Flexible Forwarding

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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, <u>servers</u> and <u>peers</u>.

- 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

- <u>IGP Viewer</u> to get IGP topology information.

- <u>BGP Engine</u> to learn BGP routes from routers and send new routes.

- <u>Route Control Server (RCS)</u> uses the information from above to compute optimal routes.
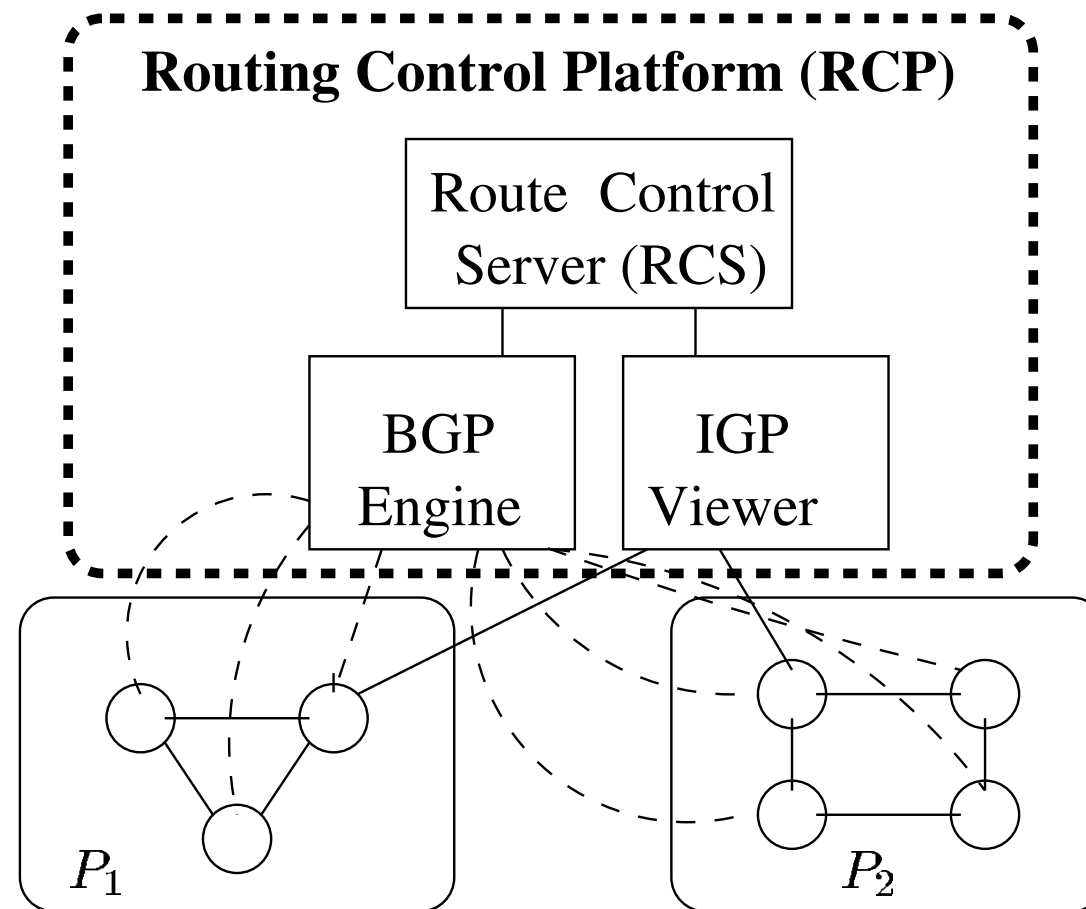
RCP Architecture

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.
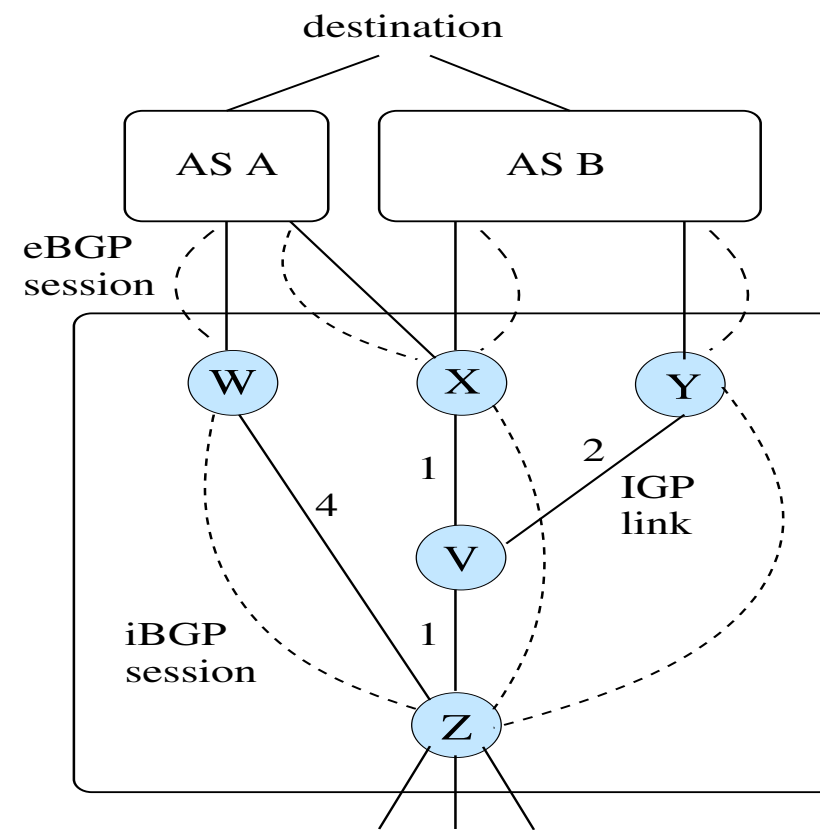
BGP Engine

- 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.
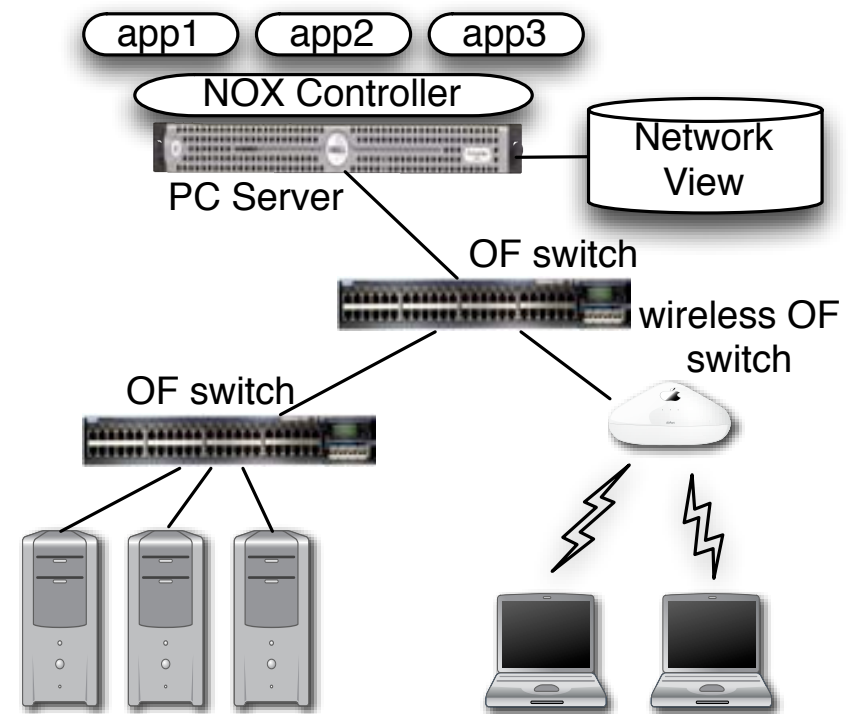
Active Networks

- 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!