12.0 IOS release images for ISPs

- 12.0S is the release for all ISPs
  - for 7200, 7500 and GSR
  - replaces 11.1CC and 11.2GS
  - currently at 12.0(10)S1
- 12.0 is the "mainline" train
  - for all other platforms
  - replaces 11.2P and 11.3T
  - currently at 12.0(11)
- Available on CCO, supported by TAC

New IOS Features

- 12.1 is the new "mainline" train
  - comes from 12.0T
  - no new features, aiming for stability
- 12.1T is the "technology train"
  - new features introduced in IOS 12.1
- Both have very new IOS features, supporting new hardware and software
- Available on CCO, supported by TAC

BGP versus OSPF/ISIS

- Internal Routing Protocols (IGPs)
  - examples are ISIS and OSPF
  - used for carrying infrastructure addresses
  - NOT used for carrying Internet prefixes or customer prefixes

BGP versus OSPF/ISIS

- BGP used internally (iBGP) and externally (eBGP)
- iBGP used to carry
  - some/all Internet prefixes across backbone
  - customer prefixes
- eBGP used to
  - exchange prefixes with other ASes
  - implement routing policy

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BGP versus OSPF/ISIS

- DO NOT:
  - distribute BGP prefixes into an IGP
  - distribute IGP routes into BGP
  - use an IGP to carry customer prefixes
- YOUR NETWORK WILL NOT SCALE

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Aggregation

- ISPs receive address block from Regional Registry or upstream provider
- Aggregation means announcing the address block only, not subprefixes
- Aggregate should be generated internally

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Configuring Aggregation - Cisco IOS

- ISP has 221.10.0.0/19 address block
- To put into BGP as an aggregate:

```
router bgp 100
 network 221.10.0.0 mask 255.255.224.0
ip route 221.10.0.0 255.255.224.0 null0 250
```

- The static route is a "pull up" route
  - more specific prefixes within this address block ensure connectivity to ISP's customers
  - "longest match lookup"

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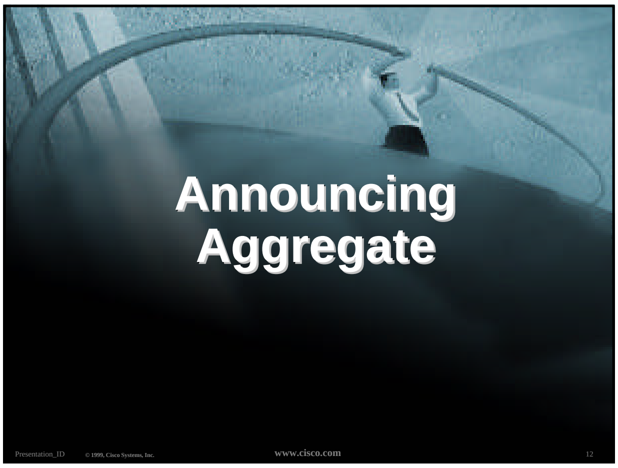


Aggregation

- Address block should be announced to the Internet as an aggregate
- Subprefixes of address block should NOT be announced to Internet unless special circumstances (more later)

Announcing Aggregate - Cisco IOS

- Configuration Example

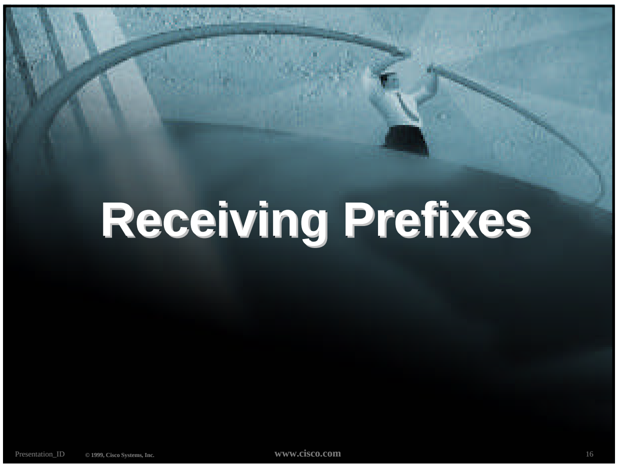
```
router bgp 100
 network 221.10.0.0 mask 255.255.224.0
 neighbor 222.222.10.1 remote-as 101
 neighbor 222.222.10.1 prefix-list out-filter out
!
ip route 221.10.0.0 255.255.224.0 null0
!
ip prefix-list out-filter permit 221.10.0.0/19
ip prefix-list out-filter deny 0.0.0.0/0 le 32
```


Announcing an Aggregate

- ISPs who don't and won't aggregate are held in poor regard by community
- Registries' minimum allocation sizes are /19s or /20s now

  no real reason to see anything longer than a /21 or /22 prefix in the Internet

  BUT there are currently >46000 /24s!



Receiving Prefixes from downstream peers

- ISPs should only accept prefixes which have been assigned or allocated to their downstream peer
- For example

  downstream has 220.50.0.0/20 block

  should only announce this to peers

  peers should only accept this from them

Receiving Prefixes - Cisco IOS

- Configuration Example on upstream

```
router bgp 100
 neighbor 222.222.10.1 remote-as 101
 neighbor 222.222.10.1 prefix-list customer in
!
ip prefix-list customer permit 220.50.0.0/20
ip prefix-list customer deny 0.0.0.0/0 le 32
```

Receiving Prefixes from upstream peers

- Not desirable unless really necessary
  - special circumstances
- Ask upstream to either:
  - originate a default-route
  - announce one prefix you can use as default

Receiving Prefixes from upstream peers

- Downstream Router Configuration

```
router bgp 100
 network 221.10.0.0 mask 255.255.224.0
 neighbor 221.5.7.1 remote-as 101
 neighbor 221.5.7.1 prefix-list infilt in
 neighbor 221.5.7.1 prefix-list outfilt out
!
ip prefix-list infilt permit 0.0.0.0/0
ip prefix-list infilt deny 0.0.0.0/0 le 32
!
ip prefix-list outfilt permit 221.10.0.0/19
ip prefix-list outfilt deny 0.0.0.0/0 le 32
```


Receiving Prefixes from upstream peers

- Upstream Router Configuration

```
router bgp 101
 neighbor 221.5.7.2 remote-as 100
 neighbor 221.5.7.2 default-originate
 neighbor 221.5.7.2 prefix-list cust-in in
 neighbor 221.5.7.2 prefix-list cust-out out
!
ip prefix-list cust-in permit 221.10.0.0/19
ip prefix-list cust-in deny 0.0.0.0/0 le 32
!
ip prefix-list cust-out permit 0.0.0.0/0
ip prefix-list cust-out deny 0.0.0.0/0 le 32
```


Receiving Prefixes from upstream peers

- If necessary to receive prefixes from upstream provider, care is required
  - don't accept RFC1918 etc prefixes
  - don't accept your own prefix
  - don't accept default (unless you need it)
  - don't accept prefixes longer than /24

Receiving Prefixes

```
router bgp 100
 network 221.10.0.0 mask 255.255.224.0
 neighbor 221.5.7.1 remote-as 101
 neighbor 221.5.7.1 prefix-list in-filter in
!
ip prefix-list in-filter deny 0.0.0.0/0              ! Block default
ip prefix-list in-filter deny 0.0.0.0/8 le 32
ip prefix-list in-filter deny 10.0.0.0/8 le 32
ip prefix-list in-filter deny 127.0.0.0/8 le 32
ip prefix-list in-filter deny 169.254.0.0/16 le 32
ip prefix-list in-filter deny 172.16.0.0/12 le 32
ip prefix-list in-filter deny 192.0.2.0/24 le 32
ip prefix-list in-filter deny 192.168.0.0/16 le 32
ip prefix-list in-filter deny 221.10.0.0/19 le 32    ! Block local prefix
ip prefix-list in-filter deny 224.0.0.0/3 le 32      ! Block multicast
ip prefix-list in-filter deny 0.0.0.0/0 ge 25        ! Block prefixes >/24
ip prefix-list in-filter permit 0.0.0.0/0 le 32
```


"Documenting Special Use Addresses" - DSUA

- This prefix-list MUST be applied to all external BGP peerings, in and out!
  - http://www.ietf.org/internet-drafts/draft-manning-dsua-03.txt

```
ip prefix-list rfc1918-dsua deny 0.0.0.0/8 le 32
ip prefix-list rfc1918-dsua deny 10.0.0.0/8 le 32
ip prefix-list rfc1918-dsua deny 127.0.0.0/8 le 32
ip prefix-list rfc1918-dsua deny 169.254.0.0/16 le 32
ip prefix-list rfc1918-dsua deny 172.16.0.0/12 le 32
ip prefix-list rfc1918-dsua deny 192.0.2.0/24 le 32
ip prefix-list rfc1918-dsua deny 192.168.0.0/16 le 32
ip prefix-list rfc1918-dsua deny 224.0.0.0/3 le 32
ip prefix-list rfc1918-dsua deny 0.0.0.0/0 ge 25
ip prefix-list rfc1918-dsua permit 0.0.0.0/0 le 32
```

Injecting prefixes into iBGP

- Use iBGP to carry customer prefixes
  - don't use IGP
- Point static route to customer interface
- Use BGP network statement
- As long as static route exists (interface active), prefix will be in BGP

Router Configuration network statement

- Example:

```
interface loopback 0
 ip address 215.17.3.1 255.255.255.255
!
interface Serial 5/0
 ip unnumbered loopback 0
 ip verify unicast reverse-path
!
ip route 215.34.10.0 255.255.252.0 Serial 5/0
!
router bgp 100
 network 215.34.10.0 mask 255.255.252.0
```


Injecting prefixes into iBGP

- 200 network statement limit removed
- interface flap will result in prefix withdraw and reannounce
  - use "ip route…permanent"
- many ISPs use redistribute static rather than network statement
  - only use this if you understand why

Router Configuration redistribute static

- Example:

```
ip route 215.34.10.0 255.255.252.0 Serial 5/0
!
router bgp 100
 redistribute static route-map static-to-bgp
<snip>
!
route-map static-to-bgp permit 10
 match ip address prefix-list ISP-block
 set origin igp
<snip>
!
ip prefix-list ISP-block permit 215.34.10.0/22 le 30
!
```


Injecting prefixes into iBGP

- Route-map ISP-block can be used for many things:
  - setting communities and other attributes
  - setting origin code to IGP, etc
- Be careful with prefix-lists and route-maps
  - absence of either/both means all statically routed prefixes go into iBGP

Scaling the network

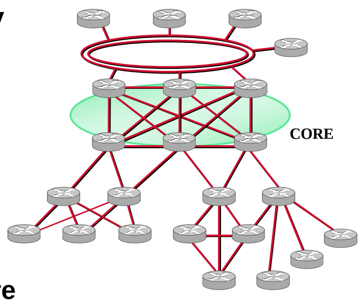
How to get out of carrying all prefixes in IGP

IGP Limitations

- Amount of routing information in the network
  - Periodic updates/flooding
  - Long convergence times
  - Affects the core first
- Policy definition
  - Not easy to do

BGP Cores Sample Network

- Geographically distributed
- Hierarchical
- Redundant
- Media independent
- A clearly identifiable core



iBGP Core Migration Plan

- Configure BGP in all the core routers
  - Transit path
  - Turn synchronization off
  - Turn auto-summarisation off
- Check network border routers
  - ensure eBGP peerings only announce aggregates and won't leak specifics

iBGP Core Migration Plan (Cont.)

- Route Generation
  - Use static routes to create summaries if required
  - Redistribution from the IGP is NOT recommended as it may cause instability

iBGP Core Migration Plan (Cont.)

- Route Generation—Example:

```
!
router bgp 109
 network 200.200.200.0
 network 201.201.0.0 mask 255.255.0.0
!
ip route 200.200.200.0 255.255.255.0 null0 250
ip route 201.201.0.0 255.255.0.0 null0 250
!
```

iBGP Core Migration Plan (Cont.)

- Verify consistency of routing information
  - Compare the IGP routing table against the BGP table—they must match!
- Change the distance parameters so that the BGP routes are preferred
  - distance bgp 20 20 20
  - All IGPs have a higher administrative distance

iBGP Core Migration Plan (Cont.)

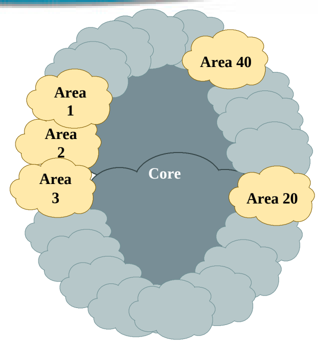
- Filter “non-core” IGP routes
  - Method will depend on the IGP used
  - May require the use of a different IGP process in the core if using a link state protocol
  - The routes to reach all the core links plus the BGP peering addresses must be carried by the IGP

iBGP Core Migration Plan (Cont.)

- Once iBGP carrying prefixes...
  - apply route-map to IGP redistribute commands so that only infrastructure addresses are in IGP
  - check that customer routes in IGP have disappeared
  - change BGP distance back to default
    - no distance bgp 20 20 20

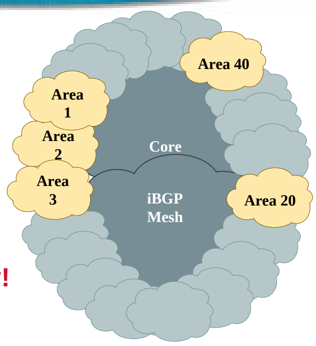
iBGP Core Before...

- IGP carries all the routes
- The core routers may be stressed due to the large number of routes



iBGP Core After...

- IGP carries only core links plus peering address information
- BGP carries all the routes
- Increased Stability!



iBGP Core Results

- The routes from the core cannot be redistributed back into the IGP
  - Non-core areas need a default route
  - Amount of routing information in non-core areas has been reduced!
- Full logical iBGP mesh
- External connections must be located in the core

Scaling Issues

- Full mesh core
  - High number of neighbors
  - Update generation
- Complex topologies
  - Not a “simple” hierarchical network
  - Multiple external and/or inter-region connections
  - Policy definition and enforcement

Scaling Issues: Solutions

- Reduce the number of updates
  - Peer groups
- Reduce the number of neighbors
  - Confederations
  - Route reflectors
- Use additional information to effectively apply policies
  - eBGP provides extra granularity
  - Confederations

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