

# Enhancing Network Services through SDXs

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Software-defined infrastructure is having a profound effect on the way digital services are implemented and delivered. That influence is mostly invisible to end users today, but the basic technology has the potential to be profoundly disruptive all through the stack and from end to end. Today open, software-controllable switches allow network services to be implemented using a variety of technologies and architectures *within* a provider’s network, while preserving the basic network service interfaces—viz., TCP/IP/Ethernet and routing protocols, particularly BGP. However, as virtualization permeates the infrastructure, we expect that the limitations of those existing interfaces will become more and more apparent, motivating the need to extend the “waist of the network protocol stack.”

We are interested in general ways to enhance network services. Software Defined Exchanges are a likely point for this to occur. (For the purposes of this white paper, an SDX is an Internet Exchange Point that is implemented using SDN technologies—that is, a place where Internet service providers exchange traffic with other ISPs.) Certain characteristics of SDXs make them an ideal platform through which to “extend” the network layer. First, they offer sophisticated infrastructure controlled by a trusted third party. (“Trusted” because they are in a position to observe the business relationships among providers, and because they are incented to keep their customers—which are competitors with each other—happy.) As such, they have the potential to act as *arbiters* when customers’ interests conflict, and to implement functions that require *neutrality*.

Second, their *on-path* situation is ideal for offering value-added services to customers. Initial examples of such services include monitoring conformance with service level agreements and detecting/reporting wide-area outages. More aggressive examples include policing data rates and enforcing policy compliance. An extreme example would be a lightweight programmable building-block service such as *ephemeral state processing* [1]. Such a service could be of interest to network operators for management purposes [2], but also potentially to end-user applications as well. We are interested in the problems of enabling, incenting, and operating such advanced services at SDXs.

Because SDXs are positioned exactly at the points at which the Border Gateway Protocol operates, the question also arises whether they might provide services that work around some of its weaknesses. As an (admittedly blue-sky) example, it might be possible to achieve more of the benefits of secure BGP by having SDXs validate signed route advertisements—a capability that some ISPs are reluctant to deploy because of the computational resources required. An even more ambitious step would be to leverage the trusted status of the SDX by having it attest to the validity of an advertisement itself (by *signing* it) before propagating it. Since the number of SDXs is likely to be much smaller than the number AS’s, such a capability might lower the well-known barriers to reaping the benefits of secure BGP deployment.

(Jim Griffioen is a collaborator on this work.)

**Author background:** Ken Calvert has more than 20 years’ experience with internet architecture. He is a participant in the Internet Architecture Board’s stack evolution program. With his students and colleagues, he has designed and implemented various extensions to the network layer functionality over the last 15 years, include concast (a programmable inverse multicast service) and ephemeral state processing (a scalable building-block service supporting a very lightweight form of in-network service). More recently they have explored ways to *refactor* network functionality, especially routing and forwarding, to expose and align incentives among stakeholders and customers. He is co-PI on a current NSF EAGER project (with PIs Jim Griffioen and Tilman Wolf, and Anna Nagurney) that explores economic aspects of SDXs.

## References

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- [3] M. O. Ascigil, K. Calvert and J. Griffioen, "On the Scalability of Interdomain Path Computations", *Proceedings of the IFIP Networking Conference* (Networking 2014), Trondheim, Norway, June 2014.