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Detailed Analysis of Multi-Mode Optical Fiber Infrastructures for Data Centers

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Abstract : With the exponential growth of social networks, video streaming and increasing demands on data rates, the number of newly built data centers rises proportionately. The data centers, however, have to adjust to the rapidly increased amount of data that has to be processed. For this purpose, multi-mode (MM) fiber based infrastructures are often employed. It stems from the fact, the connections in data centers are typically realized within a short distance, and the application of MM fibers and components considerably reduces costs. On the other hand, the usage of MM components brings specific requirements for installation service conditions. Moreover, it has to be taken into account that MM fiber components have a higher production tolerance for parameters like core and cladding diameters, eccentricity, etc. Due to the high demands for the reliability of data center components, the determination of properly excited optical field inside the MM fiber core belongs to the key parameters while designing such an MM optical system architecture. Appropriately excited mode field of the MM fiber provides optimal power budget in connections, leads to the decrease of insertion losses (IL) and achieves effective modal bandwidth (EMB). The main parameter, in this case, is the encircled flux (EF), which should be properly defined for variable optical sources and consequent different mode-field distribution. In this paper, we present detailed investigation and measurements of the mode field distribution for short MM links purposed in particular for data centers with the emphasis on reliability and safety. These measurements are essential for large MM network design. The various scenarios, containing different fibers and connectors, were tested in terms of IL and mode-field distribution to reveal potential challenges. Furthermore, we focused on estimation of particular defects and errors, which can realistically occur like eccentricity, connector shifting or dust, were simulated and measured, and their dependence to EF statistics and functionality of data center infrastructure was evaluated. The experimental tests were performed at two wavelengths, commonly used in MM networks, of 850 nm and 1310 nm to verify EF statistics. Finally, we provide recommendations for data center systems and networks, using OM3 and OM4 MM fiber connections.

Keywords : optical fiber, multi-mode, data centers, encircled flux
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