Software Defined Networking

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In this course, you will learn about software defined networking and how it is changing the way communications networks are managed, maintained, and secured.

This Module: Routing Control Platform

- Problems with BGP

- Routing Control Platform
  - Early example of control/data separation
  - Three deployment phases
    ("getting from here to there")
  - Applications at each stage of deployment

Problems with BGP

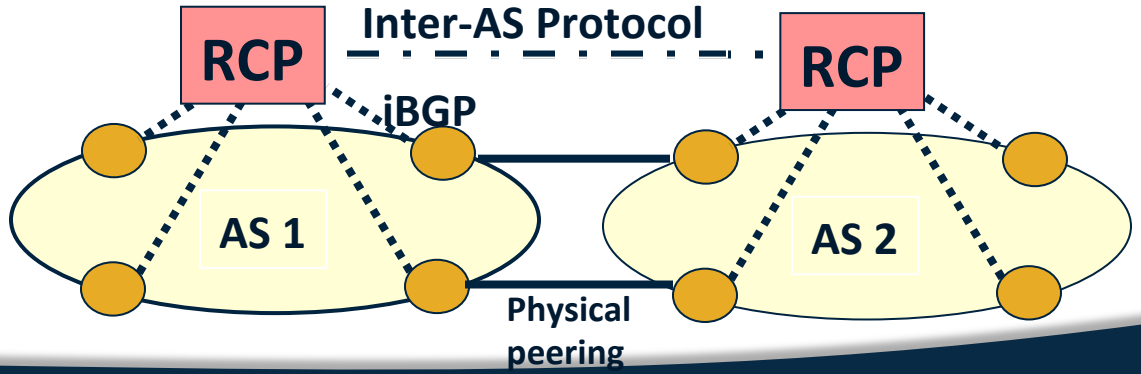
- BGP is broken
  - It converges slowly, sometimes not at all
  - It causes routing loops
  - It's misconfigured frequently
  - Traffic engineering is hard
- Fixing BGP is hard
  - Incremental fixes: Makes BGP even more complicated
  - New architectures and inter-domain protocols: Deployment is almost impossible

Problems

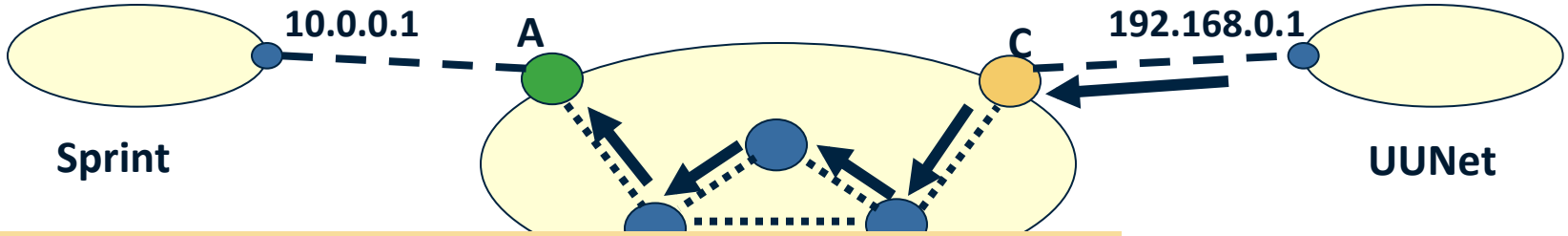
- AS is the logical entity for inter-domain
  - BGP state, logic are decomposed across routers
  - No router has complete BGP state
  - Each router makes routing decision based on partial and incomplete view
- BGP interacts in odd ways with other protocols
  - Most notably with the IGP (Interior Gateway Protocol) running inside an AS

Routing Control Platform

- Represents an AS as a single logical entity
  - Complete view of AS's routes
  - Computes routes for all routers inside an AS
    - Routers no longer have to compute routes
- Exchanges routing with RCPs in other ASes



Decomposed Configuration State



Simple policy: "Don't advertise routes learned from UUNet to Sprint"
Configuration is decomposed, so routes must carry state

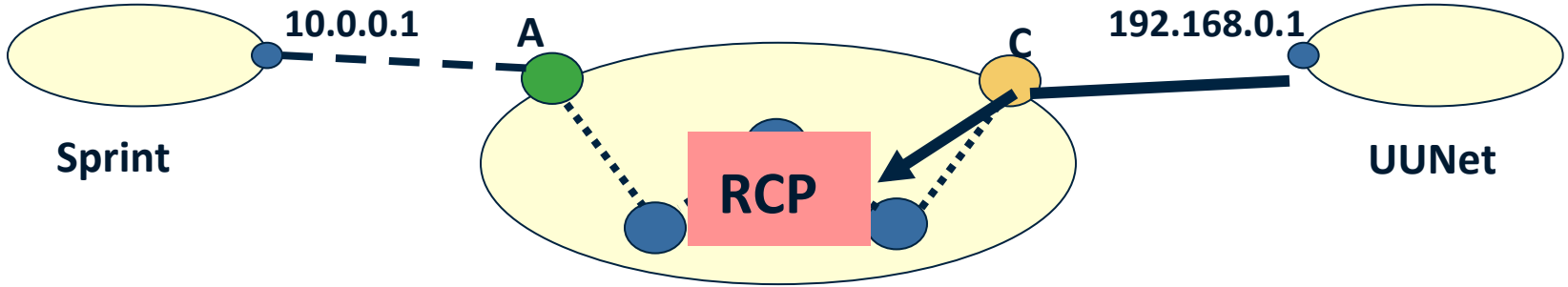
```
neighbor 192.168.0.1 route-map IMPORT-C in
route-map IMPORT-C permit 10
  set community 0:1000
```

Assign routes "From UUNet" tag at router C

```
ip community-list 1 permit 0:1000
neighbor 10.0.0.1 route-map EXPORT-A out
route-map EXPORT-A deny 10
  match community 1
```

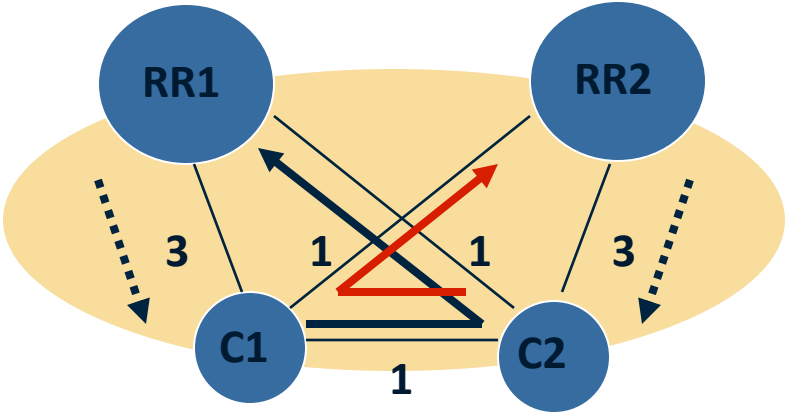
Don't send route with "From UUNet" tag to Sprint at router A

RCP: Centralize Configuration



- RCP implements policies for entire AS
  - Knows about sessions to all other ASes
  - Implements policies in terms of relationship with ASes
- Benefits
  - Simpler configuration
  - Do not have to tag routes with state

BGP Interacts with Underlying Protocols



C1 learns BGP route to destination from RR1

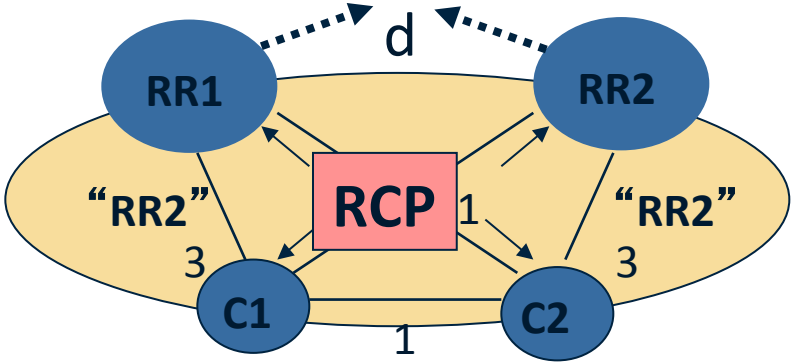
C2 learns BGP route to destination from RR2

C1 sends packets to RR1 via its IGP shortest path which traverses C2

C2 sends packets to RR2 via its IGP shortest path which traverses C1

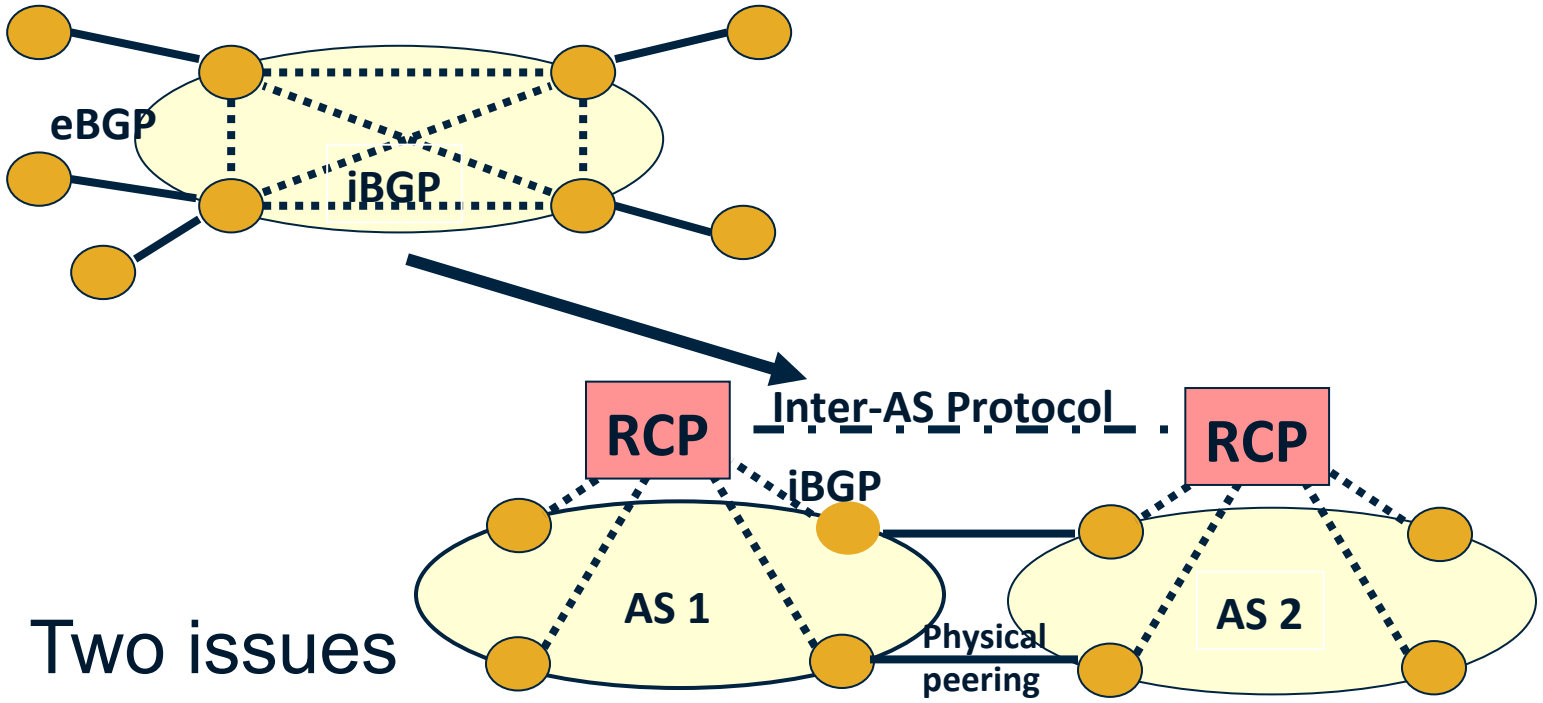
Persistent forwarding loop ☹

RCP: Compute Routes w/Complete Info



- RCP learns all externally learned routes
- Computes consistent router-level paths
- Benefits:
  - Intrinsic loop freedom and convergence
  - RCP does not have to stick to BGP decision process
  - Can "pin" paths for traffic engineering and other purposes

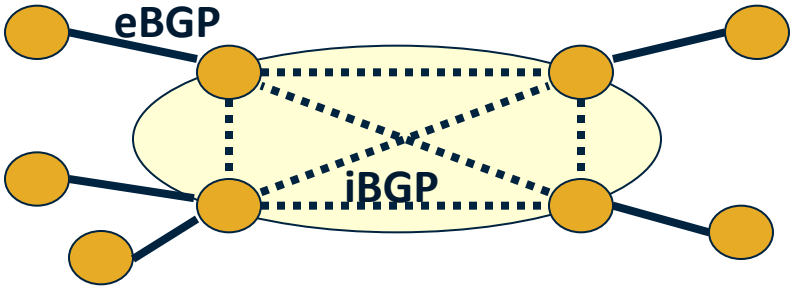
Getting From Here to There



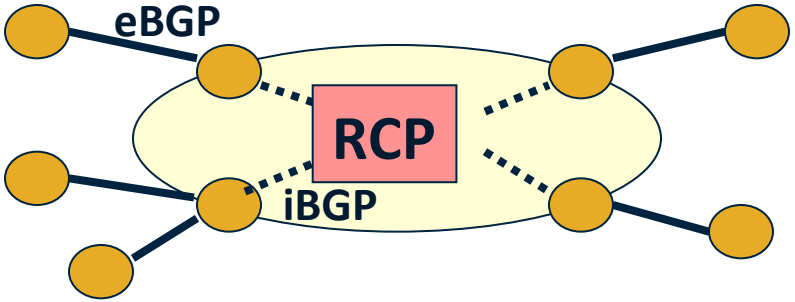
- Two issues
  - Backward compatibility
  - Deployment incentives

Phase 1: Control Protocol Interactions

Before: conventional iBGP



After: RCP gets "best" iBGP routes (and IGP topology)



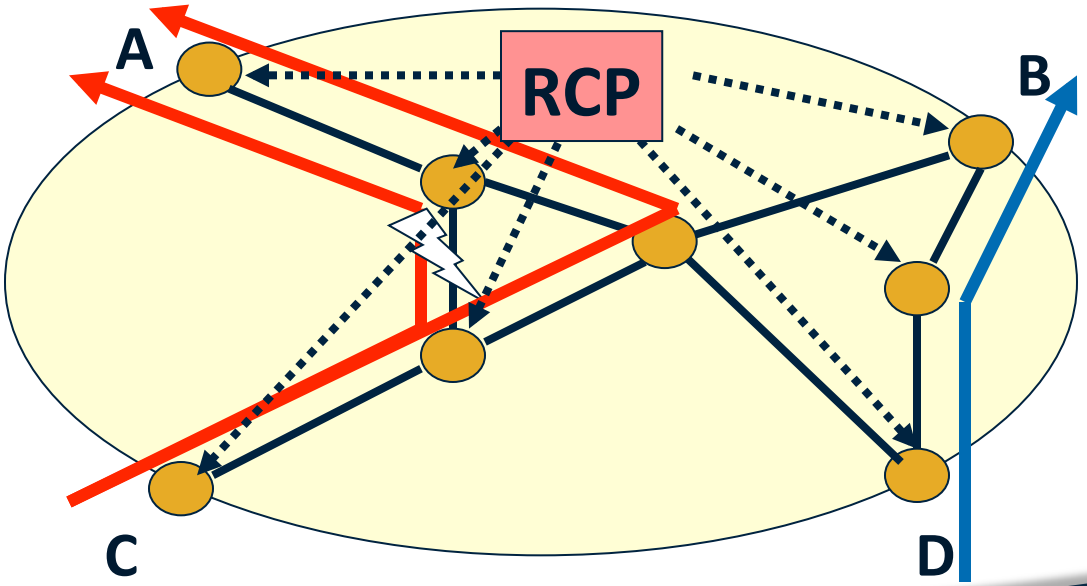
Only one AS has to change!

Application: Controlling Path Changes

BGP routes take "nearest exit" (shortest IGP path)

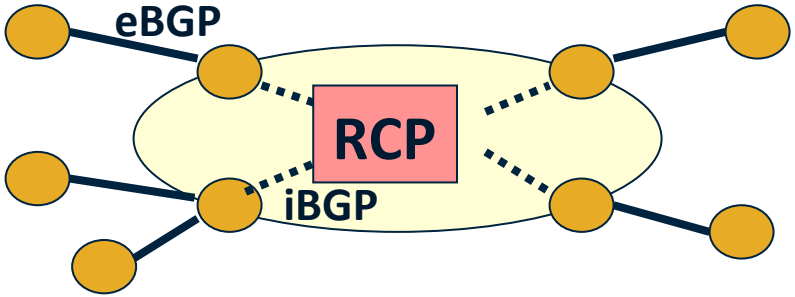
Failures or maintenance can change IGP (path) weights

RCP can "pin" exit points as IGP weights change

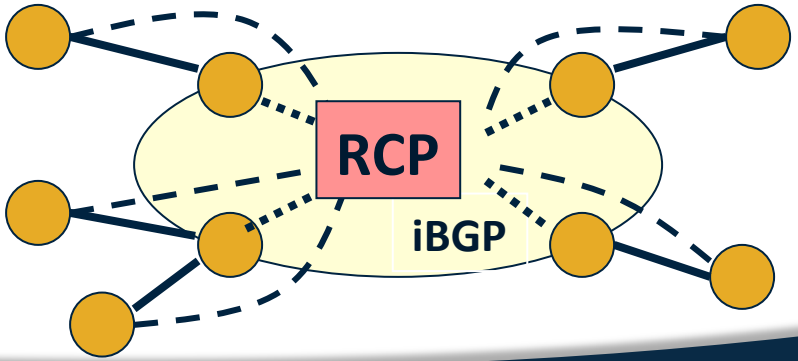


Phase 2: AS-Wide Policy

Before: RCP gets "best" iBGP routes (and IGP topology)



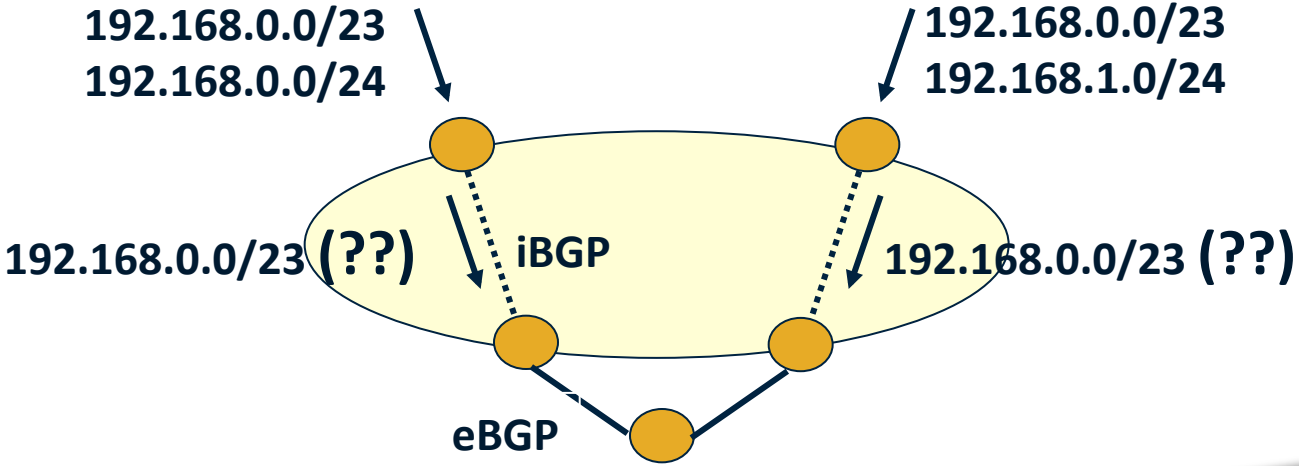
After: RCP gets all eBGP routes from neighbors



Application: Efficient Aggregation

Aggregation curbs routing table growth

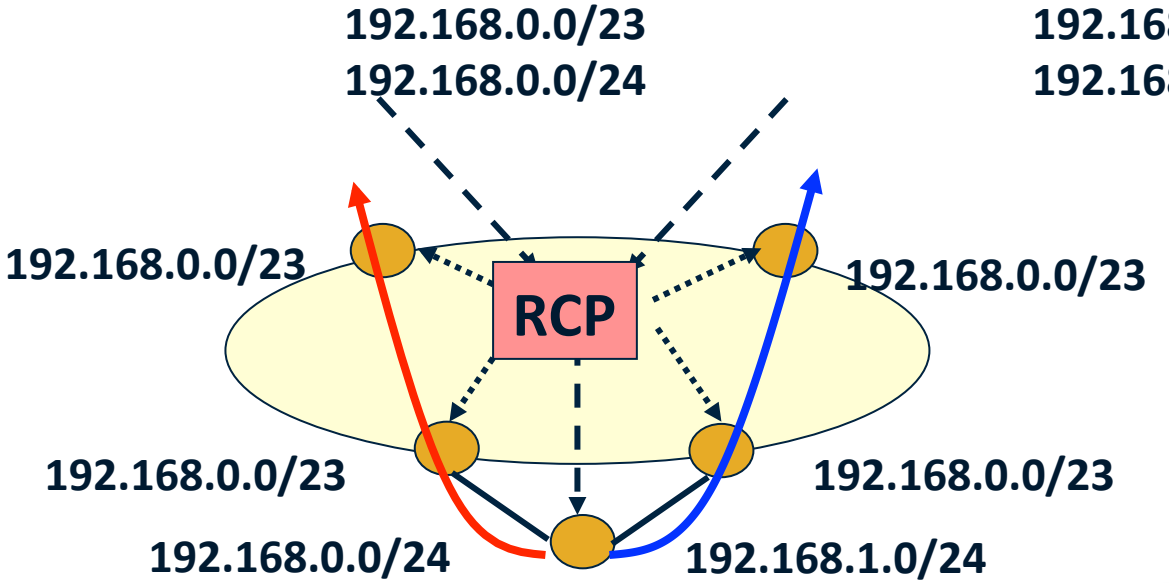
Routers can't know which routers need more specific routes



Application: Efficient Aggregation

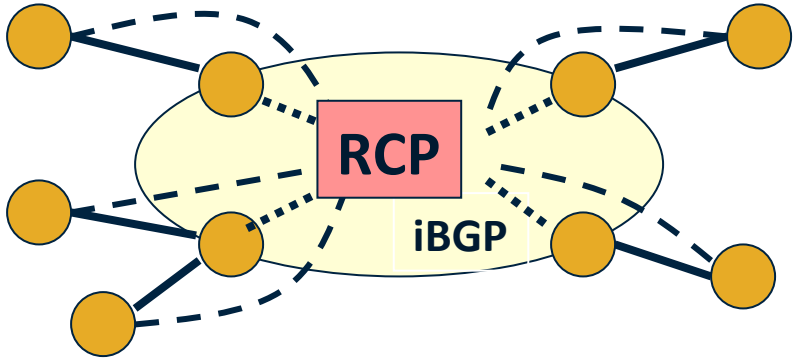
Aggregation curbs routing table growth

RCP can determine which routers need more specific routes and which routers can get by with less specific routes

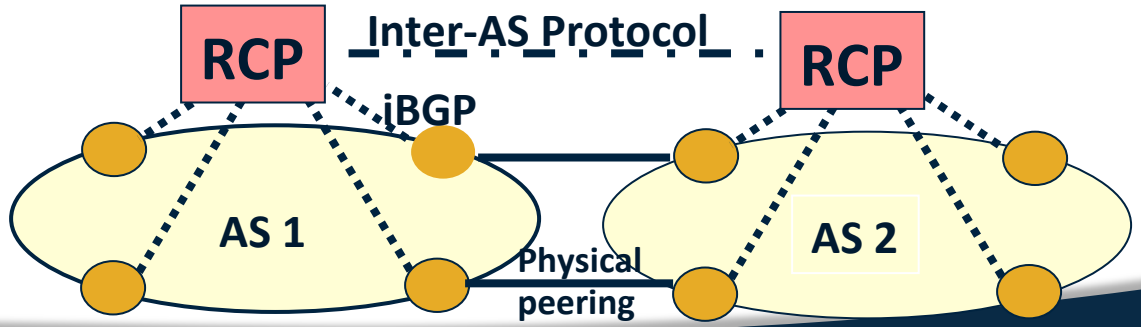


Phase 3: All ASes Have RCPs

Before: RCP gets all eBGP routes from neighbors



After: ASes exchange routes via RCP



Application: More Flexible Routing

- Better network management
  - Diagnostics and trouble-shooting
  - Routing co-located with other information (e.g. traffic)
  - Ability to reason about an AS as a single entity
- Protocol Improvements
  - Attaching prices to routes
  - Inter-AS negotiation of exit points
  - Overlay routing informed by IP-layer information
- Your application here…

Summary

- RCP embodies two principles for inter-domain routing
  - Treat an AS as a single logical entity
    - Compute consistent routes using complete AS-wide view
  - Control routing protocol interactions
- Benefits
  - Simpler, more expressive configuration
  - Intrinsic robustness: no loops, faster convergence
  - Enable new applications and innovations
    - Opportunity for new traffic engineering applications