BGP 102:
Scaling the Network

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Introduction

- BGP is relatively easy to get configured and basically announcing and using routes.
- It is difficult to scale to the tens-to-hundreds of routers scale with full iBGP mesh, AS-Path filters, and AS-Path padding as the only tools.
- We present Communities, Confederations, and local-pref use, and some other features, and show them used in context.

Topics (1)

- Review basic BGP concepts

- Simple BGP Scaling concepts
  - Inserting BGP Routes
  - Stable Routing and Scaling w/ Loopbacks
  - Save CPU and Typing w/ Peer-Groups
  - Route Refresh, Soft-Reconfig
  - TTL Hack/Security

Topics (2)

- Scalable Advertisements with Communities
- Scalable Route-Selection with local-prefs
- iBGP Scaling Issues
- BGP Confederations
- BGP Scaling with Confederations + Route Reflectors

Topics (3)

- Supporting Multi-Homed Customers
- Backup Transit

- Sample Network - Topology
- Sample Network - Design Goals
- Sample Network - Implementation
- Review Router Configuration

BGP Concept Review

BGP Intro

- BGP4 is the protocol used on the Internet to exchange routing information between providers, and to propagate external routing information through networks.
- Each autonomous network is called an Autonomous System.
- ASs which inject routing information on their own behalf have ASNs.

BGP Peering

- BGP-speaking routers peer with each other over TCP sessions, and exchange routes through the peering sessions.
- Providers typically try to peer at multiple places. Either by peering with the same AS multiple times, or because some ASs are multi-homed, a typical network will have many candidate paths to a given prefix.

The BGP Route

- The BGP route is, conceptually, a "promise" to carry data to a section of IP space. The route is a "bag" of attributes.
- The section of IP space is called the "prefix" attribute of the route.
- As a BGP route travels from AS to AS, the ASN of each AS is stamped on it when it leaves that AS. Called the AS_PATH attribute, or "as-path" in Cisco-speak.

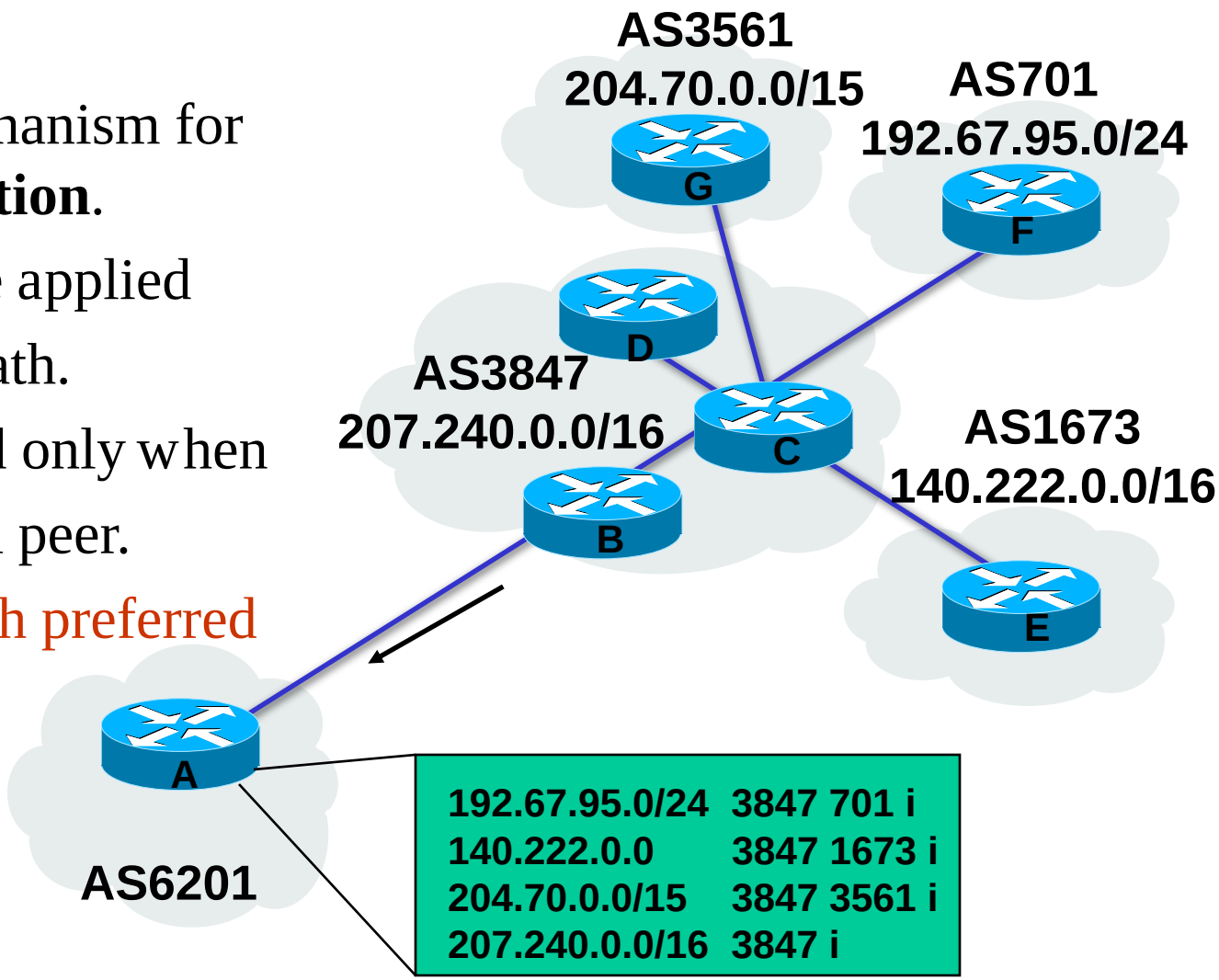
BGP Route Attributes

- In addition to the prefix, the as-path, and the next-hop, the BGP route has other attributes, affectionately known as "knobs and twiddles" -
  - weight, rarely used - "sledgehammer"
  - local-pref, sometimes used - "hammer"
  - origin code, rarely used
  - MED ("metric") - a gentle nudge

AS Path

- Sequence of AS(s) a route has traversed.
- Provides a mechanism for **loop detection**.
- Policies may be applied based on AS path.
- Local AS added only when send to external peer.

*Shortest AS path preferred

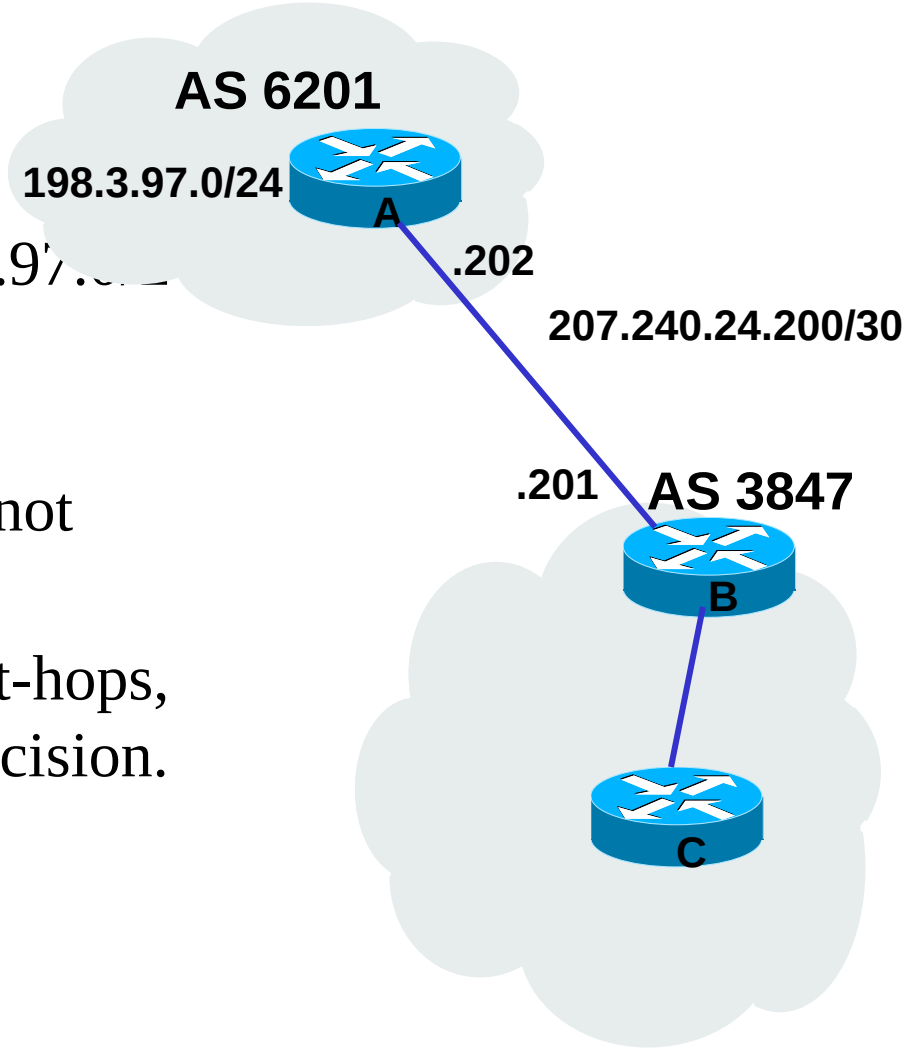


4 Byte ASNs

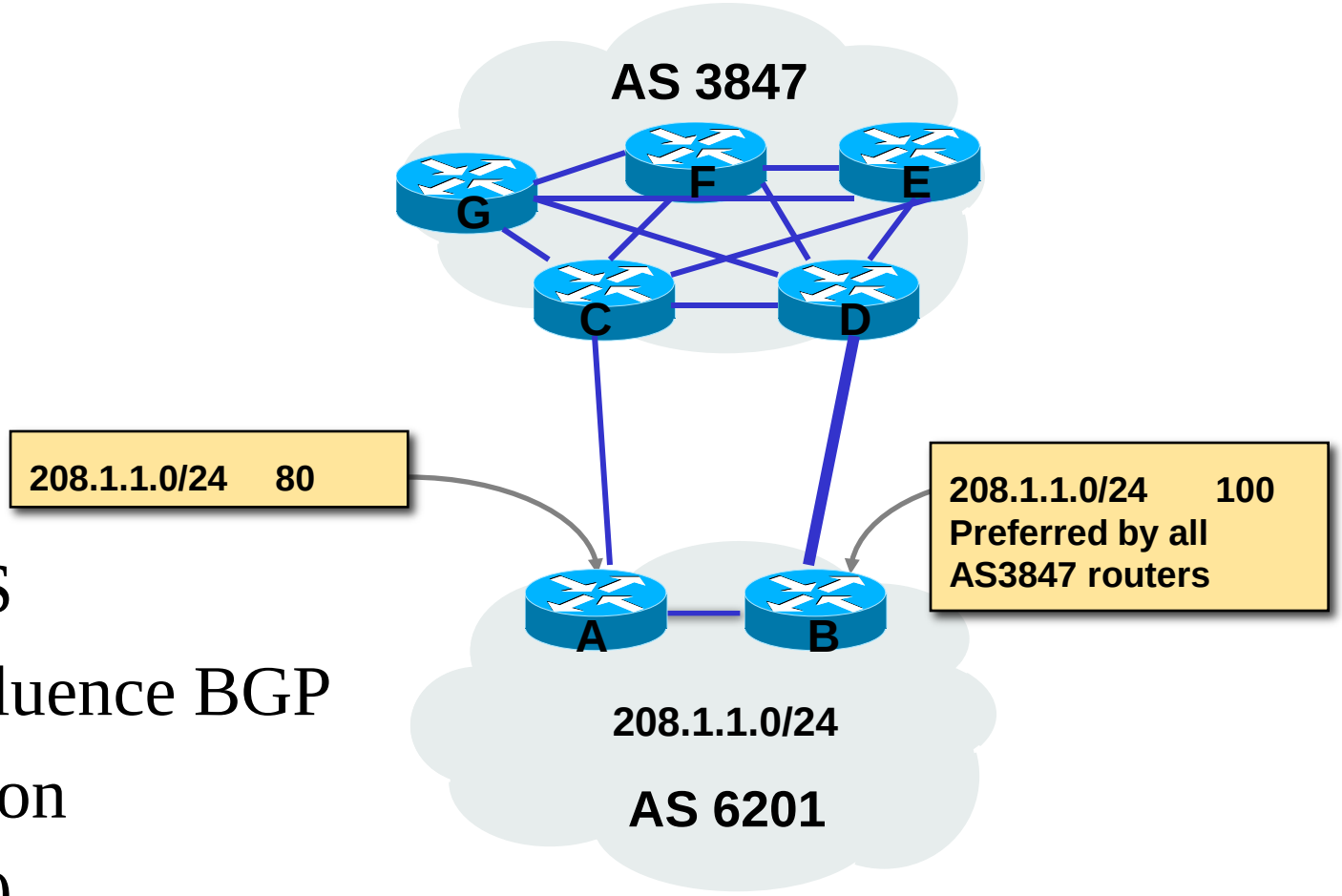
- 4 Byte ASNs are coming but…
- There isn’t yet universal support.
- Format will be 16bit.16bit (or 1.100 for 65636)
- Still, now you have to ask in some regions for 2 byte ASNs and soon it may become harder to get 2 byte ASNs.

Next Hop

- Next-hop IP address to reach a network.
- Router A will advertise 198.3.97.0/24 to router B with a next-hop of 207.240.24.202.
- With IBGP, the next-hop does not change.
- IGPs should carry route to next-hops, using intelligent forwarding decision.



Local Preference



- Local to AS
- Used to influence BGP path selection
- Default 100

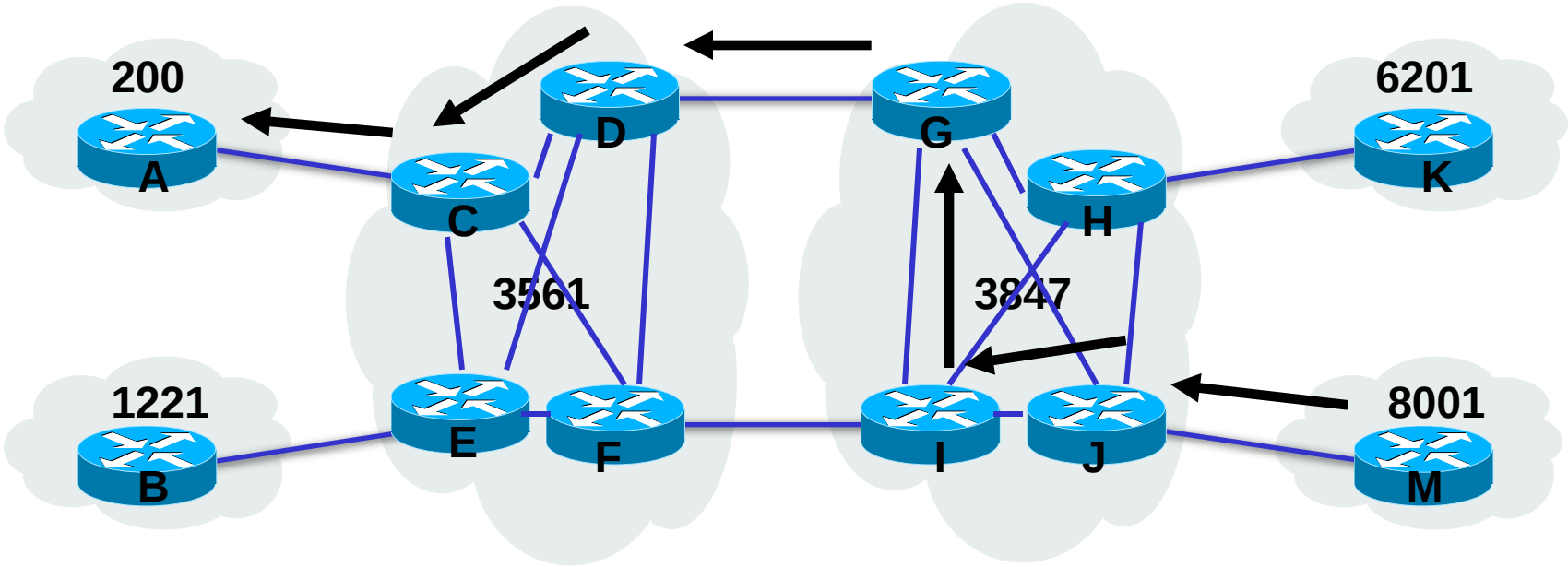
* Highest local-pref preferred

Multi-Exit Discriminator (MED)

- Indication to external peers of the preferred path into an AS.
- Affects routes with same AS path.
- Advertised to external neighbors
- Usually based on IGP metric

* Lowest MED preferred

MEDs (cont.)

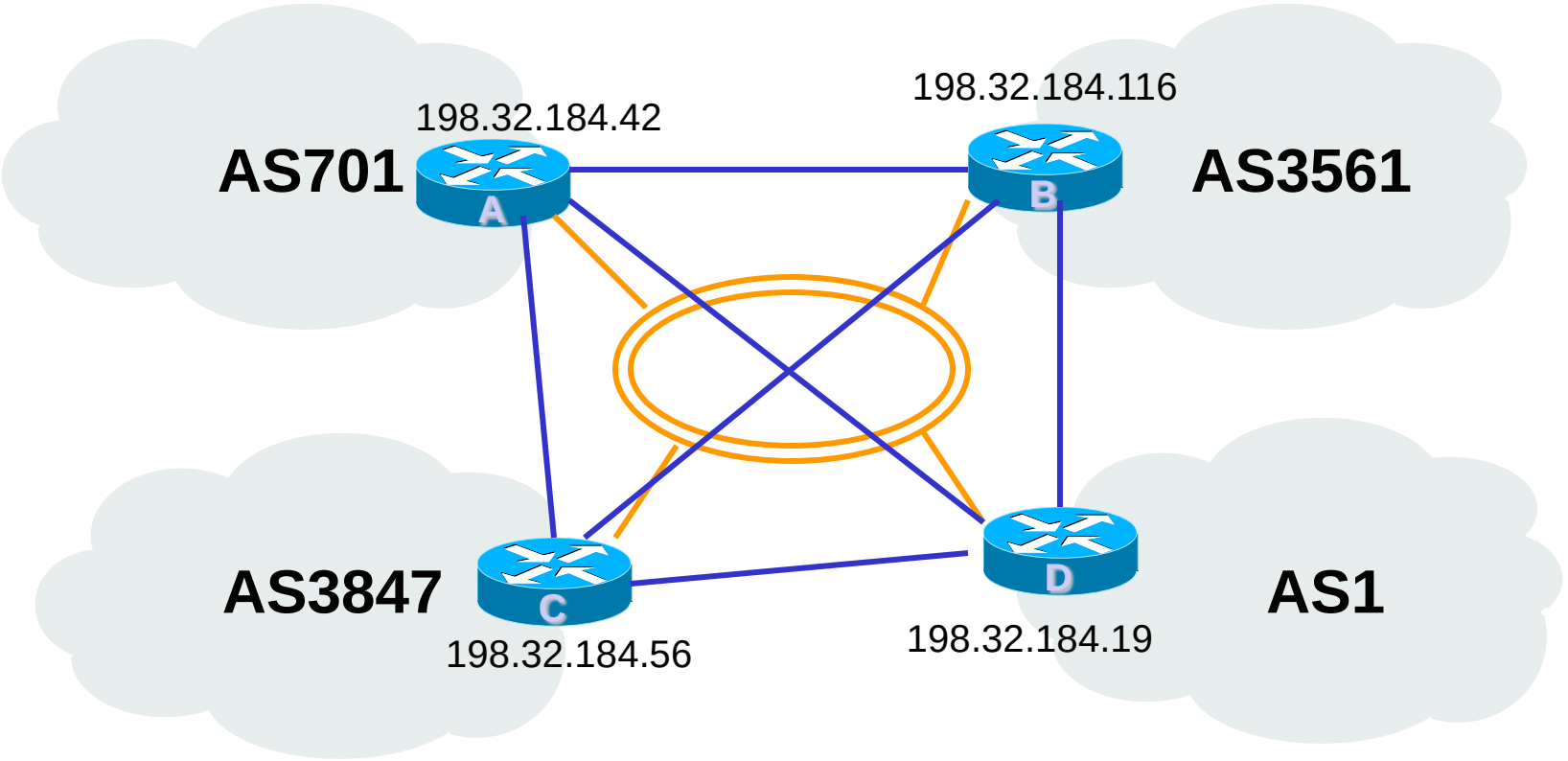


- Applies on a AS path basis
- Current aggregation schemes significantly lessen value.

Origin

- IGP (i)
  - –Network statement under router BGP
- EGP (e)
  - –Redistributed from EGP
- Incomplete (?)
  - –Redistributed from IGP

Next Hop Self



BGP Policy

- BGP was designed to allow ASs to express a routing policy. This is done by filtering certain routes, based on prefix, as-path, or other attributes - or by adjusting some of the attributes to influence the best-route selection process.

BGP Best-Route Selection

- With all of the paths that a router may accumulate to a given prefix, how does the BGP router choose which is the “best” path?
- Through an RFC-specified (mostly) route selection algorithm.
- BUT each vendor can and does differ subtly!
- Watch out for weights (can cause routing loops) and be aware that local-prefs override what remote providers are trying to tell you with as-path padding.

BGP Decision Algorithm (Cisco)

- Do not consider IBGP path if not synchronized
- Do not consider path if no route to next hop
- Highest weight (local to router)
- Highest local preference (global within AS)
- Shortest AS path
- Lowest origin code IGP < EGP < incomplete
- Lowest MED
- Prefer EBGP path over IBGP path
- Path with shortest next-hop metric wins
- Lowest router-id

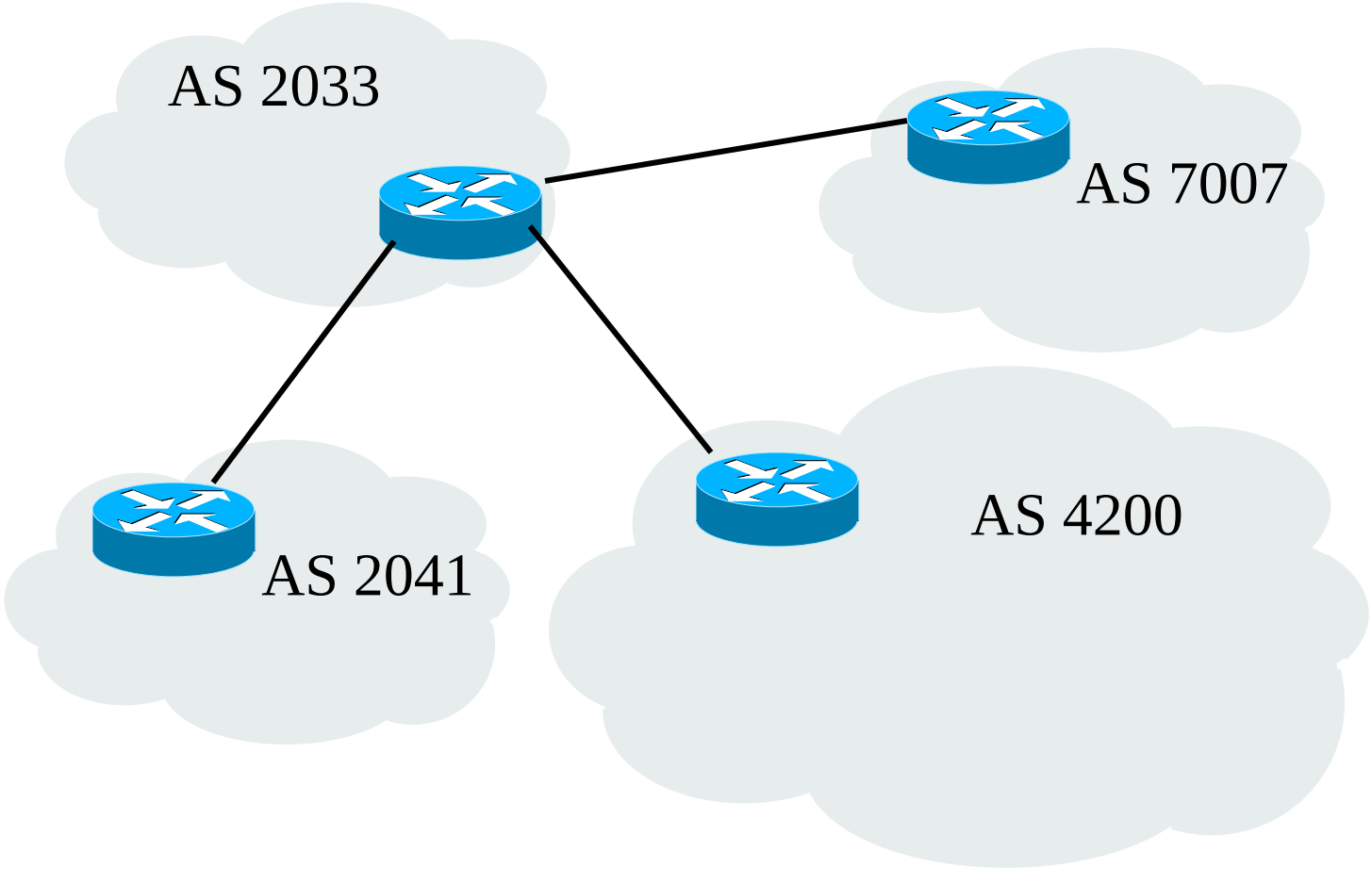
Routing Decision Process

- Important note for those using Cisco in particular – Ciscos choose which route makes it into the IP routing table by using “administative distances”.
- So for a given route you may have a connected, a static, an OSPF, a BGP version, etc, all competing to make it into the IP routing table then the FIB
- But – by default, the eBGP administrative distance may be better than your IGP distance. This could be bad, especially if you don’t properly filter your internal routes from getting in from eBGP peers.
- ‘distance bgp 200 200 200’
- May want to set the 2nd # (iBGP) < IGP metric

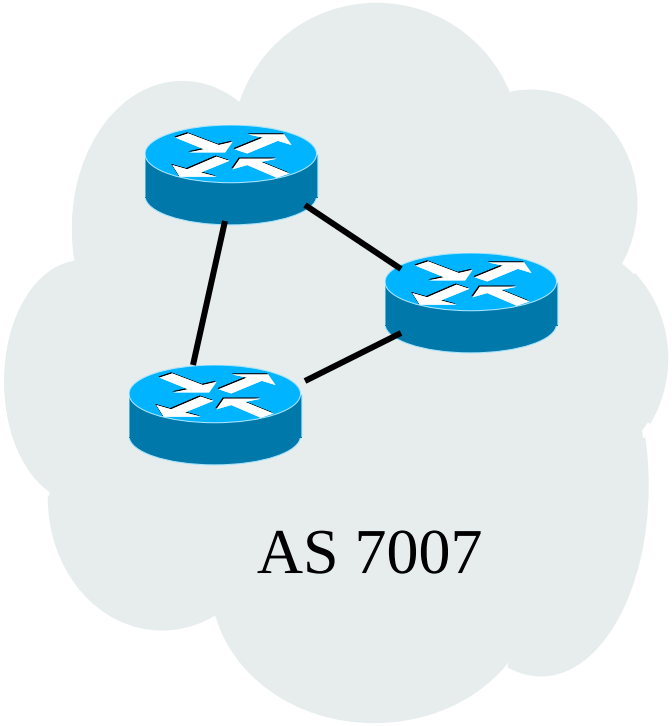
Communities

- Used to group destinations to which routing decisions can be applied.
- Each destination can belong to multiple communities.
- Usually applied with route-maps.

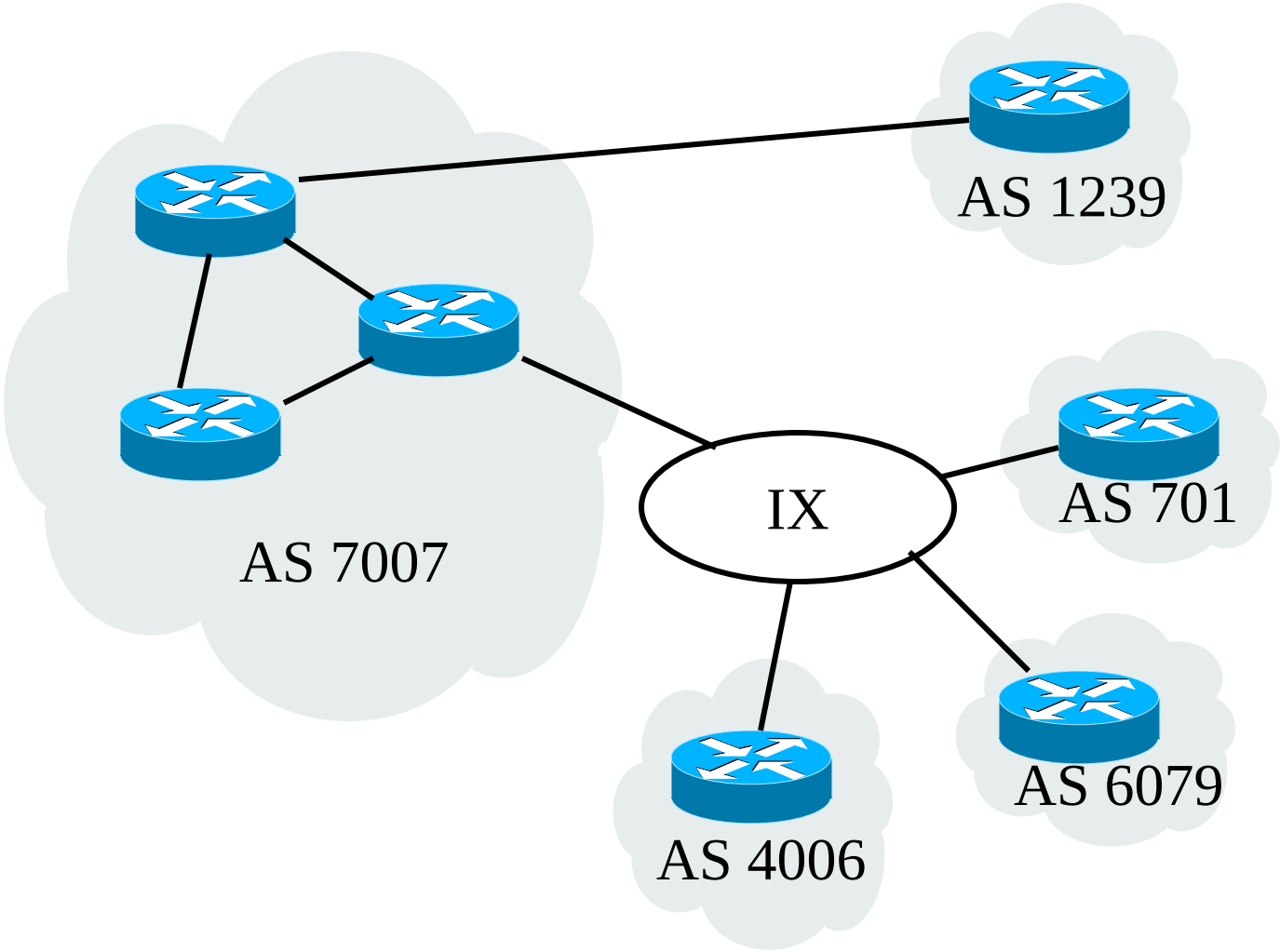
eBGP



iBGP



iBGP and eBGP



Determining Policy

- What do you want to do?
- The tricky part.
- Configuring is easier…

Typical Starting Point

- Use network statements to inject.
- Use AS-Path lists to control advertisement.
- Use AS-Path padding to prefer or de-prefer externally-heard paths.
- Have full iBGP mesh.

Inserting Routes into BGP

Route Insertion Methods

- Static Insertion/network statement - most common
  - Sometimes thought of as “non-scalable”
- Aggregation/aggregate-address statement
  - difficult to punch holes
- redistributing through filters (usually with aggregate-address statements)
  - difficult to punch holes
  - dangerous as filters are altered

Using Static Insertion

- Best to use static insertion of routes (network statements on Cisco). Don't worry about not being fancy. Stick the network statement on the router the customer is on, or on multiple routers for LAN-attach customers.
- Easy to support customers who want to advertise more specifics with BGP.
- Also easy to apply per-route route-maps.

Stable Routing and Scaling with Loopbacks

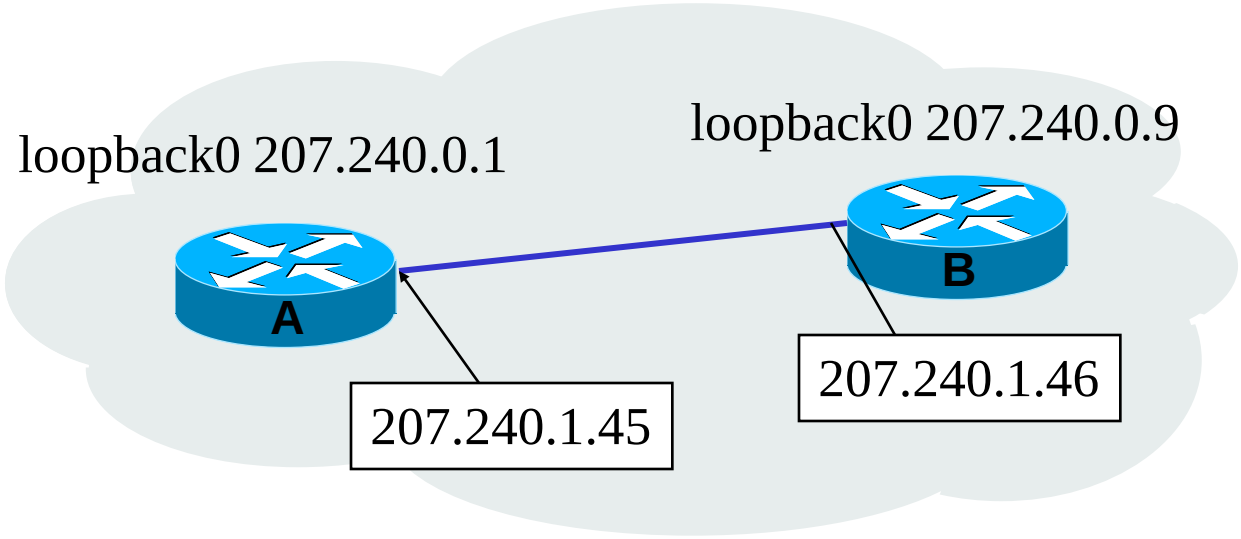
Stable BGP - Loobacks (1)

- Watch out for flapping routes.
- Sites think that if a site shows instability, it is worth blackholing for some time (30-90 minutes) until it stabilizes, though fewer networks have been using dampening in recent years.
- But, dampening hurts and flapping hurts also.
- So, nail non-multi-homed routes to loopback.

Stable BGP - Loopbacks (2)

- Also - peering between loopbacks enhances stability, since loopbacks don’t go down.
- Also, good for load-balancing (balaned statics used underlying one peering session caused load-balancing for BGP-heard routes).
- Set up lo0, then
- “neigh x.y.z.q update-source looback0”

Update-Source Loopback0



Router A and router B peer with one another's loopback address. Normally, the source address of packets sent from router A to router B would be 207.240.1.45. If router B were to receive BGP packets from router A, the packets would be dropped because router B doesn't peer with 207.240.1.45. Because of this, "update-source loopback0" should be applied to the neighbor statements on both routers, thus telling the routers to set the source address to that of the specified interface for all BGP packets sent to that peer.

Scaling with Loopbacks

- Only have to remember loopback IP of each router.
- Easy to make sure you've "got" all routers for iBGP mesh.
- You know you have a configured loopback interface, with in-addr, to nail routes to.
- Good for logging and tac authentication - eliminates multiple serials showing up.
- Also, iBGP peer between loopbacks – for stability and if you filter those IPs externally, security as well.

BGP Stability – Route Refresh

- If both you and your neighbors support Route Refresh (Dynamic Reconfig) capability, this is better than soft-reconfig since it uses no extra memory. (RFC2918)
- It's just a soft request to resend routes so you can re-apply your filters.
- Route Refresh should come up beween peers without negotiation on modern IOS/JunOS. Check with 'sho ip bgp neigh foo'
- If not use soft-reconfig.

BGP Stability - soft-reconfig

- Instead of hammering a session to cause reevaluation (“clear ip bgp” drops the TCP session), “clear ip bgp soft” can be used.
- “clear ip bgp x.y.z.q soft out” is low cpu; it issues withdrawls for all currently-advertised routes and recomputes and re-sends roues.
- Enabling soft inbound so you can do “clear ip bgp x.y.z.q soft in” can cause memory issues, as it needs to keep copy of all routes received.

BGP Security

- The simplest method of gaining some security is to use BGP passwords. Actually, this is on the underlying TCP session.
- Also or instead, (also is better) you can use the BGP “TTL Hack” (RFC5082).
- You set your router to expect TTL 254 and your neighbor sets their router to TTL 255.
- www.nanog.org/mtg-0302/hack.html

Max Prefix Filtering

- In terms of routing, the limitations in a router are RAM and CPU, not interface speed.
- # of prefixes heard from peers affects both, but in particular we're concerned with blocking accidental reannouncement and protecting our RAM.
- Enable max-prefix filtering per external peer. You can set warning thresholds (you need to syslog to be helpful), and can set various actions if triggered.

Max Prefix Filtering

- cat3.foo.com(config-router)#neigh a.b.c.d maximum-prefix 30000 ?
  <1-100> Threshold value (%) at which to generate a warning msg
  restart Restart bgp connection after limit is exceeded
  warning-only Only give warning message when limit is exceeded
  <cr>

Logging

- In general you want to enable logging via syslog but for BGP you in particular want to know about session resets + reasons, and max-prefix warnings.
- Use ‘bgp log-neighbor-changes’ in the bgp clause. Then ‘logging facility daemon’, ‘logging source-interface <intname>’, ‘logging <loghost>’, maybe ‘logging rate-limit N’

Save CPU and Typing with peer-groups

Peer Groups (1)

- Peer-groups were not designed to save typing, actually.
- By grouping neighbors with common policy together, routers can save lots of CPU by creating once a route object and then advertising that object to multiple peers.
- Also, saves typing :)

Peer Groups (2)

- Major restriction - next-hop is part of the object (one of the attributes), so a given peer-group can/should only be applied for peers on a common interface.
- So, useful for eBGP peers but sometimes not for iBGP peers.
- Still, can express different inbound policy per peer.

Sample peer-group

```
neighbor public-peer peer-group
neighbor public-peer next-hop-self
neighbor public-peer prefix-list sanity in
neighbor public-peer route-map public-in in
neighbor public-peer route-map public-out out
neighbor public-peer filter-list 30 in
```

Scalable Advertisements with Communities

AS-Path Filtering

- You can either announce routes by prefix or by as-path filtering. Updating a distributed prefix table is more difficult; as-path filtering (allowing routes from you or from customer ASs to be advertised), combined with aggressive inbound prefix-based filtering, is a good first approach.
- But...

Limitation of AS-filtering

- Either have to list all peers, or all customers. Gets really tricky when you peer with customers, or customers of peers, or peers of customers.
- These lists get difficult to read and distribute as you grow.
- So… Look at Communities to express policy.

BGP Communities - What

- Easier control of where routes go.
- Just a number (or numbers) that get stamped on BGP routes.
- ‘neigh x.y.z.q send-comm’ to send

```
ip comm 4 permit 4969:1200
route-map give-transit
  set comm 4969:1200 additive
route-map send-transit
  match community 4
```

BGP Communities - Why

- Give customers control of how you announce them
- Let customers see where you get routes
- Peering community; transit community; partial-transit community.
- Example – Philly-area ISP uses community 401 to transit some PHL-area providers to each other; 401 is the address of a PHL pop. These #s don’t really matter in particular, however.

BGP Communities

- Well-known communities -
  - no-export - don’t advertise to eBGP peers
  - no-advertise - don’t advertise to any peer
- Very Important –
  - If you use communities, remember to enable sending communities internally on all iBGP sessions. Check how your software sends by default to external and internal peers.

Sample Communities

- 4969:12392 means “pad 2 times to Sprint”
- 49690:7010 means “don’t announce to uunet”
- 4969:2 means “pad me twice to *”
- Some providers will make communities flexibly; some won’t. Ask for their doc before buying!
- http://www.nlayer.net/bgp_communities
- For a larger-scale network use a wildcard-based community system instead of manually creating route-maps per peer.

Scaling with Local-Prefs

AS-Path Padding

- A 1st-cut approach to load-balancing or quality-balancing might be to de-prefer any routes heard via a provider you're seeing problems with. How?
- First approach is to add an extra copy of the next-hop AS to the AS-Path, so ^7007$ becomes ^7007 7007$. Longer AS-Paths are less preferred, all else being equal.
- You can implement complex policy with this, in fact.

Limitations of AS-padding

- A typical first way to select between multiple outbound paths is by padding the less-preferred paths as they come into your network.
- This works reasonably well, unless you have to redistribute these paths to others.
- Local-prefs make implementing this easier, though there is a caveat.

Local-Prefs

- The local-pref is a “powerful” BGP attribute - it comes before as-path length in the selection algorithm.
- Setting can override as-path length - consider the provider with a Gige and a 10Gig who WANTS you to pay attention to the 7-times-padded path…
- Come up with a unified scheme.
- CUSTOMER ROUTES ARE SACRED.

Typical local-pref Scheme

- 80 de-preferred routes
- 100 questionable IX routes
- <101-115> better IX routes
- <116-119> transit pipes
- 120 private xcon routes
- <121-139> better private routes
- 140+ customer routes

Implementing Local-pref

```
route-map public-in
   set local 100
   set comm 15000:8100 15000:666

route-map pni-in
   set local 125
   set comm 15000:609 15000:666

route-map set-transit
   set local 140
   set comm 15000:1200 add
```

Scaling iBGP with Confederations

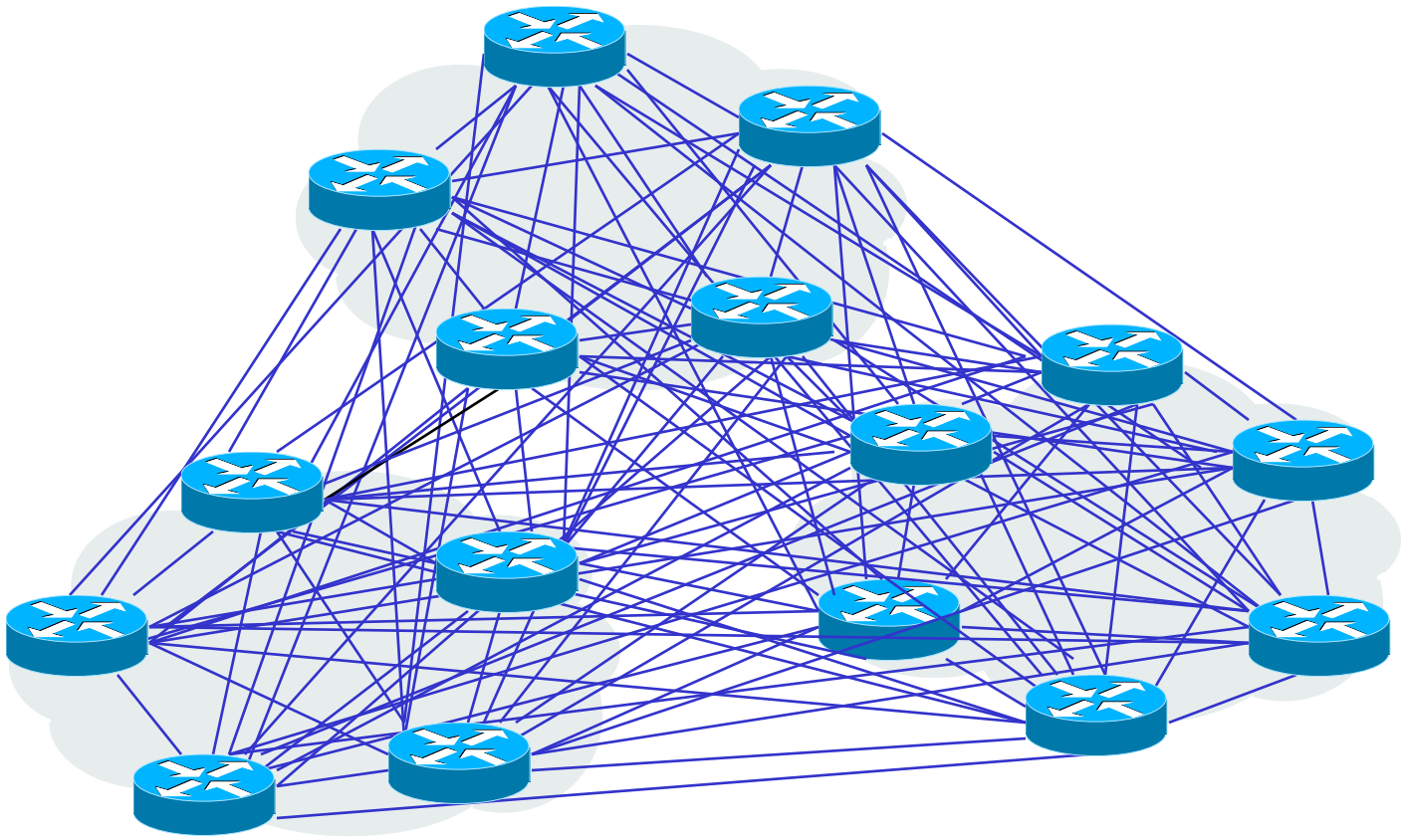
iBGP vs. eBGP Review

- iBGP and eBGP are the same protocol; just different rules.
- Rules are counter-intuitive -
  - eBGP advertises everything to everyone by default. Not the correct policy, most likely.
  - iBGP does NOT advertise “3rd-party routes” to other iBGP peers. Why?
    - No way to do loop detection with iBGP, so this solves it.

iBGP Scaling Issues

- So you have to have ALL BGP-speaking routers in your as peer with each other. Really.
- With 10 routers, an iBGP mesh is OK
- With 30 routes it is stretched
- With 100 it is taxed
- Eventually, CPU to deal with multiple sessions is nasty.

Logical View of full 16-router Mesh



(kudos to danny ex-of-genuity-now-arbor)

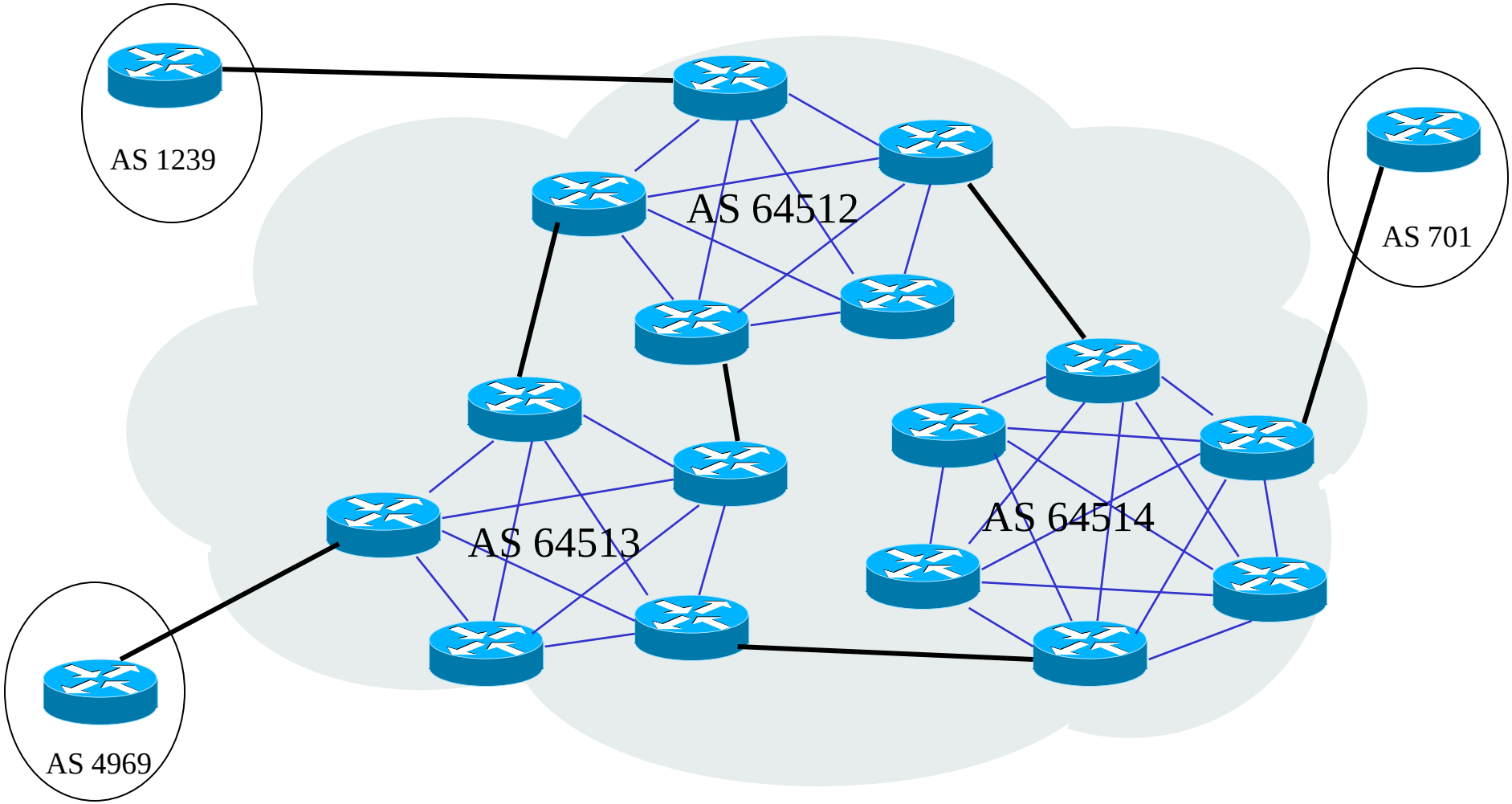
Two Approaches

- There are two approaches to allow the iBGP redistribution restriction to be broken:
  - Confederations
  - Route Reflectors
- We present confederations more heavily here, which you may want to consider for a smaller multi-pop network. Also gives you traffic engineering flexibility without MPLS.
- Route Reflectors are more commonly used now.

Confederations (1)

- Makes iBGP more promiscuous
- How?
  - Fully-mesh all BGP speakers at a POP
  - Use fake ASNs at each POP
  - Between POPs, use eBGP rules (send everything)
  - Within POPs, use iBGP rules
  - Preserve local_prefs between POPs

Confederations, Illustrated



Confederations (2)

- Reduces CPU due to internal churn, but can increases CPU due to external churn in some cases.
- Trickier as-paths; use communities.
- Identified source of routes handily (just have to remember fake AS per POP, not one loopback for each router in a POP).
- Easier to apply MEDs.
- Makes iBGP more “hop-by-hop”.

Implementing Confederations

```
router bgp 64512
 bgp confederation identifier 15000
 bgp confederation peers 64512 64513 64514 64515
```

- note - put in extra confederation peers up-front
- as-path becomes `(64512 64513) 7018` instead of `7018`

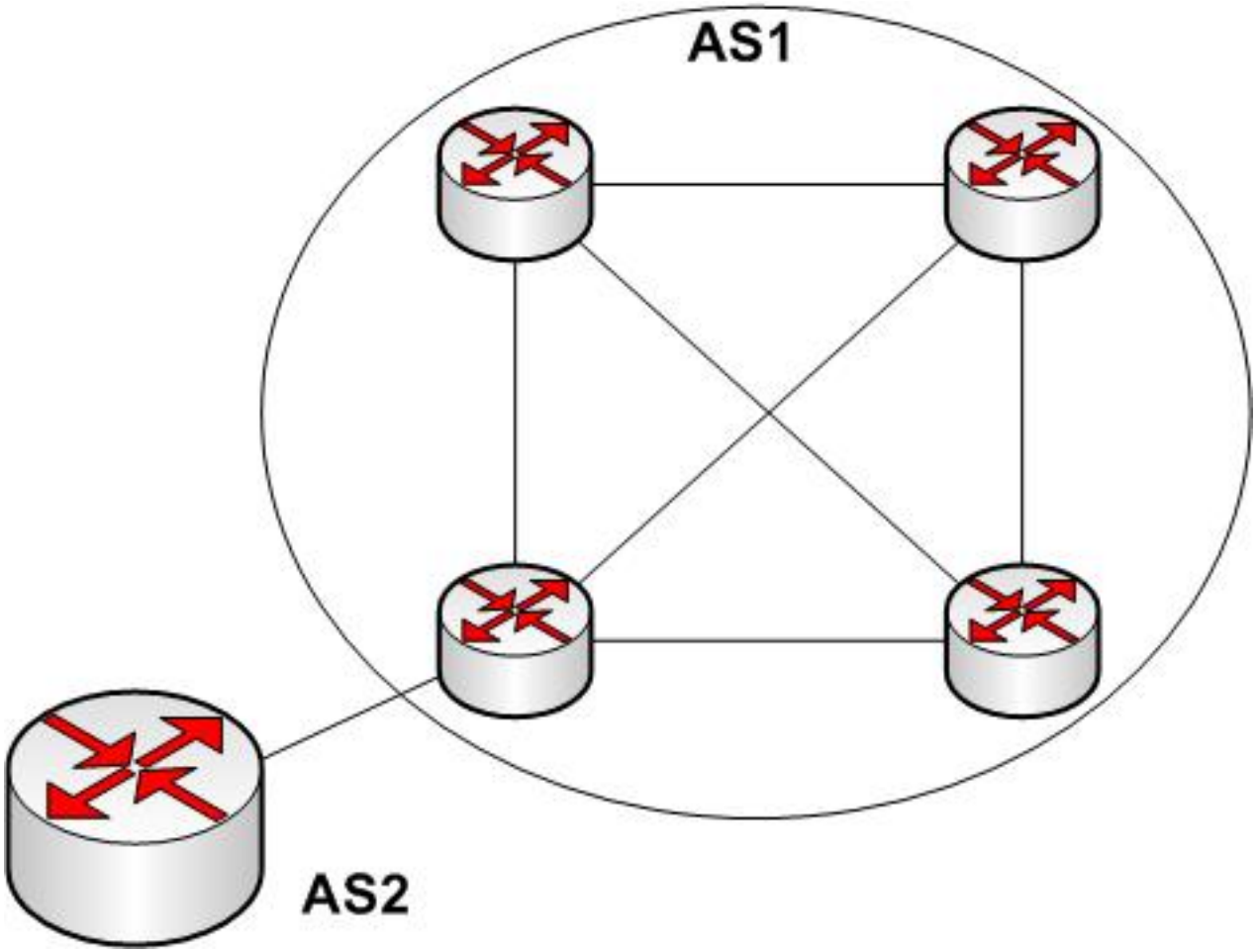
AS-Path filters for Confederations

- ^$ Doesn’t work any more…
- ^$ matches internal routes in a given POP, but with confederations your routes will look like:
- ^(64512 64513)$ as well as ^$
- ip as acc 55 deny ^(\([0-9]*\))*$

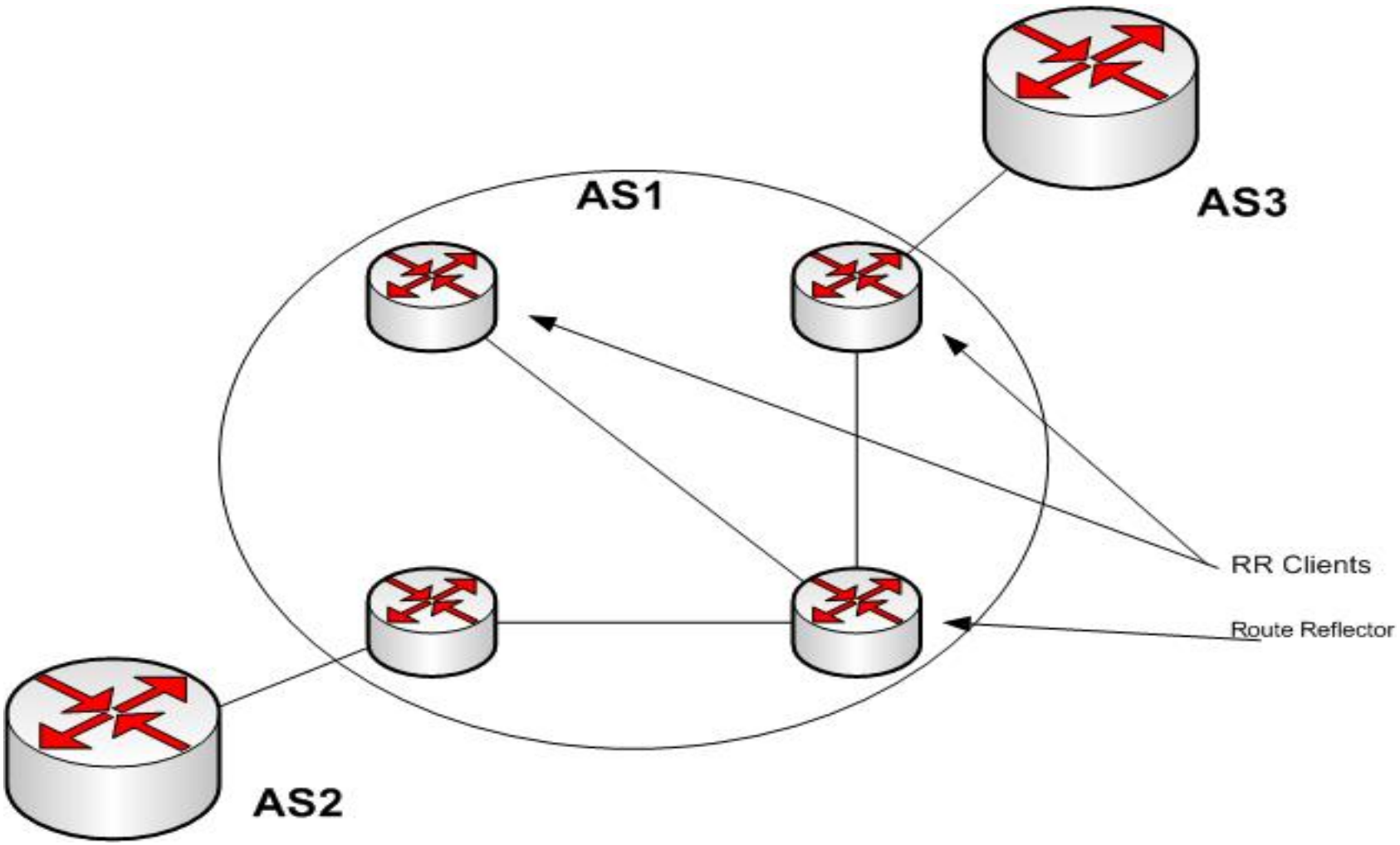
Route Reflectors (1)

- One or two routers in a ‘cluster’ (often a POP) are allowed to break the rules for their ‘clients’ and ‘reflect’ routes heard from other iBGP speakers.
- iBGP routes heard from non-clients are sent to clients but not to other non-clients.
- iBGP routes heard from clients are sent to eBGP peers, client peers, and non-clients.
- eBGP works as normal.
- RRs themselves are then fully meshed.

Route Reflectors (2)



Route Reflectors (3)



Route Reflectors (4)

- On the route-reflector server, tag each client as ‘neigh X route-reflector-client’
- All route-reflector servers must peer with each other
- (note: Enabling will reset sessions.)
- Two new attributes:
  - ORIGINATOR_ID, the Router ID of the originator. Updates never sent back to that router.
  - CLUSTER_LIST, a list of the CLUSTER_IDs the route has passed through. Loop detection here also.

Route Reflectors (5)

- sho ip bgp <route> will identify ‘Originator: 10.0.1.1, Cluster list: 10.0.1.3’ and on a core mesh member: ‘<aspath>, (Received from a RR-client)’
- On the route-reflector you can also issue ‘show ip bgp update-group’ for more info.
- Best path selection: Shortest cluster list len

Supporting Multi-Homed Customers

Supporting Multi-Homed Custs

- What they need from you is routes to the ‘net, and some ability to be flexible in how you announce their routes.
- Routes to the ‘net - give them your communities (“neighbor x.y.z.q send-communities”). Publish your communities so they know what they mean. WARN if you change community semantics.

Supporting Multi-Homed Custs

- Be prepared to punch holes in your aggregates.
  - Using network statements, or filters, no problem.
  - Otherwise, be prepared to use suppress-maps if you use aggregate-address statements.
- Set up communities they can use to control which pipes you advertise them to, and what their routes look like.

Backup Transit

Mutual Backup Transit/Peering

- Make your network better AND help your competitor. Strange world we live in.
- Find a local competitor who has diverse connectivity and share the cost of a FastE/GigE. (Easy if you're both in a metro Ethernet cloud or at a local IX).
- Announce each other either:
  - Always, but padded (best, requires lots of coordination)
  - By request
  - Only if you can't hear them from the outside (communities-based and tricky)
- Local peering just often makes bandwidth-saving and/or quality sense

Router Configs

Review - Basic Router Configuration

“How do I log config changes?”

- Run tacacs+ on most gear and it’ll log all commands (including ‘conf term’ commands).
- You might want to look into rancid and other router-config tools.
- Once you start MacGuyver-ing things it’s hard to go back

Cisco Regular Expressions

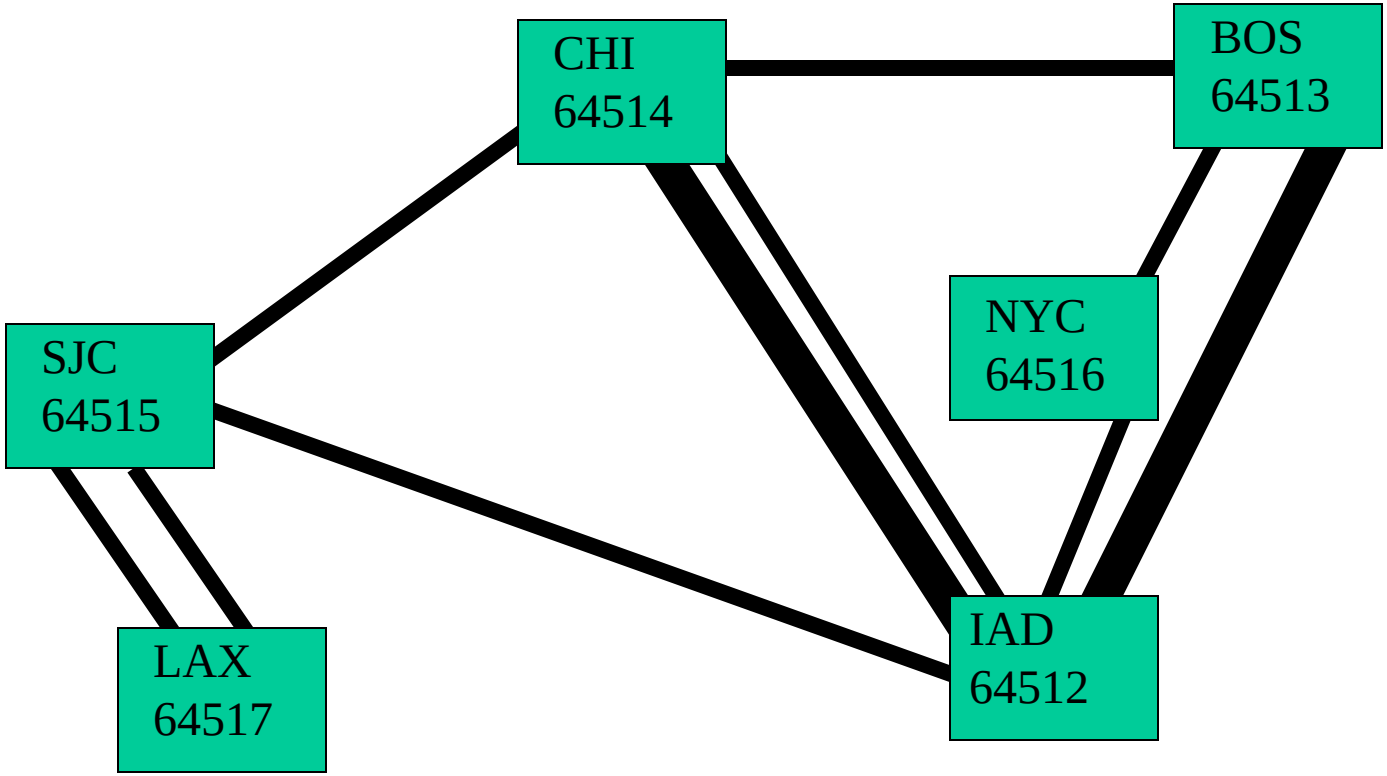
.	Period matches any single character, including white space.
*	Asterisk matches 0 or more sequences of the pattern.
+	Plus sign matches 1 or more sequences of the pattern.
?	Question mark matches 0 or 1 occurrences of the pattern
^	Caret matches the beginning of the input string.
$	Dollar sign matches the end of the input string.
_	Underscore matches a comma (,), left brace ({), right brace (}), left parenthesis, right parenthesis, the beginning or end of the input string, or a space.
[]	Brackets designate a range of single character patterns.
-	Hyphen separates the endpoints of a range.

Basic Parameters

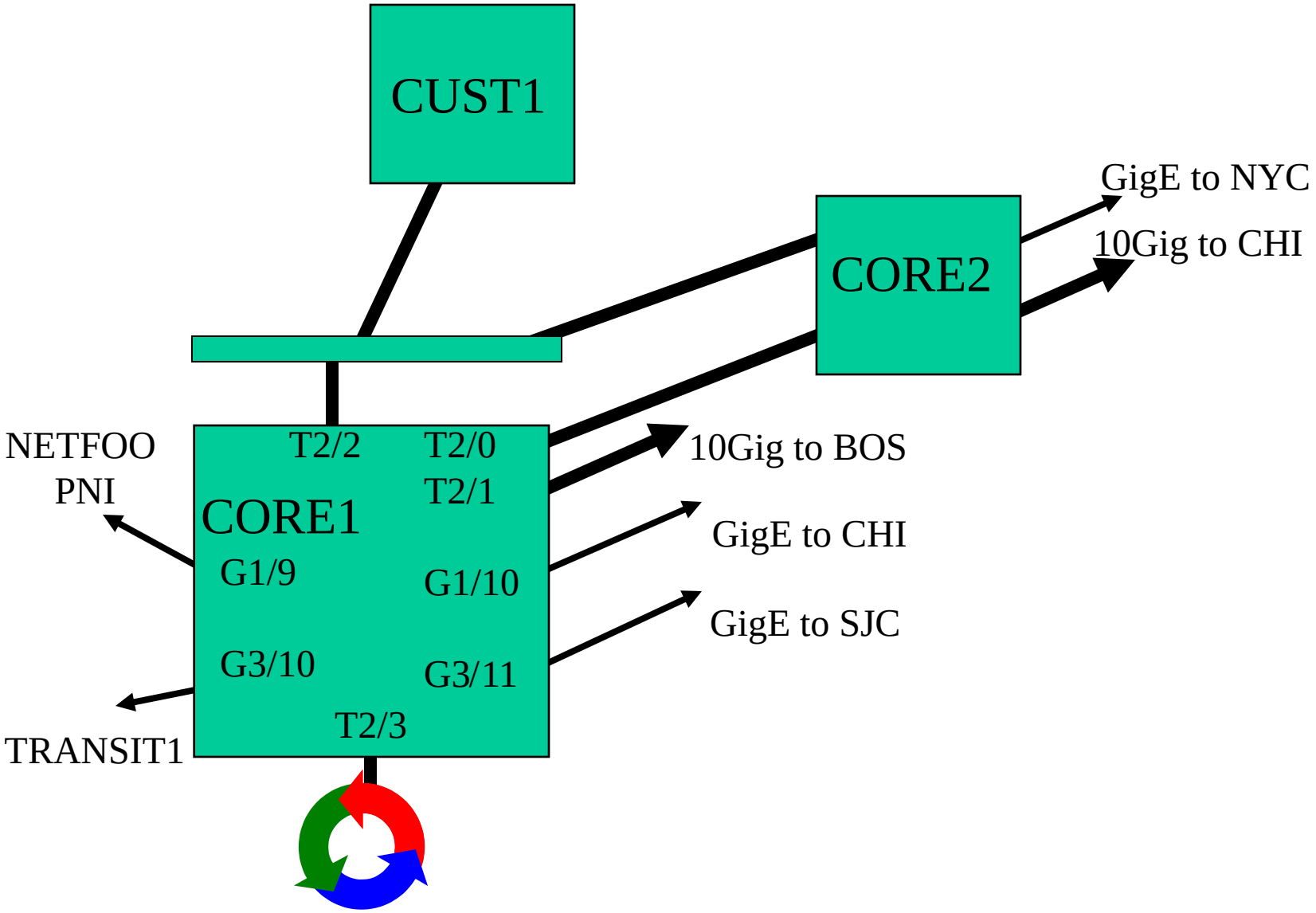
```
aaa new-model
aaa authentication login default tacacs+ local
aaa accounting commands 15 stop-only tacacs+
aaa accounting network start-stop tacacs+
aaa accounting connection start-stop tacacs+
aaa accounting system start-stop tacacs+
ip tacacs source-interface Loopback0
tacacs-server host 10.5.0.1
tacacs-server host 10.6.0.2
tacacs-server host 10.7.0.3
tacacs-server key noBaDpeers
```

Config for Sample Network

Sample Network



NoNameNet
Equinix Ashburn



Design Goals (1)

- Filter customer routes and bogons/default vigorously on inbound; assign (or let them assign) a transit community.
- Filter garbage (IX) routes inbound from everyone.
- No dampening.
- Allow customers to control how you advertise them.

Design Goals (2)

- Prefer customers, then private, then good public, then worse public, routes.
- Use confederations not because needed, but for scaling concerns.
- Use loopbacks for iBGP peering.

Interface Configs

```
interface Loopback0
 ip address 207.106.0.2 255.255.255.255
!
interface TenGigabitEthernet2/0
 description core1-core2 private
 ip add 207.106.2.89 255.255.255.252
!
interface TenGigabitEthernet2/2
 description POP Backbone
 ip address 207.106.4.1 255.255.255.224
!
Interface TenGigabitEthernet2/3
 description IX Connection
 ip address 192.41.177.4 255.255.255.0

! (and for each interface)
  no ip redirects
  ip flow ingress ! Maybe
  ip route-cache same-interface
  ip route-cache flow
  load-interval 30
```

```
Interface TenGigabitEthernet2/1
 description link to BOS
 ip address 207.106.2.5 255.255.255.252
!
interface GigabitEthernet1/10
 description link to CHI
 ip address 207.106.2.9 255.255.255.252
!
Interface GigabitEthernet3/11
 description link to SJC
 ip address 207.106.2.13 255.255.255.252
!
Interface GigabitEthernet1/9
 description PI to Network FOO
 ip address 9.9.9.10 255.255.255.252
!
interface GigabitEthernet3/10
 description Transit link to fast.net
 ip address 207.106.127.6 255.255.255.252
```

OSPF Configuration

```
router ospf 22
 redistribute connected subnets
 redistribute static subnets
 passive-interface TenGigabitEthernet3/10
 passive-interface GigabitEthernet1/9
 passive-interface TenGigabitEthernet2/3
 network 207.106.4.0 0.0.0.31  area 207.106.4.0
 network 207.106.2.0 0.0.0.255 area 0
 area 0 authentication
 area 207.106.4.0 authentication
! Plus appropriate costs on different-size links
```

BGP Config

```
ip as acc 1 permit .*
ip as acc 2 deny .*

router bgp 64512
 no synchronization
 bgp router-id 207.106.0.2
 no bgp dampening
 confederation identifier 15000
 confederation peers 64512 64513 64514 64515
   64516 64517 64518 64519
 network 207.106.60.0 mask 255.255.255.0 route-
   map set-local-community

route-map set-local-community
   set comm 15000:123
```

Public Peers (1)

```
router bgp 64512
 neighbor public-peer peer-group
 neighbor public-peer next-hop-self
 neighbor public-peer soft-reconfig in
 neighbor public-peer version 4
 neighbor public-peer send-community
 neighbor public-peer prefix-list from-peers in
 neighbor public-peer route-map public-in in
 neighbor public-peer route-map send-transit out
 neighbor public-peer filter-list 4 in
```

Peer Filter (old way)

```
access-list 110 deny   ip host 0.0.0.0 any
access-list 110 deny   ip 192.41.177.0 0.0.0.255 255.255.255.0 0.0.0.255
access-list 110 deny   ip 192.157.69.0 0.0.0.255 255.255.255.0 0.0.0.255
access-list 110 deny   ip 198.32.128.0 0.0.0.255 255.255.255.0 0.0.0.255
access-list 110 deny   ip 198.32.130.0 0.0.0.255 255.255.255.0 0.0.0.255
access-list 110 deny   ip 198.32.136.0 0.0.0.255 255.255.255.0 0.0.0.255
access-list 110 deny   ip 198.32.146.0 0.0.0.255 255.255.255.0 0.0.0.255
access-list 110 deny   ip 198.32.146.0 0.0.1.255 255.255.254.0 0.0.1.255
access-list 110 deny   ip 198.32.176.0 0.0.0.255 255.255.255.0 0.0.0.255
access-list 110 deny   ip 198.32.180.0 0.0.0.255 255.255.255.0 0.0.0.255
access-list 110 deny   ip 198.32.184.0 0.0.0.255 255.255.255.0 0.0.0.255
access-list 110 deny   ip 198.32.186.0 0.0.0.255 255.255.255.0 0.0.0.255
access-list 110 deny   ip 127.0.0.0 0.255.255.255 255.0.0.0 0.255.255.255
access-list 110 deny   ip 10.0.0.0 0.255.255.255 255.0.0.0 0.255.255.255
access-list 110 deny   ip 172.16.0.0 0.15.255.255 255.240.0.0 0.15.255.255
access-list 110 deny   ip 192.168.0.0 0.0.255.255 255.255.0.0 0.0.255.255
access-list 110 permit ip any any
```

Peer Filter (new way)

```
ip prefix-list from-peers deny 0.0.0.0/0
ip prefix-list from-peers 192.41.177.0/24 ge 24
ip prefix-list from-peers 192.157.69.0/24 ge 24
ip prefix-list from-peers 198.32.128.0/24 ge 24
ip prefix-list from-peers 198.32.130.0/24 ge 24
ip prefix-list from-peers 198.32.136.0/24 ge 24
ip prefix-list from-peers 198.32.146.0/24 ge 24
ip prefix-list from-peers 198.32.146.0/23 ge 24
ip prefix-list from-peers 198.32.176.0/24 ge 24
ip prefix-list from-peers 198.32.180.0/24 ge 24
ip prefix-list from-peers 198.32.184.0/24 ge 24
ip prefix-list from-peers 198.32.186.0/24 ge 24
ip prefix-list from-peers 127.0.0.0/8 ge 8
ip prefix-list from-peers 10.0.0.0/8 ge 8
ip prefix-list from-peers 172.16.0.0/16 ge 16
ip prefix-list from-peers 192.168.0.0/16 ge 16
! (plus plenty more from your friendly neighborhood bogon filter)
ip prefix-list from-peers permit 0.0.0.0/0 ge 3
```

Public Peers (3)

```
route-map public-in permit 10
 set community 15000:666 15000:8100
 set local 100

ip community-list 1 permit 15000:123
ip community-list 1 permit 15000:1200

route-map send-transit
 match community 1
```

Public Peers (4)

```
! Obviously, don’t apply this to UU, Sprint,
! Savvis, ATT, etc…

ip as-path access-list 4 deny _701_
ip as-path access-list 4 deny _1239_
ip as-path access-list 4 deny _3561_
ip as-path access-list 4 deny _7018_
ip as-path access-list 4 deny _1_
<etc>
ip as-path access-list 4 permit .*
```

Private Peers (1)

```
router bgp 64512
 neighbor <peerip> next-hop-self
 neighbor <peerip> soft-reconfig in
 neighbor <peerip> version 4
 neighbor <peerip> send-community
 neighbor <peerip> prefix-list from-peers in
 neighbor <peerip> route-map private-in in
 neighbor <peerip> route-map send-transit out
 neighbor <peerip> filter-list 4 in
```

Private Peers (2)

```
route-map public-in permit 10
 set community 15000:666 15000:8100
 set local 120
```

Customer Peer (1)

```
router bgp 64512
 neighbor <custip> next-hop-self
 neighbor <custip> soft-reconfig in
 neighbor <custip> version 4
 neighbor <custip> send-community
 neighbor <custip> prefix-list from-customerAA in
 neighbor <custip> route-map set-transit in
 neighbor <custip> route-map send-transit out

! Prefix list is PER-CUSTOMER!!!
```

Customer Peer (2)

```
route-map set-transit
 set local-pref 140
 set community 15000:8100 15000:1200 additive

! Or, for customers who want flexibility
! Let them set themselves for transit

route-map allow-transit
 set local-pref 140
 set community 15000:8100 additive

!also, have communities for changing local-pref
```

Internal - Same or Diff Confed

```
router bgp 64512
 neighbor <custip> next-hop-self
 neighbor <custip> update-source Loopback0
 nieghbor <custip> send-community

! Main thing is to set med on per-neigh basis.

! No need for soft-reconfig in; can always clear
! it outbound from the other end.
```

To nLayer

```
ip community 25 permit 15000:44360
ip community 26 permit 15000:44362
ip community 27 permit 15000:44361
ip community 28 permit 15000:4436
ip community 28 permit 15000:1200
ip community 28 permit 15000:123
route-map 2nlayer deny 10
 match comm 25
route-map 2nlayer permit 20
 match comm 26
 set as pre 15000 15000
route-map 2nlayer permit 30
 match comm 27
 set as pre 15000
route-map 2nlayer permit 40
 match comm 28
```

Communities Caveat

There are better (more generic), though more complex, ways of doing communities systems with wildcards that work on Cisco, Juniper, and Foundry (search NANOG presentations).

{Backup} Transit

```
route-map backup-out permit 10
 match community 1
 set as pre 15000 15000 15000 15000 15000 15000

route-map send-transit permit 10
 match community 1

route-map allow-transit
 set local-pref 140
 set community 15000:8100 additive
```