Deploying
BGP Large Communities

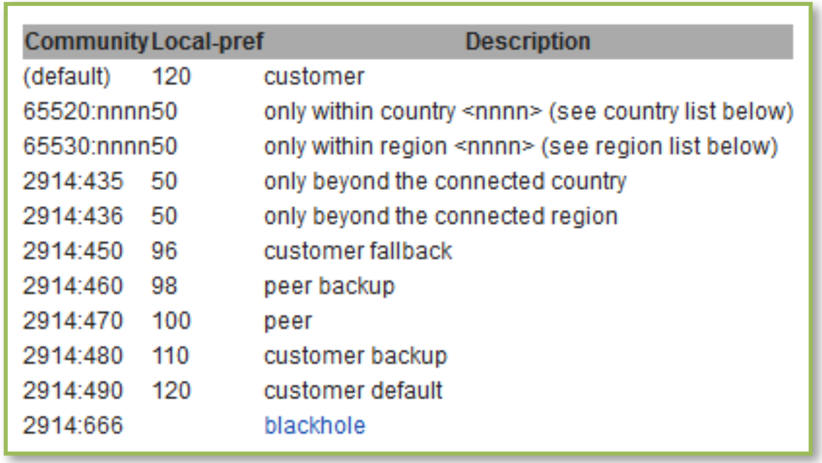
Job Snijders

job@ntt.net

NTT Communications

Network Operators Use BGP Communities

- RFC 1997 style communities have been available for the past 20 years
  - Encodes a 32-bit value displayed as: “16-bit ASN:16-bit value”
  - Designed to simplify Internet routing policies
  - Signals routing information between networks so that an action can be taken
- Broad support in BGP implementations
- Widely deployed and required by network operators for Internet routing



Community	Local-pref	Description
(default)	120	customer
65520:nnnn	50	only within country <nnnn> (see country 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

RFC 1997 Communities Examples

Source: https://www.us.ntt.net/support/policy/routing.cfm (AS 2914)

Needed RFC 1997 Style Communities, but Larger

- We knew we'd run out of 16-bit ASNs eventually and came up with 32-bit ASNs
  - RIRs started allocating 32-bit ASNs by request in 2007, no distinction between 16-bit and 32-bit ASNs now
- However, you can't fit a 32-bit value into a 16-bit field
  - Can't use native 32-bit ASNs with RFC 1997 communities
- Needed an Internet routing communities solution for 32-bit ASNs for almost 10 years
  - Parity and fairness so everyone can use their globally unique ASN

The Solution: RFC 8092
“BGP Large Communities Attribute”

- Idea progressed rapidly from inception in March 2016
- First I-D in September 2016 to RFC publication on February 16, 2017 in just seven months
- Final standard, plus a number of implementation and tools developed as well
- Network operators can test and deploy the new technology now

Cake and photo courtesy of the NTT Communications NOC.

Encoding and Usage

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      Global Administrator                     |  Autonomous System Number (Me)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Local Data Part 1                       |  Operator-Defined Value (Action)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Local Data Part 2                       |  Operator-Defined Value (You)
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

- A unique namespace for all 16-bit and 32-bit ASNs
  - No namespace collisions between ASNs
- Large communities are encoded as a 96-bit quantity and displayed as “32-bit ASN:32-bit value:32-bit value”
- Canonical representation is $Me:$Action:$You

Planning for Large Communities

- The entire network ecosystem needs to support large communities in order to provision, deploy and troubleshoot them
- Ask your vendors and implementers for software support
- Update your tools and provisioning software
- Extend your routing policies, and openly publish this information
- Train your technical staff

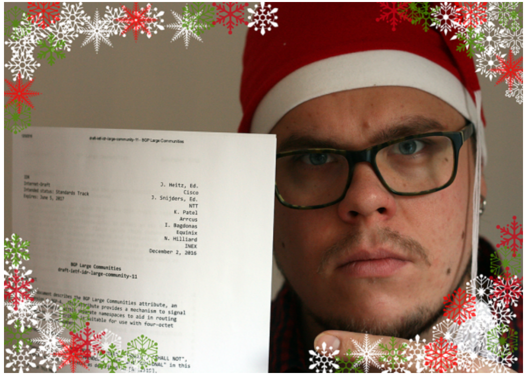


Image sources: https://www.sunet.se/blogg/all-i-want-for-christmas-is-large-bgp-communities/
“All i want for christmas is … Large BGP Communities” by Fredrik "Hugge" Korsbäck

Develop a Comprehensive Communities Policy

- Classic RFC 1997 communities will continue to be used together with large communities
  - There’s no flag day to convert, large communities simply provide an additional way to signal information
- Your existing routing policy with classic communities is still valid
- Well-known communities such as “no-advertise”, “no–export”, “blackhole”, etc. are still used
- Extend your policy with large communities that allow network operators to signal the same information as they can with classic communities

BGP Large Community Examples

RFC 1997 (Current)	BGP Large Communities	Action
65400:*peer-as*	2914:65400:*peer-as*	Do not Advertise to *peer-as* in North America (NTT)
43760:*peer-as*	43760:1:*peer-as*	Announce a prefix to a certain peer (INEX)
0:43760	43760:0:*peer-as*	Prevent announcement of a prefix to a certain peer (INEX)
65520:*nnn*	2914:65520:*nnn*	Lower Local Preference in Country *nnn* (NTT)
2914:410	2914:400:10	Route Received From a Peering Partner (NTT)
2914:420	2914:400:20	Route Received From a Customer (NTT)

- No namespace collisions or use of reserved ASNs
- Enables operators to use 32-bit ASNs in $Me and $You values

Communities Policy Development

- draft-ietf-grow-large-communities-usage is a new RFC 1998 style I-D in the IETF GROW Working Group
- Provides examples and inspiration for network operators to use large communities
- Also provides many examples on how to develop a communities policy
  - Informational communities
  - Action communities

Informational Communities

- An informational label to mark a route with
  - Its origin: ISO 3166-1 numeric country ID and UM M.49 geographic region
  - Relation or propagation: internal, customer, peer, transit
- Provides information for debugging or capacity planning
- The Global Administrator field is set to the ASN that labels the routes
- Most useful for downstream networks and the Global Administrator itself

Information Communities Example

ISO 3166-1 Country ID	
Large Community	Description
64497:1:528	Netherlands
64497:1:392	Japan
64497:1:840	USA

+

UN M.49 Region	
Large Community	Description
64497:2:2	Africa
64497:2:9	Oceania
64497:2:145	Western Asia
64497:2:150	Europe

+

Relation	
Large Community	Description
64497:3:1	Internal
64497:3:2	Customer
64497:3:3	Peering
64497:3:4	Transit

- For example, a communities value of “64497:1:528 64497:2:150 64497:3:2” would indicated that is was learned in the Netherlands, in Europe, from a customer

CDN / Eyeball Example – You do a lot with 32 bits!

British Postal Codes (~31 Bits)	
Large Community	Postal Code
64497:9:849701135	E1W 1LB (London)
64497:9:1345374681	M90 1QX (Manchester)

or

GPS Coordinates	
Large Community	Location
64497:10:1281024	Amsterdam (52.37783, 4.87995)

- Location encoding can be used to provide very accurate location information attached to more-specific routes announced to CDN caches
- British postal codes can be encoded by stripping the whitespace and doing a simple base36 to base10 conversion
- GPS coordinates can be encoded with Geohash
  - For example 52.37783, 4.87995 (Amsterdam) encoded with 600 meter precision
  - Python: import Geohash; Geohash.encode(52.37783, 4.87995, precision=6)
  - Geohash result: “u173zp”
  - Convert “u173zp” from base32 to base10 = 1281024

Action Communities

- An action label to request that a route be treated in a particular way within an AS
  - Propagation characteristics: export, selective export, no export
  - Local preference: influence ingress traffic within the AS
  - AS Path: influence traffic from outside the AS
- The Global Administrator field is set to the ASN which has defined the functionality of the community
  - Also is the AS that is expected to perform the action
- Most useful for transit providers taking action on behalf of a customer or the Global Administrator

Action Communities Example

- Selective no export
  - ASN based selective no export
  - Location based selective no export
- Selective AS path prepending
  - ASN based selective AS path prepending
  - Location based selective AS path
- Local preference
  - Global local preference
  - Region based local preference

ASN Based No Export	
Large Community	Description
64497:4:64498	AS 64498
64497:4:64499	AS 64499
64497:4:65551	AS 65551

Location Based No Export	
Large Community	Description
64497:5:528	Netherlands
64497:5:392	Japan
64497:5:840	USA

Getting Started With Large Communities

- 2018 is the year of large BGP communities
  - Preparation, testing, training and deployment can take weeks, months or even over a year
  - Start the work now, so you are ready when customers want to use large communities
- Lots of resources are available to help network operators learn about large communities
  - BGP speaker implementations
  - Analysis and ecosystem tools
  - Presentations (http://largebgpcommunities.net/talks/)
  - Documentation for each implementation
  - Configuration examples (http://largebgpcommunities.net/examples/)

Large Communities Beacon Prefixes

- The following prefixes are announced with AS path 2914_15562$
  - 192.147.168.0/24 (looking glass)
  - 2001:67c:208c::/48 (looking glass)
  - BGP Large Community: 15562:1:1

Cisco IOS Output (Without Large Communities Support)

```
route-views>show ip bgp 192.147.168.0
BGP routing table entry for 192.147.168.0/24, version 98399100
Paths: (39 available, best #30, table default)
  Not advertised to any peer
  Refresh Epoch 1
  701 2914 15562
    137.39.3.55 from 137.39.3.55 (137.39.3.55)
      Origin IGP, localpref 100, valid, external
      unknown transitive attribute: flag 0xE0 type 0x20 length 0xC
        value 0000 3CCA 0000 0001 0000 0001
      rx pathid: 0, tx pathid: 0
```

BIRD Output (With Large Communities Support)

```
COLOCLUE1 11:06:17 from 94.142.247.3] (100/-) [AS15562i]
Type: BGP unicast univ
BGP.origin: IGP
BGP.as_path: 8283 2914 15562
BGP.next_hop: 94.142.247.3
BGP.med: 0
BGP.local_pref: 100
BGP.community: (2914,410) (2914,1206) (2914,2203) (8283,1)
BGP.large_community: (15562, 1, 1)
```

BGP Speaker Implementation Status

Implementation	Software	Status	Details
Arista	EOS	Planned	Feature Requested BUG169446
Cisco	IOS XE	Planned	16.9.1 (FCS July 2018) source
Cisco	IOS XR	✔ Done!	Beta (perhaps in 6.3.2 for real?)
cz.nic	BIRD	✔ Done!	BIRD 1.6.3 (commit)
ExaBGP	ExaBGP	✔ Done!	PR482
FreeRangeRouting	frr	✔ Done!	Issue 46 (commit)
Juniper	Junos OS	Planned	Second Half 2017 (perhaps 17.3R1?)
MikroTik	RouterOS	Won’t Implement Until RFC	Feature Requested 2016090522001073
Nokia	SR OS	Planned	Third Quarter 2017
nop.hu	freeRouter	✔ Done!	
OpenBSD	OpenBGPD	✔ Done!	OpenBSD 6.1 (commit)
OSRG	GoBGP	✔ Done!	PR1094
rtbrick	Fullstack	✔ Done!	FullStack 17.1
Quagga	Quagga	✔ Done!	Quagga 1.2.0 875
Ubiquiti	EdgeOS	Planned	Internal Enhancement Requested
VyOS	VyOS	Requested	Feature Requested T143

Tools and Ecosystem Implementation Status

Implementation	Software	Status	Details
DE-CIX	pbgpp	✔ Done!	PR16
FreeBSD	tcpdump	✔ Done!	PR213423
Marco d'Itri	zebra-dump-parser	✔ Done!	PR3
OpenBSD	tcpdump	✔ Done!	OpenBSD 6.1 (patch)
pmacct.net	pmacct	✔ Done!	PR61
RIPE NCC	bgpdump	✔ Done!	Issue 41 (commit)
tcpdump.org	tcpdump	✔ Done!	PR543 (commit)
Yoshiyuki Yamauchi	mrtparse	✔ Done!	PR13
Wireshark	Dissector	✔ Done!	18172 (patch)

Visit http://largebgpcommunities.net/implementations/ for the Latest Status

Testing Large Communities

- The BGP Large Communities Playground provides an easy way run several implementations together in a lab environment
- Supports BIRD, ExaBGP, GoBGP, Quagga and pmacct
- Docker images are available
- Use the playground to
  - Become familiar with large communities
  - Test interoperability with your vendor's BGP implementations
  - Design, configure and verify your new community policies

BGP Large Communities Playground: https://github.com/pierky/bgp-large-communities-playground

Questions?

Presentation created by:

Greg Hankins
Nokia
greg.hankins@nokia.com
@greg_hankins

Job Snijders
NTT Communications
job@ntt.net
@JobSnijders

Visit http://LargeBGPCommunities.net/ for the Latest Info

Reuse of this slide deck is permitted and encouraged!

Configuration and Output Examples

BIRD Configuration

```
# match
if ((8283, 1, 2) ~ bgp_large_community) then return true;

# scrub / delete
bgp_large_community.delete([(8283, *, *)]);
bgp_large_community.delete([(8283, 0, 1)]);

# set
bgp_large_community.add((8283, 0, 100));
bgp_large_community.add([(8283, 0, 100), (8283, 2, 333)]);
```

IOS XR Configuration
(EFT – Beta “Just Like Community”)

```
# match
route-policy set-something
  if large-community matches-any (8283:4:3) then
    set local-preference 120
  endif
end-policy

# scrub / delete
route-policy set-something
  delete large-community in (8283:*:*)
  delete large-community in (8283:4:3)
end-policy

# set
route-policy set-something
  set large-community (8283:45:29)additive
end-policy
```

Nokia SR OS Configuration

```
policy-options
    community "set" members "8283:45:29"
    community "match" members "8283:4:3"
    community "delete" members "8283:4:3"
```

```
policy-statement "set-something"
    entry 10
        description "match"
        from
            community "match"
        exit
        action accept
            local-preference 120
        exit
    exit
    entry 20
        description "scrub / delete"
        action accept
            community remove "delete"
         exit
    exit
    entry 30
        description "set"
        action accept
            community add "set"
        exit
    exit
exit
```

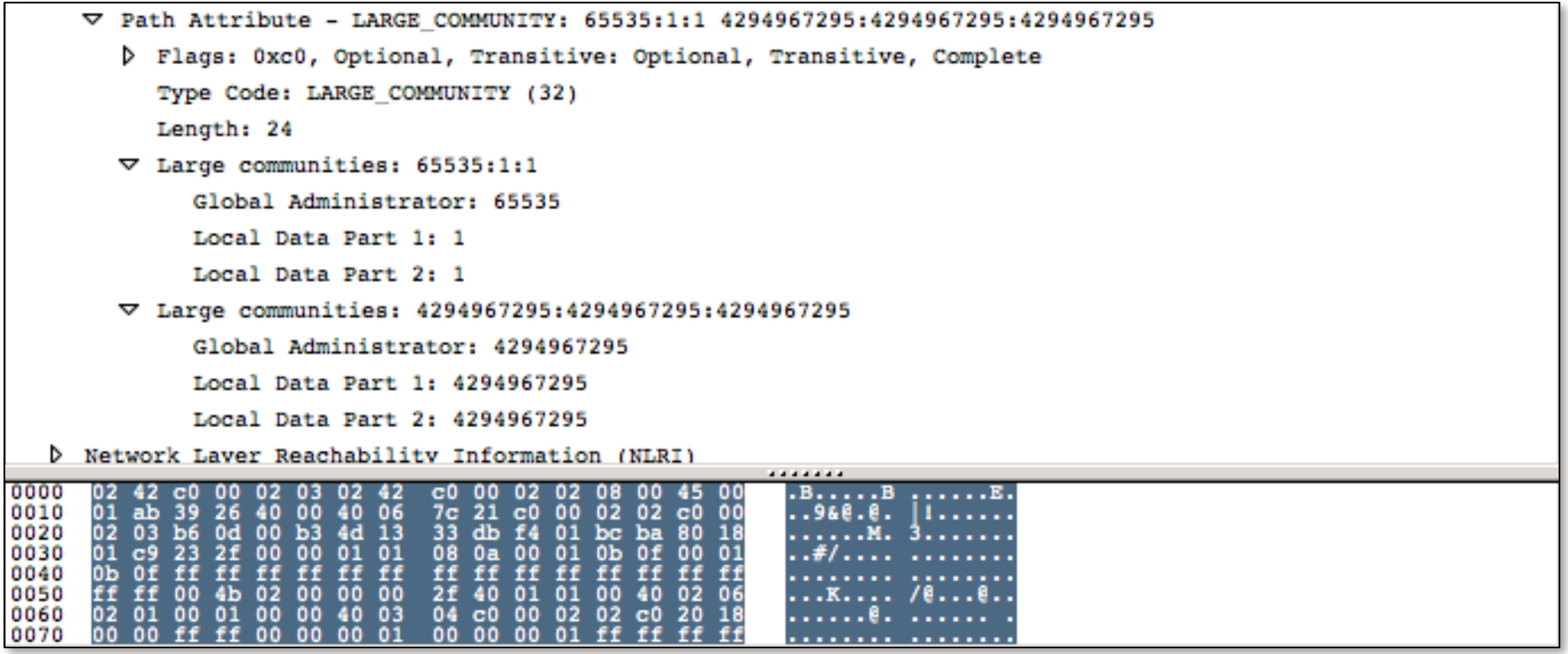
OpenBGPD Configuration

```
# match
allow from any large-community 8283:1:2
match from any large-community 8283:1:2 set localpref 300
deny to any peer-as neighbor-as \
        large-community 8283:6:neighbor-as

# scrub / delete
match from any set { large-community delete 8283:*:* }
match from any set { large-community delete 8283:1:2 }

# set
match from any set { large-community 8283:1:2 }
match from any set { large-community 8283:1:2 \
                           large-community 8283:4034:24824 }
```

tcpdump 4.9.0 Packet Capture

```
# ./tcpdump -i eth3 -n -v -c 1 src port 179
tcpdump: listening on eth3, link-type EN10MB (Ethernet), capture size 262144 bytes
16:22:08.992920 IP (tos 0xc0, ttl 64, id 41807, offset 0, flags [DF], proto TCP (6), length 181)
 94.142.247.3.179 > 94.142.247.6.33785: Flags [P.], cksum 0xabce (incorrect -> 0x1e40), seq
58743671:58743800, ack 2012368616, win 2270, options [nop,nop,TS val 857977378 ecr 149127175],
length 129: BGP
           Update Message (2), length: 129
             Origin (1), length: 1, Flags [T]: IGP
             AS Path (2), length: 34, Flags [T]: 38930 1299 3910 721 27065 1554 1555 1501
             Next Hop (3), length: 4, Flags [T]: 94.142.247.3
             Multi Exit Discriminator (4), length: 4, Flags [O]: 0
             Local Preference (5), length: 4, Flags [T]: 100
             Atomic Aggregate (6), length: 0, Flags [T]:
             Aggregator (7), length: 8, Flags [OT]:  AS #1501, origin 144.105.202.0
             Community (8), length: 8, Flags [OT]: 1299:20000, 8283:14
             Large Community (32), length: 12, Flags [OTP]:
               8283:6:14
             Updated routes:
               136.210.249.0/24
```

Wireshark 2.3.0 (Prerelease) Packet Capture



```
  ▽ Path Attribute - LARGE_COMMUNITY: 65535:1:1 4294967295:4294967295:4294967295
      ▷ Flags: 0xc0, Optional, Transitive: Optional, Transitive, Complete
        Type Code: LARGE_COMMUNITY (32)
        Length: 24
      ▽ Large communities: 65535:1:1
          Global Administrator: 65535
          Local Data Part 1: 1
          Local Data Part 2: 1
      ▽ Large communities: 4294967295:4294967295:4294967295
          Global Administrator: 4294967295
          Local Data Part 1: 4294967295
          Local Data Part 2: 4294967295
▷ Network Layer Reachability Information (NLRI)

0000   02 42 c0 00 02 03 02 42  c0 00 02 02 08 00 45 00    .B.....B ......E.
0010   01 ab 39 26 40 00 40 06  7c 21 c0 00 02 02 c0 00    ..9&@.@. |!......
0020   02 03 b6 0d 00 b3 4d 13  33 db f4 01 bc ba 80 18    ......M. 3.......
0030   01 c9 23 2f 00 00 01 01  08 0a 00 01 0b 0f 00 01    ..#/.... ........
0040   0b 0f ff ff ff ff ff ff  ff ff ff ff ff ff ff ff    ........ ........
0050   ff ff 00 4b 02 00 00 00  2f 40 01 01 00 40 02 06    ...K.... /@...@..
0060   02 01 00 01 00 00 40 03  04 c0 00 02 02 c0 20 18    ......@. ...... .
0070   00 00 ff ff 00 00 00 01  00 00 00 01 ff ff ff ff    ........ ........
```