Bi-birectional WDM-Based Free Space Optical Communication

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The demand of the network bandwidth has been continuously growing due to the more and more demanding quality of audio and video signals as well as the popularity and wider coverage of mobile communication through the smart phones and tablets. Free space optic (FSO) system has become an important research issue in recent years thanks to its infrastructure flexibility whilst offering very high speed communications. FSO could be simply setup as point-to-point transmission system thus be useful to deal with the aftermath of a natural or artificial disaster where the building, infrastructure or bridges are damaged and hence optical fiber networks. FSO system offers a viable solution to solve the communications interruption problem easily.

In this talk, the impairment of free-space optical communication due to various environmental factors along the transmission path including the oblique incidence through the building window glasses, thermally induced non-uniform air index, and the rainfall on the FSO performance are investigated and analyzed. Then, two system demonstrations will be presented:

Firstly, we will present the experimental results of the bi-directional 2x40 Gb/s WDM FSO system. For the short distance transmission within several tens of meters, it is found that the transmission loss is acceptable with a linear relationship versus distance when the fiber links in the system use the single-mode-fiber components directly. The power penalties of the bidirectional WDM communication is 0.75 dB compared with the back-to-back unidirectional single-channel system. Secondly, we will discuss on the hybrid system combining fiber optics and FSO in a bidirectional cross-bridge communications sub-system. The FSO is used for emergency link, offers a solution to resolve the problem of communication disruption caused by natural/artificial disasters, such as bridge collapsed due to a hurricane, hence the fiber communications is interrupted. If the fiber was broken due to bridge collapses, we could switch the signals to the FSO system immediately. A 10 Gb/s per channel data rate over fiber span is experimentally demonstrated to verify and evaluate the system performance by measuring the overall bit error rate (BER), eye-diagram and optical signal-to-noise ratio with good performance. In addition, a fiber-Bragg-grating sensor head is integrated to the subsystem to monitor the bridge's condition for routing operation.