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How To Properly Maintain A Fiber Optic Infrastructure

Best Practices to Minimize Damage and Failures in Fiber Optic Infrastructures

White Paper

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In today's IT environment, many elements like high speed internet, streaming video, social networking, mobile devices, government regulations, virtualization, network based security, building automation and collaboration are all driving an explosion in information content that needs to be processed and stored. This ever increasing acceleration in information being generated, processed and stored is at the highest point in history. This trend is shifting the dynamics of how networks are being designed and implemented. One of the major shifts, especially in the data center space, is the ever increasing migration to fiber optic infrastructure to accommodate the thirst for higher bandwidths, densities and application support.

For years, fiber optic media has been utilized in the IT space, however, its presence and role within the data center space is rapidly changing. Traditionally, fiber optic ports were used primarily in the core areas of the data center to handle the aggregation of multiple copper uplinks. However, in today's data center environment fiber ports are now used all the way out to the server level and are replacing those longer copper uplinks. This new dynamic is vastly increasing the number of fiber ports and thus fiber links being deployed in the data center space today. In addition to the increasing number of fiber ports, there is also a fast growing trend of utilizing preterminated fiber solutions in the data center space. With this changing landscape within the infrastructure comes a need for better focus and education on the proper way to maintain these fiber optic links.

While there has always been a need to ensure that optical fiber ports are clean and free from contamination, the reality is that up until now there has really never been any true industry standard or guidance on how best to do this and so everyone just adopted their own processes and procedures. In many cases, those processes and procedures were either lacking in "best practices" or ignored all together. So, why now is it more urgent to address this issue? We now have International Electrotechnical Commission standard IEC 61300-3-35 that emphasizes proper cleaning and outlines acceptance criteria for inspection and testing of optical fiber components. This standard is also referenced in TIA-568-C.0-2, which was approved in February, 2012. TIA-526-14-B, TIA-526-7 and TIA-568-C.0 standards all give recommendations on proper cleaning, inspection and testing of optical components and systems. For example, according to TIA-568-C.0 Annex E.4: "Several precautions should be taken when measuring the performance of optical fiber cabling. Some of these precautions include:

- Ensuring that all connectors, mating adapters, and test jumpers or launch fibers are **clean prior to and during the test measurement**.
- Ensuring that all test jumpers are **verified** per clause E.5.1.2.
- Using test jumpers that are of **acceptable quality** as they are subject to heavy use. Replace test jumpers when no longer meeting the criteria established in clause E.5.1.2.
- Keeping endface **inspection equipment** nearby to help ascertain connector quality."

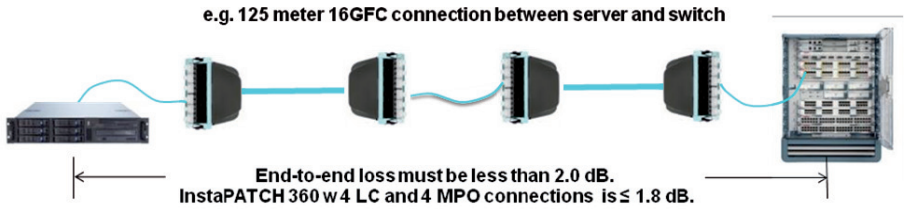
To further understand why there is an urgent need for better education and focus on the installation and maintenance of these fiber optic systems we simply need to look at the limitations of the applications these links are being designed to support. All optical applications have an associated "link loss" budget, which is derived from the overall "power budget" for those specific applications. When we look at how those link loss budgets have evolved over time, it becomes very apparent that the trend in loss budgets is on a consistantly downward slope. See tables 1 and 2 for reference.

TABLE 1

Application Ethernet	62.5um (OM1) Loss Budget @ Max. Dist.	50um (OM2) Loss Budget @ Max. Dist.	50um (OM3/OM4) Loss Budget @ Max. Dist.
10BASE-FL (850 nm)	12.5dB @ 2000m	7.8dB @ 2000m	7.8dB @ 1600m
100BASE-FX (1300 nm)	11.0dB @ 2000m	6.0dB @ 2000m	6.0dB @ 2000m
10/100BASE-SX (850 nm)	4.0dB @ 300m	4.0dB @ 300m	4.0dB @ 300m
1000BASE-SX (850 nm)	2.6dB @ 275m	3.6dB @ 550m	4.5dB @ 800m
10GBASE-SR (850 nm)	2.4dB @ 33m	2.3dB @ 82m	2.6dB @ 300m
40GBASE-SR4 (850 nm) and 100GBASE-SR10 (850 nm)	Not Supported	Not Supported	1.9dB @ 100m OM3 1.5dB @ 150m OM4

TABLE 2

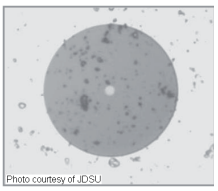
Application Fibre Channel	50um (OM3) Loss Budget @ Max. Dist.	50um (OM4) Loss Budget @ Max. Dist.
1GFC	4.6dB @ 860m	4.6dB @ 860m
2GFC	3.3dB @ 500m	3.3dB @ 500m
4GFC	2.9dB @ 380m	3.0dB @ 400m
8GFC	2.0dB @ 150m	2.2dB @ 190m
16GFC	1.9dB @ 100m	2.0dB @ 125m



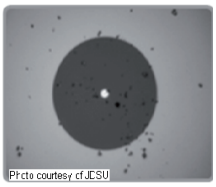
So, as can been seen from the above tables, when migrating from a 10BASE-FL application all the way to the 10GBASE-S application on 62.5um the decrease in link loss budget is 10.1dB. On the newer OM3/OM4 fibers the decrease is at least 5.2dB. When migrating to the newest 40/100GBASE-SR applications the decrease in link loss budget on the OM3/OM4 fibers is 5.9dB. These large decreases in overall link loss budgets makes cleanliness of the fiber optic components and ports a much more critical issue today than in the past.

For example, in the past if the application being deployed was 100BASE-FX and this was running on a 62.5um fiber infrastructure the link loss budget was 11.0dB. If an installer or technician installed patch cords without cleaning them and those cords were contaminated they might have added an additional 2dB – 3dB of attenuation to that channel, which would only represent a small percentage,18% - 27% of the overall budget. That channel could still work fine as long as the overall budget and distance were not exceeded. On the other hand, if today a 10GBASE-S application is being deployed over the OM3/OM4 fiber and an installer or technician installs a patch cord without cleaning and that cord is contaminated that same 2dB – 3dB of additional attenuation would represent a large percentage, 76.9% - 115% of the overall budget and that link may not operate. The contamination from those dirty patch cords can also lead to permanent damage to the fiber end-faces, which would lead to further down time and replacement costs.

Fiber cleaned by installer during installation



Dirty patch cord plugged in by end-user after installation



Installed fiber cross contaminated by dirty patch cord after installation

For this reason, it is imperative that "best practices" procedures be adopted not only by the installation contractors, but also by the end-user. While business partners/contractors go through training programs that teach them how to properly install, clean and test fiber optic infrastructures, if the end-user does not implement those same policies for the daily maintenance of those systems, the systems can quickly become unusable. This can create a strain on the relationships between end-users, contractors and manufacturers, because, if a system fails who ultimately is to blame? So, to minimize this issue everyone should be responsible for adopting and implementing the following best practices guidelines for installing and maintaining fiber optic infrastructures.

Best Practices

1. Always clean every fiber optic component before installing or using it. **NEVER** assume anything is clean!! This holds true for all "**pre-term**" fiber components, i.e. factory made patch cords, fiber modules, crimp on connectors and trunk cables. See CommScope's current "Cleaning Procedures" guide for proper cleaning techniques.

2. **NEVER** assume that dust covers or shutters will keep the connectors and ports clean!!

3. Per the IEC 61300-3-35 standard all fiber connectors shall be cleaned and **inspected** before they are connected into the system. The inspection equipment shall have a means to measure and quantify defects regardless of the method being used. If the inspection of the connector yields results that are below the acceptance criteria outlined in section 5.4 tables 3 – 6, additional cleaning is required and a final inspection. If final inspection still yields unacceptable criteria the connector is to be replaced. For complete details the standard can be purchased at www.webstore.ansi.org

4. When installing multifiber components, like MPO modules or connectors, in addition to cleaning make sure to inspect the MPO ports inside the module or the MPO connector on the cable with an inspection scope or probe before mating the modules and trunk cables. If contamination is present re-clean and then re-inspect. With a multifiber connector there is a higher potential of contamination. Also with more fibers per connector more channels may be affected, so inspection is critical.

5. For new installations, make sure to test the fiber optic links per the CommScope testing guidelines and make sure to use quality "reference grade" launch cords that have been cleaned and inspected.

6. When performing routine moves, adds or changes always make sure to clean any patch cords that have been unplugged prior to plugging them back in. Also, clean the connector on the back side of the adapter before putting it back into service.

7. Any unused ports or connectors should be protected with a dust cap or shutter device. These devices will not prevent the connectors or ports from getting contaminated, but will minimize the contamination and prevent the connectors from getting damaged.

8. Before adding additional connection points into an existing link, make sure to verify the extra attenuation can be supported. See CommScope's current version of "Performance Specification" document for guidance.

Maintenance Supplies

To properly install and/or maintain a fiber optic infrastructure the following items should be purchased and kept on hand.

1. An inspection kit with proper inspection scope and/or probe along with the proper adapters for each connector style being used, i.e. MPO, LC or ST/SC. The inspection device needs to have the ability to measure and quantify any defects. For example, CommScope's inspection kit, "KIT-Clean/Inspect"

2. Cassette based cleaner which utilizes an "anti-static" non-contaminating cloth. For example, USConec Optipop Cassette Cleaner (www.usconec.com)

3. In-bulk-head or in-adapter cleaning tools for the appropriate connector styles being used, i.e. MPO, LC or ST/SC. For example, USConec I.B.C (www.usconec.com)

4. Appropriate cleaning solution for "fiber connectors", such as > 92% isopropyl alcohol

5. Optical loss test set to measure end-to-end link loss

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