Title: Complexities of data center connectivity and need of structured cabling solutions (Data cables) that optimize efficiency.

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Main Subject Matter: Data center horizontal cabling important performance parameter and best practices.

Abstract

Deployment of new applications over datacentre is moving forward at a lightning pace and connectivity requirements becoming more complex in data canter. With the emerging applications demand it has become very critical to select the right design of cable meeting current and upcoming applications needs. Structured cabling installations with lesser control and low design valued infrastructure many times results in poorly installed systems. Structured cabling design planning includes pathways, containments and other necessary best practices which are very critical to achieve better performance and avoid the maintenance issues in future.

Keywords: SCS: Structured Cabling System, OEM: Original Equipment Manufacturer, LAN: Local area network, dB: decibel, Gb/s: Gigabits per second; PoE: Power over Ethernet; RL: Return Loss, NEXT: Near end cross talk, PLM: Product line manager

1. Introduction

The framework that enables our customers to configure the data center with an intelligent interconnected infrastructure that optimizes the environment with a flexible cabling infrastructure that will allow customers to grow as their capacity and bandwidth grows. Data centers continue to grow and expand globally as our demand for data increases daily. New applications based technologies like cloud computing, mobility, video streaming, virtual reality, autonomous driving, real time gaming and many more will be data guzzlers, pushing users and enterprises to demand hyper connectivity and low latency For example, self-driving cars will generate up to 4 Terabytes of data for 8 hours of driving, while virtual reality applications will consume 140 Petabytes of data per month by 2021. Not only in the devices that make up the network fabric, but also at the physical layer, the foundation of our network. We have 10Gb/S Ethernet, we have 40Gb/S and 100GB Ethernet over fiber and upcoming IEEE 802.3cd and P802.3bs standards are working for delivering 50/100/200/400 Gb/S over different length and types of fiber uplinks .We have 25Gb/s and 40Gb/s Ethernet are for use over copper balanced twisted pair. Given the need for hyper connectivity and low latency and the fact that these apps and storage for them is over the cloud, data centers will need to move close to the point of consumption. Hence, networks will become dense with smart design elements. Data Center efficiency will be one of the key drivers for desired performance and cabling infrastructure is one of the important elements in entire data center eco system.

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2. Background

It's important to design and implement cabling infrastructure which is forward compatible with data center technology trends. Installed cabling system to utilises new connector technologies that will be compatible with the next generation interconnect and its critical for cabling solutions to provide a positive impact in the power bandwidth battle.

As LAN data cable manufacturer our larger goal is to promote maximum deployment of high efficiency, higher bandwidth new generations Cat6A onwards design cables which will be enabling future ready networks with proper implementations best practices followed. Good cable design and installation in networks includes data center and enterprise networks have a significant impact on network performance, capacity, and cost. While Cabling accounts for 2-5% of Network investment its life expectancy can be upwards of 10-15 years. We know that up to 50% of a network's problems can be traced to the cabling infrastructure issues. Good cabling discipline and well-designed networking infrastructure can significantly improve the network performance and improve availability. Selecting the proper good quality cables up front provides assurance on the correct life-cycle choices for the network reliability, scalability and availability.

3. Cabling Standards &Technology

3.1 Structured cabling network

The cabling solution need for a data center differ from that of a traditional structured cabling network. Data center physical connectivity solutions to primarily meet three important objectives. The first objective for cabling system is for it to be reliably capable of handling huge data streams at the fastest possible rate. The second objective is fast deployment. The third objective is high density.

Standard, basic, modular components are the key to fast, simple installation, capital-effective and network flexibility. The traditional cabling process –cables laying, terminating the cables at connectors populating patch panels, testing and troubleshooting the installation then making repairs as necessary which generates too many chances for delays and introduces uncertainties that can make or break a start-up.

Copper has been preferred within the data center as the server link between the equipment and access switching. Copper is used to connect the switch to the server and the network rows to the server rows as part of Middle of Row and End of Row network row connections.

3.2 Data center cabling standards

Standards for structured cabling systems in a data center: TIA-942-B and ISO/IEC 24764 (11801-5 in next revision of data center) Under TIA-942-B Adds Category 8 as an allowed type of balanced twisted-pair cable, and changes the recommendation for Category 6A balanced twisted-pair cable to Category 6A or higher. Higher bandwidth copper Cat6A is recommended and under ISO/IEC 24764 Cat6A is minimum cable type defined.

ISO/IEC TR 11801-99-1 guidance for cabling in support of 40Gbp/s transmission specifies – 30 m channels for Cat 6A, 7, 7A that can support 40 Gb/s – 30 m channels using Cat 8.1 (backward compatible w/Cat 6A) or Cat 8.2 components (backward compatible with Cat 7A)

The EN 50600-2-4 defines basically two cabling types:

Direct connections "Point-to-point Cabling": Direct connection of two pieces of IT equipment using a dedicated cable rather than a generic cabling system. The point-to-point connection method uses discrete cords (typically factory-produced) that directly connect the active equipment.

Fixed Cabling: Structured cabling including the generic cabling solutions of the EN 50173 series between closures which have either peer-to-peer or hierarchical structure and which enables the installation of cross-connects or interconnects at those closures.

The change in data center traffic and direction requires a network design that accommodates the rapid increase of east-west data traffic. The traditional data center architecture used a three-layer topology. The core layer, typically located in the main distribution area (MDA), connects the various network switches to each other and to network sources outside the data center.
Standards ISO/IEC 11801-5 (Data Centre advising minimum Cat6a onwards designs for data center cabling.

3.3 Copper Cable Media

Following Copper cable media option for Data Center cabling Class EA/Category 6A – Enhancements to Class E/Category 6 cabling to support 100m operation with 10GBASE-T. This cabling is defined to 500 MHz and includes specifications for Alien Crosstalk. It is defined as Category 6 Augmented by TIA/EIA-568-C.2 and as Class EA by ISO/IEC 11801 Edition 2 Amendment 1 and also EN 50173-1 Edition 2 Amendment 1.

Class F/Category 7 - System comprising Category 7 cable and connecting hardware specified to 600 MHz (in accordance with ISO/IEC 11801 and EN 50173 2nd Editions).

Class FA/Category 7A – Enhancement to Class F/Category 7 cabling. This cabling is defined to 1GHz and includes specifications for Alien Crosstalk. It is defined as Class FA by ISO/IEC 11801 Edition 2 Amendment 1 and also EN 50173-1 Edition 2 Amendment 1.

Class I & II/Category 8 – Cabling defined up 2GHz for distances up to 30m using RJ45 connectors. Class I channel (Category 8.1 cable): minimum cable design U/FTP or F/UTP, fully backward compatible and interoperable with Class EA (Category 6A) using 8P8C connectors (RJ45). Class II channel (Category 8.2 cable): F/FTP or S/FTP minimum cable design.

3.4 Cabling solution value proposition for Data center

Structured trunk cabling system helps improve manageability and reliability of cable infrastructure.
Pre-terminated and tested components offer proven connectivity and faster, less-disruptive installation and removal of equipment.
Lower diameter cables increased the overall airflow and efficiency reducing operation cost.
Known cable pathways support a reliable outcome for moves, adds and changes.
Modular Cabling System for quickly attaching cabling.
Plug and Play connectivity that uses rack cabling groups to easily connect each equipment rack to the central network racks making up the entire modular cabling system.
Modular and scalable solution that grows with the Data Center meeting capacity needs and reducing costs
Interconnected cabling that reduces physical requirements enhancing overall conditions for data center cooling and ongoing support
Pre-fitted, pre-terminated, pre-tested solutions reducing time to install up to 75% and improves availability

3.5 Cable Test Results Observations and Findings:

Rise in data rates means an increase in bandwidth requirement. The minimization and reduction of losses to transmission is a key measure of performance. Return loss (RL) and Alien cross talk is a very important noise measurement parameter defined for local area networks and LAN components. It is the loss of power in the signal returned/reflected by a discontinuity in a transmission line. In the field, return loss performance mainly depends on how the installer installing the cable. When the field installer does not follow proper installation practices, there are more chances for a drastic decrease in the RL headroom and sometimes even RL failure. So, the cable manufacturing requires careful attention while designing the cables such that even after poor installation practices in the field, RL should not fail with the extra headroom available. This brings the importance of manufacturing higher headroom cables by the cable manufacturers.

As Cat 6A is the minimum category cable that is required for the datacentre applications, in order to showcase the importance of higher headroom for RL in data cables for those critical applications, testing was conducted on the below mentioned Cat 6A cables in four different testing methods using Network Analyser test equipment in TIA-568-C.2 Permanent Link specification limits keeping the equipment, the adapters and the connectors the same in all cases.

1) Cat 6A U/UTP - Higher headroom design
2) Cat 6A U/UTP - Lower headroom design

In order to verify the cable performance, the following four different testing methods have been conducted on the Cat 6A U/UTP higher headroom and lower headroom design cables one after another starting from 1 to 4.

1) In Coil condition (Figure-01)
2) In Laid condition (Figure-02)
3) By bending the cable at various positions less than the maximum allowed cable bending radius (Figure-03) and

4) By bending the cable at various positions more than the maximum allowed cable bending radius (Figure-04).

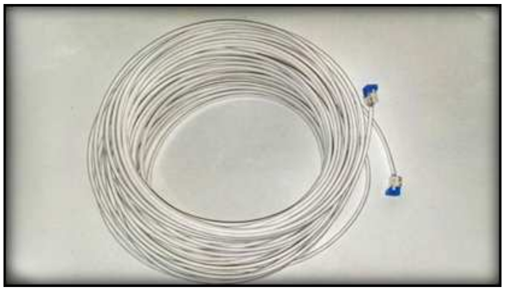

Figure-01: Coil Condition

Figure-02: Laid Condition

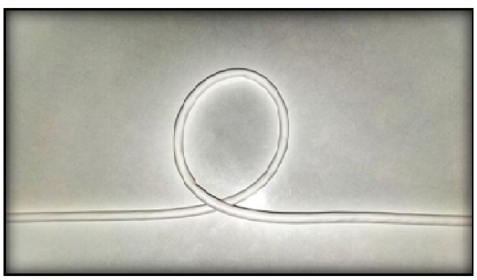

Figure-03: Bending the cable less than maximum allowed bending radius

Figure-04: Bending the cable more than maximum Allowed bending radius

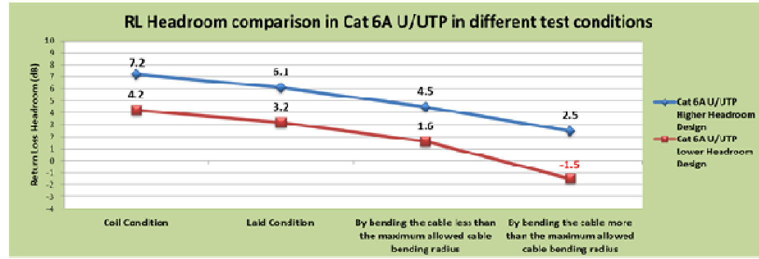

Figure-05: RL Headroom comparison between higher headroom and lower headroom design cables in different testing methods

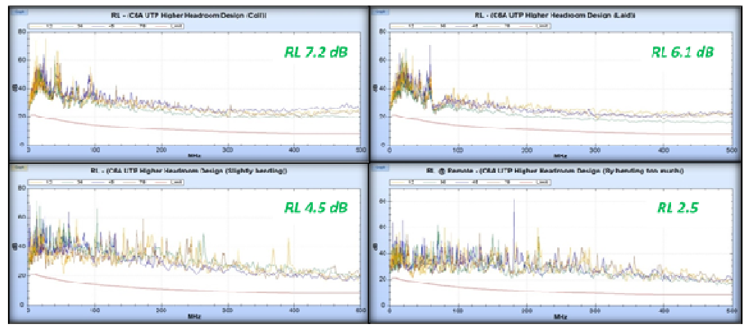

Figure-06: RL Headroom obtained in higher headroom design cable in different testing methods

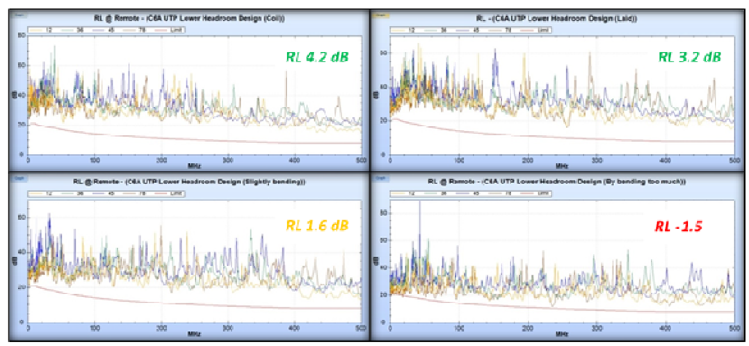

Figure-07: RL Headroom obtained in lower headroom design cable in different testing methods

3.5.1 Alien Crosstalk Results Observations

In 10GBASE-T and beyond applications, it is Alien crosstalk (the noise source) that most limits the data transmission performance over copper cable. That must be suppressed within the cabling system to ensure reliable data transmission. This noise is measured as power sum alien near-end crosstalk (PSANEXT) and as power sum alien attenuation to crosstalk ratio at the far-end (PSAACRF). When properly installed and maintained, both unshielded twisted pair cable and shielded twisted pair cable will do quite well in their applications. When the application is very high in electromagnetic interference, shielded cable can add an extra line of protection.

Alien crosstalk testing was conducted for the Cat 6A U/UTP and Cat 6A U/FTP cables separately in a 6-around-1 (six cables tightly bundled around a center cable) cabling configuration considering the worst-case effect and in TIA Cat 6A Permanent Link specification on the Network Analyzer equipment Cables routing is as shown in the Figures 08, 09, 10 and 11 and the obtained test results are as shown in the Figure-12.

Figure-08: Cables going into the Network Rack

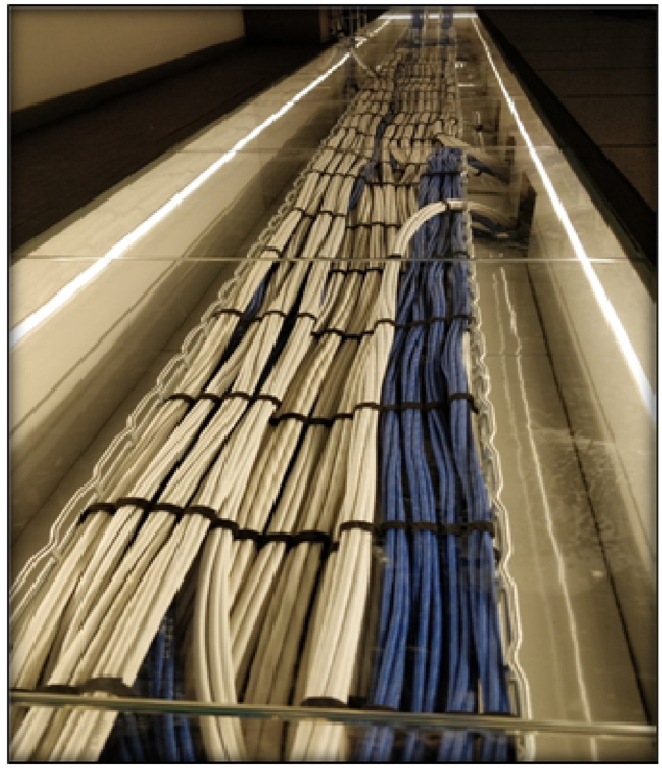

Figure-09: Cables routing in the basket

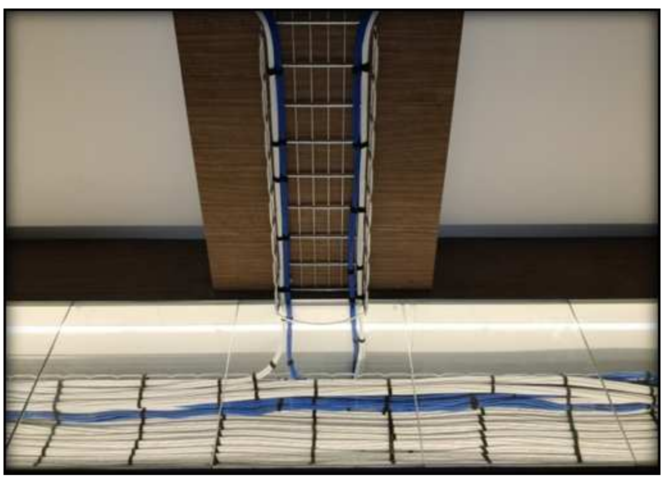

Figure-10: Cables coming from the top raceway

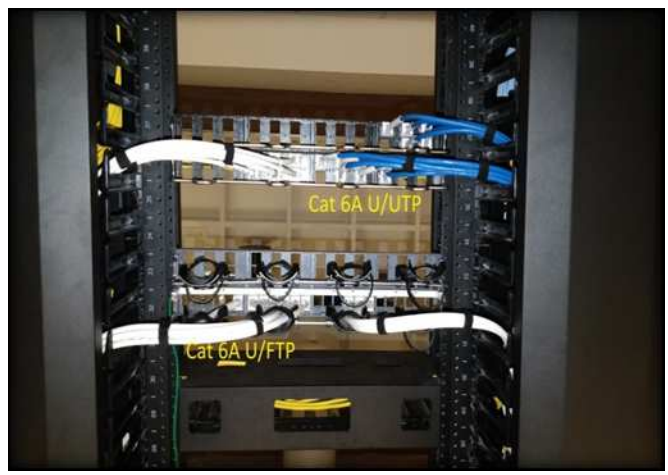

Figure-11: Cables terminated at the Jack Panels

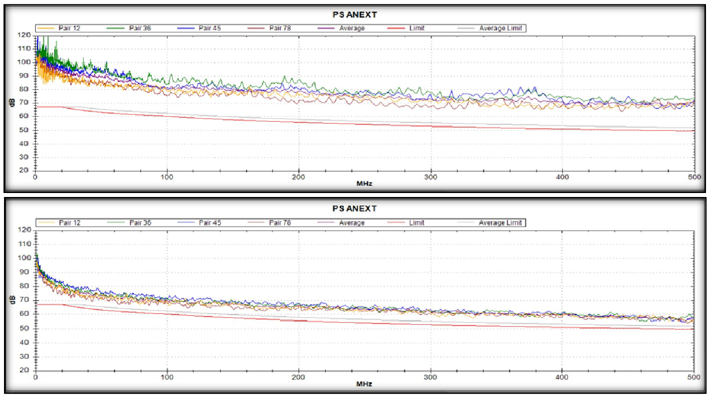

Figure-12: PSANEXT headroom comparison between shielded and unshielded Cat 6A cables

Figure 12 shows the difference in alien crosstalk performance between a Cat 6A U/UTP cable and the shielded version Cat 6A U/FTP cable. Since a wider margin to the limit line is desirable, the U/FTP Category 6A cable clearly has more margin or headroom (performance beyond the standard) than the UTP cable does. Overall, shielded Category 6A cables perform better than their Category 6A UTP counterparts simply because the metallic barrier offers superior protection from unwanted external noise.

3.6 Recommendation for Higher performance

Field Implementations best practices

- Overhead cabling if under floor space is used for cooling
- Route cables and pathways to minimize interfering with proper airflow
- Cable routing should not compromise efficiency of enclosures - blanking panels, brushes & grommets for cable openings
- Equipment should match airflow design of cabinets (front to back, use baffles for side-to-side cooled equipment)
- Untwisting dramatically affects NEXT and RL – the less untwist the better – right up to the termination point. Must keep maximum amount of pair untwist to about 6mm on CAT 6A, Cat 6 or lesser as specified by the manufacturer.

- Bending radius for UTP no less than 4x (4-PAIR) and Screened twisted pair no less than 8x of cable diameter. Cable should not be pulled through a length of conduit exceeding 30m (100 ft.) Limit 90º bends in conduit to 2

- Support cables every 4 - 5 ft. (1200mm - 1500mm), Avoid sharp objects, turns and corners.

- Use a pulley or a third man at turns and corners; Do not "jerk" cable

- Excessive compression of the cable adversely affects the cable's characteristics both physically and electrically. To prevent unwanted compression of the cable installer should avoid stepping on the cable; avoid the over-tightening of cable ties.

- Do not overload cable pathways – the weight of the cable bundle may crush cables underneath and possibly pull the pathway away from its attachment. 24 cables in a bundle are safe. Pull all cable at same time, if possible, Use a partner at the entry point

- Use lubricants if necessary (do not use petroleum-based), Pull in a continuous manner without stopping; Do not pull a terminated cable through the conduit.

- If pull boxes are used, pull to the first box, coil up the cable, then feed it back into the pull box and then pull through to the next one.

- Avoid laying cable near noise sources, such as; electrical wiring, electric motors, fluorescent lighting, copiers and other EMI/RFI (Radio frequency Interference) devices.

- Installing the cable in a closed metallic pathway such as conduit will help reduce the effects of EMI.

- If installed in an open or non-metallic pathway, maintain a minimum distance of 130mm away from fluorescent fixtures, including ballasts.

- Avoid areas where the cables will be exposed to high temperatures, such as lighting, heat, open flame, etc. High temperatures affect attenuation

- Avoid laying cable in areas with excessive moisture such as damp basements and areas where steam will form condensation on the cable.

- When pulling the cable avoid twisting it. Use a grip or a pull string attached to a swivel to minimize any twists and avoid putting any kinks in the cable.

- Shielded cables are essentially immune to alien crosstalk and may be bundled according to customer requirements. UTP cables should be randomised as much as possible and therefore "messy" cable runs are desirable
- Cables shall be installed in a smart way. Shall support air flow designs Less diameter – less space consumption

3.6.1 Advantages

Implementing high performance cable design in network we achieve many advantages as listed below.

1. Network efficiency- high performance, reliable, stable solution
2. Scalability- fast and easy provisioning of connectivity equals a more efficient deployment of system equipment
3. Effective overall operation
4. Minimize cabling system risks
5. Helps lower IT up gradation costs
6. Standards futuristic compliant passive infrastructure.

4. Conclusions

Network infrastructure has grown over the period of time and critical performance parameters needs to be continuously enhanced, monitored and control to achieve consistent network performance. Business Applications have become demanding; and there is a continuous need to deliver differentiated services. Cable design with lower headroom margin more prone to marginal pass or even fail results at project sites.

To cope up with above mentioned critical factors, cable design with higher headroom meeting and exceeding ANSI /TIA-568.C.2 Horizontal link performance margin, will enable passive network for its suitability to address present and future business communication needs.

Unstructured and less efficient Cable connectivity leads to multiple challenges includes -Diminished data center availability, Inability to manage system growth, Hindered data center performance scalability, Excessive data center heat buildup, Constraints on capacity growth

Also overfilled containments /pathways cause problems with airflow. This is particularly true in point-to-point systems that have grown into spaghetti-like conditions over time.

We can conclude here that lower category cables cannot be recommended for new installation. Higher headroom minimum Category 6A onwards design should be implemented in data center for robust and scalable cabling infrastructure that will enable IT managers to spend less time in fault management and concentrate more on important business activities.

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