SDX: A Software-Defined Internet Exchange

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SDN Has Landed

- SDN has reshaped many types of networks already
  - Data Centers
  - Others, to some extent: Campus, Enterprise, Home, Cellular

- **What about interdomain routing, the protocol which has received so much attention for being so "broken"?**

What's Wrong with BGP?

- Security
  - BGP does not prevent an AS from making arbitrary announcements
  - The forwarding path might not match the AS path
- Policy
  - Policies are too coarse-grained
  - Contracts result in market inefficiencies
- Stability
  - Even with stable inputs, BGP might not converge
  - BGP can even oscillate within a single AS

How SDN Can Help

- Benefits already known for single domains
- Programmability for more flexible route selection
- Now: New twists on some currently intractable issues in interdomain routing:
  - Policy
  - Economics/Business
  - Security

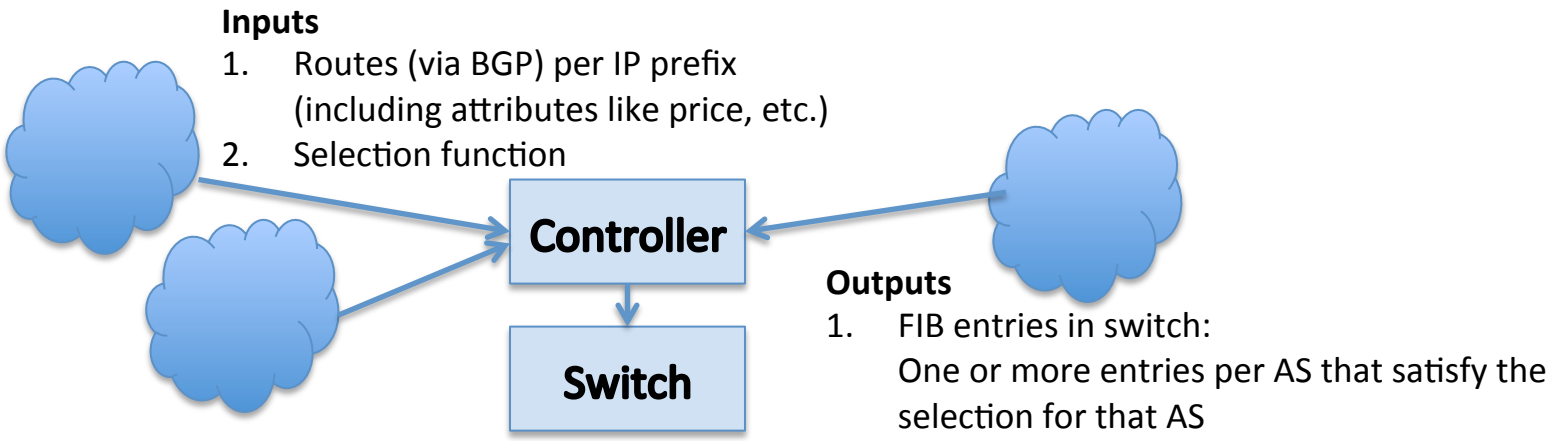
New Functions

- Time-of-day routing
- Domain-based routing
- Dynamic peering ratio maintenance
- Application-specific peering
- Route preference based on external inputs (e.g., reputation)

New Policies

- Security
  - Automatically prefer routes that have a higher reputation score (e.g., from hijack alert systems)
  - Incorporate checks for consistent route advertisement at peering points
- Economics
  - Hold an auction for transit or peering
  - More efficient pricing tiers, as opposed to “blended rate” pricing
- Performance
  - “Remote control” peering: Content provider can affect route selection along the path, closer to access network/ customer

A Preliminary SDX: One Switch, One Controller



- **Step 1:** Controller at exchange receives
  - BGP routes from all ASes at the exchange
  - Auxiliary information
    - Pricing
    - Alerts for prefixes that may be subject to hijack (and alleged perpetrators)
- **Step 2:** Participant at exchange runs a function that executes at the controller to select route

Other Designs and Extensions

- Every AS runs their own controller
  - Inter-controller protocol is responsible for exchanging routes, negotiating route selection
- Advantages
  - No need for BGP to exchange routes (or at all)
  - No need to have a single “trusted” controller
- Requires an additional step of designing the inter-controller protocol (potentially more complexity)

Challenges

- **Scaling:** Switch may need to perform per-AS forwarding, which causes state explosion in the FIB.
- **Isolation:** How to ensure that each AS can apply route selection independently?
- **Incremental deployment:** What happens when some exchanges are BGP, others SDX?
- **Distributed computation:** How to perform route computation across multiple exchange points?
- **Programming models:** Who is the programmer? (the ISP at the IXP, the content provider, etc.) What is the evaluation environment at the controller?

Status and Next Steps

- Research
  - Understanding and discovering use cases
  - Designing an architecture that supports these use cases

- Deployment at SNAP
  (need more participating ASes)