TIA-942: Data Center Standards

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Objectives

- What are concerns in the data center?
- Data center standards & best Practices
Data Center Definition

- Computer facility designed for continuous use by several users, and well equipped with hardware, software, peripherals, power conditioning and backup, communication equipment, security systems, etc. – businessdictionary.com

- It generally includes redundant or backup power supplies, redundant data communications connections, environmental controls (e.g., air conditioning, fire suppression) and security devices. – wikipedia.org

- Notice the common terminology

- Levels of implementation set them apart
Why should we care?

- DCs house mission-critical data & equipment. In addition to protecting this...

- Challenges... increased demand for:
  - Applications / systems availability / SLA
  - Complex & heterogeneous systems
  - Service levels for uptime and responsiveness
  - Amount of data (live and retention)
  - Regulatory compliance and security
  - Changing business demands
  - Green practices & energy costs
Data Center Standards

- Without standards... enormous variation in data center designs

- Three commonly known tier systems
  - Uptime Institute (1995)
  - Syska Hennessy Group
Data Center Standards

- Uptime and TIA-942
  - Neither addresses the challenges
  - Both provide a framework to alleviate challenges

- TIA-942
  - Requirements / guidelines for the design & installation of a data center
  - Multidisciplinary Design Considerations
  - Intended Audience
TIA-942 Multidisciplinary Design

Design Considerations

1. Design Process
2. Space Planning
3. Redundancy
4. Site Selection
5. Architectural
6. Structural
7. Electrical
8. Mechanical/Cooling
9. Fire Protection
10. Security
11. Building Automation
12. Access Providers
13. Telecom Spaces
14. Racks & Panels
15. Cabling & Field Testing
16. Telecom Administration
17. Information Technology
18. Commissioning
19. Maintenance

- Architectural Design
  (space, floor, light, security etc.)
- Structured Wiring
- Electrical
- Cooling
- Operations
TIA-942 - Discussion Topics

For today’s discussion, focus on...

1. Data Center Spaces.
2. Data Center Cabling
3. Electrical
4. Cooling
5. Tier System
TIA-942 – 5-key functional areas:

1. Entrance Room (ER)
2. Main Distribution Area (MDA)
3. Horizontal Distribution Area (HDA)
4. Zone Distribution Area (ZDA), opt.
5. Equipment Distribution Area (EDA)

Ideally separate rooms but not practical for normal organizations; Can be consolidated with defined areas.
Spaces

(5) Equipment Distribution Area
   Racks and Cabinets

(3) Horizontal Distribution Area
   LAN, SAN, and KVM switches

(2) Main Distribution Area
   Routers, Backbone LAN/SAN Switches, PBX, M13 Muxes

(1) Entrance Room
   Carrier Equipment and Demarcation

(4) ZDA

Source: ADC’s Data Center Optical Distribution Frame: The Data Center’s Main Cross-Connect
Connectivity is quickly and easily deployed from the ZDAs to the Server Cabinets on an as-needed basis.

Source: Corning – Distribution in the data center
**Spaces**

**Typical Data Center Requirements:**

**Location**
- Avoid locations that restrict expansion
- Redundant Access
- Delivery of large equipment
- Located away from EMI sources
- No exterior windows (inc. heat & security risk)
- Provide authorized access & monitored

**Size – no magic formula**
- Sized to meet the known requirements of specific equipment
- Include projected future as well as present requirements

**Ceiling Height**
- Min. 8.5’ from finished floor to any obstruction (sprinklers, lighting fixtures, or cameras)
- Cooling architecture may dictate higher ceilings
- Min. 18” clearance from water sprinkler heads

**Flooring / Walls**
- Anti-static properties
- Sealed / painted to minimize dust
- Light color to enhance lighting
- Min dist floor loading 150 lbf/Sq-ft, Reco. 250 lbf/Sq-ft
Spaces

Doors
- 3’ wide x 7’ high, no / removable center obstructions

Lighting
- Min. 500 lux in the horizontal plane and 200 lux in the vertical plane
- Lighting on separate circuits/panels
- Emergency lighting & signs

Other Equipment
- UPS, power dist. or conditioner
- ≤ 100kVa inside room
- > 100kVa in separate room

Operational parameters
- Dedicated HVAC system preferred (68 – 77 F); measured every 10-30 ft at 1.5ft height
- HVAC – min. 100 sqft/ton
- Max. temp rate of change: 5 F/hr
- 40% to 55% relative humidity (reduces ESD)
- Electrical - Signal reference grid (SRG)
- Sprinkler systems must be pre-action system

Security
- Camera monitoring (int./ext.)
- 100-yr flood plain
Spaces - Best Practices

- Locate ER outside of the DC for security purpose; if inside DC, consolidate ER & MDA
- MDA centrally located
- Both MDA & HDA require separate racks for fiber, UTP and coax cable
- ZDA is optional, but provides additional flexibility (pre terminated cables)
- EDA – contains equipment only
- Each space requires same power/cooling req.

ER: Entrance Room, MDA: Main Distribution Area, EDA: Equipment Distribution Area, ZDA: Zone Distribution Area, DC: Data Center
Spaces – Raised vs. Solid Floor

- Raised floor a very common notion, but...
  - Older equipment vs. newer equipment air flow (bottom-up vs. front to back)
  - Hot aisle – Cold aisle air flow dynamics
  - Cold air – want to fall, but we are pushing – requires pressure through perf. tiles
  - Opening / leaks in flooring has impact on pressure
  - Equip. densities increase -> higher head load -> higher pressure of cold air through restrictive space
  - What happens to hot air? – flows up, reduces temperature and begins to fall down again
  - Only place to go is creep into cold aisle....warmer air at cabinet tops.
  - Typically see passive components or open spaces near top of cabinets
  - Both use anti-static tiles or flooring
  - Data & electrical cabling restrictions
  - New build – more expensive
  - Have to look at your environment to see if raised floor makes sense....do use this as the rule of thumb!
Cabling Systems

Structured vs. Unstructured Cabling

- **Horizontal cabling**
- **Backbone cabling**
- Cross-connect in the entrance room or main distribution area
- Main cross-connect (MC) in the main distribution area
- Horizontal cross-connect (HC) in the telecommunications room, horizontal distribution area or main distribution area
- Zone outlet or consolidation point in the zone distribution area; and
- Outlet in the equipment distribution area
Cabling Systems

Source: Corning Cable Systems – Just the Technical Facts
Cabling Systems

- Reduced Data Center Topology
- Consolidated ER/MDA/HAD
- Applicable to most enterprises

Source: Orthronics – Standards-Based Data Center Structured Cabling System Design
Cabling Systems - Transmission Media

- 100-ohm twisted-pair copper cable
  - Category 5e or 6, 6A
  - 10GbE: Cat 6 – 37-55mts, Cat 6A – 100mts

- Multimode fiber optic cable
  - 62.5/125 μm or 50/125 μm
  - 50/125 μm 850 nm laser optimized mmf

- Singlemode optical fiber cable

- 75-ohm coaxial cable
  - Type 734 & 735 cable
  - Type T1.404 coaxial connector
Cabling Systems - Overhead / Under floor

Under Floor Cabling
- Less expensive if raised floor than overhead
- Cabling in cable trays to minimize airflow blocks; consider multilevel trays for fiber/copper
- Provide adequate capacity for growth
- Separate fiber cords from copper cabling from power
- Typically placed in the hot aisle
- Electrical – color coded PDU with locking receptacle. Receptacles labeled with PDU/panel ID & breaker #
Cabling Systems - Overhead / Under floor

- **Overhead**
  - Can be used in raised floor environments also
  - Multi level cable tray system (3 Layer)
    - Bottom layer – copper
    - Middle layer – fiber
    - Top layer – power
  - Suspended from ceiling; min. 12” clearance above each ladder
  - Separation from fluorescent lights (5”) & power
  - Avoid blocking cooling ducts (overhead cooling)
Racks / Cabinets

Placement of racks / cabinets

- Hot aisle / Cold aisle - arranged in an alternating pattern (with fronts facing each other)
- Cold aisles are front & Hot aisles are rear of racks/cabinets –
- If there is a raised floor, PDU cables are run in cold aisle. Data cable trays for telecom cabling are typically placed in hot aisle.
- Common bonding network (CBN)
  - Racks / cabinets individually, cable trays, HVAC, PDU, panel boards, raised floor structure, columns
- Front clearance – min. 3ft, 4ft recommended
- Raised Flooring vs. Traditional Flooring
Racks / Cabinets

- Placement of racks / cabinets
  - Front rails recessed for wire management
  - Switch-Panel-Switch arrangement
  - Front edge of cabinet on edge of tile
  - Perforated tiles at front of cabinets
  - Provide blank panels in empty space
Electrical Considerations

- Unfortunately no magic bullet!
  - Manual process for load configuration
  - APC’s “Calculating Total Power Requirements for Data Centers” By Richard Sawyer – framework for calculating req.
  - Color coded PDU with locking receptacle. Receptacles labeled with PDU/panel ID & breaker #

- Best Practices
  - Multiple power grid connects
  - Sub-breakers per relay rack or lineup
  - Dual A-B cording
  - Accommodate growth
  - Intelligent PDU
  - Generator capacity to include for cooling
  - UPS capacity to include cooling and lights
Cooling Considerations

# 1 Mitigating Factor – heat removal

No specific guidelines; basic physics

Cooling reqd. = Heat Generated = Electrical load

Design Implications

- Layout of racks in alternating rows
- Location of CRAC units
- Quantity and location of vents
- Sizing of ductwork
- Proper internal configuration of racks
Cooling Considerations

**Process**

- Determine critical heat load
- Establish critical loads - watts-per-RLU
- Determine the CFM requirements per RLU
- If possible, divide the room into cooling zones by RLU
- Determine appropriate air conditioner type(s)
- Equip. airflow (f->b / s->s)

- Determine cooling delivery methodology(s)
  - Room, Row, Rack
  - Blank panels/short circuits
  - Cold air containment
  - Special Considerations – high BTU

- Establish a floor plan
- Deploy a comprehensive monitoring system

**Cooling is not enough – airflow required**
# Cooling Considerations - Airflow

## Supply & Return Based

<table>
<thead>
<tr>
<th>Flooded Supply</th>
<th>Locally Ducted Return</th>
<th>Fully Ducted Return</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Small LAN rooms &lt; 40kW</strong>&lt;br&gt;Simple installation&lt;br&gt;Low cost&lt;br&gt;Cools up to 3kW per rack</td>
<td><strong>General use</strong>&lt;br&gt;Cools racks to 3kW&lt;br&gt;No raised floor needed&lt;br&gt;Low cost / ease of install</td>
<td><strong>Hot rack problem solver</strong>&lt;br&gt;Cools racks to 6kW&lt;br&gt;Retrofittable (vendor specific)&lt;br&gt;No raised floor needed&lt;br&gt;Increased CRAC efficiencies</td>
</tr>
<tr>
<td><strong>Raised floor environments</strong></td>
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<td><strong>Raised floor environments</strong></td>
</tr>
<tr>
<td><strong>Hard floor environments</strong></td>
<td><strong>Hard floor environments</strong></td>
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<td><strong>General use</strong>&lt;br&gt;Cools racks to 3kW</td>
<td><strong>General use</strong>&lt;br&gt;Cools racks to 5kW&lt;br&gt;High performance / High efficiency</td>
<td><strong>Hot rack problem solver</strong>&lt;br&gt;Cools racks to 8kW&lt;br&gt;Retrofittable (vendor specific)</td>
</tr>
<tr>
<td><strong>Fully Ducted Supply</strong></td>
<td><strong>Fully Ducted Supply</strong></td>
<td><strong>Fully Ducted Supply</strong></td>
</tr>
<tr>
<td><strong>Enclosures / mainframes with vertical airflow</strong>&lt;br&gt;Raised floor environments with poor static pressure</td>
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<td><strong>Hot rack problem solver</strong>&lt;br&gt;Cools racks up to 15kW&lt;br&gt;Specialized installation</td>
</tr>
</tbody>
</table>

*source: apc.com*
**Fire Detection and Suppression**

- Significant risk of electrical fires
- A comprehensive fire detection & suppression system is mission-critical

**Detection**

- Both heat and smoke detection
- Interconnected with the fire suppression system, local alarms, monitoring system, etc
- Installed in accordance with NFPA 72E
- Installed below raised floors and other areas
- Airflow patterns determines location of detection units

**Suppression**

- Follow NFPA 75 standard firewalls
- Sprinkler systems — both flooded and pre-action
- Chemical systems or Clean Agent (FM 200, Inergen, Ecaro-25(FE 25), Novec 1230)
- Manual systems (Manual pull stations, Portable fire extinguishers)
4-Tier System based on

- Resilience / Capacity of its MEP systems
- 16-pages of criteria

Primary Categories

- Power and cooling delivery paths
- Redundancy in components
- Initial & ultimate watts/sqft
- Support space to raised floor ratio
- Raised floor height
- Floor loading pounds/sqft
- Utility voltage
## Optimal Criticality - Choosing a tier

<table>
<thead>
<tr>
<th>Tier</th>
<th>Business characteristics</th>
<th>Effect on system design</th>
</tr>
</thead>
</table>
| 1    | • Typically small businesses  
• Limited online presence  
• Low dependence on IT  
• Perceive downtime as a tolerable Inconvenience | • Numerous single points of failure in all aspects of design  
• No generator if UPS has 8 minutes of backup time  
• Generally unable to sustain more than a 10 minute power outage |
| 2    | • Some online revenue generation  
• Multiple servers  
• Phone system vital to business  
• Dependent on email  
• Some tolerance to scheduled downtime | • Some redundancy in power and cooling systems  
• Generator backup  
• Able to sustain 24 hour power outage  
• Minimal thought to site selection  
• Vapor barrier  
• Formal data room separate from other areas |
| 3    | • World-wide presence  
• Majority of revenue from online business  
• VoIP phone system  
• High dependence on IT  
• High cost of downtime  
• Highly recognized brand | • Two utility paths (active and passive)  
• Redundant power and cooling systems  
• Redundant service providers  
• Able to sustain 72-hour power outage  
• Careful site selection planning  
• One-hour fire rating  
• Allows for concurrent maintenance |
| 4    | • Multi-million dollar business  
• Maj. of rev from electronic transactions  
• Business model entirely dependent on IT  
• Extremely high cost of downtime | • Two independent utility paths  
• 2N power and cooling systems  
• Able to sustain 96 hour power outage  
• Stringent site selection criteria  
• Minimum two-hour fire rating; High phy. security  
• 24/7 on-site maintenance staff |

**Balance cost of downtime and TCO**

*source: apc.com*
## Tier System

<table>
<thead>
<tr>
<th>Attribute / Statistic</th>
<th>Tier I</th>
<th>Tier II</th>
<th>Tier III</th>
<th>Tier IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power and Cooling Delivery Paths</td>
<td>1 Active</td>
<td>1 Active</td>
<td>1 Active 1 Passive</td>
<td>2 Active</td>
</tr>
<tr>
<td>Redundant Components</td>
<td>N</td>
<td>N + 1</td>
<td>N + 1</td>
<td>2(N + 1)</td>
</tr>
<tr>
<td>Support Space to Raised Floor Ratio</td>
<td>20%</td>
<td>30%</td>
<td>80 – 90%</td>
<td>100%</td>
</tr>
<tr>
<td>Initial Watts / sqft</td>
<td>20 – 30</td>
<td>40 – 50</td>
<td>40 – 60</td>
<td>50 – 80</td>
</tr>
<tr>
<td>Ultimate Watts / sqft</td>
<td>20 – 30</td>
<td>40 – 50</td>
<td>100 – 150</td>
<td>150+</td>
</tr>
<tr>
<td>Raised Floor Height</td>
<td>12”</td>
<td>18”</td>
<td>30 – 36”</td>
<td>30 – 36”</td>
</tr>
<tr>
<td>Floor Loading Pounds / sqft</td>
<td>85</td>
<td>100</td>
<td>150</td>
<td>150+</td>
</tr>
<tr>
<td>Utility Voltage</td>
<td>208, 480</td>
<td>208, 480</td>
<td>12 – 15 kV</td>
<td>12 – 15 kV</td>
</tr>
<tr>
<td>Months to Implement</td>
<td>3</td>
<td>3 – 6</td>
<td>15 – 20</td>
<td>15 – 20</td>
</tr>
<tr>
<td>Year First Deployed</td>
<td>1965</td>
<td>1970</td>
<td>1985</td>
<td>1995</td>
</tr>
<tr>
<td>Construction $ / sqft</td>
<td>$450</td>
<td>$600</td>
<td>$900</td>
<td>$1,100+</td>
</tr>
<tr>
<td>Annual IT Downtime due to Site</td>
<td>28.8 hrs</td>
<td>22.0 hrs</td>
<td>1.6 hrs</td>
<td>0.4 hrs</td>
</tr>
<tr>
<td>Site Availability</td>
<td>99.67%</td>
<td>99.75%</td>
<td>99.98%</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

Source: The Uptime Institute
Next / Action Steps

- Perform a risk assessment to determine hourly cost of downtime
- Determine current data center tier for each subsystem in the data center – you might not need tier-iv across the board
- Get IT and Facilities to work together on issues
- Work with finance to justify upgrades
- Understand TIA-942 (requirement & process)
Outsourced Data Center

- Fits business model - consider outsourcing
- Affordable co-location/hosted DC and 99.995% uptime are NOT mutually exclusive
- Understand levels of redundancy and the uptime SLA in order to get the best combination of uptime and affordability
- Balance between budget and availability
Outsourced Data Center

- What to look for....
  - Hardened data center buildings
  - Data center power & cooling redundancy
  - Telecom entrance redundancy
  - Availability of multiple carriers
  - Physical security
  - SAS 70 data center compliance

- Claims of Uptime Tiers – III or IV; most are not certified
Review

- TIA-942
- Key design parameters
- Tier System
- Next Steps
Resources

Useful links

- Excellent white papers from [www.apc.com](http://www.apc.com)
- Green data center efficiency savings calculator
  - [http://cooling.thegreengrid.org/namerica/WEB_APP/calc_index.html](http://cooling.thegreengrid.org/namerica/WEB_APP/calc_index.html)
  - The green grid (thegreengrid.org)
  - Department of Energy – DC Profiling Tool
    - [http://www1.eere.energy.gov/industry/datacenters/software.html](http://www1.eere.energy.gov/industry/datacenters/software.html)

- .... and obviously *Google* or *Bing* it.
Questions
Contact Information

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