Proudly Presents to

Data Center
University

Agenda

- Data Center Design
- Uptime Institute Tier Classifications
- Thermal Management
- Cabling Infrastructure
- Supply Chain Services
Introduction to:
Infrastructure &
Data Center Design
Moore’s Law

- Chip density continues to double every 18 months
- Data traffic growing exponentially
- Emerging applications are competing for bandwidth
- Evolution in Microprocessor technology creates new challenges
- Bus speed reductions will force user migration to new “threaded” software
Application Convergence

- Data Traffic
- Increasing reliance on Internet
- Growing number of IP devices on networks
- Voice Applications
- VoIP equipment market: $15.1 billion by 2007 (44% CAGR – MHOP Networks 2004)
- Can consume up to 1Mbps of sustained bandwidth
- Video on the Network
- IP Video Surveillance & Monitoring
- Distance Learning, Training & Video Conferencing
- Power Over Ethernet
- Low Voltage DC (48 VDC) distributed over 4 Twisted Pair Cabling
- Wireless AP’s, VoIP Phones, and IP Video Surveillance
Technology Evolution Drives Infrastructure & Data Center Design Problems

- Proper Facility Layout
- Cooling Issues
- Power Density Issues
- Management and Monitoring Issues
- Cable Plant Issues
Infrastructure Design Standards for the Modern Data Center
TIA-942
Telecommunications Infrastructure
TIA-942 - Telecommunications Infrastructure Standard for Data Centers

“The purpose of this Standard is to provide guidelines for the design of a data center or computer room.

It is intended for use by designers who need a Comprehensive understanding of data center design, including facility planning, the cabling system, and network design.”
More about TIA-942

- Provides a set of standards to assist in the planning of data centers, computer rooms, server rooms, and similar spaces
- Allows data center planners to make informed design decisions earlier in the building development process (architectural, facilities, and IT)
- The standard encompasses much more than telecommunications infrastructure
- Almost half of the technical content deals with facility specifications
TIA-942 Design Elements

- Cabling Design
- Copper and Fiber cabling performance
- Connectors, cables, distribution hardware
- Cabling Distances
- Space Management
- Network Design
- Support of Legacy Systems
- Enable rapid deployment of new technologies such as the emerging 10Gbps applications
TIA-942 Design Elements

- Facilities Design
- Data Center Sizing
- Power Distribution Methods
- Pathways and Spaces
- HVAC, Security, Operations, and Administration
- Bonding and Grounding
- Flexibility, Scalability, Reliability, and Space Management
- Informative Annexes Containing Best Practices
- Redundancy
- Cabling Design Considerations
- Design Examples
TIA-942 Spaces

- Entrance Room (ER) – Location of interface with campus and carrier entrance facilities
- Telecom Room (TR) – An enclosed space for housing telecommunications equipment, cable terminations, and cross-connect cabling
- Main Distribution Area (MDA) – Location of Main Cross-Connect (MC)
- Horizontal Distribution Area (HDA) – Location of horizontal cross-connect (HC)
- Zone Distribution Area (ZDA) – Location of zone outlet (ZO) or consolidation point (CP)
- Equipment Distribution Area (EDA) – Location of equipment cabinets and racks
TIA-942 Pathways

- Access Floor (Raised Floor)
- More flexible cooling with raised floor than ducted air
- Most stand-alone computer systems are designed for cabling from below
- Coordinate under floor cabling with mechanical & electrical engineers
- Overhead Cable Trays
- Less expensive than raised floor systems
- Cable trays can be attached to the top of racks and cabinets (if they are uniform in height)
- Cable trays suspended from the ceiling provides more flexibility for supporting cabinets/racks of various heights and for adding and removing cabinets/racks
TIA-942: Reduced Data center Topology

Example of a reduced data center topology

Diagram showing the reduced data center topology with:
- Main Dist Area
  - Includes Carrier Equip, Demarcation, Routers, Backbone LAN/SAN/KVM Switches, P3X, M13 Muxes
- Access Providers
- Computer Room
- Offices, Operations Center, Support Rooms
- Zone Dist Area
  - Horizontal cabling
- Equip Dist Area
  - (Rack/Cabinet)

Horizontal cabling connections are indicated between the different areas.
EN50173-5 Data Centre Cabling

- IT Cabling only as an extension to the main EN50173 standard
- Approval expected 2007
EN 50173-5: Data Centre Cabling Overview

- Class E minimum performance balanced copper channel
- OF-300 (OM2 or OM3) minimum performance fibre channel
- Recommended patch cord length extended from 5 to 10m
- Optional links allowed between LDP’s for added resilience
- Industry standard duplex SFF connector for use at ENI
  - » telecom services require >55dB return loss for Singlemode
  - » LC connector expected to be used in majority of cases
- Industry standard duplex SFF connector for use at EO
  - » either LC or MT-RJ connectors may be used
- RJ-45 Cat 6 connector adopted for use at EO with 4 pairs
- Terra & RJ-45 Cat 7 connectors for use at EO with 4 pairs
- Wish to support up to 8 optical connectors per channel
Equipment Racks and Cabinets

- Cabinets & racks should be arranged in an alternating row pattern (with fronts facing each other) to create hot and cold aisles.
- Aisles with fronts of racks/cabinets on both sides are the cold aisles.
- PDU cables should run under cold aisles.
- Locate perforated floor tiles only in cold aisles.
- Aisles with rears of racks/cabinets on both sides are the hot aisles.
- Trays for data & telecom cabling should be located under hot aisles.
Hot and Cold Aisles
Equipment Racks and Cabinets

- Provide adequate clearance for equipment to be mounted in racks & cabinets from the front (min. 0.91 metres, 1.2 metres recommended)
- Cabinets should be aligned with one edge along the edge of the floor tile
- Arrange cabinets and racks on raised floor to permit tiles along the front and rear of the cabinets to be lifted
- Floor tile cuts should be no larger than necessary and sealed where possible to minimize air pressure loss
## Hot and Cold Aisle Placement

<table>
<thead>
<tr>
<th>Front</th>
<th>Cabinets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rear</td>
<td>HOT AISLE (Rear of Cabinets)</td>
</tr>
<tr>
<td></td>
<td>Rear</td>
</tr>
<tr>
<td></td>
<td>Cabinets</td>
</tr>
<tr>
<td></td>
<td>Front</td>
</tr>
<tr>
<td></td>
<td>COLD AISLE (Front of Cabinets)</td>
</tr>
<tr>
<td></td>
<td>Front</td>
</tr>
<tr>
<td></td>
<td>Cabinets</td>
</tr>
</tbody>
</table>

- Align Front or Rear of Cabinets with Edge of Floor Tiles
- This Row of Tiles Can Be Lifted
Data Center Infrastructure Tiers

- Informative annex with general architectural, structural, electrical, mechanical, and telecommunications recommendations
- Annex includes detailed architectural, security, electrical, mechanical, and telecommunications recommendations for each Tier classification
- Higher Tiers correspond to higher availability, but also higher up-front costs
- Recommended Tier specifications are uniform way to balance infrastructure cost with desired uptime
## Data Center Reliability Tiers

This chart illustrates Tier similarities and differences.

<table>
<thead>
<tr>
<th></th>
<th>Tier I</th>
<th>Tier II</th>
<th>Tier III</th>
<th>Tier IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of delivery paths</td>
<td>Only 1</td>
<td>Only 1</td>
<td>1 active 1 passive</td>
<td>2 active</td>
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<tr>
<td>Redundant components</td>
<td>N</td>
<td>N+1</td>
<td>N+1</td>
<td>2 (N+1) or S+S</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/ft²</td>
<td>20-30</td>
<td>40-50</td>
<td>40-60</td>
<td>50-80</td>
</tr>
<tr>
<td>Ultimate watts/ft²</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/ft²</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>12-15kV</td>
<td>12-15kV</td>
</tr>
<tr>
<td>Months to implement</td>
<td>3</td>
<td>3 to 6</td>
<td>15 to 20</td>
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</tr>
<tr>
<td>Year first deployed</td>
<td>1965</td>
<td>1970</td>
<td>1985</td>
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</tr>
<tr>
<td>Construction $/ft² raised floor</td>
<td>$450</td>
<td>$600</td>
<td>900</td>
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<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>99.671%</td>
<td>99.740%</td>
<td>99.982%</td>
<td>99.995%</td>
</tr>
</tbody>
</table>

*Excludes hard and abnormal conditions. Assumes maximum of 10,000 ft² of raised floor, conventionally planned one story high set with rated capacity, but with requirements established to add components to meet the ultimate scenario.

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Source: Uptime Institute
Products. Technology.

ANIXTER

DATA CENTER UNIVERSITY
Typical Data Center

- Comprised of as many as 20 major operating systems, including:
  - Mechanical, Electrical, Telecommunications, Fire Protection, Security, etc.
- All systems require concurrent maintenance
- Each operating system has it’s own Tier Classification Rating
Terms & Definitions

- **N+1 (Need + One)**
  - A Single-Threaded Distribution Path Throughout

- **S+S (System + System)**
  - Simultaneously active distribution paths with two N+1 UPS’s

- **Concurrently Maintainable**
  - Allows operations to continue while performing planned maintenance, repair & replacement of components, the addition or removal of capacity components, system & component testing, etc.

- **Fault Tolerant**
  - Concurrently Maintainable **PLUS** allows the site to withstand at least one worst-case failure
# Functionality Evolution:

<table>
<thead>
<tr>
<th>Information Technology</th>
<th>Reliability</th>
<th>Availability</th>
<th>Serviceability</th>
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<tbody>
<tr>
<td>Clustering</td>
<td>Logical Partitions</td>
<td>Hot Pluggable</td>
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<tr>
<td>Console Automation</td>
<td>Clustering</td>
<td>Hot Microcode Updates</td>
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<td>Change Management</td>
<td>Mirrored Data</td>
<td>Call Home Remote Svc</td>
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<table>
<thead>
<tr>
<th>Electrical Infrastructure</th>
<th>Reliability</th>
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<th>Serviceability</th>
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<tbody>
<tr>
<td>UPS</td>
<td>Engine Generators</td>
<td>Engine Generators</td>
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<tr>
<td>Dual Power</td>
<td>Dual Power</td>
<td>Dual Power</td>
<td></td>
</tr>
<tr>
<td>System + System</td>
<td>System + System</td>
<td>System + System</td>
<td></td>
</tr>
<tr>
<td>Redundant Components</td>
<td>Thermal Storage</td>
<td>Dual Pipe</td>
<td></td>
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<tr>
<td>Fans &amp; Pumps on UPS</td>
<td>Thermal Storage</td>
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<table>
<thead>
<tr>
<th>Mechanical Infrastructure</th>
<th>Reliability</th>
<th>Availability</th>
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<tr>
<td>Passive Automation</td>
<td>24 by &quot;Forever&quot; Staffing</td>
<td>Work During Reg Hrs</td>
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<tr>
<td>Change Management</td>
<td>Compartmentalization</td>
<td>In-House Knowledge</td>
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</tr>
<tr>
<td>MAPS / Certification</td>
<td>Failure Bypass Options</td>
<td>In-House Supervision</td>
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<tr>
<td>Simulation</td>
<td>On-Site Spares</td>
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<tr>
<th>Facility Operations</th>
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Site Availability Tiers:

- Single Distribution Path for Power & Cooling
  - May not have Raised Floor, UPS or Engine Generator
  - NO Redundant Components
    - Requires at least one annual complete shut down to perform preventive maintenance and repairs
    - Urgent situations may require more frequent shutdowns
  - 99.671% Availability
Single Distribution Path for Power & Cooling

Likely has a Raised Floor, UPS & Engine Generator
  - Capacity likely designed for “Need plus One” (N+1)

Redundant Components
  - Slightly less susceptible to planned and unplanned disruptions

99.741% Availability
Tier III Site Availability Tiers:

- Multiple power & Cooling Distribution Paths
  - Only one Path Active
- Redundant Components
- Concurrently Maintainable
  - Able to perform planned site infrastructure activity without shutting down critical load
- Unplanned Errors or Failures will cause DC disruptions
- 99.982% Availability
Tier IV Site Availability Tiers:

- Multiple, Active Power & Cooling Distribution Paths
- Redundant Components
  - Two UPS systems, each with N+1 redundancy
  - Dual power inputs required for all computer hardware
- Fault Tolerant
  - Can sustain one “unplanned” worst-case infrastructure failure with no critical load impact
  - Provides capacity & capability to permit any planned activity with NO critical load impact
- 99.995% Availability
## Site Availability Tier Comparison:

This Chart Illustrates Tier Similarities and Differences

<table>
<thead>
<tr>
<th></th>
<th>Tier I: Basic</th>
<th>Tier II: Redundant Components</th>
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Expectation Realities:

- Even Tier IV will NOT satisfy IT expectations of “Five Nines” (99.999%) availability
- The best Tier IV can deliver, for an extended period of time, is 99.995% availability
  - Only the top 10% of Tier IV sites will reach 99.995% availability
  - Assumes an average of 5 minutes of downtime per year
## Maximum Allowable Average Annual Downtime Minutes

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<thead>
<tr>
<th></th>
<th>Yr 1</th>
<th>Yr 2</th>
<th>Yr 3</th>
<th>Yr 4</th>
<th>Yr 5</th>
<th>5 Yr Tot</th>
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<td>Minutes</td>
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<td>525,600</td>
<td>525,600</td>
<td>525,600</td>
<td>525,600</td>
<td>2,628,000</td>
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### Maximum Allowable Down Time Minutes:

<table>
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<tr>
<th>Tier</th>
<th>%</th>
<th>Min</th>
<th>Min</th>
<th>Min</th>
<th>Min</th>
<th>Min</th>
<th>5 Min</th>
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<td>99.671%</td>
<td>346</td>
<td>346</td>
<td>346</td>
<td>346</td>
<td>346</td>
<td>1,729</td>
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<td>Tier II</td>
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<td>272</td>
<td>272</td>
<td>272</td>
<td>272</td>
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<td>19</td>
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<td>19</td>
<td>95</td>
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<tr>
<td>Tier IV</td>
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<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>26</td>
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</tbody>
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General Suggestions

- Focus Signage & Training on Human Execution & Error Reduction
- Limit the number of Outsiders in critical spaces
- Locate redundant equipment in other areas
- Plan Business & Mission Critical infrastructure designs to allow immediate restoration
Introduction to:
Thermal Management & Power Distribution
Basic Facts

- 1 Watt of power consumed = 1 Watt of heat
- Heat usually rises but will always go to cold
- Fans always pull their designed volume of air
- One open floor tile changes system static pressure
Server Density Driving Data Center Changes

Moore’s Law:

- “Chip density will double every 18 months”
- 40 year trend of increasing clock speeds slowing
- Miniaturization continues
- New designs include multiple processors
  - Dual-Core & Quad-Core chips
  - Slower Clock speeds
- Pat Gelsinger predicts dozens of cores
Server Density Driving Data Center Changes

- Chip density drives increased power consumption
  - Dual Core chips initially consumed approximately 130 watts of power
- Server density exposes existing design flaws
  - Power & Cooling issues
  - Cabinet footprint & configuration
  - Cable management gains new importance
  - Significant increase in power required per rack
    - Data center power loads doubled in past 5 years
  - Thermal management is unavoidable
    - One watt of power consumed = one watt of heat
Traditional Data Center Cabinet Arrangement

- High density cabinets arranged front to back
- CRAC units positioned on perimeter of room

Source: Optimizing data centers for high-density computing
HP technology brief, 2nd edition
Cabinet / Rack Changes

- **Cabinet Footprint Growing**
  - 1998: 90% of purchases were 81 cm deep or less
  - 2003: 50% of purchases were 90 cm deep
  - 2004: 106 cm to 120 cm are becoming common

- **Cable Management**
  - Increased rack density = Increase in power & data cables

- **Enhanced cabinet designs facilitate heat dissipation**
  - New standard features force “front to rear” air flow
  - Supplemental options increase air flow
Supplemental Air Delivery & Exhaust Systems

Augmented Air Delivery System

Augmented Exhaust System
Cable Management

- Cable management offers potential solutions
  - Increased rack densities bring added data cable density
  - Density & redundancy bring more power cables to racks
    - Redundancy means more power strips as well as cables
- Re-think cable management policies
  - Overhead vs. Under floor
  - Provide for frequent/easy access to cable
  - Provides for frequent/easy access to equipment
Power Draw Trend

- 2003 actual data ave = 1.7kW
- >90% of new data centers capability
- Max 1U server
- Max blade server

Per Rack Power - kW

% of Enclosures

0% 5% 10% 15% 20% 25%
Rack density forces changes in power distribution

- Traditional single phase circuits no longer enough
- 3-phase power gaining in popularity
- 28 potential ways to power racks with 1kw-30kw
  - Most widely used:
    - 230V 20A
    - 230V 30A
    - 230/415V 20A 3-Phase
    - 230/415V 30A 3-Phase
Other Design Criteria

- Redundancy
  - Eliminates huge costs associated with downtime
  - Eliminates loss of valuable time and data
  - Design room with enough additional cooling to provide 100% of the required cooling capacity after a unit shutdown or failure of one or more units
  - For 100 kW load here are two scenarios

- [Diagram showing two configurations:]
  - 50 kW + 50 kW = 100 kW
    - Handles the 100 kW load
    - Redundant Unit
  - 75 kW + 75 kW = 150 kW
    - 150 kW capacity is 50 kW overload
Thermal Management

- ‘Hot’ Aisle / ‘Cold’ Aisle
Hot and Cold Aisle Placement

- Align Front or Rear of Cabinets with Edge of Floor Tiles
- This Row of Tiles Can Be Lifted
- HOT AISLE (Rear of Cabinets)
- Rear
- COLD AISLE (Front of Cabinets)
- Front
- Cabinets
- Rear
- Cabinets
- Front
Thermal Management (cont’d)
Positioning of Air Delivery & Return Vents
- Cold supply ductwork should be aligned with cold aisles
- CRAC units should be located on either end of hot aisles
Thermal Management (cont’d)

- Recommended cabinet & CRAC unit arrangement

Source: Optimizing data centers for high-density computing
HP technology brief, 2nd edition
Thermal Management (cont’d)

- Airflow pattern for raised floor configuration with hot aisles and cold aisles
Thermal Management (cont’d)
Rack Level

- Airflow Within Rack Impacts Component Cooling
- Air Moves Between Levels
- Air Sits Between & Around Active Components
- Facilitate Front to Back Air Flow
Thermal Management (cont’d)

- **Recirculation**
  - Internal
  - Bypass
  - Over top
  - Through neighbor

- **Proper Configuration**
  - Blanking Panels
  - Door Perforation

Source: Optimizing data centers for high-density computing
HP technology brief, 2nd edition
Thermal Management (cont’d)

- Airflow inside & through the rack
  - Rack design must discourage re-circulation
    - Install blanking panels in unused “RU” spaces
Thermal Management (cont’d)

- Using ceiling void as a return air space

Source: Optimizing data centers for high-density computing
HP technology brief, 2nd edition
Cooling system settings
- CRAC systems optimal when return air temp at maximum & humidity at lowest possible
- Disperse heat & power load when feasible
Floor vents in a raised floor environment
- Proximity of floor vents to supply source
- Left: Plenum static pressure is greater than pressure above floor
- Air velocity must slow down before static pressure will push it up through the floor tiles

Source: Optimizing data centers for high-density computing
HP technology brief, 2nd edition
Hot and Cold Aisles

Source: TIA 942
Practical Thermal Management Steps

- Utilize Overhead Cable Management
  - Power & Data Cables
  - Facilitates Moves, Adds & Changes
- Seal All Openings in Raised Floors
  - Maintain Raised Floor Static Pressure
  - Minimize Removal of Floor Tiles
- Eliminate Mixing of Hot Discharge and Cool Supply Air
  - Block Open Bays in Cabinets with Blanking Panels
  - Use Solid Side Panels & Solid Tops
- Create Unrestricted Air-Flow Pathways in Cabinets
  - Meticulous Attention to Rear Cable Management
- Position CRAC Units at Either End of Hot Aisles
General Conclusions

- Design data centers to be Scalable
  - Plan power & cooling systems to grow with demand
- Active component life averages 2.5 years
- Moves, adds & changes
  - Provide for easy rack access (front & rear)
  - Plan for easy access to cable without disrupting operations
- Pay close attention to Static Pressure
- Use ‘Hot’ aisle / ‘Cold’ aisle layout
  - Prevent exhaust air & cooling air mixing
  - Inside & outside of racks / cabinets
Infrastructure Solutions for the Modern Data Center

- **Data Center Design**
  - TIA/EIA 942 Standard
  - EN 50173-5 Draft Standard

- **Cabling Performance - Ethernet**
  - IEEE 802.3an 10 GIG Standard
  - Augmented TIA Cat 6/ISO Class E_A Standard

- **Protection of Data Center Assets**
  - National Electrical Code (NFPA 70) - Limited Combustible Cable (USA Standard) Consider local standards
  - Video Surveillance, Access Control & Network Monitoring
The purpose of this Standard is to provide requirements and guidelines for the design and installation of a data center or computer room. It is intended for use by designers who need a comprehensive understanding of the data center design including the facility planning, the cabling system, and the network design. Currently available on www.global.ihs.com
Goals of TIA-942

- Enabling planning for data centers to occur earlier in the building development process (architectural, facilities, and IT)
- Fill a void by providing standards for planning of data centers, computer rooms, server rooms, and similar spaces
- The standard encompasses much more than just telecommunications infrastructure
- Close to half of the technical content deals with facility specifications
TIA-942 Design Elements

- Cabling Design
- Network Design
- Facilities Design
- Informative Annexes Containing “Best Practices”
- Spaces
- Pathways
- Racks/Cabinets
Data Center Cabling Topology

Source: TIA 942
Data Center Infrastructure Tiers

- Annex includes detailed architectural, security, electrical, mechanical, and telecommunications recommendations for each Tier.
- Higher Tiers correspond to higher availability, but also higher construction costs.
- Recommended specifications by tier are a uniform way to rate aspects of a data center design and are a starting point for initiating design requirements with qualified architects and engineers.
Choosing the Appropriate Cabling Media

- Flexibility with respect to supported services
- Required useful life of cabling
- Facility/site size and occupant population
- Equipment vendor recommendations or specifications
- Channel capacity within the cabling system
  - Category 6 / Class E minimum recommendation for horizontal cabling
  - 50/125 micron 850 nm laser optimized multimode fiber is recommended for most backbone applications
EN 50173-5: Data Centre Cabling Overview

- Class E minimum performance balanced copper channel
- OF-300 (OM2 or OM3) minimum performance fibre channel
- Recommended patch cord length extended from 5 to 10m
- Optional links allowed between LDP’s for added resilience
- Industry standard duplex SFF connector for use at ENI
  - » telecom services require >55dB return loss for Singlemode
  - » LC connector expected to be used in majority of cases
- Industry standard duplex SFF connector for use at EO
  - » either LC or MT-RJ connectors may be used
- RJ-45 Cat 6 connector adopted for use at EO with 4 pairs
- Terra & RJ-45 Cat 7 connectors for use at EO with 4 pairs
- Wish to support up to 8 optical connectors per channel
Fibre Cabling in Today’s Data center LAN/SAN Environment

SAN

Server Cabinet

MDA

SAN Switch

Edge Switch

Distribution Switch

Storage

Server(s)

LAN

Router

LAN
Structured vs. Unstructured Cabling Solutions

The cabling starts with a few connections . . .

And this is how it ends up . . .

- No defined cable paths
- Changes made at active equipment
- Problem determination difficult
- System growth can be impacted
- Mess under the floor
Sometimes we just take shortcuts...
Star Topology Back to MDA
Cisco Design Considerations

- All cable runs located under raised flooring and appropriately marked
- All cable runs physically protected from damage via tie-downs or where appropriate in conduit
- **All cabling designed to Category 6 specifications (to support 1-Gbps data rates)**
- Communications cabling raceways separate from electrical; no intersections
- Shielded cabling for T1/T3s. DSX panels for XCONN, demarcation, and test points
- All cabling on raceways, tied down

*Source: Cisco Systems – Data Centers: Best Practices for Security and Performance*
The Road to 10G

IEEE

In 2002 the IEEE began work on creating a specification for 10 Gigabit transmission.

- Specify the performance characteristics of the active equipment like switches and NIC’s.
- Provided basic cabling targets needed to support these specification.

Today 10G is available over Fiber or twinax (short distance in data centers).

By mid-year 2006 hardware manufacturers should begin shipping 10G copper blades and boxes.
The Standards Organizations

**ISO**
ISO (International Standards Organization) is an organisation responsible for developing international standards for cabling system performance.

**CENELEC**
CENELEC is a European organisation responsible for developing standards across Europe.

**TIA**
TIA is a US trade association that develops standards for cabling performance and installation practices. The TIA standard relating to UTP cabling systems is 568-B.
What Makes 10G to the desktop Possible on UTP?

- Extending the useable bandwidth to 500MHz
  - Channel performance specifications have been extended from 250 MHz (Cat 6) out to 500MHz
- Establishing a new multi-level 10G transmission coding scheme — more information per signal
- Eliminating the negative effects of Alien Cross talk
  - Alien Cross talk is the undesired coupling of energy (signals) from adjacent channels (cables/connectors)
  - Cannot be cancelled by electronics
- Because of these two requirements Augmented Cat 6 is very different than standard Cat 6
What is Alien Cross talk?

- Alien cross talk occurs through coupling of adjacent pairs in parallel runs of multi-pair cabling.
- Caused by the interaction of same color pairs in adjacent cables which would have identical twist rates.
- PSANEXT and PSALELFEXT are the primary parameters impairing performance.
Cabling for 10GBASE-T

- Augmented Cat 6 is vastly different from standard Cat 6
- Cat 6 will not support 10GBase-T up to 100m
  - Cabling systems should always support 100m
- There is no “in-between”
  - You’ll either run at a full 10G or the electronics will throttle back to 1G!
- Tuned systems required – not open architectures

“...To support distances of 330 feet, as required in the U.S. market, substantial augmentation to the existing cabling specifications are required. This will result in a separate cabling system designed for 10GBASE-T. The TIA cabling subcommittee currently is addressing this task.”

– Source: NetworkWorld Fusion 4/17/05
802.3an Update

- Maximum 10 Gigabit Application Frequency is 500 MHz
- Alien NEXT and Alien FEXT Significant Factors in Cabling Channel Capacity on UTP
- TIA and ISO Cable Specifications Based on IEEE Requirements
- Short reach option recently added
  - Targeted for data center applications (< 30 m)

<table>
<thead>
<tr>
<th>IEEE Model</th>
<th>Standard</th>
<th>Media</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ISO Class F (individual shields)</td>
<td>STP</td>
<td>100m</td>
</tr>
<tr>
<td></td>
<td>ISO Class EA</td>
<td>UTP</td>
<td>100m</td>
</tr>
<tr>
<td></td>
<td>TIA Augmented Cat 6</td>
<td>UTP</td>
<td>100m</td>
</tr>
<tr>
<td>2,3,4</td>
<td>Shielded Cat 6 (overall shield)</td>
<td>FTP</td>
<td>100m</td>
</tr>
<tr>
<td></td>
<td>TIA Standard Cat 6/ISO Class E</td>
<td>UTP</td>
<td>&lt;55m</td>
</tr>
</tbody>
</table>
IEEE 802.3an Short Reach Mode

- Primary goal is to reduce power consumption of PHY (< 3.5 watts)
- In short reach mode, the PHY powers down components that are only needed to go further than the transmission link length limits
  - TX voltage can be lowered
  - Canceller and equalizer performance requirements can be relaxed
- Short Reach Mode operates at lengths of 30 meters or less using Category 6A/ISO Class E_A or Class F Cabling
- Category 6/Class E cannot take advantage of Short Reach Mode
Two Projects Underway

Augmented Category 6 (568-B.2-Ad10)
- Will include component, channel, and permanent link specifications up to 100m
- Will become Addendum to 568-B.2 standard
- Estimated publication date will coincide with IEEE 802.3an release sometime in 2006

Current Category 6 (TSB-155)
- Channel and permanent link specifications only (<55m)
- Field and laboratory testing procedures being debated for PSANEXT and extended (500Mhz) frequency testing
- PSANEXT mitigation procedures will be included
## ISO Compared to TIA

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<th>Characteristics 500 MHz (dB)</th>
<th>ISO Class EA</th>
<th>TIA Augmented Cat 6 Draft</th>
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<tr>
<td>PSNEXT Loss</td>
<td>24.8dB</td>
<td>23.2dB</td>
</tr>
<tr>
<td>NEXT Loss</td>
<td>27.9dB</td>
<td>26.1dB</td>
</tr>
<tr>
<td>PSANEXT Loss</td>
<td>49.5dB</td>
<td>49.5dB</td>
</tr>
<tr>
<td>Return Loss</td>
<td>8.0dB</td>
<td>6.0dB</td>
</tr>
<tr>
<td>Insertion Loss</td>
<td>49.4dB</td>
<td>49.4dB</td>
</tr>
<tr>
<td>Referred to by IEEE</td>
<td>Yes</td>
<td>No</td>
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More Stringent than TIA

Anixter’s UL certified lab tests to ISO standards
## TIA Category 6 vs. Augmented Category 6

<table>
<thead>
<tr>
<th>Feature</th>
<th>TIA Category 5e UTP</th>
<th>TIA Category 6 UTP</th>
<th>TIA Augmented Category 6 UTP</th>
<th>ISO Class EA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recognized by IEEE 802.3an</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>55 Meter Distance Support</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>100 Meter Distance Support</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Extrapolated Test Limits for NEXT and PSNEXT to 500 MHz</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
# 10G Channel Applications

<table>
<thead>
<tr>
<th>Application</th>
<th>10GBase Fiber (802.3ae)</th>
<th>10GBase-T</th>
<th>10GBase-CX4 (802.3ak)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Center Server Clustering</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes (&lt;15m)</td>
</tr>
<tr>
<td>Horizontal In Building</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Vertical Risers</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Campus/Metro</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
Cabling for 10Gigabit Applications

- **10GBASE-S**
  - Multimode fiber, a serial transmission at 850 nm
  - Lowest cost for new installs (<=550 m)
  - Data Centers and Building/Campus Backbones

- **10GBASE-LX4**
  - Multimode or single-mode fiber, DWDM transmission in the 1300 nm region
  - Multimode fiber solution intended for legacy systems

- **10GBASE-L**
  - Single-mode fiber, serial transmission at 1300 nm
  - Campus backbones
Cabling for 10Gigabit Applications

- **10GBASE-E**
  - Single-mode fiber, serial transmission at 1550 nm
  - Metro area networks

- **10GBASE-LRM**
  - Multimode fiber, FDDI Fiber, 1300 nm, 220 m (legacy Fiber)
  - Compatibility and Interoperability Issues
  - 2005-2006 Completion
Cabling for 10Gigabit Applications

- **10GBASE-CX4**
  - Data Center applications operating at less than 15 meters in length
  - More cost effective than 10GBASE-S at short distances
  - Not compatible with RJ45 connectivity
  - Available Today

- **10GBASE-T**
  - Horizontal Applications (<100 meters) using Augmented Category 6 Cable
  - Limited distance support (<55 meters) using current Category 6 Cable
  - Alien Cross talk (PSANEXT and PSALELFEXT) primary parameters impairing performance
  - Electronics not available until 2006
Protection of Data Center Assets

- Fire Loss
- Environmental Monitoring
- CCTV (Video Surveillance)
- Access Control
Types of Losses Due to Fire & Smoke

- Building and Contents
- Downtime Cost
- Computer Equipment & Data
- Productivity/Efficiency Loss
- Employee Absenteeism
- Clean Up
- Medical Costs
- Damage to Customer Relationships
- Loss of Competitive Advantage
- Litigation
- Damage to Public Image
- Regulatory Requirements
Types of Copper Cable Construction

International Specifications
IEC754 part2 : Non-halogen
IEC61034 part2 : Smoke emission
IEC 60332 part1 : Flammability and flame retardant
Nes 713 : Toxicity
LCC in Action
Status of Limited Combustible Classification in NFPA 70 – National Electrical Code

- Currently, the NFPA neither requires or prohibits the use of “Limited Combustible” cables.
- Limited Combustible cables will be up for consideration again in 2008 as a requirement.

This is for information only, all local standards will apply and should be checked. Most European countries use Low Smoke Halogen Free cables which meet European standards.
Environmental monitoring solutions should protect critical assets from:

- **Environmental harm such as extreme temperatures and humidity**
  - Temperature: 20°C (68°F) to 25°C (77°F)
  - Humidity: 40% to 55%
  - Maximum Rate of Change: 5°C (9°F) Per Hour

- **Human error and sabotage**

- ...and virtually all other threats, from power spikes to radioactive and chemical materials.
Data Center Security Tiers

- **CCTV Monitoring**
  - Building Perimeter and Parking
  - Generators
  - Access Controlled Doors…etc.

- **Access Control/Monitoring**
  - Door to Emergency Exits, Perimeter and Computer Rooms
  - Fiber Vaults…etc
Data Center Infrastructure Solutions Summary

- **Anixter Recommends:**
  - At minimum, Cat 6 should be used for horizontal cabling requirements. 10 GIG is highly recommended.
  - Use fiber in your backbone, metro, and campus requirements.
  - To avoid fire loss, limited combustible cable should be used.
  - Protect your assets in your data center by using video surveillance, access control, and network monitoring products.
Products. Technology.
Supply Chain Solutions Overview
The Supply Chain Model

Efficient flow of goods, services and related information from the point of origin to the point of consumption.
The Goal of Supply Chain Services

- Reduce Cost
- Save Time
- Improve Productivity
- Improve Efficiency
- Enhance Financial Performance
- Scalable, Repeatable
- Mitigate Risk

“Poor supply chain design regularly increases project costs by 10% or more, project duration might be similarly affected”

(University of Florida)
Challenges in Technology Deployments

- Right Products, Right Place, Right Quantity, Right Condition, Right Time.
- Process Coordination: Transactions, Shipping, Communication.
- Eliminate Disruption to Regular Business Operations.
Supply Chain Solutions: Minimise Process and Cost

- Evaluate all processes involved with material procurement and deployment.
- Determine specific areas to streamline - Order Entry, Material Management, Delivery, Freight, etc..
- Develop a well defined program to help take costs out of our customers businesses while maximizing efficiency and reducing risk.
The Supply Chain Model

Efficient flow of goods, services and related information from the point of origin to the point of consumption.
Sourcing

- Product and Systems Specifications
  - Network Cabling
  - Physical Security
  - Network Systems, etc.
- Engineering Support
- OEM Vendor
  - Selection
  - Management
- In-country Sourcing
Logistics

- Inbound to Anixter Warehouse
  - Mode of Transportation
  - Import/Export
- Anixter Delivery Service
  - To Building 3A
  - To Building 3B
  - To Building 3C
Inventory Management

- Anixter Distribution Center(s) Selection
  - $600M existing investment
  - Standard Operation Procedures
  - Quality Control Program
- Piece Part Inventory
  - lead time management
  - visibility
  - provisioning
Deployment

- Labeled Zone Delivery Kits
  - By IDF
  - By Floor/Zone
  - By contractor/trade
  - By product set (NCS, Electronics, PSS)
- Whole Order Delivery
- Implementation Plan
eBusiness

- Custom eCatalogue – Customer Specifications Only
- Password Protected 7x24 Login ID
- Real Time Views
  - Inventory Availability
  - Pricing
  - Delivery Information
- Bid Management Tool for Materials
- Custom Report
  - Product/Vendor Spend Reports
  - Inventory Management Reports
Anixter’s Supply Chain Services Model

“Supply chain costs, as a percent of total costs, can average between 10% and 30%”

(e2e Consulting)
All components needed to complete an installation delivered as one part number in one shipment

Each kit a labeled to identify its contents and destination
Complete cabinet with all of the components and accessories delivered as one part number.
- Whole order delivery by closet
- Multiple racks or cabinets
- Installation kits
- Consumables and accessories
One Faceplate + four color jacks + identification + accessories = one part number
READY!Floor is a whole order delivery of multiple closets, cable, workstations, etc. to complete a floor or section of the building.

Each floor is labeled in a different color combination to ease identification.
READY! Deployment services are customized to each project.
Case Study: Data Center

- **Opportunity**
  - 3 Phase Data Center expansion over 12 months
  - Team with contractor to help save customer money
  - Focused on ‘non-craft specific labor”

- **Solution**
  - Phase I -- 70 Cabinets (bid and tightly managed)
  - Phase II -- 117 Cabinets (no bid)
  - Phase III -- 55 Cabinets (no bid)
  - Cabinet Types: MDF Fiber, MDF Copper, Switch, Server
  - Included Customer Owned Material Management
Thank You

- **Anixter Inc.**
  - Established infrastructure.
  - Strong financials.
  - Global expertise.
  - Proven systems and process integration.
  - Experience with all facets of supply chain.
  - Track record of success.

- **Keys to a successful partnership:**
  - Committed to understanding your business issues.
  - Committed to understanding your process(s) and technology needs.
  - Committed to process integration and improvement.
  - Proven experience
Thank You for Listening

Products. Technology.

Thank You for Listening