

Touching on Failure: Sources of Fiber-Optic Network Issues in the Data Center

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THE BIGGEST CAUSES OF FAILURE

What are the biggest causes of fiber-optic network failure in the data center? Study after study shows that they are:

- 1) connector contamination
- 2) connector damage

In one example, a study conducted by NTT-Advanced Technology, 96% of installers and 80% of network operators have experienced issues with contamination of the connector endface. What's more, 81% of fiber network installers and 39% of network operators have had to deal with issues caused by damage on the ferrule endface. Other issues mentioned are defective splicing and excessive bending on the cable.

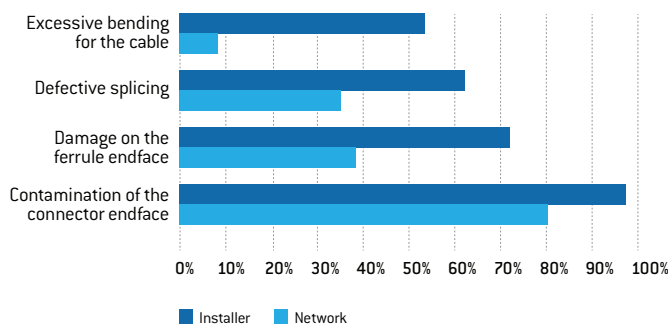


Figure 1. Connector cleanliness, contamination and damage is the greatest cause of fiber-optic network failures—Study conducted by NTT-Advanced Technology

INSTALLATION PRACTICES

The NTT-Advanced Technology study is interesting because it clearly shows that the first three problem categories (excessive bending, defective splicing, and ferrule endface damage) are linked to fiber network installation practices.

Only 8% of the excessive bending issues were reported after network installation. This indicates that when best practices are used during installation, there is little chance for this parameter to become an issue during network operation.

SPLICES

But it comes to defective splicing and ferrule endface damage, slightly less than 40% of the case issues were reported during network operation. This statistic makes a lot of sense. In enterprise and data centers networks, splices are often located closer to the connector and this is the section of the fiber-optic network with the greatest risk for faulty manipulation during the operation of the network.

SCRATCHES AND CONTAMINANTS

What about damage on the ferrule endface? Here, scratches of different sizes crossing the mode field diameter (MFD) of the core can result in catastrophic failure. Manipulations can cause splices to degrade and the ferrule endface to be damaged. This in turn influences the main cause of fiber-optic network failure: connector endface contamination. Why? Because manipulation is the most frequent source of connector contamination during fiber network installation and operation. Multiple types of contaminants can appear, with the most likely being dirt, dust, alcohol residues and oil contamination.

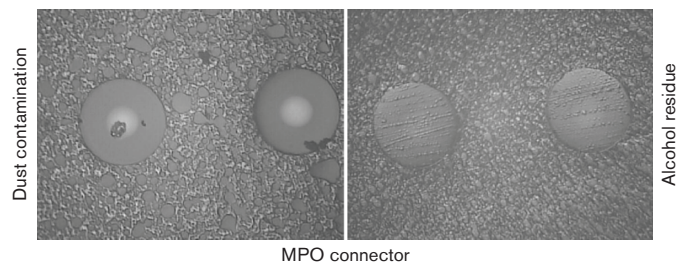
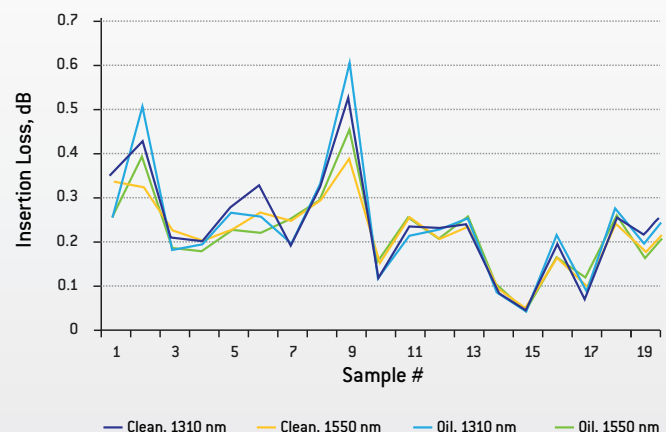


Figure 2. Contaminations on multimode MPO connector magnified at 400X

PAY CLOSE ATTENTION TO SKIN OIL CONTAMINATION

Oil contamination is a frequent fiber-optic network disruptor. Unsurprisingly, the main source on a connector endface is skin oil from fingers—the same fingers that are handling the connector!

According to a study performed by INEMI, the Fiber Connector End-Face Inspection Project, the application of oil contamination on connector endfaces resulted in significant changes in return loss (RL): an average of 10-12 dB clean versus oil. But there were no significant changes in insertion loss (IL). Most important, the impact of oil contamination on the RL showed significant degradation in bit error rate test (BERT) performance at 10 Gbit/s.



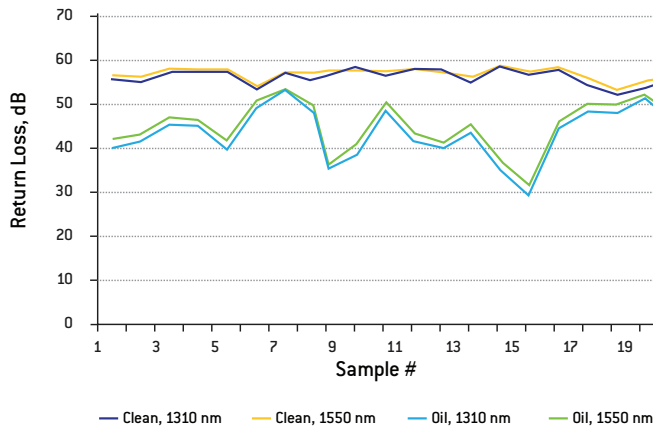


Figure 3. Impact of oil contamination on IL (minimal) and RL (10-12 dB)

THE FIBER FAILURE CHAIN

A very simple chain of events can be established between dirty connectors, damaged ferrule endfaces and poorly mated connectors (especially multifiber push-on MPO connector ferrules). They all share root causes and impacts on a fiber-optic network.

Problems with dirty or broken connectors start during network installation, when proper fiber inspection, cleaning and testing are not specifically required to prove a job is finished first-time right. When the job is done first-time right, the operation of the network will start smoothly. But poorly handling connectors in a transceiver line rate upgrade on another section of the network can introduce contaminants or result in damaged splicing on the connector endface, if these manipulations are not performed diligently. Most of the time when this type of situations occurs, it can be explained by a lack of technician training or limited experience with fiber optics.

INSERTION LOSS AND RETURN LOSS

Dirty or damaged connectors will increase insertion loss and return loss. In some cases, a combination of both loss types will result in additional modal and reflection noise or intersymbol interference. In other cases—for instance, oil contamination, insertion loss will be minimally affected but a significant change in return loss will degrade bit error rate (BER) and affect user service.

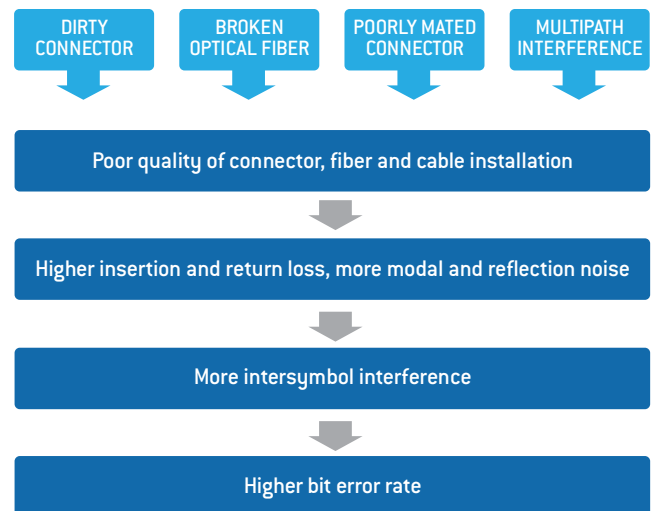


Figure 4. Chain of events leading from dirty, damaged connector endface to higher BER

Most of the documentation and surveys cited in this application note are based on fiber-optic networks running at 10 Gbit/s on direct detection-based transmission. The advent of line rates at 25, 50 and 100 Gbit/s for direct detection and coherent-based transmission and the increase in the adoption of MPO/MTP connectors with one or two rows of fibers will not improve this situation. It is easy to extrapolate that the higher the number of rows on a MPO/MTP connector and the faster the line rate, the greater the issues. More work must be done to validate and specifically quantify these impacts in the near future.

In the meantime, the following considerations are proposed:

1. For trouble-free fiber-optic performance, connector cleanliness and mating quality must be validated and documented.
2. The return loss specification on connectors, especially for non-angled multimode MPO/MTP ferrules, and its impact on BER for 25, 50 and 100 Gbit/s line rates, must be more scrutinized by the industry.

References

How confident are you about your connector cleanliness?—Lightwave magazine, May 2014
www.lightwaveonline.com/articles/2014/05/how-confident-are-you-about-your-connector-cleanliness.html

Fiber Optic Connector End Face Quality and Maintenance—US Conec, 2012
www.bicsi.org/uploadedfiles/pdfs/presentations/fibre%20optic%20connector.pdf

Optical Connector Contamination and its Influence on Optical Signal Performance—INEMI, Fiber Connector End-Face Inspection Project, May 2007
<http://thor.inemi.org/webdownload/projects/opto/Signal%20Performance.pdf>