Introduction to Data Centres

Grant Sauls

CCDA CDNIDS CDCSNDS CDCD DCCA JNCIA-ER JNCIS-E Project+ DCE CCTT (FIA) CDS

Certified Data Center Design Specialist

AGENDA

- 9am – 5pm
- What and why we have Data Centre’s
- General issues facing Data Centre’s
- 10 Critical components of a Data Centre
- Data centre design guidelines

What is a Data Centre?

- “ A Building or portion of a building whose primary function is to house a computer room and its support areas”

.....Simplicity, Flexibility, scalability, modularity

- There are four functional requirements of a data center

1. Location i.e. A place to locate computer, storage and networking devices.
2. Power i.e. Power needed to maintain the devices
3. HVAC i.e. Temperature controlled environment within the parameters need.
4. Structured cabling i.e. Connectivity provided to other devices both inside and out.

Data Centre Global Market

- $8 billion dollar market 2007
- $15.6 billion expected in 2008
- 50% spending of I.T and Facilities Managers budgets will go to this area
- Data Centre expect growth for 2009 /2010 will be 40%
- Virtualisation?
  - Yes / No

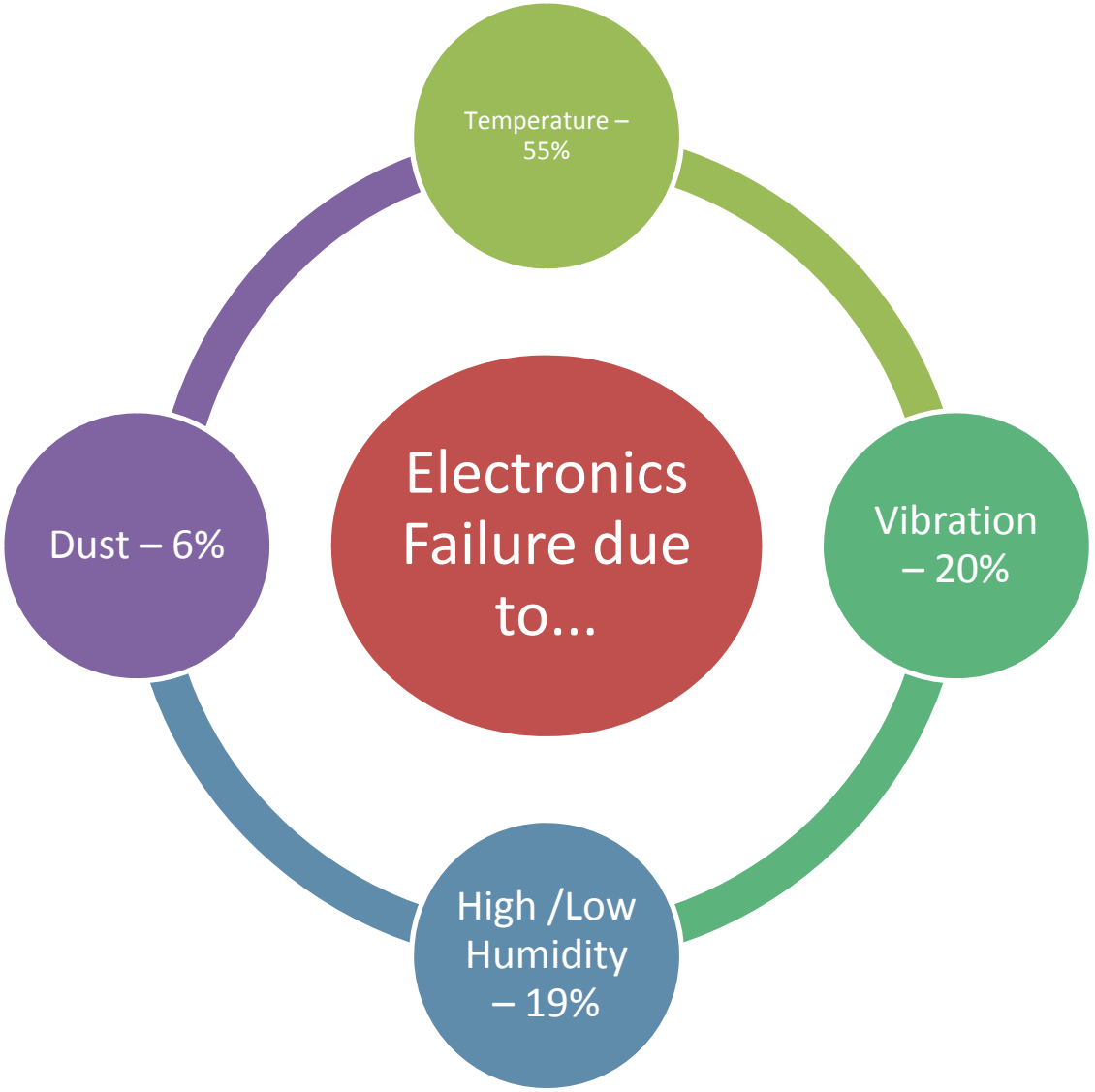
Market drivers for Data Centres

- Disaster Backup
- Data Protection –Sarbanes-Oxley
- Growing Financial sectors i.e. Internet banking
- Distance learning for university students
- Corporates requiring security, storage, resilience
- Growth for online business

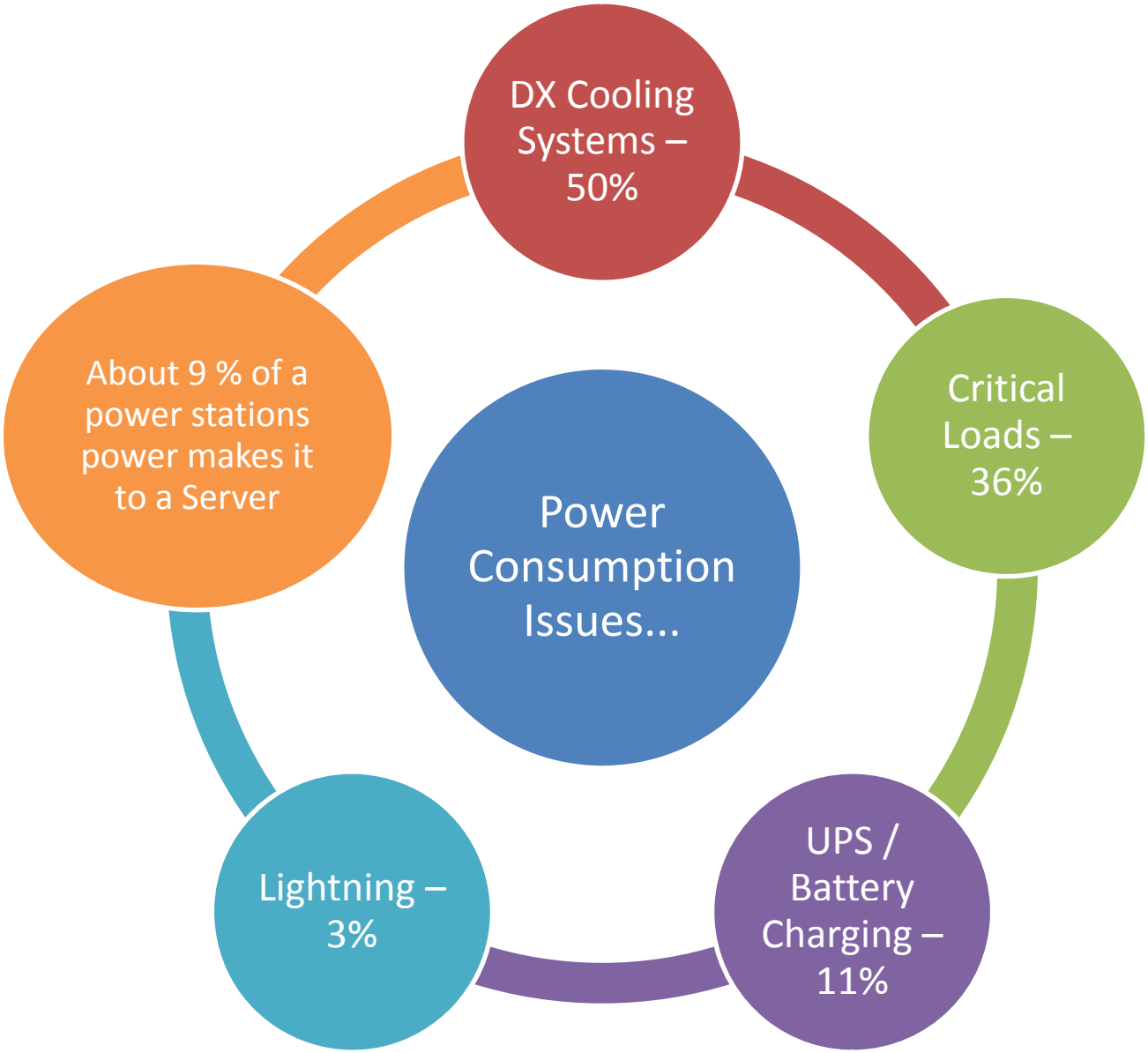
Issues facing Data Centres

- Reliability and Availability
- Power
- Rack Space
- Site Location
- Heat
- Cooling

Reliability



POWER


DX Cooling Systems – 50%
Critical Loads – 36%
UPS / Battery Charging – 11%
Lightning – 3%
About 9 % of a power stations power makes it to a Server
Power Consumption Issues...

Rack Space

- Servers require 3+2 basic utilities
  - Power
  - Data
  - Control / KVM

  -Cooling

  -Racking

  18% of Rack space goes unused due to power consumption and cooling.

Site Location

- Seismic Problems
- Ground Subsidence problems
- Security / criminal problems
- Availability of Electricity, water, sewage and telecoms.
- Proximity to railway lines, airports, chemical storage and military
- EMC Problems i.e. Mobile masts, radar transmitters

HEAT

- Heat accounts for 55% of electronic failure.
- There must be 1kw of aircon for 1kw of heat inside your rack.
- There are three methods of heat
  - Conduction – transferring heat through metal
  - Convection – transferring heat through liquids or gas
  - Radiation – transferring heat through electromagnetic waves

- It’s important not to over fill your rack.
- For every eight server racks, you should have one comms and one storage rack.
- Remember heat generation occurs at the Chip, Server, Rack and Room level
- A 4kw rack is ideal i.e. Average server is 370W

10 critical components of a Data Centres

- Rack Fundamentals
- Cooling Fundamentals
- Power Distribution Fundamentals
- Generator Fundamentals
- Availability and Reliability Fundamentals
- Physical Infrastructure Management Fundamentals
- Fire Protection Methods
- General Design

Rack Location Unit Concept

- A non application specific working space
- An area of the computer room floor i.e. 600 x 1000mm
- Adequate power and air conditioning to that location is essential

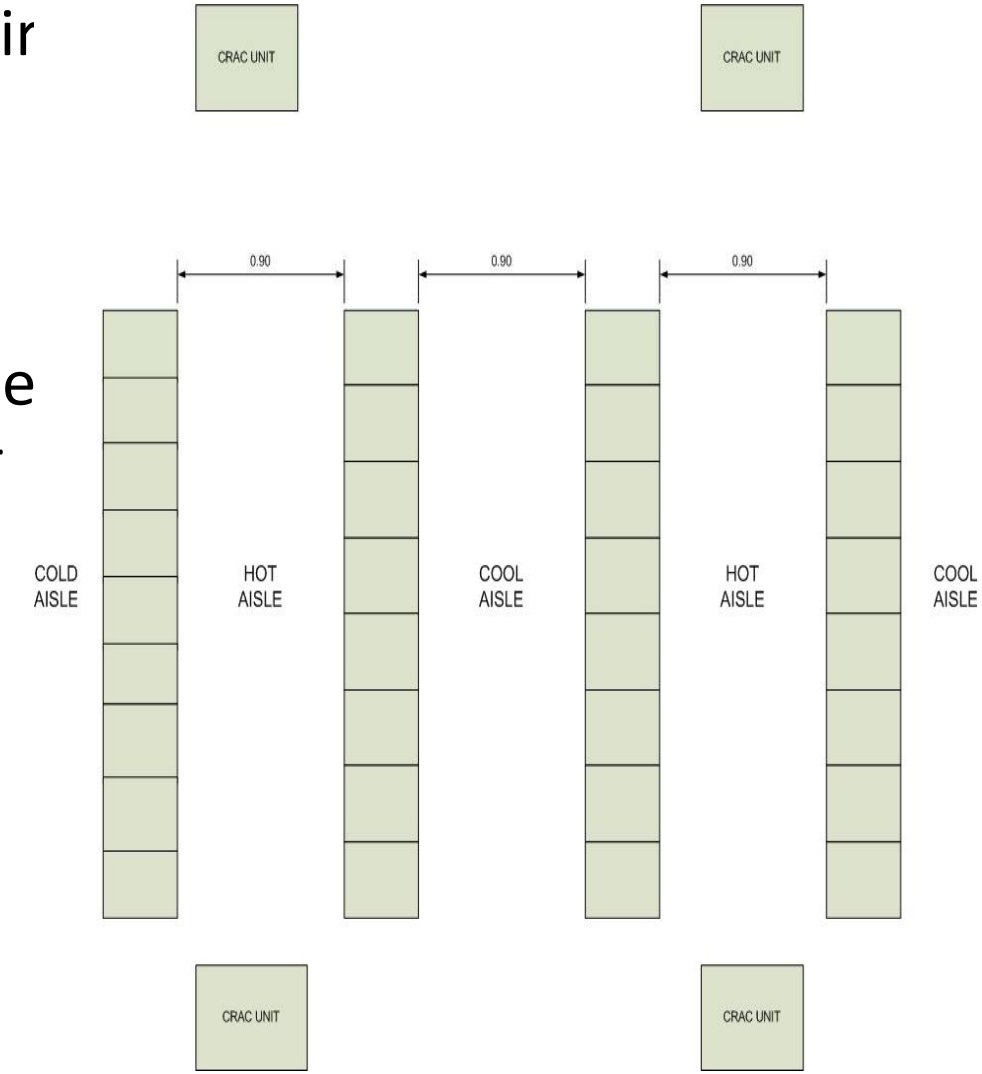
Rack Location
within Data Centers

- TIA-942 and ASHRAE

recommend laying out equipment racks according to the HOT AISLE – COLD AISLE, seven pitch tile model

Rack Location con’d

- This Model means that air conditioning units pump cold air into the floor void.
- Vents in the floor deliver cold air to the front of the racks facing each other – Cold Aisle
- Hot Air escapes through the back of the rack into the Hot Aisle where it returns the air to the air conditioning unit



Rack Location Con’d

- There are nine different Air Flow models
- Three different types of rack location designs
  - 7 tile pitch
  - 8 tile pitch
  - 9 tile pitch

- The 7 tile pitch is the biggest space saver when using a 4kw rack

Rack Location Safety

- Ensure the Floor is strong enough
- Ensure the floor is level and in good order
- Put heavy equipment at the bottom of the rack.
- **Correctly earth all the metal work**

- EIA -310-D is the standard for racks, cabinets, Panels and associated equipment.

Rack Location Clearance

- A minimum of 1m front clearance must be provided for installation of equipment.
- 1.2m front clearance is recommended.
- A minimum of 0.6m rear clearance must be provided for service access.
- A 1m Rear clearance is recommended.

Rack Location Design
Issues to Address

- Size of Rack
- Cable entry, top or bottom including cable sealing
- Cooling Method
- Power Supplies (Centralised or Rack Mount UPS)
- Earth / Grounding
- Cable Management
- Rack Monitoring
- Fire Suppression

Data Center Cooling

- The cooling system for a Data Center consist of CRAC (computer room air conditioning) and for larger Data Centres CRAH (computer room air handling unit)
- Data Center have HOT SPOTS that traditional cooling methods have not been able to address.
- There are 3 types of Cooling Architectures – Room, Rack and Row.
- The primary distinctions that affect the capability of cooling systems are rooted in the distribution systems.
- It is the configuration of these distributions systems that distinguishes the different types of cooling systems.

Data Center Cooling Con'd

- There are 3 basic distribution systems

- Flooded – not recommended 1 – 3kW
  - The CRAC and the loads draw in bulk air from the room, without any special ducting in between them.
- Locally Ducted – 4 – 8 kW
  - Air is provided or returned via ducts when have vents located near to the loads
- Fully Ducted – 5 – 15kW
  - Supply or return air is directly ducted into or out of the loads

- Based on this information there are 9 combinations of Cooling available.

Data Center Cooling Con’d

- **Design Cooling Considerations**
  - Layout racks in alternating rows
  - Location of CRAC Units – Crucial
  - Quantity and location of vents – Crucial
  - Sizing of Ductwork
  - Proper internal configuration of racks
  - Ensure plumbing routes are available
  - Establish and plan power supplies to the units
  - Decide on levels of redundancy

Data Center Cooling

- **Typical Challenges for Rack, Room and Row oriented Cooling Architectures**
  - **Agility** - ability of system to adapt to change
    - Power Density
    - Extensive Engineering installations
    - Adapt – business requirements
  - **System Availability** –
    - Eliminate hot spots
    - redundancy
    - Eliminate vertical temperature
    - Liquid leaks
    - Human Error
  - **Lifecycle Cost** – Capital investment vs. Operational efficiency
  - **Serviceability** – Mean time to recover
  - **Manageability** – predictive failure analysis

Data Center Power Distribution

- Power is key to maintain availability in a data center
- US claim to lose $164 Billion a year due to power disruptions
- Each Data Center must have a separate and dedicated power source and power infrastructure
- Power from the utility to the DC is either stepped down or stepped up at least 6 times before it reaches the DC or User.
- Nominal vs. Normal Voltage

Data Center Rack Power Distribution

- Rack Power Systems must be adaptable to the following
  - Equipment
  - On-Demand
  - Safety Hazards
  - Adversely effect the system

- Patterns show that rack power requirements are on an increase from year to year. i.e. 2004 – 2kW rack
- 2008 patterns have shown that the average rack power requirement is at 6kW per rack.
- Advancement are being made towards the 15kW rack at a rapid rate.

Data Center Rack Power Distribution

- Here is a breakdown of Equipment vs. kiloWatts

- Very Low loads
  - Patch Panels
  - Switches

- Loads in 1kW range 16Amp
  - Entry Level 1u severs

- Loads in 2 -3kW range 16 -20Amp circuits only
  - Medium level 1u servers
  - Switches
  - Majority of rack open

- Loads in 5kW range – 20 – 30Amps depending on what's connected
  - Half filled with 1u high-end Servers
  - Routers
  - Mix of technologies

- 7kw + Range – 30Amp Circuits Only
  - Blade Servers – HP C3000
  - Storage Devices
  - Switching Gear
  - Extremely Rare

Data Center Power Distribution

- Voltage coming into the DC must be check to verify if it is too high or too low as this can impact the equipment.
- Therefore Delta transformers must be installed.
- Stepping up or down 3 phase power must use a delta transformer.

Data Center Power Distribution

- There are two types of Transformers
- Delta Transformers – use 3 phase power with Ground
- Wye Transformers – use 3phase power with a Neutral
- The most common transformer configuration is a Delta to Wye.

Data Center Power Requirements

- Calculate critical load
  - Name Plate rating – worse case rating
  - Voltage requirement
  - Single or Three Phase
- UPS Requirements
  - multiplying the incoming current in amps by the voltage of the device with give your VA rating, then multiply the anticipated VA number by 0.67 to estimate the actual power, in Watts and then divide by 1000 to determine for kW rating

Generator Stats

According to Contingency Planning Research

power related events such as;

- blackouts and surges account for 31% of

computer downtime episodes lasting more than 12 hours,

- power failure and surges account for 45.3% of data loss, and
- according to IDC power disturbances account for about 33% of all

server failures.

Therefore standby generators are a essential component in a Data Center

Data Center Standby Generators

- Generators are made up of the following:
  - Prime Mover – 4 stroke
  - Alternator
  - Governor
    - Maintain RPM / AC output Quality
    - Isochronous Design
    - Superior Electronic Design
  - Distribution Systems
    - Automatic transfer switch,
    - Switching Gear

Physical Infrastructure Management Basics

- Core Issues
  - ❖Maintaining System Availability; and
  - ❖Managing problems and changes

- Essential Categories for Infrastructure Management are
  - Incident management
  - Change management
  - Availability management
  - Capacity management

Physical Infrastructure Management Basics

Physical infrastructure management Basics

- Physical infrastructure management requires all key devices and data points to be monitored. These include all the devices in the physical infrastructure layer and the surrounding environment.

- Best practices dictate that the following list of devices be monitored at the rack level:
- • A minimum of two temperature data points
- • Individual branch circuits
- • Transfer switches
- • Cooling devices, and
- • UPS systems

Data Center
Fire Protection, prevention and suppression

- 43% of business that close due to fire, never re-open
- 29% who do re-open fail within 3years
- Therefore it is essential as a data center to prepare for unseen disasters.
- The best Fire protection method is Fire prevention

Data Center
Fire Protection, prevention and suppression

- NFPA 75 is the standard for protection of computer or data processing equipment. One notable addition to NFPA 75 that took place in 1999, allows data centers to continue to power electronic equipment upon activation of a Gaseous Agent Total Flooding System, which we will discuss later in detail. This exception was made for data centers that meet the following risk considerations:
- • Economic loss that could result from:
- • Loss of function or loss of records
- • Loss of equipment value
- • Loss of life
- • and the risk of fire threat to the installation, to occupants or exposed property within that installation

Data Center
Fire Prevention

- It is important to maintain the following guidelines in Data Center for Fire Prevention
  - Do not build a DC close to our building
  - All furniture must be constructed in Metals except for chairs
  - Do not allow any smoking in or around your communication and IT facilities within the DC.
  - DC's should be void of any trash receptacles
  - No acoustical material such as foam or fabric

Data Center
Fire Protection

- There are 3 system objectives to Fire Protection
  - Fire Detection
    - Detecting the presence of fire
  - Communication
    - Communicate the existence of a fire
  - Suppression
    - Contain and extinguish the fire

Data Center
Fire Protection

- The four stages of combustion are:
  - 1. The incipient stage or pre-combustion stage,
  - 2. The visible smoke stage,
  - 3. The flaming fire stage, and lastly
  - 4. The intense heat stage.

Data Center Detectors

- There are two types of Smoke detectors
- Air sampling smoke detectors
  - VESDA
  - High powered photoelectric
  - 200 – 7000sq m
  - Uses a laser beam

- Intelligent spot type detectors
  - More sensitive
  - They use a laser to scan particles
  - Individual addressable

- EPO – Emergency Power Off

Data Center
Fire Suppression

- 2 types of Suppression agents for DC's
  - Fire Extinguishers
  - Total flooding fire extinguishing systems

- 2 commonly used agents in DC's
  - Inert gas –Inergen
  - Fluorine based compounds
    - FE-200
    - FE-227ea

Data Center
Availability and Reliability Fundamentals

- 93% of companies that have lost availability for 10days or more have filed for bankruptcy in 1 year
- Availability and reliability are built on NCPI
- NCPI are built on 3 core business objectives
  - Increase in turnover
  - Reduction in cost
  - Better utilization of assets
- Availability is determined by a systems reliability and its recovery time.
- Five 9's of Availability

Data Center
Availability and Reliability Fundamentals

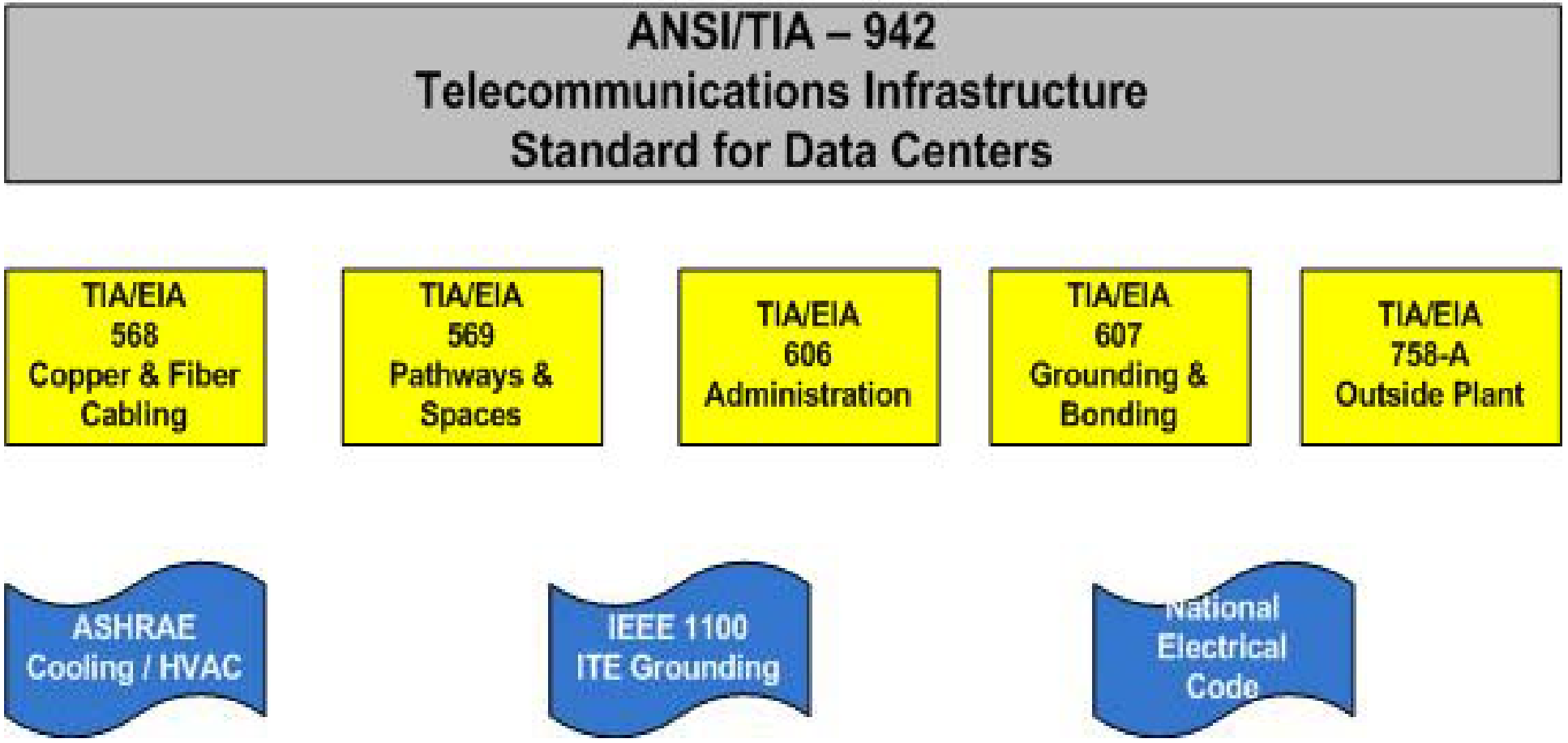
- Factors affecting Availability and Reliability
  - AC Power Conditions
    - Sag / under voltage
    - Swell / over voltage
    - transients
  - Cooling
    - Hot Spots
  - Equipment Failure
    - Temperature Swings
  - Natural Disasters
    - Blackouts
  - Human Error
    - Poor training and Documentation management

Data Center
General Design Guidelines

Data Centre Standards

- TIA 942 Telecommunications Infrastructure standard for Data Centres, April 2005
- EN 50173-5 Information Technology – data centres Europe
- ANSI-BICSI-002 Data Center Standard complementary to TIA 942
- ISO/IEC NP 24764 – Information Technology – Generic cabling for Data Centres

Others Standards within Data Centres



TR / ER

- A Telecommunications Room is an enclosed architectural space for housing telecommunications equipment cable terminations and cross connect cabling.
- An Equipment Room is an environmentally controlled centralized space for telecom equipment
- Difference between TR and ER’s are that ERs serve a building or campus while TRs serve a floor in building.

TR / ER Sizing

- TRs of 460 sq m or less must be 3m x 2.4m
- TRs of 929 sq m and not less than 740 sq m must be 3m x 3.4m

- ER minimum size must be 3 x 5m
- Generally allow 9 sq m per work area
- Multiply no of work areas by 0.07 sq m
- 5000 sq m
- 5000/9 = 555 x 0.07 = 39sq m of ER space.

Ideal Computer Room Size

- The ideal room size would be not larger than 600 sq m
- They require large amounts of air conditioning
- CRAC / CRAH (Computer Room Air Conditioning) Calculations become difficult when the room is bigger than 600 sq m
- Gas Fire Suppression quantities will be huge.

Requirements for a Data Center

Space Required	Function
Computer Room / Server Room	House computer Racks and Communications Equipment
Control Room	all control and monitoring functions are concenrated
General Office Area	Office area where IT staff can work
Entrance Facility	where all the external communications cabling enter the building
Fire Gas Suppression Store	Storage space depends on which gas is used **Inert gase** or **Halocarbons**
Electrical Switch Room	External power cables enter the building and forms a demarcation point
UPS and Battery Room	Loads of 100kVA it is recommended to have a seperate UPS room
Generator Room	house a standby Diesel Generator

Requirement for Data center con'd

Space Requirement	Function
Oil Store	House Diesel fuel for generator
Storage and Build Area	To store and unpack equipment to build
Delivery and Loading Area	Adjacent area to allow heavy equipment to be shipped into building
Planning and Meeting Room	To hold meetings
Internal staff facilities	Male/female/disabled toilets and showers
Electrical Substation	Due to power needs a separate substation may be required
Air Conditioning Condensers	A secure area is required depending on the aircon requirements
External staff facilities	Parking space, bicycle and smoke shelter

Facilities Requirements

- Room Dimensions and Height
- Floor Strength
- Connection of Services
- External Services
- Access, Load and DDA
- Decor
- Lighting
- Fire Regulations

Data Center Room Height

- Minimum Ceiling height must be 2.6m from the finished floor to any obstruction such as sprinklers

- Slab to Slab must be 2.9m i.e.
  - 400mm under Floor
  - 2.1m racks
  - 400mm air return path for CRAC

Data Center Floor Strength

- Minimum distributed floor loading capacity must be 7.2kPA
- The recommended loading capacity is 12kPA
- The floor must have minimum of 1.2kPA hanging capacity for supporting loads that are suspended from the bottom of the floor.
- The recommended hanging capacity of the floor is 2.4kPA
- KPA/1000 = N/per sq meter

Data Center Lighting

A minimum of 500 lux in the horiziontal plane and 200 lux in the vertical plan.

This must be measured 1m above the finished floor in the middle of all aisles between cabinets.

Data Center Access

- Doors must be a minimum of 1m wide and 2.13m high without doorsills, hinged to open outward
- Door must be fitted with locks and have either center posts or removable center posts to facilitate access for large equipment
- DDA – Ramps to be not less than 1.12 and all pathways to be 900 wide

Data Center Decor

- Floors, walls and ceiling must be
  - Sealed
  - Painted and,
  - Constructed out of material to minimize dust.
- Floors must have anti-static properties as per IEC 61000-4-2

Data Center Fire Regulations

- Fire Plan and Risk assessment
- Emergency Lighting and Signage
- Door and Emergency exits

- MUST ALL BE **CLEARLY** MARKED

Data Center Connection Services

- Electricity Supply
  - Who from?
  - What Capacity?
  - Where does it enter the building?
  - Is there more than one?
- Telecommunications
  - Who from?
  - What capacity / type
  - Where does it enter the building
  - Is there more than one.
- Gas, water, drainage and sewage
- No other service should cross the computer room space

Data Center External services

- Suitable location for standby generators
  - What noise?
  - What weight?
  - What Security
  - What Fuel Storage
  - What proximity

- Suitable location for external air conditioning components
  - What DX condenser units?
  - What central chiller system?
  - What weight?
  - What security?
  - What power supplies?
  - What proximity

END