



Infrastructure Solutions for High-Performance Data Networks

A Planning Guide for Network Managers



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Your data center is a critical resource within the enterprise, and the decisions you make in regards to infrastructure have implications now and in the future.

To allow you to fully assess and document the physical aspects of your data center, and gain insight into how it can be optimized, ADC has created this Planning Guide for Network Managers.

Within the guide, we'll address several key questions:

- What is the ideal layout and how does that compare to your current setup?
- What about cable management? How can you better manage cabling to maximize efficiency and minimize costs?
- What are the main challenges in power supply sizing and how should you adjust your current operations to meet them?
- What should you be doing to ensure proper cooling is taking place, and how can you do so while keeping costs down?



Charting the Future Direction of Your Data Center

This is a hands-on reference document. We invite you to share it with your staff and use this workbook together as you chart the future direction of your company's data center strategy.

This planning guide has the potential to help you and your staff:

- Analyze the strengths and weaknesses of your current data center environment and put them on paper
- Explore strategies for improving reliability and cost effectiveness in terms of layout, cable management, cooling and power utilization
- Pursue forward-thinking strategies for the 21st century data center

How to Use the Planning Guide-Sections A through C

This guide is broken into three sections:

Section A- Analyzing Your Data Center Design and Layout - Contains a worksheet that poses a series of questions designed to help you assess your operation and the major challenges you currently face. The information you provide in this worksheet will help ADC to fully understand your situation.

Section B- Optimizing Your Data Center - Examines the steps required to plan and execute a data center that will support your needs.

Section C- Learning from Your Peers: Real-World Data Center Scenarios - Shows how companies have used these steps to optimize their data centers, improve network reliability and contain costs.

Worksheet: Analyzing Your Data Center Design and Layout

The key to maintaining a high-performance data network is the design and layout of your data center.

In Section A, we'll examine your current or planned data center. The worksheet will help you document your current infrastructure and will provide ADC with the information we need to serve you better. Building on the information you gather, you can create a working design for your data center. Implementing a well-conceived physical plant enables you to improve operating efficiency, protect capital investments, ensure reliable operations and optimize facilities to maintain cost control.

After you've completed this worksheet and carefully examined the important aspects of IP infrastructure and optimization of your network, call **1.866.210.3524** and let ADC answer your tough questions.

In general, how satisfied are users with the performance of your data center?

- Very satisfied; we receive almost no complaints about performance.
- Somewhat satisfied; while our users occasionally experience minor issues, these are typically dealt with in a rapid manner.
- Dissatisfied; we are struggling to attain an acceptable level of performance.

What type of equipment do you house in your data center? Please check all that apply.

- Mainframe
- UNIX Servers
- Intel Servers
- PBX/other telecom equipment
- Storage arrays
- Networking gear
- Other: _____



Which operating systems do you support?

- IBM Mainframe OS
- UNIX
- Linux
- Windows
- NetWare
- VMS
- Other: _____

What databases do you support?

- DB2/UDB
- SQL Server
- Oracle
- CICS
- Sybase
- Informix
- Other: _____

**Which are the biggest problem areas in your data center operations right now?
Please check all that apply.**

- Storage capacity
- Poor performance
- Lack of bandwidth
- Backup/restore
- Budget
- Unmanageable growth
- Application management
- Power consumption
- Cooling
- Cable management
- Other: _____

What plans do you have to expand your existing data center and what impact will this have on layout, power supply, cabling and cooling?



Spatial Layout

How would you characterize the spatial layout of your data center?

- Excellent; space can be reallocated easily to respond to changing requirements and anticipated growth.
- Somewhat satisfactory; while space reallocation is far from easy, we can usually find some way to solve a problem. However, rapid growth may well prove difficult to resolve.
- Poor; space reallocation is a constant challenge and we anticipate significant problems due to changing requirements and further growth.

To what extent is the space utilized within your data center?

- 100%; our data center is completely full of equipment and there is no room for any more.
- 75 to 99%; our data center is heavily utilized, but we do have room for some more equipment.
- 50 to 74%; our data center has plenty of room for expansion.
- Less than 50%; our current data center space is underutilized.

How physically secure would you say your data center is?

- Very secure
- Somewhat secure
- Somewhat insecure

How differentiated are your racks?

- Well-differentiated; we have separate racks for fiber, UTP and coaxial cable.
- Somewhat differentiated; where possible, we have separate racks, but in some cases, they are mixed.
- Poorly differentiated; we routinely mix fiber, UTP and coaxial cable.

Do you have separate racks for fiber, UTP and coaxial cable in all of your horizontal distribution areas (HDAs)?

- Yes
- No

How aware are you of the TIA-942 standard, the Telecommunications Infrastructure Standard for Data Centers?

- Fully aware; we have been tracking the developments surrounding TIA-942 closely and are actively taking steps to implement this standard.
- Somewhat aware; we are aware of TIA-942 but have been waiting for the standard to be finalized before taking action.
- Not aware; we, as an organization, are not aware of this standard.

Does your existing layout include ample areas of flexible white space, i.e., empty spaces within the center that can be easily reallocated to a particular function, such as a new equipment area?

- Yes
- No

How much room do you currently have for data center expansion?

- Lots of room; our assessment of data center space requirements includes more than enough space for expansion in the foreseeable future.
- Probably enough; while we have been surprised by the rapid growth of our data center, we probably have enough space to last us another year or two, if not longer.
- Not enough; our data center has grown so rapidly that it is already close to full capacity.

What contingency plans do you have in place if the data center outgrows its current confines?

- No contingency plan; we have plenty of space
- Move to another building
- Move to another floor
- Take over adjacent office space
- Not sure

How likely is it that you can annex surrounding offices if your data center fills up?

- Very likely; plans are being made to expand the data center.
- Unlikely because we have plenty of room in the data center already.
- Not sure.



How easily are you able to reallocate space within the data center to respond to changing requirements?

- Very easily; space reallocation is rarely a challenge.
- Adequately; space reallocation is always a challenge, but one that we are usually able to deal with.
- With great difficulty; our data center is close to full capacity and any space reallocation is a major headache.

Cable Management

What types of cabling do you utilize in your data center? Please check all that apply.

- Unshielded
- Unshielded plenum
- Shielded
- Shielded plenum
- Low smoke zero halogen (LSZH)
- Singlemode and multimode fiber
- Other: _____

Which kind of cabling do you employ in your data center?

- Under-floor (raised floor environment)
- Overhead
- Both under-floor and overhead cabling

Do you utilize any kind of color-coding scheme to simplify the recognition and management of cabling?

- Yes
- No

How prominent a role does the data center play in corporate image?

- Prominent; our data center is clearly visible and we encourage visitors to take a tour.
- Somewhat prominent; we would like to showcase our data center, but unfortunately, it is lacking in appeal.
- Well hidden; we go to great lengths to make sure no one outside of IT enters the data center.

What are the major causes of outages/service interruptions in the data center? Please check all that apply.

- Damage to jumpers and cables
- Downtime due to routine maintenance and upgrades
- Downtime due to moves, adds and changes
- Failure of active equipment

How long does it normally take to trace a cable from end to end within the data center?

- One or two minutes
- Up to 10 minutes
- Up to 30 minutes

What connection types do you utilize in your data center? Please check all that apply.

- Direct connect; we hardwire all active equipment directly together.
- Interconnect; we cable some active equipment to patching fields.
- Cross-connect; we cable all active equipment to patching fields.

How tidy are the cabling connections, patch cords and the routing of wires within the data center?

- Our cabling and routing is aesthetically pleasing.
- Our cabling and routing is somewhat untidy but not embarrassingly so.
- Our cabling is largely a jumble of wires and its routing is so chaotic that technicians waste time trying to figure out which line is which.

Do your racks and cabinets provide ample vertical and horizontal cable management?

- Yes
- No

Fiber

In which of the following applications is fiber used in your data center?

Please check all that apply.

- Environments, such as factory floors, where high levels of electromagnetic radiation are likely.
- Gigabit and 10 Gigabit Ethernet implementations.
- Cable runs that exceed the recommended distances for copper.
- Other: _____

Which method of fiber cable connection do you primarily use?

- Splicing
- Field connectorization

How long is a typical cable run in your data center?

- Longer than 100 meters
- Shorter than 100 meters

How good a job do you feel you are doing with the routing of fiber?

- Excellent; we never have issues caused by bending fiber cables beyond the bend diameter specified by the manufacturer.
- Fair; we don't have many problems with fiber routing, but occasionally we experience breakage due to exceeding the recommended bend diameter.
- Poor; we experience frequent breakages and other routing issues.

Powering the Data Center

What major power interruptions have you suffered over the past year?

- We had multiple power interruptions over the past year.
- We had only one or two power interruptions over the past year.
- We never have power interruptions.
- Not sure

How satisfied were you with the procedures you had in place to address these power interruptions?

- Very satisfied; service was not interrupted
- Satisfied; service was only minimally interrupted
- Not satisfied; service was down
- Not sure

How many power feeds do you have from the utility?

- One
- Two
- More than two

Do you utilize Uninterrupted Power Supplies (UPS) for all major equipment?

- Yes
- No

Is your UPS system specifically designed for computer systems?

- Yes
- No

Which make of UPS system are you using?

- Liebert
- Exide/Powerware
- APC/Silcon
- Other: _____



Which of the following features does your UPS include?

- Redundant configuration
- Filtering is built into the system
- Monitoring of utility power while running on batteries or your generator

Do you have multiple circuits to computing and communications systems, and to cooling equipment?

- Yes
- No

What sources of on-site power do you utilize?

- Generator
- Battery backup
- Generator and battery backup
- None

How often do you suffer downtime due to planned or unplanned maintenance?

- Daily
- Weekly
- Monthly
- Quarterly
- A couple of times a year
- Annually
- Never

What level of reliability is sufficient for your organization?

- 99.671% (Tier I)
- 99.741% (Tier II)
- 99.982% (Tier III)
- 99.995% (Tier IV)
- Other: _____



How well do you feel you estimate your power requirements?

- Perfectly; we know our power requirements precisely and always have enough power.
- Quite well; we are aware of some areas of waste and overestimation of power requirements. However, overall, we are satisfied.
- Poorly; we are well aware of considerable overspends due to overestimation of power needs and underutilized or non-utilized resources.

How utilized is the power capacity in your organization?

- 81 to 100% utilized
- 51 to 80% utilized
- 31 to 50% utilized
- 30% or lower

Cooling the Data Center

What type of cooling equipment do you have in your data center?

- Localized AC units
- Building HVAC system
- Other: _____

How would you best characterize the current state of cooling in the data center?

- Excellent; we have more than sufficient cooling equipment for our existing needs.
- OK; we cope well with most situations but sometimes experience a limited amount of overheating in some equipment.
- Poor; we often have to address overheating situations.

How closely do you comply with the hot aisle/cold aisle configuration (equipment racks are arranged in alternating rows of hot and cold aisles)?

- Well; we adhere closely to a hot aisle/cold aisle configuration.
- Somewhat; where possible, we adhere to a hot aisle/cold aisle configuration.
- Poorly; we do not adhere closely to a hot aisle/cold aisle configuration.

How closely do you track humidity levels inside the data center?

- Carefully; we pay close attention to humidity levels and maintain it within a strict range.
- Somewhat; we take steps to prevent humidity becoming too high or too low when we become aware of an issue.
- Hardly at all; we don't pay much attention to humidity levels within the data center.

What kinds of environmental extremes is your data center environment subjected to? Please check all that apply.

- Temperatures at freezing or below
- Heavy rain
- Snow and ice
- Extreme heat
- Very low humidity

Based on this review of your data center layout as a whole, what would you say are the most important areas in which to focus resources and improve operations?

1. _____
2. _____
3. _____

Now that you've completed this worksheet, carefully examine the important aspects of IP infrastructure and optimization of your network found in Sections B and C. Then call **1.866.210.3524** and ADC will help you evaluate your data center needs.

Optimizing Your Data Center

In Section B, ADC shows you how the decisions you make today will directly impact data center success. We'll examine the many critical decisions you face to arrive at an overall data center design that maximizes flexibility and minimizes costs:

- Planning for the space you need today, and the space required to accommodate future growth.
- Establishing a well-deployed cabling setup to reduce cable congestion and confusion, and to increase network uptime.
- Creating an architecture within the data center that allows for moves, adds and changes without disruption of service.
- Determining sufficient power levels to prevent outages and sustain high availability.
- Establishing air flow and cooling standards to dissipate heat from servers, storage area devices and communications equipment.

We'll examine proven practices that support a high level of operational efficiency and overall improvement in productivity.

Space and Layout

Data center real estate is valuable, so designers need to ensure that there is a sufficient amount of it and that it is used wisely. This must include the following:

- Ensuring that future growth is included in the assessment of how much space the data center requires.
- Ensuring that the layout includes ample areas of flexible white space, i.e., empty spaces within the center that can be easily reallocated to a particular function, such as a new equipment area.
- Ensuring that there is room to expand the data center if it outgrows its current confines. This is typically done by ensuring that the space that surrounds the data center can be easily and inexpensively annexed.
- Cable can be easily managed so that cable runs do not exceed recommended distances and changes are not unnecessarily difficult.

Layout Help: TIA-942

TIA-942, Telecommunications Infrastructure Standard for Data Centers, offers guidance on data center layout. According to the standard, a data center should include the following key functional areas:

- One or more entrance rooms
- A main distribution area (MDA)
- One or more horizontal distribution areas (HDA)
- A zone distribution area (ZDA)
- An equipment distribution area

Entrance Room

The entrance room houses carrier equipment and the demarcation point. It may be inside the computer room, but the standard recommends a separate room for security reasons. If it is housed in the computer room, it should be consolidated within the main distribution area.

Main Distribution Area

The MDA houses the main cross-connect, the central distribution point for the data center's structured cabling system. This area should be centrally located to prevent exceeding recommended cabling distances and may include a horizontal cross-connect for an adjacent equipment distribution area. The standard specifies separate racks for fiber, UTP and coaxial cable.

Horizontal Distribution Area

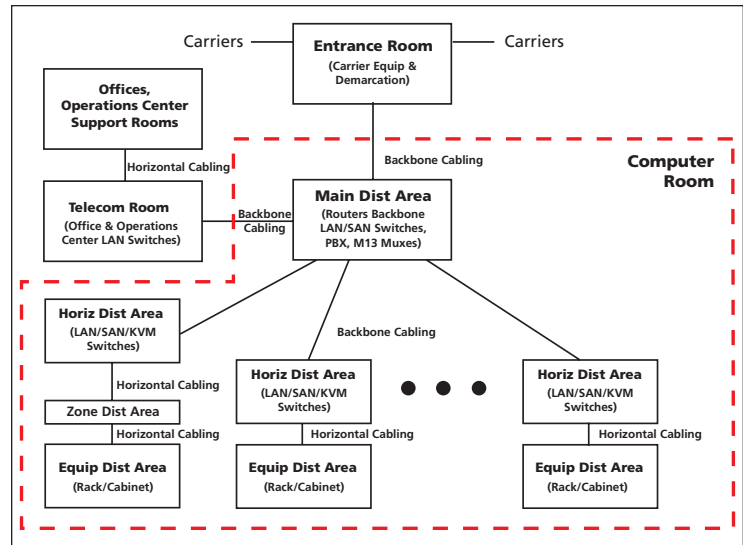
The HDA is the location of the horizontal cross-connects, the distribution point for cabling to equipment distribution areas. There can be one or more HDAs, depending on the size of the data center and cabling requirements. A guideline for a single HDA is a maximum of 2,000 4-pair UTP or coaxial terminations. Like the MDA, the standard specifies separate racks for fiber, UTP and coaxial cable.

Zone Distribution Area

This is the structured cabling area for floor-standing equipment that cannot accept patch panels. Examples include some mainframes and servers.

Equipment Distribution Area

This is the location of equipment cabinets and racks. The standard specifies that cabinets and racks be arranged in a "hot aisle/cold aisle" configuration to effectively dissipate heat from electronics. See the discussion on cooling on page 24.



TIA-942 Compliant Data Center

Key Principles of Cable Management

The key to cable management in the optimized data center is an understanding that the cabling system is permanent and generic. It's like the electrical system, a highly reliable and flexible utility that you can plug any new applications into. When it's designed with this vision in mind, additions and changes aren't difficult or disruptive.

Highly reliable and resilient cabling systems adhere to the following principles:

- Common rack frames are used throughout the main distribution and horizontal distribution areas to simplify rack assembly and provide unified cable management.
- Common and ample vertical and horizontal cable management is installed both within and between rack frames to ensure effective cable management and provide for orderly growth.
- Ample overhead and under-floor cable pathways are installed – again, to ensure effective cable management and provide for orderly growth.
- UTP and coaxial cable are separated from fiber in horizontal pathways to avoid crushing fiber-electrical cables in cable trays and fiber in troughs mounted on trays.
- Fiber is routed using a trough pathway system to protect it from damage.

Racks and Cabinets

Cable management begins with racks and cabinets, which should provide ample vertical and horizontal cable management. Proper management not only keeps cabling organized, it also helps keep equipment cool by removing obstacles to air movement. These cable management features should protect the cable, ensure that bend radius limits are not exceeded and manage cable slack efficiently.



It's worth doing a little math to ensure that any rack or cabinet provides adequate cable management capacity. The formula for category 6 UTP is shown below. The last calculation (multiplying by 1.30) is done to ensure that the cable management system is no more than 70 percent full.

Formula for Cable Management Capacity

Formula	Cables x 0.0625 square inches (cable diameter) x 1.30 = Cable Management Requirement
Example	350 cables x .0625 x 1.30 = 28.44 square inches (min. cable manager of 6" x 6" or 4" x 8")

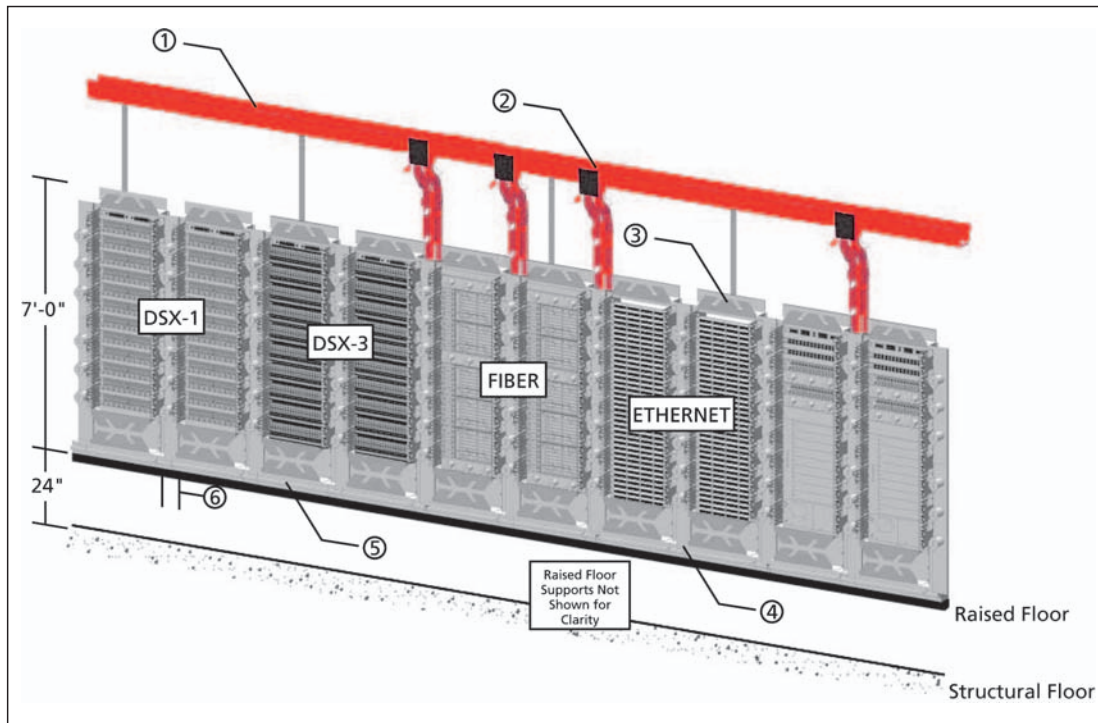
Cable Routing Systems

A key to optimized cable routing is ample overhead and under-floor cable pathways. Use the under-floor pathways for permanent cabling and the overhead for temporary cabling. Separate fiber from UTP and coaxial to ensure that the weight of other cables doesn't crush the more fragile fiber.

Ideal Rack and Cable Routing System

What is an ideal rack and cable routing system? Below is an illustration of ADC's vision. Here are some of the key features:

1. The FiberGuide® assembly is mounted to the overhead cable racking and protects fiber optic cabling.
2. Express Exits™ units are mounted where they are needed, allowing flexible expansion or turn-up of new network elements.
3. Upper and lower cable troughs are used for patch cords and jumpers, and an overhead cable rack is used for connection to equipment located throughout the data center.
4. Eight-inch Glide Cable Manager with integrated cable management organizes cables and aids in accurate cable routing and tracing.
5. Racks are equipped with 3.5-inch upper troughs (2 RUs) and 7-inch lower troughs (4 RUs), providing adequate space for cable routing.
6. Eight-inch vertical cable managers are shown. Six-, ten-, and 12-inch cable managers are also options to best meet the specific requirements of the data center installation and applications.



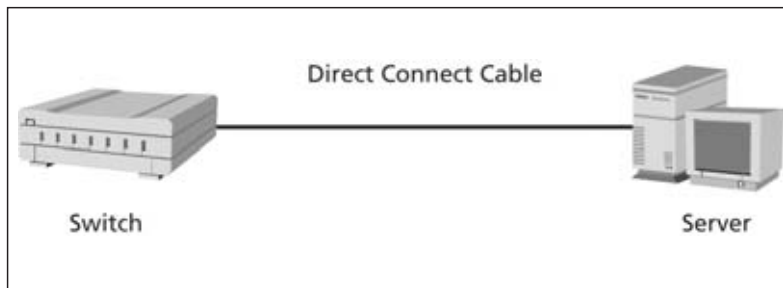
Fully populated, fully integrated lineup

Introduction to Connection Methods

The industry recognizes three methods of connecting equipment in the data center: direct connect, interconnect, and cross-connect. Only one of these, however, cross-connect, adheres to the vision of the cabling system as a highly reliable, flexible and permanent utility.

Direct Connect

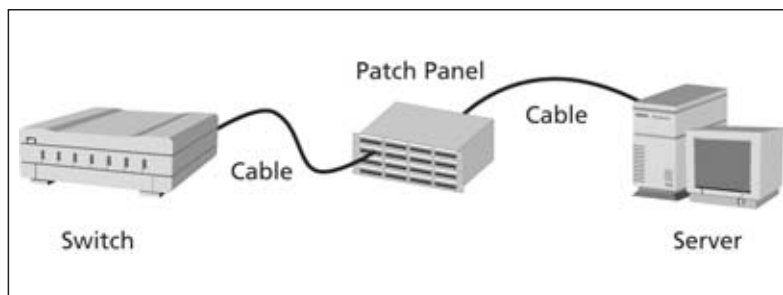
In the data center, direct connection is not a wise option because when changes occur (Figure 7), operators are forced to locate cables and carefully pull them to a new location, an intrusive, expensive, unreliable, and time-consuming effort. Data centers that comply with TIA-942 do not directly connect equipment.



Direct connect

Interconnect

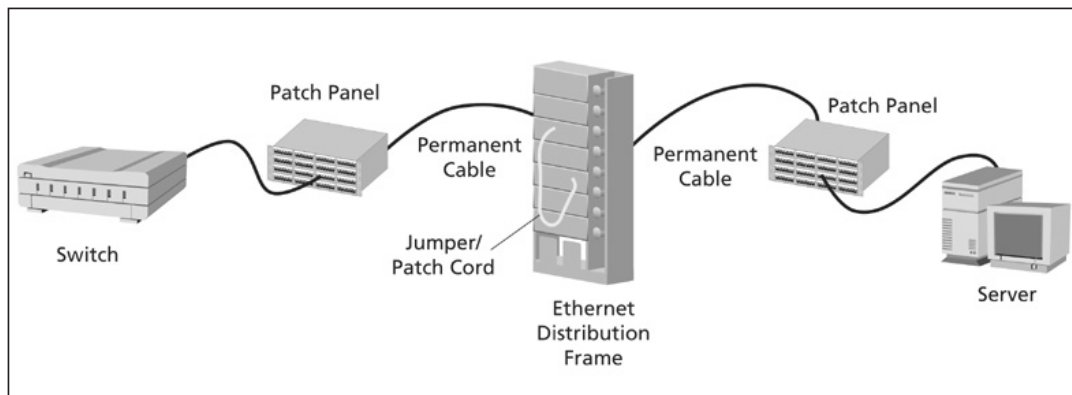
When change occurs with an interconnect connection operators reroute end system cables to reroute the circuit. This is far more efficient than the direct connect method, but not as easy or reliable as the cross-connection method.



Interconnect

Cross-Connect

With a centralized cross-connect patching system, achieving dual requirements of lower costs and highly reliable service is possible. In this simplified architecture, all network elements have permanent equipment cable connections that are terminated once and never handled again. Technicians isolate elements, connect new elements, route around problems, and perform maintenance and other functions using semi-permanent patch cord connections on the front of the cross-connect system, such as the ADC Ethernet Distribution Frame shown below.



Cross-connect

Here are a few key advantages provided by a well-designed cross-connect system:

- **Lower operating costs:** Compared to the other approaches, cross-connect greatly reduces the time it takes for adding cards, moving circuits, upgrading software, and performing maintenance.
- **Improved reliability and availability:** Permanent connections protect equipment cables from daily activity that can damage them. Moves, adds, and changes are effected on the patching field instead of on the backplanes of sensitive routing and switching equipment, enabling changes in the network without disrupting service. With the ability to isolate network segments for troubleshooting and reroute circuits through simple patching, the data center staff gains time for making proper repairs during regular hours instead of during night or weekend shifts.
- **Competitive advantage:** A cross-connect system enables rapid changes to the network. Turning up new service is accomplished by plugging in a patch cord instead of the labor-intensive task of making multiple hard-wired cable connections. As a result, cards are added to the network in minutes instead of hours, decreasing time to service delivery and providing a competitive edge – faster service availability.

Fiber Optics: An Introduction

The benefits of fiber optic cabling are well known. It's indispensable for bandwidth hungry applications, environments where high levels of EMI are likely, and cable runs that exceed the recommended distances for copper. To get the most from your investment in this valuable resource, however, it needs to be managed properly.

Plan for Growth

Data center personnel often underestimate their requirements for fiber optic cabling, believing that the first few strands are the end of it. That's seldom true. The best practice is to assume that your fiber requirements will grow and to put a plan in place to efficiently handle that growth.

Handling Considerations

Fiber is far from the delicate medium imagined by some. It can be broken, however, if it is bent beyond the bend diameter specified by the manufacturer. To prevent this, effective fiber management systems provide:

- Routing paths that reduce the twisting of fibers
- Access to the cable such that it can be installed or removed without inducing excessive bends in adjacent fiber
- Physical protection for the fiber from accidental damage by technicians and equipment

Splicing vs. Field Connectorization

There are two methods for connecting strands of fiber, splicing and field connectorization. The best choice depends on the applications. For short runs of multimode fiber, using field connectorization is a good choice. It is also an alternative for temporary connections. Otherwise, splicing is the preferred method for the following reasons:

- Lower signal loss. Field-terminated connectors – under the best circumstances – offer 0.25 dB signal loss. Loss from fusion splicing is typically 0.01dB.
- More predictable results. Anecdotal evidence indicates that as many as 50 percent of field-installed connectors fail when done by green technicians.
- Speed. Trained technicians can splice two strands of fiber together in as little as 30 seconds, or six minutes for two 12-strand fiber bundles.

Power

Requirements

Electricity is the lifeblood of a data center. A power interruption of even a fraction of a second is enough to cause a server failure. To meet demanding availability requirements, data centers often go to great lengths to ensure a reliable power supply. Common practices include the following:

- Two or more power feeds from the utility company
- Uninterrupted power supplies (UPS)
- Multiple circuits to computing and communications systems and to cooling equipment
- On-site generators

The measures you employ to prevent disruptions will depend on the level of reliability required, and, of course, the costs. To help you sort through the tradeoffs, the Uptime Institute, an organization concerned with improving data center performance, has developed a method of classifying data centers into four Tiers, with Tier I providing the least reliability and Tier IV the most. Use this system, which is described briefly in the following table, to help you sort through the tradeoffs.

Tier I

Description

Tier I centers risk disruptions from planned and unplanned events. If they have a UPS or an engine generator, they are single-module systems with many single points of failure. Maintenance will require a shutdown and spontaneous failures will cause data center disruption.

Availability: 99.671%

Tier II

Description

Tier II centers are slightly less susceptible to disruptions than Tier I centers because they have redundant components. However, they have a single-threaded distribution path, which means that maintenance on the critical power path and other infrastructure parts will require a shutdown.

Availability: 99.741%

Tier III

Description

Tier III centers can perform planned maintenance work without disruption. Sufficient capacity and distribution are available to simultaneously carry the load on one path while performing maintenance on the other. Unplanned activities, such as errors in operation or spontaneous failures of components will still cause disruption.

Availability: 99.982%

Tier IV

Description

Tier IV centers can perform any planned activity without disruption to the critical load and sustain at least one worst-case unplanned failure with no critical load impact. This requires simultaneously active distribution paths. Electrically, this means two separate UPS systems in which each system has N+1 redundancy. Tier IV requires all computer hardware to have dual power inputs. Because of fire and electrical safety codes, there will still be downtime exposure due to fire alarms or people initiating an Emergency Power Off (EPO).

Availability: 99.995%

Estimating Power Requirements

Take a few moments to estimate your data center power needs:

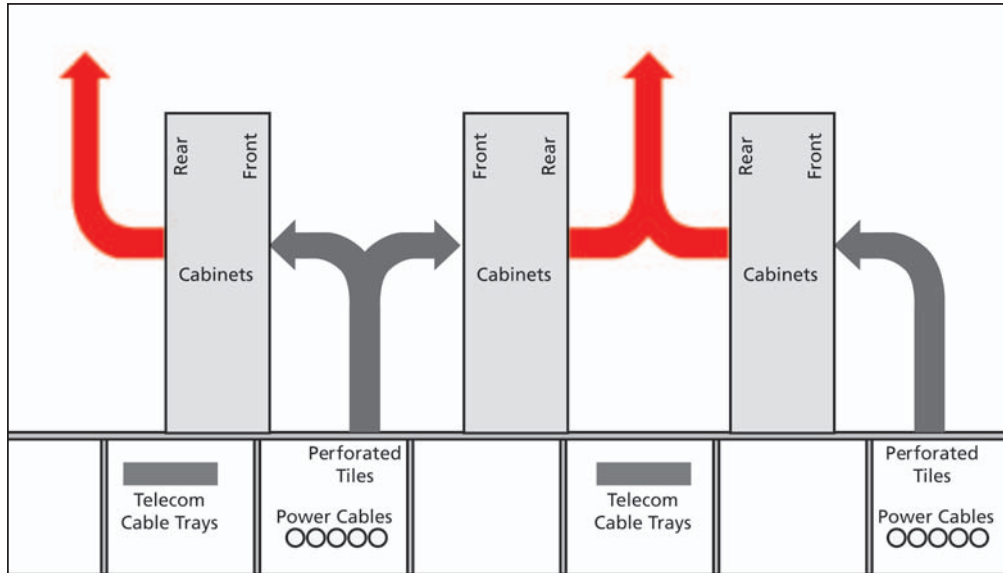
- A. Determine the electrical requirements for the servers and communication devices currently in use. You can get this information from the device's nameplate. While the nameplate rating isn't a perfect measurement, it is the best data available to you.
- B. Estimate the number of devices required to accommodate future growth and assume that these new devices will require the average power draw of your current equipment. Be sure that this estimate includes equipment that will supply the level of redundancy required by your data center. While estimating future needs is a difficult and imprecise exercise, it's likely to provide better guidance on future needs than any other method.
- C. Estimate the requirements for support equipment, such as power supplies, conditioning electronics, backup generation, HVAC equipment, lighting, etc. Again, be sure that this estimate includes redundant facilities where required. Calculate the power requirements for this support equipment.
- D. Total the power requirements from A, B, and C.

Based on the numbers above, how well do you feel you will be able to meet your future power requirements?

Cooling

Servers, storage area devices, and communications equipment are getting smaller and more powerful. The tendency is to use this reduced footprint to cram more gear into a smaller space, thus concentrating an incredible amount of heat. Dealing with this heat is a significant challenge. Adequate cooling equipment, though a start, is only part of the solution. Airflow is also critically important.

To encourage airflow, the industry has adopted a practice known as "hot aisle/cold aisle." In a hot aisle/cold aisle configuration, equipment racks are arranged in alternating rows of hot and cold aisles. In the cold aisle, equipment racks are arranged face to face. In the hot aisle, they are back to back. Perforated tiles in the raised floor of the cold aisles allow cold air to be drawn into the face of the equipment. This cold air washes over the equipment and is expelled out the back into the hot aisle. In the hot aisle, of course, there are no perforated tiles, which keeps the hot air from mingling with the cold. For the best results with this method, aisles should be two tiles wide, enabling the use of perforated tiles in both rows if required. See the figure on the next page for an illustration of how this works.



Hot aisle/cold aisle cooling

This practice has met with wide industry acceptance. In fact, it's part of the TIA-942 recommendation. Unfortunately, it's not a perfect system. While it's common for equipment to exhaust heat out the back, it's not a universal practice. Some equipment draws cold air in from the bottom and discharges the heated air out the top or sides. Some brings in cold air from the sides and exhausts hot air out the top. If additional steps are required, other things to try include the following:

- Spreading equipment out over unused portions of the raised floor. Obviously, this is an alternative only if unused space is available.
- Increasing the height of the raised floor. Doubling floor height has been shown to increase air flow as much as 50%.
- Using open racks instead of cabinets. If security concerns or the depth of servers makes using racks impossible, cabinets with mesh fronts and backs are alternatives.
- Increasing air flow under the floor by blocking all unnecessary air escapes.
- Replacing existing perforated tiles with ones with larger openings. Most tiles come with 25% openings, but some provide openings of 40 to 60%.

Learning from your Peers: Real-World Data Center Scenarios

The scenarios are a series of real life situations whereby organizations just like yours are challenged with issues related to the physical layout of the data center. We believe that by reviewing each of these cases, you may find your own situation played out in the lives of others, thus giving you the opportunity to learn from their experiences. Perhaps some of the short strategic challenges discussed here can benefit you today.

Scenario #1 - Increasing the Value of Ethernet Data Services

A service provider is offering 10/100Base-T and Gigabit Ethernet services to business customers. These services offer higher bandwidth at a lower cost per bit than traditional circuit-based data delivery, such as T1 and T3 services. They selected a leading multi-service platform to provide transport for 10/100Base-T over RJ45 copper and Gigabit Ethernet over fiber. Yet even with the Ethernet delivery platform in place, several challenges remain:

- Integrating multi-service elements into the network so that subsequent rearrangements and upgrades would be transparent to customers and take less time
- Overcoming the 100 meter copper Ethernet distance limitation with a more cost-effective solution than purchasing additional Ethernet switches

Using EDF and Media Converters

By incorporating a central patching location, an Ethernet Distribution Frame (EDF), between active Ethernet elements, these challenges could be resolved. By creating a centralized craft interface for adds, upgrades and rearrangements of Ethernet equipment, the EDF enables change without service disruptions. This central patching location provides a logical and easy-to-manage infrastructure.

Media converters are used for intra-office communications via fiber for network elements more than 100 meters from the EDF. In addition, Fiber Management Trays complement media converters by providing termination and storage of fiber cables. Power distribution and protection fuse panels improve reliability and availability of Ethernet network elements.

Scenario #2 - Supporting Data Center Operations

To minimize both capital and operating expenses, a major corporation designed a data center that stores, transfers and delivers information using 10/100Base-T and Gigabit Ethernet services. Major network elements chosen for each data center include Cisco 7500 routers and Cisco Catalyst 6509 Ethernet switches. In addition, connections to data servers from multiple manufacturers are required.

To facilitate the highest quality and reliability of services, two capabilities are required:

- To enable the quick addition and change over of any network element or server with minimal service disruption
- To optimize floor space usage

Utilizing EDF cross-connects

This challenge was met by incorporating an EDF between data servers and Ethernet switching bays. This central patching location provides a logical and easy-to-manage infrastructure through two design characteristics.

- All network elements have permanent equipment cable connections that are, once terminated, never handled again.
- All changes, circuit routing, upgrades, maintenance and other activities are accomplished using semi-permanent patch cords on the front of the EDF cross-connect bay.

About ADC

ADC's network equipment and systems integration services make broadband communications a reality by enabling communications service providers to deliver high-speed Internet, data, video, and voice services to consumers and businesses worldwide.

ADC provides efficient and flexible solutions for physical data center design and cable management. Through innovative products and time-tested techniques, ADC is a leader in data center layout and cabling. Bringing its experience and design philosophy to data services networks, ADC has a comprehensive line of connectivity products for copper and fiber cabling. ADC's data connectivity systems are designed and built to maintain signal integrity across today's network environments. ADC surrounds these products with responsive service and support.

Based in Minneapolis, the company had annual sales of \$1.2 billion in FY 2005. Its 8,200 employees span more than 35 countries. ADC's network equipment, software, and systems integration services are sold in more than 140 countries.

Now that you've filled out the worksheet and carefully examined the important aspects of IP infrastructure and optimization of your network, call this number and let ADC help you plan a new data center or optimize your current data center.

1.866.210.3524

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