

# Programming Languages for Programmable Networks

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## Abstract

Today's computer networks perform a bewildering array of tasks, from routing and access control, to traffic monitoring and load balancing. To support wireless users accessing services hosted in the cloud, enterprise and data-center networks are under increasing pressure to support client mobility, virtual-machine migration, resource isolation between cloud services, and energy-efficient operation. Yet, network administrators must configure the network through closed and proprietary interfaces to heterogeneous devices, such as routers, switches, firewalls, load balancers, network address translators, and intrusion detection systems. Not surprisingly, configuring these complex networks is expensive and error-prone, and innovation in network management proceeds at a snail's pace.

During the past several years, the networking industry and research community have pushed for greater openness in networking software, and a clearer separation between networking devices and the software that controls them. This broad trend is known as *Software Defined Networking* (SDN). A hallmark of SDN is having an open interface for controller software running on a commodity computer to install packet-processing rules in the underlying switches. In particular, the *OpenFlow* protocol (see [www.openflow.org](http://www.openflow.org)) has significant momentum. Many commercial switches support OpenFlow, and a number of campus, data-center, and backbone networks have deployed the new technology.

With the emergence of open interfaces to network devices, the time is ripe to rethink the design of network software, to put networking on a stronger foundation and foster innovation in networked services. The programming languages community can play a vital role in this transformation, by creating languages, compilers, run-time systems, and testing and verification techniques that raise the level of abstraction for programming the network. In this talk, we give an overview of Software Defined Networking, and survey the early programming-languages research in this area. We also outline exciting opportunities for interdisciplinary research at the intersection of programming languages and computer networks.

**Categories and Subject Descriptors** C.2.1 [Computer-Communication Networks]: Network Architecture and Design; D.3.0 [Programming Languages]: General

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