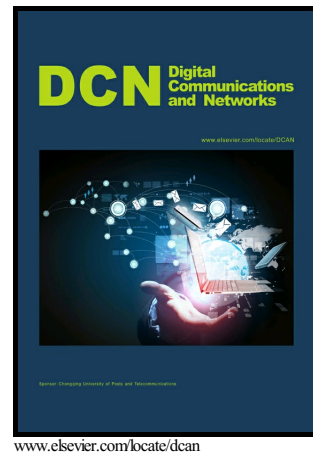


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In Keun Son, Shiwen Mao



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# A Survey of Free Space Optical Networks

In Keun Son<sup>b</sup>, Shiwen Mao<sup>\*,a</sup>

<sup>a</sup>Department of Electrical and Computer Engineering, Auburn University, Auburn, AL, USA

<sup>b</sup>Defense Acquisition Program Administration (DAPA), Republic of Korea

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## Abstract

Free Space Optical (FSO) networks, also known as optical wireless networks, have emerged as viable candidates for broadband wireless communications in the near future. The range of the potential application of FSO networks is extensive, from home to satellite. However, FSO networks have not been popularized because of insufficient availability and reliability. Researchers have focused on the problems in the physical layer in order to exploit the properties of wireless optical channels. However, recent technological developments with successful results make it practical to explore the advantages of high bandwidth. Some researchers have begun to have eyes for the problems of network and upper layers in FSO networks. In this survey, we classify prospective global FSO networks into three subnetworks and give an account of them. We also present state-of-the-art research and discuss what kinds of issues have to be challenged.

*Key words:* Wireless access networks; Free space optical networks; Free space optical communications; Network architecture; Optical wireless networks; Satellite networks.

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## 1. Introduction

Free Space Optical (FSO) networks, namely optical wireless networks, are wireless telecommunication systems that make use of free space as a transmission medium to deliver optical data signals at high bit rates. FSO research has started in the 1960s. The National Aeronautics and Space Administration (NASA)'s Deep Space Optical Communications Project "is to develop key technologies for the implementation of a deep space optical transceiver and ground receiver that will enable greater than 10X the data rate of a state-of-the-art deep space RF system (Ka-band) for similar spacecraft mass and power [1]." The European Space Agency (ESA) has started funding various FSO projects since the summer of 1977, aiming to develop high-data-rate laser links in space. Although optical wireless links can provide high data rates, FSO communications have not prevailed so far in spite of a long investigative history. As new advances are made in optics and communication devices, there has been renewed, increasing interest in analyzing and enhancing wireless optical links and adopting FSO technology for wireless access networks. Recently, successful experimental results [2] have demonstrated the feasibility of FSO communications. Researchers at the German Aerospace Center have demonstrated FSO data transmissions at 1.72 terabits per second

across a distance of 10.45 km [3]. The FSO network could become a viable candidate for use in broadband wireless networks of the next generation.

Wireless communications have beneficial properties not found in wired communications, such as the lower deployment cost due to the lack of having to ditch and lay down cables, ease of construction of network topology, flexible maintenance of operating networks, and so on. Wireless communications also allow users of mobile devices to access the Internet at any time and many locations. For instance, IEEE 802.11 ("Wi-Fi"), Bluetooth, and IrDA are intended for short-range wireless data communications [4], while Long-Term Evolution (LTE) is for long-range wireless communication for both mobile phones and data terminals [5]. As the number of mobile devices continues to increase, leading to the establishment of ubiquitous networks, wireless communication service are now indispensable to many people, like water and electricity supplies. Therefore, the volume of data traffic carried on wireless network is fast growing at unprecedented speed. In addition, data sharing in various multimedia services, like AOD (Audio On Demand), VOD (Video On Demand), and P2P (Peer-To-Peer) stimulates the necessity of higher data rate networks.

To meet high demand for wireless capacity, radio-based wireless communications have enjoyed widespread use to this point, but have limitations on scalability and bandwidth. For example, there are considerable technical problems in Wireless Local Area Networks (LANs), one of the major wireless access technologies, which limit the support of an ever-increasing volume of data services. In particular, wireless LANs suffer from (i) low end-to-end through-

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*Email addresses:* soninkeun@gmail.com (In Keun Son), smao@ieee.org (Shiwen Mao)

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