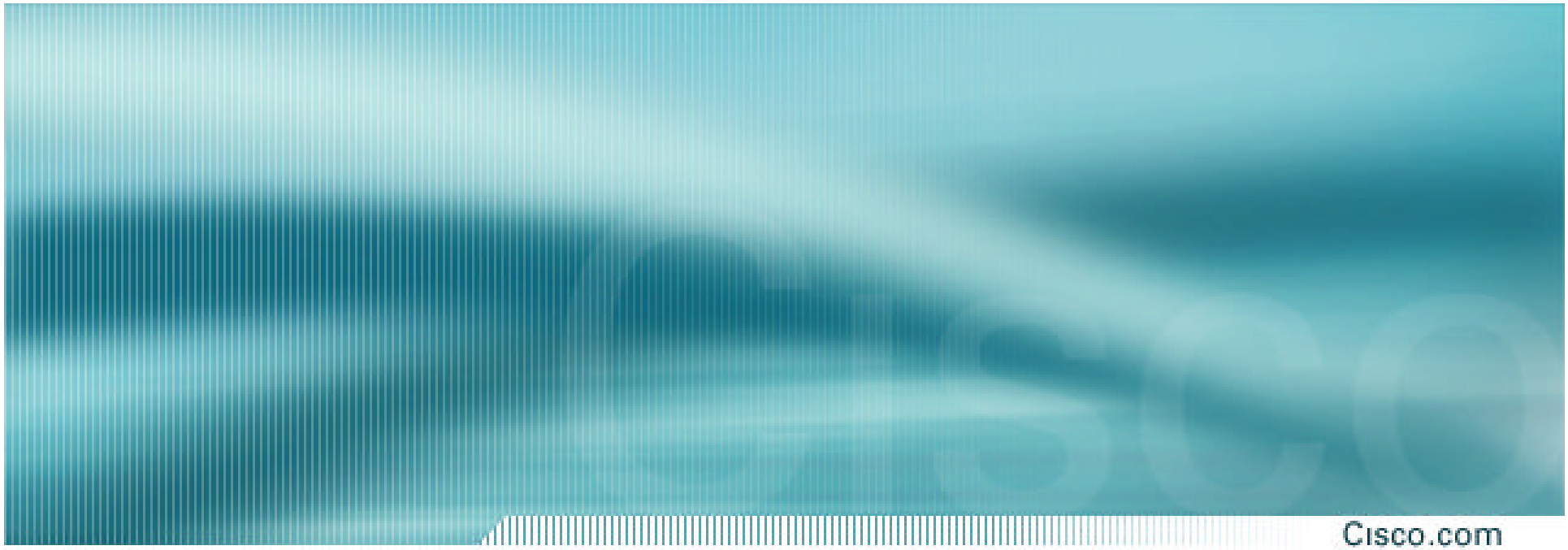

BGP and the Internet

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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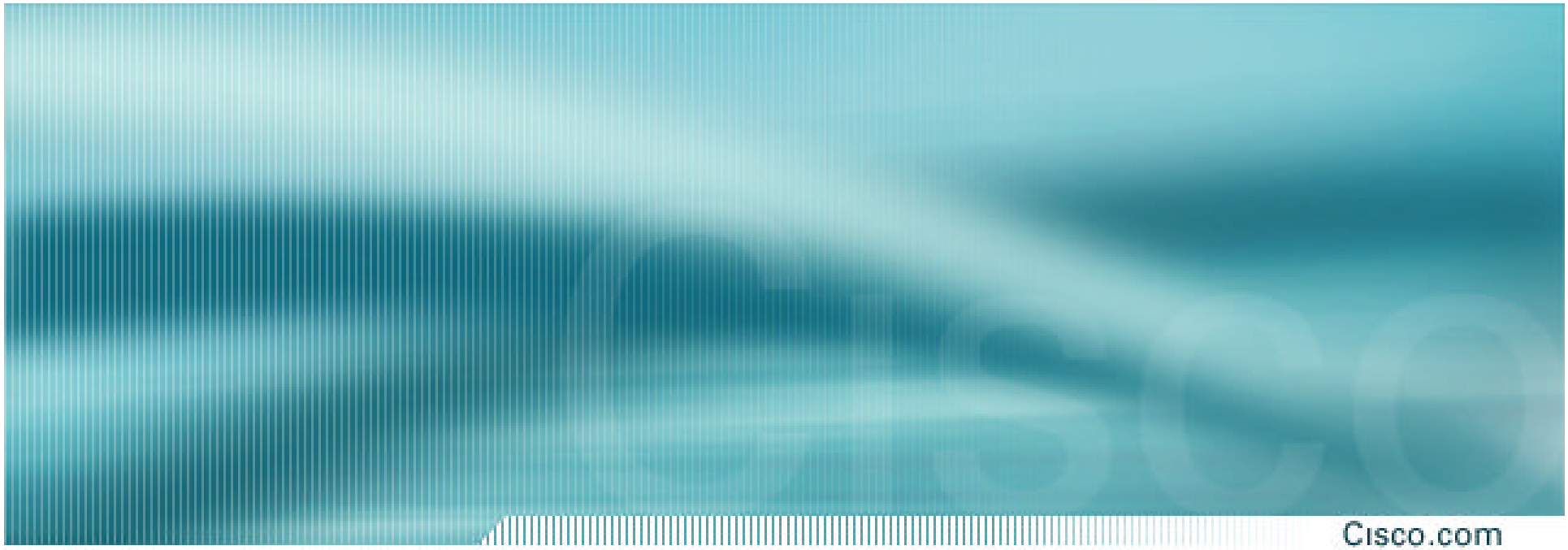

Loadsharing Using Communities

4 links – Private AS

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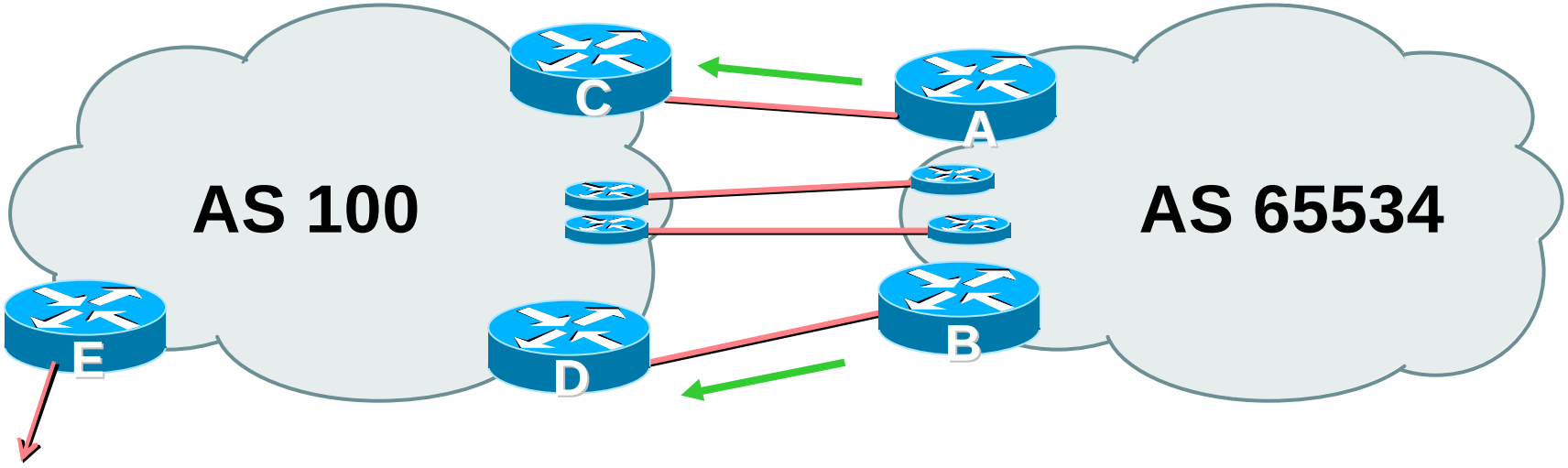
Communities
Private AS



- **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


```
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

- **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


```
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

- **Router E Configuration**

```
router bgp 100
 neighbor 222.222.10.17 remote-as 110
 neigbhor 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

- 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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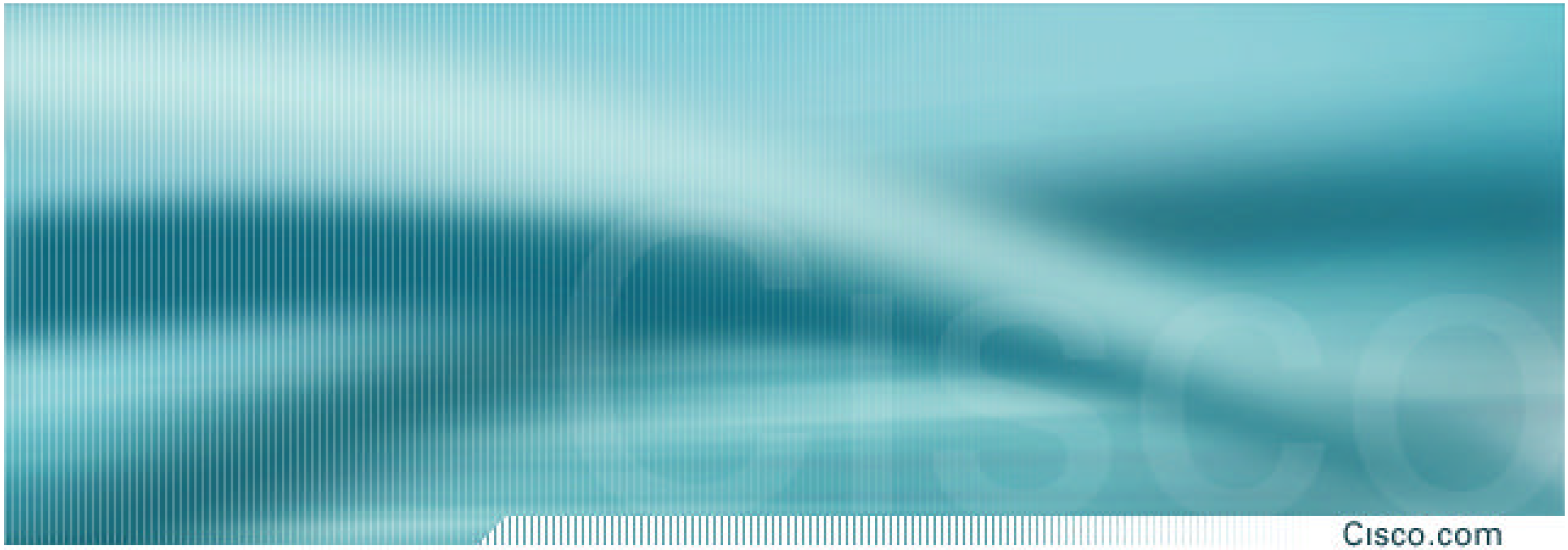

Loadsharing Using Communities

4 links – Public AS

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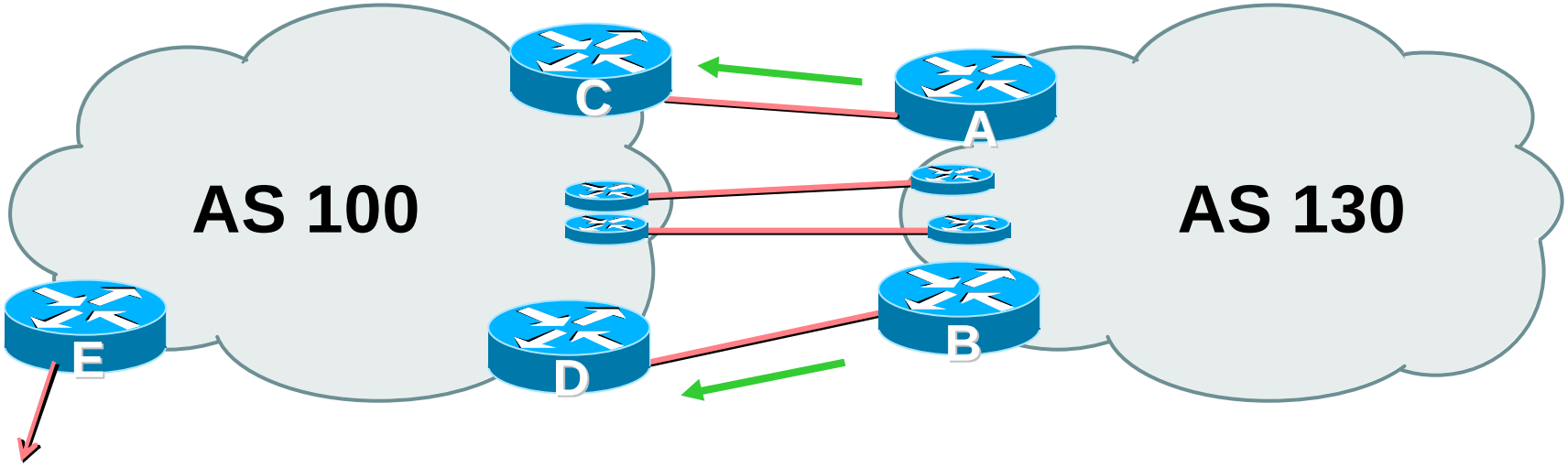
Communities
Public AS



- **4 links between AS130 and AS100**

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Communities
Public 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
Public AS

- **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


```
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

- **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


```
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

- **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

- **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

- **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

- 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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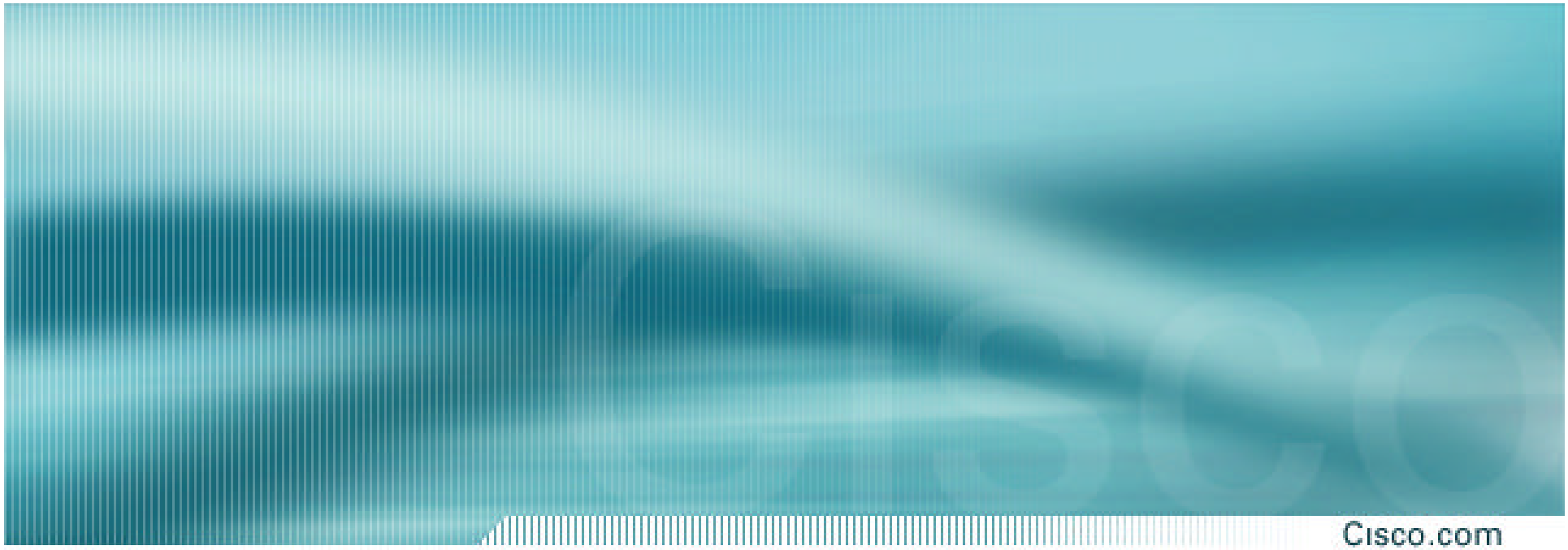

RFC1998

An example of how ISPs use communities…

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RFC1998

- 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

- **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

- **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

- **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

- **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

- **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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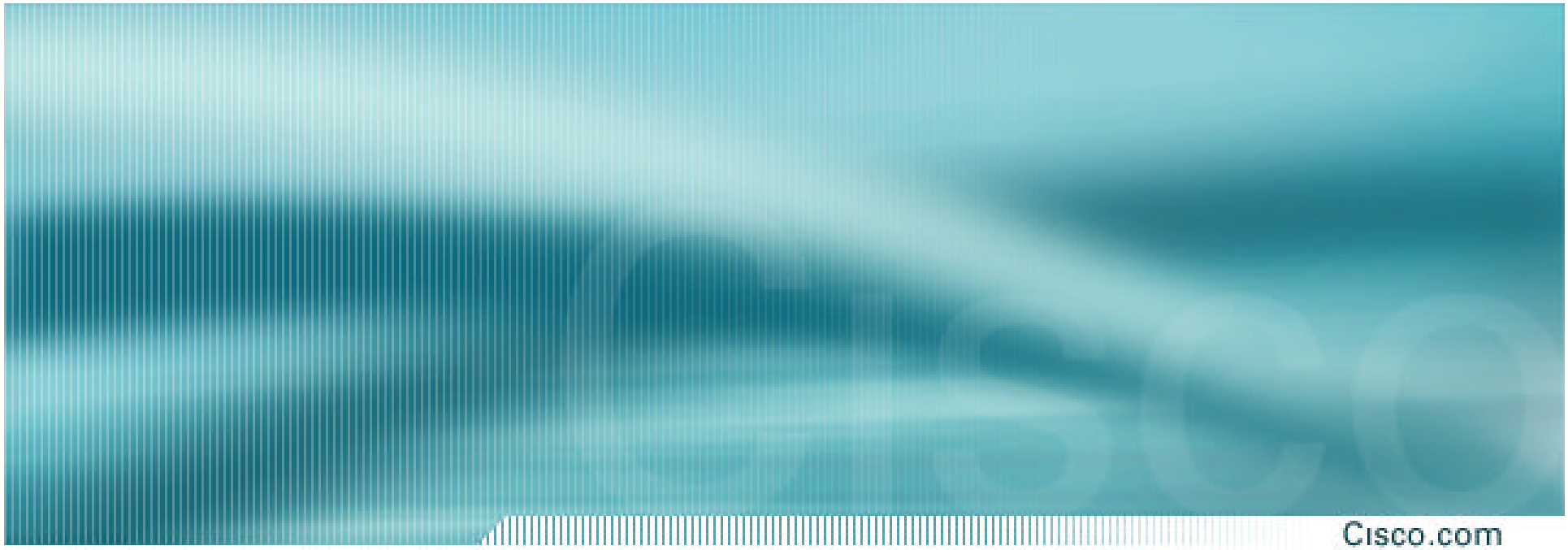

Two links to the same ISP

One link primary, the other link backup only

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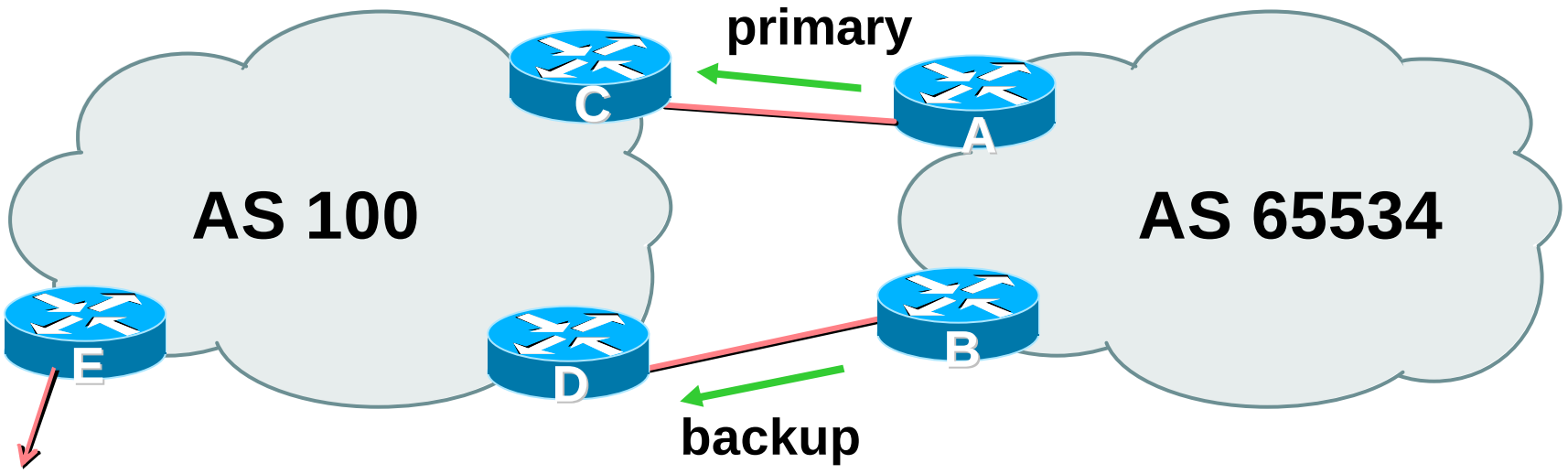
Two links to the same ISP



- **AS100 proxy aggregates for AS 65534**

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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

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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
!
```


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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
```


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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
!
```


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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
```


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

- **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)


```
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)

- **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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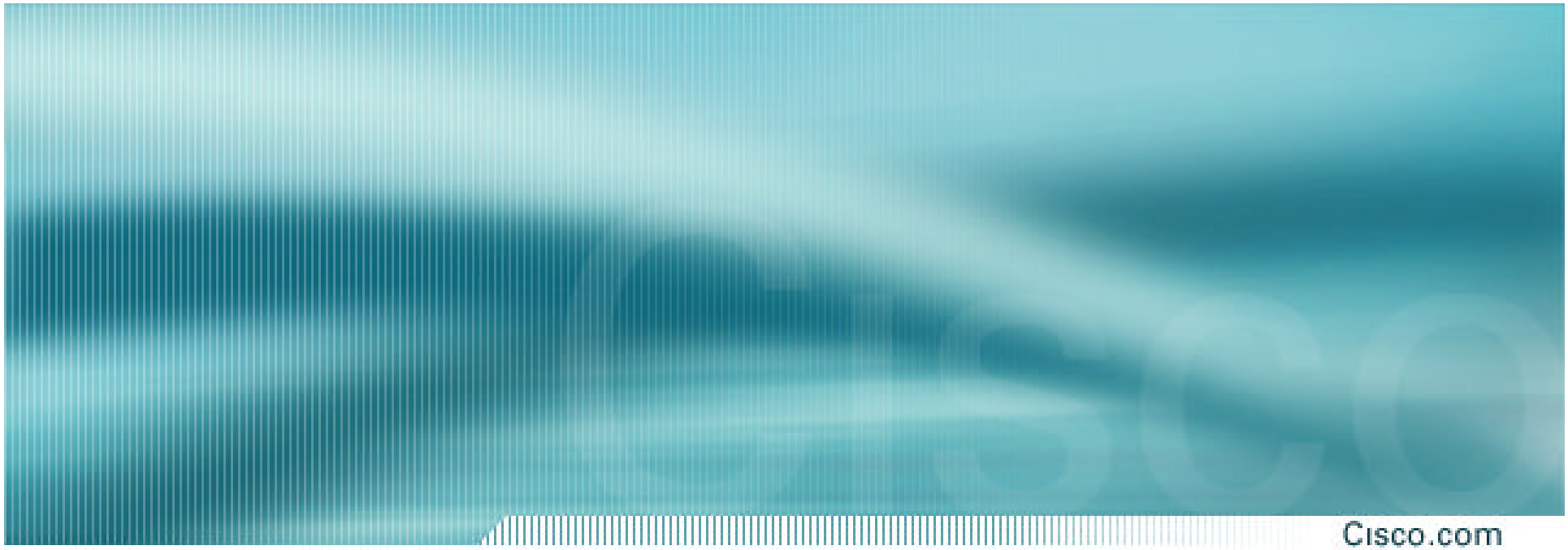

Two links to different ISPs

One link primary, the other link backup only

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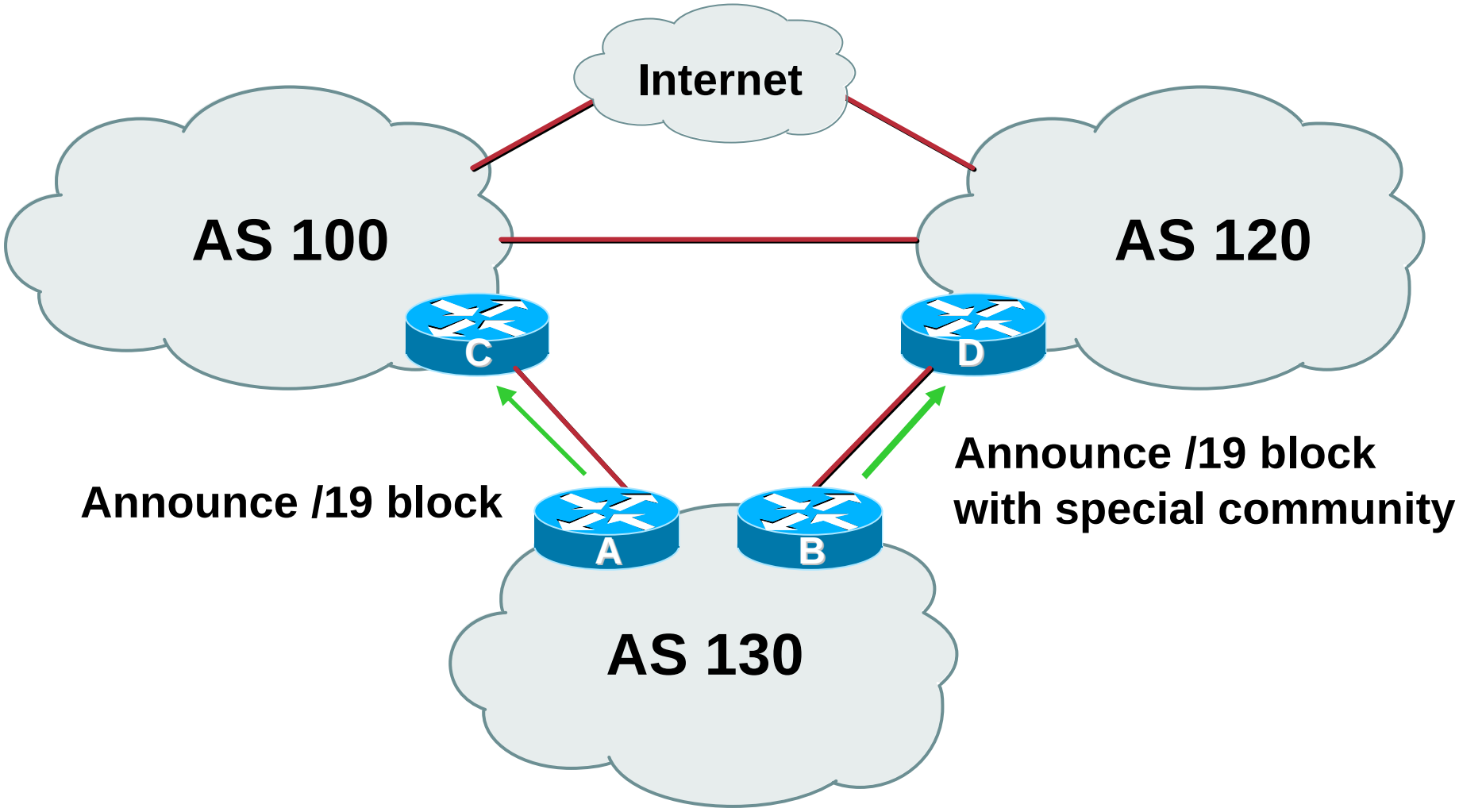
Two links to different ISPs (one as backup only)



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Two links to different ISPs (one as backup only)

- **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)

- 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)

- **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)

- **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)


```
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)

- **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)

- **Router D**

  Only requires RFC1998 configuration

  no per customer configuration

  scalability!

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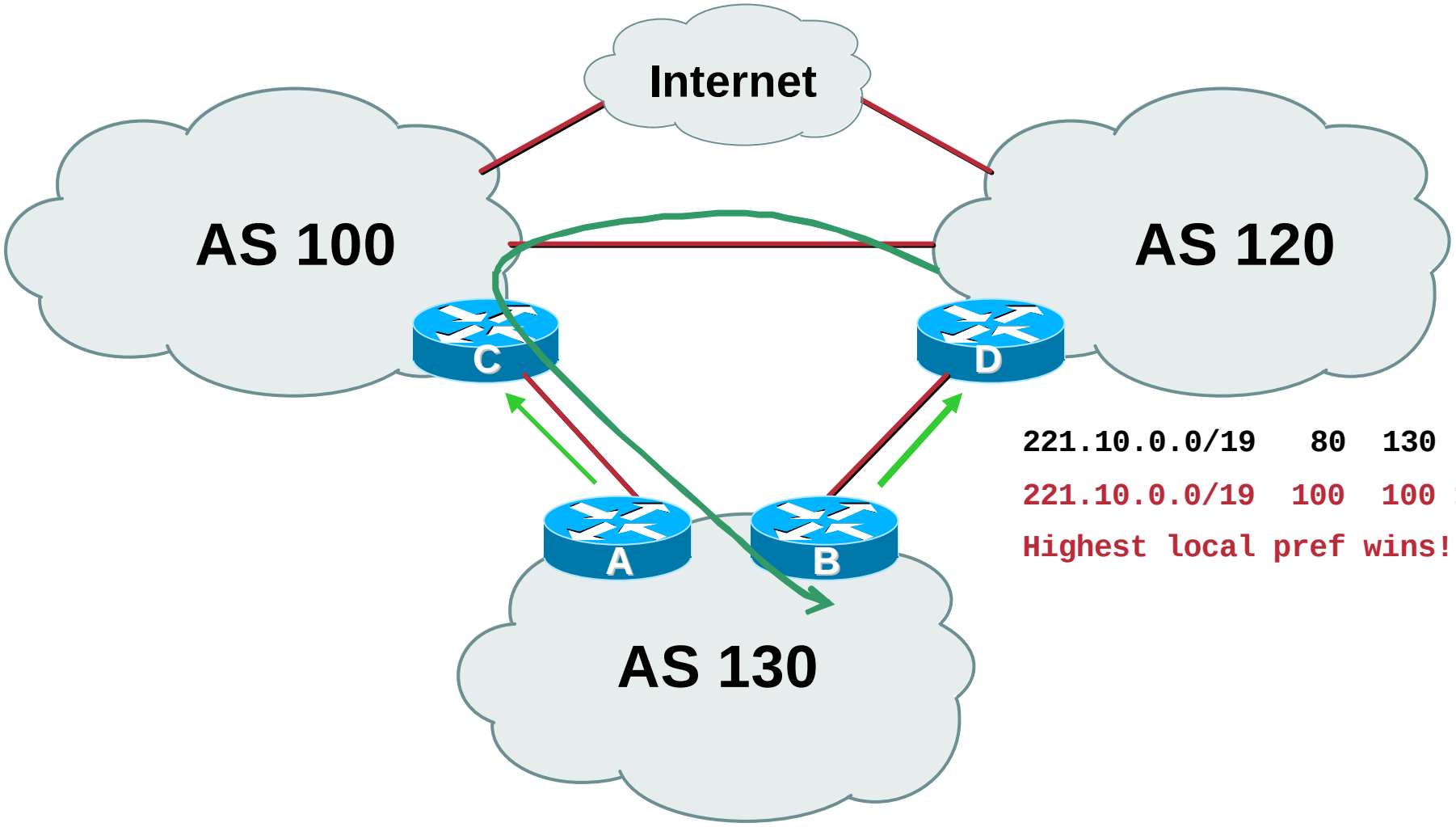
Two links to different ISPs (one as backup only)



221.10.0.0/19 80 130

221.10.0.0/19 100 100 130

Highest local pref wins!

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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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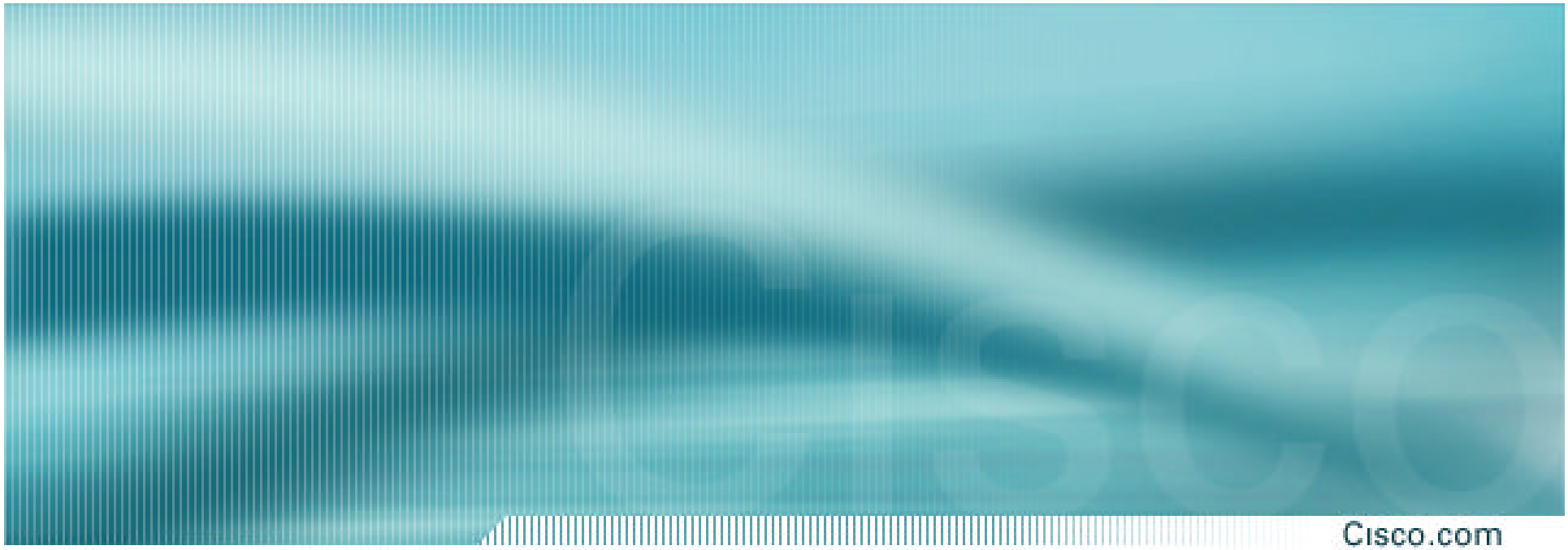

Service Provider use of Communities

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
Conne

```
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
```

Some IS
UUN

```
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's
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 ISP
BT Ig

```
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                                  Community to
remarks:        Not announce        To peer:                  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 ISP
Carrier

```
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:         inoc@carrier1.net
mnt-by:         CARRIER1-MNT
source:         RIPE
```

Some IS
Leve

```
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!***

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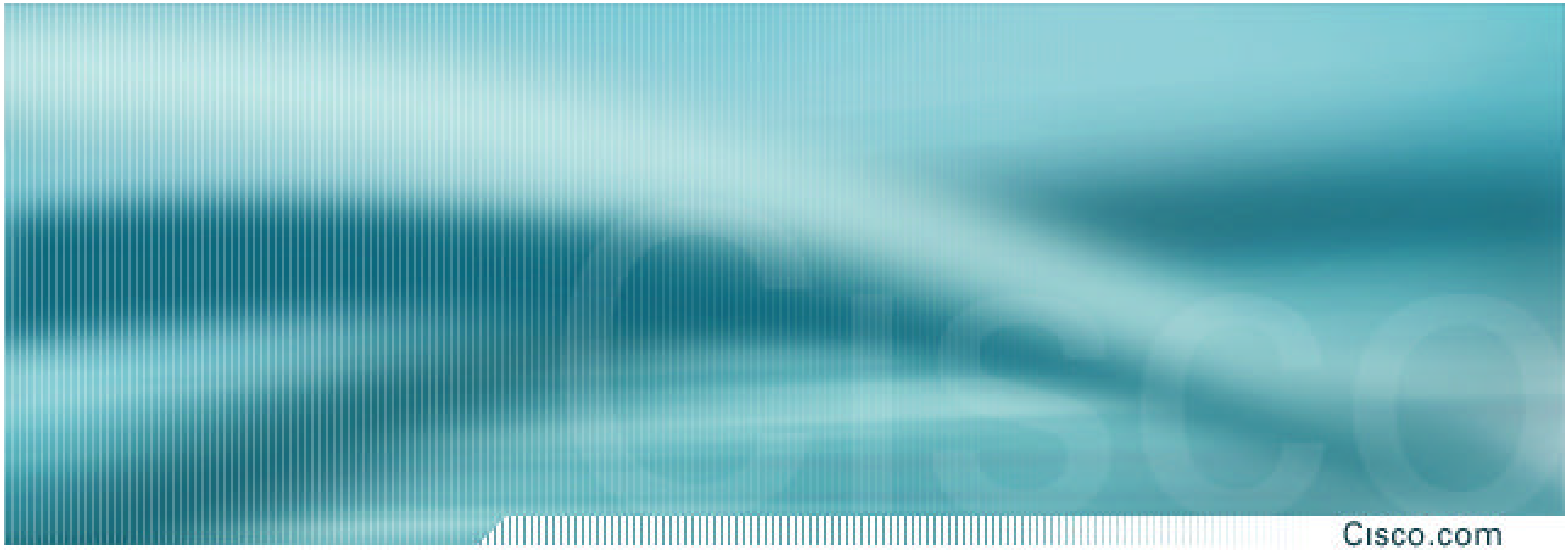

BGP and the Internet

Using Communities for Multihoming

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