Unicast Reverse Path Forwarding

ISP Workshops

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Acknowledgements

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

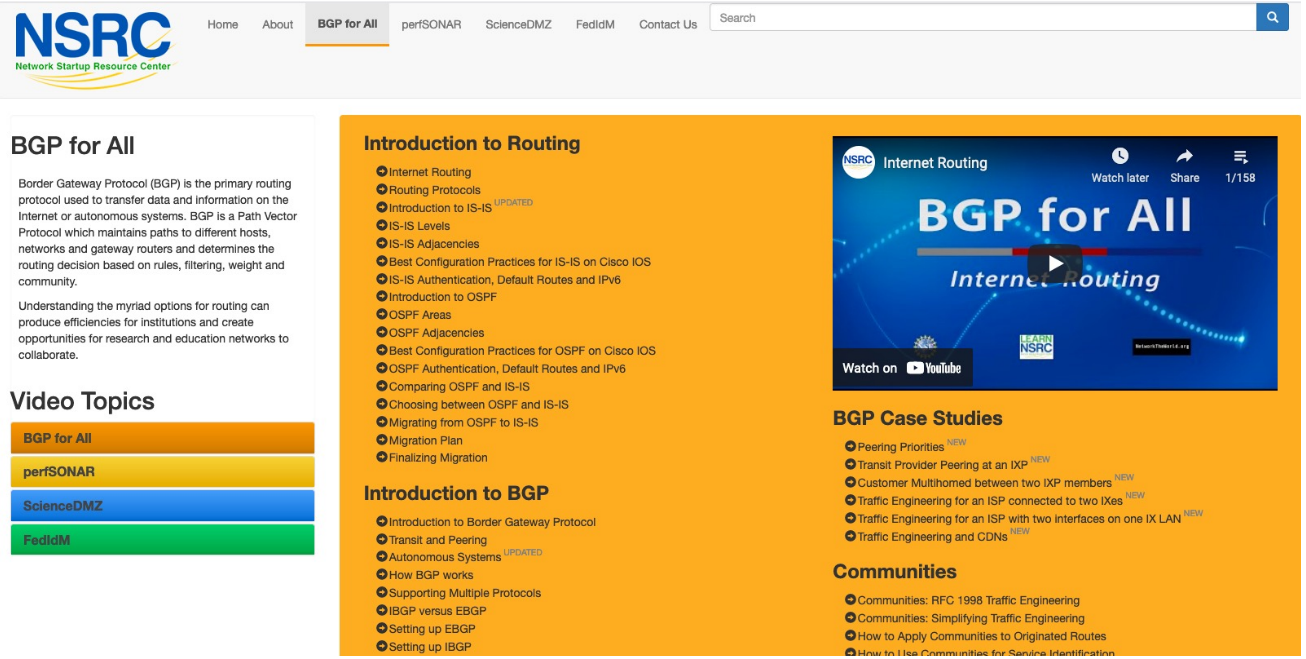
- Use of these materials is encouraged as long as the source is fully acknowledged and this notice remains in place

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

Philip Smith

BGP Videos

- NSRC has produced a library of BGP presentations (including this one), recorded on video, for the whole community to use
  - https://learn.nsrc.org/bgp



BGP for All

Border Gateway Protocol (BGP) is the primary routing protocol used to transfer data and information on the Internet or autonomous systems. BGP is a Path Vector Protocol which maintains paths to different hosts, networks and gateway routers and determines the routing decision based on rules, filtering, weight and community.

Understanding the myriad options for routing can produce efficiencies for institutions and create opportunities for research and education networks to collaborate.

Video Topics

- BGP for All
- perfSONAR
- ScienceDMZ
- FedIdM

Introduction to Routing

- Internet Routing
- Routing Protocols
- Introduction to IS-IS UPDATED
- IS-IS Levels
- IS-IS Adjacencies
- Best Configuration Practices for IS-IS on Cisco IOS
- IS-IS Authentication, Default Routes and IPv6
- Introduction to OSPF
- OSPF Areas
- OSPF Adjacencies
- Best Configuration Practices for OSPF on Cisco IOS
- OSPF Authentication, Default Routes and IPv6
- Comparing OSPF and IS-IS
- Choosing between OSPF and IS-IS
- Migrating from OSPF to IS-IS
- Migration Plan
- Finalizing Migration

Introduction to BGP

- Introduction to Border Gateway Protocol
- Transit and Peering
- Autonomous Systems UPDATED
- How BGP works
- Supporting Multiple Protocols
- IBGP versus EBGP
- Setting up EBGP
- Setting up IBGP

BGP Case Studies

- Peering Priorities NEW
- Transit Provider Peering at an IXP NEW
- Customer Multihomed between two IXP members NEW
- Traffic Engineering for an ISP connected to two IXes NEW
- Traffic Engineering for an ISP with two interfaces on one IX LAN NEW
- Traffic Engineering and CDNs NEW

Communities

- Communities: RFC 1998 Traffic Engineering
- Communities: Simplifying Traffic Engineering
- How to Apply Communities to Originated Routes
- How to Use Communities for Service Identification

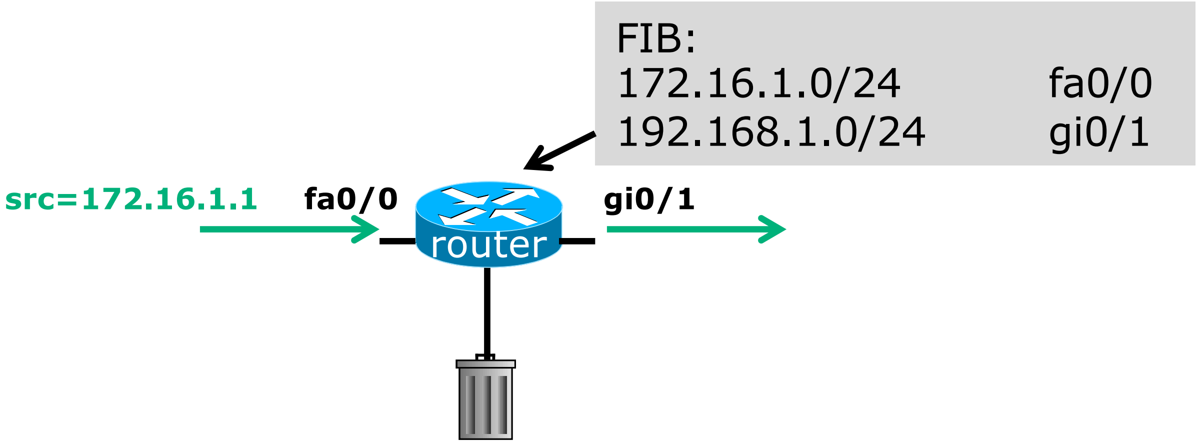
Unicast Reverse Path Forwarding

- uRPF is a technique where the router can discard packets with invalid/fake/incorrect source addresses by a simple check against the Forwarding Table (FIB)
  - More efficient than implementing ingress packet filters
- Part of BCP 38
  - https://tools.ietf.org/html/bcp38
- uRPF is a very effective tool to assist with defeating Denial of Service attacks, at source
  - Implemented by network operators on access devices, where end-users and end-devices connect to their network

uRPF

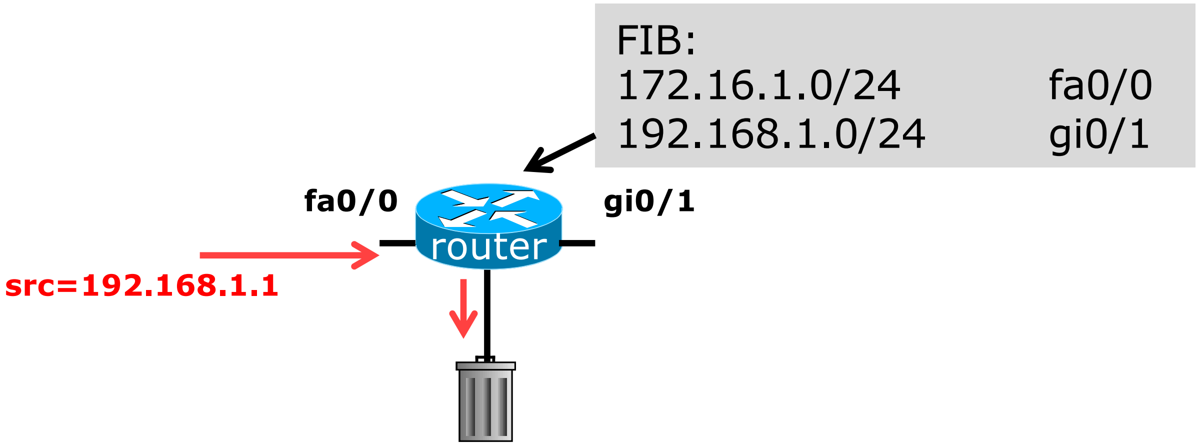
- There are two modes for uRPF:
  - Strict Mode
    - Source address must be reachable via the source (incoming) interface
    - Typically used in Access Networks
  - Loose Mode
    - Source address must be in the FIB
    - Typically used to drop non-routed address space
    - Also can be used when asymmetric traffic flows are present (for example, when multihoming)

uRPF: Strict Mode



- Router compares source address of incoming packet with FIB entry
  - If FIB entry interface matches incoming interface, the packet is forwarded
  - If FIB entry interface does not match incoming interface, the packet is dropped

uRPF: Strict Mode



FIB:

172.16.1.0/24	fa0/0
192.168.1.0/24	gi0/1

- Router compares source address of incoming packet with FIB entry
  - If FIB entry interface matches incoming interface, the packet is forwarded
  - If FIB entry interface does not match incoming interface, the packet is dropped

uRPF: IOS Configuration

- Configuring Strict Mode uRPF:

```
interface FastEthernet 0/1
 ip address 192.168.0.254 255.255.255.0
 ip verify unicast source reachable-via rx allow-self-ping
 ipv6 address 2001:DB8:0:1::FF/64
 ipv6 verify unicast source reachable-via rx
!
ip route 192.168.1.0 255.255.255.0 192.168.0.1
ipv6 route 2001:DB8:1:1::/64 2001:DB8:0:1::1
!
```

- This shows an ethernet LAN with uRPF configured
  - For IPv4 and IPv6
  - For both the direct LAN, *and*
  - For another network connected to the LAN

uRPF: IOS Configuration

- The router’s IPv4 and IPv6 FIBs would look something like this:

```
router# sh ip fib
...
192.168.0.0/24       attached                 FastEthernet0/1
192.168.1.0/24       192.168.0.1              FastEthernet0/1
...
router# sh ipv6 fib
...
2001:DB8:0:1::/64
  attached to FastEthernet0/1
2001:DB8:1:1::/64
  nexthop FE80::6EB2:AEFF:FE6F:A508 FastEthernet0/1
...
```

uRPF: IOS Configuration

- Configuring Loose Mode uRPF on Cisco IOS:

```
interface FastEthernet 0/1
 ip address 192.168.0.254 255.255.255.0
 ip verify unicast source reachable-via any allow-self-ping
 ipv6 address 2001:DB8:0:1::FF/64
 ipv6 verify unicast source reachable-via any
!
ip route 192.168.1.0 255.255.255.0 192.168.0.1
ipv6 route 2001:DB8:1:1::/64 2001:DB8:0:1::1
!
```

  - The router will check the entire FIB for the destination

uRPF: IOS Configuration

- Cisco IOS allows various options:
  - reachable-via allows either
    - strict mode using the rx keyword *or*
    - loose mode using the any keyword
  - allow-self-ping enables the operator to use ping on the local interface to check local link connectivity
    - Without allow-self-ping it would not be possible to ping the local interface address from the router
  - In loose mode, the allow-default option allows a successful match against the default route
  - Access-lists to cover selective uRPF checks

Deployment advice

- Implement uRPF on ***all*** single-homed customer facing interfaces
  - Cheaper (CPU & RAM) than implementing packet filters
- Make uRPF a default setting in all access router templates

- In the case of Multihomed connections, the deployment of uRPF needs very careful planning
  - Asymmetric traffic flows are common
  - Strict mode needs the BGP Weight feature (at minimum)
  - Loose mode ensures uRPF can be implemented

Summary

- uRPF has been available in major vendor implementations since the late 1990s
- More documentation contained in BCP38
  - https://tools.ietf.org/html/bcp38

- Implementation of uRPF is an essential technique for assisting with defeating Denial of Service attacks
- One of the principles in the MANRS initiative
  - https://www.manrs.org/manrs

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