BGP in the Internet

Best Current Practices

Cisco Systems

Recommended IOS Releases

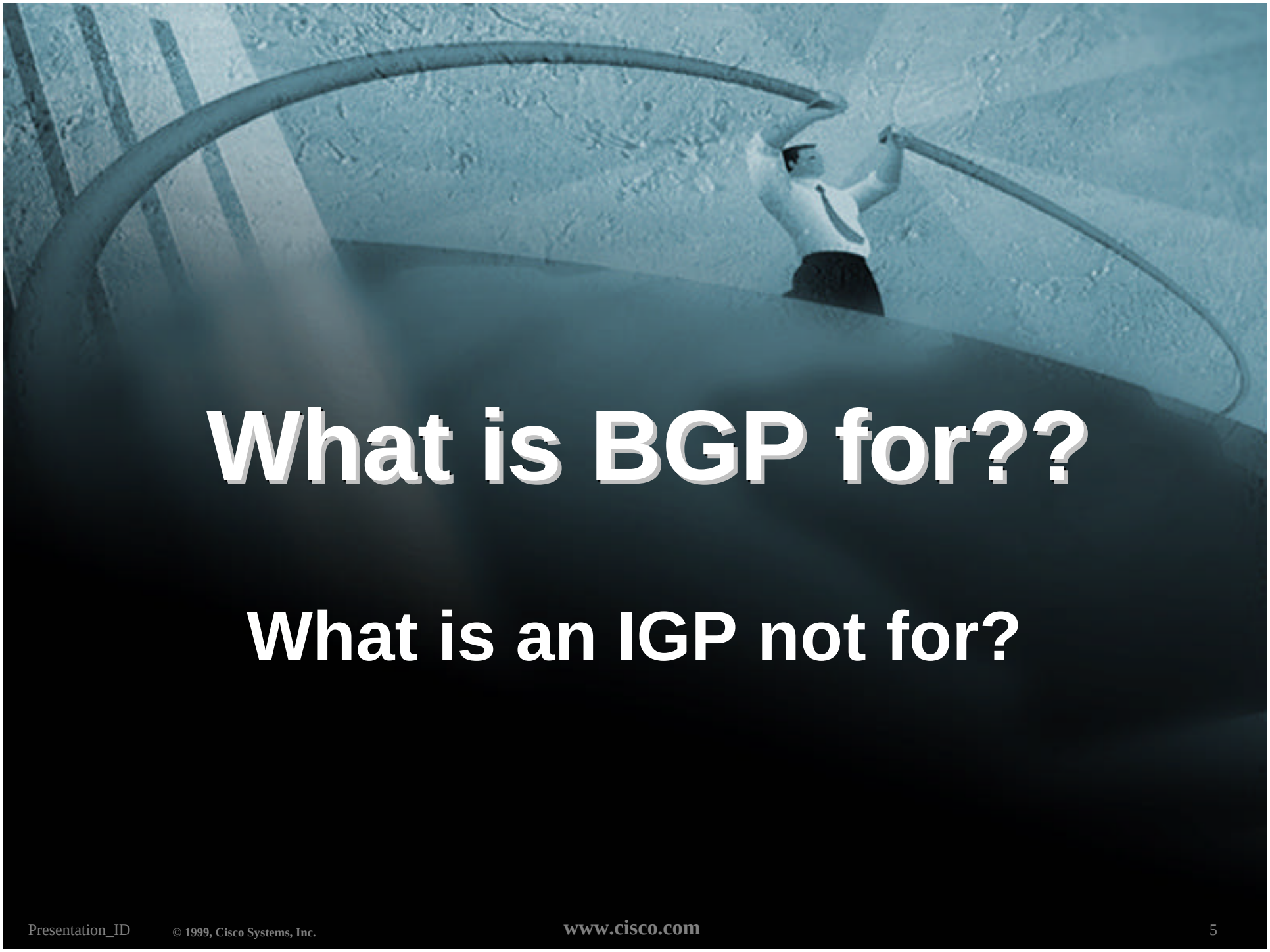
Which IOS??

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



What is BGP for??

What is an IGP not for?

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

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**

Generating an Aggregate

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**

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”

Announcing Aggregate

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

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
```

Prefixes into iBGP

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

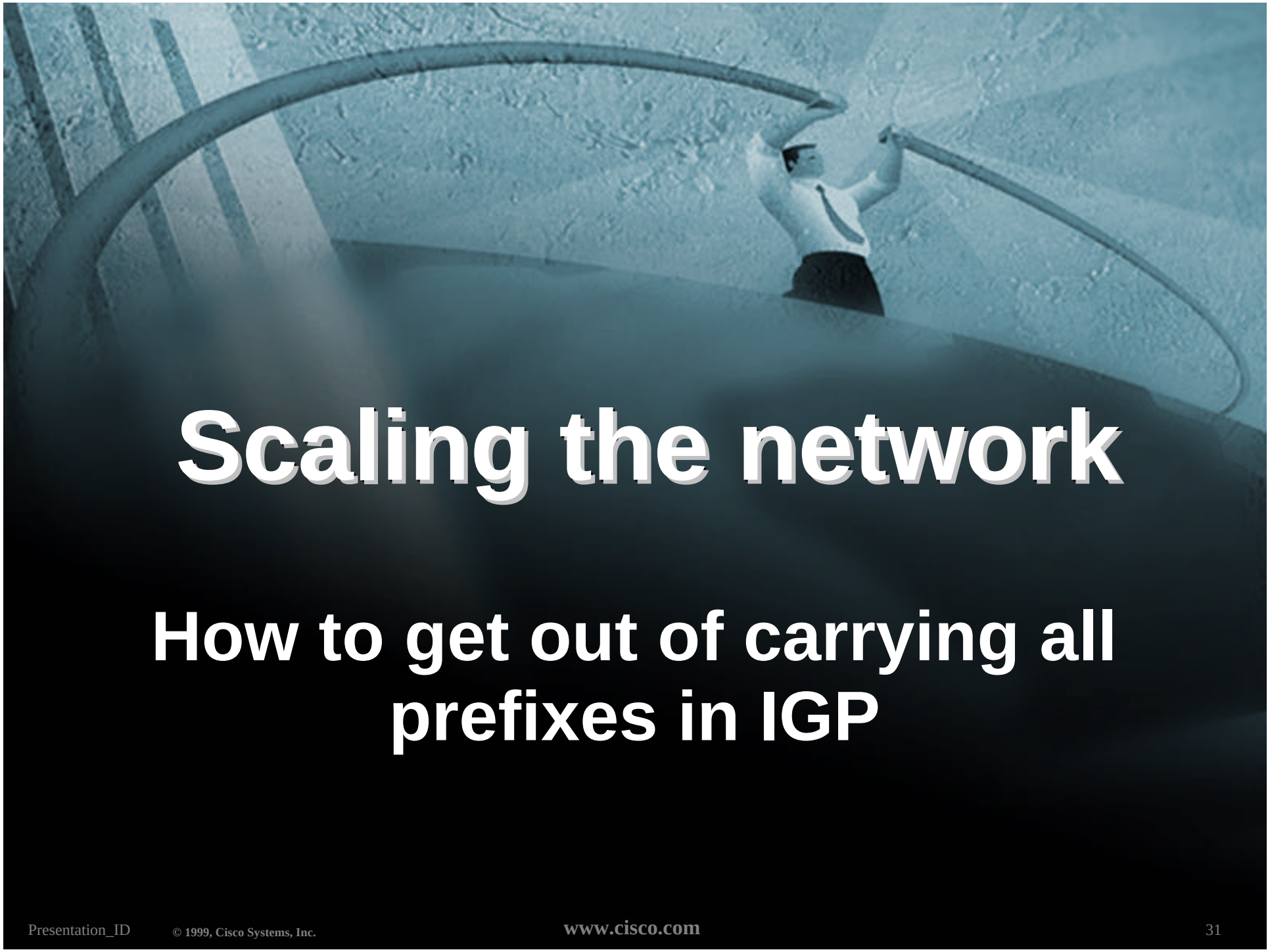
- **Route-map ISP-block can be used for many things:**

  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

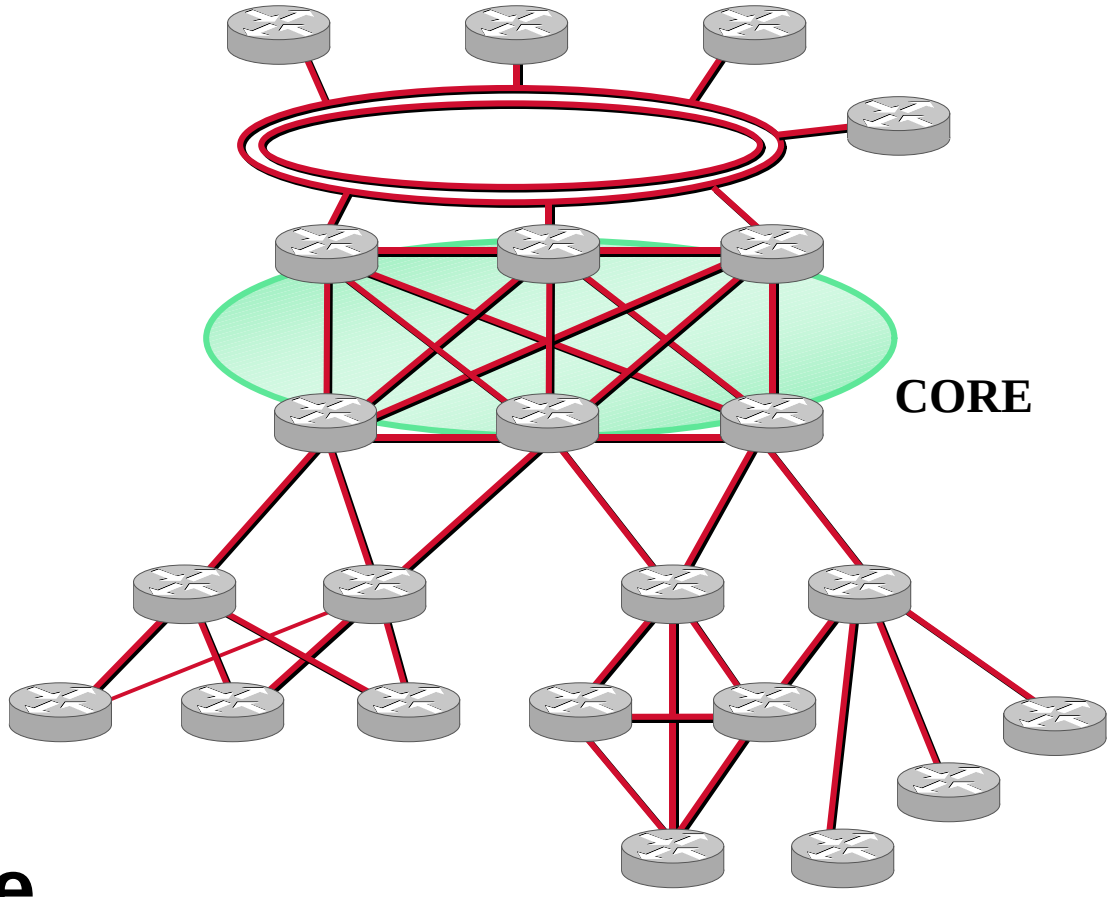
How to get out of carrying all prefixes in IGP

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

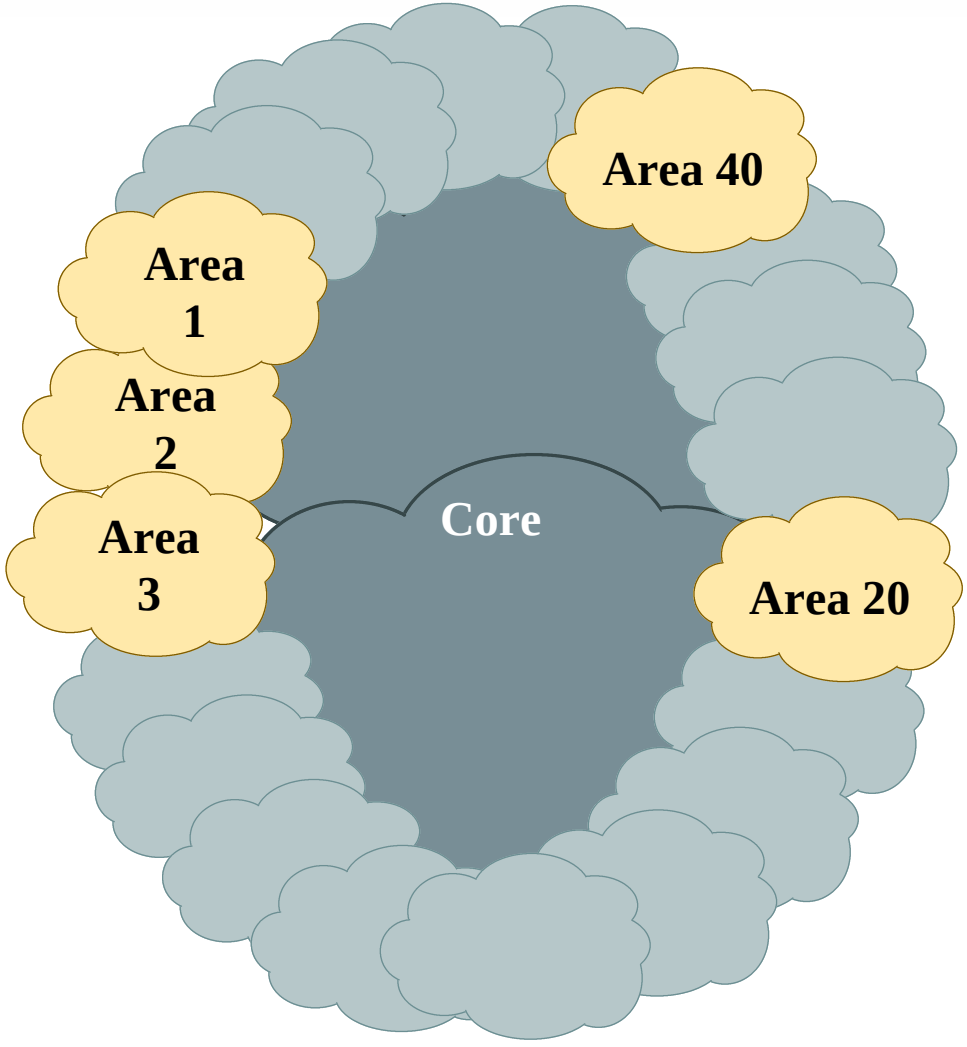
  check that customer routes in IGP have disappeared

  change BGP distance back to default

  no distance bgp 20 20 20

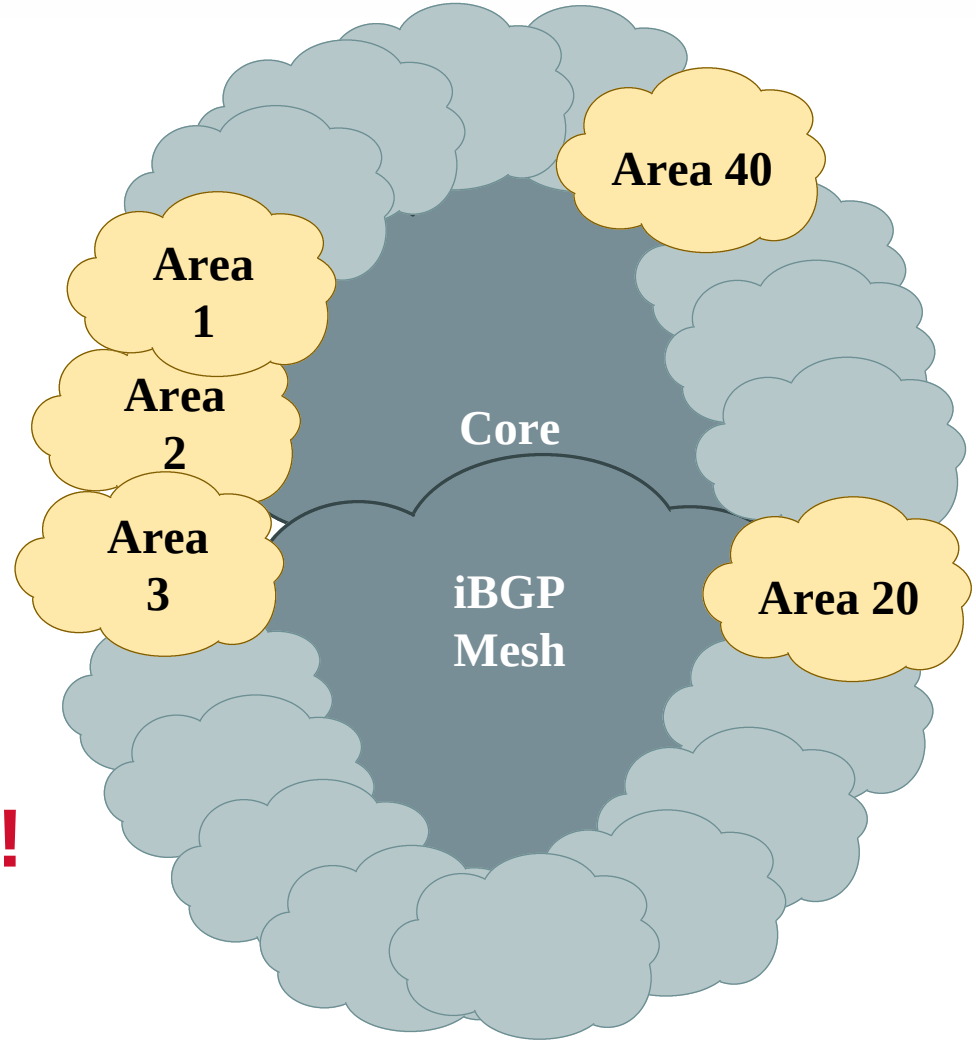
iBGP Core Before...

- 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**


Cisco Systems
Empowering the
Internet Generation℠