Definitions

- **Transit** – carrying traffic across a network, usually for a fee
  traffic and prefixes originating from one AS are carried across an intermediate AS to reach their destination AS
- **Exchange Points** – common interconnect location where several ASes exchange routing information and traffic

ISP Transit Issues

- Only announce default to your BGP customers unless they need more prefixes
- Only accept the prefixes which your customer is entitled to originate
- If your customer hasn’t told you he is providing transit, don’t accept anything else

ISP Transit Provider

**Simple Example**

- AS130 and AS100 are stub/customer ASes of AS120
  - they may have their own peerings with other ASes
  - minimal routing table desired
  - minimum complexity required
**ISP Transit**

- AS120 is transit provider between AS130 and AS100.

**Router A Configuration**

```
router bgp 130
network 221.10.0.0 mask 255.255.224.0
neighbor 222.222.10.2 remote-as 120
neighbor 222.222.10.2 prefix-list upstream out
neighbor 222.222.10.2 prefix-list default in
!
ip prefix-list default permit 0.0.0.0/0
ip prefix-list upstream permit 221.10.0.0/19
!
ip route 221.10.0.0 255.255.224.0 null0
```

**Router B Configuration**

```
router bgp 120
neighbor 222.222.10.1 remote-as 130
neighbor 222.222.10.1 default-originate
neighbor 222.222.10.1 prefix-list Customer130 in
neighbor 222.222.10.1 prefix-list default out
!
ip prefix-list Customer130 permit 221.10.0.0/19
ip prefix-list default permit 0.0.0.0/0
```

**Router B announces default to Router A, only accepts customer /19.**

**Router C Configuration**

```
router bgp 120
neighbor 222.222.20.1 remote-as 100
neighbor 222.222.20.1 default-originate
neighbor 222.222.20.1 prefix-list Customer100 in
neighbor 222.222.20.1 prefix-list default out
!
ip prefix-list Customer100 permit 219.0.0.0/19
ip prefix-list default permit 0.0.0.0/0
```

**Router C announces default to Router D, only accepts customer /19.**

**Router D Configuration**

```
router bgp 100
network 219.0.0.0 mask 255.255.224.0
neighbor 222.222.20.2 remote-as 120
neighbor 222.222.20.2 prefix-list upstream out
neighbor 222.222.20.2 prefix-list default in
!
ip prefix-list default permit 0.0.0.0/0
ip prefix-list upstream permit 219.0.0.0/19
!
ip route 219.0.0.0 255.255.224.0 null0
```

**This is simple case:**

If AS130 or AS100 get another address block, it requires AS120 and their own filters to be changed.

Some ISP transit provider are better skilled at doing this than others!

May not scale if they are frequently adding new prefixes.
ISP Transit Provider

More complex Example 1

ISP Transit

- AS130 and AS100 are stub/customer ASes of AS120
  - AS120 provides transit between AS130 and AS100 only
  - AS120 does not provide Internet connectivity to AS130

ISP Transit

- Router A Configuration
  - router bgp 130
  - network 221.10.0.0 mask 255.255.224.0
  - neighbor 222.222.10.2 remote-as 120
  - neighbor 222.222.10.2 prefix-list upstream out
  - neighbor 222.222.10.2 prefix-list rfc1918-dsua in
  - ip prefix-list upstream permit 221.10.0.0/19
  - ip route 221.10.0.0 255.255.224.0 null0

ISP Transit

- Router B Configuration
  - router bgp 120
  - neighbor 222.222.10.1 remote-as 130
  - neighbor 222.222.10.1 prefix-list Customer130 in
  - neighbor 222.222.10.1 prefix-list rfc1918-sua out
  - neighbor 222.222.10.1 filter-list 15 out
  - ip as-path access-list 15 permit *$*
  - ip as-path access-list 15 permit ^100*
  - ip prefix-list Customer130 permit 221.10.0.0/19

- Router B announces AS120 and AS100 prefixes to Router A, only accepts customer /19

ISP Transit

- Router C Configuration
  - router bgp 120
  - neighbor 222.222.20.1 remote-as 100
  - neighbor 222.222.20.1 default-originate
  - neighbor 222.222.20.1 prefix-list Customer100 in
  - neighbor 222.222.20.1 prefix-list default out
  - ip prefix-list Customer100 permit 219.0.0.0/19
  - ip prefix-list default permit 0.0.0.0/0

- Router C announces default to Router D, only accepts customer /19
**ISP Transit**

- **Router D Configuration**
  
  ```
  router bgp 100
  network 219.0.0.0 mask 255.255.224.0
  neighbor 222.222.20.2 remote-as 120
  neighbor 222.222.20.2 prefix-list upstream out
  neighbor 222.222.20.2 prefix-list default in
  !
  ip prefix-list default permit 0.0.0.0/0
  ip prefix-list upstream permit 219.0.0.0/19
  !
  ip route 219.0.0.0 255.255.224.0 null0
  ```

**ISP Transit**

- **AS130 only hears AS120 and AS100 prefixes**
  
  inbound AS path filter on Router A is optional, but good practice (never trust a peer)
  
  inbound Martian prefix-list filters are mandatory on all Internet peerings

**ISP Transit Provider**

More complex Example 2

**ISP Transit**

- **AS130 and AS100 are stub/customer ASes of AS120**
  
  AS130 has many customers with their own ASes
  
  AS105 doesn’t get announced to AS120
  
  AS120 provides transit between AS130 and AS100

**ISP Transit**

- **Router A Configuration**
  
  ```
  router bgp 130
  network 221.10.0.0 mask 255.255.224.0
  neighbor 222.222.10.2 remote-as 120
  neighbor 222.222.10.2 prefix-list upstream-out
  neighbor 222.222.10.2 filter-list 5 out
  neighbor 222.222.10.2 prefix-list upstream-in in
  !
  ip route 221.10.0.0 255.255.224.0 null0 250
  !
  ..next slide
  ```
ISP Transit

! As-path filters...
ip as-path access-list 5 permit ^$
ip as-path access-list 5 permit ^101_+\$nip as-path access-list 5 permit ^102$nip as-path access-list 5 permit ^103$ip as-path access-list 5 permit ^104$ip as-path access-list 5 deny ^105_!

..next slide

ISP Transit

! Outbound Martian prefixes to be blocked to eBGP peers
ip prefix-list upstream-out deny 0.0.0.0/8 le 32
ip prefix-list upstream-out deny 10.0.0.0/8 le 32
ip prefix-list upstream-out deny 127.0.0.0/8 le 32
ip prefix-list upstream-out deny 169.254.0.0/16 le 32
ip prefix-list upstream-out deny 172.16.0.0/12 le 32
ip prefix-list upstream-out deny 192.0.2.0/24 le 32
ip prefix-list upstream-out deny 192.168.0.0/16 le 32
ip prefix-list upstream-out deny 224.0.0.0/3 le 32
ip prefix-list upstream-out deny 0.0.0.0/0 ge 25

! Extra prefixes
ip prefix-list upstream-out deny 221.10.0.0/19 ge 20
ip prefix-list upstream-out permit 0.0.0.0/0 le 32
..next slide

ISP Transit

! Inbound Martian prefixes to be blocked from eBGP peers
ip prefix-list upstream-in deny 0.0.0.0/8 le 32
ip prefix-list upstream-in deny 10.0.0.0/8 le 32
ip prefix-list upstream-in deny 127.0.0.0/8 le 32
ip prefix-list upstream-in deny 169.254.0.0/16 le 32
ip prefix-list upstream-in deny 172.16.0.0/12 le 32
ip prefix-list upstream-in deny 192.0.2.0/24 le 32
ip prefix-list upstream-in deny 192.168.0.0/16 le 32
ip prefix-list upstream-in deny 224.0.0.0/3 le 32
ip prefix-list upstream-in deny 0.0.0.0/0 ge 25

! Extra prefixes
ip prefix-list upstream-in deny 221.10.0.0/19 le 32
ip prefix-list upstream-in permit 0.0.0.0/0 le 32

..next slide

ISP Transit

• Router B Configuration
router bgp 120
neighbor 222.222.10.1 remote-as 130
neighbor 222.222.10.1 prefix-list rfc1918-sua in
neighbor 222.222.10.1 prefix-list rfc1918-sua out
neighbor 222.222.10.1 filter-list 10 in
neighbor 222.222.10.1 filter-list 15 out
ip as-path access-list 15 permit ^$
ip as-path access-list 15 permit ^100$

Router B announces AS120 and AS100 prefixes to Router A, and accepts all AS130 customer ASes

..next slide

ISP Transit

• Router C Configuration
router bgp 120
neighbor 222.222.20.1 remote-as 100
neighbor 222.222.20.1 default-originate
neighbor 222.222.20.1 prefix-list Customer100 in
neighbor 222.222.20.1 prefix-list default out
ip prefix-list Customer100 permit 219.0.0.0/19
ip prefix-list default permit 0.0.0.0/0

Router C announces default to Router D, only accepts customer /19

..next slide

ISP Transit

• Router D Configuration
router bgp 100
network 219.0.0.0 mask 255.255.224.0
neighbor 222.222.20.2 remote-as 120
neighbor 222.222.20.2 prefix-list upstream out
neighbor 222.222.20.2 prefix-list default in
ip prefix-list default permit 0.0.0.0/0
ip prefix-list upstream permit 219.0.0.0/19
ip route 219.0.0.0 255.255.224.0 null0
ISP Transit

- AS130 only hears AS120 and AS100 prefixes
  - inbound AS path filter on Router A is optional, but good practice (never trust a peer)
  - Special Use Address prefix-list filters are required on all Internet peerings

ISP Transit Provider

More complex Example 3

ISP Transit

- AS130 and AS100 are stub/customer ASes of AS120
  - AS130 has many customers with their own ASes
  - AS105 doesn’t get announced to AS120
  - AS120 provides transit between AS130 and AS100
- Same example as previously but using communities

ISP Transit

- AS130 has several customer ASes connecting to its backbone

ISP Transit

- Router A configuration is greatly simplified
  - all prefixes to be announced to upstream are marked with community 130:5100
  - route-map on outbound peering implements community policy
  - Martian prefix-lists still required

Router A Configuration

```
router bgp 130
  network 221.10.0.0 mask 255.255.224.0 route-map setcomm
  neighbor 222.222.10.2 remote-as 120
  neighbor 222.222.10.2 prefix-list upstream-out out
  neighbor 222.222.10.2 route-map to-AS120 out
  neighbor 222.222.10.2 prefix-list upstream-in in
  ip route 221.10.0.0 255.255.224.0 null0 250
```

ISP Transit

! ip community-list 5 permit 130:5100
!
! Set community on local prefixes
route-map setcomm permit 10
set community 130:5100
!
route-map to-AS120 permit 10
match community 5
!
• upstream-in and upstream-out prefix-lists are the same as in the previous example

Router E Configuration

router bgp 130
neighbor x.x.x.x remote-as 101
neighbor x.x.x.x default-originate
neighbor x.x.x.x prefix-list customer101 in
neighbor x.x.x.x route-map bgp-cust-in in
neighbor x.x.x.x prefix-list default out
neighbor x.x.x.x remote-as 102
neighbor x.x.x.x default-originate
neighbor x.x.x.x prefix-list customer102 in
neighbor x.x.x.x route-map bgp-cust-in in
neighbor x.x.x.x prefix-list default out

..next slide

AS130 only announces the community 130:5100 to AS120

• Notice how Router E tags the prefixes to be announced to AS120 with community 130:5100
• More efficient to manage than using filter lists

Notice that AS105 peering has no route-map to set the community policy

Exchange Point Example

• Exchange point with 6 ASes present
  Layer 2 – ethernet switch
• Each ISP peers with the other
  NO transit across the IXP allowed
Exchange Point

Router A configuration

interface fastethernet 0/0
description Exchange Point LAN
ip address 220.5.10.2 mask 255.255.255.224
ip verify unicast reverse-path
no ip directed-broadcast
no ip proxy-arp
no ip redirects

! router bgp 100
network 221.10.0.0 mask 255.255.224.0
neighbor ixp-peers peer-group
neighbor ixp-peers soft-reconfiguration in
neighbor ixp-peers prefix-list myprefixes out

..next slide

Exchange Point

• Configuration of the other routers in the AS is similar in concept
• Notice inbound and outbound prefix filters
  outbound announces myprefixes only
  inbound accepts peer prefixes only

Exchange Point

• Ethernet port configuration
  use ip verify unicast reverse-path
  helps prevent “stealing of bandwidth”
• IXP border router must NOT carry prefixes
  with origin outside local AS and IXP participant ASes
  helps prevent “stealing of bandwidth”
Exchange Point

- Issues:
  - AS100 needs to know all the prefixes its peers are announcing
  - New prefixes requires the prefix-lists to be updated
- Alternative solutions
  - Use the Internet Routing Registry to build prefix list
  - Use AS Path filters (could be risky)

Exchange Point Example

- Exchange point with 6 ASes present
  - Layer 2 – ethernet switch
  - Each ISP peers with the other
  - NO transit across the IXP allowed
  - ISPs at exchange points provide transit to their customers

Exchange Point A configuration

```plaintext
interface fastethernet 0/0
description Exchange Point LAN
ip address 220.5.10.2 mask 255.255.255.224
ip verify unicast reverse-path
no ip directed-broadcast
no ip proxy-arp
no ip redirects

router bgp 100
network 221.10.0.0 mask 255.255.224.0
neighbor ixp-peers peer-group
neighbor ixp-peers soft-reconfiguration in
neighbor ixp-peers prefix-list rfc1918-sua out
neighbor ixp-peers filter-list 10 out
```

Exchange Point

Each of these represents a border router in a different autonomous system

```plaintext
neighbor 220.5.10.2 remote-as 110
neighbor 222.5.10.2 peer-group ixp-peers
neighbor 222.5.10.2 prefix-list peer110 in
neighbor 220.5.10.3 remote-as 120
neighbor 222.5.10.3 peer-group ixp-peers
neighbor 222.5.10.3 prefix-list peer120 in
neighbor 220.5.10.4 remote-as 130
neighbor 222.5.10.4 peer-group ixp-peers
neighbor 222.5.10.4 prefix-list peer130 in
neighbor 220.5.10.5 remote-as 140
neighbor 222.5.10.5 peer-group ixp-peers
neighbor 222.5.10.5 prefix-list peer140 in
neighbor 220.5.10.6 remote-as 150
neighbor 222.5.10.6 peer-group ixp-peers
neighbor 222.5.10.6 prefix-list peer150 in
```
• Notice the change in router A’s configuration
  
  filter-list instead of prefix-list permits local and customer ASes out to exchange
  
  prefix-list blocks Special Use Address prefixes
  – rest get out, could be risky

• Other issues as previously