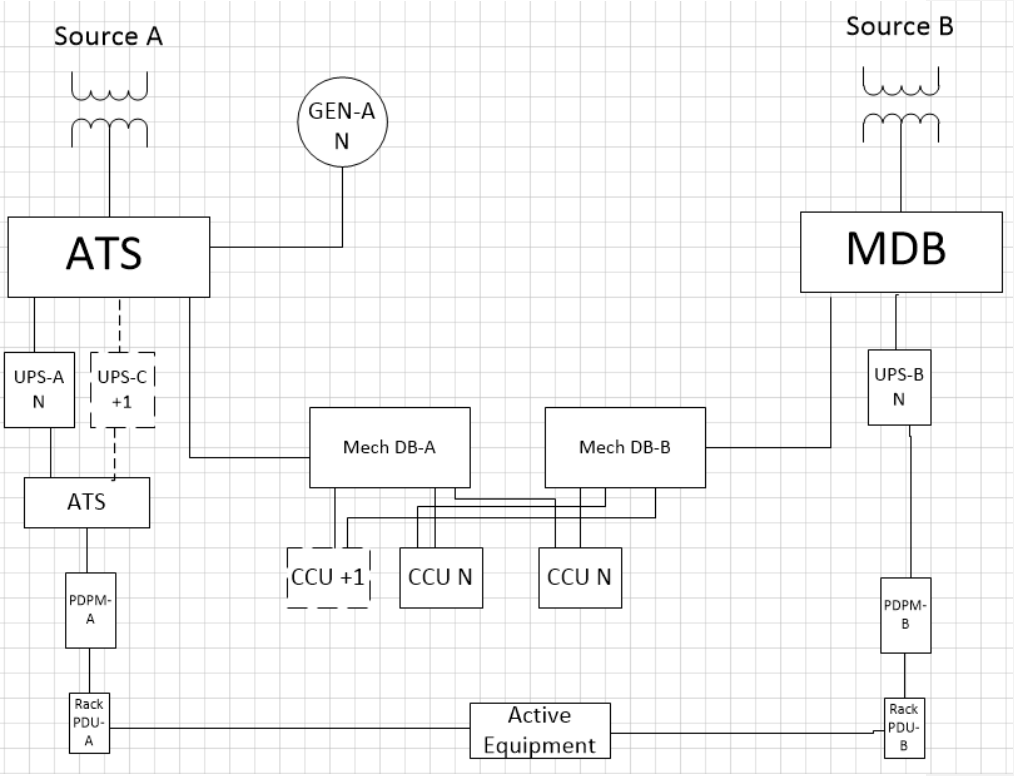


Figure 3 Data Centre Tier 3

Tier 4

Tier 4 Data Centre is Fault Tolerance site infrastructure builds on Tier 3 which have dedicated White and Grey area that have same as Tier 3 component but the redundant cooling outdoor and UPS are in two different location and the UPS is powered from different transformer path so No shutdown is required for equipment replacement or maintenance. (Hector Diaz)

- Two in depended utility path
- Fully redundant (2N+1)

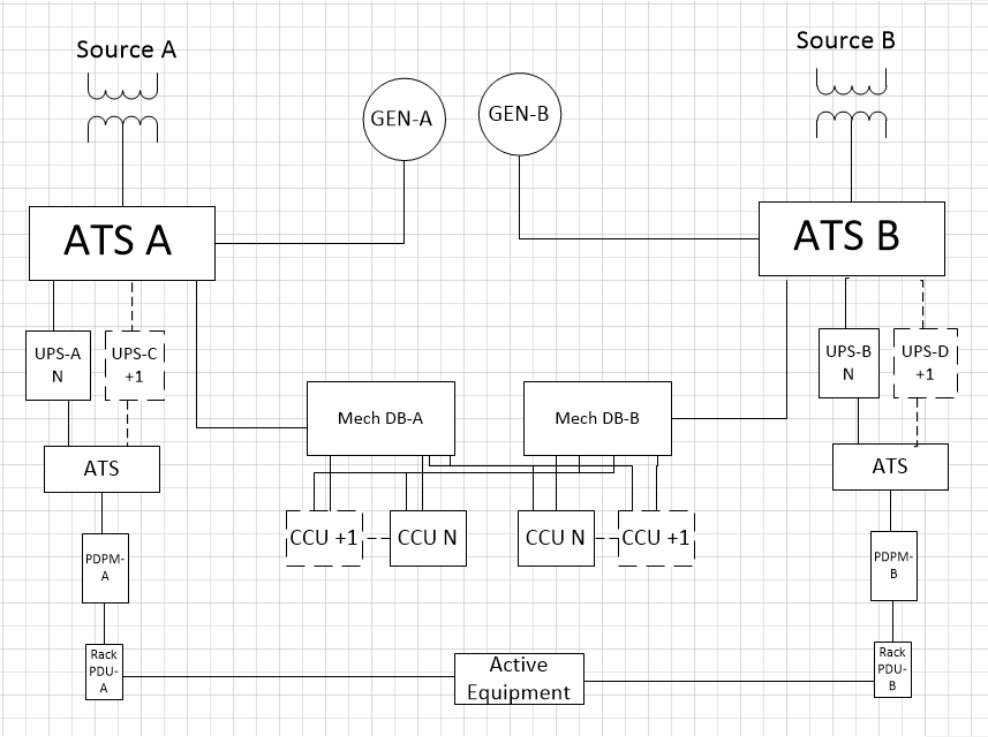


Figure 4 Data Centre Tier 4

Site Selection

There are many factors affecting Data Centre site selection, these factors will be looked from strategic perspective.

Geographic location

Geographical location site is the first and foremost factor which include Natural disasters such as Flood, Hurricane, Tornado, Fire, Earthquake etc. probably you will study the location that you have been choosing and will consider the Natural Hazard that might happened to your location, accordingly certain procedure will be taken in place at the said location; also the affect Climate which support free cooling (outside air cooling) will be an added advantage.

Ex: city that might be in earthquake zone will install special raised floor pedestal with anti-vibration properties for reduce movement.

Bad practices: the location of Data Centre is near to ocean that have frequent flood, also building Data Centre and Disaster Recovery site on the same area is bad practice.

Best practices is choosing the area has the least hazard and take certain method to avoid the possibility of other hazard, also use some analysis method to identify the Disaster Recovery site from Data Centre. (PRASHANT BAWEJA, 2013)

Figure 5 Data Centre Geographic Location

Location & Site selection

During site selection you have to ask the below question to correctly choose and build a new or rebuild an existing facility.

What is the general layout of the site?

In our case is the Data Centre on the Mezzanine floor as the best practice.

- It is not advisable to build the Data Centre on the ground floor as it is prone to flood, accidents from cars and physical security.

Is the area enough for required equipment?

Room size is 12.5*9.5 to accommodate Racks, AC, UPS, PDPM, FFS, Electric equipment, Network and Electric connection, the current space is not enough to accommodate the required equipment, the team working on the solution.

- Best practice is building a Data Centre that have extra capacity "Double space" for future business expansion. Provisions for future cooling and power to be considered.
- Bad practice is to design a Data Centre that can only accommodate the initial requirement where there is no possibility of future business expansion.

What is the closest area to chillers and condenser units?

Mezzanine floor balcony has enough space to install the AC out door unit.

- Best practice to have the condenser in proximity of the Data Centre for maintenance reason.
- Bad practice to have the condenser far from the Data Centre where there will be difficulties on maintaining it due to pipe distance for gas leakage trace.

Is there suitable access for entering large equipment?

Service elevator is enough for entering a large equipment

- Best practice to have service elevator that can contain large equipment
- Bad practice no service elevator or other entry that can contain large equipment where it will lead to install or remove the equipment by mobile crane which is very risky.

What are the possibilities of controlling access?

Physical security where we use Access control and CCTV

- Best practice the floor should be isolated by access control system for Data Centre where unauthorized people should not be able to enter the floor without prior approval and also monitor by CCTV from the Command Centre.
- Bad practice the Data Centre is visible from corridor or on ground floor which have less control over the security.

Is the area isolated from liquid leaks?

After checking the building services no Water services are passing above or below the Data Centre which confirms that there are no source of water around the Data Centre area.

- Best practice there should not be any water source passing over the Data Centre or below the Data Centre
- Bad practice Data Centre having some water source passing over Data Centre where these area must be isolated from Data Centre by water proof material and Water Leak Detection sensors

Is there space for future expansion?

The Data Centre was designed considering the future expansion.

- Best Practice to have space for Future expansion
- Bad practice building Data Centre that serve the current company need where need to add some Rack, AC

Can walls be adjusted without creating structural instability?

Fire rated wall will be install on the top of existing wall.

- Best practices fire rated wall should be installed on Data Centre and fire stopping material should be installed on the opening, the new layer of wall can be installed instead of restructuring the walls
- Bad practice non-fire rated wall, non-fire stopping material, non-fire rated door or different fire rating for each material.

What is the room height?

The height of the room from lower slap to upper slap 6 Meter there will be challenges to build new slab in between to divide the room to different area, lower area electric room "Grey area" upper floor Data Centre "White area" also the new slab can't effort the load of the equipment, therefore 6 Meter will be efficient of we didn't divide the floor.

- Best practice it all about the services that coming from the ceiling and below raised floor and coordination with Air flow
- Bad practice some people doesn't install raised floor and they and up with services on the floor or under a permanent floor where it is difficult to add ,remove equipment or troubleshoot any issue

Can a raised floor be added?

Raised floor can be added according to the design

- Best practice, raised floor height should be identified after the of the service below the raised floor such as number of power cable and Network cable with cable try, drainage pipe, water supply pipe, AC air flow if perforated tiles used
- Bad practice raised floor height identified without considering number of power cable and Network cable with cable try, drainage pipe, water supply pipe, AC air flow, once the services installed their might be miss of cable because of less height or not efficient air flow because of cable blocking, also it would be difficult to maintained

Is the floor to ceiling height suitable for a raised floor, false ceiling, and equipment height?

- Yes it is

Is the existing slab floor will be able to handle the weight load?

- As per the equipment load the slap can handled

Is there space for a separate Command Center?

- No space to Command Center on the same floor, therefore the Command Center is on the floor above Data Centre

Data Centre Design

Data Centre Design Philosophy

Data Centre Design core values that are the foundation of a Data Centre design philosophy:

- Simplicity
- Flexibility
- Scalability

Simplicity

A simple Data Centre design is easier to understand and manage, a basic design makes it simple to do the best work, trace any issue and more difficult to do sloppy work.

Figure 6 Simplicity Philosophy

Flexibility

Nobody knows where technology will be in 3 years, but it is a good guess that there will be some major changes. Making sure that the design is flexible and easily upgradable is critical to a successful long-term design.

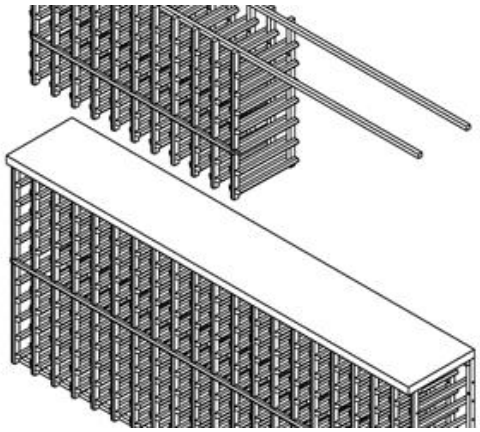


Figure 7 Flexibility Philosophy

Scalability

The design should work equally well for a 2,000, 20,000, or 2,000,000 square foot Data Centre it only matter to add an equipment to extend the Data Centre.

Figure 8 Scalability Philosophy

Design Process

The design stages for the Data Centre usually take the assistances of Architects, Structural, Mechanical, Electrical, HVAC, System, and Network engineers, Project managers, Procurement personnel and most probably insurance carriers and risk management analysts involve on major activity.

Data Centre design engineer is the project manager who aim to achieve the requirements of the system and network engineers with share the work with the rest of project team member to guarantee that the Data Centre requirements are based on the project scope.

Design Drawings

- Architectural drawings: it show the building as built drawing which present the physical building with dimension, material and services of the building, these drawing is been studied before proceed with Data Centre Design.

- Structural Drawings: these drawings are studied to ensure the floor hold materials and construction techniques from collapsing under the weight of all Data Centre Equipment such as UPS, loaded Racks and AC units.

- Electrical design: These are involving building single line diagram and lighting control system, electrical distribution board, wire ways under the raised floor, bar bus and grounding connection, MCO or ATS, breaker and subpanels, power from transformers , wiring for the fire detection system, and smoke alarms.

- Equipment design:
  - These drawing include HVAC unit weight, placement with manufacturer recommendation and determine proper installation of piping units with section elevation.

  - UPS unit weight, placement with manufacturer recommendation and determine proper termination with section elevation.

  - FSS cylinder weight, placement with manufacturer recommendation and determine proper installation of piping, control panel, smoke detector and release button with section elevation.

Data Centre Material

Some Data Centre Materials are important and other that used in Data Centre should be fire rated such as:

- Raised floor
- Racks
- Walls
- Doors
- Glass
- Sealants
- Drainage & Water supply Pipes
- AC gas pipes
- DBs
- Paint
- Cable tray
- Cable ladder
- Cable containments

Raised Floor

This is followed on most Data Centre design as best practice since it providing flexibility to network and electrical cabling and other services such as AC piping also it increasing the efficiency of air conditioning. While bad practice is having all the connection from the top to the Racks which will have bulk of network and electrical cabling behind or on the top of the equipment for the connection also having AC pipe on the top of the Data Centre is increasing the risk of water leakage.

Figure 9 Raised Floor

HVAC Aisles

This is for controlling the temperature and the humidity of the Data Centre for utilize equipment peak performance and optimize and increase the equipment life cycle.
In our Data Centre we are having shortage of space where we have to re-design the Data Centre to contain all equipment that already purchased, the design was including Cold Aisle with CRAC unit, The CRAC unit would require 200cm space to provide efficiencies air flow to the cold aisle we have to consider 60cm for the CRAC unit and 60cm space behind it as per the manufacturer recommendation.

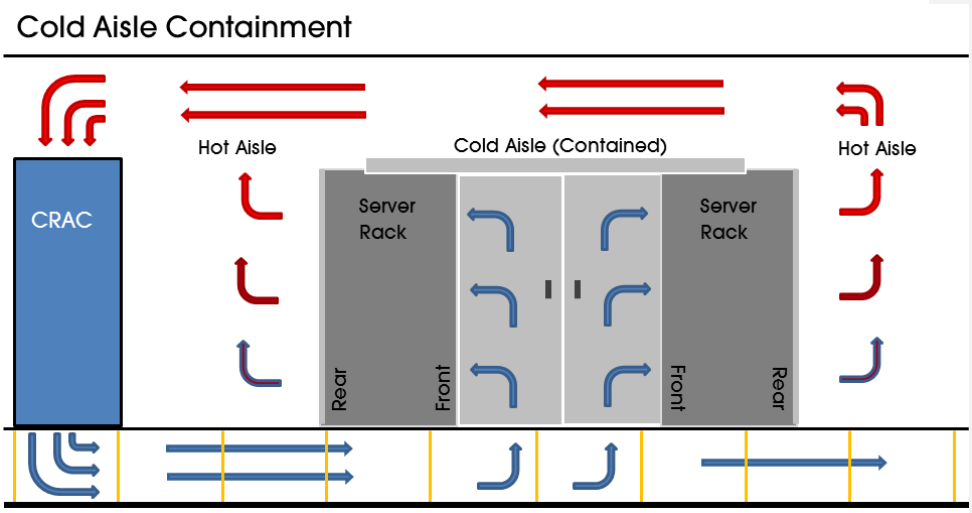


Figure 10 Cold Aisle Containment

Accordingly we have replace the CRAC unit to InRow unit which will be placed between the racks and consume Zero space, also we have change the design from cold aisle containment to Hot Aisle containment which not require perforated tiles, containing all hot air in one place and recycle it to cold air, increasing the efficiency of the equipment by supply efficient air, in addition hot aisle containment would be perfect in our case because of space shortage since the cold air will not be wasted.

Figure 11 Hot Aisle Containment

Rack Location Units

The Rack Location Unit (RLU) system is need to be flexible enough to be used for troubleshoot, replace or provisioning new equipment which is 120cm front of rack and 100cm behind of rack in a Data Centre. The racks are set-up in a specific place on the Data Centre to connect the services such as power to PDU, Raised floor tiles etc.

UPS location and connectivity

The UPS Location is need to be in location that would be easy to connect to SMDB, Batteries and PDPM also the UPS should have space of 100cm in front and 60cm from each side and 50cm from the top to have efficient cooling also these space is required for troubleshooting. The Batteries cabinet is located in a specific place around the UPS for connection.

Fire Suppression System (FSS)

Fire suppression system to protect against fire destroying Data Centre and the equipment installed, we have choosing Novec 1230 against FM 200 because of the below

- Novec 1230 are designed to fully discharge in 10 seconds. They act on fire by removing heat quickly so the fire will be extinguishing in less than 10 seconds
- Safety Novec 1230 is adverse effects on human is around 10% which is 90% safely for human
- Novec 1230 is the smallest cylinder size comparing with other FSS
- Novec 1230 is Green gas which has less impact on environment. (Finian Quinn, 2015)

Lights & 13 amp

Lights are important in Data Centre as industrial sites, also having some 13Amp for general use inside the Data Centre

It is essential to provide adequate light in Data Centre and to make sure that the intensity of lights at 1m height from the floor is 500 Lux

Data Centre Structural Layout

Data Centre Structural Layout came on stage of start approving the Data Centre design after studding the location, Site, Room measurement (height-Width-depth), deciding on equipment that will be purchased with manufacturer recommendation and method of connect the cables and pipes inside the Data Centre with considering where the equipment will be placed, raised floor and Ramp with considering the weight of the equipment.

In our Project we have room of 1250cm*950cm*500cm that should contain:

- 44 Racks
- 10 ACs
- 2 UPS
- 2 Battery cabinets
- DBs
- Gas cylinder
- Raised Floor height 60 cm

As mentioned earlier we are running out of space and the initial design been rejected therefore we are redesign the Data Centre to accommodate all requirement following the best practice.

Data Centre measurement layout

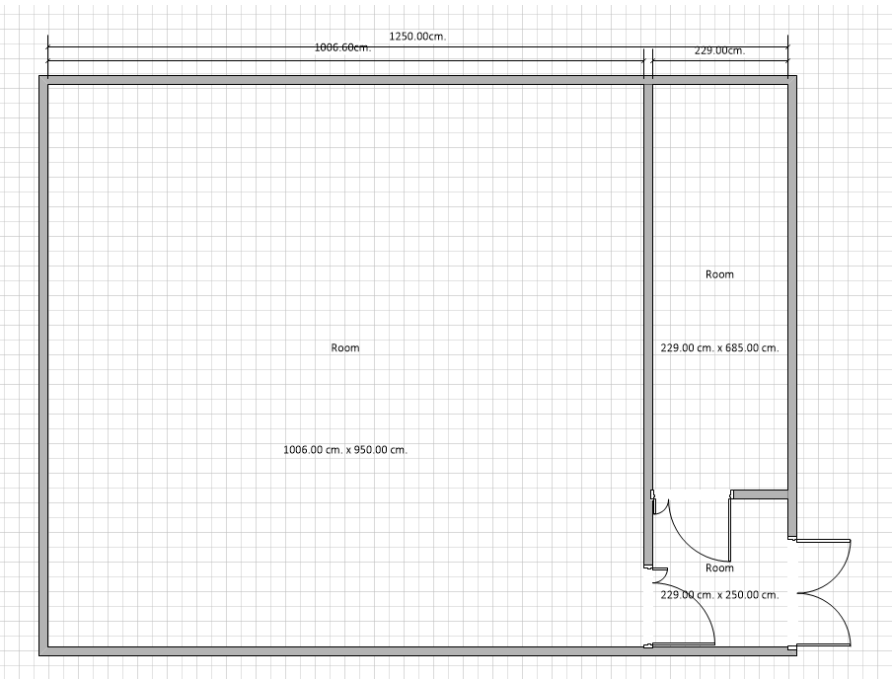


Figure 12 Data Centre Measurement Layout

The rejected design were having the below equipment

- 32 Server Rack 60cm*107cm
- 12 Network Rack 75cm*107cm
- 4 CRAC AC connected to each other
- 2 UPS
- 2 Battery cabinets
- 2 PDPM
- DBs
- Gas cylinder
- Solid and Perforated Raised Floor with height of 60 cm

Rejected design

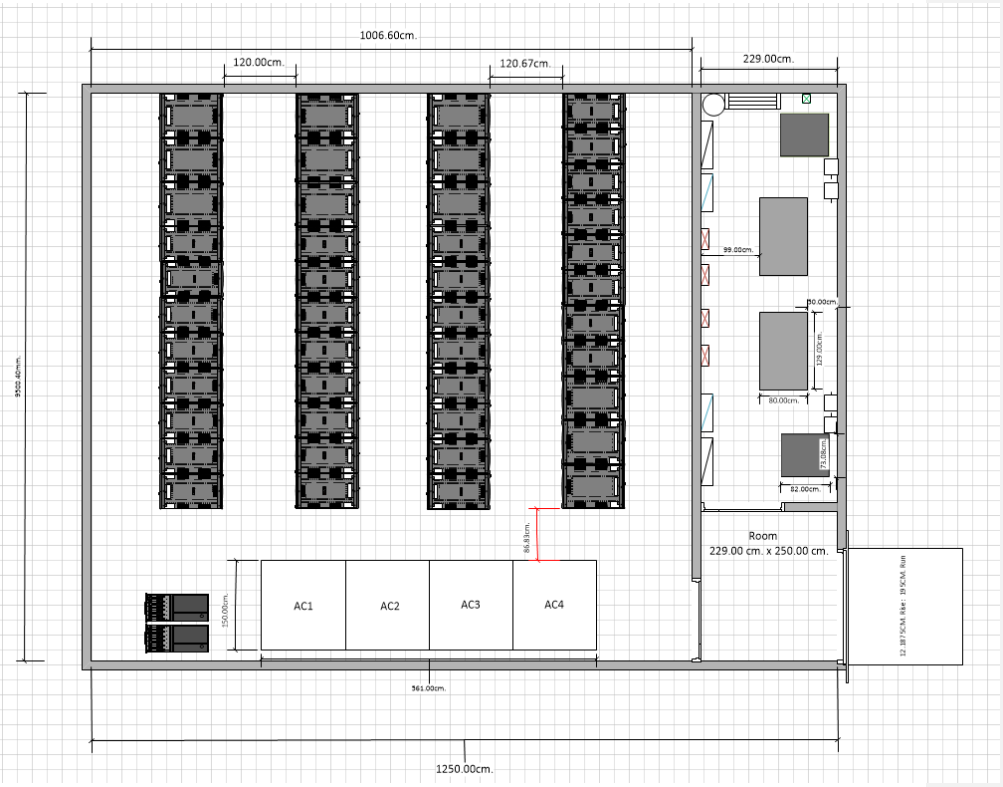


Figure 13 Data Centre Rejected Design

The rejected design have three major issues

- Technical wise the distance between the AC and first Rack is 85cm which is not accepted by the AC manufacturer otherwise the air flow to first rack will be extra on the first rack and there will be hot spot at the end of the row, the CRAC unit should be minimum 200cm far from the nearest rack to provide an sufficient air flow
- The distance between the AC and first Rack is 85cm which is not acceptable, this is will be as disaster in future for adding or removing new equipment.
- The AC location which is in front of the Data Centre door is so ugly, design wise the Data Centre should have efficient space at the entrance, also the AC is blocking the people from looking at the Data Centre

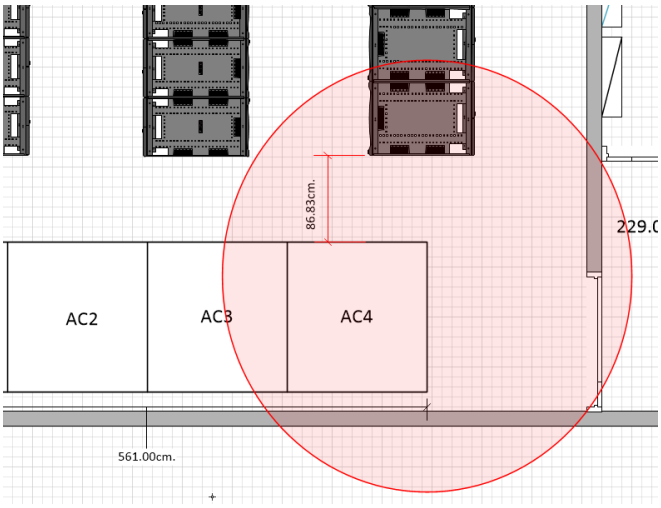


Figure 14 the Rejected Design

The new design having the below equipment:

Commented [U6]: How do you decide the capacity of the apps: is it application wise?

- 32 Server and Storage Rack 60cm*107cm
- 12 Network Rack 75cm*107cm
- 10 InRow AC 60cm*107cm "replaced of 4 CRAC AC"
- 2 UPS
- 2 Battery cabinets
- 2 PDPM
- DBs
- Gas cylinder
- Solid Raised Floor with height of 60 cm
- Hot aisle containment

New design

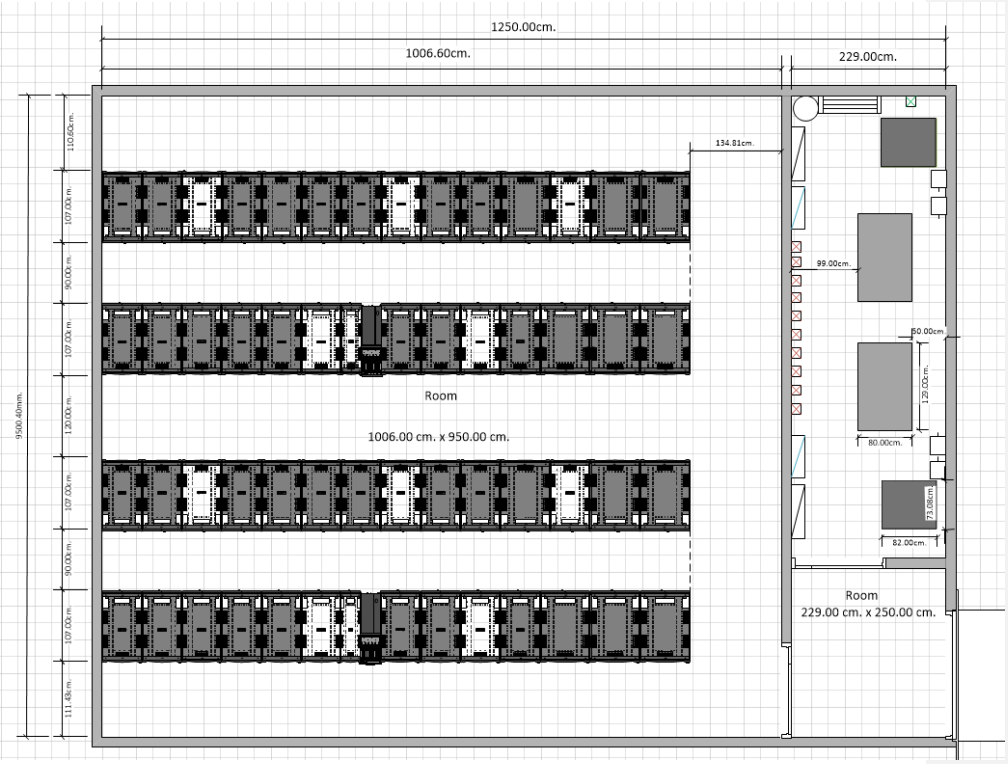


Figure 15 Data Centre Approved Design

The advantage of the design new design

- New design have InRow AC which is placed between the Racks, The AC will provide the cooling equally to the rack since the InRow are distributed in the Data centre.
- Hot Aisle containment, we have taken the advantage of the space shortage in the Data Centre, this containment restricts all the heat from the rack and contains in one place were the InRow suck these hot air and transferred to cold air inside the Data Centre, in addition since we have limited space on Data Centre the utilization of the InRow will be less which extend the equipment's life cycle
- Design wise the Data Centre is more arranged and have open space in front of the entrance.

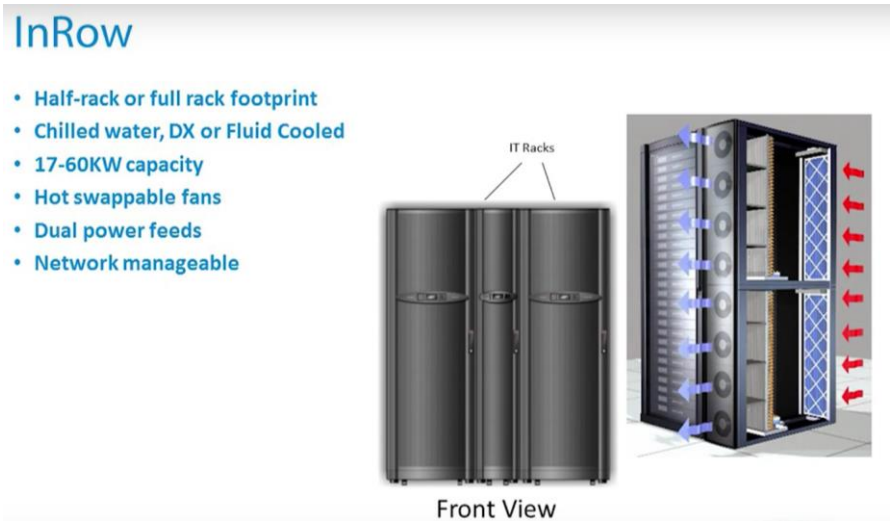


Figure 16 InRow Cooling

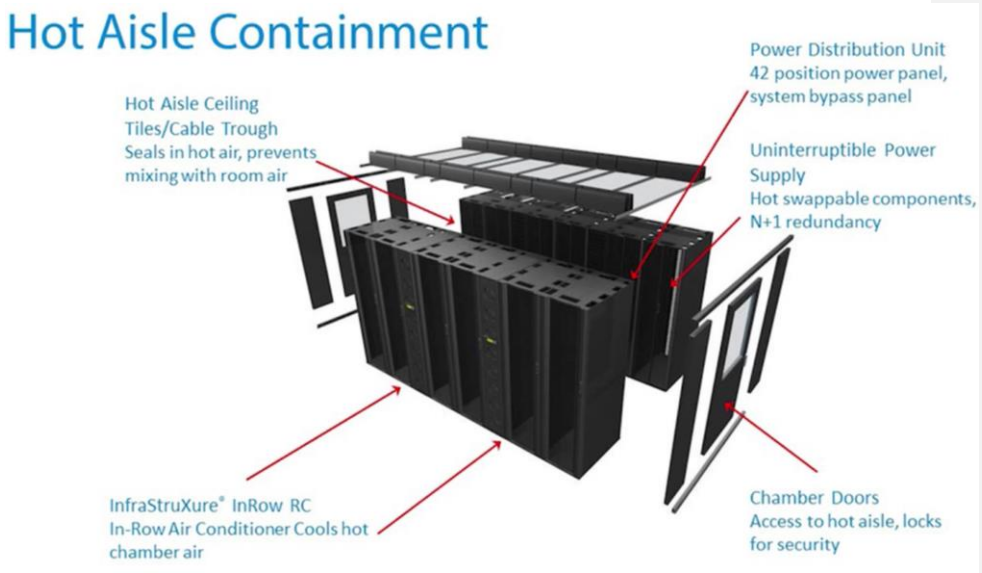


Figure 17 Hot Aisle Containment

Data Centre Capacity

Designing for Data Centre Capacity is critical as all future provisions should be considered. The maximum capacity should be agreed and identified from day one to properly asses the design. Data Centre capacity should be in line with the business requirement and White Space availability. By knowing the extents of the design then supporting future requirement will not be an issue.

- Budget
- District & Site
- Insurance
- Computing
- Power
- Cooling
- Connectivity
- Space
- Weight

IT Infrastructure

We allied business Vision with Data Centre computing therefore the Data Centre is being designed to serve Business long future expansion, Architecture Team is involving on designing blue print of Data Centre and services integration.

Data Centre will consist of Physical machine and Hosts that contain Virtual machines this is been configure according to the application requirement.

Data Centre Team is responsible to design the Physical servers according to application needs & accordingly reach out to actual physical core requirements.

The below is been consider in the Design phase:

- The required IT Infra (Cores, RAM, Storage, Network and Security)
- The required Hosts or Machines to provide such Computing
- The required Rack to mount these Hosts
- The required Power in Kilo Watt to feed these Hosts
- The efficiency of cooling that support the Hosts to use max performance

Data Centre required Computing

The Data Centre Designed to populate 13000 Cores and it can be populated up to 21000 Cores

Network Racks

We have total of 12 Network and security racks, 4 of them Passive "No Power" which will be populated by Fiber and Copper patch panel for interconnection
8 Network racks for Network and Security appliances, each rack will be using 8 Kw per Rack in total of 64 KW

Computing

Storage and Server Racks
We have total of 32 racks, 6 racks for storage and archiving which designed by Storage Team and consume "10 Kw per Rack" which mean total of 60 KW

26 Server Rack where we have chosen enclosure specifically HPE Synergy 12000 Frame that contain 12 number of 480 Gen9 half height blade server
HPE Synergy 12000 Frame 10U size, can contain 12 number of half height blade server
HPE Synergy 12000 full populated according to our configuration will consume 6.9 Kw in peak time, 1.9Kw the minimum consume and we will have 528 core per Enclosure

Calculation "2 CPU * 22 Core * 12 Blade Server = 528 core per Enclosure
Time 26 racks = Total of 179Kw of power and 13728 Cores

Commented [U7]: Again, how did you decide the need of 528 core?

We have procure the latest technology that provide high performance consuming least energy The Enclosure has new power capping feature, this can enable enclosure to use minimum power as possible.

Enclosure also has an advantage on cable arrangement since all connection will be connected to Enclosure internal switches (6 in total) where we will have less cabling

Table 1 Blade Server Configuration

No of CPU	Cores	RAM	HDD
2	22 core each CPU	8*16= 128 GB can be increased up to 512 GB	2*800 GB

Racks population

According to the current setup we will use 26U out of 42U size
The Data Centre designed to serve the coming 5 years with current setup also we have availability of 16U per Server Rack for any long future expansion

Power

When you design the Data Centre you have to consider the following:

- How much power (Kw) each rack will consume
    - Total Power 26 Server Rack * 6.9 Kw per Rack + 6 Storage and archive rack * 10Kw per Rack + 8 Network rack * 8Kw per Rack = 303Kw
    - UPS Output is 500Kw to feed the existing load and future load
- Is the rack require single or three phase
    - Three phase 32 amp = 13Kw max for each Rack
- PDU can plugged to three phase then distributed to single phase as per connector type
- The outlet type so the PDU is ordered accordingly "C14,C15,C20"
- The brand of equipment and manufacturer recommendation
- All racks have redundant PDU connected to PDPM-A also you have to consider the same module from PDPM-B should be connected to PDU in the rack

Maximum installed power use in current setup is 303 KW
We got this number from equipment that mounted in the Racks, 64KW from Network and Security rack, 60KW from Storage and Archiving Rack and 179 KW from Servers Racks (64+60+179= 303KW).
We still having provision of 147KW

Cooling

Once you have the total power consumption of equipment, these report will be used to identify the amount of cooling that the Data Centre requires. Then you have to calculate the AC utilization without the redundancy AC, not more than 80% of AC utilization should be used with equipment peak time.

Also you have to consider the rotation of AC, not all AC will work at the same time as we mentioned earlier but there should be a rotation such as each week different AC will be in standby mode so we are sure that all AC's are functioning.

When we are calculating cooling, these numbers are only the lowest estimation, but when the design is well structured and the operation is well managed the efficiency of AC will increase defiantly

In our project we have 10 ACs "2 sets of 5 each" of Model ACRD600/P in two hot aisle containment each containment N+1 where N=4

As per the Manufacturer it requires approximately 1 watt of cooling for every watt consumed by hardware

Since we have two containment the below formula will be applied

Each AC is consuming 14 Kw with cooling capacity 50 Kw

N+1 and N+1 (4*50) + (4*50) and 80% cooling capacity in Kw = 400 *0.8 = 320 Kw which is efficient to cool 303 Kw consumption
All active and 80% cooling capacity in Kw = 500 *08 = 400Kw Cooling
Total cooling capacity in Kw = 500Kw cooling

Cabling

Cabling are divided to two parts "Power" and "Network"

Power cables in our project been pulled to be under Raised Floor on cable tray. 2 main cables "300 Sq.mm" have been installed to PDPM then distributed to all racks from PDPM, also we have 10 number of 16 Sq.mm cable connected to each AC unit.

Network Cables "Copper STP and Fiber" in our project have been installed at high level "Above Racks" on a cable ladder while power cables have been installed under raised floor to avoid the noise and loss of communication that might happened.

Weights

It is important to calculate the load or weights of all equipment distributed to the floor, each equipment load in point and the future load that might be added, these studies need to be completed to confirm whether the floor or slab can handle the total load, below some items need to be considered on the load calculation

- Rack without and with equipment
- AC
- PDPM
- UPS
- Battery cabinet
- FSS Cylinder
- Power cable
- Raised floor
- Floor screed
- Stands for equipment
- Estimation of cable tray, Ramp, etc..

Physical Space

Identify the dimensions of the racks, rack containment, UPS, Battery cabinet, PDPM, AC dimensions plus the space that needed efficient air flow as defined by the cooling manufacturer. The free space needed for aisles, row breaks, ramps, and air flow circulation.

Data Centre Support

Data Centre support or "Grey Area" must provide certain services to Data Centre such as power for cooling to keep the racks from overheating, the location of AC outdoor unit, distance, and the method of connectivity with redundancy, Power to run the racks, redundancy line of power such as generator with ATS "Automatic changeover". These Planned redundancies should follow tiers classification as we explain about the tiers on this report.

Physical and Logical Security

The security of the Data Centre is highly critical, Data Centre does not only contain valuable server hardware but also have data in the machines that are valuable which the core company is depending on rather than the equipment cost itself. Access should be restricted from non-authorized or untrained personnel. Several levels of physical security should be in place such as mantrap area between the Data Centre White Space and main entrance.

In addition the Data Centre is having Access Control and CCTV solution to monitor unauthorized staff access. The Command Center or Control Center is beneficial for controlling access to the consoles of company critical systems. This is just one of the numerous security devices used in the Data Centre. Control Room is a key area on disaster recovery scenarios and other critical times.

Data Centre Infrastructure Management

DCIM Monitoring Temperature and Room Humidity Levels, Geographical temperature view, Power fed from UPS-PDPDM-PDU-Servers, Equipment information, Water leakage and new planning changes in Data Centre.
Data Centre condition is not based on one sensor in the Data Centre, a single sensor will show that the conditions is perfect in the Data Centre but the truth is they are only perfect in that particular part of the Data Centre accordingly all sensors are connected to single monitoring and management device "Netbotz" that analyze the parameter of each sensor and presented as a single view.

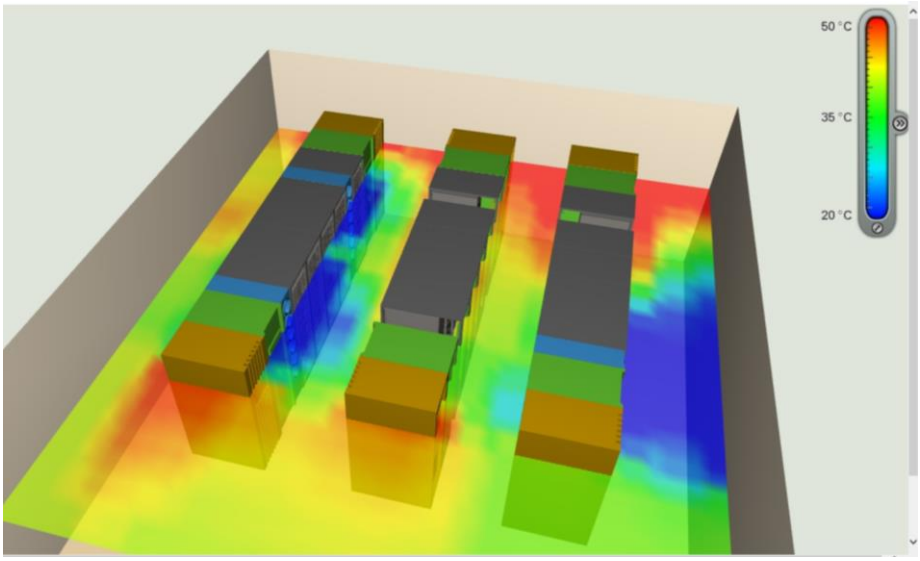


Figure 18 3D Temperature Map

DCIM provide single dashboard of sensor coordination view and as single sensor view as well

- DCIM is monitoring system and send alarm according the configuration low, medium, critical such as WLD alarm, High RH, High Rack power density etc..
- DCIM is having inventory option where you have to add device details on the time of installation and the system will track all parts of the Data Centre.
- DICM is planning and documenting the changes on the Data Centre, before you implement any changes it should be planned on DCIM to have up to date Data Centre Asset. Recommendation is option provided by DCIM in planning phase, once the information of the new device add to DCIM it will provide you the best location of mounting this device according to space, power and cooling density

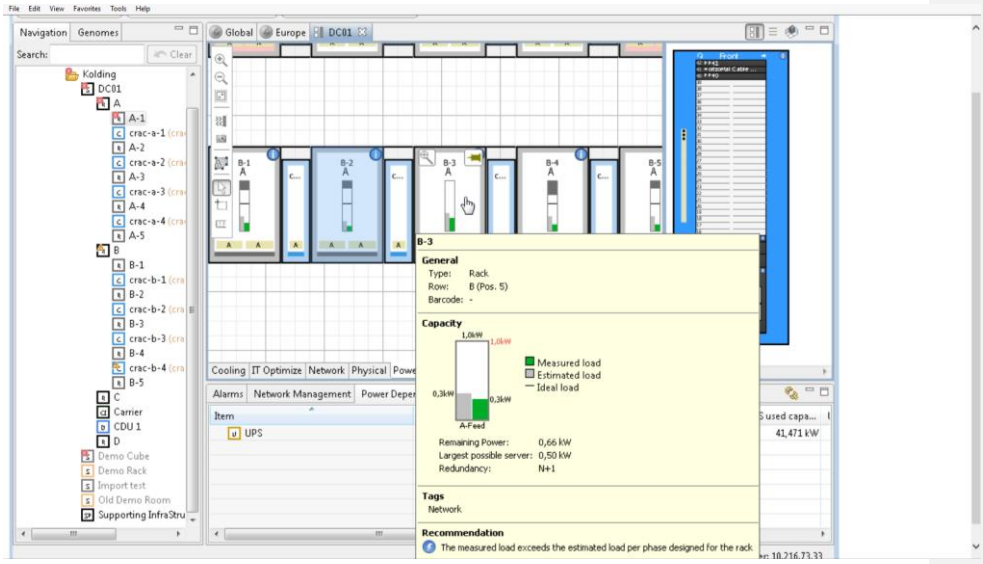


Figure 19 DCIM Dashboard

Hazard & Personal Health and Safety

Avoiding hazard is difficult but understanding what possible hazards are in the Data Centre area is the first step to avoid hazard or manage them.

We will explain briefly the following sections that came under Hazard and Personal Health & Safety

- Types of Hazards
- Personnel Health and Safety
- Fire
- Flooding
- Noise Problems

Type of Hazard

The Hazard that classified as natural hazards such as:

- Fire from electrical storms
- Flooding from rain, overflows, runoff
- Earthquakes
- High winds
- Hurricanes
- Tornados

The Hazard that classified as human-created hazards such as

- Fire from electrical short circuits
- Flooding from equipment failure, leaking plumbing, sprinkler systems
- Vibration caused by construction, large equipment, nearby industry
- Noise from Data Centre computers, large machinery, nearby industry
- Non-certified people inside the Data Centre
- Poor Data Centre Management

Personnel Health and Safety

At the earliest design phases of the Data Centre, the most critical concern in disaster avoidance and recovery is human health & safety. Equipment is important as well but it comes in second place.

- Authorized personnel should be trained to respond to emergency situations
- Monitor air quality in the room and smoke detector
- Ensure that personnel are able to exit the Data Centre efficiently by testing the integration Access Control system with fire Alarm system
- Make sure that exit lights are maintained so it dose function on emergency to guide the people
- Close long rows of racks to be avoided to have people scape easily

Fire Suppression Systems

Make sure the Fire Suppression System is gas equipment friendly that doesn't impact the equipment also the reaction of FSS is testes since the speed of FSS can minimize the damage which make the Data Centre to continue operations. Gas system has an issue that once it discharge, it won't function again until it recharged so the Data Centre will be on dangerous

Flooding

Avoid building the Data Centre on ground or basement floor where it will have chances of rain flood, raised floor can be helpful but if the power connectivity were on the slab it might get effected as will.

Flood can be from chiller pipes that connected to cooling units so to have immediate alarm of any leakage in Data Centre we are installing Water Leakage sensor around the chiller and the cooling unit to react on solving the leakage issue

Noise Problems

Nose are affecting the processors by getting faster and disks becoming denser accordingly the heat inside the Data Centre will increase, which mean cooling units will be fully utilized.

The installation of noise cancelling equipment is useful but expensive, these noise cancellation can be installed to avoid moving the noise from electric room "Battery" to Data Centre, while this good solution to people who are often visiting the Data Centre

Data Centre Operation & Management

This is created to maximize uptime efficiency in Data Centre and related information technology (IT) facilities owned and managed by DC Team. This provides guarantee and accountability for the operations team, service providers and end users to meet the criteria for 24 x 7 service requirement. Our goal is to achieve full uptime potential, obtain maximum leverage of the installed infrastructure or design, improve operations efficiency and realize opportunities for energy efficiency. This mainly provides the guidance and framework to drive best practices for the effective management and operations of the Data Centre

- Staff and Organization
- Policies and Procedures
- Access Management
- Maintenance Program
- Operations Monitoring
- Studies
- Trainings and Induction
- Reports
- Documentation
- Automation of Services

Staff and Organization

The right number of qualified individuals organized correctly is critical to a Data Centre meeting long-term performance objectives.
Enough qualified in-house staff and/or vendor support must be available to perform all the maintenance activities and operate the Data Centre to provide the greatest opportunity to meet the uptime objective.
All personnel working in a Data Centre must have the experience and technical qualifications necessary to perform their assigned activities without impacting the Data Centre operations.

Requirements

- Organizational Structure - this shows the structure of ITS department and define which team is responsible or related to the Data Centre operations.
- DC Team Escalation Matrix – this specifies multiple user contacts to be notified in the event of critical issues or emergency.
- Staff Qualifications – this is to ensure that the team assign to handle the Data Centre are qualified, trained and has enough experience to properly manage its operations.
- RACI Matrix – this clearly states or assigns who is Responsible, Accountable, Consulted or Informed in relation to each specific tasks to be defined as per the requirement

Policies and Procedures

An effective Data Centre management strategy includes policies and procedures that needs to be documented and enforced to ensure that they are understood and followed as inconsistencies in the performance can lead to service interruptions or worse - downtime

Requirements

- Data Centre User Manual – This includes all information that is critical to run the Data Centre from construction phase to operation.
- Data Centre Instructions – This are set of rules inside the Data Centre that prevents any risk to Data Centre operations.
- Emergency / Crisis Management Plan – this is to ensure control and management inside the Data Centre during an emergency or abnormal situations.
- SOP's – Set of instructions or guide to operate DC configurations on normal conditions
- Health & Safety Procedures – Set of HSE guidelines specifically for the Data Centre to prevent accidents or harm to the DC team or visitors.
- Change Management Procedures – this is to review and approve the proposed changes and evaluate the risk that comes with it.
- Access Procedures - this access guideline specifies the criteria for granting access to specific individuals or groups, and the different levels of access allowed.
- Maintenance Procedures – this specifies how a maintenance procedure is scheduled and performed.

Access Management

This access guideline specifies the criteria for granting Data Centre access to specific individuals or groups, and the different levels of access allowed.
These are composed of instructions and policies to restrict and prevent unauthorized and unqualified access that may cause any type of risk to our operation.

Requirements

- Permit to Access (PTA) – This provides access to the Data Centre strictly for inspection or survey purposes only. Any type of work or configuration will not be allowed.
    - Permanent Access – given to authorized or qualified Data Centre managers or operations team only.
    - Temporary Access – also called visitor access. This is given to individuals authorized to access the Data Centre for a period of time.
- Permit to Work (PTW) – This allows an individual to do work such as configuration, updates, shutdown, patching, maintenance etc.. This also applies to DC maintenance vendors
- Permit to Modify Equipment (PTME) – This allows an individual to add, remove or replace any equipment from the Data Centre.
- No Objection Certificates (NOC) – this is to allow any new requirement or projects directly impacting Data Centre operations.
- Change Request Forms (CR) – This is required for any major modification on the existing setup of the Data Centre. This also covers revoking access permissions to existing permanent users

Maintenance Program

An effective maintenance program is necessary to keep equipment in an optimum condition, minimize failures and prevent downtime. This includes preventive and predictive maintenance, strong vendor support, failure analysis, life cycle tracking and documentation.
Any level of vendor support to maintain infrastructure should have a corresponding list of qualified vendors with formal contracts specifying the scope of work, call-in process, qualifications, and response times to ensure the level of service required meets the uptime objectives.
Housekeeping is also an equally important aspect of maintenance to keep combustibles and contaminants out of the Data Centre and technical rooms.

Requirements

- List of Equipment – this includes Generator, UPS, DBs, cooling, Fire Alarm & Suppression, Access control & CCTV and related sensors.
- Specialized Vendor Details – this contains the details of the vendor(s) assigned to maintain DC equipment. Technician information, qualifications and certifications should be available.
- Service Level Agreements – should clearly define the Response Time and Conditions to match our requirement as well as OEM recommendations.
- Planned Preventive Maintenance (PPM) – PPM schedule should be fixed for the entire year. So we can plan other activities accordingly without conflict.
- Sequence of Operation – This shows the operation of any equipment with redundant functionality in case of a primary source failure. Example: UPS, Generator, Etc.
- Escalation Matrix or Emergency Call-out Matrix – this allows us to clearly identify the response team responsible for any equipment failure
- Vendor Evaluation – this is to evaluate the assigned team and request for changes if required. This will increase the quality to the support from the service provider.
- Methodology and Risk Assessment – this is to provide information on how the maintenance will be performed and the risk that comes with it. This is required for all maintenance activities – may it be major or minor.
- Housekeeping Schedule – this can either be planned or on-call but otherwise required. Housekeeping Team will be supervised at all times.
- Critical Spare Parts - these are list of spare parts to be made available on site to sustain operation of DC critical equipment.

Operations Monitoring

Monitor everything continuously at the network level for the ability to look at all assets, physical and virtual, that reside on the LAN, even those that are offline, and all inter-connections between them.
This monitoring should be done on a continuous basis and should be capable of monitoring dynamic network fabrics.
Monitor for missing patches or application or configuration changes that can introduce vulnerabilities that can be exploited.

Requirements

- Physical or Visual Inspection – this should be in daily basis at random times. Daily inspection should be routine work for the Data Centre managers. This involves visual checking of the electrical devices, cooling equipment, UPS, sensors, lighting, Etc..
- Online / Remote monitoring – this type of monitoring is applied to all Data Centre components connected to the network (DCIM). This shows actual information received from sensors, smart devices, Etc..
- Critical Alerts – there should be an automated system capable of sending alerts or notification through Email or SMS to all Data Centre manages for any critical system failure that requires immediate action.

Data Centre Studies

- End-of-life study – this is to indicate that the product is in the end of its useful life and the vendor stops marketing, selling, or sustaining it.
- Life Cycle study – this is will enable us to know when the equipment has reached its peak performance and will be subject to replacement.
- Predictive Maintenance – this will allow us to alter PPM schedule to match the equipment maintenance as required.
- Budget forecasting – this is essential for laying out plans to sustain or improve the Data Centre.

Trainings and Induction

Proper training and induction ensures that the team understands the policies, procedures, and unique requirements for working inside the Data Centre.
This is essential in avoiding unplanned outages and ensuring proper response to both anticipated and unplanned events.
This is applicable to anyone accessing the Data Centre in line with their trades and purpose.

Requirements

- Data Centre Induction – This is having the team familiarize with the existing configuration of the Data Centre and to follow the guidelines for operation.
- Data Centre Trainings – all DC operations team should have the basic and effective knowledge on how the facility operates as per the implemented design. This involves network connection, power, cooling and support.

Reporting

This is to communicate the compiled information as outcome of any activity related to the Data Centre operations.
It is important that these documents are accurate, objective and complete according to its purpose as this is the only relevant factor used for referencing.

Requirements

- Data Centre Activity Report – This includes total number of PTA, PTW, PTME, NOC and CR. Can be monitored monthly, quarterly and annually.
- PPM Reports – This should be submitted monthly or as per OEM. This ensures proper maintenance has been done.
- Incident Report – It is required to monitor every incident to prevent recurrence.
- KPI Report – this is to monitor all targeted activities. Can be monitored monthly, quarterly and annually.

Documentation

These are set of references or records provided on paper or on digital media. These documents act as the store of collective organizational and operational knowledge regarding the processes and can be accessed by anyone in times of need.
Should be updated, protected and available.

Requirements

- Asset list – list of equipment installed for Data Centre operations.
- As-built drawings – final approved layouts as installed before activation. This is used as basis
- Operation manuals – used as reference for the equipment functions.
- Data Sheets – reference for equipment specification.
- Equipment Set Points – reference for equipment configuration.
- Testing and Commissioning – verifies proper operations of systems via documented testing procedures and establishes performance criteria in line with OEM standards.
- Warranty Certification – an effective warranty management program secures operational stability through knowing the limits and exceptions of the product as per OEM.

Automation of Services

All Data Centre services should be automated or through the company service & incident management to request and approve of the following:

- Permit to Access
- Permit to Work
- Permit to Modify Equipment
- NOC
- Change Request
- All DC alerts related to critical equipment should be sent through SMS or Email

References

https://www.paloaltonetworks.com/documentation/glossary/what-is-a-data-center (What is a data center, 2016)

http://www.sapdatacenter.com/article/data_center_functionality/#!

https://journal.uptimeinstitute.com/explaining-uptime-institutes-tier-classification-system/ (Hector Diaz, 2014)

http://www.datacenterknowledge.com/archives/2013/07/24/refining-your-criteria-for-data-center-site-selection/ (PRASHANT BAWEJA, 2013)

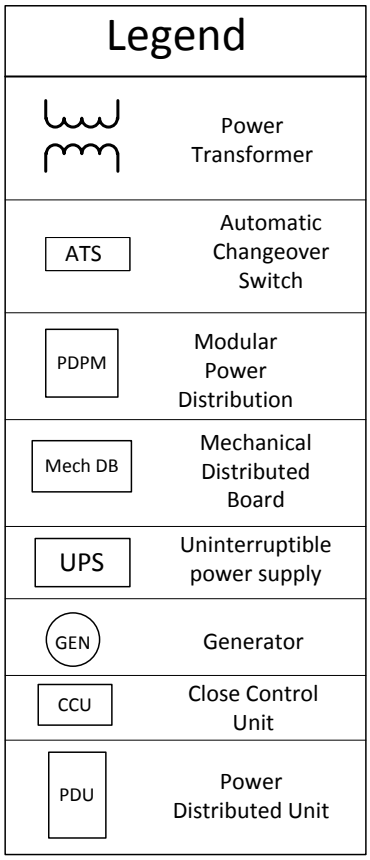
http://www.slideshare.net/mirfallah/data-center-building-general-specification?qid=e45ce6ef-f6d4-47ad-899b-5ed5b77b60eb&v=&b=&from_search=2

http://www.slideshare.net/mirfallah/data-center-building-general-specification?qid=e45ce6ef-f6d4-47ad-899b-5ed5b77b60eb&v=&b=&from_search=2

http://www.kssfiresuppression.ie/single-post/2015/10/18/Which-Gas-Fire-Suppression-System-is-best-FM200-Novec-1230-or-Inergen (Finian Quinn, 2015)

Appendix

Legend	
	InRow AC
	Sever Rack 60cm*107cm
	Network Rack 75cm*107cm
	PDPM
	Batteries cabinet for UPS
	300 KVA UPS
	FSS Novec 1230
	3 ton split AC
	SMDB
	Mechanical SMDB
	Access Control DB
	MCO for AC “InRow”
	Isolator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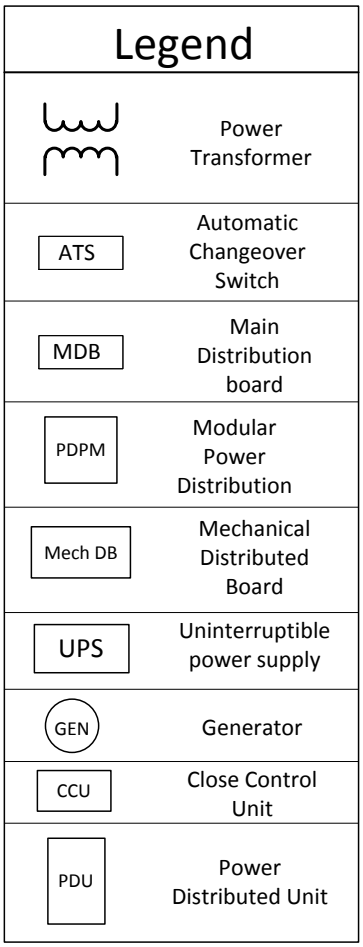
Automatic Changeover Switch
PDPM
Modular Power Distribution
Mech DB
Mechanical Distributed Board
UPS
Uninterruptible power supply
GEN
Generator
CCU
Close Control Unit
PDU
Power Distributed Unit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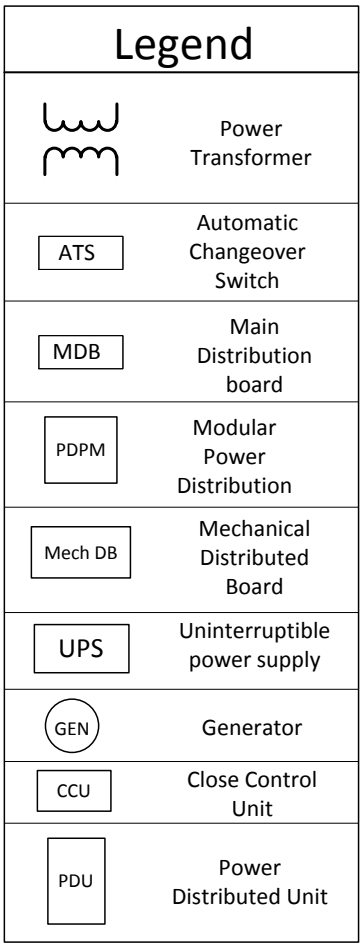
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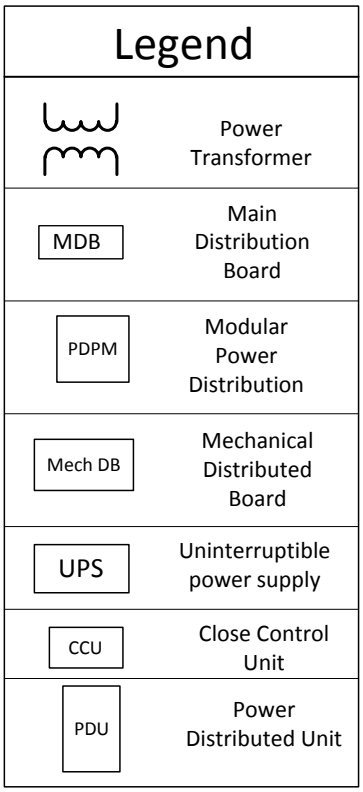
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