

Real Internet Experiments for Future Internet Services - SDX Workshop White Paper  
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Software-defined infrastructure promises Internet services that are easier to evolve, better understood, and more performant and secure. Researchers are developing components of this vision and beginning to address issues of federation and interconnection.

As we move forward, one research concern is how emerging services will coexist and interoperate with the legacy Internet, even as it evolves. User-facing Internet services will serve globally-distributed clients and have traffic traversing networks around the world. Sunk costs, distributed management, and slow evolution of protocols and devices make forklift upgrades infeasible, and so services will depend on infrastructure at mixed stages of evolution. They will depend on interoperation and interactions with legacy devices and protocols such as BGP that are known to contribute to security, performance, and availability problems for Internet services.

Researchers need to experiment and prototype solutions in this mixed setting while interacting with realistic networks and clients. However, while Internet services are subject to the topologies and policies of networks around the world, the research community has limited visibility into them and hence limited ability to model them with high fidelity. Therefore, the community needs research infrastructure that interconnects with the actual Internet, including exchanging routing protocol messages and traffic. The interconnection must be rich and configurable to suit a range of experiments, including approximating the widespread peering of cloud services.

Towards that end, we developed the PEERING testbed and have been working to expand its functionality and make it available to researchers. The testbed acts as an autonomous system on the Internet, peering with hundreds of real networks at a dozen points of presence across three continents. A researcher can grab a slice of the testbed, including dedicated public IP space, choose peers, and exchange route announcements and traffic between an experiment and the rest of the Internet. We are in the early stages of federating the testbed with related efforts in other settings, such as CloudLab's cloud emulation and Internet2's AL2S virtual wide-area network provisioning, to enable experiments that span these domains. The testbed will soon have routers online at five Internet exchange points, with plans for more.

The testbed is useful for a range of research in scope for the workshop. The authors of the SDX SIGCOMM 2014 paper used PEERING to perform proof-of-concept experiments. We are using it to experiment with systems to allow cloud tenants to take advantage of the rich interdomain connectivity of cloud providers, without requiring tenants to have networking expertise and in ways that allow providers to benefit from insight into traffic patterns.

**Background:** I am a co-operator and co-PI of PEERING. My own research has included relevant topics such as Internet exchange points, routing, and peering; and multi-cloud systems.

**Funding:** The availability of funding will not impact my decision of whether to attend the workshop. However, I would of course appreciate any funding that is available.