BGP Hijacking

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About BGP

- The Border Gateway Protocol (BGP) is an inter-Autonomous System routing protocol
- The primary function of a BGP speaking system is to exchange network reachability information with other BGP systems.

BGP hijacking

- **BGP hijacking** (sometimes referred to as **prefix hijacking**, **route hijacking** or **IP hijacking**) is the illegitimate takeover of groups of IP addresses by corrupting Internet routing tables maintained using the Border Gateway Protocol (BGP)

- IP hijacking can occur deliberately or by accident in one of several ways:

▲ An AS announces that it originates a prefix that it does not actually originate
▲ An AS announces a more specific prefix than what may be announced by the true originating AS
▲ An AS announces that it can route traffic to the hijacked AS through a shorter route than is already available, regardless of whether or not the route actually exists

Public incidents

- Recent notable Incident
- Google routing blunder

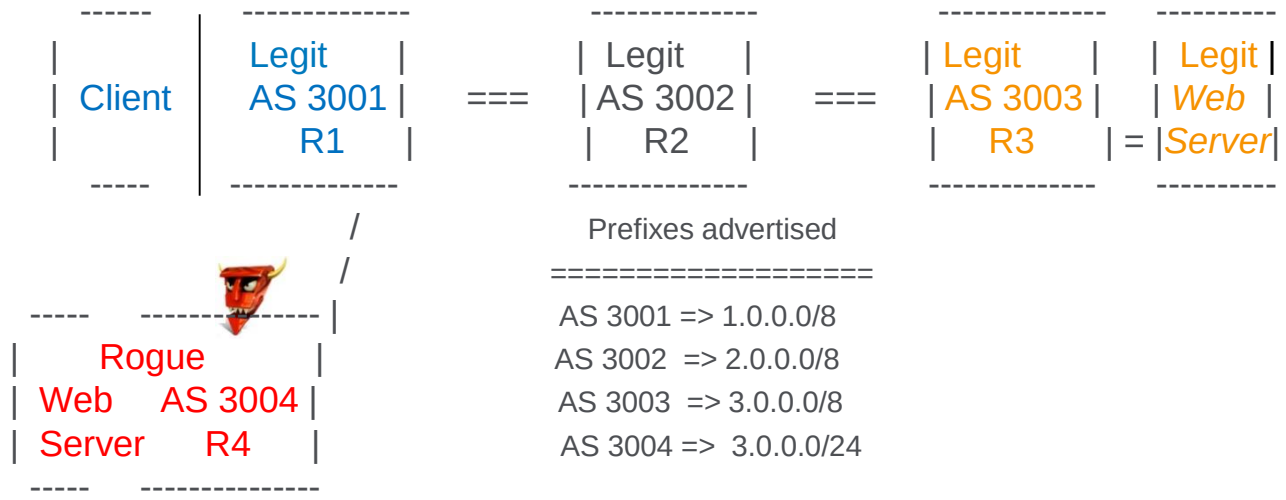
https://bgpmon.net/bgp-leak-causing-internet-outages-in-japan-and-beyond/
https://www.japantimes.co.jp/news/2017/08/26/national/japanese-government-probes-internet-disruption/
https://www.internetsociety.org/blog/tech-matters/2017/08/google-leaked-prefixes-and-knocked-japan-internet/

◎ Google accidentally became a transit provider for thousands of networks
◎ Google accidentally leaked BGP prefixes it learned from peering relationships, essentially becoming a transit provider instead of simply exchanging traffic between two networks and their customers
◎ A configuration error or software problem in Google's network led to inadvertently announcing thousands of prefixes to Verizon, who in turn propagated the leak to many of its peers

Public incidents

- April 1997: The "AS 7007 incident"
- December 24, 2004: TTNet in Turkey hijacks the Internet
- May 7, 2005: Google's May 2005 Outage
- January 22, 2006: Con-Edison hijacks big chunk of the Internet
- February 24, 2008: Pakistan's attempt to block YouTube access within their country takes down YouTube entirely
- November 11, 2008: The Brazilian ISP CTBC - Companhia de Telecomunicações do Brasil Central leaked their internal table into the global BGP table. It lasts over 5 minutes. Although, it was detected by a RIPE route server and then it was not propagated, affecting practically only their own ISP customers and few others
- April 8, 2010: Chinese ISP hijacks the Internet[8] - China Telecom originated 37,000 prefixes not belonging to them in 15 minutes, causing massive outage of services globally
- February, 2014: Canadian ISP used to redirect data from ISPs.[9] - In 22 incidents between February and May a hacker redirected traffic for roughly 30 seconds each session. Bitcoin and other crypto-currency mining operations were targeted and currency was stolen
- January 2017: Iranian pornography censorship

Demo Setup



Prefixes advertised

==========

AS 3001 => 1.0.0.0/8

AS 3002 => 2.0.0.0/8

AS 3003 => 3.0.0.0/8

AS 3004 => 3.0.0.0/24

Client IP => 1.0.0.2

WebServer => IP 3.0.0.2

Rogue WebServer IP => 3.0.0.2

BGP path hijacking attack demo

- BGP path AS 3004 announces a more specific prefix (3.0.0.0/24) than what may be announced by the true originating AS 3003 (3.0.0.0/8) and hijackes the BGP path
- Normal traffic flow from the Client to the legit web server

  AS3001(Client) > AS 3002 > AS3003 (Legit WebServer)

- Normal traffic flow from Client to the legit web server seen with traceroute

```
# traceroute 3.0.0.2
traceroute to 3.0.0.2 (3.0.0.2), 64 hops max
 1   1.0.0.1 (1.0.0.1) 0.364ms 0.247ms 0.743ms
 2   11.11.11.12 (11.11.11.12) 1.950ms 1.926ms 1.953ms
 3   12.12.12.13 (12.12.12.13) 7.075ms 8.080ms 5.029ms
 4   3.0.0.2 (3.0.0.2) 12.712ms 10.010ms 8.914ms
```

BGP path hijacking attack demo

- R1's BGP routing table in normal circumstances

```
R1#show ip bgp
BGP table version is 5, local router ID is 32.32.32.32
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  1.0.0.0          0.0.0.0                  0         32768 i
 *>  3.0.0.0          11.11.11.12                            0 3002 3003 i
R1#show ip bgp 3.0.0.2
BGP routing table entry for 3.0.0.0/8, version 3
Paths: (1 available, best #1, table default)
  Advertised to update-groups:
     1
  Refresh Epoch 1
  3002 3003
    11.11.11.12 from 11.11.11.12 (15.15.15.15)
      Origin IGP, localpref 100, valid, external, best
      rx pathid: 0, tx pathid: 0x0
```

- Notice the normal AS path => 3002 3003

BGP path hijacking attack demo

- R3's BGP routing table in normal circumstances

```
R3#show ip bgp
BGP table version is 5, local router ID is 192.168.119.9
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  1.0.0.0          12.12.12.12                            0 3002 3001 i
 *>  3.0.0.0          0.0.0.0                  0         32768 i
R3#show ip bgp 3.0.0.2
BGP routing table entry for 3.0.0.0/8, version 3
Paths: (1 available, best #1, table default)
  Advertised to update-groups:
     1
  Refresh Epoch 1
  Local
    0.0.0.0 from 0.0.0.0 (192.168.119.9)
      Origin IGP, metric 0, localpref 100, weight 32768, valid, sourced, local, best
      rx pathid: 0, tx pathid: 0x0
```

- Notice the local route towards 3.0.0.2

BGP path hijacking attack demo

- Accessing 3.0.0.2 web page before path hijacking

```
root@# while true;do curl http://3.0.0.2/BgpHij.html | grep Welcome -A 1 ;sleep 1;done
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100   221  100   221    0     0   8811      0 --:--:-- --:--:-- --:--:-- 31571
<h1>Welcome to the legit web server</h1>
```

- It points to the legit web server

BGP path hijacking attack demo

- Rogue AS3004 advertise a more specific prefix 3.0.0.0/24 and hijacks the BGP path

```
R4(config-router)#network 3.0.0.0 mask 255.255.255.0
R1#
*Sep 11 16:31:03.540: BGP(0): 14.14.14.15 rcvd UPDATE w/ attr: nexthop 14.14.14.15, origin i, metric 0, merged path 3004, AS_PATH
*Sep 11 16:31:03.540: BGP(0): 14.14.14.15 rcvd 3.0.0.0/24
*Sep 11 16:31:03.540: BGP(0): Revise route installing 1 of 1 routes for 3.0.0.0/24 -> 14.14.14.15(global) to main IP table
```

- Traffic flow from the Client to the legit web server will change, going to the Rogue AS

AS3001(Client) > AS3004(Rogue Web Server)

```
              # traceroute 3.0.0.2
traceroute to 3.0.0.2 (3.0.0.2), 64 hops max
 1   1.0.0.1 (1.0.0.1) 6.291ms 1.926ms 1.924ms
 2   14.14.14.15 (14.14.14.15) 5.067ms 2.015ms 1.930ms
 3   3.0.0.2 (3.0.0.2) 3.812ms 3.878ms 3.995ms
```

BGP path hijacking attack demo

- R1's BGP routing table after path hijacking

```
R1#show ip bgp
BGP table version is 6, local router ID is 32.32.32.32
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  1.0.0.0          0.0.0.0                  0         32768 i
 *>  3.0.0.0/24       14.14.14.15              0             0 3004 i
 *>  3.0.0.0          11.11.11.12                            0 3002 3003 i
R1#show ip bgp 3.0.0.2
BGP routing table entry for 3.0.0.0/24, version 6
Paths: (1 available, best #1, table default)
  Advertised to update-groups:
     1
  Refresh Epoch 1
  3004
    14.14.14.15 from 14.14.14.15 (33.33.33.33)
      Origin IGP, metric 0, localpref 100, valid, external, best
      rx pathid: 0, tx pathid: 0x0
```

- Notice the hijacked AS Path => traffic going directly to the Rogue AS 3004

BGP path hijacking attack demo

- R3's BGP routing table after path hijacking

```
R3#show ip bgp
BGP table version is 6, local router ID is 192.168.119.9
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale, m multipath, b backup-path, f RT-Filter,
              x best-external, a additional-path, c RIB-compressed,
Origin codes: i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

     Network          Next Hop            Metric LocPrf Weight Path
 *>  1.0.0.0          12.12.12.12                            0 3002 3001 i
 *>  3.0.0.0/24       12.12.12.12                            0 3002 3001 3004 i
 *>  3.0.0.0          0.0.0.0                  0         32768 i
R3#show ip bgp  3.0.0.2
BGP routing table entry for 3.0.0.0/24, version 6
Paths: (1 available, best #1, table default)
  Not advertised to any peer
  Refresh Epoch 1
  3002 3001 3004
    12.12.12.12 from 12.12.12.12 (15.15.15.15)
      Origin IGP, localpref 100, valid, external, best
      rx pathid: 0, tx pathid: 0x0
```

- Notice the route to 3.0.0.2 poiting to the Rogue AS 3004

BGP path hijacking attack demo

- Accessing 3.0.0.2 web page after path hijacking

```
root@indishell:~# while true;do curl http://3.0.0.2/BgpHij.html | grep BE -A 1 ;sleep 1;done
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100   213  100   213    0     0  48387      0 --:--:-- --:--:-- --:--:-- 71000
<h1>BEWARE!!! ROGUE web server</h1>
```

- It points to the Rogue web server

Mitigations

- RPKI(https://en.wikipedia.org/wiki/Resource_Public_Key_Infrastructure)
- Have filters on both sides of an EBGP session

Mitigations

- Example: insert a prefix-list to deny the prefix “3.0.0.0/8” on the neighbor adjacency with the Rogue AS 3004 (IP 14.14.14.15)
- Create the prefix list and use it inbound (“in”) on the neighbor adj with the Rogue AS 3004 (IP 14.14.14.15)

```
R1(config)#ip prefix-list StopRogue  deny 3.0.0.0/8
R1(config-router)#neighbor 14.14.14.15 prefix-list StopRogue in
```

- When the Rogue AS tries to hijack the path it will be blocked by the prefix list

```
R1(config-router)#
*Sep 11 16:53:44.564: BGP(0): 14.14.14.15 rcvd UPDATE w/ attr: nexthop 14.14.14.15, origin i, metric 0, merged path 3004, AS_PATH
*Sep 11 16:53:44.564: BGP(0): 14.14.14.15 rcvd 3.0.0.0/24 -- DENIED due to: distribute/prefix-list;
```

References

- RFC 4271
https://tools.ietf.org/html/rfc4271

- Wikipedia
https://en.wikipedia.org/wiki/BGP_hijacking