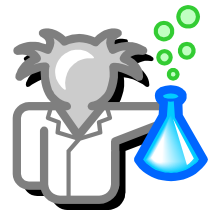


Where are we with Securing Addressing and Routing?

Geoff Huston
Chief Scientist, APNIC

1 September 2015



On the Internet...

...there are many ways to be bad!



An Ascending Scale of Badness

- Port Scan for known exploits

General annoyance

- Spew spam

Yes, there are still gullible folk out there!

- Cryptolocker extortion

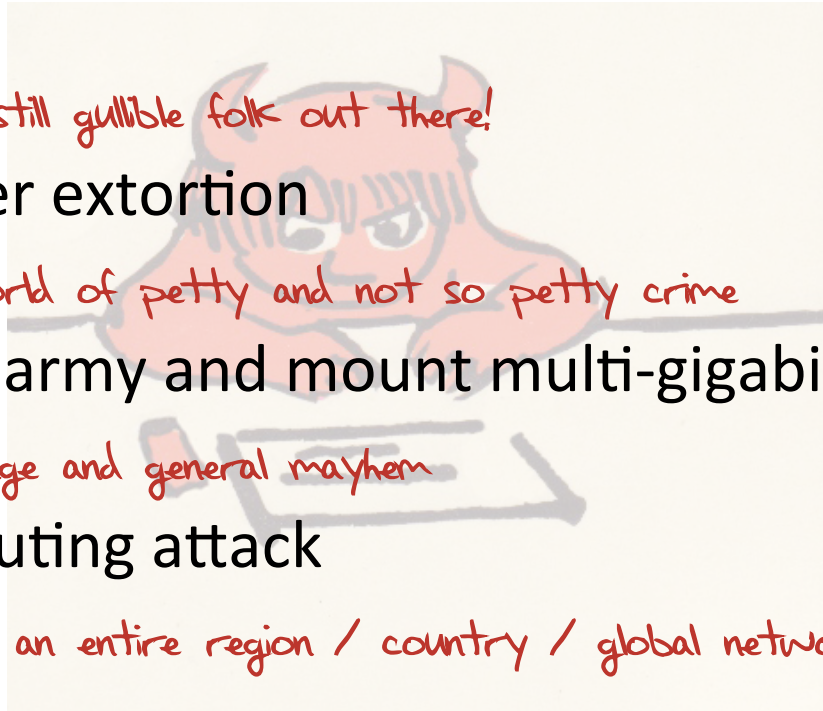
And enter a world of petty and not so petty crime

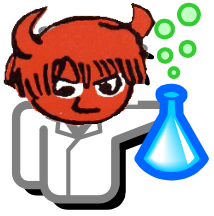
- Enlist a bot army and mount multi-gigabit DOS attacks

Extortion leverage and general mayhem

- Mount a routing attack

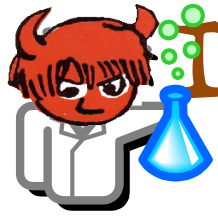
And bring down an entire region / country / global network!





If I were really bad
(and evil)...

I'd attack routing.



If I were really bad (and evil)...

- Through routing I'd attack:
 - isolate critical public servers and resources
 - overwhelm the routing system with spurious information

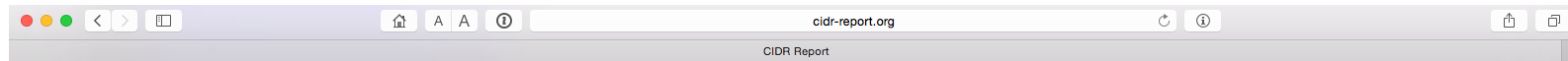
And bring selected parts of the network to a complete chaotic halt!

How many advertisements in today's BGP are "lies"?

We've all heard of the "YouTube" route hijack, and similar incidents of injecting false information into the routing system.

But the situation is a little more mundane than a few isolated high profile incidents - who uses addresses and AS numbers that are not registered as "in use" in our Internet number registry system?

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Possible Bogus Routes and AS Announcements

Possible Bogus Routes

Prefix	Origin AS	AS Description	Unallocated block
5.100.241.0/24	AS199573	-Reserved AS-,ZZ	5.100.240.0 - 5.100.247.255
23.92.160.0/24	AS14013	EPSON-ROBOTS - EPSON America (Factory Automation/Robotics),US	23.92.160.0 - 23.92.175.255
23.92.161.0/24	AS14013	EPSON-ROBOTS - EPSON America (Factory Automation/Robotics),US	23.92.160.0 - 23.92.175.255
23.252.224.0/20	AS62502	-Reserved AS-,ZZ	23.252.224.0 - 23.252.239.255
23.252.224.0/21	AS62502	-Reserved AS-,ZZ	23.252.224.0 - 23.252.239.255
23.252.232.0/21	AS62502	-Reserved AS-,ZZ	23.252.224.0 - 23.252.239.255
24.231.96.0/24	AS21548	MTO - MTO Telecom Inc.,CA	24.231.96.0 - 24.231.111.255
27.100.7.0/24	AS56096		27.100.4.0 - 27.100.7.255
31.217.248.0/21	AS44902	COV-ASN COVAGE NETWORKS SASU,FR	31.217.248.0 - 31.217.255.255
37.16.88.0/23	AS57652	-Reserved AS-,ZZ	37.16.88.0 - 37.16.95.255
41.73.1.0/24	AS37004	-Reserved AS-,ZZ	41.73.0.0 - 41.73.31.255
41.73.10.0/24	AS37004	-Reserved AS-,ZZ	41.73.0.0 - 41.73.31.255
41.73.11.0/24	AS37004	-Reserved AS-,ZZ	41.73.0.0 - 41.73.31.255
41.73.12.0/24	AS37004	-Reserved AS-,ZZ	41.73.0.0 - 41.73.31.255
41.73.13.0/24	AS37004	-Reserved AS-,ZZ	41.73.0.0 - 41.73.31.255
41.73.15.0/24	AS37004	-Reserved AS-,ZZ	41.73.0.0 - 41.73.31.255
41.73.16.0/24	AS37004	-Reserved AS-,ZZ	41.73.0.0 - 41.73.31.255
41.73.18.0/24	AS37004	-Reserved AS-,ZZ	41.73.0.0 - 41.73.31.255
41.73.20.0/24	AS37004	-Reserved AS-,ZZ	41.73.0.0 - 41.73.31.255
41.73.21.0/24	AS37004	-Reserved AS-,ZZ	41.73.0.0 - 41.73.31.255
41.76.48.0/21	AS36969	MTL-AS,MW	41.76.48.0 - 41.76.55.255
41.78.180.0/23	AS37265	-Reserved AS-,ZZ	41.78.180.0 - 41.78.183.255
41.189.96.0/20	AS37000	-Reserved AS-,ZZ	41.189.96.0 - 41.189.159.255
41.189.127.0/24	AS37000	-Reserved AS-,ZZ	41.189.96.0 - 41.189.159.255
41.189.128.0/24	AS37000	-Reserved AS-,ZZ	41.189.96.0 - 41.189.159.255
41.191.108.0/22	AS37004	-Reserved AS-,ZZ	41.191.108.0 - 41.191.115.255
41.191.108.0/24	AS37004	-Reserved AS-,ZZ	41.191.108.0 - 41.191.115.255
41.191.109.0/24	AS37004	-Reserved AS-,ZZ	41.191.108.0 - 41.191.115.255
41.191.110.0/24	AS37004	-Reserved AS-,ZZ	41.191.108.0 - 41.191.115.255
41.191.111.0/24	AS37004	-Reserved AS-,ZZ	41.191.108.0 - 41.191.115.255
41.223.208.0/22	AS37000	-Reserved AS-,ZZ	41.223.208.0 - 41.223.211.255
41.242.152.0/22	AS37558	LITC,LY	41.242.152.0 - 41.242.159.255
41.242.156.0/22	AS37558	LITC,LY	41.242.152.0 - 41.242.159.255
62.122.74.0/23	AS5577	ROOT root SA,LU	62.122.72.0 - 62.122.79.255
64.18.128.0/24	AS14037	AS-DZ-14037 - Dedicated Zone Inc,US	64.18.128.0 - 64.18.159.255
64.25.16.0/23	AS19535	-Reserved AS-,ZZ	64.25.16.0 - 64.25.31.255
64.25.20.0/24	AS19535	-Reserved AS-,ZZ	64.25.16.0 - 64.25.31.255
64.25.21.0/24	AS19535	-Reserved AS-,ZZ	64.25.16.0 - 64.25.31.255
64.25.22.0/24	AS19535	-Reserved AS-,ZZ	64.25.16.0 - 64.25.31.255
64.25.24.0/23	AS19535	-Reserved AS-,ZZ	64.25.16.0 - 64.25.31.255
64.25.27.0/24	AS7046	RFC2270-UUNET-CUSTOMER - MCI Communications Services, Inc. d/b/a Verizon Business,US	64.25.16.0 - 64.25.31.255
64.25.28.0/23	AS19535	-Reserved AS-,ZZ	64.25.16.0 - 64.25.31.255
64.44.0.0/16	AS46879	-Reserved AS-,ZZ	64.44.0.0 - 64.44.255.255
64.112.0.0/17	AS46879	-Reserved AS-,ZZ	64.112.0.0 - 64.112.191.255
64.112.128.0/18	AS46879	-Reserved AS-,ZZ	64.112.0.0 - 64.112.191.255
64.140.128.0/18	AS7385	INTEGRATELECOM - Integra Telecom, Inc.,US	64.140.128.0 - 64.140.191.255
64.187.208.0/24	AS174	COGENT-174 - Cogent Communications,US	64.187.208.0 - 64.187.223.255
65.75.216.0/23	AS10494	AAI - Accurate Automation, Inc.,US	65.75.192.0 - 65.75.223.255
65.75.217.0/24	AS10494	AAI - Accurate Automation, Inc.,US	65.75.192.0 - 65.75.223.255
65.111.1.0/24	AS32258	SDNGLOBAL - SDN Global,US	65.111.0.0 - 65.111.31.255
66.180.64.0/21	AS32558	ZEUTER - Zeuter Development Corporation,CA	66.180.68.0 - 66.180.79.255

and...

66.187.240.0/20	AS14552	ACS-SOUTHEASTDATACENTER - Affiliated Computer Services, Inc.,US	66.187.240.0 - 66.187.255.255
66.205.224.0/19	AS16526	BIRCH-TELECOM - Birch Telecom, Inc.,US	66.205.224.0 - 66.205.255.255
66.251.128.0/24	AS33227	BLUEBRIDGE-NETWORKS - Blue Bridge Networks,US	66.251.128.0 - 66.251.191.255
66.251.133.0/24	AS33227	BLUEBRIDGE-NETWORKS - Blue Bridge Networks,US	66.251.128.0 - 66.251.191.255
66.251.134.0/24	AS33227	BLUEBRIDGE-NETWORKS - Blue Bridge Networks,US	66.251.128.0 - 66.251.191.255
66.251.136.0/21	AS33227	BLUEBRIDGE-NETWORKS - Blue Bridge Networks,US	66.251.128.0 - 66.251.191.255
66.251.140.0/24	AS33227	BLUEBRIDGE-NETWORKS - Blue Bridge Networks,US	66.251.128.0 - 66.251.191.255
66.251.141.0/24	AS33227	BLUEBRIDGE-NETWORKS - Blue Bridge Networks,US	66.251.128.0 - 66.251.191.255
66.251.142.0/24	AS33227	BLUEBRIDGE-NETWORKS - Blue Bridge Networks,US	66.251.128.0 - 66.251.191.255
67.210.0.0/20	AS62502	-Reserved AS-,ZZ	67.210.0.0 - 67.210.15.255
67.210.0.0/21	AS62502	-Reserved AS-,ZZ	67.210.0.0 - 67.210.15.255
67.210.8.0/21	AS62502	-Reserved AS-,ZZ	67.210.0.0 - 67.210.15.255
72.19.0.0/19	AS16526	BIRCH-TELECOM - Birch Telecom, Inc.,US	72.19.0.0 - 72.19.31.255
74.113.200.0/23	AS46939	-Reserved AS-,ZZ	74.113.200.0 - 74.113.203.255
74.114.52.0/22	AS40818	-Reserved AS-,ZZ	74.114.52.0 - 74.114.55.255
74.114.52.0/23	AS40818	-Reserved AS-,ZZ	74.114.52.0 - 74.114.55.255
74.114.52.0/24	AS40818	-Reserved AS-,ZZ	74.114.52.0 - 74.114.55.255
74.114.53.0/24	AS40818	-Reserved AS-,ZZ	74.114.52.0 - 74.114.55.255
74.114.54.0/23	AS40818	-Reserved AS-,ZZ	74.114.52.0 - 74.114.55.255
74.114.54.0/24	AS40818	-Reserved AS-,ZZ	74.114.52.0 - 74.114.55.255
74.114.55.0/24	AS40818	-Reserved AS-,ZZ	74.114.52.0 - 74.114.55.255
74.114.184.0/22	AS19888	-Reserved AS-,ZZ	74.114.184.0 - 74.114.187.255
74.118.132.0/22	AS5117	-Reserved AS-,ZZ	74.118.132.0 - 74.118.135.255
74.120.212.0/23	AS32326	MORPHOTRUST-USA - MorphoTrust USA, Inc.,US	74.120.212.0 - 74.120.215.255
74.120.214.0/23	AS32326	MORPHOTRUST-USA - MorphoTrust USA, Inc.,US	74.120.212.0 - 74.120.215.255
74.121.24.0/22	AS36263	FORONA - Forona Technologies, Inc.,US	74.121.24.0 - 74.121.27.255
74.123.136.0/21	AS53358	-Reserved AS-,ZZ	74.123.136.0 - 74.123.143.255
77.243.91.0/24	AS42597	-Reserved AS-,ZZ	77.243.80.0 - 77.243.95.255
80.78.133.0/24	AS16422	NEWSKIES-NETWORKS - New Skies Satellites, Inc.,US	80.78.128.0 - 80.78.143.255
80.78.134.0/23	AS16422	NEWSKIES-NETWORKS - New Skies Satellites, Inc.,US	80.78.128.0 - 80.78.143.255
80.78.134.0/24	AS16422	NEWSKIES-NETWORKS - New Skies Satellites, Inc.,US	80.78.128.0 - 80.78.143.255
80.78.135.0/24	AS16422	NEWSKIES-NETWORKS - New Skies Satellites, Inc.,US	80.78.128.0 - 80.78.143.255
80.250.32.0/22	AS37106	ODUA-AS,NG	80.250.32.0 - 80.250.47.255
83.142.48.0/24	AS13213	UK2NET-AS UK2 - Ltd,GB	83.142.48.0 - 83.142.55.255
83.142.49.0/24	AS13213	UK2NET-AS UK2 - Ltd,GB	83.142.48.0 - 83.142.55.255
91.103.8.0/24	AS42551	-Reserved AS-,ZZ	91.103.8.0 - 91.103.15.255
91.103.9.0/24	AS42551	-Reserved AS-,ZZ	91.103.8.0 - 91.103.15.255
91.103.10.0/24	AS42551	-Reserved AS-,ZZ	91.103.8.0 - 91.103.15.255
91.103.11.0/24	AS42551	-Reserved AS-,ZZ	91.103.8.0 - 91.103.15.255
91.193.60.0/22	AS3356	LEVEL3 - Level 3 Communications, Inc.,US	91.193.60.0 - 91.193.63.255
91.195.66.0/23	AS3356	LEVEL3 - Level 3 Communications, Inc.,US	91.195.64.0 - 91.195.67.255
91.197.36.0/22	AS43359	-Reserved AS-,ZZ	91.197.36.0 - 91.197.43.255
91.220.84.0/24	AS5577	ROOT root SA,LU	91.220.84.0 - 91.220.84.255
91.230.27.0/24	AS57022	-Reserved AS-,ZZ	91.230.27.0 - 91.230.27.255
98.143.160.0/24	AS17184	ATL-CBEYOND - CBEYOND COMMUNICATIONS, LLC,US	98.143.160.0 - 98.143.175.255
98.143.161.0/24	AS17184	ATL-CBEYOND - CBEYOND COMMUNICATIONS, LLC,US	98.143.160.0 - 98.143.175.255
98.143.162.0/24	AS17184	ATL-CBEYOND - CBEYOND COMMUNICATIONS, LLC,US	98.143.160.0 - 98.143.175.255
98.143.163.0/24	AS17184	ATL-CBEYOND - CBEYOND COMMUNICATIONS, LLC,US	98.143.160.0 - 98.143.175.255
98.143.164.0/24	AS17184	ATL-CBEYOND - CBEYOND COMMUNICATIONS, LLC,US	98.143.160.0 - 98.143.175.255
98.143.165.0/24	AS17184	ATL-CBEYOND - CBEYOND COMMUNICATIONS, LLC,US	98.143.160.0 - 98.

plus...

cidr-report.org			CIDR Report		
102.2.88.0/22	AS38456	PACTEL-AS-AP Pacific Teleports. ,AU	102.0.0.0 - 102.255.255.255		
103.10.222.0/24	AS131891		103.10.222.0 - 103.10.222.255		
103.15.92.0/22	AS23818	JETINTERNET JETINTERNET Corporation,JP	103.15.92.0 - 103.15.95.255		
103.18.248.0/22	AS18097	DCN D.C.N. Corporation,JP	103.18.248.0 - 103.18.251.255		
103.19.0.0/22	AS18097	DCN D.C.N. Corporation,JP	103.19.0.0 - 103.19.3.255		
103.20.100.0/24	AS23937		103.20.100.0 - 103.20.103.255		
103.20.101.0/24	AS23937		103.20.100.0 - 103.20.103.255		
103.20.219.0/24	AS55795	VERBDC1-AS-AP Verb Data Centre Pty Ltd,AU	103.20.219.0 - 103.20.219.255		
103.21.4.0/22	AS12182	INTERNAP-2BLK - Internap Network Services Corporation,US	103.21.4.0 - 103.21.11.255		
103.23.148.0/23	AS132090		103.23.148.0 - 103.23.149.255		
103.23.148.0/24	AS132090		103.23.148.0 - 103.23.149.255		
103.26.116.0/22	AS17676	GIGAINFRA Softbank BB Corp.,JP	103.26.116.0 - 103.26.119.255		
103.243.72.0/24	AS36351	SOFTLAYER - SoftLayer Technologies Inc.,US	103.243.72.0 - 103.243.75.255		
103.243.73.0/24	AS36351	SOFTLAYER - SoftLayer Technologies Inc.,US	103.243.72.0 - 103.243.75.255		
103.243.74.0/23	AS36351	SOFTLAYER - SoftLayer Technologies Inc.,US	103.243.72.0 - 103.243.75.255		
103.248.88.0/22	AS23818	JETINTERNET JETINTERNET Corporation,JP	103.248.88.0 - 103.248.91.255		
103.248.220.0/22	AS17676	GIGAINFRA Softbank BB Corp.,JP	103.248.220.0 - 103.248.223.255		
103.250.0.0/22	AS17676	GIGAINFRA Softbank BB Corp.,JP	103.250.0.0 - 103.250.3.255		
103.252.116.0/22	AS10015	CWJ-NET Cyber Wave Japan Co., Ltd.,JP	103.252.116.0 - 103.252.119.255		
111.92.184.0/22	AS9797	NEXONASIAPACIFIC-AS-AP Nexon Asia Pacific P/L,AU	111.92.184.0 - 111.92.187.255		
116.206.72.0/24	AS6461	ABOVENET - Abovenet Communications, Inc,US	116.206.0.0 - 116.206.255.255		
116.206.85.0/24	AS6461	ABOVENET - Abovenet Communications, Inc,US	116.206.0.0 - 116.206.255.255		
116.206.103.0/24	AS6461	ABOVENET - Abovenet Communications, Inc,US	116.206.0.0 - 116.206.255.255		
117.120.56.0/21	AS4755	TATACOMM-AS TATA Communications formerly VSNL is Leading ISP,IN	117.120.56.0 - 117.120.63.255		
124.158.28.0/22	AS45857		124.158.28.0 - 124.158.31.255		
142.147.62.0/24	AS3958	AIRCANADA - Air Canada,CA	142.147.62.0 - 142.147.65.255		
162.216.176.0/22	AS36114	VERSAWEB-ASN - Versaweb, LLC,US	162.216.176.0 - 162.216.179.255		
162.217.156.0/22	AS62502	-Reserved AS-,ZZ	162.217.156.0 - 162.217.159.255		
162.217.156.0/23	AS62502	-Reserved AS-,ZZ	162.217.156.0 - 162.217.159.255		
162.217.158.0/23	AS62502	-Reserved AS-,ZZ	162.217.156.0 - 162.217.159.255		
162.221.48.0/21	AS62502	-Reserved AS-,ZZ	162.221.48.0 - 162.221.55.255		
162.221.48.0/22	AS62502	-Reserved AS-,ZZ	162.221.48.0 - 162.221.55.255		
162.221.52.0/22	AS62502	-Reserved AS-,ZZ	162.221.48.0 - 162.221.55.255		
162.222.128.0/21	AS36114	VERSAWEB-ASN - Versaweb, LLC,US	162.222.128.0 - 162.222.135.255		
162.223.64.0/21	AS62502	-Reserved AS-,ZZ	162.223.64.0 - 162.223.71.255		
162.223.64.0/22	AS62502	-Reserved AS-,ZZ	162.223.64.0 - 162.223.71.255		
162.223.68.0/22	AS62502	-Reserved AS-,ZZ	162.223.64.0 - 162.223.71.255		
166.93.0.0/16	AS23537	CRITIGEN - Micro Source, Inc.,US	166.93.0.0 - 166.93.255.255		
172.102.0.0/22	AS4812	CHINANET-SH-AP China Telecom (Group),CN	172.64.0.0 - 172.127.255.255		
176.111.168.0/22	AS50586	MACROSOLUTIONS MacroSolution SRL,RO	176.111.168.0 - 176.111.175.255		
182.237.25.0/24	AS10201	DWL-AS-IN Dishnet Wireless Limited. Broadband Wireless,IN	182.237.24.0 - 182.237.31.255		
185.28.180.0/22	AS18097	DCN D.C.N. Corporation,JP	185.28.180.0 - 185.28.183.255		
186.65.108.0/22	AS22927	Telefonica de Argentina,AR	186.65.104.0 - 186.65.111.255		
190.124.252.0/22	AS7303	Telecom Argentina S.A.,AR	190.124.252.0 - 190.124.255.255		
192.9.0.0/16	AS11479	BRM-SUN-AS - Sun Microsystems, Inc,US	192.9.200.0 - 192.9.200.255		
192.25.10.0/24	AS5714	HPES - Hewlett-Packard Company,US	192.25.10.0 - 192.25.11.255		
192.25.11.0/24	AS5714	HPES - Hewlett-Packard Company,US	192.25.10.0 - 192.25.11.255		
192.25.13.0/24	AS5714	HPES - Hewlett-Packard Company,US	192.25.13.0 - 192.25.14.255		
192.25.14.0/24	AS5714	HPES - Hewlett-Packard Company,US	192.25.13.0 - 192.25.14.255		
192.34.152.0/21	AS10835	VISIONARY - Visionary Communications, Inc.,US	192.34.152.0 - 192.34.159.255		
192.75.23.0/24	AS2579	AS2579 - Alcatel-Lucent,FR	192.75.23.0 - 192.75.23.255		
192.75.239.0/24	AS23498	CDSI - COGECODATA,CA	192.75.239.0 - 192.75.239.255		
192.81.70.0/24	AS393636	NPLUSNETWORKS - NPlus Networks,CA	192.81.70.0 - 192.81.71.255		
192.84.24.0/24	AS4323	TWTC - tw telecom holdings, inc.,US	192.84.24.0 - 192.84.24.255		
192.101.70.0/24	AS701	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US	192.101.64.0 - 192.101.74.255		
192.101.71.0/24	AS701	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US	192.101.64.0 - 192.101.74.255		
192.101.72.0/24	AS702	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US	192.101.64.0 - 192.101.74.255		
192.124.252.0/22	AS680	DFN Verein zur Foerderung eines Deutschen Forschungsnetzes e.V.,DE	192.124.255.0 - 192.124.255.255		

yes, there's more

cidr-report.org			CIDR Report		
192.131.233.0/24	AS7018	ATT-INTERNET4 - AT&T Services, Inc.,US	192.131.233.0 - 192.131.234.255		
192.149.81.0/24	AS14454	PERIMETER-ESECURITY - Perimeter eSecurity,US	192.149.81.0 - 192.149.81.255		
192.154.32.0/19	AS81	NCREN - MCNC,US	192.154.56.0 - 192.154.56.255		
192.154.64.0/19	AS81	NCREN - MCNC,US	192.154.80.0 - 192.154.80.255		
192.155.48.0/22	AS209	ASN-QWEST - Qwest Communications Company, LLC,US	192.155.7.0 - 192.155.71.255		
192.155.57.0/24	AS6128	CABLE-NET-1 - Cablevision Systems Corp.,US	192.155.7.0 - 192.155.71.255		
192.155.58.0/23	AS6128	CABLE-NET-1 - Cablevision Systems Corp.,US	192.155.7.0 - 192.155.71.255		
192.155.61.0/24	AS6128	CABLE-NET-1 - Cablevision Systems Corp.,US	192.155.7.0 - 192.155.71.255		
192.155.65.0/24	AS6128	CABLE-NET-1 - Cablevision Systems Corp.,US	192.155.7.0 - 192.155.71.255		
192.155.66.0/24	AS174	COGENT-174 - Cogent Communications,US	192.155.7.0 - 192.155.71.255		
192.155.67.0/24	AS174	COGENT-174 - Cogent Communications,US	192.155.7.0 - 192.155.71.255		
192.155.68.0/24	AS174	COGENT-174 - Cogent Communications,US	192.155.7.0 - 192.155.71.255		
192.166.32.0/20	AS702	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US	192.166.32.0 - 192.166.47.255		
192.188.208.0/20	AS721	DNIC-ASBLK-00721-00726 - DoD Network Information Center,US	192.188.223.0 - 192.188.223.255		
192.245.195.0/24	AS7381	SUNGARDS - SunGard Availability Services LP,US	192.245.195.0 - 192.245.195.255		
193.9.59.0/24	AS1257	TELE2,SE	193.9.32.0 - 193.9.63.255		
193.16.106.0/24	AS31539	-Reserved AS-,ZZ	193.16.106.0 - 193.16.106.255		
193.16.145.0/24	AS31392	-Reserved AS-,ZZ	193.16.144.0 - 193.16.145.255		
193.22.86.0/24	AS24751	MULTIFI-AS Jakobstadsnejdens Telefon Ab,FI	193.22.86.0 - 193.22.86.255		
193.22.224.0/20	AS3322	-Reserved AS-,ZZ	193.22.224.0 - 193.22.241.255		
193.22.238.0/23	AS62383	LDS-AS Lambrechts Data Services VOF,BE	193.22.224.0 - 193.22.241.255		
193.26.213.0/24	AS31641	BYTEL-AS Bytel Ltd,GB	193.26.210.0 - 193.26.213.255		
193.28.14.0/24	AS34309	LINK11 Link11 GmbH,DE	193.28.14.0 - 193.28.14.255		
193.33.6.0/23	AS3356	LEVEL3 - Level 3 Communications, Inc.,US	193.33.6.0 - 193.33.7.255		
193.33.252.0/23	AS3356	LEVEL3 - Level 3 Communications, Inc.,US	193.33.252.0 - 193.33.253.255		
193.46.200.0/24	AS34243	WEBAGE Web Age Ltd,GB	193.46.192.0 - 193.46.200.255		
193.106.32.0/22	AS49873	-Reserved AS-,ZZ	193.106.32.0 - 193.106.35.255		
193.111.229.0/24	AS3356	LEVEL3 - Level 3 Communications, Inc.,US	193.111.229.0 - 193.111.229.255		
193.149.2.0/23	AS15919	INTERHOST Servicios de Hosting en Internet S.A.,ES	193.149.2.0 - 193.149.3.255		
193.164.152.0/24	AS3356	LEVEL3 - Level 3 Communications, Inc.,US	193.164.152.0 - 193.164.152.255		
193.178.196.0/22	AS15657	SPEEDBONE-AS Speedbone Internet & Connectivity GmbH,DE	193.178.196.0 - 193.178.199.255		
193.188.252.0/24	AS8697	JTC-AS8697 Jordan Telecommunications Company,JO	193.188.251.0 - 193.188.252.255		
193.200.244.0/24	AS3356	LEVEL3 - Level 3 Communications, Inc.,US	193.200.244.0 - 193.200.244.255		
193.201.244.0/24	AS702	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US	193.201.244.0 - 193.201.251.255		
193.201.245.0/24	AS702	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US	193.201.244.0 - 193.201.251.255		
193.201.246.0/24	AS702	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US	193.201.244.0 - 193.201.251.255		
193.202.8.0/21	AS3322	-Reserved AS-,ZZ	193.202.8.0 - 193.202.15.255		
193.202.9.0/24	AS6824	HERMES-NETWORK Hermes Telecom International Ltd,GB	193.202.8.0 - 193.202.15.255		
193.223.103.0/24	AS8437	UTA-AS Tele2 Telecommunication GmbH,AT	193.223.103.0 - 193.223.103.255		
193.227.109.0/24	AS3356	LEVEL3 - Level 3 Communications, Inc.,US	193.227.109.0 - 193.227.109.255		
193.227.236.0/23	AS3356	LEVEL3 - Level 3 Communications, Inc.,US	193.227.236.0 - 193.227.237.255		
194.6.252.0/24	AS21202	DCSNET-AS Bredband2 AB,SE	194.6.251.0 - 194.6.252.255		
194.9.8.0/23	AS2863	SPRITELINK Centor AB,SE	194.9.8.0 - 194.9.9.255		
194.9.8.0/24	AS2863	SPRITELINK Centor AB,SE	194.9.8.0 - 194.9.9.255		
194.33.11.0/24	AS8943	JUMP Jump Networks Ltd.,GB	194.33.8.0 - 194.33.11.255		
194.39.78.0/23	AS702	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US	194.39.78.0 - 194.39.79.255		
194.49.17.0/24	AS13135	CREW-AS Wiese's Crew GmbH,DE	194.49.16.0 - 194.49.18.255		
194.50.8.0/24	AS3356	LEVEL3 - Level 3 Communications, Inc.,US	194.50.8.0 - 194.50.8.255		
194.60.88.0/21	AS5089	NTL Virgin Media Limited,GB	194.60.86.0 - 194.60.95.255		
194.61.147.0/24	AS702	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US	194.61.140.0 - 194.61.157.255		
194.61.150.0/24	AS702	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US	194.61.140.0 - 194.61.157.255		
194.61.151.0/24	AS702	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US	194.61.140.0 - 194.61.157.255		
194.63.152.0/22	AS3356	LEVEL3 - Level 3 Communications, Inc.,US	194.63.152.0 - 194.63.155.255		
194.76.224.0/24	AS34701	WITZENMANN-AS Witzenmann GmbH, Pforzheim,DE	194.76.224.0 - 194.76.225.255		
194.76.225.0/24	AS34701	WITZENMANN-AS Witzenmann GmbH, Pforzheim,DE	194.76.224.0 - 194.76.225.255		
194.79.36.0/22	AS3257	TINET-BACKBONE Tinet SpA,DE	194.79.36.0 - 194.79.39.255		
194.88.6.0/24	AS35093	RO-HTPASSPORT High Tech Passport Ltd SUA California San Jose SUCURSALA BUCURESTI ROMANIA,RO	194.88.6.0 - 194.88.7.255		
194.88.226.0/23	AS3356	LEVEL3 - Level 3 Communications, Inc.,US	194.88.226.0 - 194.88.227.255		

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194.99.67.0/24	AS9083	CARPENET carpeNet Information Technologies GmbH,DE	194.99.67.0 - 194.99.67.255
194.126.152.0/23	AS3356	LEVEL3 - Level 3 Communications, Inc.,US	194.126.152.0 - 194.126.155.255
194.126.219.0/24	AS34545	-Reserved AS-,ZZ	194.126.219.0 - 194.126.219.255
194.126.233.0/24	AS31235	SKIWEBCENTER-AS SKIWEBCENTER SARL,FR	194.126.233.0 - 194.126.233.255
194.150.214.0/23	AS30880	SPACEDUMP-AS SpaceDump IT AB,SE	194.150.214.0 - 194.150.215.255
194.156.179.0/24	AS3209	VODANET Vodafone GmbH,DE	194.156.176.0 - 194.156.183.255
194.180.25.0/24	AS21358	ATOS-ORIGIN-DE-AS Atos Information Technology GmbH,DE	194.180.25.0 - 194.180.25.255
194.187.24.0/22	AS8856	UKRNET UkrNet Ltd,UAE	194.187.24.0 - 194.187.27.255
195.8.48.0/23	AS3356	LEVEL3 - Level 3 Communications, Inc.,US	195.8.48.0 - 195.8.49.255
195.8.48.0/24	AS3356	LEVEL3 - Level 3 Communications, Inc.,US	195.8.48.0 - 195.8.49.255
195.8.119.0/24	AS34304	TEENTELECOM Teen Telecom SRL,RO	195.8.118.0 - 195.8.119.255
195.42.232.0/22	AS15657	SPEEDBONE-AS Speedbone Internet & Connectivity GmbH,DE	195.42.232.0 - 195.42.235.255
195.85.194.0/24	AS3356	LEVEL3 - Level 3 Communications, Inc.,US	195.85.194.0 - 195.85.194.255
195.85.201.0/24	AS3356	LEVEL3 - Level 3 Communications, Inc.,US	195.85.201.0 - 195.85.201.255
195.110.0.0/23	AS3356	LEVEL3 - Level 3 Communications, Inc.,US	195.110.0.0 - 195.110.3.255
195.128.240.0/23	AS21202	DCSNET-AS Bredband2 AB,SE	195.128.240.0 - 195.128.241.255
195.149.119.0/24	AS3356	LEVEL3 - Level 3 Communications, Inc.,US	195.149.119.0 - 195.149.119.255
195.189.174.0/23	AS3356	LEVEL3 - Level 3 Communications, Inc.,US	195.189.174.0 - 195.189.175.255
195.216.234.0/24	AS31309	NMV-AS New Media Ventures BVBA,BE	195.216.234.0 - 195.216.234.255
195.234.156.0/24	AS25028	-Reserved AS-,ZZ	195.234.156.0 - 195.234.156.255
195.242.182.0/24	AS3356	LEVEL3 - Level 3 Communications, Inc.,US	195.242.182.0 - 195.242.182.255
195.244.18.0/23	AS3356	LEVEL3 - Level 3 Communications, Inc.,US	195.244.18.0 - 195.244.19.255
196.3.182.0/24	AS37004	-Reserved AS-,ZZ	196.3.180.0 - 196.3.183.255
196.3.183.0/24	AS37004	-Reserved AS-,ZZ	196.3.180.0 - 196.3.183.255
196.22.8.0/24	AS27822	Emerging Markets Communications de Argentina S.R.L,AR	196.22.8.0 - 196.22.11.255
196.22.11.0/24	AS16422	NEWSKIES-NETWORKS - New Skies Satellites, Inc.,US	196.22.8.0 - 196.22.11.255
196.192.124.0/23	AS37301	AFRINIC-ZA-CPT-AS,MU	196.192.125.0 - 196.192.139.255
196.216.18.0/24	AS33790	-Reserved AS-,ZZ	196.216.16.0 - 196.216.31.255
197.149.188.0/22	AS37282	MAINONE,NG	197.149.188.0 - 197.149.191.255
198.22.195.0/24	AS54583	-Reserved AS-,ZZ	198.22.195.0 - 198.22.195.255
198.23.26.0/24	AS4390	BELLATLANTIC-COM - Bell Atlantic, Inc.,US	198.23.26.0 - 198.23.27.255
198.71.17.0/24	AS11268	-Reserved AS-,ZZ	198.71.16.0 - 198.71.27.255
198.71.18.0/23	AS11268	-Reserved AS-,ZZ	198.71.16.0 - 198.71.27.255
198.71.20.0/23	AS11268	-Reserved AS-,ZZ	198.71.16.0 - 198.71.27.255
198.71.22.0/24	AS11268	-Reserved AS-,ZZ	198.71.16.0 - 198.71.27.255
198.71.26.0/24	AS11268	-Reserved AS-,ZZ	198.71.16.0 - 198.71.27.255
198.71.27.0/24	AS11268	-Reserved AS-,ZZ	198.71.16.0 - 198.71.27.255
198.74.11.0/24	AS14573	KEYSPANENERGY-NE1 - Keyspan Energy,US	198.74.8.0 - 198.74.15.255
198.74.13.0/24	AS14573	KEYSPANENERGY-NE1 - Keyspan Energy,US	198.74.8.0 - 198.74.15.255
198.74.38.0/24	AS16966	SBCIDC-LSAN03 - AT&T Internet Services,US	198.74.32.0 - 198.74.41.255
198.74.39.0/24	AS16966	SBCIDC-LSAN03 - AT&T Internet Services,US	198.74.32.0 - 198.74.41.255
198.74.40.0/24	AS16966	SBCIDC-LSAN03 - AT&T Internet Services,US	198.74.32.0 - 198.74.41.255
198.97.72.0/21	AS721	DNIC-ASBLK-00721-00726 - DoD Network Information Center,US	198.97.77.0 - 198.97.77.255
198.97.96.0/19	AS721	DNIC-ASBLK-00721-00726 - DoD Network Information Center,US	198.97.102.0 - 198.97.102.255
198.97.192.0/20	AS721	DNIC-ASBLK-00721-00726 - DoD Network Information Center,US	198.97.202.0 - 198.97.203.255
198.97.240.0/20	AS721	DNIC-ASBLK-00721-00726 - DoD Network Information Center,US	198.97.241.0 - 198.97.242.255
198.163.214.0/24	AS21804	ACCESS-SK - Access Communications Co-operative Limited,CA	198.163.214.0 - 198.163.216.255
198.163.215.0/24	AS6327	SHAW - Shaw Communications Inc.,CA	198.163.214.0 - 198.163.216.255
198.163.216.0/24	AS6327	SHAW - Shaw Communications Inc.,CA	198.163.214.0 - 198.163.216.255
198.168.0.0/16	AS701	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US	198.168.122.0 - 198.168.123.255
198.252.165.0/24	AS20115	CHARTER-NET-HKY-NC - Charter Communications,US	198.252.165.0 - 198.252.169.255
198.252.166.0/24	AS20115	CHARTER-NET-HKY-NC - Charter Communications,US	198.252.165.0 - 198.252.169.255
198.252.167.0/24	AS20115	CHARTER-NET-HKY-NC - Charter Communications,US	198.252.165.0 - 198.252.169.255
198.252.168.0/24	AS20115	CHARTER-NET-HKY-NC - Charter Communications,US	198.252.165.0 - 198.252.169.255
198.252.169.0/24	AS20115	CHARTER-NET-HKY-NC - Charter Communications,US	198.252.165.0 - 198.252.169.255
199.85.9.0/24	AS852	ASN852 - TELUS Communications Inc.,CA	199.85.7.0 - 199.85.15.255
199.88.52.0/22	AS17018	QTS-SACRAMENTO-1 - Quality Investment Properties Sacramento, LLC,US	199.88.52.0 - 199.88.55.255
199.116.200.0/21	AS22830	-Reserved AS-,ZZ	199.116.200.0 - 199.116.207.255

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199.121.0.0/16	AS721	DNIC-ASBLK-00721-00726 - DoD Network Information Center,US	199.121.254.0 - 199.121.255.255		
199.123.16.0/20	AS721	DNIC-ASBLK-00721-00726 - DoD Network Information Center,US	199.123.30.0 - 199.123.31.255		
199.204.144.0/21	AS36007	-Reserved AS-,ZZ	199.204.144.0 - 199.204.151.255		
200.1.112.0/24	AS29754	GO2TEL - GO2TEL.COM INC.,US	200.1.112.0 - 200.1.112.255		
200.6.87.0/24	AS27947	Telconet S.A,EC	200.6.80.0 - 200.6.95.255		
200.58.248.0/21	AS27849		200.58.248.0 - 200.58.255.255		
200.81.48.0/24	AS11664	Techtel LMDS Comunicaciones Interactivas S.A.,AR	200.81.48.0 - 200.81.55.255		
200.81.49.0/24	AS11664	Techtel LMDS Comunicaciones Interactivas S.A.,AR	200.81.48.0 - 200.81.55.255		
202.8.106.0/24	AS9530	SHINSEGAE-AS SHINSEGAE I&C Co., Ltd.,KR	202.8.96.0 - 202.8.127.255		
202.53.138.0/24	AS4058	CITICTEL-CPC-AS4058 CITIC Telecom International CPC Limited,HK	202.53.134.0 - 202.53.140.255		
202.58.113.0/24	AS19161	-Reserved AS-,ZZ	202.58.104.0 - 202.58.115.255		
202.61.108.0/24	AS55812		202.61.108.0 - 202.61.108.255		
202.94.1.0/24	AS4808	CHINA169-BJ CNCGROUP IP network China169 Beijing Province Network,CN	202.94.0.0 - 202.94.31.255		
202.158.251.0/24	AS9255	CONNECTPLUS-AS Singapore Telecom,SG	202.158.248.0 - 202.158.251.255		
202.165.120.0/24	AS19161	-Reserved AS-,ZZ	202.165.120.0 - 202.165.127.255		
202.165.124.0/24	AS23749	GLOBAL-TRANSIT-AS-HKCOLO-AP HKCOLO Ltd. Internet Service Provider,HK	202.165.120.0 - 202.165.127.255		
202.174.125.0/24	AS9498	BBIL-AP BHARTI Airtel Ltd.,IN	202.174.124.0 - 202.174.127.255		
203.28.240.0/20	AS10148	UNIMELB-AS-AP The University of Melbourne, Melbourne, Victoria,AU	203.28.252.0 - 203.28.253.255		
203.142.219.0/24	AS45149		203.142.219.0 - 203.142.219.255		
203.160.48.0/21	AS38008		203.160.48.0 - 203.160.55.255		
203.175.8.0/23	AS23858		203.175.8.0 - 203.175.15.255		
203.175.11.0/24	AS9229	SPEEDCAST-AP SPEEDCAST Limited,HK	203.175.8.0 - 203.175.15.255		
203.189.116.0/22	AS45606		203.189.116.0 - 203.189.119.255		
203.189.116.0/24	AS45606		203.189.116.0 - 203.189.119.255		
203.189.117.0/24	AS45606		203.189.116.0 - 203.189.119.255		
203.189.118.0/24	AS45606		203.189.116.0 - 203.189.119.255		
203.189.119.0/24	AS45606		203.189.116.0 - 203.189.119.255		
204.8.216.0/21	AS14037	AS-DZ-14037 - Dedicated Zone Inc,US	204.8.216.0 - 204.8.223.255		
204.8.217.0/24	AS19318	NJIIIX-AS-1 - NEW JERSEY INTERNATIONAL INTERNET EXCHANGE LLC,US	204.8.216.0 - 204.8.223.255		
204.8.218.0/24	AS19318	NJIIIX-AS-1 - NEW JERSEY INTERNATIONAL INTERNET EXCHANGE LLC,US	204.8.216.0 - 204.8.223.255		
204.8.222.0/24	AS14037	AS-DZ-14037 - Dedicated Zone Inc,US	204.8.216.0 - 204.8.223.255		
204.10.88.0/21	AS3356	LEVEL3 - Level 3 Communications, Inc.,US	204.10.88.0 - 204.10.91.255		
204.15.208.0/22	AS13706	COMPLETEWEBNET - CompleteWeb.Net LLC,US	204.15.208.0 - 204.15.215.255		
204.16.96.0/24	AS19972	-Reserved AS-,ZZ	204.16.96.0 - 204.16.99.255		
204.16.97.0/24	AS19972	-Reserved AS-,ZZ	204.16.96.0 - 204.16.99.255		
204.16.98.0/24	AS19972	-Reserved AS-,ZZ	204.16.96.0 - 204.16.99.255		
204.16.99.0/24	AS19972	-Reserved AS-,ZZ	204.16.96.0 - 204.16.99.255		
204.69.144.0/24	AS27283	RJF-INTERNET - Raymond James Financial, Inc.,US	204.69.144.0 - 204.69.144.255		
204.87.251.0/24	AS22217	-Reserved AS-,ZZ	204.87.251.0 - 204.87.251.255		
204.106.16.0/24	AS4323	TWTC - tw telecom holdings, inc.,US	204.106.16.0 - 204.106.16.255		
204.187.11.0/24	AS51113	ELEKTA-AS Elekta,GB	204.187.11.0 - 204.187.11.255		
205.137.240.0/20	AS11686	ENA - Education Networks of America,US	205.137.240.0 - 205.137.255.255		
205.159.44.0/24	AS40157	ADESA-CORP-AS - ADESA Corp,US	205.159.44.0 - 205.159.44.255		
205.166.231.0/24	AS7029	WINDSTREAM - Windstream Communications Inc,US	205.166.231.0 - 205.166.231.255		
205.211.160.0/24	AS30045	UHN-ASN - University Health Network,CA	205.211.160.0 - 205.211.160.255		
206.197.184.0/24	AS23304	DATOTEL-STL-AS - Datotel LLC, a NetLabs LLC Company,US	206.197.184.0 - 206.197.184.255		
206.223.224.0/24	AS21548	MTO - MTO Telecom Inc.,CA	206.223.224.0 - 206.223.255.255		
207.2.120.0/21	AS6221	USCYBERSITES - US Cybersites, Inc,US	207.2.112.0 - 207.2.127.255		
207.174.131.0/24	AS26116	INDRA - Indra's Net Inc,US	207.174.131.0 - 207.174.135.255		
207.174.132.0/23	AS26116	INDRA - Indra's Net Inc,US	207.174.131.0 - 207.174.135.255		
207.174.152.0/23	AS26116	INDRA - Indra's Net Inc,US	207.174.144.0 - 207.174.155.255		
207.174.154.0/24	AS26116	INDRA - Indra's Net Inc,US	207.174.144.0 - 207.174.155.255		
207.174.155.0/24	AS26116	INDRA - Indra's Net Inc,US	207.174.144.0 - 207.174.155.255		
207.174.200.0/24	AS22658	EARTHNET - Earthnet, Inc.,US	207.174.192.0 - 207.174.200.255		
207.189.0.0/19	AS46879	-Reserved AS-,ZZ	207.189.0.0 - 207.189.31.255		
207.231.96.0/19	AS11194	NUNETPA - NuNet Inc.,US	207.231.104.0 - 207.231.111.255		
207.254.128.0/21	AS30689	FLOW-NET - FLOW,JM	207.254.128.0 - 207.254.143.255		
207.254.128.0/24	AS30689	FLOW-NET - FLOW,JM	207.254.128.0 - 207.254.143.255		

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207.254.128.0/24	AS30689	FLOW-NET - FLOW,JM	207.254.128.0 - 207.254.143.255		
207.254.136.0/21	AS30689	FLOW-NET - FLOW,JM	207.254.128.0 - 207.254.143.255		
208.66.64.0/24	AS16936	-Reserved AS-,ZZ	208.66.64.0 - 208.66.67.255		
208.66.65.0/24	AS16936	-Reserved AS-,ZZ	208.66.64.0 - 208.66.67.255		
208.66.66.0/24	AS16936	-Reserved AS-,ZZ	208.66.64.0 - 208.66.67.255		
208.66.67.0/24	AS16936	-Reserved AS-,ZZ	208.66.64.0 - 208.66.67.255		
208.67.132.0/22	AS701	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US	208.67.132.0 - 208.67.135.255		
208.75.152.0/21	AS32146	-Reserved AS-,ZZ	208.75.152.0 - 208.75.159.255		
208.76.20.0/24	AS31812	-Reserved AS-,ZZ	208.76.20.0 - 208.76.23.255		
208.76.21.0/24	AS31812	-Reserved AS-,ZZ	208.76.20.0 - 208.76.23.255		
208.77.164.0/24	AS22659	-Reserved AS-,ZZ	208.77.164.0 - 208.77.167.255		
208.77.166.0/24	AS4323	TWTC - tw telecom holdings, inc.,US	208.77.164.0 - 208.77.167.255		
208.83.53.0/24	AS40569	YGOMI-AS - Ygomi LLC,US	208.83.52.0 - 208.83.55.255		
208.84.232.0/24	AS33131	-Reserved AS-,ZZ	208.84.232.0 - 208.84.239.255		
208.84.233.0/24	AS33131	-Reserved AS-,ZZ	208.84.232.0 - 208.84.239.255		
208.84.234.0/24	AS33131	-Reserved AS-,ZZ	208.84.232.0 - 208.84.239.255		
208.84.237.0/24	AS33131	-Reserved AS-,ZZ	208.84.232.0 - 208.84.239.255		
208.93.216.0/22	AS209	ASN-QWEST - Qwest Communications Company, LLC,US	208.93.216.0 - 208.93.219.255		
208.94.216.0/23	AS13629	-Reserved AS-,ZZ	208.94.216.0 - 208.94.223.255		
208.94.219.0/24	AS13629	-Reserved AS-,ZZ	208.94.216.0 - 208.94.223.255		
208.94.221.0/24	AS13629	-Reserved AS-,ZZ	208.94.216.0 - 208.94.223.255		
208.94.223.0/24	AS13629	-Reserved AS-,ZZ	208.94.216.0 - 208.94.223.255		
209.135.171.0/24	AS701	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US	209.135.160.0 - 209.135.191.255		
209.135.175.0/24	AS701	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US	209.135.160.0 - 209.135.191.255		
209.177.64.0/20	AS6461	ABOVENET - Abovenet Communications, Inc,US	209.177.72.0 - 209.177.79.255		
209.193.112.0/20	AS209	ASN-QWEST - Qwest Communications Company, LLC,US	209.193.112.0 - 209.193.127.255		
209.209.51.0/24	AS18687	MPOWER-2 - MPOWER COMMUNICATIONS CORP.,US	209.209.0.0 - 209.209.127.255		
209.234.112.0/23	AS32252	-Reserved AS-,ZZ	209.234.112.0 - 209.234.127.255		
209.234.114.0/23	AS32252	-Reserved AS-,ZZ	209.234.112.0 - 209.234.127.255		
209.234.116.0/24	AS32252	-Reserved AS-,ZZ	209.234.112.0 - 209.234.127.255		
209.234.117.0/24	AS32252	-Reserved AS-,ZZ	209.234.112.0 - 209.234.127.255		
209.234.118.0/24	AS32252	-Reserved AS-,ZZ	209.234.112.0 - 209.234.127.255		
209.234.119.0/24	AS32252	-Reserved AS-,ZZ	209.234.112.0 - 209.234.127.255		
209.234.120.0/24	AS32252	-Reserved AS-,ZZ	209.234.112.0 - 209.234.127.255		
209.234.121.0/24	AS32252	-Reserved AS-,ZZ	209.234.112.0 - 209.234.127.255		
209.234.122.0/24	AS32252	-Reserved AS-,ZZ	209.234.112.0 - 209.234.127.255		
209.250.224.0/22	AS14037	AS-DZ-14037 - Dedicated Zone Inc,US	209.250.224.0 - 209.250.255.255		
209.250.224.0/24	AS14037	AS-DZ-14037 - Dedicated Zone Inc,US	209.250.224.0 - 209.250.255.255		
209.250.225.0/24	AS14037	AS-DZ-14037 - Dedicated Zone Inc,US	209.250.224.0 - 209.250.255.255		
209.250.230.0/24	AS19318	NJIIIX-AS-1 - NEW JERSEY INTERNATIONAL INTERNET EXCHANGE LLC,US	209.250.224.0 - 209.250.255.255		
209.250.253.0/24	AS19318	NJIIIX-AS-1 - NEW JERSEY INTERNATIONAL INTERNET EXCHANGE LLC,US	209.250.224.0 - 209.250.255.255		
209.250.254.0/24	AS19318	NJIIIX-AS-1 - NEW JERSEY INTERNATIONAL INTERNET EXCHANGE LLC,US	209.250.224.0 - 209.250.255.255		
213.255.128.0/20	AS24863	LINKdotNET-AS,EG	213.255.128.0 - 213.255.159.255		
213.255.144.0/20	AS24863	LINKdotNET-AS,EG	213.255.128.0 - 213.255.159.255		
216.24.208.0/24	AS3561	SAVVIS - Savvis,US	216.24.208.0 - 216.24.223.255		
216.73.81.0/24	AS6432	DOUBLECLICK - Double Click, Inc.,US	216.73.80.0 - 216.73.95.255		
216.73.82.0/24	AS6432	DOUBLECLICK - Double Click, Inc.,US	216.73.80.0 - 216.73.95.255		
216.73.85.0/24	AS6432	DOUBLECLICK - Double Click, Inc.,US	216.73.80.0 - 216.73.95.255		
216.73.88.0/24	AS6432	DOUBLECLICK - Double Click, Inc.,US	216.73.80.0 - 216.73.95.255		
216.73.89.0/24	AS6432	DOUBLECLICK - Double Click, Inc.,US	216.73.80.0 - 216.73.95.255		
216.73.94.0/24	AS6432	DOUBLECLICK - Double Click, Inc.,US	216.73.80.0 - 216.73.95.255		
216.73.95.0/24	AS6432	DOUBLECLICK - Double Click, Inc.,US	216.73.80.0 - 216.73.95.255		
216.146.0.0/19	AS11915	US-TELEPACIFIC - TelePacific Communications,US	216.146.0.0 - 216.146.31.255		
216.152.24.0/22	AS22773	ASN-CXA-ALL-CCI-22773-RDC - Cox Communications Inc.,US	216.152.16.0 - 216.152.31.255		
216.170.96.0/24	AS4565	MEGAPATH2-US - MegaPath Networks Inc.,US	216.170.96.0 - 216.170.111.255		
216.170.101.0/24	AS4565	MEGAPATH2-US - MegaPath Networks Inc.,US	216.170.96.0 - 216.170.111.255		
216.170.104.0/24	AS4565	MEGAPATH2-US - MegaPath Networks Inc.,US	216.170.96.0 - 216.170.111.255		
216.170.105.0/24	AS4565	MEGAPATH2-US - MegaPath Networks Inc.,US	216.170.96.0 - 216.170.111.255		

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207.254.128.0/24	AS30689	FLOW-NET - FLOW,JM	207.254.128.0 - 207.254.143.255		
207.254.136.0/21	AS30689	FLOW-NET - FLOW,JM	207.254.128.0 - 207.254.143.255		
208.66.64.0/24	AS16936	-Reserved AS-,ZZ	208.66.64.0 - 208.66.67.255		
208.66.65.0/24	AS16936	-Reserved AS-,ZZ	208.66.64.0 - 208.66.67.255		
208.66.66.0/24	AS16936	-Reserved AS-,ZZ	208.66.64.0 - 208.66.67.255		
208.66.67.0/24	AS16936	-Reserved AS-,ZZ	208.66.64.0 - 208.66.67.255		
208.67.132.0/22	AS701	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US	208.67.132.0 - 208.67.135.255		
208.75.152.0/21	AS32146	-Reserved AS-,ZZ	208.75.152.0 - 208.75.159.255		
208.76.20.0/24	AS31812	-Reserved AS-,ZZ	208.76.20.0 - 208.76.23.255		
208.76.21.0/24	AS31812	-Reserved AS-,ZZ	208.76.20.0 - 208.76.23.255		
208.77.164.0/24	AS22659	-Reserved AS-,ZZ	208.77.164.0 - 208.77.167.255		
208.77.166.0/24	AS4323	TWTC - tw telecom holdings, inc.,US	208.77.164.0 - 208.77.167.255		
208.83.53.0/24	AS40569	YGOMI-AS - Ygomi LLC,US	208.83.52.0 - 208.83.55.255		
208.84.232.0/24	AS33131	-Reserved AS-,ZZ	208.84.232.0 - 208.84.239.255		
208.84.233.0/24	AS33131	-Reserved AS-,ZZ	208.84.232.0 - 208.84.239.255		
208.84.234.0/24	AS33131	-Reserved AS-,ZZ	208.84.232.0 - 208.84.239.255		
208.84.237.0/24	AS33131	-Reserved AS-,ZZ	208.84.232.0 - 208.84.239.255		
208.93.216.0/22	AS209	ASN-QWEST - Qwest Communications Company, LLC,US	208.93.216.0 - 208.93.219.255		
208.94.216.0/23	AS13629	-Reserved AS-,ZZ	208.94.216.0 - 208.94.223.255		
208.94.219.0/24	AS13629	-Reserved AS-,ZZ	208.94.216.0 - 208.94.223.255		
208.94.221.0/24	AS13629	-Reserved AS-,ZZ	208.94.216.0 - 208.94.223.255		
208.94.223.0/24	AS13629	-Reserved AS-,ZZ	208.94.216.0 - 208.94.223.255		
209.135.171.0/24	AS701	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US	209.135.160.0 - 209.135.191.255		
209.135.175.0/24	AS701	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US	209.135.160.0 - 209.135.191.255		
209.177.64.0/20	AS6461	ABOVENET - Abovenet Communications, Inc,US	209.177.72.0 - 209.177.79.255		
209.193.112.0/20	AS209	ASN-QWEST - Qwest Communications Company, LLC,US	209.193.112.0 - 209.193.127.255		
209.209.51.0/24	AS18687	MPOWER-2 - MPOWER COMMUNICATIONS CORP,US	209.209.0.0 - 209.209.127.255		
209.234.112.0/23	AS32252	-Reserved AS-,ZZ	209.234.112.0 - 209.234.127.255		
209.234.114.0/23	AS32252	-Reserved AS-,ZZ	209.234.112.0 - 209.234.127.255		
209.234.116.0/24	AS32252	-Reserved AS-,ZZ	209.234.112.0 - 209.234.127.255		
209.234.117.0/24	AS32252	-Reserved AS-,ZZ	209.234.112.0 - 209.234.127.255		
209.234.118.0/24	AS32252	-Reserved AS-,ZZ	209.234.112.0 - 209.234.127.255		
209.234.119.0/24	AS32252	-Reserved AS-,ZZ	209.234.112.0 - 209.234.127.255		
209.234.120.0/24	AS32252	-Reserved AS-,ZZ	209.234.112.0 - 209.234.127.255		
209.234.121.0/24	AS32252	-Reserved AS-,ZZ	209.234.112.0 - 209.234.127.255		
209.234.122.0/24	AS32252	-Reserved AS-,ZZ	209.234.112.0 - 209.234.127.255		
209.250.224.0/22	AS14037	AS-DZ-14037 - Dedicated Zone Inc,US	209.250.224.0 - 209.250.255.255		
209.250.224.0/24	AS14037	AS-DZ-14037 - Dedicated Zone Inc,US	209.250.224.0 - 209.250.255.255		
209.250.225.0/24	AS14037	AS-DZ-14037 - Dedicated Zone Inc,US	209.250.224.0 - 209.250.255.255		
209.250.230.0/24	AS19318	NJIIIX-AS-1 - NEW JERSEY INTERNATIONAL INTERNET EXCHANGE LLC,US	209.250.224.0 - 209.250.255.255		
209.250.253.0/24	AS19318	NJIIIX-AS-1 - NEW JERSEY INTERNATIONAL INTERNET EXCHANGE LLC,US	209.250.224.0 - 209.250.255.255		
209.250.254.0/24	AS19318	NJIIIX-AS-1 - NEW JERSEY INTERNATIONAL INTERNET EXCHANGE LLC,US	209.250.224.0 - 209.250.255.255		
213.255.128.0/20	AS24863	LINKdotNET-AS,EG	213.255.128.0 - 213.255.159.255		
213.255.144.0/20	AS24863	LINKdotNET-AS,EG	213.255.128.0 - 213.255.159.255		
216.24.208.0/24	AS3561	SAVVIS - Savvis,US	216.24.208.0 - 216.24.223.255		
216.73.81.0/24	AS6432	DOUBLECLICK - Double Click, Inc.,US	216.73.80.0 - 216.73.95.255		
216.73.82.0/24	AS6432	DOUBLECLICK - Double Click, Inc.,US	216.73.80.0 - 216.73.95.255		
216.73.85.0/24	AS6432	DOUBLECLICK - Double Click, Inc.,US	216.73.80.0 - 216.73.95.255		
216.73.88.0/24	AS6432	DOUBLECLICK - Double Click, Inc.,US	216.73.80.0 - 216.73.95.255		
216.73.89.0/24	AS6432	DOUBLECLICK - Double Click, Inc.,US	216.73.80.0 - 216.73.95.255		
216.73.94.0/24	AS6432	DOUBLECLICK - Double Click, Inc.,US	216.73.80.0 - 216.73.95.255		
216.73.95.0/24	AS6432	DOUBLECLICK - Double Click, Inc.,US	216.73.80.0 - 216.73.95.255		
216.146.0.0/19	AS11915	US-TELEPACIFIC - TelePacific Communications,US	216.146.0.0 - 216.146.31.255		
216.152.24.0/22	AS22773	ASN-CXA-ALL-CCI-22773-RDC - Cox Communications Inc.,US	216.152.16.0 - 216.152.31.255		
216.170.96.0/24	AS4565	MEGAPATH2-US - MegaPath Networks Inc.,US	216.170.96.0 - 216.170.111.255		
216.170.101.0/24	AS4565	MEGAPATH2-US - MegaPath Networks Inc.,US	216.170.96.0 - 216.170.111.255		
216.170.104.0/24	AS4565	MEGAPATH2-US - MegaPath Networks Inc.,US	216.170.96.0 - 216.170.111.255		
216.170.105.0/24	AS4565	MEGAPATH2-US - MegaPath Networks Inc.,US	216.170.96.0 - 216.170.111.255		

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216.212.192.0/19	AS46879	-Reserved AS-,ZZ	216.212.192.0 - 216.212.223.255		
216.234.132.0/24	AS14545	ADR-DRIVING-RECORDS - AMERICAN DRIVING RECORDS, INC.,US	216.234.130.0 - 216.234.132.255		
216.238.192.0/24	AS17184	ATL-CBEYOND - CBEYOND COMMUNICATIONS, LLC,US	216.238.192.0 - 216.238.207.255		
216.238.193.0/24	AS17184	ATL-CBEYOND - CBEYOND COMMUNICATIONS, LLC,US	216.238.192.0 - 216.238.207.255		
216.238.194.0/24	AS26566	-Reserved AS-,ZZ	216.238.192.0 - 216.238.207.255		
216.238.196.0/22	AS17184	ATL-CBEYOND - CBEYOND COMMUNICATIONS, LLC,US	216.238.192.0 - 216.238.207.255		
216.251.50.0/24	AS38191	INFOSYS-AS Infosys Technologies Ltd,IN	216.251.48.0 - 216.251.63.255		
216.251.53.0/24	AS38191	INFOSYS-AS Infosys Technologies Ltd,IN	216.251.48.0 - 216.251.63.255		
216.251.62.0/24	AS38191	INFOSYS-AS Infosys Technologies Ltd,IN	216.251.48.0 - 216.251.63.255		

Report: [Allocated and Reserved IPv4 address blocks](#)

Possible Bogus ASs

Bogus AS

AS1446	Announced by	AS209	ASN-QWEST - Qwest Communications Company, LLC,US
AS2733	Announced by	AS701	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US
AS3322	Announced by	AS6824	HERMES-NETWORK Hermes Telecom International Ltd,GB
AS3328	Announced by	AS8452	TE-AS TE-AS,EG
AS3402	Announced by	AS2914	NTT-COMMUNICATIONS-2914 - NTT America, Inc.,US
AS3402	Announced by	AS16880	AS2-TRENDMICRO-COM - TREND MICRO INCORPORATED,US
AS3708	Announced by	AS3356	LEVEL3 - Level 3 Communications, Inc.,US
AS3708	Announced by	AS12182	INTERNAP-2BLK - Internap Network Services Corporation,US
AS4892	Announced by	AS2828	XO-AS15 - XO Communications,US
AS4892	Announced by	AS18647	ACCEL-AS - Accel Net, Inc.,US
AS4946	Announced by	AS1239	SPRINTLINK - Sprint,US
AS5116	Announced by	AS174	COGENT-174 - Cogent Communications,US
AS5117	Announced by	AS3561	SAVVIS - Savvis,US
AS5402	Announced by	AS5387	NSC Institute of Computational Technologies of SB RAS,RU
AS5669	Announced by	AS8928	INTERROUTE Interoute Communications Limited,GB
AS6183	Announced by	AS3561	SAVVIS - Savvis,US
AS6746	Announced by	AS2614	ROEDUNET Agentia de Administrare a Retelei Nationale de Informatica pentru Educatie si Cercetare,RO
AS6973	Announced by	AS3356	LEVEL3 - Level 3 Communications, Inc.,US
AS6973	Announced by	AS5049	MORGAN-ASN - Morgan Stanley Group Inc.,US
AS6973	Announced by	AS12179	INTERNAP-2BLK - Internap Network Services Corporation,US
AS6973	Announced by	AS13789	INTERNAP-BLK3 - Internap Network Services Corporation,US
AS7960	Announced by	AS3549	LVL3-3549 - Level 3 Communications, Inc.,US
AS8214	Announced by	AS21183	ABCOM-AS ABCOM Shpk,AL
AS10926	Announced by	AS7018	ATT-INTERNET4 - AT&T Services, Inc.,US
AS10931	Announced by	AS4323	TWTC - tw telecom holdings, inc.,US
AS10946	Announced by	AS4323	TWTC - tw telecom holdings, inc.,US
AS11245	Announced by	AS6661	EPT-LU Entreprise des Postes et Telecommunications,LU
AS11245	Announced by	AS7018	ATT-INTERNET4 - AT&T Services, Inc.,US
AS11245	Announced by	AS51964	ORANGE-BUSINESS-SERVICES-IPSN-ASN Equant Inc.,FR
AS11268	Announced by	AS4323	TWTC - tw telecom holdings, inc.,US
AS11289	Announced by	AS19893	RAGINGWIRE - RagingWire Data Centers, Inc.,US
AS11316	Announced by	AS20141	QUALITYTECH-SUW-300 - Quality Technology Services, LLC.,US
AS11364	Announced by	AS7018	ATT-INTERNET4 - AT&T Services, Inc.,US
AS11364	Announced by	AS19855	MASERGY - Masergy Communications,US
AS11480	Announced by	AS701	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US
AS11531	Announced by	AS18710	GKG-NET - GKG.NET, INC,US
AS11568	Announced by	AS803	SASKTEL - Saskatchewan Telecommunications,CA
AS11568	Announced by	AS21804	ACCESS-SK - Access Communications Co-operative Limited,CA
AS11636	Announced by	AS174	COGENT-174 - Cogent Communications,US
AS11789	Announced by	AS20161	TRGO - TeraGo Networks Inc.,CA

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AS11793	Announced by	AS4323	TWTC - tw telecom holdings, inc.,US
AS11793	Announced by	AS22773	ASN-CXA-ALL-CCI-22773-RDC - Cox Communications Inc.,US
AS11929	Announced by	AS1239	SPRINTLINK - Sprint,US
AS11930	Announced by	AS701	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US
AS11930	Announced by	AS7018	ATT-INTERNET4 - AT&T Services, Inc.,US
AS11936	Announced by	AS1239	SPRINTLINK - Sprint,US
AS12011	Announced by	AS20001	ROADRUNNER-WEST - Time Warner Cable Internet LLC,US
AS12017	Announced by	AS33154	DQECOM - DQE Communications Network Services, LLC,US
AS12058	Announced by	AS3356	LEVEL3 - Level 3 Communications, Inc.,US
AS12058	Announced by	AS8220	COLT COLT Technology Services Group Limited,GB
AS12071	Announced by	AS701	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US
AS12122	Announced by	AS4323	TWTC - tw telecom holdings, inc.,US
AS12122	Announced by	AS19108	SUDDENLINK-COMMUNICATIONS - Suddenlink Communications,US
AS12122	Announced by	AS22911	SINAP-TIX - SINAP-TIX, LLC,US
AS12126	Announced by	AS10594	CEC - Cutting Edge Communications, Inc.,US
AS12172	Announced by	AS2379	EMBARQ-WNPk - Embarq Corporation,US
AS12172	Announced by	AS7018	ATT-INTERNET4 - AT&T Services, Inc.,US
AS12195	Announced by	AS701	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US
AS12240	Announced by	AS7018	ATT-INTERNET4 - AT&T Services, Inc.,US
AS12343	Announced by	AS8218	NEO-ASN Neo Telecoms S.A.S.,FR
AS12910	Announced by	AS3215	AS3215 Orange S.A.,FR
AS12910	Announced by	AS6461	ABOVENET - Abovenet Communications, Inc,US
AS13317	Announced by	AS7018	ATT-INTERNET4 - AT&T Services, Inc.,US
AS13347	Announced by	AS1239	SPRINTLINK - Sprint,US
AS13405	Announced by	AS7018	ATT-INTERNET4 - AT&T Services, Inc.,US
AS13430	Announced by	AS1239	SPRINTLINK - Sprint,US
AS13471	Announced by	AS4323	TWTC - tw telecom holdings, inc.,US
AS13540	Announced by	AS7018	ATT-INTERNET4 - AT&T Services, Inc.,US
AS13540	Announced by	AS14744	INTERNAP-BLOCK-4 - Internap Network Services Corporation,US
AS13570	Announced by	AS174	COGENT-174 - Cogent Communications,US
AS13570	Announced by	AS13799	INTERNAP-BLK3 - Internap Network Services Corporation,US
AS13599	Announced by	AS3356	LEVEL3 - Level 3 Communications, Inc.,US
AS13599	Announced by	AS6128	CABLE-NET-1 - Cablevision Systems Corp.,US
AS13629	Announced by	AS2828	XO-AS15 - XO Communications,US
AS13629	Announced by	AS3561	SAVVIS - Savvis,US
AS13629	Announced by	AS6461	ABOVENET - Abovenet Communications, Inc,US
AS13696	Announced by	AS174	COGENT-174 - Cogent Communications,US
AS13723	Announced by	AS1239	SPRINTLINK - Sprint,US
AS13723	Announced by	AS7018	ATT-INTERNET4 - AT&T Services, Inc.,US
AS13758	Announced by	AS2828	XO-AS15 - XO Communications,US
AS13847	Announced by	AS7018	ATT-INTERNET4 - AT&T Services, Inc.,US
AS13847	Announced by	AS10796	SCRR-10796 - Time Warner Cable Internet LLC,US
AS13956	Announced by	AS174	COGENT-174 - Cogent Communications,US
AS14004	Announced by	AS174	COGENT-174 - Cogent Communications,US
AS14015	Announced by	AS3356	LEVEL3 - Level 3 Communications, Inc.,US
AS14045	Announced by	AS209	ASN-QWEST - Qwest Communications Company, LLC,US
AS14045	Announced by	AS701	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US
AS14045	Announced by	AS2828	XO-AS15 - XO Communications,US
AS14045	Announced by	AS3356	LEVEL3 - Level 3 Communications, Inc.,US
AS14106	Announced by	AS3356	LEVEL3 - Level 3 Communications, Inc.,US
AS14118	Announced by	AS1239	SPRINTLINK - Sprint,US
AS14130	Announced by	AS20115	CHARTER-NET-HKY-NC - Charter Communications,US
AS14147	Announced by	AS2828	XO-AS15 - XO Communications,US
AS14147	Announced by	AS11019	HAPROXY-TECHNOLOGIES - HAProxy Technologies, Inc.,US
AS14150	Announced by	AS174	COGENT-174 - Cogent Communications,US

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AS14190	Announced by	AS852	ASN852 - TELUS Communications Inc.,CA
AS14267	Announced by	AS7018	ATT-INTERNET4 - AT&T Services, Inc.,US
AS14310	Announced by	AS174	COGENT-174 - Cogent Communications,US
AS14310	Announced by	AS2828	XO-AS15 - XO Communications,US
AS14353	Announced by	AS1239	SPRINTLINK - Sprint,US
AS14360	Announced by	AS13789	INTERNAP-BLK3 - Internap Network Services Corporation,US
AS14422	Announced by	AS3356	LEVEL3 - Level 3 Communications, Inc.,US
AS14461	Announced by	AS22773	ASN-CXA-ALL-CCI-22773-RDC - Cox Communications Inc.,US
AS14528	Announced by	AS4323	TWTC - tw telecom holdings, inc.,US
AS14566	Announced by	AS701	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US
AS14566	Announced by	AS7018	ATT-INTERNET4 - AT&T Services, Inc.,US
AS14630	Announced by	AS12179	INTERNAP-2BLK - Internap Network Services Corporation,US
AS14630	Announced by	AS13791	INTERNAP-BLK3 - Internap Network Services Corporation,US
AS14665	Announced by	AS3356	LEVEL3 - Level 3 Communications, Inc.,US
AS14691	Announced by	AS7018	ATT-INTERNET4 - AT&T Services, Inc.,US
AS14694	Announced by	AS6939	HURRICANE - Hurricane Electric, Inc.,US
AS14731	Announced by	AS1239	SPRINTLINK - Sprint,US
AS14756	Announced by	AS174	COGENT-174 - Cogent Communications,US
AS14764	Announced by	AS7018	ATT-INTERNET4 - AT&T Services, Inc.,US
AS14806	Announced by	AS3561	SAVVIS - Savvis,US
AS14844	Announced by	AS701	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US
AS14892	Announced by	AS3356	LEVEL3 - Level 3 Communications, Inc.,US
AS14942	Announced by	AS4323	TWTC - tw telecom holdings, inc.,US
AS14993	Announced by	AS20161	TRGO - TeraGo Networks Inc.,CA
AS15009	Announced by	AS209	ASN-QWEST - Qwest Communications Company, LLC,US
AS15009	Announced by	AS3356	LEVEL3 - Level 3 Communications, Inc.,US
AS15009	Announced by	AS7018	ATT-INTERNET4 - AT&T Services, Inc.,US
AS15037	Announced by	AS20115	CHARTER-NET-HKY-NC - Charter Communications,US
AS15115	Announced by	AS10912	INTERNAP-BLK - Internap Network Services Corporation,US
AS15132	Announced by	AS7018	ATT-INTERNET4 - AT&T Services, Inc.,US
AS15182	Announced by	AS20001	ROADRUNNER-WEST - Time Warner Cable Internet LLC,US
AS15239	Announced by	AS701	UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US
AS15239	Announced by	AS7018	ATT-INTERNET4 - AT&T Services, Inc.,US
AS15289	Announced by	AS7018	ATT-INTERNET4 - AT&T Services, Inc.,US
AS15292	Announced by	AS4323	TWTC - tw telecom holdings, inc.,US
AS15302	Announced by	AS1616	CORELINK-US-ASN - CoreLink Data Centers,US
AS15302	Announced by	AS4323	TWTC - tw telecom holdings, inc.,US
AS15347	Announced by	AS174	COGENT-174 - Cogent Communications,US
AS15347	Announced by	AS12064	ASN-CXA-HR-12064-CBS - Cox Communications Inc.,US
AS16159	Announced by	AS3356	LEVEL3 - Level 3 Communications, Inc.,US
AS16437	Announced by	AS10796	SCRR-10796 - Time Warner Cable Internet LLC,US
AS16468	Announced by	AS2828	XO-AS15 - XO Communications,US
AS16468	Announced by	AS7018	ATT-INTERNET4 - AT&T Services, Inc.,US
AS16547	Announced by	AS5713	SAIX-NET,ZA
AS16555	Announced by	AS3491	BTN-ASN - Beyond The Network America, Inc.,US
AS16584	Announced by	AS20115	CHARTER-NET-HKY-NC - Charter Communications,US
AS16665	Announced by	AS209	ASN-QWEST - Qwest Communications Company, LLC,US
AS16665	Announced by	AS7018	ATT-INTERNET4 - AT&T Services, Inc.,US
AS16667	Announced by	AS22773	ASN-CXA-ALL-CCI-22773-RDC - Cox Communications Inc.,US
AS16667	Announced by	AS22911	SINAP-TIX - SINAP-TIX, LLC,US
AS16708	Announced by	AS13789	INTERNAP-BLK3 - Internap Network Services Corporation,US
AS16756	Announced by	AS209	ASN-QWEST - Qwest Communications Company, LLC,US
AS16769	Announced by	AS10910	INTERNAP-BLK - Internap Network Services Corporation,US
AS16797	Announced by	AS174	COGENT-174 - Cogent Communications,US
AS16797	Announced by	AS3356	LEVEL3 - Level 3 Communications, Inc.,US

AS20429	Announced by	AS10912	INTERKAP-BER - Interkap Network Services Corporation,US
AS21043	Announced by	AS21236	AICHYNA-AS Additional Liability Company Alchyna Plus,BY

AS26939	Announced by	AS174	COGENT-174 - Cogent Communications,US
AS27015	Announced by	AS2828	XO-AS15 - XO Communications,US



almost done...

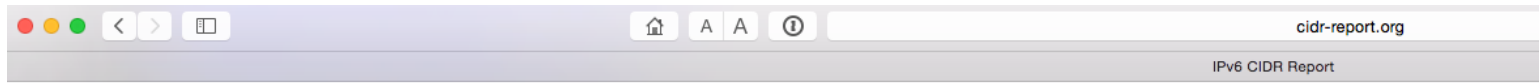
		csp-report	
		CSP Report	
AS54890	Announced by AS546887	LIGHTHOUSE - Lighttower Fiber Networks,US	
AS55576	Announced by AS64543	AS64543 - TATA COMMUNICATIONS (AMERICA) INC,US	
AS55706	Announced by AS69334	MAXIS-AS-AP Binatang Berhad,MY	
AS55706	Announced by AS54788	TNET-AS-AP TM Net, Internet Service Provider,MY	
AS56112	Announced by AS54545	BYT-SEA-TELECOMMUNICATIONS, Inc,PH	
AS56096	Announced by AS54545	TH-25IN-AP Two S One N Co Ltd, Internet Service Provider and IT Solutions,TH	
AS57022	Announced by AS58997	ASN-SPRINT OCS Rozelecom,RO	
AS57052	Announced by AS51703	PULSANT-AS Pulsestar (Scotland) Ltd,GB	
AS57202	Announced by AS533597	INFOLINEY - InfoFoley Online Systems, Inc,US	
AS58200	Announced by AS53707	BUSINESS707 - MCI Communications Services, Inc, d/b/a Verizon Business,US	
AS64001	Announced by AS517812	SYMCALTHEUTNET Syrmatic Inc,AU	
AS64023	Announced by AS57303	Telecom Argentina S.A.,AR	
AS64023	Announced by AS33849	LU3T-3549 - Level 3 Communications, Inc,US	
AS64097	Announced by AS522884	Iusacell PCS de Mexico, S. A. de C.V.,MX	
AS64097	Announced by AS522884	Iusacell PCS de Mexico, S. A. de C.V.,MX	
AS64100	Announced by AS53549	LU3T-3549 - Level 3 Communications, Inc,US	
AS64111	Announced by AS519555	KNI-NETWORK - Knight, Inc,US	
AS64121	Announced by AS519555	KNI-NETWORK - Knight, Inc,US	
AS64500	Announced by AS35661	SAVVIS - SavvisUS,US	
AS64500	Announced by AS521992	ESHA-ONE-ASN - ehealth Ontario,CA	
AS64511	Announced by AS53549	LU3T-3549 - Level 3 Communications, Inc,US	
AS64512	Announced by AS701	LUJNET - MCI Communications Services, Inc, d/b/a Verizon Business,US	
AS64512	Announced by AS514613	ROCK-HILL-TELEPHONE - Comporium, Inc,US	
AS64512	Announced by AS510924	BORISAULETELEKOM-AS VODAFONE NET LETISETIM HIZMETLERI ANONIM SIRKETI,TR	
AS64512	Announced by AS536963	PROTONET-AS PROTONET Adriaan Ludvya,PL	
AS64513	Announced by AS549185	TELECOM-AS TSCA ICLT Icy Pty Ltd,AU	
AS64513	Announced by AS513615	UGANDA-TELECOM Uganda Telecom,UG	
AS64514	Announced by AS521491	Southern Cable Network,BZ	
AS64514	Announced by AS528094	DUKUNET-DUKUNET Communications - Dukernet Communications, LLC,US	
AS64515	Announced by AS539706	2D-GERMANY-AS Telefunica Germany GmbH & Co.IG,DE	
AS64516	Announced by AS539706	SIFY-AS Sify Sify Limited,IN	
AS64519	Announced by AS59583	VOXILITY Voxility S.R.L.,RO	
AS64520	Announced by AS52373	GOVSK-AS The Slovak Republic Government Office,SK	
AS64520	Announced by AS537943	VOXILITY-AS Voxility S.R.L.,RO	
AS64521	Announced by AS59802	AMNET-AU-AP Amnet IT Services Pty Ltd,AU	
AS64521	Announced by AS539706	2D-GERMANY-AS Telefunica Germany GmbH & Co.IG,DE	
AS64522	Announced by AS534551	CDS-LEADS-ASN C.C.S. (Leads) Ltd,US	
AS64525	Announced by AS59730	BHARTITELEONIC-AS-IN-AP Bharti Teleonic Ltd,IN	
AS64525	Announced by AS513520	DSP-AS-AP DSP BlackRock Investment Managers Pvt. Ltd,IN	
AS64526	Announced by AS514426	CLARIS-TELECOM - Claris Network LLC,US	
AS64528	Announced by AS538635	VIAIP-AS-VIA IPAAU	
AS64534	Announced by AS527775	Telecommunicationcompany Suriname - TeleSur,SR	
AS64535	Announced by AS53762	INSTINET-AS - Instinet,US	
AS64553	Announced by AS59730	BHARTITELEONIC-AS-IN-AP Bharti Teleonic Ltd,IN	
AS64555	Announced by AS513773	TELNETCOM - Telnet Communications,CA	
AS64555	Announced by AS519949	SECON-AS Grupo On Seguredad S.L,ES	
AS64562	Announced by AS57545	TPG-INTERNET-AP TPG Telecom Limited,AU	
AS64567	Announced by AS52685	AT&T-AT&T Global Networks Services, LLC,US	
AS64579	Announced by AS4	ISI-AS - University of Southern California,US	
AS64598	Announced by AS58715	EARTHTELECOMMUNICATION-AS EARTH TELECOMMUNICATION (Pvt) Ltd,BO	
AS64609	Announced by AS536047	ALTEL-AS, DZ	
AS64612	Announced by AS5476	Avaya - Avaya Inc,US	
AS64612	Announced by AS518676	Avaya - Avaya Inc,US	
AS64620	Announced by AS518113	PIZZER-SG-AP Pizer Pte Ltd Singapore dual homed,SG	
AS64626	Announced by AS513978	AT-IPPR - AT&T Services, Inc,US	
AS64628	Announced by AS513979	AT-IPPR - AT&T Services, Inc,US	
AS64664	Announced by AS59729	IS-AP Advanced Limited,HK	
AS64682	Announced by AS59583	SIFY-AS IN Sify Limited,IN	
AS64714	Announced by AS5174	COGENT-174 - Cogent Communications,US	
AS64718	Announced by AS537161	MARSH - Marsh Inc,US	

IP Address	Organization
AS65522	AS65407 PRIMUS-Telekomunikations Canada Inc.,CA
AS65530	UBAL CSC Unit WEI,RU
AS65530	AS58387 T-SYSTEMS AT Systems Austria GesmbH,AT
AS65536	AS43450 SPOTIFY Spotify Technology S.A.,SE
AS65403	AS5701 UNINET - MCI Communications Services, Inc d/b/a Verizon Business,US
AS65403	AS51803 ICNMTS - Sprint,US
AS65408	AS5792 UNINET - MCI Communications Services, Inc d/b/a Verizon Business,US
AS65412	AS48447 CNIX-AP China Networks Inter-Exchange,CN
AS65412	AS69764 TEO2-TEO LT AB Autonomous System,LT
AS65412	AS59583 CNIX-AP Sprint Limited,IN
AS65412	AS36866 JT_LKE
AS65430	AS52383 MICROSOFT S.A. DE C.V.,HN
AS65500	AS52884 IUSCOR PCS de Mexico, S.A. de C.V.,MX
AS65500	AS51113 MF-MGSM-AS DISC Megafon,ES
AS65501	AS53208 TRANSTELECOM - Transatel Inc,US
AS65501	AS65500 Private Use AS-22
AS65502	AS641710 MITTLO-AS MITT Ltd.,UA
AS65506	AS42362 ALIANA-AS DISC Rostelecom,RU
AS65512	AS42806 Magticom Ltd,IL
AS65512	AS45899 VNPT-AS VNPT Corp,VN
AS65514	AS52509 YODANET Vodafone GmbH,DE
AS65514	AS48861 APAGA-Aspa Technologies CISCAM,CN
AS65518	AS5174 COGENT-174 - Cogent Communications,US
AS65521	AS39442 UNIC-AS ISC UNIC,RU
AS65525	AS49947 DIGITELNET Digital Telecommunications Philippines Inc.,PH
AS65525	AS522405 MONTANA-OPTICOM-AS2155 - Montana Optical, LLC,US
AS65529	AS51836 AXALYSIS ARAX I.S.P,MN
AS65530	AS53235 UARNET-AS State Enterprise Scientific and Telecommunication Centre "Ukrainian Academic and Research Center",UA
AS65530	AS39604 GABRIEL MORAS SIMOES ME,RB
AS65531	AS53255 UARNET-AS State Enterprise Scientific and Telecommunication Centre "Ukrainian Academic and Research Center",UA
AS65531	AS53125 NAF - Nucleio de Assessoria aos Prof. e Emp,r,BR
AS65533	AS502545 PCKP Paghman Tostoo Farnavab Ebrah et Ertebat Jonoub,IR
AS65534	AS511274 ADHOST - Adhost Internet Services, LLC,US
AS65534	AS52983 SHAW-ENVISION - Enmax Envision Inc,CA
AS65534	AS45786 CHMNET-AS ID IHNET
AS65535	AS513773 TELNETCOMM - Telnet Communications,CA
AS65535	AS528805 CHMNET-NAP-AS TrmTel NAP,OM
AS65535	AS533771 SAFARICOM-LIMITED
AS65535	AS5133178 ACAPBS-AP Australian Customs and Border Protection Service,AU
AS65535	AS534791 BTR-ASN - Beyond Telecom Australia Pty Ltd,AU
AS65536	AS58697 JTC-AS697 Jandair Telecommunications Company,JO
AS65538	AS51273 CW Cable and Wireless Worldwide plc,CB
AS65539	AS51273 CW Cable and Wireless Worldwide plc,CB
AS65545	AS59441 NEXT-BD Next Online Limited,BD
AS65550	AS519771 ENEURGE-AS - Emerge Telecom LLC,US
AS65560	AS530372 SUNEYES2 - Suneyes, LLC,US
AS65575	AS512735 ESTERNET TurkeyNet AS, Turkey Hamamel el,SA,TR
AS511306	AS52084 CZ-TNET-AS Telecommunications Czech Republic, s.r.o.,CZ
AS5131891	AS59498 BBIL-AP BHARTI Airtel Ltd,IN
AS5132090	AS456871 SAI-NET AU Servers Australia Pty Ltd,AU
AS5132210	AS59503 PK-PRIMARY-AS FX Networks Limited,AU
AS5137993	AS542055 TELINET netxio Informations Technologie und Telekommunikation KG&A,DE
AS5199573	AS53356 LEVEL3 - Level 3 Communications, Inc,US
AS5393223	AS5174 COGENT-174 - Cogent Communications,US
AS5393223	AS51239 PRINTLINK - Sprint,US
AS5393223	AS51273 CW Cable and Wireless Worldwide plc,CB
AS5393223	AS56039 HURRICANE - Hurricane Electric LLC,US
AS512645938	AS512741 AS-NETIA NetIA,SA
AS5261021733	AS57029 WINSTONNET - Windstream Communications Inc,US
AS5261177220	AS436560 SPOTIFY Spotify Technology SARL,BE

[illegible]

AS4261171720	Announced by	AS43650	SPOTIFY Spotify Technology SARL,BG
AS4261171721	Announced by	AS43650	SPOTIFY Spotify Technology SARL,BG
AS4261171722	Announced by	AS43650	SPOTIFY Spotify Technology SARL,BG
AS4261181720	Announced by	AS43650	SPOTIFY Spotify Technology SARL,BG
AS4267245596	Announced by	AS51653	PRENET-AS PRENET S.r.o.,SK
AS4267245596	Announced by	AS51653	PRENET-AS PRENET S.r.o.,SK

and lets not forget IPv6!



Possible Bogus Routes and AS Announcements

No Bogus Routes

Report: [Allocated and Unallocated IPv6 address blocks](#)

Possible Bogus ASs

Bogus AS

[AS3402](#) Announced by
[AS5669](#) Announced by
[AS14844](#) Announced by
[AS15009](#) Announced by
[AS18747](#) Announced by
[AS19972](#) Announced by
[AS25746](#) Announced by
[AS26806](#) Announced by
[AS27205](#) Announced by
[AS30037](#) Announced by
[AS30037](#) Announced by
[AS32346](#) Announced by
[AS33343](#) Announced by
[AS41102](#) Announced by
[AS56418](#) Announced by
[AS64401](#) Announced by
[AS64560](#) Announced by
[AS65000](#) Announced by
[AS65123](#) Announced by
[AS65149](#) Announced by
[AS65201](#) Announced by
[AS65206](#) Announced by
[AS65251](#) Announced by
[AS65260](#) Announced by
[AS65441](#) Announced by
[AS65530](#) Announced by
[AS2.2077](#) Announced by

Announcing-AS

[AS2914](#) NTT-COMMUNICATIONS-2914 - NTT America, Inc.,US
[AS8928](#) INTERROUTE Interoute Communications Limited,GB
[AS701](#) UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US
[AS209](#) ASN-QWEST - Qwest Communications Company, LLC,US
[AS3257](#) TINET-BACKBONE Tinet SpA,DE
[AS4323](#) TWTC - tw telecom holdings, inc.,US
[AS209](#) ASN-QWEST - Qwest Communications Company, LLC,US
[AS6509](#) CANARIE-NTN - Canarie Inc,CA
[AS6461](#) ABOVENET - Abovenet Communications, Inc,US
[AS701](#) UUNET - MCI Communications Services, Inc. d/b/a Verizon Business,US
[AS7018](#) ATT-INTERNET4 - AT&T Services, Inc.,US
[AS29838](#) AMC - Atlantic Metro Communications,US
[AS6223](#) QWEST-ASNBLK-2 - Qwest Communications Company, LLC,US
[AS9009](#) M247 M247 Ltd,BE
[AS5541](#) ADNET-TELECOM SC AD NET MARKET MEDIA SRL,RO
[AS11271](#) BT Latam Brasil Ltda,BR
[AS10024](#) LGA-AS-SG-AP LGA International,SG
[AS3.341](#) PODRYAD-AS Kozitskiy A.M. PI,RU
[AS38294](#) SERVERWORKS-NZ-AP Serverworks Content Provider,NZ
[AS3758](#) ERX-SINGNET SingNet,SG
[AS21688](#) GMP-METROCAST - GMP Cable TV,US
[AS9930](#) TTNET-MY TIME dotCom Berhad,MY
[AS3758](#) ERX-SINGNET SingNet,SG
[AS3758](#) ERX-SINGNET SingNet,SG
[AS3758](#) ERX-SINGNET SingNet,SG
[AS4788](#) TMNET-AS-AP TM Net, Internet Service Provider,MY
[AS9931](#) CAT-AP The Communication Authoity of Thailand, CAT,TH

What's the base problem
here?

What's the base problem
here?

We really are not doing a very good job!

Why?

The Internet uses a decentralised and distributed model of control in many aspects of its operation

Routing is perhaps the best example:

- There is no point of “authority”
- There is no arbitrator or referee, and no reference source of information
- Everyone is trusted by everyone else to act correctly and honestly
- And not everyone has the same set of motives to act honestly and with good intent all the time
- And not all software and hardware is perfect all of the time

What's the base problem here?

- Routing is built on vague mutual trust models
- Routing auditing is a low value activity that noone really performs with any level of thoroughness
 - And no matter how good a job you may do, that does not mean everyone else shares your enthusiasm and zeal to police the routing system
- We have grown used to lousy solutions and institutionalized lying in the routing system, and accept that as “normal”
- And because instances of abuse are supposedly relatively infrequent we are prepared to tolerate the risks with having a completely insecure routing system

What's the base problem here?

No one is sufficiently motivated to care enough about the integrity of the network to address routing integrity!

And we all need to act to be effective!

Routing Security is a shared problem

It's a tragedy of the commons situation

- Nobody can single-handedly apply rigorous tests on the routing system
- And the lowest common denominator approach is to apply no integrity tests at all
- It's all misplaced trust and absolutely no effective defence!

So we have routing "problems" from time to time

Leaking Routes

March 2012

Its happened again.

We've just had yet another major routing leak, this time bringing down the Internet for most of an entire country. Maybe twenty years ago no one would've noticed, let alone comment, but now of course its headline material in the media. What happened? And how could this have been prevented? Can we do better? I'd like to look at this incident in here, and also look at the implications for the current efforts to secure our inter-domain routing system, BGP.

In my previous column I described an approach to detect the presence of so-called bogon filters in the Internet by using online ads, and embedding our reachability tests into the advertisement using embedded Flash code. (<http://www.potaroo.net/ispcol/2012-02/bogonfilter.html>) In that article I also noted that the continued use of bogon filters were perhaps an anachronism in today world:

The Telegraph

Home News World Sport Finance Comment Culture T
Technology News Technology Companies Technology Reviews V

HOME » TECHNOLOGY » INTERNET

Is the Internet full? Major sites brought problems

Likely repeat of this week's technical problems affecting eba millions as the Internet runs out of space, experts fear

THE WALL STREET JOURNAL | TECH | **US\$8 for 8 Weeks** | [BE A READER NOW](#)

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The Switch

Here's why your Internet might have been slow on Tuesday

Facebook | Twitter | Email | Print | RSS | + More

By Andrea Peterson August 12 @washingtonpost

Some users were frustrated to find some of their favorite Web sites were unresponsive or otherwise inaccessible Tuesday. But it wasn't a data center outage or a squirrel chewing through a cable line causing the disruption. Instead, structural problems with one of the core technologies that keeps the Internet working were to blame, researchers say.

news.com.au

National World Finance Sport Entertainment Lifestyle Technology Video

online

Dodo cops blame for national internet outages
By Ky Doolan, Journalist | Published on Feb 23, 2012 2:03 PM
Filed under: Technology

Telstra routers drained for 38 minutes.
Dodo has revealed its "router hardware issue" was central to Telstra's outage that impacted multiple services providers and Internet service providers.

The outage, which lasted approximately 38 minutes, affected all Telstra services, including landline, mobile, broadband, and satellite. Telstra's network is a critical part of Australia's infrastructure, and the outage was a significant event.

Telstra's network is a critical part of Australia's infrastructure, and the outage was a significant event. The company has been working to improve its network resilience and prevent such outages in the future.

Press Clip - Dodo Route Leak

More Leaky Routes

June 2015

Most of the time, mostly everywhere, most of the Internet appears to work just fine. Indeed, it seems to work just fine enough to the point that that when it goes wrong in a significant way then it seems to be fodder for headlines in the industry press.

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Home / News / Technology / Telstra/BGP

Australia's internet hit hard by massive Malaysian route leak

By Julia Sackmann on Jun 15, 2015 11:49 AM (UTC) Filed under: Telstra/BGP

2 Comments

Telstra Malaysia apologises for BGP blunder

A configuration error at Telstra Malaysia late last week caused large-scale routing problems for its customers in Australia and elsewhere in the world, leading to a significant disruption of services.

The issue started at 6:00 AM AEST last Friday when Telstra Malaysia made changes to its routers to allow for a faster BGP peering arrangement. The changes were intended to improve the speed of BGP updates, but instead caused a major routing problem.

The Register

ISP Level 3 goes TIFTSUP after giganto traffic routing blunder

Explorations agreed way faster than Level 3's own

ISP Level 3 has been hit by a major routing problem, which has caused significant disruption to its customers. The company has been working to resolve the issue, but it has been a long and difficult process.

The problem was caused by a configuration error in the company's routing tables, which led to a large number of traffic being misrouted. This caused a significant increase in latency and, in some cases, complete loss of connectivity.

What SHOULD we be doing?

Routing Security A01

1. Protecting the routers

- Threat model:
 - Compromised router used to insert corrupted address information into your network's routing tables
 - Insert corrupt reachability information into your network's forwarding tables
 - Allow the routing protocol to disseminate the corrupted information across the entire internet
- Response:
 - Secure your routers!



Routing Security A01

1. Protecting the routers

– Threat model:

- Compromised router used to inject malicious traffic into your network's routing

- Insert corrupted information into routing

This is up to you, and the tools and operational practices are

widely disseminated to achieve this – it's not rocket science!

– Response:

- Secure our routers!



Routing Security A02

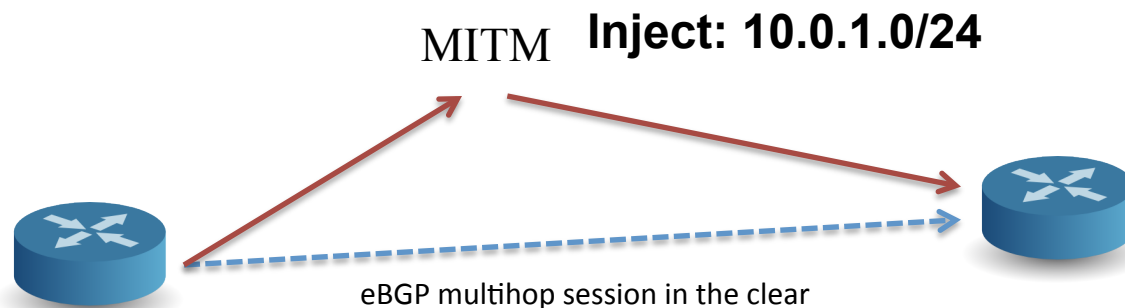
2. Protecting routing protocols and their operation

– Threat model:

- Disrupt the operation of the routing protocol by a “man-in-the-middle” attack
- Compromise the topology discovery / reachability operation of the routing protocol by injection of false routing information

– Response:

- Current operational best practice uses TCP-MD5 and avoids multihop for all eBGP sessions



Routing Security A02

2. Protecting routing protocols and their operation

– Threat model:

- Disrupt the operation of...
- attack
- Com...

– Res

- C
- al.

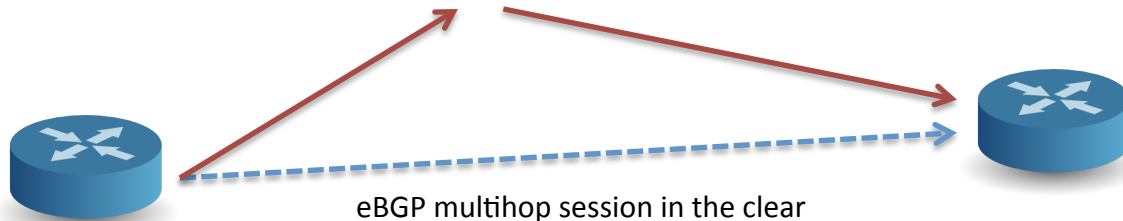
This is up to you and your eBGP peers, and the tools and operational practices are widely disseminated to achieve this – again, it's not rocket science!

the-middle”

of the

→ TCP-MD5 and avoids multihop for

MITM Inject: 10.0.1.0/24



Routing Security A03

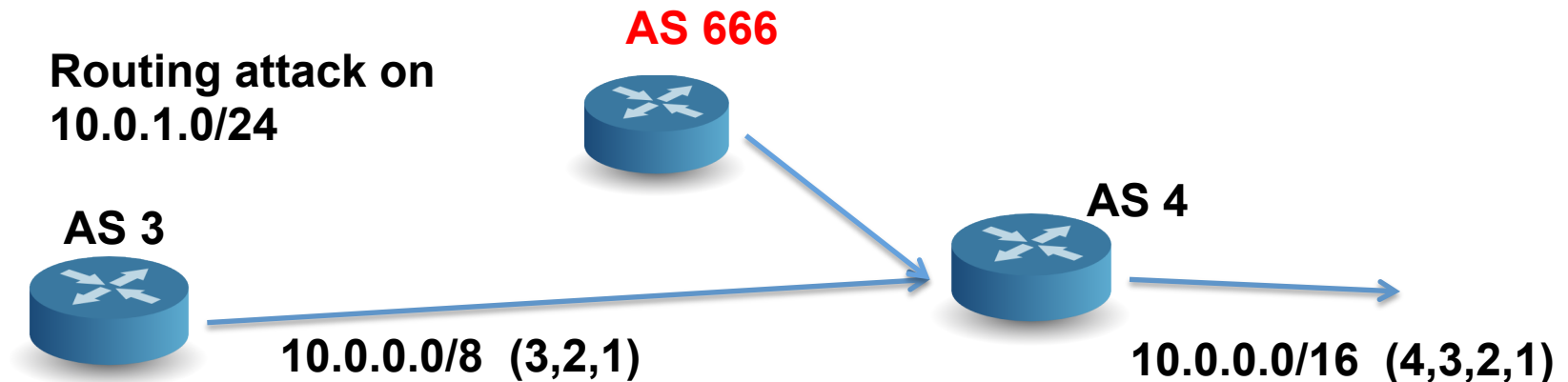
3. Protecting the routing protocol payload

– Threat model:

- Insert corrupted address information into your network's routing tables
- Insert corrupt reachability information into your network's forwarding tables
- Allow the routing protocol to disseminate the corrupted information across the entire internet

– Response:

- ?



Routing Security A03

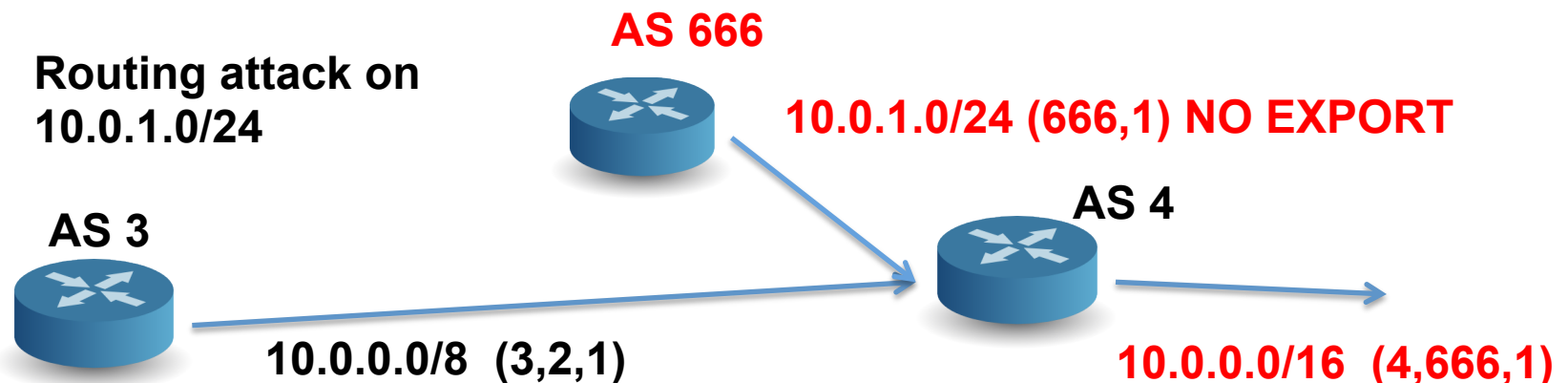
3. Protecting the routing protocol payload

– Threat model:

- Insert corrupted address information into your network's routing tables
- Insert corrupt reachability information into your network's forwarding tables
- Allow the routing protocol to disseminate the corrupted information across the entire internet

– Response:

- ?



Routing Security A03

3. Protecting the routing protocol payload

– Threat model:

- Insert corrupted address information
- Insert corrupt reachability tables
- Allow

outing tables
forwarding

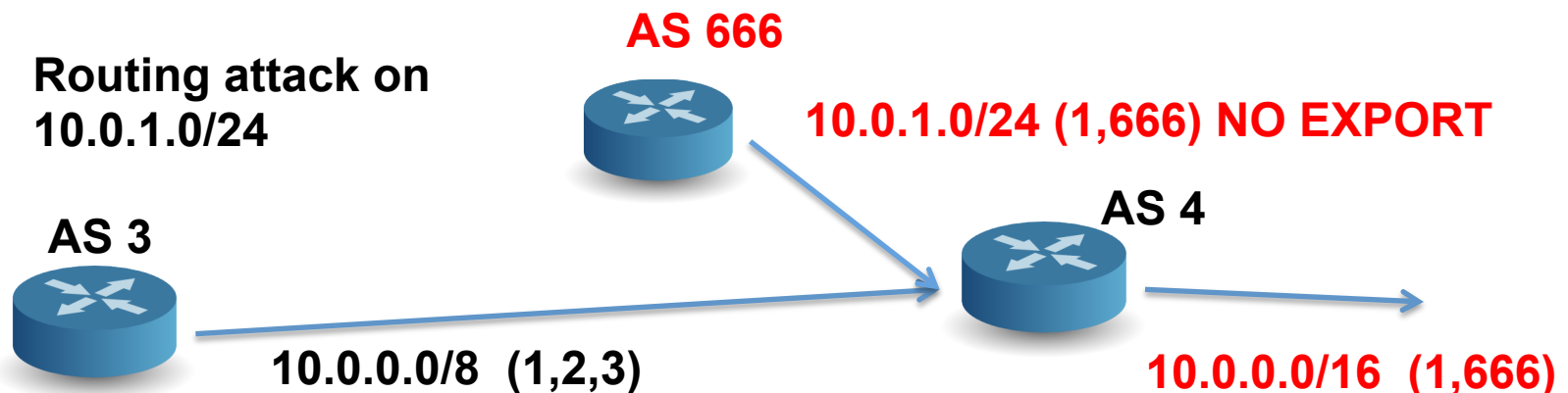
– Res

-

Unfortunately, detecting and preventing this could well be rocket science!

corrupted information

Routing attack on
10.0.1.0/24



Can we "tweak" BGP so that it can detect the difference between good and evil, and only advertise and propagate the "good" routes?

Routing Security

- The basic routing payload security questions that need to be answered are:
 - **Who** injected this address prefix into the network?
 - Did they have the necessary **credentials** to inject this address prefix? Is this a valid address prefix?
 - Is the forwarding path to reach this address prefix **trustable**?
- And can these questions be answered by any BGP speaker quickly and cheaply?

A (random) BGP Update

2015/01/26 00:03:35 rcvd UPDATE w/ attr:

nexthop 203.119.76.3, origin i, path 4608 1221 4637 3561 3356 4657 4773
124.197.64.0/19

BGP Update Validation

2015/01/26 00:03:35 rcvd UPDATE w/ attr:

nexthop 203.119.76.3, origin i, path 4608 1221 4637 3561 3356 4657 4773
124.197.64.0/19

- Is 124.197.64.0/19 a “valid” prefix?
- Is AS4773 a “valid” ASN?
- Is 4773 an “authorized” AS that is permitted to advertise a route to this prefix?
- Is the AS Path “valid”?
 - Is AS 4657 a valid AS, and did AS 4773 advertise this route to AS 4657?
 - Is AS 3356 a valid AS, and did AS 4657 advertise this route to AS 3356?
 - Etc
- Does this AS Path represent a viable forwarding path to reach this address prefix?

The Basics of Update Validation

- The **VALIDITY** of the Address and AS number
- The **AUTHORISATION** provided by the address holder to permit the AS to originate the route
- The **CORRECTNESS** of the path to reach the destination

Approaches to Validity

- The awesome power of Whois!
- Entries in a routing registry
- Delegation of reverse DNS zone
- Certification of an allocation registry entry

All of these approaches rely on some form of trusted third party attestation to provide information about the address

The credentials of the party holding the address are not well described in the first two approaches

For reverse DNS it's the delegated zone admin

For certification it's the holder of the private key

None of these Approaches are a Perfect Fit

Route Registries:

- The route registry model relies on the maintenance of a trustable registry write access model. Too often this access model becomes a Mail From access or user / password. Efforts to move to keyed access and user certs have often foundered on user resistance to cert management tools in user systems
- There is no single IRR, but many IRRs each with partial (and sometimes conflicting data) or dubious quality and uncertain validity
- The Route Registry Object access model is variously implemented
- All this can be improved, but to do so probably requires keys (and certs) and signed objects
- In theory, and practice, this can work for a diligent, mutually trusting community using simple origination registry objects
- If you operate a network high in the interconnection hierarchy, then the large ACL filters pose a scaling issue in terms of router config / state bloat
- The operating overhead of maintaining current accurate data is high and the integrity of the route registry contents is vulnerable to bad actors

None of these Approaches are a Perfect Fit

Populating Reverse DNS:

- The reverse DNS model does not cleanly map across CIDR delegations
 - It can be coerced to do so, but its not a smooth fit
- The approach relies on integrity of zone delegation and management
- Mapping AS numbers?
 - How can you answer “assemble the list of all addresses originated by an AS” if all you have in the reverse DNS is address -> AS mapping
- Integrity of critical information in the DNS really needs DNSSEC
 - Which in turn implies private key management tools and practices on the part of address holders
- Would this approach be a case of overloading the DNS?

None of these Approaches are a Perfect Fit

Number PKI:

- A PKI for Addresses and AS numbers has issues has its own issues
- Key / Cert management for a new PKI requires a dedicated tool set
- End User unfamiliarity with managing keys is an issue
- Current hardware and software tools for use in this PKI tend to be “raw” and they expose much of the underlying mechanics of the crypto system to the user
- Distribution of Certificates and CRLs using “just in case” flooding and runs into a novel set of issues of distribution and synchronization of routing information and the associated credentials that need to be used to validate the routing information

But

A Foundation for Routing Security

A PKI for addresses and ASNs makes a lot of sense: (*)

- Use digital signatures to both the integrity, the authenticity and the currency of the signed data. This allows systems to automatically validate attestations about addresses and their use
- Digital signatures that can be validated in this PKI can be used to sign:
 - Route Registry Entries
 - Route Requests
 - BGP

* Yes, that's a personal opinion!

But what about BGP?

- What are the trade-offs in adding any of these approaches into the context of BGP?
 - How a BGP speaker can be assured that the origination of the route is valid?
 - And that the AS path that is being presented is an authentic representation of a viable forwarding path to the address?

BGP Elements

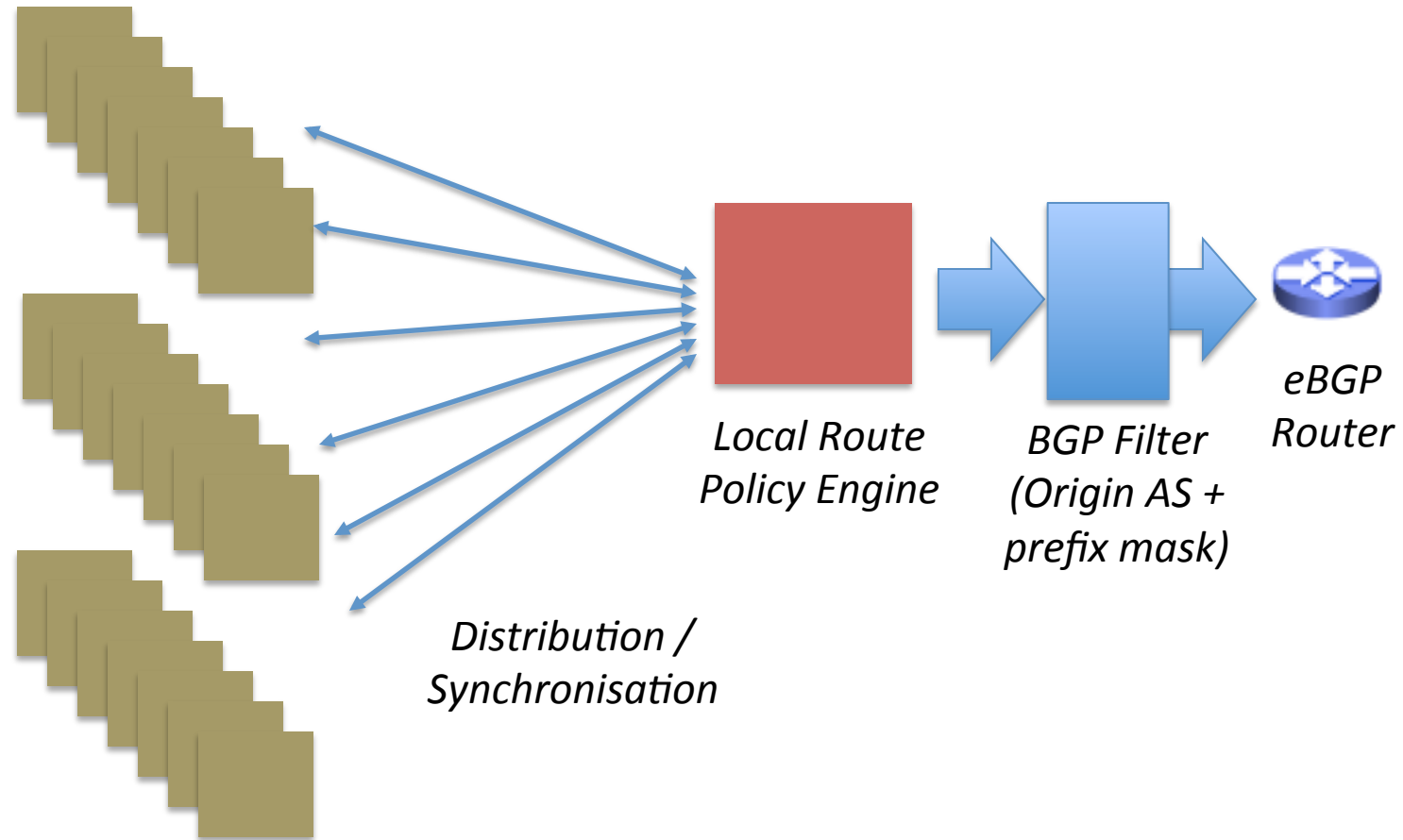
- Origination
 - Is the address valid?
 - Is the origination of this route a duly authorized use of this address?
- Path
 - Is the forwarding path represented in the route an authentic path?
 - If I pass a packet into this path will it get to its intended destination?

BGP Origination (1)

Managed Filters

- Filter lookup is fast within the router, and filter construction can be undertaken by a trusted off-unit subsystem, using an incremental difference sync protocol to keep the router state in sync
- Route Registry model of declaring in advance what addresses you may advertise to your BGP peers
 - The peer constructs an acceptance filter based on this list
- RPKI ROA model of declaring in advance what addresses you may advertise to your BGP peers
 - The peer constructs an acceptance filter based on this list
- This is a “just in case” provisioning model (all filtered systems install filters for all ROA-managed prefixes)

A filter-based architecture for securing BGP origination



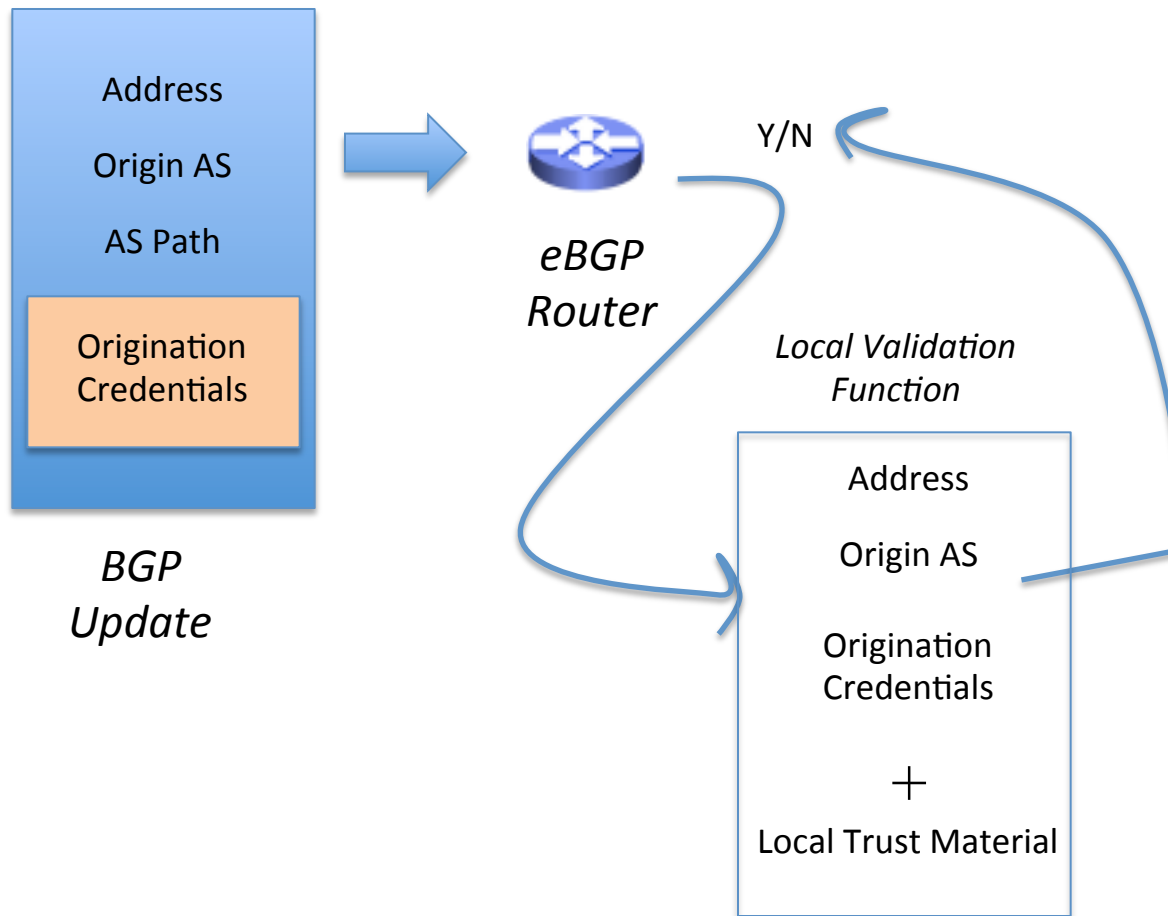
*Route Origination Information
(Route Registries or RPKI certs and ROAS)*

BGP Origination (2)

Update Filtering

- Update filtering allows the credential information to be passed with the data, allowing for “just in time” delivery of credentials and information
- Can be undertaken on-board, or outsourced to update filtering BGP route server(s) within each AS
- RKPI ROA attached to the update as an opaque transitive attribute?
 - BGP bloat?
 - Digital signatures plus PKI Certs can add significant size to updates and processing load to routers (as in a BGP peer session reset)
- Or perform a Reverse DNS lookup
 - Validate originating AS through a DNS query of the prefix

A update-based architecture for securing BGP origination



Path Validation

Origination validation reduces the attack surface, but an attacker can still inject bogus routes as long as it synthesizes the specified originating AS in the bogus route entry

So while origination protection is a good initial step, it is just an initial step and by itself its not a completely adequate approach to routing security

But how far (and at what cost) should we go to secure AS Paths?

Option a:

Route Registries and RPSL

- Using RPSL and various forms of export and import attestations in a route registry it is feasible to construct AS Path filters that allow a BGP speaker to filter out implausible AS Paths from incoming updates
- In practice RPSL has never really gained widespread acceptance. Some communities have worked hard to promulgate its use, but overall it has been unable to achieve widespread adoption and the effort / benefit equation looks like its unsustainable

Option b:

AS Path Validation and BGPsec

- BGPsec proposes a strict form of AS Path validation where each eBGP speaker uses its own digital key to sign across the path and the AS to whom the update is being sent
- It is not possible for a third party to construct a bogus route in this scenario unless it gains access to keys
- But this sequence of interlocking signatures implies:
 - BGPsec routers are required to unchain the signature set and match it to the AS Path in the update, using the local RPKI cache to validate the router signatures
 - BGP bloat in carrying interlocking signatures
 - a high crypto processing overhead in processing updates in the router
 - no useful validation in cases of piecemeal adoption of BGPsec

Option c:

AS Adjacency and soBGP

- In soBGP a pair of adjacent ASs publish and propagate a signed AS Adjacency Attestation, saying that they peer directly and exchange routes
- If a BGP speaker receives a AS Path it can break the path into a sequence of AS adjacency pairs and determine if the AS Path represents a plausible transit path through the network based on signed adjacencies
- This plausibility test can be performed through a filter operation performed on received updates, either on-board or off-loaded

Concerns

A major issue here is that of *partial use and deployment*

- This security mechanism has to cope with partial deployment in the routing system
 - The basic conventional approach of “what is not certified and proved as good must be bad” will not work in a partial deployment scenario
- In BGP we need to think about both origination and the AS Path of a route object in a partial deployed environment
 - AS path validation is challenging indeed in an environment of piecemeal use of secure credentials, as the mechanism cannot tunnel from one BGPsec “island” to the next “island”
- A partially secured environment may incur a combination of high incremental cost with only marginal net benefit to those deploying BGPsec

Concerns

Is a *trust hierarchy* the best approach to use?

- The concern here is **concentration of vulnerability**

If validation of routing information is dependent on the availability and validity of a single root trust anchor then what happens when this single digital artifact is attacked?

- But is there a viable alternative approach?

Can you successfully incorporate robust diversity of authentication of security credentials into a supposedly highly resilient secure trust framework?

This is a very challenging question about the nature of trust in a diverse networked environment!

Concerns

Is certification the *only way* to achieve useful outcomes in securing routing?

- Is this form of augmentation to BGP to enforce “protocol payload correctness” over-engineered, and does it rely on impractical models of universal adoption?
- Can various forms of *routing anomaly detectors* adequately detect the most prevalent forms of typos and deliberate lies in routing with a far lower overhead, and allow for unilateral detection of routing anomalies?
- Or are such anomaly detectors yet another instance of “cheap security pantomime” that offer a thinly veiled placebo of apparent security that is easily circumvented or fooled by determined malicious attack?

What are we trying to do?

Is securing the routing system alone actually enough?

- Can you validate the “correctness” of the forwarding paths being proposed by a routing system?
 - Is secure routing helpful in and of itself?
 - Or this this just pushing the vulnerability set to a different point in the network integrity space?
 - Does this adequately reduce the level of exposure to attack?
 - Is BGP too incomplete in terms of its information distribution properties to allow robust validation of the intended forwarding state?

If not, then is this a case of too high a cost or too low a benefit?

- Is this a case of reducing the security credential generation and validation workload by reducing the security outcomes through reduced trust and/or reduced amount of validated information
- Or is this a case of increasing the level of assurance and the amount of routing information secured by these mechanisms

What are we trying to do?

Is Partial Deployment of any value?

- Are the semantics of routing security and incomplete credentials compatible concepts?
 - Can you deploy high integrity security using partial deployment scenarios?
 - The issue here is that credentials can assure a recipient that the information that they receive are authentic. They can mark what's "good". But the aim of the exercise is to identify what's "bad".
 - In a scenario of comprehensive deployment, then the inability to determine "good" implies "bad"
 - In partial deployment scenarios the inability to determine "good" means...?

Good, Fast, or Cheap?

Pick one!

We just can't make secure routing mechanisms cheaper, faster, more robust, and more effective than existing routing tools ...

- We can make it robust, but it won't be cheap, and probably not fast!
- We can make it fast, but it won't be robust and it won't be cheap!
- We can make it cheap, but it won't be completely robust!

Good, Fast, or Cheap?

Pick one!

We just can't make secure routing mechanisms cheaper, faster, more robust, and more secure than existing routing tools ..

- We can make

So where should we compromise in the design of a secure routing infrastructure?

- Robust and it won't be
- Cheap and it won't be
- Fast and it won't be
- Cheap, fast, and it won't be completely robust!

Caution: Opinions!

My personal view of design compromise:

- Improve the robustness of RPKI certs by altering the cert validation algorithm
- Place origination signatures, ROAs and certs into the BGP protocol updates as opaque attributes
- Use AS Adjacency attestations in preference to a fully signed path
- Place AS Adjacency attestations into BGP protocol updates as opaque attributes
- Exploit the use of TCP in BGP to never resend already sent certs
- Flatten parts of the CA hierarchy by using RAs rather than CA delegations
- Reduce OOB credential distribution to TA material
 - For which you can use the DNS and DNSSEC if you really want!

Like all the other approaches, this represents a particular set of compromises about speed, complexity, cost, deployment characteristics and robustness – it has it's weaknesses in terms of comprehensive robustness, but it attempts to reduce the number of distinct moving parts

Thank You

Questions?

Do you envision a world in the not so distant future where RPKI will be used to secure routing globally on an operational level; and if so when would you predict this will happen?

If you mean RPKI + BGPsec then this is just not going to happen in my opinion. Path Validation is just too difficult and Origin Validation is not enough by itself. So my answer is a bold: “never!” with BGPsec - The technology model needs to change before adoption begins to look feasible.

However, if we are allowed to look at other methods of Path Validation, then I can't see how we can build a validatable framework of routing addresses without using a validation framework based on this RPKI. In other words, any approach that tries to secure routing should take advantage of the RPKI, due to its ability to validate the implicit assertions made in a routing system

Can RPKI itself be attacked, misconfigured, or legally forced to misclassify a legitimate BGP route as bogus? Using the example of where DNS is subject to legal orders to take down domains; could RPKI be used to take down IP prefixes?

Yes, and yes.

The first question exposes some strange subtle aspects of PKIs. In an environment of multiple trust anchors, and where clients are free to choose whom they trust there is no “absolute” legitimacy.

There are issues with the validation algorithm in RPKI that allows windows of opportunity for otherwise valid routes to be classified as bogus. If you attack the local cache synchronisation mechanisms then you can play with a out of date cache, which can be used to categorise valid routes as bogus

Hypothetically, if an Australian court ordered APNIC to remove 203.10.60.0/24 from its trust anchor certificate then that prefix has a hypothetical problem. But ordering APNIC to REMOVE a resource from its TA set does not make it “unroutable.” It just makes it “not found”. We’d need an order to generate a ROA for 203.10.60.0/24 with an Originating AS of 0 to cause the route to be regarded as invalid . But as long as noone uses RPKI seriously its probably a very small problem! But IF we all start using RPKI as the trust foundation for the routing system then yes, it is a potential mechanism for takedowns.

Is it true that RPKI cannot prevent some classes of attacks - such as route leaks and path shortening attacks? Can you explain why this is?

The mechanisms in BGPSEC talk about correctness of the *protocol*, NOT correctness of *policy*.

Example: A is both a “customer” of B and a “customer of C”. What if A forwarded all the routes it learned from B to C? C might believe A and hand to A all the traffic it would’ve passed through other connections to get to B, particularly if B is not directly connected to C. Obviously this is wrong, but in protocol terms there is no violation of BGP as a protocol, and BGPsec would not find anything wrong here.

Equally in this example there is nothing that is “wrong” or invalid in the context of the underlying RPKI. It’s just that the routes are being passed through the network in a way that is counter to the policy-driven intention. Stopping leaks requires the formal statement of “intent” (policy) and including this intent into the framework (i.e. route registries).

The BGPsec model has avoided the concept of route policy objects, and frankly it seems daft to redo the old RPSL work. But that then brings us back to routing registries and their issues.

I have now created ROA objects for my resources in MyAPNIC. I understand the benefits of creating ROA objects. However, since ROA objects are still in a testing phase, will this achieve the benefits of creating ROA object? What will actually happen to my resources now?

Hopefully, nothing!

If you have been careful in the construction of your ROAs then some others will pick up these ROAs and construct BGP route admission filters. In the event that some third party attempts a route hijack of your routes using more specific prefixes and a false origin AS then the points in the network that use such ROA-based filters will filter out this.

Of course, if the attacker puts your AS in as the origin AS and advertised within the bounds of the permitted more specifics of your ROAS then the attack will be successful.

And of course , if you have not been careful and complete in the construction of your ROAs, or let your keys elapse, then you stand the risk of having your legitimate routes filtered!

Is ROA object and RPKI framework “standard” among all the RIR? If not, what are the differences?

The public key certificates, signed attestations and published products conform to the published RFCs – they are standards, and we believe that all the RIRs produce certificates that comply in every respect to the specifications described in the RFCs.

The Trust Anchors published by the RIRs are not all the same. In practice the differences are inconsequential as long as nothing goes wrong. APNIC’s practice is to include only those resources that are listed in its database, but the cost of this accuracy is operational fragility. Other RIRs (e.g. ARIN) list 0/0 (all numbers) in its trust anchor. Operationally, this approach is robust, but in another sense it is a misrepresentation of the resources that are under the RIRs administrative control.

I did not receive the resources directly from APNIC. However, I am keen to set up the ROA objects to secure my announcement. How can I get these ROA objects created?

The trust implicit in the PKI is that each certificate issuer only issues certificates according to its published practices statement. APNIC has a published a practice statement that it issues certificates for resources that APNIC itself has allocated, AND ONLY THOSE RESOURCES, and it issues those certificates to those entities who received those resources AND ONLY THOSE SUBJECTS.

You need to speak to whoever allocated those resources to you and ask them for a certificate that covers those allocated resources that you did not receive directly from APNIC.

Would Route Origin Authorisation every become a mandate attribute with routing, if yes, the approximate time frame?

Personally, I doubt that this will happen anytime soon. What we have is still an early iteration of this technology (BGPsec) and I suspect that more ideas will emerge in the coming years that address some of the shortcomings in the BGPsec model.

It's likely that ROAs will persist in any BGP security model – ROAs represent a minimal and useful testable attestation about the origination of a route into the routing system.

How could we up sell ROA? Benefits of ROA?

Errr Ummm – I wouldn't go there myself!

Any technical aspects that Member Service staff should know to promote ROA into the community.

Well there are a number of considerations here

One view is that we (APNIC) undertake a simple Registry function.

There are very good reasons to have RPKI certificates over resources, and there are a wide set of opportunities to explore about how to use signed attestations to ensure that addresses are handled with integrity. ROAs are just one form of attestation and right now its one that has a set of issues that would mean that a responsible voice would be one of caution rather than “promotion”.

We usually say RKPI does not guarantee 100% routing security. If everyone has created their ROAs and everyone uses validators, what other threats exist for BGP routing security ?

If you lock the doors they can still come in the windows!

Without path security the ROA is not all that useful (as all you need to do is fake the origin) But even with path protection there are still problems with policy violations. And even then this does not get to the heart of the problem: what we actually want is certainty in forwarding, and strengthening the routing system is just one part of the larger problem.

Validators are an essential part of RPKI framework. What kind of a cost factor are we looking at if a large ISP wants to implement validators? And what kind of hardware is required?

The current approach to construction of filters (just in case) offloads the validation overhead for ROA validation, and the software solutions (typically based on OpenSSL libraries) on general commodity hardware are easily up to it.

Path validation is an entirely different problem, and validating a full route set following a BGP session restart requires some 2 – 5 million asymmetric crypto operations, and this cannot be readily outsourced from the BGP speaker. Its hard to see how this can happen

With cryptographic information, ROAs are relatively big objects. Validation may take bit of time too. Is there any possibility that the routing performance will go down (noticeably) because of RPKI ?

ROAS are NOT big objects – they are relatively compact ASN.1 data objects.

The implementation of ROAs as filters has no real impact on routing performance, with the possible exception of an increased update load through route refresh operations. But this is not a major factor for routing performance.

But, as with the previous response, path validation is an entirely different problem, and BGPsec-style and validating a full route set following a BGP session restart requires some 2 – 5 million asymmetric crypto operations, and this cannot be readily outsourced from the BGP speaker. Its hard to see how this can happen. Path validation is not going to happen easily.

Is ROA intended to ultimately replace route objects or will it need to coexist with route objects? If coexist: What is the operational difference between ROA and route object? Why should network operators worry about maintaining both these objects?

I assume you mean a “route object in a routing registry”. The difference is the policy framework – a ROA associates a prefix with an originating AS. A route object is capable of associating a prefix with an AS with a routing policy

In theory, if you had signed route objects you would not need ROAs, but not vice versa. But we don't have signed route objects, and that means that the route registry system is lacking in explicit validation capability. There are other problems with route registries including currency, completeness and consistency.

If they won't coexist: Route objects are used for both human and router consumption. Our members often ask us to register route object and then verify visually that the object is visible in their choice of IRR. The ROA object is a binary file stored in repositories only meant for router consumption. People can not visually see if a ROA is created for a prefix or not. Shouldn't the registries provide some mechanism for relying parties to visually see what ROAs are created like they can for route objects by querying IRRs?

When we designed the ROA system we thought about what tools we would build and deploy and what we would leave to others to build. It's a good question about what we should do as APNIC using member's resources and what we should leave for others to do.

Please show me the actual configuration in BGP router which relates with RPKI.

```
bgp rpki server 192.168.179.3 port 43779 refresh 60
```

```
route map validity-0
```

```
    match rpki valid
```

```
    set local-preference 100
```

```
route map validity-1
```

```
    match rpki not-found
```

```
    set local-preference 50
```

What type of equipment and the average cost for ISP or a company to run this service.

RPKI relying party software (rpki.net)

*nix server

Cisco / Juniper routers

Major cost components are investments in processes and expertise, not in equipment per se

What is the biggest issue if something goes wrong with the RPKI system, and how does the ISP/company fix it. Do you have any specific example of what would go wrong? One of the example:
If there are networks on the other side can not validate and dropped the traffic, although everything in the IP source network side has been configured correctly.
How does the IP source network quickly identify this issue before the customer got affected.

There are many moving parts in this operation and much to go wrong. Keys expire, and if this occurs in a trust anchor than large parts of the RPKI can no longer be validated. If the local cache sync tool fails then similarly larges amount of the address space can no longer be validated.

But the implications to BGP are probably more to the bounds of 'slight' rather than 'significant'. The reason is that validation is applied to updates, not to stored routes. So if a previously valid route is invalidated then that will only be apparent when that route is updated. This is good and bad – good in that the impacts of a PKI error are not immediately applied to the routing system and bad in that PKI problems may not be noticed for some time,

During MyNOG, someone presented how you can verify if the prefix have valid or invalid ROAs in your router configuration. Apparently not all routers supported this, would he know a list where we can verify what routers support this? (ex. Juniper apparently does not support this yet).

Speak to your router vendor. I do not sell routers.

Will RPKI be fully operational at all, if so when do we expect this to happen judging the percentage of ROAs created now (still low)? Any suggestions on how we get people to create their ROAs on top of the initiatives we do now?

Its hard to sell fragility, particularly if the supposed benefits are significantly discounted by the lack of Path validation.

ROAs are easily circumvented through Path manipulation, and only really protect against mis-origination leaks, which are not all that common

Path protection is significantly harder than Origin protection and noone is doing it. That makes it tough to “sell” ROAs when all it does is introduce new fragility factors and not much else

What is the difference of creating ROA objects than creating route objects with other Routing Registry (i.e. RADB)? Does creating ROA objects affect my actual routing configuration?

In both cases the object creator (ROA, IRR Route Object) is creating information that other people can use in their BGP configuration to populate a BGP filter.

However ... a few folk use a general route registry to populate their routing filters. The data is not consistent and of dubious quality so it becomes a risk to use it to drive a routing filter. In theory only the prefix holder can create a valid ROA so there are fewer issues about authenticity of the data. But a ROA contains no policy information, so has a more limited application

If a member has a /22 and routes the /22 (only). Should they create a ROA with (and why?):

- no max length
- max length of /24 (in case of future requirement)
- max length of /22

/22 – otherwise they are opening the door for more specific attacks with origin spoofing

Should we be actively contacting our members with "invalids" and notify them? Is there a way of automatically notifying the network operators once their ROA becomes invalid?

Who made us the routing police?

By the way, “Invalidity” is NOT a global condition – it’s a local condition. Its relative to local trust anchors, which makes this a tougher proposition – there is no assured global in/out judgement here.

For some large organizations when creating ROA's they need to do their research first, then push it up to their management. What kinds of things can they add to their business case before submitting to their management?

To what extent do address holders see integrity of routing of their own addresses being their own responsibility, and to what extent do they see it as their upstream ISP problem or more generally SEP?

- Some folk are happy to use APNIC's online system to generate and maintain ROAs.
- Some folk think its so important that they want to do it themselves and not rely on APNIC
- Some folk don't care enough to do it at all

Given that the investment / cost is nonzero and the benefits are arguable from the current very very low use of ROAs and BGPsec any of those responses are reasonable!