

OFCNFOEC-2007 WORKSHOP

40Gb/s Networks and the PMD Challenge

Will PMD allow the world existing fiber plant to support 40Gb/s DWDM upgrades?

What is the market impact of PMD?

Chairman & Organizer: Sergio Barcelos, PhD
FiberWork Optical Communications

Monday, March 26th 2007, 8.00am – 11.00am
Ballroom B
Anaheim Convention Center

Title: Opening Remarks
Chairman & Organizer: **Sergio Barcelos, PhD**
Affiliation and contact details: FiberWork Optical Communications
sbarcelos@fiberwork.net

Summary of the Workshop:

We are currently seen a major move towards 40Gb/s line interfaces, pushed by some router manufacturers. Thus, DWDM transport shall have to follow swiftly. Polarization Mode Dispersion (PMD) has been a stringent parameter for 10Gb/s and is set to be the most though challenge at 40Gb/s DWDM transmission. On the other hand, the world installed fiber base is large, with a great portion of it built during the fiber market boom period (1997-2001). New major fiber constructions are not expected again for the next few years due to the current overcapacity, at least in the long distance market sector. So, 40Gb/s DWDM transmission must tolerate PMD impairments as currently seen in the field rather than as idealized in laboratory demonstrations. However, it is clear that the extent of the world PMD problem has not yet been recognized as most PMD-impaired fiber networks are still operating at low channel rates and/or at low DWDM channel counts. Some questions then arise: What is the volume of high PMD fibers installed around the world? How much of today's world fiber plant can support 40Gb/s transmission? What is the average PMD level of the world fiber plant? This workshop will address these questions, which shall benefit telecom operators and equipment manufacturers enormously. Presenters will show their findings in different regions of the world, then allowing deriving a better perspective of the global PMD problem. A teaser talk pointing out the motivation behind the 40Gb/s push and reviewing solutions for alleviating the PMD impairment (new modulation techniques, PMD compensation, forward error correction, selection of best installed fibers for upgrade) is also planned. Interested presenters should contact the organizer.

Workshop Description:

High PMD means that carriers will find problems in exploiting high transmission rates per DWDM channel, then limiting the future of their fiber networks. Moreover, as PMD induces higher bit error rates, OSNR margins become lower and, therefore, less DWDM channels can be lit in high PMD fibers. Forward error correction can alleviate the PMD problem but only to a certain extent. PMD compensators can also be used but at the cost of bringing complexity and higher investments for the network. New coding schemes can narrow down the modulation bandwidth, thus allowing transmission of higher data rates through high PMD fibers, but this is a limited resource too. Specialized diagnostics of the installed fiber plant can identify best fibers and provide a sequence of span intercalations through "picking the wheat out of the chaff". Eventually, replacing the network with newer lower PMD fibers may turn to be the alternative of choice when looking towards a higher bit rate future, but this may sound outrageous for the carrier finance department.

Around 1997, a common conference discussion was "N x 10Gbs channels *versus* 4N x 2.5Gb/s channels – which solution would be technically and economically more feasible. Most bets were on DWDM systems

with 2.5Gb/s channels, meaning 4 times more channels to supply a certain bandwidth. The number of advantages for this option was expressive. Even so, what seemed fewer advantages was enough to bring the 4th placed DWDM market competitor to a first position in just 6 months after releasing its 10Gb/s per channel DWDM solution. Nowadays, that discussion is over. OC-48 and OC-192 DWDM systems and line interfaces are practiced at similar prices, although technical requirements can still push towards one or the other solution, depending on specific fiber plants and customer requirements.

The current battle, “N x 40Gbs channels *versus* 4N x 10Gb/s channels”, is tougher as requirements on OSNR, chromatic dispersion compensation and PMD impairment becomes much tighter and more critical at 40Gb/s. However, “N x 40Gb/s” has its advantages too and can well be the winner. PMD will though be its hardest challenge! While successful 40Gb/s DWDM transmission has so far been a matter of idealized laboratory demonstrations, the actually installed fiber plants are, unfortunately, a bit far from that ideal world.

This workshop is planned to start with a teasing talk, which may address the cost impact of PMD on 40G deployment fair or discuss the “N x 40Gb/s *versus* 4N x 10Gb/s battle”, pointing out the advantages and drawbacks of each alternative. Next, renowned professionals from different regions of the world (USA, UK, Europe, Japan, Asia, South America), who have been involved with PMD characterization of installed fiber plants and who are backed by great amounts of PMD field results, will talk about their findings.

As an ending talk, it has been planned a review of the alternatives for alleviating the PMD impairment (such as new modulation techniques, PMD compensation, forward error correction, and selection of best installed fibers for upgrade). Opening and ending talks are to be teasing presentations only as the main workshop focus is to derive a clear view of the PMD levels in today’s world installed fiber plant.

Biography:

Dr. Sergio Barcelos obtained his PhD degree in optical fiber communications at the Optoelectronics Research Centre, Southampton, United Kingdom, in 1995; his Master degree in coherent optical communications at the Faculty of Electrical Engineering, Unicamp, Brazil, in 1991, and his electronics engineering degree at the Aeronautics Institute of Technology, ITA, Brazil, in 1987. He is the founder of FiberWork Optical Communications Ltd., a company specialized in developing innovative fiber optic products. He has worked with Alcatel, Brazilian Research and Development Center for Telecommunications, Dept. of Communications of the Faculty of Electrical and Computing Engineering, Unicamp, Brazil. Dr. Barcelos has been the coordinator of the work group on optical network elements of the Brazilian National Association for Technical Standards and is member of the IEEE/ComSoc & IEEE/Leos societies. He was the founder and the president of the first OSA international Student Chapter at Southampton University, UK. Dr Barcelos has got over 45 publications in journals and conferences worldwide, 3 international patents and a British award for invention in fiber optics ("Metrology for World Class Manufacturing Award"). Dr. Barcelos links a profound and broad R&D background with strong experience in the real world applications of optical communication technology. His expertise covers subjects as: DWDM & CWDM optical networking, 40Gb/s transmission, impairments in optical communications, chromatic dispersion and dispersion compensation techniques, Polarization Mode Dispersion (PMD), fiber non-linearities, optical losses, fiber amplification technologies, optical components, sub-systems and systems, fiber metrology, fiber network field diagnosis, fiber plant supervision, availability and reliability of fiber optic networks, optical protection technologies, FTTH/FTTP, FTTN, SONET/SDH, HFC/CATV networks, GBitEthernet, fiber LAN technologies, fiber sensors etc..

In the last 8 years, Dr Barcelos has been involved in characterizing more than 800,000km of installed fibers. His results have been published in different conferences and magazines (IEEE, NFOEC etc). He firmly believes the world PMD problem is been underestimated while new technologies are been discussed by vendors and the R&D community based on idealized network demonstrations. He believes there is an urge for a broad and fair discussion of this matter.