



Designing an Optimised Data Centre

Designing an Optimised Data Centre

The data centre is a key resource. Many organisations simply shut down when employees and customers are unable to access the servers, storage systems, and networking devices that reside there. Literally, millions of dollars can be lost in a single hour of down time for some businesses, such as large banks, airlines, package shippers, and online brokerages. Given these consequences, reliability is a key data centre attribute. Another is flexibility. Designing and building a data centre to meet these requirements is not usually a simple task. When armed with information, however, the task may become more manageable.



Figure 1. Equipment and Cable Racks

Space and Layout

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

- Ensuring that future growth is included in the assessment of how much space the data centre requires. The space initially needed may be inadequate in the future.
- Ensuring that the layout includes ample areas of flexible white space, empty spaces within the centre that can be easily reallocated to a particular function, such as a new equipment area.
- Ensuring that there is room to expand the data centre if it outgrows its current confines. This is typically done by ensuring that the space that surrounds the data centre can be easily and inexpensively annexed.

Layout

In a well-designed data centre, functional areas are laid out in a way that ensures that:

- Space can be reallocated easily to respond to changing requirements, particularly growth.
- Cable can be easily managed so that cable runs do not exceed recommended distances and changes are not unnecessarily difficult.

Layout Suggestions

Telecommunications Infrastructure Standards for Data Centres offer guidance on data centre layout. According to the standards, a data centre 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

These are illustrated in Figure 3. and discussed below.

Entrance Room

The entrance room houses carrier equipment and is their demarcation point. It may be inside the computer room, but standards recommend a separate room for security reasons. If it's housed in the computer room, it should be consolidated within the main distribution area. In lightning prone areas, it should be away from the data centre with access to good earthing for over-voltage protection.

Main Distribution Area

The MDA houses the main cross connect, the central distribution point for the data centre'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. There should be separate racks for fibre and UTP cable. This the main location for CopperTen™ and HighBand® modules or patch panels.



Figure 2. Elements of Cable Management with ADC KRONE Racks

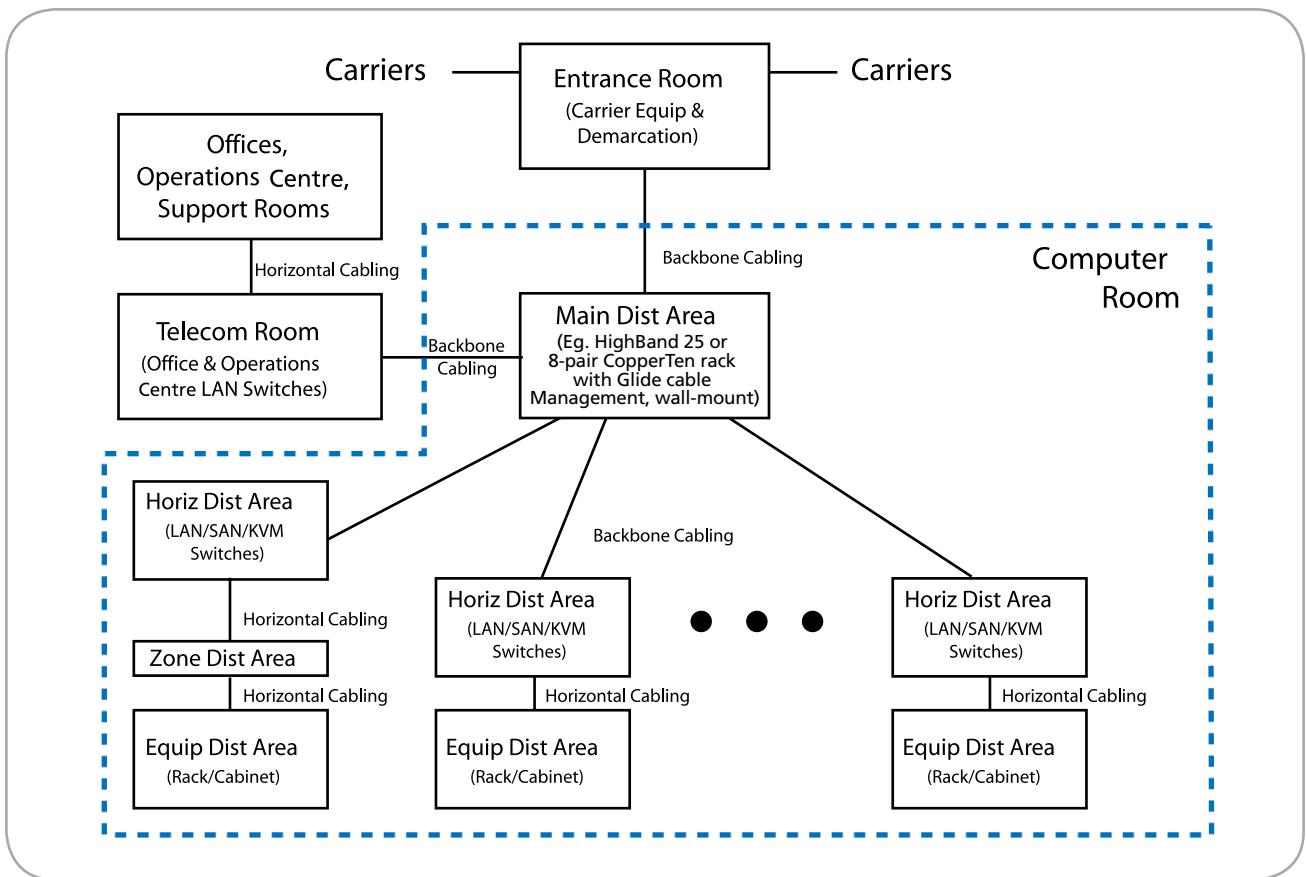


Figure 3. TIA-942 Compliant Data Centre

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 centre and cabling requirements. A guideline for a single HDA is a maximum of 2000 4-pair UTP terminations. Like the MDA, specify separate racks for fibre and UTP cable.

Zone Distribution Area

The Zone Distribution Area, if it's necessary, is the structured cabling area for floor-standing equipment that cannot accept patch panels. Examples include some mainframes and servers.

Equipment Distribution Area

The Equipment Distribution Area is inside the equipment cabinets and racks. Standards specify that cabinets and racks be arranged in a "hot aisle/cold aisle" configuration to more effectively dissipate heat from electronics. See the discussion on cooling on the following page.

Minimise EMI Sources

Sources of Electromagnetic Interference must be kept away from the Data Centre. Wherever possible, locate UPS equipment, air conditioning electrical equipment and any other noise generators outside the data centre.



Figure 4. Data centre main distribution centre

Power

Requirements

Reliable electricity supply is essential in a data centre. A power interruption of even a fraction of a second is enough to cause a server failure. To meet demanding availability requirements, data centres often go to great lengths to ensure a reliable power supply. Common practices include the following:

- Two or more power feeds from the power company
- Uninterrupted power supplies (UPS) located outside the data centre
- Multiple power circuits to computing and communications systems and to cooling equipment
- On-site generators, usually feeding the UPS room

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 trade-offs, The Uptime Institute, an organisation concerned with improving data centre performance, has developed a method of classifying data centres 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 assist in sorting through the trade-offs.

Estimating Power Requirements

Estimating the data centre power needs involves the following steps:

1. Determine the average electrical requirements for the servers and communication devices that are to be used. You can get this information from the device's data sheet or nameplate.
2. Estimate the number of devices required to accommodate future growth and assume that these new devices will require the average power draw of your initial equipment. Be sure that this estimate includes equipment that will supply the level of redundancy required by your data centre.
3. 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.
4. Total the power requirements from these three estimates.

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 keep 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. Figure 5 illustrates how this works.

This practice has met with wide industry acceptance. Unfortunately, it's not a perfect system. While it's common for equipment cabinets to exhaust heat out the back, it's not a universal practice. Some equipment cabinets draw cold air in from the bottom and discharge the heated air out the top or sides. Some bring in cold air from the sides and exhaust hot air out the top. If additional steps are required, try including the following:

- Spreading equipment out over unused portions of the raised floor if available.
- Increasing the height of the raised floor. Doubling floor height has been shown to increase air flow as much as 50%.

Tier	Description	Availability
I	Tier I centres 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 centre disruption.	99.671%
II	Tier II centres are slightly less susceptible to disruptions than Tier I centres 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.	99.741%
III	Tier III centres 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.	99.982%
IV	Tier IV centres 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).	99.995%

Table 1. Data Centre Tier Classifications

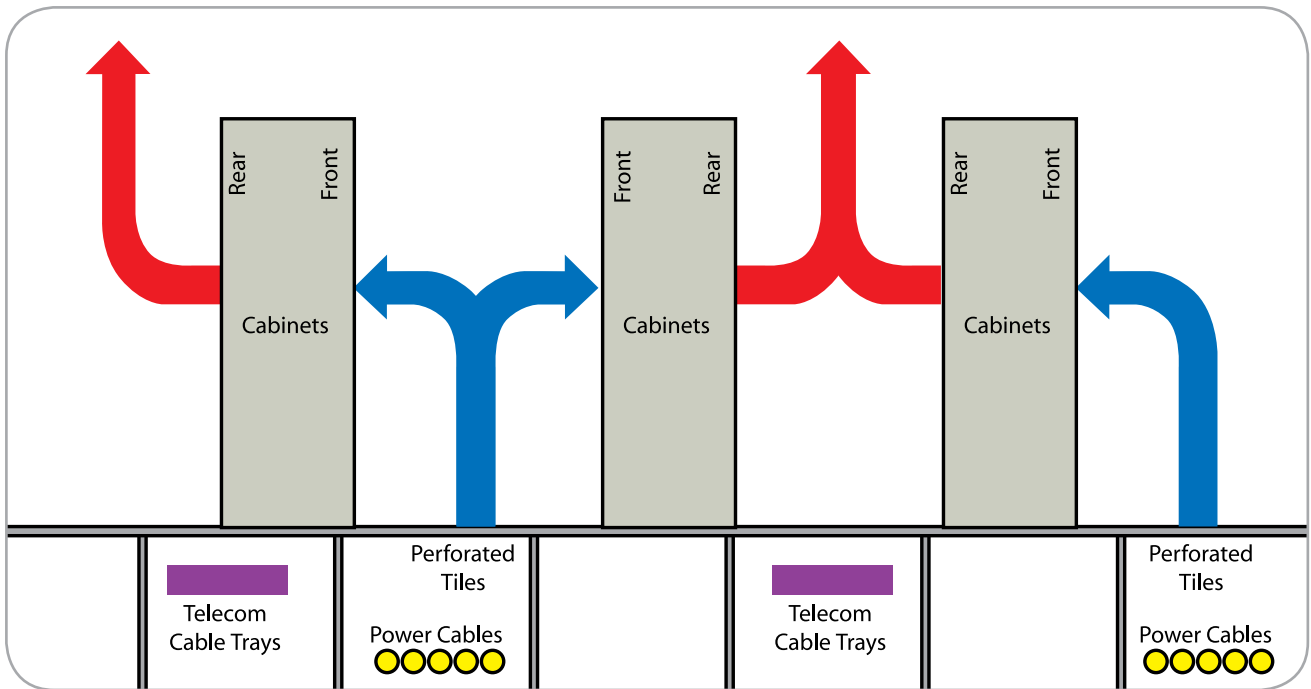


Figure 5. Hot-aisle / Cold-aisle Layout

- Using open racks instead of cabinets. If security concerns or the depth of servers makes using racks impossible, cabinets with mesh fronts and solid 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%.
- Plan underfloor cable pathways to minimise cold air exit restrictions. Put power cables low under exit tiles because they occupy less area than data cables.

- 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.

Cable Management

The key to cable management in the optimised data centre is 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.

ISO Data Centre standards allow as a minimum only Cat6_A copper cable and OM3 optical fibre to be used.

Key Principles

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

- Common wall-mount frames, cabinets and rack-mount frames are used throughout the main distribution area and horizontal distribution area to simplify assembly and provide unified cable management.



Figure 6. Elements of Cable Management with ADC KRONE Racks



Figure 7. ADC KRONE Cable Racks with Glide Cable Management Systems

- Ample overhead and underfloor cable pathways are installed to ensure effective cable management and provide for orderly growth.
- Use separate pathways to ensure UTP cable is separated from fibre cable and electrical cable in all pathways. This will avoid crushing fibre cables in cable trays and will minimise electrical noise.
- Fibre is routed using a trough pathway system to protect it from damage.
- All data cabling pathways have at least 50mm minimum bend radius support fittings where cables change direction vertically by more than 45°.

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 organised, 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 the maths to ensure that the rack or cabinet provides adequate cable management capacity. The formula for UTP cable is shown below. The last calculation (multiplying by 1.50) is done to ensure that the cable management system is no more than 50 percent full.

Formula	Cable Management Requirement = Cables x (cable dia mm) ² x 1.50
Example Cat6	500 cables x 6 ² x 1.50 = 27000 mm ² (min. cable manager of 100 x 300)
Example C6A	500 cables x 8 ² x 1.5 = 48000 mm ² (min. cable manager of 100 x 500)

It is very important to consider the weight of the cables in the tray pathways within the data centre. Firstly, the

pathway must be able to adequately support all the cable. This means fixing the pathway to the building structure, independent of the racks and cabinets, which will inevitably be moved at some future date. Secondly the cables at the bottom of the pathway must not be crushed by the weight of the cables on top. Crushed cables will result in increased Return Loss problems that increase unwanted noise in the cable. This in turn means the links between servers will run slower, and that is definitely unwanted in a data centre.

To prevent problems with cable crushing, all tray or mesh pathways must be designed to minimise the height of the cables in the tray. For the mass of cables in a tray, a maximum height of 90mm is recommended. So in the Cat6 example above, the cable management size is recommended to be 100 high x 300 wide. A size of 150 x 200 would exceed 90mm cable depth and likely lead to cable crush, especially on a non-continuous pathways like metal mesh.

Cable Routing Systems

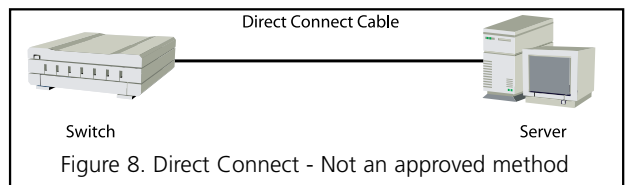
A key to optimised cable routing is ample overhead and under floor cable pathways. Use the under floor pathways for permanent cabling and the overhead for temporary cabling. Separate fibre from UTP to ensure that the weight of other cables doesn't crush the more fragile fibres. Separate Cat6 from Cat6_A cable by 25mm to minimise alien crosstalk.

Introduction to Connection Methods

The industry recognises three methods of connecting equipment in the data centre: direct connect, interconnect, and cross-connect. Only one of these, however, cross-connect, adheres to the vision of the cabling system as a generic, highly reliable, flexible and permanent utility. All methods, are discussed below.

Direct Connect

In the data centre, direct connection is not a wise option because when changes occur (Figure 8), staff are forced to locate cables and carefully pull them to a new location, an intrusive, expensive, unreliable, and time consuming effort. Data centres must not directly connect equipment.



Interconnect

When change occurs with an interconnect connection, staff 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.

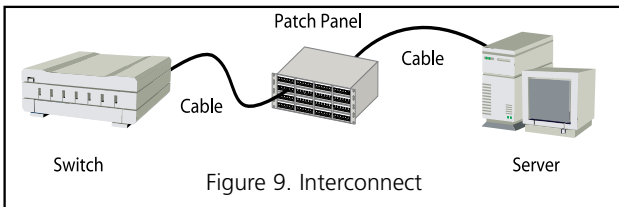


Figure 9. Interconnect

Cross-Connect

When change occurs within a cross-connect system, the permanent terminations remain intact at the cross-connect field. A change in the cross-connect jumper (patch cord) is all that is required to reroute the circuit.

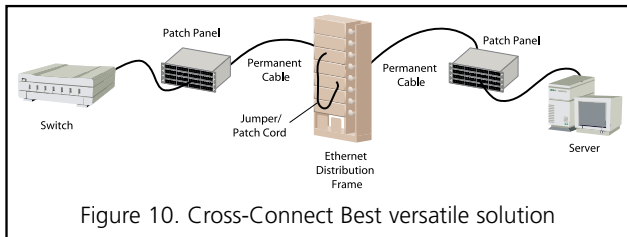


Figure 10. Cross-Connect Best versatile solution

Fibre Considerations

Common Fibre Applications

While fibre can be used for most applications that use twisted pair cable, it is most commonly used in the following areas:

- Environments, such as factory floors, where high levels of EMI are likely.
- Gigabit and 10 Gigabit Ethernet campus or backbone implementations.
- Cable runs that exceed the recommended distances for copper.

Plan for Growth

Organisations commonly underestimate their requirements for fibre optic cabling, believing that the first few strands are all that's needed. That's often wrong. The best practice is to assume that your fibre requirements will grow and to put a plan in place to efficiently handle that growth.

Special Handling Issues

Bending fibre cables beyond the minimum bend diameter specified by the manufacturer can cause them to break, resulting in network service failures. To prevent this, effective cable management systems provide the following:

- Routing paths that reduce the twisting of fibres.
- Access to the cable such that it can be installed or removed without inducing excessive bends in adjacent fibre.

- Physical cable bend support at all pathway exits.
- Physical protection for the fibre from accidental damage by technicians and equipment.

Splicing vs. Field Connectors

Cutting fibre to the desired length and attaching connectors in the field is usually not the best solution for fibre, especially when cable runs are longer than 25 metres and a degree of permanency is required. For these situations, pre-terminated multicore fibre or splicing individual fibres is the preferred alternative. Singlemode fibre must be fusion spliced onto factory-tested pigtails to meet warranty requirements.

Among the benefits of splicing fibre are the following:

- Lower signal loss. Field-terminated connectors under the best circumstances—offer 0.25 dB signal loss. While loss from fusion splicing is typically less than 0.01dB.
- More predictable results. Experience shows that as many as 50 percent of field-installed connectors fail when done by inexperienced technicians.
- Speed. Trained technicians can splice two strands of fibre together in as little as 30 seconds or 6 minutes for two 12-core fibre bundles.

Pre-Terminated Optical Fibres

Pre-Terminated Optical Fibres (PTOF) are fast becoming the cabling solution of choice for data centres. The cables can be singlemode or multimode or a combination of both. The benefits of PTOF include:

- Fibre lengths, measured FOBOT to FOBOT and routes are known within the data centre design and can therefore be ordered from the supplier beforehand.
- There is no need for skilled staff doing on-site terminations or splicing.
- Less skilled staff can install the PTOF cables.
- No splicing equipment needed.
- There are no splice insertion losses.
- Speed of installation has been estimated to be twice as fast as conventional on-site termination work.

Fibre Cleaning and Testing

The most important activity when working on fibres in the data centre is to clean the ends of the fibre before testing the insertion loss. Even if all connector ends are fitted with dust caps and even if PTOF cables are used, it is still important to clean the connectors before testing and connecting them into position. It is also important to clean the connector ends of patch cords before inserting them into the patch panels or equipment.

WHITE PAPER



www.adckrone.com/asia

SOUTH EAST ASIA

SINGAPORE 100 Beach Road #18-01 Shaw Tower Singapore 189702
Ph: +65 6394 3800, Fax: +65 6297 5035

INDONESIA: Ph: +62 21 520 0231, Fax: +62 21 522 1312

PHILIPPINES: Ph: +63 2 848 9901, Fax: +63 2 848 9904

THAILAND: Ph: +662 512 3688, Fax: +662 512 4747

MALAYSIA: Ph: +603 2615 0146, Fax: +603 2615 0147

VIETNAM: Hanoi: Ph: 8443 9343 968, Fax: +8443 9343 956

HCMC: Ph: +8483 8219 225, Fax: +8383 8219 181

NORTH EAST ASIA

HONG KONG 2206-7, ING Tower, 308 Des Voeux,
Road Central, Sheung Wan, Hong Kong

Ph: + 852 2865 4888, Fax: +852 2861 1444

KOREA: Ph: + 822 398 5834, Fax: +822 398 5835

www.adckrone.com/jp

JAPAN: Ph: + 81 3 3560 2722, Fax: +81 3 3584 1025

ADC Telecommunications, Inc., P.O. Box 1101, Minneapolis, Minnesota USA 55440-1101

Specifications published here are current as of the date of publication of this document. Because we are continuously improving our products, ADC reserves the right to change specifications without prior notice. At any time, you may verify product specifications by contacting your local ADC KRONE office. ADC Telecommunications, Inc. views its patent portfolio as an important corporate asset and vigorously enforces its patents. Products or features contained herein may be covered by one or more U.S. or foreign patents. An Equal Opportunity Employer.

400010HK 06/10 © 2010 ADC Telecommunications, Inc. All Rights Reserved.