White Paper: Programmable Optical Systems in Future Wireless Cities

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Optical systems are increasingly making their way into edge network applications as flow sizes and aggregate traffic volumes continue to rapidly increase. The approach of designing optical systems as 'fat pipes' is no longer scalable. They need to be included in the programmable communication infrastructure of the future Internet. Unfortunately today these optical transmission and switching systems use closed, proprietary control and enable very limited programmability from the outside. My research group is focusing on two areas: 1) opening up the control of optical systems to make them fully, deeply programmable and 2) developing software controls and control architectures for emerging integrated photonic devices. A key question for these technologies is what level of control and detail should be passed to the higher layers/applications—what abstractions should we apply to the optical physical layer? This is a balance between added flexibility for control versus control complexity and the potential for instability. The capabilities enabled by programmable optical systems and emerging photonic integrated devices will be essential for 5G wireless, in which traffic in the fronthaul as well as the backhaul will require optical capacities with the agility to follow traffic variations between base stations, antenna sites, and cloud (C-RAN) infrastructure. I'm also interested in using programmable optical systems to support 'network operating systems' in smart cities. Projects such as TOUCAN/open Bristol in the UK show the potential for SDN enabled optical systems to support a wide range of smart services and I'm currently consulting with the New York City government (DoITT) on their network planning.

At the University of Arizona I have built the Transparent Optical Access Networks (TOAN) testbed, which is uniquely equipped to study SDN and programmability for optical systems. In particular, my group is working on new methods to emulate large networks in a laboratory environment. The control complexity and application interfaces in programmable systems make traditional long haul experimental techniques (i.e. recirculating loops) problematic. Our new methods are compatible with SDN control and can emulate the essential physical behavior to prove-in programmability in the physical layer. Our work is supported by the Center for Integrated Access Networks (CIAN) and the DOE and we would like to see these new methods incorporated into other SDN testbeds.

Prior to joining the faculty at the University of Arizona as a tenure equivalent research professor, I spent 13 years at Bell Labs. Although my background is optics, I've worked closely with experts on wireless networks, particularly in the area of energy efficient networking and smart cities. I understand optical systems and their connection with wireless networks at a very practical level as well as from a research perspective. My research was recently highlighted in a Royal Society workshop on 'Communication Networks Beyond the Capacity Crunch'. I was also the lead organizer of the NSF workshop on Scaling Terabit Networks. I have a research leadership and administrative role in the NSF CIAN center and have had leadership team roles in international academic and industry research centers including the Center for Energy Efficient Telecommunications (CEET), CTVR1&2, and GreenTouch. I have authored more than 100 peer reviewed publications, including four book chapters.

I would like to request travel reimbursement.