Technical Reference

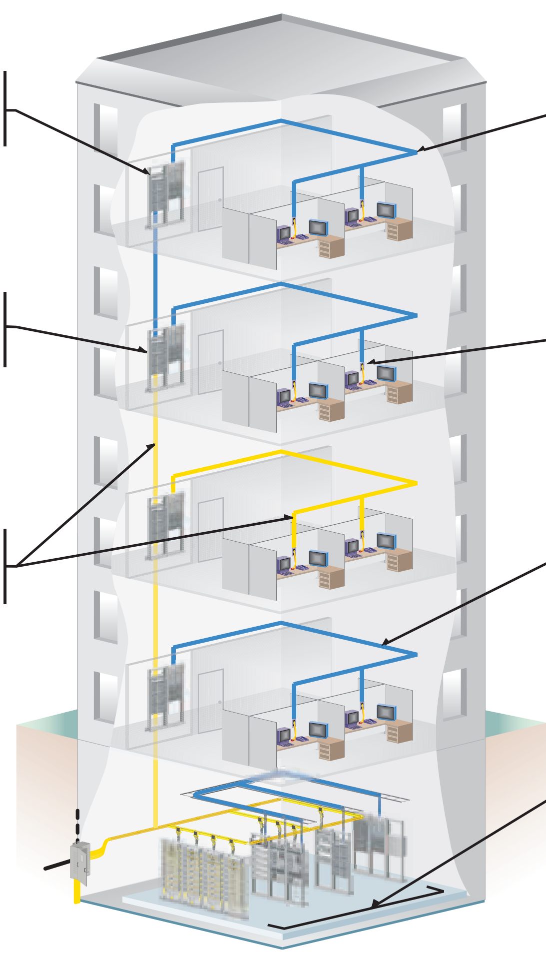
Technical Reference

TrueNet® Structured Cabling Solutions

ADC KRONE's TrueNet® Structured Cabling System is the integrated portfolio of high-performance copper and fibre cable, connectivity, and cable management products from ADC KRONE. The precisely tuned TrueNet® system uniquely exceeds ISO and TIA/EIA standards and provides a clear path for uninterrupted data throughput throughout the network.

"With TrueNet®, you can push networks to the performance edge. Innovative products that exceed industry standards and support advanced applications such as 10GigE copper, VoIP, and Wi-Fi today and tomorrow."

True End-to-End Solutions



Technical Reference

TrueNet® Solutions for Data Centres

When your company's reputation and its business success depend on delivering SLAs (service level agreements) of 99.999% or better, it is essential that the structured cabling system – the network foundation – is ultra reliable.

Solutions

In the central fibre and copper distribution frame room, bandwidth, flexibility and cable-management are key. The Glide Racks and Cable Management are the ideal solution. High density 24/32 port 1U patch panels for copper and the fibre split patch panel with two completely independent 12 duplex port fibre trays in a 1U housing provide the connection density within the frame. FiberGuide®, the best fibre management solution available, gives protection, bend radius management and the unique ability to add in new fibre exits without disturbing existing fibres.

In the customer suites, co-location and active equipment cabinets, utilising TrueNet® CopperTen™ means that 10Gigabit/s Ethernet can now be delivered on copper as well as on fibre. Available in both unshielded (UTP) or shielded (S/FTP) formats offering high noise immunity and alien crosstalk rejection. CopperTen™ facilitates the use of active equipment with standard copper interfaces from 10/100Mbit/s right through to 10Gigabit/s – without any re-configuration necessary. TrueNet® fibre split patch panels allow both singlemode and multimode fibre to be delivered to the cabinet in a single 1U unit – saving space for the active equipment.

Technical Reference

TrueNet® Solutions for Education

Whether the network is for a school, college or university, bandwidth is becoming a very important issue – as video services are used more and more by education professionals to support their seminars and lectures.

Increasingly, remote-teaching and distance-learning use streamed and on-demand video-casting which can place massive bandwidth demands on the network as lessons and lectures need to be delivered in near-broadcast quality video formats.

Schools are spread-out, and universities occupy immense campuses – often spread over several sites around a city. This type of topology brings its own challenges where correct planning of backbone capacity and future flexibility are key to the success of the network in years to come.

This is where network planners need an infrastructure partner with the experience of ADC KRONE that has designed network solutions for hundreds of educational institutions around the globe. ADC KRONE can offer all of the available technologies and so our engineers will offer you totally impartial advice – to ensure that your specific solution is ideal for your project in terms of capital cost, operating cost, flexibility, futureproofing and planned upgrade paths.

Most colleges and universities, and indeed many schools, have grown over the years and now have a wide range of buildings from very old to ultra-modern. Frequently, there is a serious lack of ducting between buildings – but the cost of digging-in new ducting is prohibitive. With solutions like TrueNet® blown fibre, ADC KRONE engineers can help solve these problems now and provide a solution that gives all the upgrade/flexibility the organisation's network is likely to need over the next 15 to 20 years.

We normally recommend a minimum of TrueNet® Category 6 for educational networks, since its 250MHz bandwidth gives far better scope for video services. TrueNet® CopperTen™ is already highly popular in educational installations because it allows Ethernet at 10 Gigabit/s and video up to 500MHz. All TrueNet® copper cabling solutions are available in both unshielded (UTP) and shielded (STP/FSTP) formats to ensure you have the best and most appropriate solution for your individual project.

Solutions

TrueNet® Category 5e and Category 6 offer Gigabit data-rate operation at all times. TrueNet® CopperTen™ increases the data-rate ten-fold to 10 Gigabit/s and is ideal for high video bandwidths and low latency for digital video and voice (VoIP)

TrueNet® Fibre provides Gigabit and 10 Gigabit solutions with the option to blow in more capacity at any time, while TrueNet® CWDM-ready fibre will enable 10 Gigabits/s now futureproofed to deliver up to 80 Gigabit/s per fibre pair in the future using Coarse Wave Division Multiplexing technology.

Technical Reference

TrueNet® Solutions for Financial Services

There are few industries where the IT infrastructure is so critical. For example in trader environments, a single floor can be trading $150 billion at any instant. Downtime can cost $millions, MACs (move, adds and changes) are needed in minutes, not days. Milliseconds can make all the difference to a trader's competitive advantage. Bandwidth and low latency are key to success.

High-density solutions are crucial, with traders needing up to 16 outlets each, maybe more, often with 10,000 outlets per trader floor. Easily re-locatable multi-outlet under-floor units are essential to facilitate rapid physical desk moves.

Security is a key issue, as is the ability to generate full audit-trails of network connections and network access – helping to comply with "good governance" and legislation such as Sarbanes-Oxley and its international equivalents.

Solutions

TrueNet® category 6 is the minimum standard our engineers recommend for financial services installations. With 250 MHz bandwidth, it enables video distribution as well as Gigabit Ethernet. TrueNet® CopperTen™, supporting IEEE802.3an 10 Gigabit/s, in both unshielded (UTP) or shielded (S/FTP) formats, gives 10 times the data capacity and video up to 500MHz. It is ideal for the comms room and data centre as well as the horizontal network.

In the financial services data centre, CopperTen™ handles all data rates from 10Mbit/s right through to 10Gigabit/s with no reconfiguration necessary – facilitating the use of everything from legacy equipment to 10 Gigabit/s active equipment – all with a single solution. Cost effective, it means that network managers can bring all active equipment ports out onto patching frames so that active equipment like switches can be left un-touched in locked cabinets – greatly reducing the chances of accidental disconnections and potentially disastrous downtime.

In comms closets and the comms room, Glide high capacity patching frames for copper and fibre, together with FiberGuide® fibre management, provide high levels of patching-density and cable management.

TrueNet® OM3/3e multimode fibre delivers 10 Gigabit/s capability, while OS1 singlemode and TrueNet® CWDM-ready fibre will allow for up to 80 Gigabit/s when the need arises. The TrueNet® fibre split patch panel, with two independent 12 duplex port patch-panels in a 1U housing, means that expansion capacity can be built-in without working fibres ever having to be disturbed.

Specialist TrueNet® Integrators concentrate on financial services projects. Their expertise is key to project success. Understanding the logistics necessary, they are adept at working out-of-hours, with restricted access and have the capacity to turn around massive projects rapidly.

For many financial services organisations only ADC KRONE can offer the true global partnership they need with a full range of shielded and unshielded solutions to meet all local country needs. Local and international support is always to hand.

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Technical Reference

TrueNet® Solutions for Local and National Government

Often thought to be a very difficult market to serve and restricted by many regulations, the experience of ADC KRONE and its integration channel delivers many successful solutions to the public sector.

Due to historical reasons, Government buildings often have a mixture of networks, bought and extended under different purchasing schemes, and not always ideal to support the moves in most countries towards e-Government – where services and information are increasingly being made available to the electorate via an ever-growing array of IT systems.

ADC KRONE and many of its TrueNet® Integrators have vast experience in this area – worldwide. For every situation, our engineering teams are happy to sit down with your specifiers and procurement personnel to devise specifications that will facilitate the network standardisation needed to help provide e-Government. Specifications which can then be put out to tender.

With our global array of products and services, we can design a migration plan whatever the existing network or the project challenges – such as listed buildings, lack of cable ducts and limited budgets.

We can design, supply, install and commission a network for the IT department to operate – or increasingly, with our channel partners, we can provide every type of solution right through to fully outsourced IT services under Framework Contract arrangements.

We understand the concepts of best-value tendering and regularly demonstrate that we can deliver the highest quality with low TCO (total cost of ownership). We understand the need of Government departments and agencies to be able to demonstrate that they are spending the electorate's money in the most responsible manner. Our ability to supply every type of structured cabling solution means that we can offer the most appropriate solution for each and every tender.

With our global stature and that of our TrueNet® Integrators, we can readily demonstrate our financial stability and the capacity to deliver any size of project from small extension to massive new-build or data centre.

Solutions

There is no one-size-fits-all solution for Government or public sector IT requirements. The TrueNet® portfolio includes Category 5e, 6 and 6_A (10 Gigabit/s) in both shielded and unshielded formats – as well as a fibre in OM1, OM2, and OM3/3e multimode, OS1 singlemode and even CWDM (Coarse Wave Division Multiplexing) ready fibre for extra high data-rates. With this massive range, we can build any network requirement in any country.

Technical Reference

TrueNet® Solutions for Healthcare

From doctor's surgeries to health centres and major hospitals, they all have special requirements that need robust, dependable, always-available networks to underpin vital functions – often critical functions, where every second counts. From accessing patient records, to X-ray, MRI and CT scans; and from building automation to intensive care – increasingly it is a single structured cabling solution that has to provide this functionality 24x7, 365 days per year.

Healthcare network managers need high quality, highly reliable network hardware at an affordable price. Equally important is to work with an infrastructure solutions partner who understands the needs of the Healthcare sector – such as outstretched campus environments often with a wide mixture of old and new buildings and who can overcome the challenges of congested ducting which was installed without today's ITC requirements in mind. A partner experienced in the logistics of providing new and upgraded infrastructure in a working care-delivery environment – with busy consultation rooms, hospital wards and operating theatres that cannot be interrupted.

Solutions

Every project requires its own unique solution, but based on tens of years of experience in Healthcare around the globe, ADC KRONE engineers know that fibre (often with a mixture of OS1 singlemode and OM3 multimode fibre) provides one of the most economical and flexible backbone solutions; while TrueNet® fibre and TrueNet® shielded copper solutions from Category 5e to CopperTen™ Category 6_A, are ideal for areas of high electromagnetic interference (EMI) such as near MRI scanners and X–ray machines.

TrueNet® Category 5e and Category 6 offer full Gigabit data-rate operation at all times. TrueNet® CopperTen™ increases the data-rate ten-fold to 10 Gigabit/s and is destined to become essential for rapid transfer of the very large files associated with scans and X–rays.

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Technical Reference

TrueNet® Solutions for Manufacturing

Manufacturing organisations provide a wide range of network requirements and challenges – from everyday Category 5e or Category 6 in the general office, through high bandwidth requirements in the CAD design department to very long cable-runs and harsh environments on the shop floor or process plant.

In office environments, the structured cabling can be easily laid in false floors or affixed to the fabric of the building and is generally used for 'bursty' data transmission often with large files for images and presentations.

Down on the shop floor, it is very different. Conditions are harsh, often with extreme temperatures, high dust and humidity levels, vibrating machinery and the ever present risk of mechanical damage. There are chemical hazards to the structured cabling too from oily or aggressive atmospheres and there may be ultraviolet exposure out of doors.

Solutions

Within the office environment, TrueNet® Category 5e and Category 6 – either shielded or unshielded – provide the ideal solution with TrueNet® fibre providing the backbone links from comms closet to comms room.

In the CAD design department, if extra bandwidth is needed then TrueNet® CopperTen™ provides 10Gigabit/s capacity to the IEEE802.3an standard.

Production offices and connected machinery are ideally served by fibre links from the comms room to small wall or floor mounted cabinets containing active equipment such as switches and media converters.

Although EMI is a concern, experience has shown that with TrueNet® unshielded products it is rarely an issue. For additional EMI protection TrueNet® shielded products from Category 5e to Category 6_A (CopperTen™) offer data rates right up to 10 Gigabit/s as well as the low latency needed for highly time-dependant industrial machine control data. Our engineers are happy to advise on the best solution for your specific requirements.

Together with our manufacturing-sector specialist TrueNet® Integrators, ADC KRONE has the full suite of solutions to provide complete manufacturing plant communications and IT infrastructure however large or small the plant.

Technical Reference

TrueNet® Solutions for Retail

Many people don't realise what a dynamic business retail is. Summer sales, Diwali sales and New Year rush and countless sales promotions all mean that every day can be a very different day. Even the weather can mean different goods need to be merchandised at short notice.

Very often, elements of the network need to be rapidly redeployed to support shopfloor needs. For example, temporary Electronic Point of Sale (EPOS) for the sales or the Diwali rush – or special EPOS positions in high traffic areas for sales promotions. They may be needed for a few days or a few months, but they are essentially temporary and retailers need a network installation that takes all of these in its stride yet remains as reliable as a fixed network.

Retail network managers need a network partner that understands how retail works and how to ensure that networks help, not hinder, the retailer.

TrueNet® structured cabling from ADC KRONE, with our highly flexible multi-port consolidation and distribution solutions mean that network access need never be more than a few metres away, perhaps out of sight in ceiling voids or unobtrusively located on pillars and walls – ready to be patched-through at a moments notice.

Network reliability is of the highest importance too. EPOS transaction data must not be lost or corrupted and there's no question of losing the 'window' to update the pricing database from headquarters. One cash till down could cost thousands of Rupees per day. Worse still the whole store could be down. The TrueNet® warranty is one of the most comprehensive in the world and can be offered up to 20 years

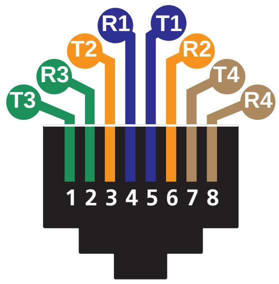
Solutions

TrueNet®, from Category 5e to Augmented Category 6, with its extra headroom, and TrueNet® fibre all come with our unique 20 year solution warranty, when installed by a TrueNet® Integrator.

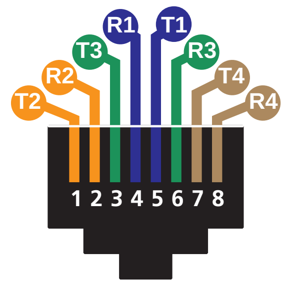
Many of our TrueNet® Integrators are specialists in retail networks and have regional, national and international coverage to give a true single-partner solution anywhere in the world.

Technical Reference

Wiring to Standards



T568A RJ45



T568B RJ45

The ISO/IEC 11801, Information Technology - Generic Cabling for Customer Premises defines pin/pair assignments for eight-position modular jacks in the work area. The preferred wiring configuration in India is T568B. A second, optional configuration, T568A, is allowed to accommodate certain eight-pin wiring systems already in use.

For modular RJ45 patch cords, 568A or 568B wiring are both usable, regardless of which wiring scheme is used in the horizontal cabling.

A crossover cord is wired T568A on one end and T568B on the other, and is typically used for peer to peer networking or to connect stacked hubs or switches. Many active devices now have a switch that crosses one port, negating the need for a crossover cable.

Wiring schemes also raise a variety of questions:

Q: What's the difference between T568A and T568B?
A. The only difference is the positioning of the Green and Orange pairs of wires.

Q: Is there a performance difference between T568A and T568B?
A: No. Both wiring schemes have to meet the same performance criteria.

Q: Why two schemes?

A: The reason is outside of the scope of this discussion but it is related to old telephone legacy issues. All you really need to know is that there are two schemes, and how to deal with them.

The solution really is fairly simple: Just pick one wiring scheme and use it consistently throughout your network. The only problem you would ever encounter would be if the two wiring schemes were accidentally mixed in an installation. T568B is the predominant scheme in India; T568A is popular in Australia, New Zealand and most other countries. The safest way to determine which to use is to check with the network equipment provider to determine the predominant wiring scheme used in the equipment. The reason for this check is quite simple: you can change the wiring scheme used in the network but you cannot change the wiring scheme used in the network equipment.

Technical Reference

10 Gigabit Ethernet over UTP: CopperTen™ Cabling Solution

For years, copper UTP solutions have been the preferred medium over which most local area networks communicate. And in this same period, a debate has raged as to when fibre would displace copper as the preferred infrastructure.

For years, fibre has led the Ethernet industry forward in port speed progression. So if Fibre is one step ahead why doesn't it replace copper? The answer is quite simple. To convert electrons to photons and then back to electrons adds cost (from an active hardware perspective). This makes the cost of fibre optic active hardware as much as six times more expensive per port than the equivalent speed copper UTP solution on Gigabit Ethernet switch ports.

The IEEE develops the electrical parameters needed to run transmission protocols and then gives TIA and ISO responsibility for developing measurable parameters for cable. For 10 Gigabit Ethernet, IEEE 802.3an Study Group was formed to discuss how best to approach running 10 Gigabit transmission over a copper infrastructure. The group is composed of representatives from several different aspects of the networking community, such as chip manufacturers, hardware manufacturers and cabling/ connectivity manufacturers.

The 10GBASE-T working group discussions include which protocol encoding will be used, how it relates to the needed bandwidth from the cabling infrastructure (what the frequency range is) and what measurement of Shannon's capacity is needed to support them. The value for the capacity is measured in bits per second. To achieve 10Gbps transmission, a Shannon's capacity of >18Gbps is required from the cabling solution. The additional capacity over the desired data rate is due to the amount of bandwidth used within the active hardware noise parameters (i.e. jitter, quantization, etc.).

Shannon's Law (Capacity)

It is one thing to understand how this law works, but another to meet the much needed channel capacities required to run protocols. That being said, the following is the basic formula for understanding how efficiently a cable can transmit data at different rates.

Concerning a communications channel: the formula relates bandwidth in Hertz, to information carrying capacity in bits per second. Formally:

$$Q = B \log_2 (1 + S)$$

Where Q is the information carrying capacity (ICC), B is the bandwidth and S is the signal-to-noise ratio. This expression shows that the ICC is proportional to the bandwidth, but is not identical to it.

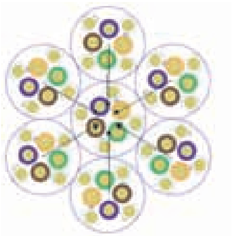
The frequencies needed to support the different proposed encoding schemes (to achieve a full 10 Gigabits) were now extending out as far as 625MHz. It quickly became evident that the signal-to-noise ratio within a cabling solution could be predicted, and therefore cancelled out within the active electronics. A random noise source, alien crosstalk, now existed from outside the cable. This noise source would need to be measured and reduced to achieve the Shannon's capacity requirements of the cabling solution.

In order to prevent the effects of crosstalk within cables, pairs within a single cable are twisted at different rates (as the different colours in the cable would indicate). These different rates are used in an effort to minimise the crosstalk between pairs along parallel runs. While this works well within the cable, it doesn't do much for cable-to-cable crosstalk (alien crosstalk).

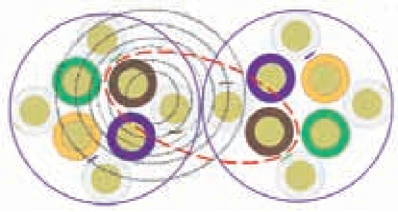
Technical Reference

10 Gigabit Ethernet over UTP: CopperTen™ Cabling Solution

Alien crosstalk is quite simply the amount of noise measured on a pair within a cable induced from an adjacent cable. This is not only a concern for different twist lay pairs between cables, but more so between same twist lay pairs between adjacent cables.

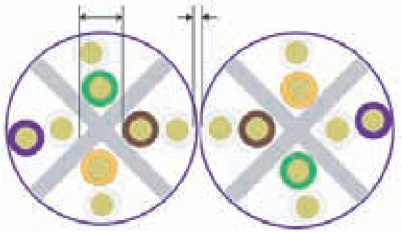


Example of a centre cable being impacted by the adjacent 6 cables in the bundle.



Example of how cables with same twist lays impact one another.

The star filler used within several Category 6 cable designs increases and controls the distance between pairs.



While the distance between pairs within the same cable is maintained, the distance between same lay lengths on adjacent cables is still compromised.

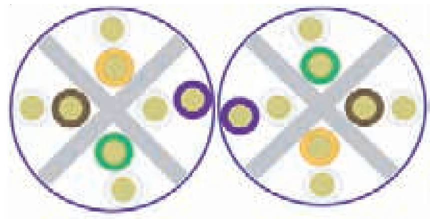
Initial testing on existing Category 6 UTP cable designs quickly showed that the rationale behind reducing the impact of crosstalk between pairs within a cable could not support alien crosstalk requirements. Twist lay variation and controlled distances between the pairs have been standard design practice for achieving Category 6 compliance. While the distance between pairs can be controlled within a cable jacket, it could not be controlled between same lay length pairs on adjacent cables.

Technical Reference

10 Gigabit Ethernet over UTP: CopperTen™ Cabling Solution

ADC KRONE's world-first CopperTen™ solutions presented the industry with an answer to the 10 Gigabit, 100 metre UTP problem.

Addressing Pair Separation



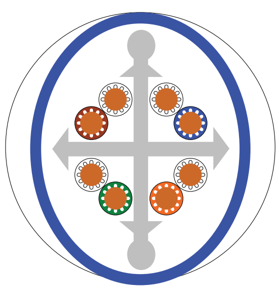
With standard Category 6 cable construction, the pair separation within the cable is counter-productive for pair separation between cables.

The often-used star filler pushed the pairs within the cable as close to the jacket as possible leaving same pair combinations between cables susceptible to high levels of crosstalk.

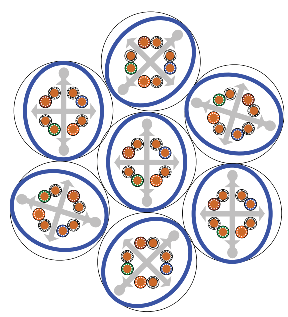
In CopperTen™ cables new design, the pairs are now kept apart by creating a higher degree of separation through a unique elliptical star filler design. Crowned high points are designed into the filler to push the cables away from one another within the bundle. This is very similar to rotating a cam lobe.

Due to the oblique shape of the star, the pairs remain close to the centre, while remaining off-centre as the cable rotates, creating a random oscillating separation effect. The bundled cables now have sufficient separation between same lay length (same colour) pairs to prevent alien crosstalk.

The separation can be better understood through the actual cross section below. The unique design keeps cable pairs of the same twist rate within different cables at a greater distance from one another than in the past. Air is used between these pairs.

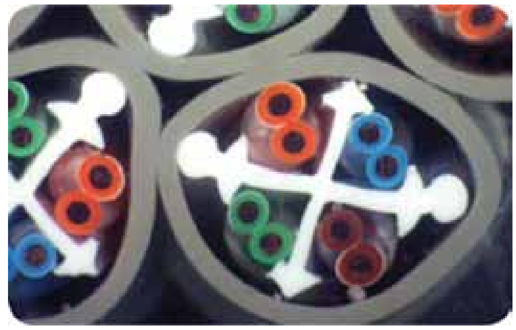


Oblique, elliptical, offset filler, which rotates along its length to create an air gap between the cables within a bundle.

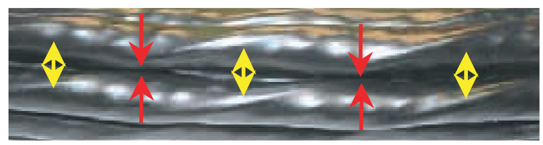


Technical Reference

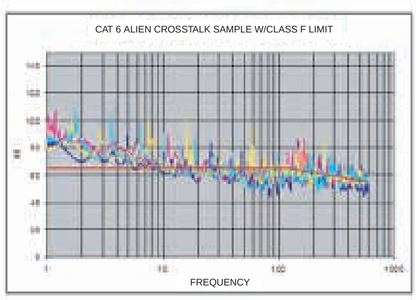
10 Gigabit Ethernet over UTP: CopperTen™ Cabling Solution

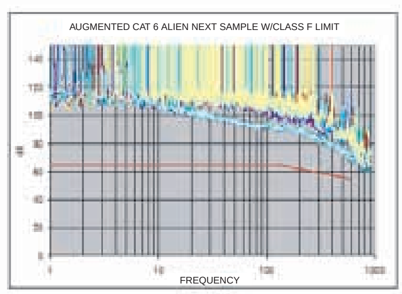


This effect is even more dramatic when viewed from the side of a cable bundle. The peaks of the oblique, elliptical filler (red arrows) are used as the contact points along the length of the run. These provide the greatest distance between the actual pairs by vaulting the sides of the ellipse (yellow arrows) where the pairs are housed.



The reduction of alien crosstalk is now greatly improved over the standard Category 6 cable and the new CopperTen™ cable. The improvements are approximately 20dB better on CopperTen™ cable than standard Category 6 cable. To put this in perspective: for every 3dB of extra noise there's a doubling effect resulting in standard Category 6 cable being more than six times noisier than CopperTen™ cable.





For the purpose of comparison, the Category 7 limit line was used to show the dramatic improvement in preventing alien crosstalk.

This ability to create a future-proofing cable in the CopperTen™ solution brings up a question as to the need for standard Category 6 cable, a cable sold and purchased (for the most part) in an effort to support the next technology leap.

The industry now has taken the next leap. Copper UTP has been given another lease on life to support the next future proofing step in a 10 Gigabit transport protocol. The cost of active hardware will remain in check and be cost effective for future advancements in data transfer rate speeds.

Technical Reference

Choosing the Right Product

The problem with having choices is that in the end, you must make one. This is clearly apparent with structured cabling where the primary protocol, Ethernet, is supported by a variety of media types, including singlemode and multimode fibre, different categories of shielded and unshielded twisted pair copper, and wireless. Regardless of what you may hear in the marketplace, each media has an inherent set of strengths and weaknesses. The choice you make as a network designer should to be made based upon what is right for the unique requirements of the network.

This article explores the advantages and disadvantages of the common media types that are used today to transmit Ethernet with a focus in on higher speeds such as gigabit Ethernet and 10 gigabit Ethernet because these are, for the most part, new to many network designs.

Optical Fibre Systems

Optical fibre is a valid media for transmitting gigabit and 10 gigabit signals per IEEE 802.3z and 802.3ae, respectively. The primary advantage of using optical fibre is the capability of laser optimised optical fibre to increase distances that 10 gigabit signals can run before being regenerated. The IEEE 802.3ae standard defines distance limitations of grades of fibre per the chart below.

The distance advantage makes optical fibre the best choice for the areas in the network that equire longer distances such as:

- Campus backbone cabling
- Building backbone cabling
- Horizontal or centralised cabling for distances greater than 100 metres, such as a factory environment or large data centre. The disadvantage of optical fibre is the cost of active electronics such as switch ports and network interface cards (NIC). It is estimated that the cost of 10GBASE-T copper electronics will be roughly half the cost of 10 gigabit optical fibre equivalents initially and will continue to drop as volume and technology progress.

Optical Fibre Advantages

- Distance
- Size of media, relative to copper solutions
- Security – impervious to EMI, extremely difficult to tap or monitor without detection
- Bandwidth – future protocols beyond 10 gigabit will be supported by fibre

IEEE Standard	Designation	Bandwidth	Distance Limitation	Common Applications	Solutions
802.3z	1000Base-SX	1000 Mb/s	220 to 550 metres	Enterprise backbone	» Multimode Fibre
802.3z	1000Base-LX	1000 Mb/s	5 kilometres	WAN, MAN	» Singlemode Fibre
802.3ae	10GBase-SR/SW	10 Gb/s	300 metres	Data Centre and Enterprise Backbone Cabling	» Laser Optimised Multimode Fibre
802.3ae	10GBase-LR/LW	10 Gb/s	10 kilometres	WAN, MAN	» Singlemode Fibre
802.3ae	10GBase-ER/EW	10 Gb/s	40 kilometres	WAN	» Singlemode Fibre
802.3ae	10GBase-LX-4	10 Gb/s	300 metres	Data Centre and Enterprise Backbone Cabling	» Multimode Fibre
802.3ae	10GBase-LX-4	10 Gb/s	10 kilometres	WAN, MAN	» Singlemode Fibre

Technical Reference

Choosing the Right Product

Optical Fibre Disadvantages

- Electronics cost
- Inability to carry substantial power on the cable
- Installation – optical fibre today is more difficult to field terminate than UTP copper

Compatibility – requires singlemode or multimode specific electronics. Work is underway to enable power over fibre (PoF) and it appears at this writing that enough power to operate a transceiver is possible. However, it also appears questionable today if PoF can deliver enough power for devices such as IP phones.

Shielded Twisted Pair Systems

There are different types of shielded systems:

- S/FTP – shielded overall cable with individual foiled twisted pairs, also known as ISO Class F or category 7.
- F/UTP – foil over unshielded twisted pairs, also known as foiled twisted pair (FTP) or screened twisted pair (ScTP). This design does not meet ISO Class F or category 7 requirements and can be used to meet augmented category 6 requirements.

Shielded twisted pair systems are popular in Germany, France, Switzerland and parts of Eastern Europe. Shielded systems are not pervasive in the India or other regions of the world, especially in the India where unshielded twisted pair (UTP) has been the dominant choice for copper media.

A properly installed and grounded shielded system effectively suppresses alien crosstalk, which is noise between cables in a bundle, for 10GBASE-T applications. However, as with any copper system, an improperly grounded shielded system will perform poorly because the shields may become antennas when there is no ground for radiating signals to flow to. It is critical to use a certified and properly trained contractor that is experienced with shielded systems when doing this type of installation.

When considering a shielded system it is also critical to consider all of the electrical parameters, and not just alien crosstalk. For a given conductor size, UTP cables will have superior attenuation characteristics as compared to S/FTP and F/UTP systems because shields absorb some of the radiated energy from the signaling conductors. Also, if patch cords used in a shielded system are 26 AWG, versus 24 AWG in UTP systems, this smaller gauge of copper can further compromise the attenuation of the system.

STP Advantages

- Internal noise suppression (S/FTP)
- External noise suppression (S/FTP and F/UTP)
- Backwards compatibility – supports 10/100/1000BASE-T

STP Disadvantages

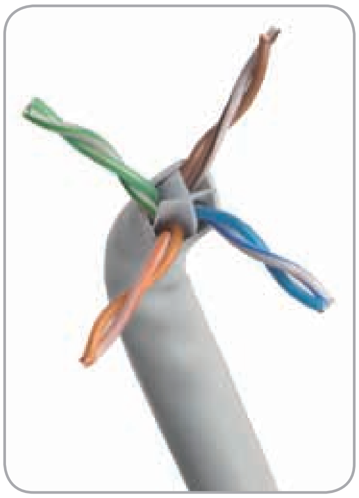
- Installation, relative to UTP
- Attenuation, relative to UTP where smaller conductors are used
- Size and cost of media, relative to UTP

Of course, installation practices can vary. Yet today, termination time for STP systems can be two to three times longer than for UTP systems. More problematic is finding a contractor experienced with installing and grounding STP.

Technical Reference
Choosing the Right Product

Category 6 UTP

Category 6 supports gigabit Ethernet and is recognised by standards bodies as supporting 10GBASE-T, however there are limitations that must be considered. The IEEE 802.3an standard cites a 55 metre distance limitation for standard category 6, which is not universally agreed upon within the TIA and ISO standards.



TIA TSB 155 recently released a Technical Service Bulletin covering additional parameters for running 10GBASE-T on standard category 6. In this document a 37 metre distance limitation is referenced for 10GBASE-T on standards compliant category 6 systems. Between 37 metres and the IEEE referenced 55 metres, standard category 6 may support 10GBASE-T, but it is possible that the installer may have to use alien crosstalk mitigation techniques such as unbundling cables or replacing patch cords to improve the electrical parameters to allow 10GBASE-T to work properly. Above 55 metres, it is unlikely that category 6 UTP would work properly without a large amount of mitigation to reduce alien crosstalk.

Category 6 Advantages
- Cost and size of media, relative to augmented category 6 and STP
- Installed base – currently the dominant UTP cabling standard
- Installation – widely accepted

Category 6 Disadvantages
- Limited distance for 10GBASE-T
- External noise suppression relative to shielded systems or augmented category 6

Augmented Category 6 UTP

The newest media for the transmission of 10 gigabit Ethernet is augmented category 6 UTP, also referred to as category 6_A. Augmented category 6 was specifically designed to support the IEEE 802.3an 10GBASE-T standard. It differs from standard category 6 in that it is tested to 500 MHz (versus 250 MHz) and has additional parameters for mitigation of alien crosstalk. Improvement of these electrical parameters is what allows augmented category 6 to run 10GBASE-T for a full 100 metres.

The primary concern with augmented category 6 UTP is the size of the cable. Cable with smaller outside diameter helps alleviate issues and concerns surrounding diminished conduit and tray fill rates.

Augmented Category 6 Advantages
- Distance, relative to category 6 – supports 10GBASE-T for 100 metres
- Installation – relative to S/FTP and F/UTP
- External and internal noise suppression, relative to category 6
- Enhanced performance for PoE Plus – larger conductor and cable size

Augmented Category 6 Disadvantages

- Size of media, relative to category 6 or optical fibre
- External noise suppression, relative to S/FTP and F/UTP
- Standardisation – TIA and ISO standards are still in draft state, although draft standards are available

PoE Plus is proposed to push over 30 Watts of power down two pairs of cable. Heat dissipation is a concern per IEEE studies. Yet it is known from IEEE testing that a larger conductor has less resistance and less heat generation due to resistance. The larger augmented category 6 cables are also able to dissipate heat better because the conductors are spaced apart from each other to suppress alien crosstalk.

Wireless (IEEE 802.11x)

Wireless technology continues to progress and be a convenient way to give users more freedom and accessibility to the network. Largely, these wireless networks are an overlay to the existing wired network. Although security was once a concern on these networks, encryption and authentication has progressed to a point where casual intrusion is really not an issue. The advantages of a wireless network are obvious as users are free to move about without restriction, making wireless an attractive solution for common areas and conference rooms. The primary concern with wireless becomes an issue of both capacity and coverage. Too many users on a given access point will limit the available bandwidth to each user, which even at maximum capacity is limited to 54 Mb/s (IEEE 802.11g). Additionally, the larger the coverage area, the more access points that are required, which can cause co-channel interference that further limits bandwidth. Future standards may address this by increasing the amount of bandwidth available.

Wireless Advantages

- Mobility
- Ease of deployment
- Standardisation

Wireless Disadvantages

- Coverage–limited to type and number of access points
- Capacity

Conclusion

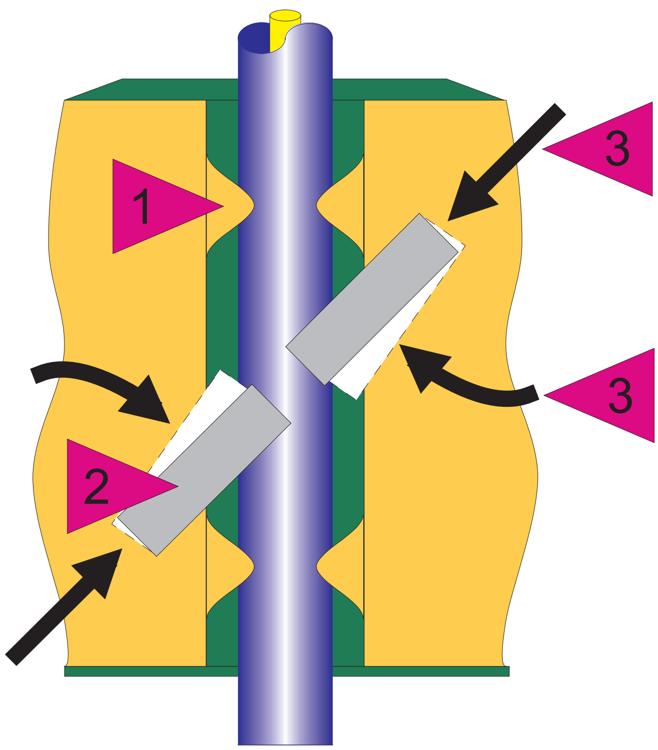
There are distinct advantages and disadvantages for each media type. It is critical that each of these is factored into network design. In many cases several of the above media will be deployed into a single network—for example, deployment of category 6 to each desktop with a wireless overlay or augmented category 6 in the data centre with and a fibre infrastructure to support the building and data centre backbone and storage area network. Each network has specific needs and requirements, so it is important to make your decisions based on the strengths and weaknesses of available media for the project.

Technical Reference

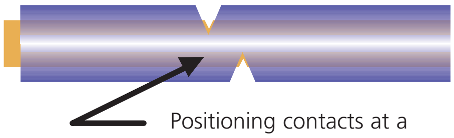
The LSA-PLUS® Contact Difference

The LSA PLUS® quick connection technique is a highly reliable and cost effective wire connection method for modern telecommunications and data networks. In fact, there are billions of connections in service in most of the world's highest profile networks.

1. Insulation clamping ribs hold the wire securely and isolate the contact area from vibration and mechanical stress.
2. Silver-plated contact tags at 45° angles across the axis of the wire make a solid, gas-tight connection.
3. Unique axial and torsional restoring forces maintain a durable connection.

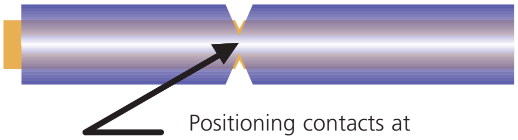


Effects of LSA-PLUS® contact on wire:



Positioning contacts at a 45° angle leaves more wire between contact points and provides a more reliable, stress-resistant connection.

Effects of other traditional contacts on wire:



Positioning contacts at a 90° angle produces a point of weakness subject to possible breakage.

Technical Reference

Designing the Optimised Data Centre

Figure 1. Equipment and Cable Racks

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.

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.

Technical Reference

Designing the Optimised Data Centre

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. If 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

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.

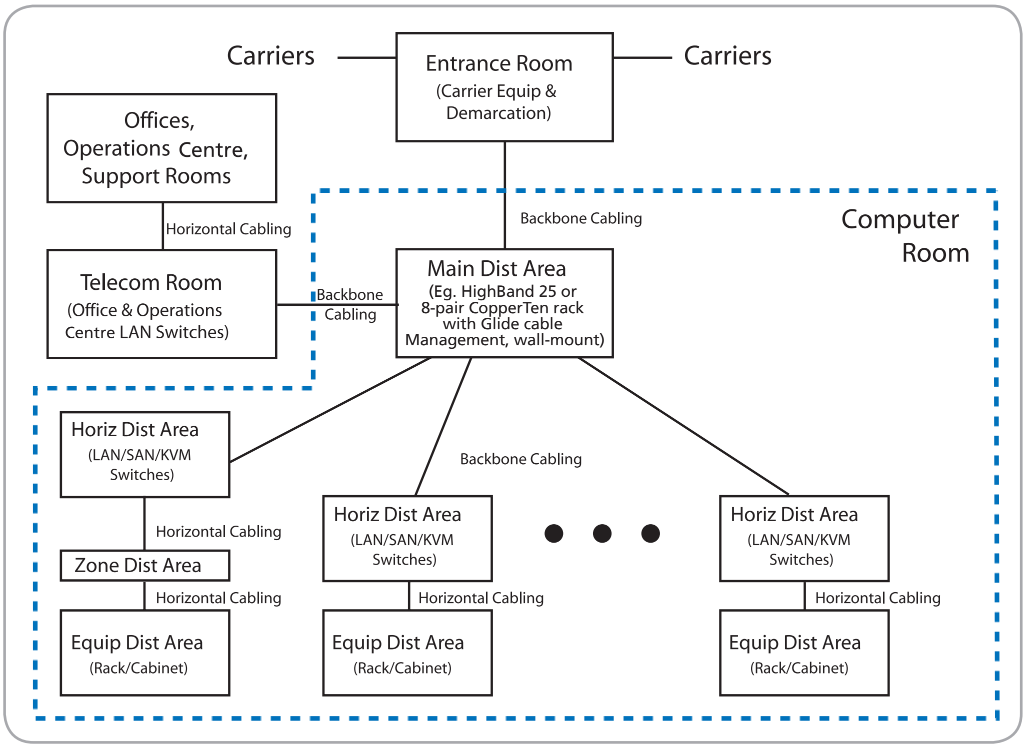


Figure 3. TIA-942 Compliant Data Centre

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.

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

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.	99.74%
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%

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.

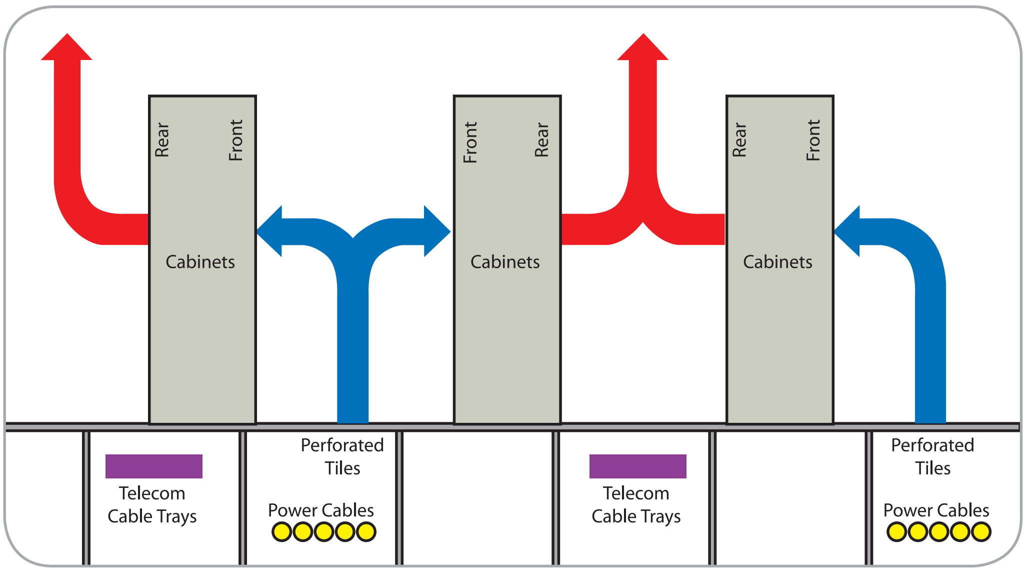


Figure 4. Hot Aisle/Cold Aisle Configuration

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.

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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%.
- 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.

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 Cat 6_A copper cable and 0M3 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.
- 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 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°.

Figure 5. Elements of Cable Management with ADC KRONE Racks

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.

Figure 6. ADC KRONE Glide Cable Management System

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 C6$_A$	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

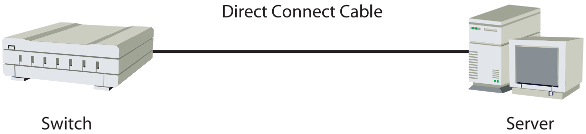
A key to optimised cable routing is ample overhead and under floor cable pathways. Use the under floor pathways for permanent cabling and the overhead for temporary cabling. Separate fibre from UTP to ensure that the weight of other cables doesn't crush the more fragile fibres. Separate Cat6 from Cat6$_A$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

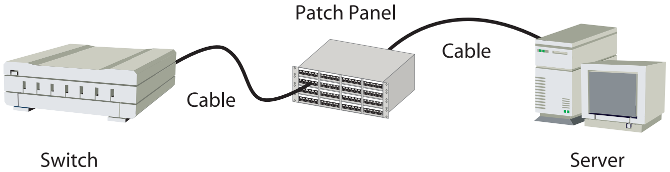


Technical Reference

Designing the Optimised Data Centre

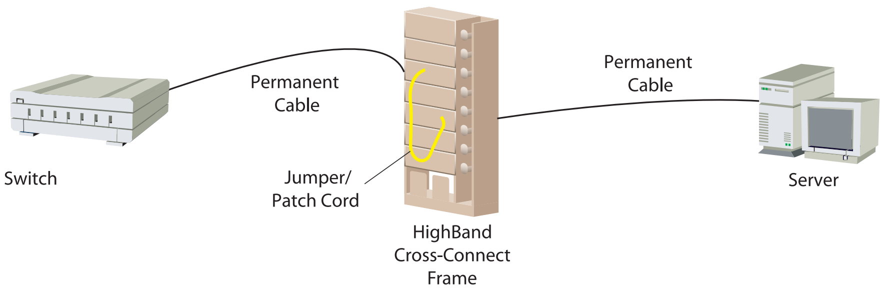
Interconnect

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.



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.



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.

Technical Reference
Patch-by-Exception

In the race for high performance, it is important to consider the elements that go beyond pure performance. ADC KRONE's termination modules with their unique Patch-by-Exception design provide an easy and inexpensive cabling alternative. The design not only provides industry-leading performance, but also many additional benefits that make installation, administration and maintenance of a structured cabling system fast and efficient. Cost savings are made at the initial investment of the solution, leading to significant cost savings over the lifetime of the asset.

The Need

The most common method of installation for communications systems throughout the world is to utilise a standard RJ45 patch panel style solution.

Advantages of the RJ45 patch panel solution:
- Changes can be made by most staff.
- Does not require a qualified technician to make changes.

Disadvantages of the RJ45 patch panel solution:
- No records kept or very hard to keep records up to date.
- Unauthorised changes can be made without approval.
- Testing of outlets requires disconnection of the service.
- Patch cords required for every service.
- Poor management can lead to a patch cable nightmare.
- Takes up space in equipment racks.
- Changes can be made to network equipment within the equipment rack.

Patch cord mismanagement and an inability to test/monitor circuits create a costly operational nightmare. The good news is that there is a better way, one that will not result in a tangled mess of patch cords.

Patch-by-Exception technology offers a superior patching solution whilst avoiding many of these issues associated with traditional RJ45 systems.

What is Patch-by-Exception (PBE)?

The following definitions come from satisfied users around the world.
- "PBE is the ability to create a completely interconnected communications management system at the floor distributor without the entangled mess of patch cords or expensive patch cord management systems."
- "PBE is where hard wiring is used to connect circuits. This hard wiring can then be overridden by a patch cord making patching the exception rather than the rule."
- "PBE is a solution whereby you hard wire your network and make subsequent changes utilising patch cords.To go back to the original configuration, simply remove the patch cords."
- "PBE provides the simplicity of an RJ patch panel solution without the need for patch cords or messy leads."

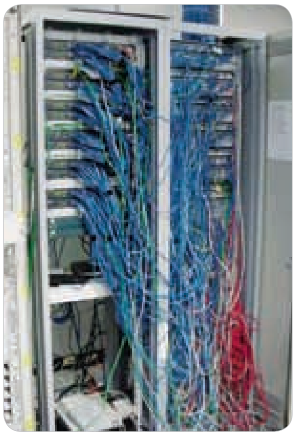
ADC KRONE offers a Patch-by-Exception solution for Category 5e, 6 and 6_A applications.

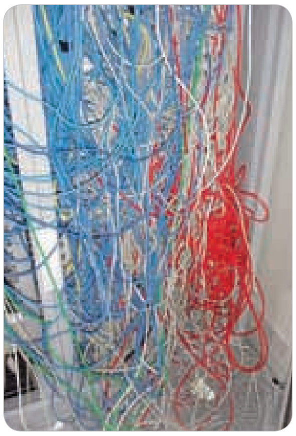
Immediate Cost Savings

The Patch-by-Exception solution offers many cost savings to an organisation. This is both in the initial installation and most importantly the ongoing cost of maintaining your patching environment.

Technical Reference

Patch-by-Exception





These initial cost savings are due to:

- Fewer patch cords required.
- Fewer equipment racks required.
- The wall mounted solution reduces the real estate required for equipment racks.
- Labour is reduced due to the front termination of the disconnect modules.
- Cable offcuts are used for connecting services (no special jumper wires required).

The ongoing cost savings that Patch-by-Exception offers are:

- Neat and manageable patching environment increases the productivity of the IT department.
- Quick deployment of adds, moves and changes.
- Easier to locate network faults, on all four pairs.
- Uses disconnection modules instead of patch panels.
- Unauthorised changes can be easily identified.
- Records of moves and changes are more easily kept up to date.
- Protection of the patching environment by using a non standard RJ45 patching solution.

Operational Benefits

The worldwide move to VoIP means that Patch-by-Exception has really come of age. In a VoIP system, all adds, moves and changes to user handsets are done using software tools. The user name and phone number are related to the handset by the IP and MAC address assigned to the VoIP enabled handset itself. Thus when a user needs to move, they simply unplug the handset from the current RJ45 outlet and plug it into another active RJ45 outlet on the same logical IP network. This could be across the hall, the building or the world. All this is achieved with no patch cord changes on the cross connect at all. Thus in a VoIP environment utilising this system, the need for patch cords is eliminated, only to be used perhaps for diagnosis or to bypass a damaged cable.

The unique design of the ADC KRONE LSA-PLUS® contact allows two wires to be inserted into each contact slot. This can be used when call monitoring or double jumpering is required for voice services.

Anatomy of a Disconnection Module

A disconnection module has two contacts for each wire, an ‘in’ and an ‘out’ as shown in Figure 2. These two contacts touch in the middle of the modules with a controlled amount of spring pressure. The central spring contacts allow the single-wire circuit to be disconnected, hence the name ‘disconnection contact’, and provides the access for patch plugs, test plugs, monitoring plugs or isolation plugs.

All HighBand® and CopperTen™ modules contain disconnection contacts. It’s this distinctly unique feature that sets it above other contact types, like the through-connect 110-style. You can only achieve the benefits of a Patch-by-Exception solution by utilising disconnect modules.

The design of disconnection modules provides a clean front panel. The insulation displacement contacts for the wire and the disconnection spring contacts are recessed inside the module, so accidental contact of the module with a metallic tool like a screwdriver will not cause any short circuits.

Technical Reference

Patch-by-Exception

During moves, adds and changes, the act of plugging a patch cord into the work area modules opens the internal spring contacts, thereby disconnecting the existing circuit as shown in Figure 3. When the other end of the patch cord is plugged into the module on the network equipment field, it will disconnect that existing circuit and feed the signal via the patch cord to the new work area outlet.

The patch cord has therefore created a new patched configuration, bypassing the original hard wired configuration. The patch has become an exception to the original, hence the name "Patch-by-Exception".

To revert to the original jumpered configuration, simply remove the patch plug from the network equipment modules, then the work area module. This sequence ensures no signal voltages will appear on the plug ends. The patch cords can be hung in a cupboard ready for use the next time an exception is required to the original jumpering.

How does Patch-by-Exception work?

Referring to Figure 1, one vertical column of disconnection modules is terminated with system tails that plug straight into the front ports of a switch/router with a standard RJ45. All of the work area horizontal cabling from the telecommunications outlets is terminated onto a second vertical column of disconnection modules which is located beside the first vertical column. The technicians simply terminate a series of 4-pair cables known as "hardwired (jumpered) cross-connects" on to the disconnection modules to complete the connection between the switch and the work area outlets.

Moves, Adds and Changes

When it is time to move services for an individual from one location to another, no special tools are required. Moves are done quickly and efficiently with a patch cord. Simply plug a patch cord into the work area field at the circuit to be moved and then plug the other end into the new source on the network switch field. The 4-pair patch cord will move all signals from one work area to another in a matter of seconds.

ADC KRONE manufactures patch cords in lengths of 1.2, 2.1, 3, 4.5, 7.5 and 15 metres. These lengths not only provide flexibility in patching, but also the best possible performance. ADC KRONE has found that these specific lengths offer better electrical performance at critical wavelengths and frequencies.

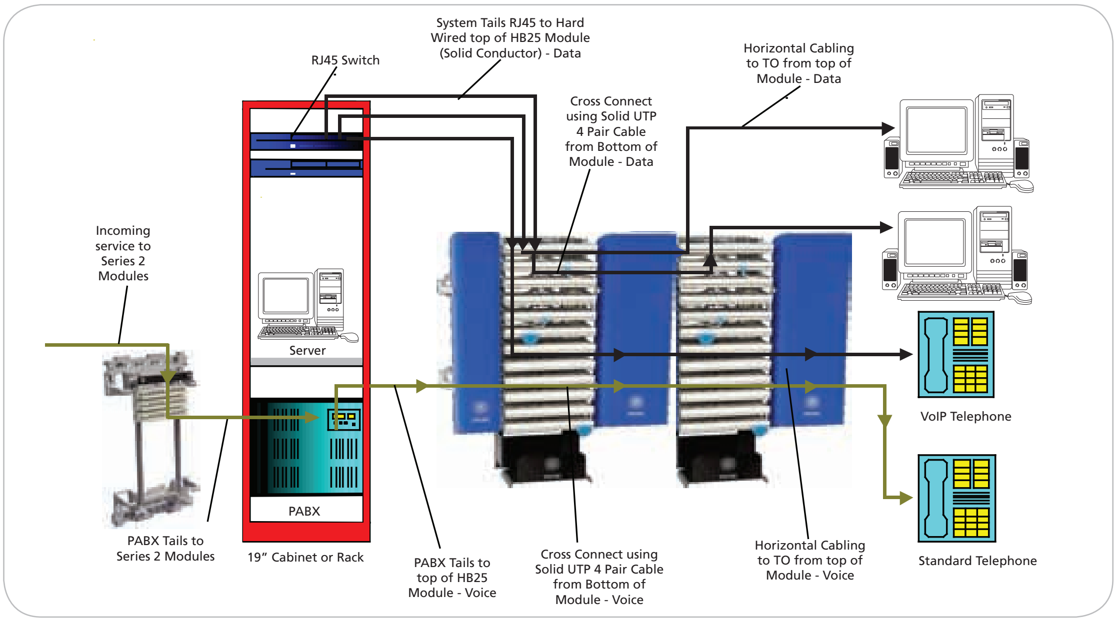


Figure 1

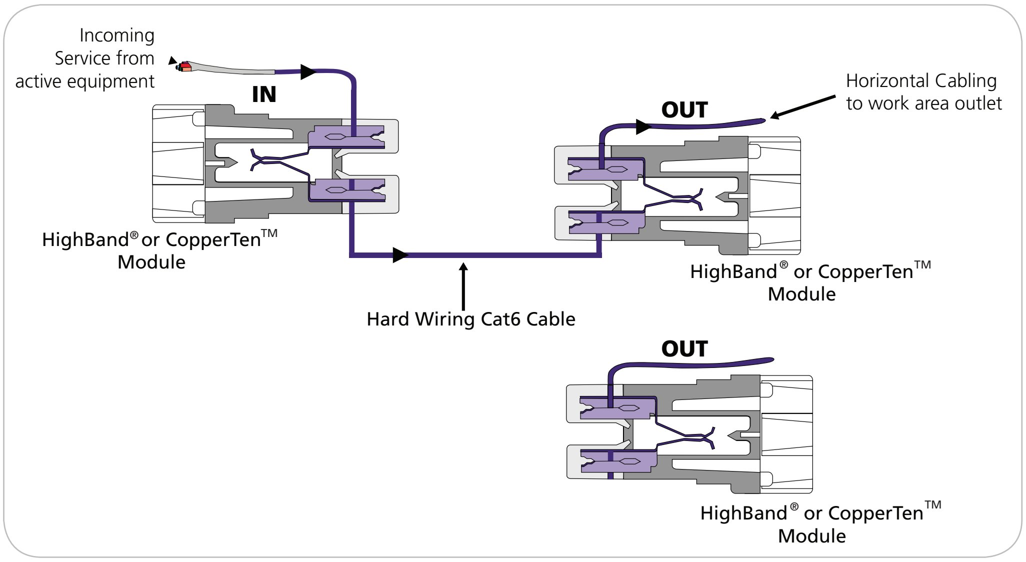


Figure 2

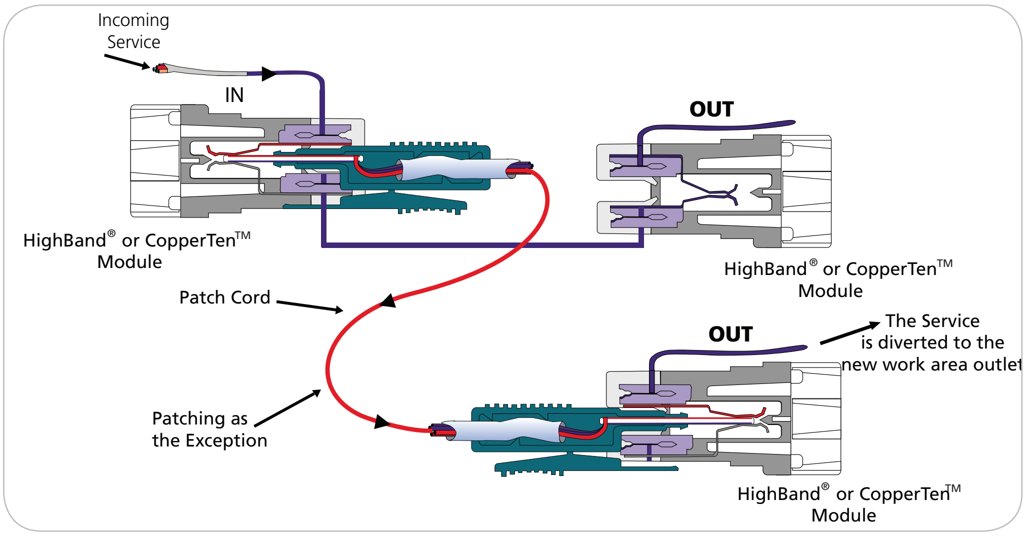


Figure 3

In time, as more and more changes are made, the fields of disconnection modules show all changes that have been made by the patch cords and you may want to make some or all of these changes part of your jumpered solution. At that time, a technician may be called in to rewire the temporary changes and make them permanent. This restores the cross-connect fields to their original "patch cord free" state. The panel will again look like it did the day it was first installed. The removed patch cords are then available for the next round of inevitable moves, adds and changes.

Added Security

All active equipment can be safely locked away in cabinets, as technicians do not require access to perform moves, adds and changes. Any unauthorised patching will stand out from the normally clean front faces on the modules. Sometimes a patch cord can be incorrectly positioned on a patch panel system but difficult to locate. This problem is eliminated in a Patch-by-Exception system, all temporary patch cords and plugs stand out from the normally clean module faces so you can quickly see an incorrect patch.

Security Isolation

If you have ever had an employee make unauthorised long distance phone calls from a vacant office, send anonymous e-mail from someone else's computer, or log onto the Internet and incur service charges, you know how important it is to be able to disconnect services temporarily. To disable services to a work area, simply place a disconnection plug into the centre port for that outlet. Because the plug fits a single pair, it allows for very selective management. The entire work area may be disabled or just one or two services, whichever is necessary. Isolation management of the network, phones and Internet service requires no special tools or training - just a simple disconnection plug.

Protection for IDC Contacts

All Insulation Displacement Connection (IDC) contacts work on the principle of displacing the insulation on the wire and displacing a small amount of the copper wire to form a gas-tight joint. ADC KRONE's IDC contacts are set at 45° and are isolated from mechanical vibration by the clamping ribs on both sides of the IDC slot. It is vitally important that the gas-tight IDC junction with the copper wire remains free from vibration and disturbance otherwise it will start a corrosion process that over time will increase circuit resistance and can cause an open-circuit inside the connection. This would have to be a technician's worst nightmare because it is virtually impossible to detect during fault finding.

The use of ADC KRONE disconnection modules with the central spring contacts for the plug means that the IDC-wire junctions are not disturbed in any way during the plugging in and removal of patch plugs. This ensures ADC KRONE disconnection modules have unparalleled protection for the IDC contacts. This is a more desirable patch plug process than those plug systems like the through-connect style that make contact with the IDC at the wire junction area. ADC KRONE's contacts can accept up to 200 re-terminations, allowing for repeated use.

Colourful Slots

All disconnection modules are marked on the top of each turret with either a colour code or a number to show the correct location of the wires when terminating. When modules are used in a cross-connect arrangement, all network equipment system leads are terminated on the top row of the module. In addition, all horizontal cables from the work areas are terminated on the top row of their modules. The cross-connecting jumper cables are terminated onto the bottom of both modules.

Labelling

The labelling facilities of PBE systems are far superior to that of an RJ45 style patch panel installations. Labels are larger and easier to follow for each wire either by colour code or number. Coloured tags are easy to apply to PBE disconnection modules enabling fast identification of groups of circuits. Records are more easily kept for PBE sites because once initially entered, any subsequent exception patching is easy to see on the modules. Patch cords will no longer obscure your view of labelling information on modules. ADC KRONE's hinged label holders for 8-pair modules can be applied to every module if desired or in groups of 10 with push-in numbers for the intervening modules. Conventional numbering in a vertical stack is left to right, starting from the bottom left module and numbering up the vertical.

Installed Appearance

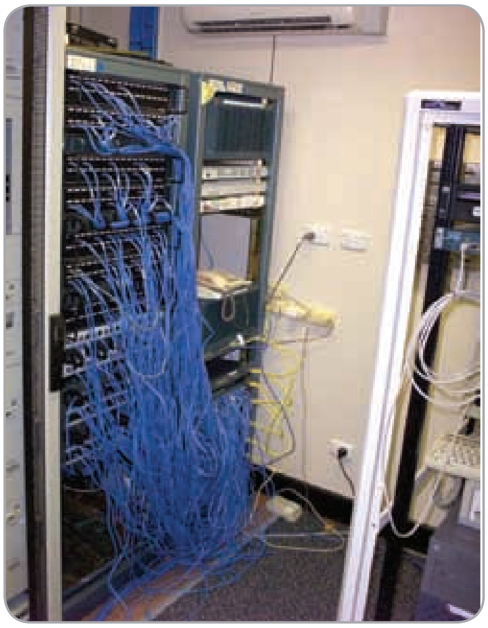
The Patch-by-Exception installations use disconnect modules that mount directly onto wall mounted backmount frames, equipment rack mounting frames are available however it is highly recommended that the wall mount option is utilised.

In all newly installed PBE systems there are no patch cords or jumper cables visible to the front. The system is totally hard wired from network equipment to work area, providing a secure, reliable, high performance infrastructure from switch to work area, or PABX to telephone. Neat, uncluttered, eliminating patch cord mess, aesthetically pleasing, and a breeze to operate and maintain.

Performance

International telecommunications standards recognise there is a difference in insertion loss between solid (horizontal) cable and stranded (patch) cable. Solid cable is 20 to 50 percent better. So by using solid jumpers at the cross-connect, not only are you saving money, you are getting better performance. This translates directly into fewer problems in the network, more data throughput and less fault-finding issues.

ADC KRONE's disconnection modules used for PBE solutions provide the highest performance available anywhere in the world today. This ensures not only high bandwidth now, but also spare bandwidth capacity for future upgrades.



These pictures were taken at a customer site, before and after the HighBand® installation.

Technical Reference

Physical Layer Management

TrueNet® PLM is the easy way to bring Layer 1, the physical layer of your network, up to the same standard of real-time management that you give to active equipment in layers 2 and 3.

TrueNet® PLM is an all-embracing management solution which monitors, in real-time, the location and connectivity of every copper circuit, fibre circuit and every connected Ethernet device – from server to security camera – throughout an entire enterprise. Single site or multi-site.

TrueNet® PLM is specifically designed to bring physical networks out of the shadows and under professional management control. It integrates with network management (NMC) and network operations (NOC) centre software to put you in full control.

TrueNet® PLM will help you to increase asset utilisation, reduce costly downtime, speed up and cost-reduce moves, adds and changes (MACs).

TrueNet® PLM is supplied complete with the TrueNet® System Warranty.

Some other management solutions use special 'managed' patch panels and patch cords. These can impact on the transmission channel and can have a detrimental effect in some systems. This is not the case with TrueNet® PLM. ADC KRONE engineers have ensured that the 'management' elements of the system are completely 'non-invasive' and have zero impact on the best-in-class quality of the TrueNet® transmission and connectivity components. Like all TrueNet® system elements it's warranted to deliver zero bit-error performance for maximum data throughput.

Technical Reference

Physical Layer Management

Managing the Physical Layer

TrueNet® PLM doesn't just track patch cords as with some 'intelligent patching' systems. By interconnecting with the switches and other active equipment at the Simple Network Management Protocol (SNMP) level, TrueNet® PLM is able to detect and confirm the location and usage of every Ethernet device with an Internet Protocol (IP) address connected to the network.

Because it knows which devices are connected, it also knows immediately when they are disconnected and if the network manager has marked them as critically important the system will raise an alarm if they become disconnected.

So, for example, if a critical storage device, a server or a backbone fibre link becomes disconnected, the alarm is immediately raised. You can even set the system to raise the alarm if the CEO's Voice over Internet Protocol (VoIP) phone or PC becomes accidentally disconnected. TrueNet® PLM is fully configurable.

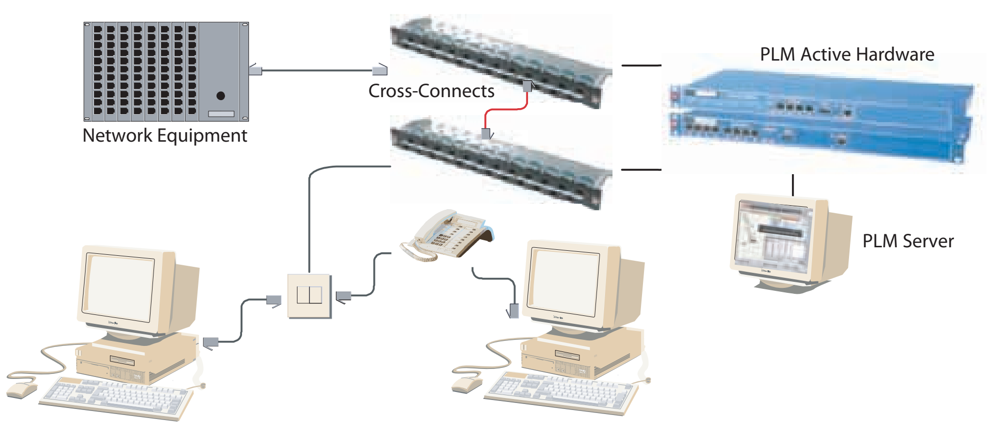
TrueNet® PLM will report the physical location, connection status and usage statistics on every active device connected to every port right across the network.

How it works

PLM only requires special purpose patch panels and patch cords in the cross-connect area, all other elements of the structured cabling installation are standard.

The web-based PLM software resides on a server which contains information on the layout of the buildings and cabling infrastructure. Each patch panel is connected to a piece of active hardware which continuously scans the cross-connects to determine which ports are connected. The PLM software also links in with the switches via SNMP (simple network management protocol) to gather information about the devices connected to the network (PCs, printers, phones etc).

By combining this information, the PLM software is able to automatically detect and determine the physical location of any and every device with an IP address on the network, giving a 100% accurate view of the entire network in real time. This information also gives the software the ability to log and pin-point every single connection based event across the network.



Raising the alarm

Alarms and alerts are highly configurable within TrueNet® PLM. Specific devices, circuits or classes of device and circuit can be given varying degrees of alarm urgency. So the highest levels of alert can be given to unplanned disruptions to backbone fibre links or edge devices like Wide Area Network (WAN) routers. Disconnections of critical equipment like servers and Storage Area Network (SAN) devices can be given their own severity level.

TrueNet® PLM can also raise alarms whenever an unauthorised Ethernet device is connected by a network user – for example a laptop computer within a high security area or an unauthorised Wireless Fidelity (WiFi) access point.

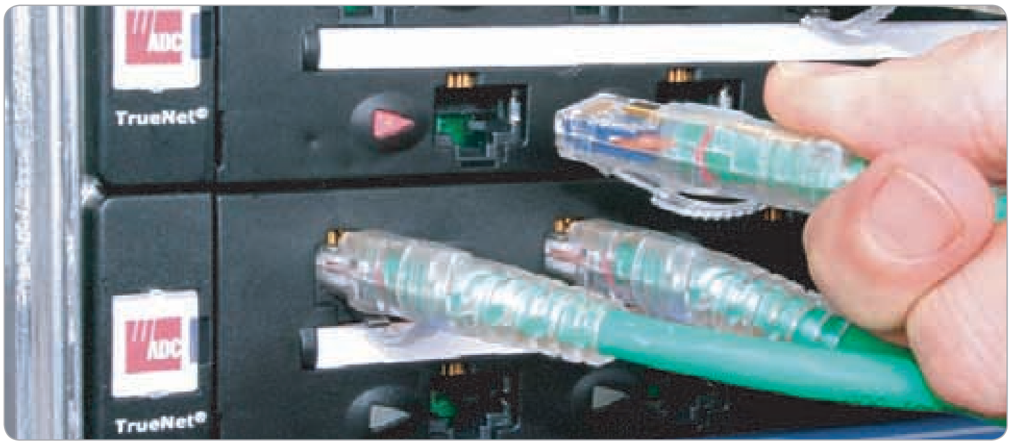
Alarms can be presented in a number of ways

- Via the Network Management Centre software
- Text message to mobile phones or to pagers
- E-mail alert.

TrueNet® PLM will even raise an alarm if personnel undertaking MACs accidentally plug a patch cord into the wrong port saving hours of fault finding.

Technical Reference

Physical Layer Management



Benefit from better network utilisation

As the months and years go by, every network undergoes hundreds or thousands of moves, adds and changes (MACs). Inevitably, record keeping is never 100% accurate. Sometimes old patch cords aren't removed leaving switch-ports to look as though they are in use when in fact there's nothing at the other end of the link.

Often a switch port is patched through to a link which goes through to an outlet where there is no equipment connected – or perhaps there is a PC or printer which hasn't seen traffic for over three months.

Does this sound familiar?

It is so common that it has a name – "phantom utilisation" – and in a study by Gartner research, they discovered that it can be as high as 40% of total apparent utilisation.

TrueNet® PLM solves this problem at a stroke and can release this spare network capacity – so that ***you don't have to invest in new switches to satisfy user demand.***

TrueNet® PLM continuously scans the networks' physical connections and correlates this with information on connected Ethernet devices and device usage via SNMP from the various switches. It immediately identifies unused switch ports, redundant patch cords as well as under-utilised ports where the connected device hasn't actually sent or received traffic for a specific number of days.

TrueNet® PLM checks:

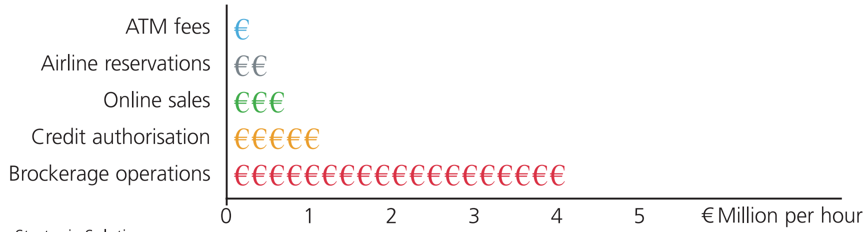
- **All horizontal and vertical links – copper and fibre**
- **Redundant patch cords**
- **Links with no attached Ethernet device**
- **Links with inactive Ethernet device attached**
- **All switch and router ports**
- **'Reserved' backbone and campus capacity**

Technical Reference

Physical Layer Management

Managing Costs

The financial impact of network downtime



Source: Strategic Solutions

Cost savings and ROI

Releasing up to 40% of your switch ports for re-use represents a massive saving because you're not having to invest in new switches. There are many other areas where TrueNet® PLM can save costs – which is why the payback period is generally one year or less.

Physical layer management with TrueNet® PLM is a sound financial investment. Most TrueNet® PLM installations typically have a payback of one year or less – even for networks as small as 100 users or for small branch offices.

Guided moves, adds and changes (MACs) with work scheduling can reduce technician time from hours to minutes because records are up to date and there's no need to trace patch cords to find out what's actually connected to where. TrueNet® PLM's LED guidance system means that during a MAC there is no possibility of causing expensive downtime by accidentally pulling the wrong patch-cord, nor costly fault finding when a new patch cord is accidentally plugged into the wrong port. Even if a technician did manage to ignore the LEDs and plug into the wrong port, TrueNet® PLM will raise an immediate alarm. Users report savings of up to 87% on MAC technician-time.

(Source – industry white paper)

Downtime slashed

Various studies show that 59% to 70% of network downtime is caused by problems in the physical layer. Yet Network Management Centre (NMC) solutions only manage the active equipment! A study by Strategic Solutions quantified the cost of network downtime from thousands per hour up to several millions per hour depending on the industry segment (see diagram above).

With TrueNet® PLM, management of the physical layer (Layer 1 of the OSI model) can be integrated with layer 2 and layer 3 into your NMC or network operations centre (NOC). Now operations staff can immediately see the cause of any problem without lengthy and complex fault-isolation procedures. The result – faults can be rectified in minutes instead of hours – often before users have even noticed.

Security and good governance compliance

Recently introduced legislation, such as Sarbanes Oxley and Basel II accord, requires new levels of corporate governance, accountability and service delivery. Affected companies must now institute event monitoring and vulnerability assessments as a critical part of their IT internal control systems. Compliance objectives include:

- Access control enforcement
- Configuration control
- Malicious code detection
- User monitoring and management
- Policy enforcement
- Transmission security

With TrueNet® PLM all circuits and connected devices are continuously monitored and any connectivity event within the physical layer is recorded and reported as required.

In addition information can be directly extracted from the software database, instantly providing comprehensive reports making expensive and time consuming on-site audits a thing of the past, secure with the knowledge that all information is 100% accurate, generated in real-time.

Fully managed infrastructure

Automated Deployment and Provisioning

TrueNet® PLM's connection deployment and service provisioning is designed to significantly improve the planning and provisioning process for data centres and work space environments, providing the user with various tools that automate and speed deployment and reduce the amount of time spent on planning and implementing tasks. This dramatically reduces the number of human errors and the time needed to complete the work while increasing accuracy.

While being fully automated, the user can still make changes/modifications at every step of the process if they choose, thus allowing the user to maintain complete control over the process and to enjoy the automation benefits.

Innovative features include various tools, such as Next Available Service Algorithms, automatic Work Orders, and Customer Optimised Policies. These features enable support of provisioning operations such as 'Swaps' and 'Removes' in addition to the normal moves, adds and changes.

Taking the guesswork out of patching

No longer will you suffer from incomplete or inaccurate records and redundant or misplaced patch cords. TrueNet® PLM constantly scans all patch cords – copper and fibre – making sure that your database is 100% accurate and up to the minute.

TrueNet® PLM eliminates patching errors during moves adds and changes (MACs) because once the task is scheduled the job via the NMC or NOC, or simply using a Windows based PC, the technician is guided by LEDs on the patch panels showing exactly which patch cords to remove and precisely where they should be inserted.

So there's no more accidental disconnection of links to critical devices like servers, storage devices or the CEO's PC. And there's no tracing of patch cords to find out why a MAC hasn't provided the user with service.

- Work orders to technicians or lay staff
- LEDs show which patch cords to disconnect and where to plug new
- Immediate alarm if incorrect patch cord disconnected
- Immediate alarm if patch cord is inserted into wrong ports
- 100% accurate records in real time
- Remote sites and branch offices integrated into one TrueNet® PLM solution for network-wide management
- Ideal for 'installer managed' sites because there's no need to send technicians to do MACs
- Alarms raised if circuits or critical equipment are tampered with or disconnected.
- Alarms raised if 'foreign' devices are connected to the network

Network-wide management

Remote sites and branch offices can be integrated into a single PLM data base giving the same level of visibility, security and control as a local network.

This means that when a move, add or change (MAC) is needed at a remote site or branch office there is no need for the cost and time delay of despatching a technician to the site. Any lay person – from receptionist to branch manager – can follow the LED guide lights and faultlessly complete the MAC.

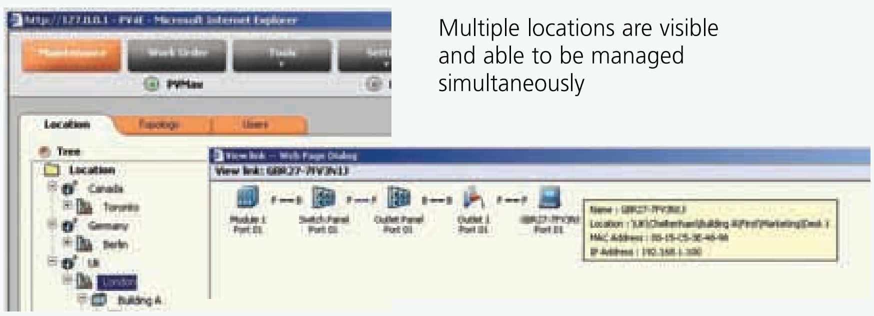
There is no need for completing and updating records either, TrueNet® PLM constantly scans and records all connections at remote sites in real time in exactly the same way as a local network, reporting to NOC/NMC management any changes that occur and raising an alarm if there is any problem.

Technical Reference

Physical Layer Management

User friendly

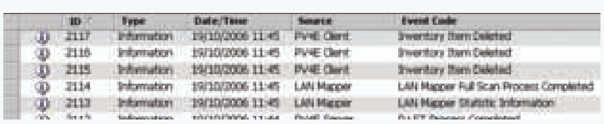
TrueNet® PLM Software has a clear and easy-to-use interface



Multiple locations are visible and able to be managed simultaneously

Each and every device in the network can be monitored with the device locator

Panel graphics make the MAC process infallible



	ID	Type	Date/Time	Source	Event Code
	2117	Information	19/10/2006 11:45	PV4E Client	Inventory Item Deleted
	2116	Information	19/10/2006 11:45	PV4E Client	Inventory Item Deleted
	2115	Information	19/10/2006 11:45	PV4E Client	Inventory Item Deleted
	2114	Information	19/10/2006 11:45	LAN Mapper	LAN Mapper Full Scan Process Completed
	2113	Information	19/10/2006 11:45	LAN Mapper	LAN Mapper Statistic Information

The event log gives a concise report on physical layer activity