SDX: A Software-Defined Internet Exchange

Arpit Gupta, Muhammad Shahbaz, Laurent Vanbever, Nick Feamster, Jennifer Rexford, Scott Shenker, Russ Clark

Limitations of BGP

- Routing only on destination IP prefix
  - No customization of routes by application, sender
- Influence only over neighbors
  - No ability to affect end-to-end paths
- Indirect expression of policy
  - Indirect mechanisms to influence path selection (e.g., local preference, AS path prepending)

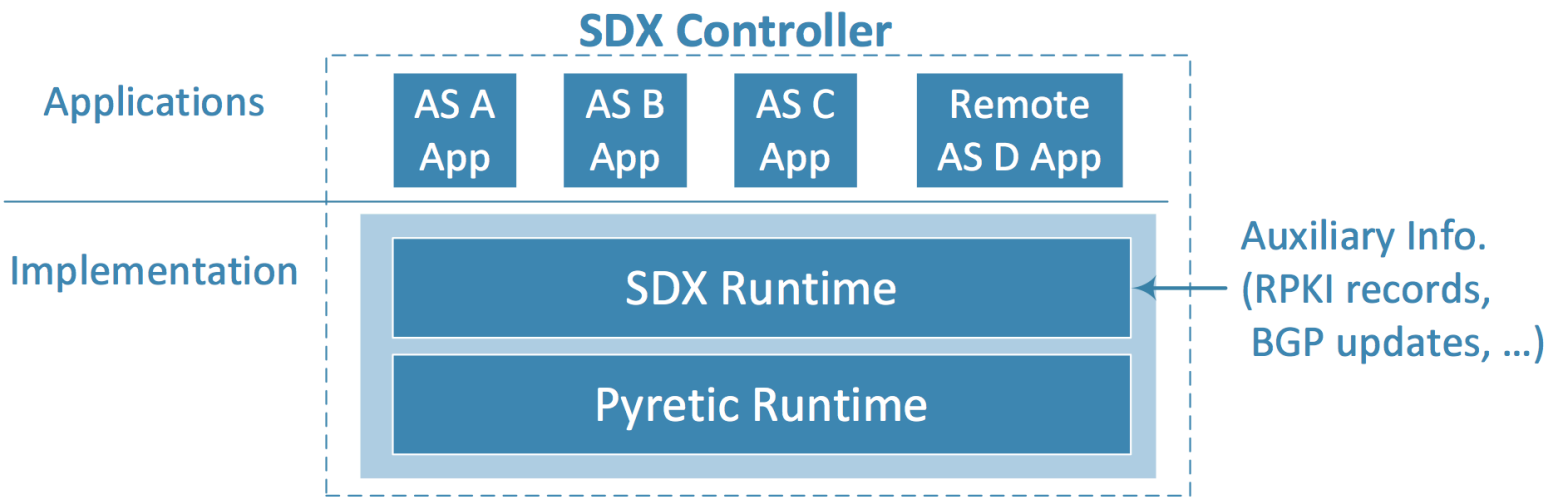
SDX: Evolution at Internet Exchanges

- New technology at a single IXP can yield benefits for tens to hundreds of ISPs.
- IXPs are currently experiencing a rebirth (e.g., Open IX) and wanting to differentiate
- New traffic demands and applications create the need for richer peering

Things We'd Like to Do

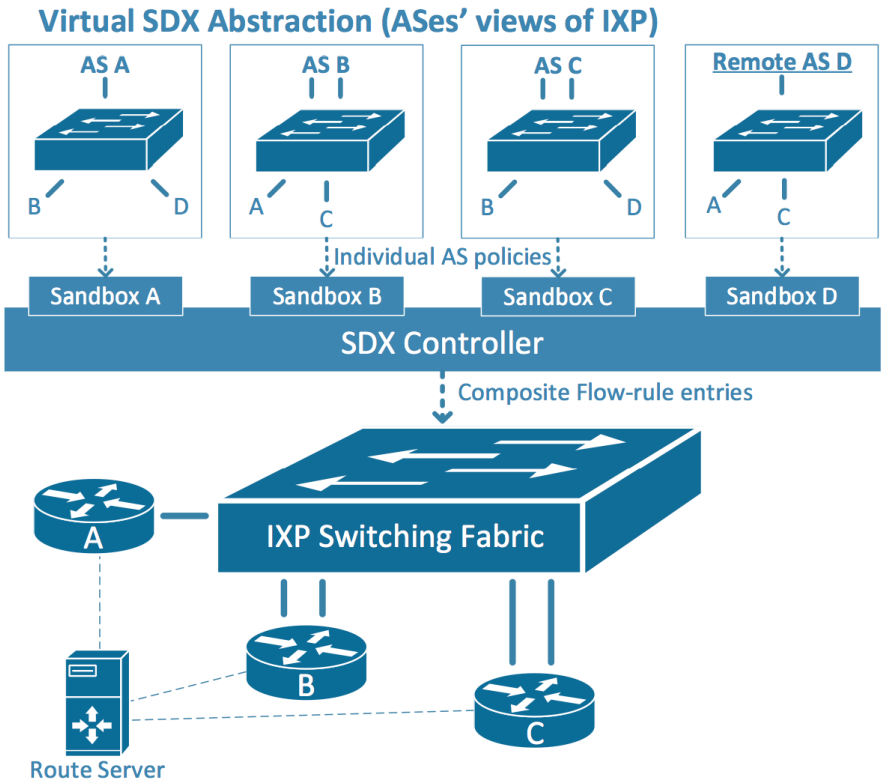
- **Application-specific peering:** Peering for specific applications like video
- **Redirection to middleboxes:** Redirection of specific traffic subsets to middleboxes
- **Traffic offloading:** Avoiding sending traffic through intermediate peers at IXPs
- **Preventing free-riding:** Dropping inbound traffic that is not associated with any peering relationship
- **Wide-area load balancing:** Rewriting destination IP address for load balancing (vs. DNS)

SDX Architecture



- **Each AS sees only its own virtual IXP topology (isolation)**
  - Applications run on top of SDX runtime
  - Runtime makes decisions based on both participants' applicationsand policies and auxiliary information (e.g., route server information)
- **No changes to BGP**
- **ASes do not need to deploy custom hardware**

Virtual SDX Abstraction



- ISPs that do not have business relationships with one another cannot see each other
  - (e.g., AS A and C have no direct connection)
- Enforced using symbolic execution at SDX

Two Kinds of Applications

- Routing Applications
  - ASes that transit traffic
  - ASes that terminate traffic

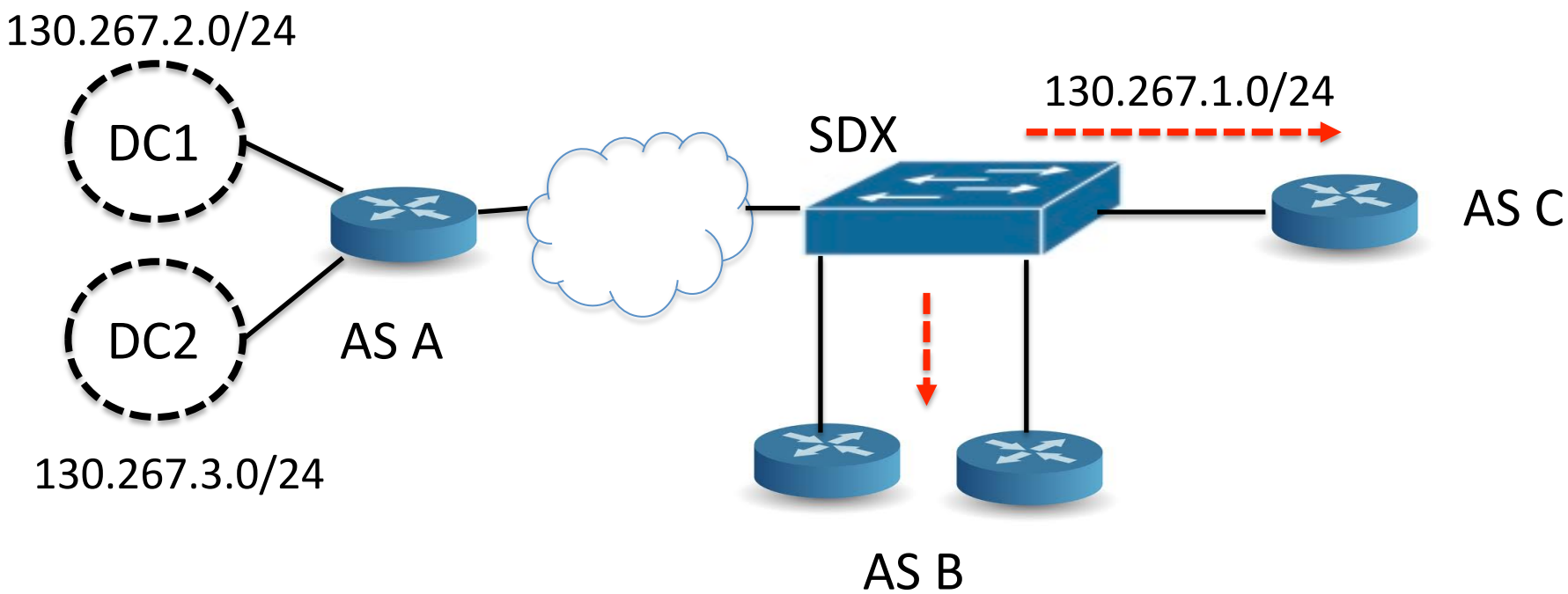
- Integration of SDX with Services

New Primitive: Remote Control

- Ases can control exchange traffic remotely
- Opportunity to process packets and control routing decisions remotely
- Applications
  - Traffic engineering
  - Prevent selection of paths via problematic ASes
  - DDoS Squelching

Remote Control

- For WAN load balancing, AS A can remotely apply its load balancing policy at SDX



Deployment Status

- Deployment at 55 Marietta Street in Atlanta, GA (SNAP)
- Two servers:
  - Floodlight controller
  - Virtual machine/network host
  - Brocade switch
- Connectivity
  - 56 Marietta (TelX)
  - Southern Crossroads
  - Georgia Tech (via SOX)
  - Experimental rack at 55 Marietta

Summary

- Interdomain routing continues to be plagued by problems with security and manageability.
- An **SDN-based exchange (SDX)** is promising for both fixing these problems and presenting new opportunities
- Many research challenges remain, both for building the exchange and for using it