Flexible Forwarding

Tim Sally

<tsally2@illinois.edu>
Current State of Routing

• General idea: what to do with a packet when it arrives at an inbound interface?

• Border Gateway Protocol (BGP) and Interior Gateway Protocol (IGP) used to exchange routing information.
BGP Shortcomings

• Small networks can use complete iBGP graph, but this does not scale.

• Incomplete information results in suboptimal routing and protocol oscillations.
Some Solutions

• Replace BGP. Unlikely “flag day” is possible today.

• Use route reflectors.

• Use a Routing Control Platform (today’s paper).
Overview of Route Reflectors

• Divide routers into two classes, servers and peers.
• Forward updates from peers to servers only.
• Forward updates from servers to everyone.
• Servers should perform some logic to only forward the best routes.
Problems with Route Reflectors

- Only an approximation of a complete graph.
- What if two peers along a path are assigned different routes by two different servers?
- We can stop inconsistent routes at the cost of efficiency with a large number of servers.
Routing Control Platform (RCP)

• A route reflector server that is connected to every router.

• Can send different routes to different routers.

• Makes the same decisions as a fully connected network.
RCP Components

- **IGP Viewer** to get IGP topology information.
- **BGP Engine** to learn BGP routes from routers and send new routes.
- **Route Control Server (RCS)** uses the information from above to compute optimal routes.
Routing Control Platform (RCP)

Route Control Server (RCS)

BGP Engine

IGP Viewer

P1

P2

RCP Architecture
IGP Viewer

- Why do we even care about the IGP topology?
- Say we have two optimal BGP routes; we can pick either one.
- Pick the BGP route with the closet egress router according to IGP.
BGP Engine

- iBGP session with every router.
- RCP can learn about candidate routes and inform routers of optimal routes.
- We can forward different routes to different routers.
Route Control Server

- Must have both IGP and BGP information.
- Simply execute the BGP decision making process on behalf of all routers.
Network Operating System (NOX)

- Abstraction of network resources.
- Currently writing applications for networks is like using hardware specific assembly.
Active Networks

• Capsules (special packets) can program the behavior of the network.

• Interface is decentralized but code has to be certified by a central authority (or maybe executed in a “sandbox”).

• Trade off between capsule processing and packet forwarding at every router.
Thoughts on Flexible Forwarding

• Interoperability with the current network is a major concern.

• At the same time, we’d like to increase the number of things that are possible in the network.

• Seek to invent generalizations that cover current implementations and allow for new ones.
Thoughts on Flexible Forwarding

• Typically this involves some sort of control server (active networks take a different approach).

• Keeping any necessary logic and state at the control server minimizes changes that need to be made to the network.

• A global view of the network is often quite useful.
Thanks!