Data Center Architecture

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Data Center Requirements

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Requirements

- Provide a physical secure location for servers, storage, and network equipment.

- Provide 24x7 network connectivity for equipment within the datacenter to devices outside the data center

- Provide necessary power to operate all equipment

- Provide an environment where the temperature and humidity are controlled within a narrow range and air exchanged at an adequate rate.

Required Physical Area for Equipment and Unoccupied Space

- servers

- storage

- network devices

- HAVAC (heating ventilation and air conditioning)

- power panels

- breakers

- floor to support the height of the equipment

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Required Physical Area for Equipment and Unoccupied Space

- Components stored in racks.

- Height of equipment measured in U's; 1U=1,75".

- 50% of space occupied by racks and stand alone hardware.

- 50% of space for aisles, ramp, space next to walls, breaks between rows of racks and open space to let exhaust air from racks to the HVAC.

- Plan for the growth

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Required Power to Run All the Devices

- UPS must be present to protect against power failures.

- Generators may be required if outages are frequent and take long.

- Start by collecting the power requirements of the equipment.

- This will define the number of

  - breakers

  - outlet types, single-phased or three-phased,

  - layout of data wiring

- Plan for the growth

Required Cooling and HVAC

- Keep devices cool

- Maintain low humidity within the data center

- Measured in British Thermal Units (BTUs) per hour

- Collect the BTUs requirements of all equipment to establish the HVAC necessities

- Plan for the growth

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Required Weight

- Determine the weight of all empty racks

- Determine the weight of all equipment

- Determine if the existing data center floor is strong enough for the weight

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Required Weight

- Types of load that the floor must support

  - Maximum weight that the entire data-center floor can support

  - Maximum weight that a single tile can support

  - Maximum point load that a tile can support

Required Network Bandwidth

- The bandwidth offered by the ISP should at least be equal to the data center's inbound and outbound bandwidth specifications

- If business-critical servers must be connected to the internet, reliable and redundant ISP links are mandatory

- Most of the wiring requirements can be fulfilled with

  - Cat6 copper

  - multi-mode fiber

  - single mode fibers may be needed for WAN connections, NAS, network-IO bound servers

Selecting a Geographic Location

- Safe from natural hazards

  - floods, fire, tornados, strong winds, earthquakes

- Safe from man-made disasters

  - Should not be close to an airport, electrical railways or telecommunications signal center because of RFI and EMI

  - Should not be close to a mine, quarry, highway or heavy industrial plant

  - Should be away of sources of pollution

- Availability of local technical talent

- Abundant and inexpensive utilities such as power and water

Selecting an Existing Building (Retrofitting)

- There must be enough space for a raised floor

- If network and electrical cables will be run in the subfloor plenum, they must not obstruct the flow of cold air

- It must be easy to setup T1, DS3, fiber-optic, and other high bandwidth network links

- The building must have adequate power and redundant electrical grids to guarantee 24x7 operations

- The room or floor must be large enough for present and future equipment

- The data center must be isolated from contaminant-producing areas within the building

Selecting an Existing Building (Retrofitting)

- The exhaust from generators and other sources should not be allowed to enter the data center air intakes

- The gas and water pipes must be safe and leak-free.

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Remarks

- The functional requirement of a data center is to provide a safe and secure place for servers, storage, and networking equipment.

- The data center must also provide the required power, a well-controlled environment (with regard to temperature and relative humidity), and network connectivity to other devices within and outside the data center.

Guides for Planning a Data Center

- Plan in advance

- Plan for the worst

- Plan for growth

- Simplify your design

- Plan for changes

- Label all equipment, especially cables and ports

Characteristics of an Outstanding Design

- Design must be simple

  - all cables, circuit breakers, servers, storage devices, networks ports and power outlets must be labeled

- Design must be scalable

- Design must be modular

- Design must be flexible

Data Center Structures

- No-Raised or raised floor

- Aisles

- Ramp

- Compulsory local building codes

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Raised Floor Design and Deployment

- place for the equipment to sit

- grounding for the equipment

- a means to channel cold air from the HVAC

- place to route network cables, power outlets and cables for the equipment on the tiles

Raised Floor Design and Deployment

- Plenum

  space between the datacenter subfloor and the floor tiles. The HVAC must be capable of pressurizing it

- Floor tiles

  floor panels that provide a supporting base for the racks and equipment.

  Can be solid or perforated

- Equipment Weight and Tile Strength

  Point load

  Static Load

- Electrical wireways

- Cable trays

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Design and Plan Against Vandalism

- For most organizations, online data is one of their most expensive assets

- Data center must be selected in a building or neighborhood where it is easy to control access

- The data center must not be accessible from the outside

- Should have various monitoring devices, motion sensors and alarms

- Unauthorized accesses to the data center should be prevented

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Best Practices

- The design must be modular

- Label everything

- Document everything

- Isolate cables

- Use cast aluminium tiles

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Remarks

- It is important to get the design right because retrofitting a data center is too expensive and unwieldy.

- A data center design must be simple to modify and manage, scalable to accommodate future needs without any changes, and modular an flexible so upgrades can be made if necessary.

- Common structures within a data center are raised floor, aisles, floor tiles, subfloor plenum and ceiling plenum, electrical wireways, and cable trays.

- All equipment, cable ends, and grid locations must be labeled in an orderly manner.

Modular Cabling Design

- Keep it simple

- Patch panels

Points of Distribution (PODs)

- Rack with devices

- network switches

- terminal servers

- patch panels

Best Practices

- Label your equipment

- Color code cables

- Avoid a tangle of cables

- Patch panel ports and connections must be verified by the installer

- Remote console access

- cable bending radius

Remarks

- The network and cabling infrastructure within a data center must be modular, which is possible using patch panels and points of distribution containing cross-patch ports, network subswitches, and terminal servers.

- All cable connections must be well labeled.

- Internet access from ISPs must be redundant and reliable.

Data Center Maintenance

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Network Operations Center (NOC)

- Dedicated facility staffed with people who monitor the availability of all devices and services within the data center and respond to any data center problems.

- Central logging point for all alarms and for evaluating the present status of the data center

Network Monitoring

- Gathering real-time data and its classification into performance and outages

- Used to predict the need for future scaling

- Outage info is used to alert staff and early problem resolution

- SNMP

- In-band and out-of-band monitoring

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Data Center Physical Security

- All entry points and doors must be controlled by card readers or persons who monitor and restrict access to those entering the data center.

- Co-location DC

- Managed hosting DC

- CCTV

Data Center Cleaning

- Do not require regular cleaning or vacuum.

- Approved cleaning supplies.

  HEPA vacuums, three pin ground configured outlets, antistatic materials.

- Floor surface cleaning.

  avoid disturbing cables

- Subfloor and above-ceiling plenum cleaning

  the space above the tiles must be cleaned. Care must be taken when removing the tiles

- Equipment cleaning

  Chemicals must not be used directly on equipment
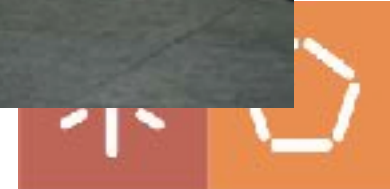
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Best Practices

- A high level of physical, network, and host level security must be enforced at all times.

- Regular cleaning of the data center is important to remove all dust and dirty, which can damage devices.

- Quarterly, preventive maintenance must include

  - UPS and batteries

  - Generator and automatic transfer switch (ATS)

  - Power cables, outlets, subpanels and circuit breakers

  - static switching equipment

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Best Practices

- Free-standing and rack based power distribution equipment.

- Fire suppression and detection equipment.

- Overhead sprinkler systems.

- Air conditioning and HVAC units, air ducts, and filters

- Inlet-air blockages near perforated tiles

- Physical site inspection every month.

- A copy of all documents and standard operating procedures must be maintained at a central web site.

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Power Distribution

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Estimating Your Power Needs

- Power for racks and stand-alone equipment

- Power for the HVAC System

  A majority of the equipment power should be allocated for the HVAC

- Power for lighting, monitoring systems, NOC servers, fire control devices,...

- Uninterruptible Power Supply (UPS)

- Generators

- Power Conditioning

- Single phased and three phase power

- Power distribution units (PDUs)

- Electrostatic Discharge (ESD)

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Data Center HVAC

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HVAC

- Must be redundant to cope with failures and maintenance

- Must be efficient. Account for 40 to 60% of the power used in the DataCenter

Environmental factor	Temperature	Relative Humidity
Optimal range	21°C to 23°C	45-50%
Acceptable Range	10°C to 32°C	25-75%

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Narrow Range in temperature and RH

- Servers and storage generate substantial amounts of heat

- Certain areas require more cooling

- The weather is unpredictable

- Equipment changes within the data center

- Numerous air exchanges

- High RH causes corrosion and short circuits

- Low RH causes ESD problems

- Data center activities that can disrupt the temperature profile

Air conditioning Systems

- Cold-Liquid Air-Conditioning

    - for hot, desert regions

- Dry Air-Conditioning

    - for humid regions

- Air Circulation

    - Airflow pattern with subfloor supply and overhead return vents

    - Airflow pattern with overhead supply and return vents

Air Placement of Hardware Racks

- Bottom-to-Top Cooled Racks

- Top-to Bottom Cooled Racks

- Front-to-Front Cooled Racks

- Front-to-Back Cooled Racks

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Best Practices

- Should exist cold and hot aisles. Racks should be set back-to-back pointing to the hot aisle and front-to-front facing the cold aisle

- Devices are designed to expel their own heat in an optimal manner. The air-flow pattern must pick-up hot air and transport it to the HVAC

- Different perforation levels for tiles in the cold aisle balance air-flow patterns. Hot aisles should not contain perforated tiles

- Devices with lower temperature requirements must be placed on the lower half of the racks, and high heat-generating devices in the upper half

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Best Practices

- Incoming air-flow rates must be balanced to maintain a uniform temperature along the rack height

- Since cables impede air flow, they must be bundled properly and correct sized cables must be used to keep air-flow passages as open as possible

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Key points

- The heat loads within each data center continue to rise at a fast rate

- The objective of the HVAC is to provide enough cold air flow to maintain a temperature that meets the equipment requirements

- Cold-liquid and dry air conditioning systems are commonly used for DC cooling

- Data centers are arranged into cold and hot aisles

Data Center Classification

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	Tier I	Tier II	Tier III	Tier IV
Number of power delivery paths	Only 1	Only 1	1Active 1Passive	2 Active
Redundancy	N	N+1	N+1	S+S or 2(N+1)
Compartmentalization	No	No	No	Yes
Concurrently Maintainable	No	No	Yes	Yes
Fault tolerance to Worst Event	None	None	None	Yes