Using BGP Communities

ISP Workshops

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Acknowledgements

- This material originated from the Cisco ISP/IXP Workshop Programme developed by Philip Smith & Barry Greene

- Bug fixes and improvements are welcomed
  - Please email *workshop (at) bgp4all.com*

Philip Smith

Multihoming and Communities

- The BGP community attribute is a very powerful tool for assisting and scaling BGP Policies and BGP Multihoming
- Most major ISPs make extensive use of BGP communities:
  - Internal policies
  - Inter-provider relationships (MED replacement)
  - Customer traffic engineering

Using BGP Communities

- Four scenarios are covered:
  - Use of RFC1998 traffic engineering
  - Extending RFC 1998 ideas for even greater customer policy options
  - Community use in ISP backbones
  - Customer Policy Control (aka traffic engineering)

RFC1998

An example of how ISPs use communities…

RFC1998

- Informational RFC
- Describes how to implement loadsharing and backup on multiple inter-AS links
  - BGP communities used to determine local preference in upstream's network
- Gives control to the customer
  - Means the customer does not have to phone upstream's technical support to adjust traffic engineering needs
- Simplifies upstream's configuration
  - Simplifies network operation!

RFC1998

- RFC1998 Community values are defined to have particular meanings
- ASx:100 **`set local preference 100`**
  - Make this the preferred path
- ASx :90 **`set local preference 90`**
  - Make this the backup if dualhomed on ASx
- ASx :80 **`set local preference 80`**
  - The main link is to another ISP with same AS path length
- ASx :70 **`set local preference 70`**
  - The main link is to another ISP

RFC1998

- Upstream ISP defines the communities mentioned
- Their customers then attach the communities they want to use to the prefix announcements they are making
- For example:
  - If upstream is AS 100
  - To declare a particular path as a backup path, their customer would announce the prefix with community 100:70 to AS100
  - AS100 would receive the prefix with the community 100:70 tag, and then set local preference to be 70

RFC1998

- Sample Customer Router Configuration

```
router bgp 130
 address-family ipv4
  neighbor 100.66.32.1 remote-as 100
  neighbor 100.66.32.1 description Backup ISP
  neighbor 100.66.32.1 route-map as100-out out
  neighbor 100.66.32.1 send-community
  neighbor 100.66.32.1 activate
!
ip as-path access-list 20 permit ^$
!
route-map as100-out permit 10
 match as-path 20
 set community 100:70
!
```

RFC1998

- Sample ISP Router Configuration

```
router bgp 100
 address-family ipv4
  neighbor 100.66.32.2 remote-as 130
  neighbor 100.66.32.2 route-map customer-policy-in in
  neighbor 100.66.32.2 activate
!
! Homed to another ISP
ip community-list 7 permit 100:70
! Homed to another ISP with equal ASPATH length
ip community-list 8 permit 100:80
! Customer backup routes
ip community-list 9 permit 100:90
!
```

RFC1998

```
route-map customer-policy-in permit 10
 match community 7
 set local-preference 70
!
route-map customer-policy-in permit 20
 match community 8
 set local-preference 80
!
route-map customer-policy-in permit 30
 match community 9
 set local-preference 90
!
route-map customer-policy-in permit 40
 set local-preference 100
!
```

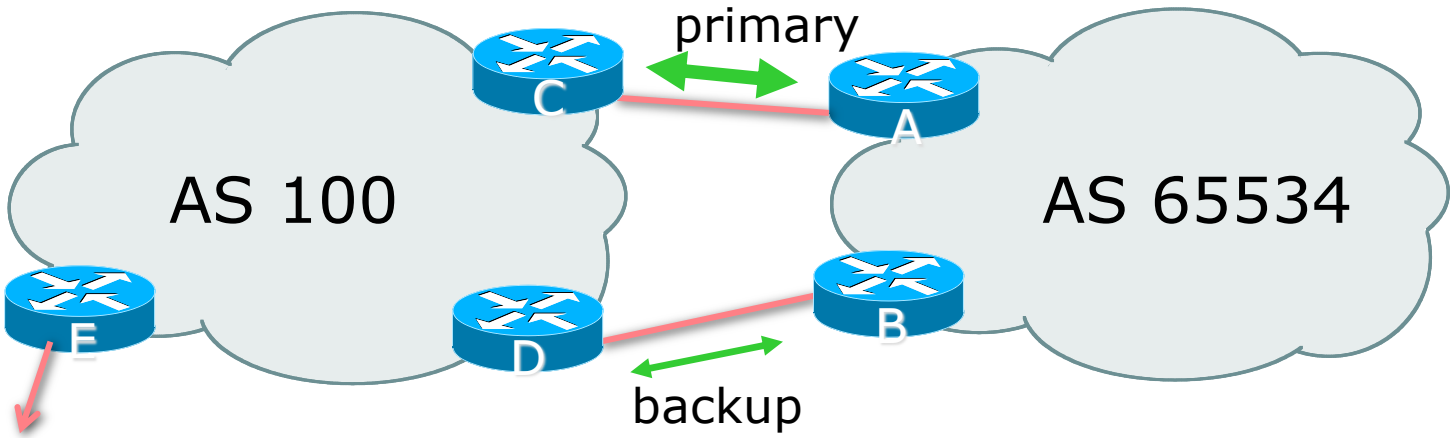
RFC1998

- RFC1998 was the inspiration for a large variety of differing community policies implemented by ISPs worldwide
- There are no “standard communities” for what ISPs do
- But best practices today consider that ISPs should use BGP communities extensively for multihoming support of traffic engineering
- Look in the ISP AS Object in the IRR for documented community support

RFC1998 Example

Two links to the same ISP, one link primary, the other link backup

Two links to the same ISP



- AS100 proxy aggregates for AS 65534

Two links to the same ISP (one as backup only)

- Announce /19 aggregate on each link
  - primary link makes standard announcement
  - backup link sends community
- When one link fails, the announcement of the /19 aggregate via the other link ensures continued connectivity

Two links to the same ISP (one as backup only)

- Router A Configuration

```
router bgp 65534
 address-family ipv4
  network 100.64.0.0 mask 255.255.224.0
  neighbor 100.66.10.2 remote-as 100
  neighbor 100.66.10.2 description RouterC
  neighbor 100.66.10.2 prefix-list aggregate out
  neighbor 100.66.10.2 prefix-list default in
  neighbor 100.66.10.2 activate
!
ip prefix-list aggregate permit 100.64.0.0/19
ip prefix-list default permit 0.0.0.0/0
!
```

Two links to the same ISP (one as backup only)

- Router B Configuration

```
router bgp 65534
 address-family ipv4
  network 100.64.0.0 mask 255.255.224.0
  neighbor 100.66.10.6 remote-as 100
  neighbor 100.66.10.6 description RouterD
  neighbor 100.66.10.6 send-community
  neighbor 100.66.10.6 prefix-list aggregate out
  neighbor 100.66.10.6 route-map routerD-out out
  neighbor 100.66.10.6 prefix-list default in
  neighbor 100.66.10.6 route-map routerD-in in
  neighbor 100.66.10.6 activate
!
..next slide..
```

Two links to the same ISP (one as backup only)

```
ip prefix-list aggregate permit 100.64.0.0/19
ip prefix-list default permit 0.0.0.0/0
!
route-map routerD-out permit 10
 match ip address prefix-list aggregate
 set community 100:90
route-map routerD-out permit 20
!
route-map routerD-in permit 10
 set local-preference 90
!
```

Two links to the same ISP (one as backup only)

- Router C Configuration (main link)

```
router bgp 100
 address-family ipv4
  neighbor 100.66.10.1 remote-as 65534
  neighbor 100.66.10.1 default-originate
  neighbor 100.66.10.1 prefix-list Customer in
  neighbor 100.66.10.1 prefix-list default out
  neighbor 100.66.10.1 activate
!
ip prefix-list Customer permit 100.64.0.0/19
ip prefix-list default permit 0.0.0.0/0
```

Two links to the same ISP (one as backup only)

- Router D Configuration (backup link)

```
router bgp 100
 address-family ipv4
  neighbor 100.66.10.5 remote-as 65534
  neighbor 100.66.10.5 default-originate
  neighbor 100.66.10.5 prefix-list Customer in
  neighbor 100.66.10.5 route-map bgp-cust-in in
  neighbor 100.66.10.5 prefix-list default out
  neighbor 100.66.10.5 activate
!
ip prefix-list Customer permit 100.64.0.0/19
ip prefix-list default permit 0.0.0.0/0
!
...next slide...
```

Two links to the same ISP (one as backup only)

```
!
ip community-list 90 permit 100:90
!
<snip>
route-map bgp-cust-in permit 30
 match community 90
 set local-preference 90
route-map bgp-cust-in permit 40
 set local-preference 100
!
```

Two links to the same ISP (one as backup only)

- This is a simple example
- It looks more complicated than the same example presented earlier which used local preference and MEDs
- But the advantage is that this scales better
  - With larger configurations, more customers, more options, it becomes easier to handle each and every requirement

Service Provider use of Communities

RFC1998 was so inspiring…

Background

- RFC1998 is okay for “simple” multihoming situations
- ISPs create backbone support for many other communities to handle more complex situations
  - Simplify ISP BGP configuration
  - Give customer more policy control

ISP BGP Communities

- There are no recommended ISP BGP communities apart from
  - RFC1998
  - The five well known communities
    - www.iana.org/assignments/bgp-well-known-communities
- Efforts have been made to document from time to time
  - totem.info.ucl.ac.be/publications/papers-elec-versions/draft-quoitin-bgp-comm-survey-00.pdf
  - But so far… nothing more… ☹
  - Collection of ISP communities at www.onesc.net/communities
  - NANOG Tutorial: www.nanog.org/meetings/nanog40/presentations/BGPcommunities.pdf
- ISP policy is usually published
  - On the ISP's website
  - Referenced in the AS Object in the IRR

Typical ISP BGP Communities

- X:80 **`set local preference 80`**
  - Backup path
- X:120 **`set local preference 120`**
  - Primary path (over ride BGP path selection default)
- X:1 **`set as-path prepend X`**
  - Single prepend when announced to X's upstreams
- X:2 **`set as-path prepend X X`**
  - Double prepend when announced to X's upstreams
- X:3 **`set as-path prepend X X X`**
  - Triple prepend when announced to X's upstreams
- X:666 **`set ip next-hop 192.0.2.1`**
  - Blackhole route – very useful for DoS attack mitigation (RFC7999)

Sample Router Configuration (1)

```
router bgp 100
 address-family ipv4
  neighbor 100.66.32.2 remote-as 130
  neighbor 100.66.32.2 route-map customer-policy-in in
  neighbor 100.66.32.2 activate
  neighbor 100.65.8.9 remote-as 200
  neighbor 100.65.8.9 route-map upstream-out out
  neighbor 100.65.8.9 activate
!
ip community-list 1 permit 100:1
ip community-list 2 permit 100:2
ip community-list 3 permit 100:3
ip community-list 4 permit 100:80
ip community-list 5 permit 100:120
ip community-list 6 permit 100:666
!
ip route 192.0.2.1 255.255.255.255 null0
```

Customer BGP

Upstream BGP

Black hole route (on all routers)

Sample Router Configuration (2)

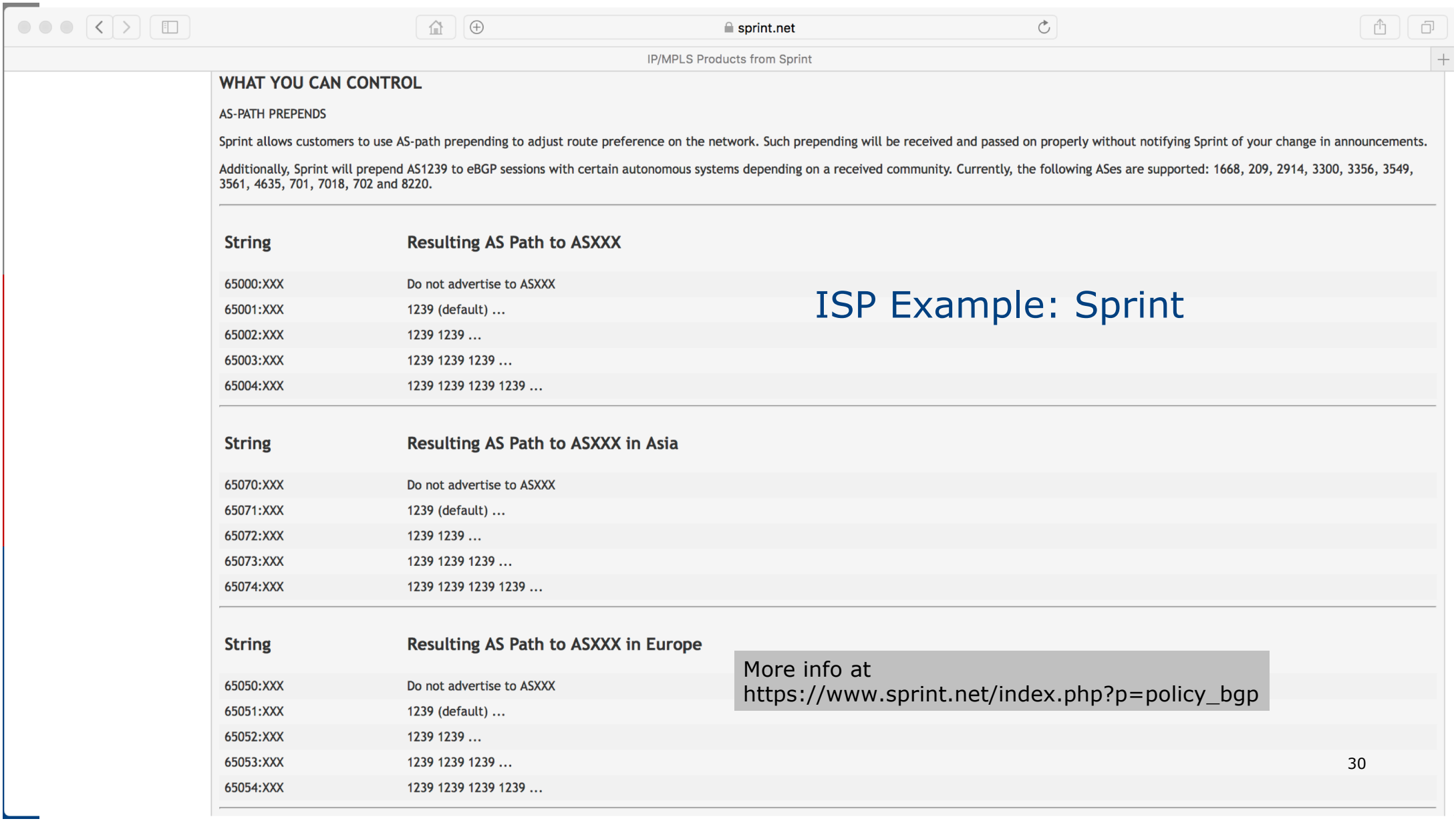
```
route-map customer-policy-in permit 10
 match community 4
 set local-preference 80
!
route-map customer-policy-in permit 20
 match community 5
 set local-preference 120
!
route-map customer-policy-in permit 30
 match community 6
 set ip next-hop 192.0.2.1
!
route-map customer-policy-in permit 40

...etc...
```

Sample Router Configuration (3)

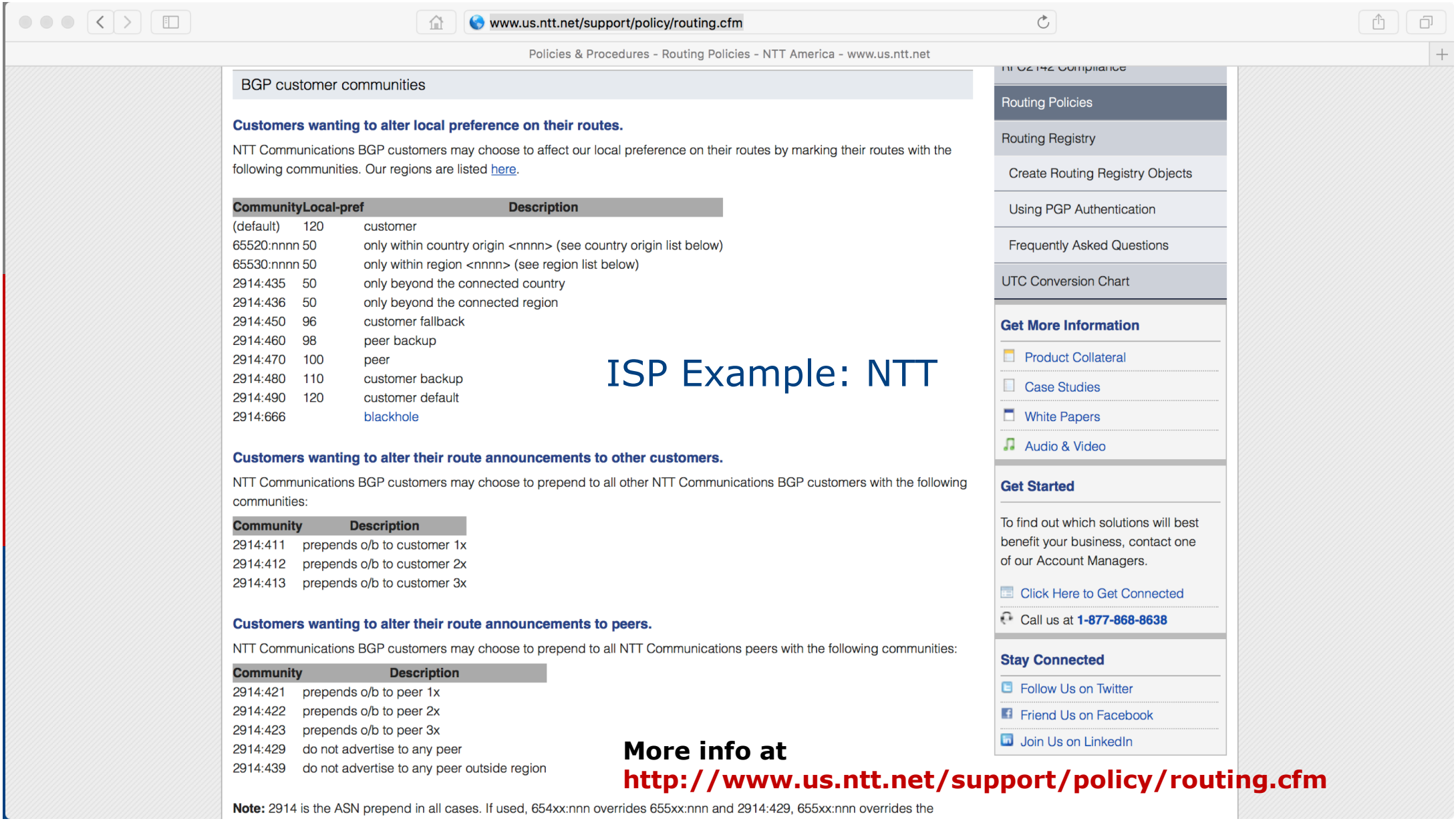
```
route-map upstream-out permit 10
 match community 1
 set as-path prepend 100
!
route-map upstream-out permit 20
 match community 2
 set as-path prepend 100 100
!
route-map upstream-out permit 30
 match community 3
 set as-path prepend 100 100 100
!
route-map upstream-out permit 40

...etc...
```



ISP Example: Sprint

More info at
https://www.sprint.net/index.php?p=policy_bgp


www.us.ntt.net/support/policy/routing.cfm
Policies & Procedures - Routing Policies - NTT America - www.us.ntt.net
BGP customer communities
Customers wanting to alter local preference on their routes.
NTT Communications BGP customers may choose to affect our local preference on their routes by marking their routes with the following communities. Our regions are listed here.
Community Local-pref Description
(default) 120 customer
65520:nnnn 50 only within country origin <nnnn> (see country origin list below)
65530:nnnn 50 only within region <nnnn> (see region list below)
2914:435 50 only beyond the connected country
2914:436 50 only beyond the connected region
2914:450 96 customer fallback
2914:460 98 peer backup
2914:470 100 peer
2914:480 110 customer backup
2914:490 120 customer default
2914:666 blackhole
ISP Example: NTT
Customers wanting to alter their route announcements to other customers.
NTT Communications BGP customers may choose to prepend to all other NTT Communications BGP customers with the following communities:
Community Description
2914:411 prepends o/b to customer 1x
2914:412 prepends o/b to customer 2x
2914:413 prepends o/b to customer 3x
Customers wanting to alter their route announcements to peers.
NTT Communications BGP customers may choose to prepend to all NTT Communications peers with the following communities:
Community Description
2914:421 prepends o/b to peer 1x
2914:422 prepends o/b to peer 2x
2914:423 prepends o/b to peer 3x
2914:429 do not advertise to any peer
2914:439 do not advertise to any peer outside region
More info at
http://www.us.ntt.net/support/policy/routing.cfm
Note: 2914 is the ASN prepend in all cases. If used, 654xx:nnn overrides 655xx:nnn and 2914:429, 655xx:nnn overrides the
Routing Policies
Routing Registry
Create Routing Registry Objects
Using PGP Authentication
Frequently Asked Questions
UTC Conversion Chart
Get More Information
Product Collateral
Case Studies
White Papers
Audio & Video
Get Started
To find out which solutions will best benefit your business, contact one of our Account Managers.
Click Here to Get Connected
Call us at 1-877-868-8638
Stay Connected
Follow Us on Twitter
Friend Us on Facebook
Join Us on LinkedIn

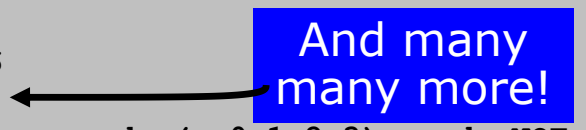
ISP Example: Verizon Europe

```
aut-num:        AS702
descr:          Verizon Business EMEA - Commercial IP service provider in Europe
<snip>
remarks:        ----------------------------------------------------------
                Verizon Business filters out inbound prefixes longer than /24.
                We also filter any networks within AS702:RS-INBOUND-FILTER.
                ----------------------------------------------------------
                VzBi uses the following communities with its customers:
                702:80    Set Local Pref 80 within AS702
                702:120   Set Local Pref 120 within AS702
                702:20    Announce only to VzBi AS'es and VzBi customers
                702:30    Keep within Europe, don't announce to other VzBi AS's
                702:1     Prepend AS702 once at edges of VzBi to Peers
                702:2     Prepend AS702 twice at edges of VzBi to Peers
                702:3     Prepend AS702 thrice at edges of VzBi to Peers
                ----------------------------------------------------------
                Advanced communities for customers
                702:7020  Do not announce to AS702 peers with a scope of
                National but advertise to Global Peers, European
                Peers and VzBi customers.
                702:7001  Prepend AS702 once at edges of VzBi to AS702
                peers with a scope of National.
                702:7002  Prepend AS702 twice at edges of VzBi to AS702
                peers with a scope of  National.
<snip>
```

And many more!

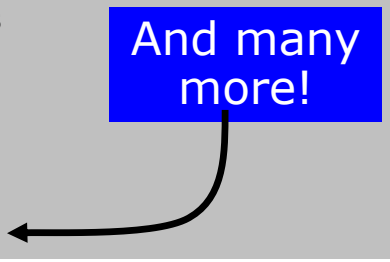
ISP Example: Telia

```
aut-num:        AS1299
descr:          TeliaSonera International Carrier
<snip>
remarks:        ----------------------------------------------------
remarks:        BGP COMMUNITY SUPPORT FOR AS1299 TRANSIT CUSTOMERS:
remarks:
remarks:        Community Action (default local pref 200)
remarks:        ----------------------------------------
remarks:        1299:50 Set local pref 50 within AS1299 (lowest possible)
remarks:        1299:150 Set local pref 150 within AS1299 (equal to peer, backup)
remarks:
remarks:        European peers
remarks:        Community Action
remarks:        --------- ------
remarks:        1299:200x All peers Europe incl:
remarks:
remarks:        1299:250x Sprint/1239
remarks:        1299:251x Savvis/3561
remarks:        1299:252x NTT/2914
remarks:        1299:253x Zayo/Abovenet/6461
remarks:        1299:254x FT/5511
remarks:        1299:255x GBLX/3549
remarks:        1299:256x Level3/3356
<snip>
remarks:        Where x is number of prepends (x=0,1,2,3) or do NOT announce (x=9)
```



ISP Example: BT Ignite

```
aut-num:      AS5400
descr:        BT Ignite European Backbone
<snip>
remarks:        The following BGP communities can be set by BT
remarks:        BGP customers to affect announcements to major peers.
remarks:
remarks:        5400:NXXX
remarks:        N=1         not announce
remarks:        N=2         prepend an extra "5400 5400" on announcement
remarks:        Valid values for XXX:
remarks:        000         All peers and transits
remarks:        500         All transits
remarks:        503         Level3 AS3356
remarks:        509         Telia AS1299
remarks:        510         NTT Verio AS2914
remarks:        002         Sprint AS1239
remarks:        003         Savvis AS3561
remarks:        004         C&W AS1273
remarks:        005         Verizon EMEA AS702
remarks:        014         DTAG AS3320
remarks:        016         Opentransit AS5511
remarks:        018         GlobeInternet Tata AS6453
remarks:        023         Tinet AS3257
remarks:        027         Telia AS1299
remarks:        045         Telecom Italia AS6762
remarks:        073         Eurorings AS286
remarks:        169         Cogent AS174
<snip>
```



ISP Example: Level3

```
aut-num:      AS3356
descr:        Level 3 Communications
<snip>
remarks:        ------------------------------------------------------
remarks:        customer traffic engineering communities - Suppression
remarks:        ------------------------------------------------------
remarks:        64960:XXX - announce to AS XXX if 65000:0
remarks:        65000:0   - announce to customers but not to peers
remarks:        65000:XXX - do not announce at peerings to AS XXX
remarks:        ------------------------------------------------------
remarks:        customer traffic engineering communities - Prepending
remarks:        ------------------------------------------------------
remarks:        65001:0   - prepend once  to all peers
remarks:        65001:XXX - prepend once  at peerings to AS XXX
remarks:        65002:0   - prepend twice to all peers
remarks:        65002:XXX - prepend twice at peerings to AS XXX
<snip>
remarks:        ------------------------------------------------------
remarks:        customer traffic engineering communities - LocalPref
remarks:        ------------------------------------------------------
remarks:        3356:70   - set local preference to 70
remarks:        3356:80   - set local preference to 80
remarks:        3356:90   - set local preference to 90
remarks:        ------------------------------------------------------
remarks:        customer traffic engineering communities - Blackhole
remarks:        ------------------------------------------------------
remarks:        3356:9999 - blackhole (discard) traffic
<snip>
```

And many more!

Creating your own community policy

- Consider creating communities to give policy control to customers
  - Reduces technical support burden
  - Reduces the amount of router reconfiguration, and the chance of mistakes
  - Use previous ISP and configuration examples as a guideline

Using Communities for Backbone Scaling

Scaling BGP in the ISP backbone…

Communities for iBGP

- ISPs tag prefixes learned from their BGP and static customers with communities
  - To identify services the customer may have purchased
  - To identify prefixes which are part of the ISP's PA space
  - To identify PI customer addresses
  - To control prefix distribution in iBGP
  - To control prefix announcements to customers and upstreams
  - (amongst several other reasons)

Service Identification

- ISP provides:
  - Transit via upstreams
  - Connectivity via major IXP
  - Connectivity to private peers/customers
- Customers can buy all or any of the above access options
  - Each option is identified with a unique community
- ISP identifies whether address space comes from their PA block or is their customers' own PI space
  - One community for each

Community Definitions

100:1000	AS100 aggregates
100:1001	AS100 aggregate subprefixes
100:1005	Static Customer PI space
100:2000	Customers who get Transit
100:2100	Customers who get IXP access
100:2200	Customers who get BGP Customer access
100:3000	Routes learned from the IXP

```
ip community-list 10 permit 100:1000
ip community-list 11 permit 100:1001
ip community-list 12 permit 100:1005
ip community-list 13 permit 100:2000
ip community-list 14 permit 100:2100
ip community-list 15 permit 100:2200
ip community-list 16 permit 100:3000
```

Aggregates and Static Customers into BGP

```
router bgp 100
 address-family ipv4
  network 100.64.0.0 mask 255.255.224.0 route-map as100-prefixes
  redistribute static route-map static-to-bgp
!
ip prefix-list as100-block permit 100.64.0.0/19 le 32
!
route-map as100-prefixes permit 10
 set community 100:1000
!
route-map static-to-bgp permit 10
 match ip address prefix-list as100-block
 set community 100:1001
route-map static-to-bgp permit 20
 set community 100:1005
```

Aggregate community set

Aggregate subprefixes community set

PI community is set

Service Identification

- AS100 has four classes of BGP customers
  - Full transit (upstream, IXP and BGP customers)
  - Upstream only
  - IXP only
  - BGP Customers only
- For BGP support, easiest IOS configuration is to create a peer-group for each class (can also use peer-templates to simplify further)
  - Customer is assigned the peer-group of the service they have purchased
  - Simple for AS100 customer installation engineer to provision

BGP Customers
Creating peer-groups

```
router bgp 100
 address-family ipv4
  neighbor full-transit peer-group
  neighbor full-transit route-map customers-out out
  neighbor full-transit route-map full-transit-in in
  neighbor full-transit default-originate
  neighbor upstream-only peer-group
  neighbor upstream-only route-map customers-out out
  neighbor upstream-only route-map upstream-only-in in
  neighbor upstream-only default-originate
  neighbor ixp-only peer-group
  neighbor ixp-only route-map ixp-routes out
  neighbor ixp-only route-map ixp-only-in in
  neighbor bgpcust-only peer-group
  neighbor bgpcust-only route-map bgp-cust-out out
  neighbor bgpcust-only route-map bgp-cust-in in
```

BGP Customers
Creating route-maps

```
route-map customers-out permit 10
 match ip community 10
!
route-map full-transit-in permit 10
 set community 100:2000 100:2100 100:2200
!
route-map upstream-only-in permit 10
 set community 100:2000
!
route-map ixp-routes permit 10
 match ip community 10 12 13 14 16
!
route-map ixp-only-in permit 10
 set community 100:2100
!
route-map bgp-cust-out permit 10
 match ip community 10 12 13 15
!
route-map bgp-cust-in permit 10
 set community 100:2200
```

Customers only get AS100 aggregates and default route

Full transit go everywhere

Customers buying IXP access only get aggregates, static & full transit customers and IXP routes

Customers buying BGP customer access only get aggregates, static & full transit customers and other BGP customers

BGP Customers – configuring customers

```
router bgp 100
 address-family ipv4
  neighbor 100.67.3.2 remote-as 200
  neighbor 100.67.3.2 peer-group full-transit
  neighbor 100.67.3.2 prefix-list as200cust-in
  neighbor 100.67.3.2 activate
  neighbor 100.67.3.6 remote-as 300
  neighbor 100.67.3.6 peer-group upstream-only
  neighbor 100.67.3.6 prefix-list as300cust-in
  neighbor 100.67.3.6 activate
  neighbor 100.67.3.10 remote-as 400
  neighbor 100.67.3.10 peer-group ixp-only
  neighbor 100.67.3.10 prefix-list as400cust-in
  neighbor 100.67.3.10 activate
  neighbor 100.67.3.14 remote-as 500
  neighbor 100.67.3.14 peer-group bgpcust-only
  neighbor 100.67.3.14 prefix-list as500cust-in
  neighbor 100.67.3.14 activate
```

Customers are placed into the appropriate peer-group depending on the service they paid for

Note the specific per-customer inbound filters

BGP Customers – configuring upstream

```
router bgp 100
 address-family ipv4
  neighbor 100.66.32.1 remote-as 130
  neighbor 100.66.32.1 prefix-list full-routes in
  neighbor 100.66.32.1 route-map upstream-out out
  neighbor 100.66.32.1 activate
!
route-map upstream-out permit 10
 match ip community 10 12 13
!
! IP prefix-list full-routes is the standard bogon
! prefix filter - or use a reputable bogon
! route-service such as that offered by Team Cymru
```

Aggregates, PI customers and full transit customers are announced to upstream

BGP Customers – configuring IXP peers

```
router bgp 100
 address-family ipv4
  neighbor 100.70.0.1 remote-as 901
  neighbor 100.70.0.1 route-map ixp-peers-out out
  neighbor 100.70.0.1 route-map ixp-peers-in in
  neighbor 100.70.0.1 prefix-list AS901-peer in
  neighbor 100.70.0.1 activate
  neighbor 100.70.0.2 remote-as 902
  neighbor 100.70.0.2 route-map ixp-peers-out out
  neighbor 100.70.0.2 route-map ixp-peers-in in
  neighbor 100.70.0.2 prefix-list AS902-peer in
  neighbor 100.70.0.2 activate
!
route-map ixp-peers-out permit 10
 match ip community 10 12 13 14
!
route-map ixp-peers-in permit 10
 set community 100:3000
```

Aggregates, PI customers full transit and IXP customers are announced to the IXP

Service Identification

- While the community set up takes a bit of thought and planning, once it is implemented:
  - eBGP configuration with customers is simply a case of applying the appropriate peer-group
  - eBGP configuration with IXP peers is simply a case of announcing the appropriate community members to the peers
  - eBGP configuration with upstreams is simply a case of announcing the appropriate community members to the upstreams
- All BGP policy internally is now controlled by communities
  - No prefix-lists, as-path filters, route-maps or other BGP gymnastics are required

What about iBGP itself?

- We've made good use of communities to handle customer requirements
  - But what about iBGP?
- Most ISPs deploy Route Reflectors as a means of scaling iBGP
- In transit networks:
  - Core routers (the Route Reflectors) carry the full BGP table
  - Edge/Aggregation routers carry domestic prefixes & customers

iBGP core router/route reflector

```
router bgp 100
 address-family ipv4
  neighbor rrc peer-group
  neighbor rrc descr Route Reflector Clients
  neighbor rrc remote-as 100
  neighbor rrc route-reflector-client
  neighbor rrc route-map ibgp-filter out
  neighbor rrc send-community
  neighbor ibgp-peer peer-group
  neighbor ibgp-peer Standard iBGP peers
  neighbor ibgp-peer remote-as 100
  neighbor ibgp-peer send-community
  neighbor 100.64.0.1 peer-group ibgp-peer
  neighbor 100.64.0.1 activate
  neighbor 100.64.0.2 peer-group rrc
  neighbor 100.64.0.2 activate
!
route-map ibgp-filter permit 10
 match community 10 11 12 13 14 15 16
!
```

The filter to restrict client iBGP to just domestic prefixes

Must NOT forget to send community to iBGP peers

Allow all prefixes coming from the domestic network & IXP

iBGP in the core

- Notice that the filtering of iBGP from the core to the edge is again achieved by a simple route-map applying a community match
  - No prefix-lists, as-path filters or any other complicated policy
  - Once the prefix belongs to a certain community, it has the access across the backbone determined by the community policy in force

Using Communities for Customers Policy

Giving policy control to customers…

Customer Policy Control

- ISPs have a choice on how to handle policy control for customers
- No delegation of policy options:
  - Customer has no choices
  - If customer wants changes, ISP Technical Support handles it
- Limited delegation of policy options:
  - Customer has choices
  - ISP Technical Support does not need to be involved
- BGP Communities are the only viable way of offering policy control to customers

Policy Definitions

- Typical definitions:

Community	Action
Nil:	No community set, just announce everywhere
X:1	1x prepend to all BGP neighbours
X:2	2x prepend to all BGP neighbours
X:3	3x prepend to all BGP neighbours
X:80	Local preference set to 80 on customer prefixes
X:120	Local preference set to 120 on customer prefixes
X:666	Black hole this route please! (RFC7999)
X:5000	Don’t announce to any BGP neighbour
X:5MM0	Don’t announce to BGP neighbour MM
X:5MMN	Prepend N times to BGP neighbour MM

Policy Implementation

- The BGP configuration for the initial communities was discussed at the start of this slide set
- But the new communities, X:5MMN, are worth covering in more detail
  - The ISP in AS X documents the BGP transits and peers that they have (MM can be 01 to 99)
  - The ISP in AS X indicates how many prepends they will support (N can be 1 to 9, but realistically 4 prepends is usually enough on today's Internet)
  - Customers then construct communities to do the prepending or announcement blocking they desire
- If a customer tags a prefix announcement with:
  - 100:5030 don't send prefix to BGP neighbour 03
  - 100:5102 2x prepend prefix announcement to peer 10

Community Definitions

- Example: ISP in AS 100 has two upstreams. They create policy based on previously slide to allow no announce and up to 3 prepends for their customers

```
ip community-list 100 permit 100:5000
ip community-list 101 permit 100:5001
ip community-list 102 permit 100:5002
ip community-list 103 permit 100:5003
ip community-list 110 permit 100:5010
ip community-list 111 permit 100:5011
ip community-list 112 permit 100:5012
ip community-list 113 permit 100:5013
ip community-list 120 permit 100:5020
ip community-list 121 permit 100:5021
ip community-list 122 permit 100:5022
ip community-list 123 permit 100:5023
```

Don't announce anywhere

Single prepend to all

Don't announce to peer 1

Single prepend to peer 2

Creating route-maps – neighbour 1

```
route-map bgp-neigh-01 deny 10
 match ip community 100 110
!
route-map bgp-neigh-01 permit 20
 match ip community 101 111
 set as-path prepend 100
!
route-map bgp-neigh-01 permit 30
 match ip community 102 112
 set as-path prepend 100 100
!
route-map bgp-neigh-01 permit 40
 match ip community 103 113
 set as-path prepend 100 100 100
!
route-map bgp-neigh-01 permit 50
```

Don't announce these prefixes to neighbour 01

Single prepend of these prefixes to neighbour 01

Double prepend of these prefixes to neighbour 01

Triple prepend of these prefixes to neighbour 01

All other prefixes remain untouched

Creating route-maps – neighbour 2

```
route-map bgp-neigh-02 deny 10
 match ip community 100 120
!
route-map bgp-neigh-02 permit 20
 match ip community 101 121
 set as-path prepend 100
!
route-map bgp-neigh-02 permit 30
 match ip community 102 122
 set as-path prepend 100 100
!
route-map bgp-neigh-02 permit 40
 match ip community 103 123
 set as-path prepend 100 100 100
!
route-map bgp-neigh-02 permit 50
```

Don't announce these prefixes to neighbour 02

Single prepend of these prefixes to neighbour 02

Double prepend of these prefixes to neighbour 02

Triple prepend of these prefixes to neighbour 02

All other prefixes remain untouched

ISP's BGP configuration

```
router bgp 100
 address-family ipv4
  neighbor 100.67.3.2 remote-as 200
  neighbor 100.67.3.2 route-map bgp-neigh-01 out
  neighbor 100.67.3.2 route-map policy-01 in
  neighbor 100.67.3.2 activate
  neighbor 100.67.3.6 remote-as 300
  neighbor 100.67.3.6 route-map bgp-neigh-02 out
  neighbor 100.67.3.6 route-map policy-02 in
  neighbor 100.67.3.6 activate
```

- The route-maps are then applied to the appropriate neighbour
- As long as the customer sets the appropriate communities, the policy will be applied to their prefixes

Customer BGP configuration

```
router bgp 600
 address-family ipv4
  neighbor 100.69.1.1 remote-as 100
  neighbor 100.69.1.1 route-map upstream out
  neighbor 100.69.1.1 prefix-list default in
  neighbor 100.69.1.1 activate
!
route-map upstream permit 10
 match ip address prefix-list blockA
 set community 100:5010 100:5023
route-map upstream permit 20
 match ip address prefix-list aggregate
```

- This will:
  - 3x prepend of blockA towards their upstream's 2nd BGP neighbour
  - Not announce blockA towards their upstream's 1st BGP neighbour
  - Let the aggregate through with no specific policy

Customer Policy Control

- Notice how much flexibility a BGP customer could have with this type of policy implementation
- Advantages:
  - Customer has flexibility
  - ISP Technical Support does not need to be involved
- Disadvantages
  - Customer could upset ISP loadbalancing tuning
- Advice
  - This kind of policy control is very useful, but should only be considered if appropriate for the circumstances

Conclusion

Communities

- Communities are fun! ☺
- And they are extremely powerful tools
- Think about community policies, e.g. like the additions described here
- Supporting extensive community usage makes customer configuration easy
- Watch out for routing loops!

Using BGP Communities

ISP Workshops