Input to NSF NeTS Free Space Elastic Optical Networking Program

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1. Challenges and Opportunities of FSO

Free space optical (FSO) [1] communications can simultaneously support very high communication capacity and mobility at the same time. The key benefits of FSO compared to RF communications are (a) vast spectral bandwidth, (b) license-free spectrum, and (c) robustness to interference. The key benefits of FSO compared to optical fiber communications are support of (a) mobility and (b) flexible reconfigurability of communication topologies. However, practical and widespread deployment of FSO faces a large number of challenges: (1) channel outage and fading (due to turbulence and scintillation) problems, (2) lack of effective mechanisms for point, acquisition, and tracking (PAT), (3) scalability of control planes for adaptive network reconfiguration methods, (4) effective congestion-avoidance schemes, (5) lack of inexpensive and robust photonic integrated circuit technologies for FSO, and (6) lack of interdomain networking architectures and protocols for FSO.

2. Necessary Research for FSO

Possible research elements necessary for FSO networks are: (1) non-mechanical pointing and tracking with extremely high accuracy and sharp focus in support of low-power and high-fidelity communication across long distance without resorting to bulky mechanical beam steering, (2) interdomain FSO network framework (network control and management) interoperating with heterogeneous networks (this can be software defined network framework but must address multidomain networking with heterogeneous networks), (3) situation-aware and adaptive FSO networking algorithm that flexibly optimizes resource and bandwidth allocations (similar to flexgrid or elastic optical networking for FSO), (4) the electronic-photonic integrated circuits provide power-efficient and adaptive high-capacity communications in support of intelligent power resource management for given link conditions and communication capacity needs, (5) novel coding methods for optical MIMO and spatial/spectral/temporal diversity overcoming scintillation, turbulence, and other challenges.