

BGP and the Internet

Using Communities for Multihoming

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Multihoming and Communities

- The BGP community attribute is a very powerful tool for assisting and scaling BGP Multihoming

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Loadsharing Using Communities

4 links – Private AS

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Communities Private AS

The diagram shows two Autonomous Systems (AS 100 and AS 65534) connected via four links labeled C, D, E, and F. AS 100 contains routers C, D, and E. AS 65534 contains routers A, B, and R. Link C connects router C to A, D to B, and E to R. Link D connects router D to A, E to B, and F to R. Link E connects router E to A, D to B, and F to R. Link F connects router F to A, D to B, and R to R.

- AS100 removes private AS and any customer subprefixes from Internet announcement

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Communities Private AS

- Announce /19 aggregate on each link
- Split /19 and announce as four /21s, one on each link
 - basic inbound loadsharing
 - assumes equal circuit capacity and even spread of traffic across address block
- Vary the split until “perfect” loadsharing achieved
 - use the no-export community for subprefixes

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Communities Private AS

- Router A Configuration


```
router bgp 65534
network 221.10.0.0 mask 255.255.224.0
network 221.10.0.0 mask 255.255.248.0
neighbor 222.222.10.2 remote-as 100
neighbor 222.222.10.2 send-community
neighbor 222.222.10.2 prefix-list subblocks1 out
neighbor 222.222.10.2 route-map routerC-out out
neighbor 222.222.10.2 prefix-list default in
!
```

..next slide

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Communities Private AS

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```
ip prefix-list subblocks1 permit 221.10.0.0/19
ip prefix-list subblocks1 permit 221.10.0.0/21
!
ip prefix-list firstblock permit 221.10.0.0/21
ip prefix-list default permit 0.0.0.0/0
!
route-map routerC-out permit 10
match ip address prefix-list firstblock
set community no-export
route-map routerC-out permit 20
```

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Communities Private AS

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• Router B Configuration

```
router bgp 65534
network 221.10.0.0 mask 255.255.224.0
network 221.10.24.0 mask 255.255.248.0
neighbor 222.222.20.2 remote-as 100
neighbor 222.222.20.2 send-community
neighbor 222.222.20.2 prefix-list subblocks2 out
neighbor 222.222.20.2 route-map routerD-out out
neighbor 222.222.20.2 prefix-list default in
!
..next slide
```

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Communities Private AS

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```
ip prefix-list subblocks2 permit 221.10.0.0/19
ip prefix-list subblocks2 permit 221.10.24.0/21
!
ip prefix-list secondblock permit 221.10.24.0/21
ip prefix-list default permit 0.0.0.0/0
!
route-map routerD-out permit 10
match ip address prefix-list secondblock
set community no-export
route-map routerD-out permit 20
```

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Communities Private AS

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• Router E Configuration

```
router bgp 100
neighbor 222.222.10.17 remote-as 110
neighbor 222.222.10.17 remove-private-AS
!
```

- Router E removes the private AS from external announcements
- Router E automatically removes subprefixes with no-export community set
- Private AS still visible inside AS100

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Communities Private AS

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- Router C and D configuration is as previously
- AS100 routers will not advertise prefixes marked with community no-export to other ASes
- AS100 routers still need to filter the private AS
- Only a single /19 prefix is announced to the Internet - no routing table bloat! :-)

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Loadsharing Using Communities

4 links – Public AS

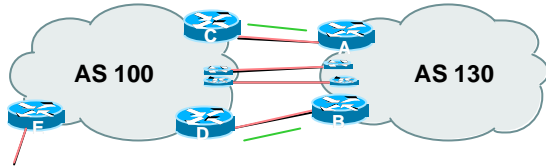
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Communities Public AS

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- 4 links between AS130 and AS100

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Communities Public AS

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- Announce /19 aggregate on each link
- Split /19 and announce as four /21s, one on each link
 - basic inbound loadsharing
 - assumes equal circuit capacity and even spread of traffic across address block
- Vary the split until “perfect” loadsharing achieved
 - use the no-export community for subprefixes

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Communities Public AS

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- Router A Configuration

```
router bgp 130
network 221.10.0.0 mask 255.255.224.0
network 221.10.0.0 mask 255.255.248.0
neighbor 222.222.10.2 remote-as 100
neighbor 222.222.10.2 send-community
neighbor 222.222.10.2 prefix-list subblocks1 out
neighbor 222.222.10.2 route-map routerC-out out
neighbor 222.222.10.2 prefix-list default in
!
..next slide
```

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Communities Public AS

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```
ip prefix-list subblocks1 permit 221.10.0.0/19
ip prefix-list subblocks1 permit 221.10.0.0/21
!
ip prefix-list firstblock permit 221.10.0.0/21
ip prefix-list default permit 0.0.0.0/0
!
route-map routerC-out permit 10
match ip address prefix-list firstblock
set community no-export
route-map routerC-out permit 20
```

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Communities Public AS

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- Router B Configuration

```
router bgp 130
network 221.10.0.0 mask 255.255.224.0
network 221.10.24.0 mask 255.255.248.0
neighbor 222.222.20.2 remote-as 100
neighbor 222.222.20.2 send-community
neighbor 222.222.20.2 prefix-list subblocks2 out
neighbor 222.222.20.2 route-map routerD-out out
neighbor 222.222.20.2 prefix-list default in
!
..next slide
```

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Communities Public AS

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```
ip prefix-list subblocks2 permit 221.10.0.0/19
ip prefix-list subblocks2 permit 221.10.24.0/21
!
ip prefix-list secondblock permit 221.10.24.0/21
ip prefix-list default permit 0.0.0.0/0
!
route-map routerD-out permit 10
match ip address prefix-list secondblock
set community no-export
route-map routerD-out permit 20
```

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Communities Public AS

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- Router C Configuration

```
router bgp 100
 neighbor 222.222.10.1 remote-as 130
 neighbor 222.222.10.1 default-originate
 neighbor 222.222.10.1 prefix-list Customer in
 neighbor 222.222.10.1 prefix-list default out
!
ip prefix-list Customer permit 221.10.0.0/19 le 21
ip prefix-list default permit 0.0.0.0/0
```

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Communities Public AS

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- Router D Configuration

```
router bgp 100
 neighbor 222.222.10.5 remote-as 130
 neighbor 222.222.10.5 default-originate
 neighbor 222.222.10.5 prefix-list Customer in
 neighbor 222.222.10.5 prefix-list default out
!
ip prefix-list Customer permit 221.10.0.0/19 le 21
ip prefix-list default permit 0.0.0.0/0
```

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Communities Public AS

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- Router E Configuration

```
router bgp 100
 neighbor 222.222.10.17 remote-as 110
 neighbor 222.222.10.17 filter-list 1 out
!
ip as-path access-list 1 permit ^130$
ip as-path access-list 1 permit ^$
```

- Router E only has to announce AS130 in the same way it announces other ASes

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Communities Public AS

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- AS100 routers will not advertise prefixes marked with community no-export to other ASes
- AS100 ISP has no configuration work to do
AS130 ISP can control his own loadsharing
- Only a single /19 prefix is announced to the Internet - no routing table bloat! :-)

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RFC1998

An example of how ISPs use communities...

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RFC1998

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- 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
- Simplifies upstream's configuration
simplifies network operation!

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RFC1998

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- **Community values defined to have particular meanings:**

ASx:100 set local pref 100 preferred route
ASx:90 set local pref 90 backup route if dualhomed on ASx
ASx:80 set local pref 80 main link is to another ISP with same AS path length
ASx:70 set local pref 70 main link is to another ISP

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RFC1998

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- **Sample Customer Router Configuration**

```
router bgp 130
  neighbor x.x.x.x remote-as 100
  neighbor x.x.x.x description Backup ISP
  neighbor x.x.x.x route-map config-community out
  neighbor x.x.x.x send-community
  !
  ip as-path access-list 20 permit ^$
  ip as-path access-list 20 deny .*
  !
  route-map config-community permit 10
  match as-path 20
  set community 100:90
```

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RFC1998

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- **Sample ISP Router Configuration**

```
! Homed to another ISP
ip community-list 70 permit 100:70
! Homed to another ISP with equal ASPATH length
ip community-list 80 permit 100:80
! Customer backup routes
ip community-list 90 permit 100:90
!
route-map set-customer-local-pref permit 10
match community 70
set local-preference 70
```

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RFC1998

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- **Sample ISP Router Configuration**

```
route-map set-customer-local-pref permit 20
match community 80
set local-preference 80
!
route-map set-customer-local-pref permit 30
match community 90
set local-preference 90
!
route-map set-customer-local-pref permit 40
set local-preference 100
```

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RFC1998

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- **Supporting RFC1998**

many ISPs do, more should
check AS object in the Internet Routing Registry
if you do, insert comment in AS object in the IRR

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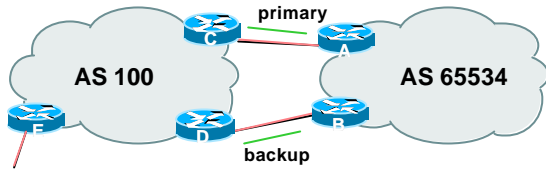
Two links to the same ISP

One link primary, the other link backup only

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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
 network 221.10.0.0 mask 255.255.224.0
 neighbor 222.222.10.2 remote-as 100
 neighbor 222.222.10.2 description RouterC
 neighbor 222.222.10.2 prefix-list aggregate out
 neighbor 222.222.10.2 prefix-list default in
!
ip prefix-list aggregate permit 221.10.0.0/19
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
 network 221.10.0.0 mask 255.255.224.0
 neighbor 222.222.10.6 remote-as 100
 neighbor 222.222.10.6 description RouterD
 neighbor 222.222.10.6 send-community
 neighbor 222.222.10.6 prefix-list aggregate out
 neighbor 222.222.10.6 route-map routerD-out out
 neighbor 222.222.10.6 prefix-list default in
 neighbor 222.222.10.6 route-map routerD-in in
!
..next slide
```

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

```
ip prefix-list aggregate permit 221.10.0.0/19
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
 neighbor 222.222.10.1 remote-as 65534
 neighbor 222.222.10.1 default-originate
 neighbor 222.222.10.1 prefix-list Customer in
 neighbor 222.222.10.1 prefix-list default out
!
ip prefix-list Customer permit 221.10.0.0/19
ip prefix-list default permit 0.0.0.0/0
```

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

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- Router D Configuration (backup link)

```
router bgp 100
neighbor 222.222.10.5 remote-as 65534
neighbor 222.222.10.5 default-originate
neighbor 222.222.10.5 prefix-list Customer in
neighbor 222.222.10.5 route-map bgp-cust-in in
neighbor 222.222.10.5 prefix-list default out
!
ip prefix-list Customer permit 221.10.0.0/19
ip prefix-list default permit 0.0.0.0/0
!
```

..next slide

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

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```
ip prefix-list Customer permit 221.10.0.0/19
ip prefix-list default permit 0.0.0.0/0
!
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
```

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

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- Router E Configuration

```
router bgp 100
network 221.10.0.0 mask 255.255.224.0
neighbor 222.222.10.17 remote-as 110
neighbor 222.222.10.17 filter-list 1 out
!
ip as-path access-list 1 deny ^(65534_)+$
ip as-path access-list 1 permit ^$
ip route 221.10.0.0 255.255.224.0 null0
```

- Router E removes prefixes in the private AS from external announcements
- Private AS still visible inside AS100

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Two links to different ISPs

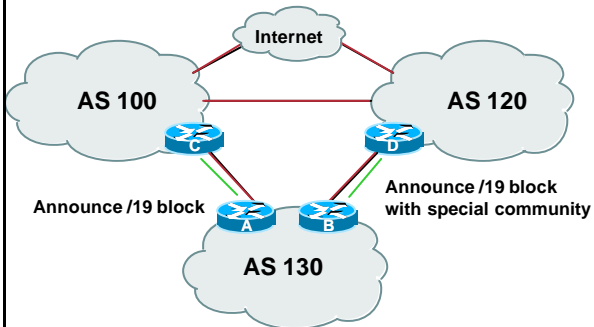
One link primary, the other link backup only

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Two links to different ISPs (one as backup only)

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Two links to different ISPs (one as backup only)

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- Announce /19 aggregate on each link

main link sends community 100:100 – this sets local pref in AS100 to 100

backup link sends community 120:80 – this sets local pref in AS120 to 80

- When one link fails, the announcement of the /19 aggregate via the other link ensures continued connectivity

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Two links to different ISPs (one as backup only)

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- Note that this assumes that AS100 and AS120 are interconnected
- If they are not, AS path length “stuffing” has to be used too
but that can be done on a per community basis also

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Two links to different ISPs (one as backup only)

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- Router A Configuration

```
router bgp 130
network 221.10.0.0 mask 255.255.224.0
neighbor 222.222.10.1 remote-as 100
neighbor 222.222.10.1 prefix-list aggregate out
neighbor 222.222.10.1 route-map routerC-out out
neighbor 222.222.10.1 prefix-list default in
!
ip prefix-list aggregate permit 221.10.0.0/19
ip prefix-list default permit 0.0.0.0/0
!
route-map routerC-out permit 10
set community 100:100
```

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Two links to different ISPs (one as backup only)

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- Router B Configuration

```
router bgp 130
network 221.10.0.0 mask 255.255.224.0
neighbor 220.1.5.1 remote-as 120
neighbor 220.1.5.1 prefix-list aggregate out
neighbor 220.1.5.1 route-map routerD-out out
neighbor 220.1.5.1 prefix-list default in
neighbor 220.1.5.1 route-map routerD-in in
..next slide
```

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Two links to different ISPs (one as backup only)

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```
ip prefix-list aggregate permit 221.10.0.0/19
ip prefix-list default permit 0.0.0.0/0
!
route-map routerD-out permit 10
set community 120:80
!
route-map routerD-in permit 10
set local-preference 80
```

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Two links to different ISPs (one as backup only)

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- Router D

- sees path from router B with community 120:80
- set – sets local preference to 80
- sees path from peering with AS100 – default local preference is 100
- local-pref comes before AS Path length
- highest local-pref wins
- traffic for AS130 is sent to AS100

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Two links to different ISPs (one as backup only)

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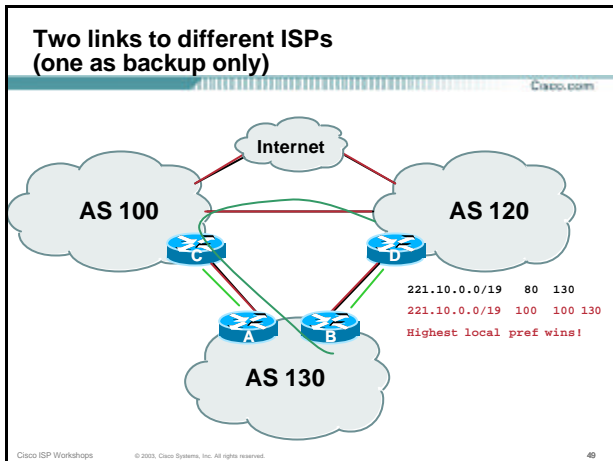
- Router D

- Only requires RFC1998 configuration
- no per customer configuration
- scalability!

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- ### Two links to different ISPs (one as backup only)
- If AS130 wants to make the link to AS120 the main link
 - sends community 120:100 to router C
 - sends community 100:80 to router B
 - AS120 and AS100 NOC intervention not required
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Service Provider use of Communities

Some working examples

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- ### Background
- RFC1998 is okay for "simple" multihomed customers
 - assumes that upstreams are interconnected
 - ISPs create many other communities to handle more complex situations
 - Simplify ISP BGP configuration
 - Give customer more policy control
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- ### Some ISP Examples
- Public policy is usually listed in the IRR
 - Following examples are all in the IRR or referenced from the AS Object in the IRR
 - Consider creating communities to give policy control to customers
 - Reduces technical support burden
 - Reduces the amount of router reconfiguration, and the chance of mistakes
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Some ISP Connections

```

aut-num: AS2764
as-name: ASN-CONNECT-NET
descr: connect.com.au Pty Ltd
admin-c: CC89
tech-c: MP151
remarks: Community Definition
remarks: -----
remarks: 2764:1 Announce to "domestic" rate ASes only
remarks: 2764:2 Don't announce outside local POP
remarks: 2764:3 Lower local preference by 25
remarks: 2764:4 Lower local preference by 15
remarks: 2764:5 Lower local preference by 5
remarks: 2764:6 Announce to non customers with "no-export"
remarks: 2764:7 Only announce route to customers
remarks: 2764:8 Announce route over satellite link
notify: routing@connect.com.au
mnt-by: CONNECT-AU
changed: mrp@connect.com.au 19990506
source: CCAIR

```

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```

Some ISPs
UUNET

aut-num: AS702
as-name: AS702
descr: UUNET - Commercial IP service provider in Europe
remarks: -----
remarks: UUNET uses the following communities with its customers:
remarks: 702:80 Set Local Pref 80 within AS702
remarks: 702:120 Set Local Pref 120 within AS702
remarks: 702:20 Announce only to UUNET AS'es and UUNET customers
remarks: 702:30 Keep within Europe, don't announce to other UUNET AS'es
remarks: 702:1 Prepend AS702 once at edges of UUNET to Peers
remarks: 702:2 Prepend AS702 twice at edges of UUNET to Peers
remarks: 702:3 Prepend AS702 thrice at edges of UUNET to Peers
remarks: Details of UUNET's peering policy and how to get in touch with
remarks: UUNET regarding peering policy matters can be found at:
remarks: http://www.uu.net/peering/
remarks: -----
mnt-by: UUNET-MNT
changed: eric-apps@eu.uu.net 20010928
source: RIPE

```

```

Some ISPs
BT Ignite

aut-num: AS5400
as-name: CIPCORE
descr: BT Ignite European Backbone
remarks: The following BGP communities can be set by BT Ignite
remarks: BGP customers to affect announcements to major peers.
remarks: -----
remarks: Community to      To peer:      Community to
remarks: Not announce      AS prepend 5400
remarks: -----
remarks: 5400:1000 European peers      5400:2000
remarks: 5400:1001 Sprint (AS1239)      5400:2001
remarks: 5400:1003 Unisource (AS3300)    5400:2003
remarks: 5400:1005 UUnet (AS702)        5400:2005
remarks: 5400:1006 Carrier1 (AS8918)    5400:2006
remarks: 5400:1007 SupportNet (8582)    5400:2007
remarks: 5400:1008 AT&T (AS2686)        5400:2008
remarks: 5400:1009 Level 3 (AS9057)     5400:2009
remarks: 5400:1010 RIPE (AS3333)       5400:2010
<snip>
remarks: 5400:1100 US peers           5400:2100
notify: notify@eu.ignite.net
mnt-by: CIP-MNT
source: RIPE

```

And many many more!

```

Some ISPs
Carrier1

aut-num: AS8918
descr: Carrier1 Autonomous System
<snip>
remarks: Community Support Definitions:
remarks: Communities that determine the geographic
remarks: entry point of routes into the Carrier1 network
remarks: -----
remarks: Community      Entry Point
remarks: -----
remarks: 8918:10         London
remarks: 8918:15         Hamburg
remarks: 8918:18         Chicago
remarks: 8918:20         Amsterdam
remarks: 8918:25         Milan
remarks: 8918:28         Berlin
remarks: 8918:30         Frankfurt
remarks: 8918:35         Zurich
remarks: 8918:40         Geneva
remarks: 8918:45         Stockholm
<snip>
notify: ino@carrier1.net
mnt-by: CARRIER1-MNT
source: RIPE

```

And many many more!

```

Some ISPs
Level 3

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
remarks: 65003:0 - prepend 3x to all peers
remarks: 65003:XXX - prepend 3x at peerings to AS XXX
remarks: 65004:0 - prepend 4x to all peers
remarks: 65004:XXX - prepend 4x at peerings to AS XXX
<snip>
mnt-by: LEVEL3-MNT
source: RIPE

```

And many many more!

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!

BGP and the Internet

Using Communities for Multihoming