

Internet Interconnection and Observability Walkthrough

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NANOG[™]

Introduction

- This presentation is a high-gloss attempt to educate newcomers about internet interconnection and observability.
- Who am I? A network engineer.
- I've spent most of my career focused on content distribution networks and internet backbone architecture.
- Currently, I'm focused on GPU/AI datacenter networks.

Bits

- If you didn't know already, computers digitally convert messages into 0s and 1s. Off/On in terms of electricity is simple to signal.
- Those 0s and 1s are called bits.
- Bit is short for binary digit. Follows the metric system.
 - 1000 bits = 1 kilobit, 1000 kilobits = 1 megabit, and so on...
- Network bandwidth is usually measured in bits.

Routers

- Routers forward bits by sharing and following routes of other routers, predefined standards, and configuration.
- Networks interconnect their routers over physical cable or wirelessly over antenna to exchange bits and routes.
- To transmit and receive bits over cable or antenna, bits are modulated into electrical signal or light waves.

Modulating Bits Into Light Waves

- Most industrial routers' have empty sockets to plug in small modules called transceivers aka optics.
- Optics are rated to go different distances (km) and speeds (bps).
- The latest Ethernet standard optics can reach 800 Gbps over 120km (75 mi)! These are called 800G-ZR optics.
- SR, DR, FR, LR, ER, ZR, ZR+ references max [R]each.

Modulating Bits Into Light Waves

- Light waves have parameters that we can modify to encode bits:
 - Amplitude: Modifying power (off, weak, moderate, strong).
 - Wavelength/Frequency: Modifying color (wavelength).
 - Which thereby modifies frequency.
 - Phase: Modifying alignment/offset.

Modulating Bits Into Light Waves

- Old Way: Non-Return-to-Zero (NRZ)
 - 1 bit at a time.
 - Off = 0, On = 1.

Modulating Bits Into Light Waves

- Newer Way: Pulse Amplitude Modulation (PAM)
 - 2 bits at once. Faster!
 - Uses 4 distinct amplitude (strength) levels.
 - Off (00), Weak (01), Moderate (10), Strong (11)

Modulating Bits Into Light Waves

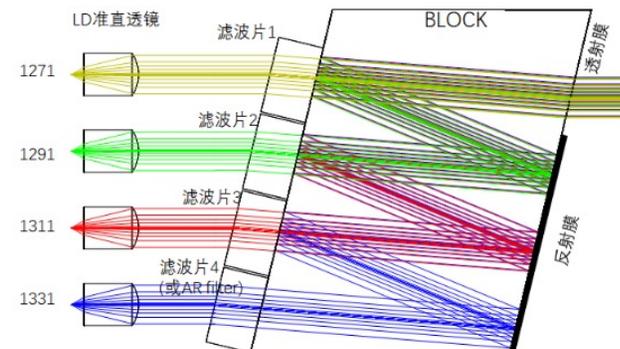
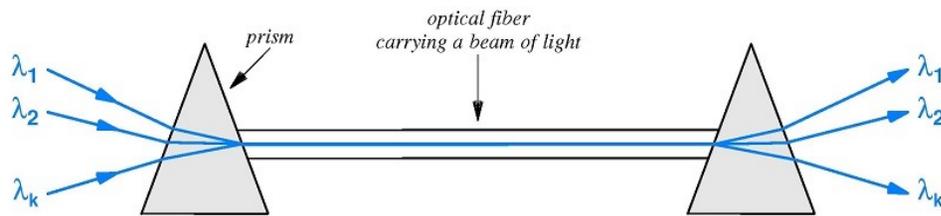
- Newest Way: Quadrature Amplitude Modulation (QAM)
 - Combines amplitude (intensity) + phase (alignment/offset).
 - 16-QAM sends 4 bits at once with 16 different combinations.
 - 0000, 0001, 0010, 0011, etc...
 - 4k-QAM, can send 12 bits at once with 4,096 combinations.
 - 00000000000000, 00000000000001, 00000000000010, etc...

Multiplexing

- To further increase efficiency, multiplexers merge (mux) and split (demux) different channels of colors/freq over the same strand.
 - This is known as wavelength division multiplexing (WDM) or dense wavelength division multiplexing (DWDM).
- Polarization division multiplexing (PDM) is used to send different waves in vertical and horizontal orientation.

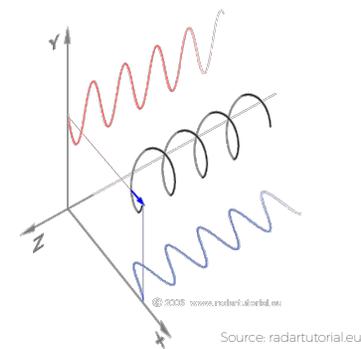
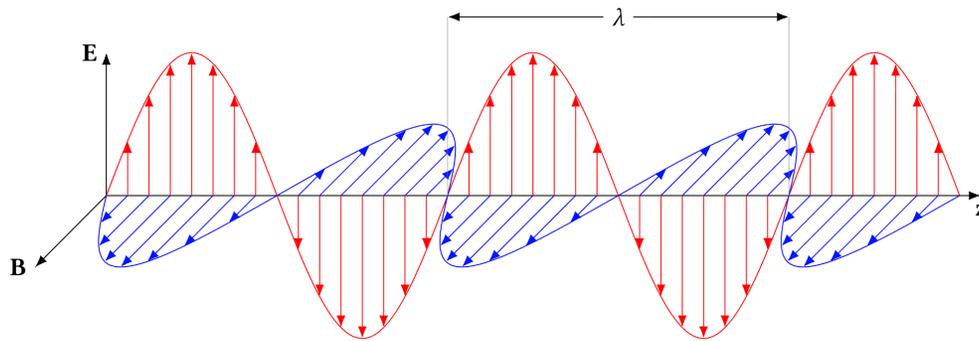
Wave Division Multiplexing

- Each laser sends a unique color/frequency and thereby each wavelength is a distinct channel or lane of communication.
- Prisms and chemically tuned mirrors are used to mux/demux.



Polarization Division Multiplexing

- Polarization division multiplexing is used to send different waves in vertical and horizontal orientation. Coherent optics use DSP (Digital Signal Processors) chips inside to untwist these waves.



North America Core Long Haul Wavelength Network



The Zayo Network | **Connecting What's Next**

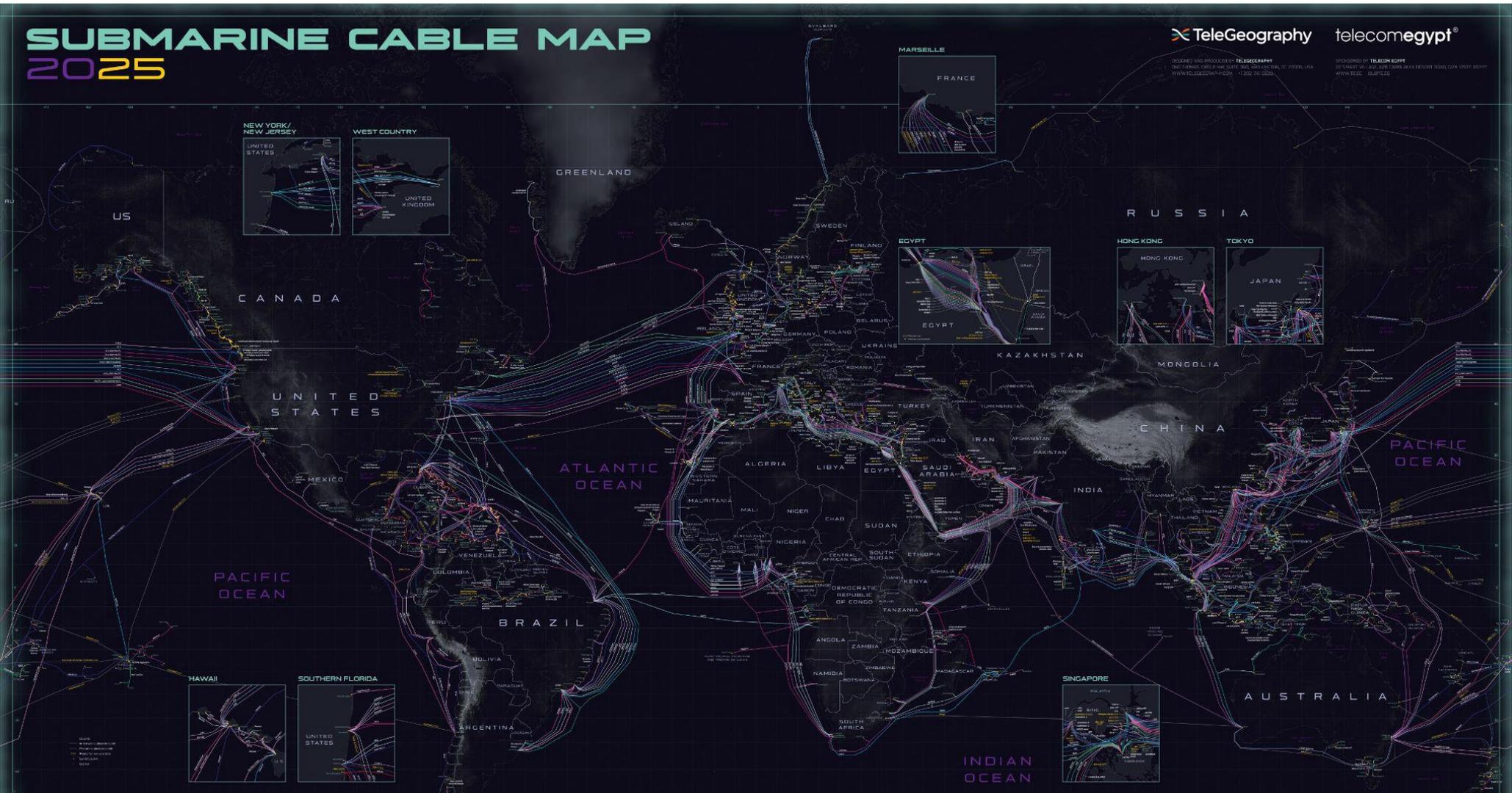
SUBMARINE CABLE MAP 2025

TeleGeography

telecomegypt®

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100 EL-DOKKI VILLAGE, 11834 HELWAN ROAD, HELWAN, EGYPT
WWW.TELECOM.EG.0001500



Examples Of Physical Faults

- Trenched lines get accidentally cut by construction.
- Poles fall due to car collisions and weather. Sometimes catch fire.
- Ships anchors drop and cut subsea cables, usually close to port.
- Signal is prone to decay by dust (physical) or weather (wireless).
- Transceivers, inline amplifiers, and routers go faulty.
- Electricity or cooling fails, humans make mistakes, etc...

Where The Light Meets Business

- Facilities:
 - Data Centers
 - Carrier Hotels
 - Universities
 - Utility & Water Closets

Where The Light Meets Business

- Facilities rent you:
 - Space: Racks, cages
 - Cooling: Hot/Cold Aisles
 - Power: kw/rack, distinct feeds for redundancy
 - Interconnection/cross-connects/xconns
 - rack-to-rack, cage-to-cage, rack/cage-MMR.

Facilities & Business Relationships

- Facilities are not meant to remain empty.
- Sourcers find facilities with resources for the best price.
- Some networks end up having to build their own facilities.
- As demand increases, resource supply in dense metros becomes constrained, therefore it's implied some will have to build further out into unprecedented communities.

Facilities & Business Relationships

- You'll often hear about the buying and selling of "waves" or "dark fiber" by service providers connected to different facilities.
- A wave implies the fiber is already lit and tuned to a certain wavelength/frequency.
- Dark fiber implies the link is not lit and you are expected to light the strand and mux/demux as needed.

Facilities & Business Relationships

- Besides leased waves or dark fiber routes for site to site connectivity, networks connect to each other with different business relationships locally in these facilities.
- Waves, fiber, and interconnection in these facilities is what makes up the internet.
- How do you participate?

Registration

- Besides getting space, power, and cooling, you need to register for numbers...and pay.
- Five Regional Internet Registries (RIRs) assign numbers to distinguish networks, machines, and their purposes.
 - ARIN, LACNIC, RIPE, AFRINIC, APNIC
- There are independent brokers that resale and auction numbers.

ASNs and IPs

- Autonomous System Numbers (ASNs) provide network identification and distinction.
- Internet Protocol (IPs) addresses distinguish machines and are aggregated into prefixes.
- Out of RIR region use is sometimes permitted with conditions.
- IPv6? IPv6 was mostly driven by resource exhaustion. $2^{32} \rightarrow 2^{128}$.

BGP

- Border Gateway Protocol (BGP) is a standard implemented in software used to exchange routes to IPs within ASNs.
 - BGP is the routing protocol of the internet.
 - BGP has evolved and extended its capabilities over time.
 - The most specific prefix with the shortest path of ASNs wins.
 - BGP has many traffic engineering possibilities.

BGP Peering Business Relationships

- Transits: Comparable to you paying a courier like FedEx to deliver your package anywhere in the world.
 - In theory, transits are supposed to get you to any destination, but in practice every network has different reachability (view).
 - Transit networks capacity to other networks is shared amongst all customers. Lossless delivery not guaranteed!

BGP Peering Business Relationships

- Transits:
 - Burstable billing (95/5): Transits sample how much you use over a month, and they will sort those samples high to low. They ignore the top 5% of samples or bursts. You are billed the next highest number for the month. Brief spikes are "free."

BGP Peering Business Relationships

- Transits:
 - Transit services can be resold and this makes up a large amount of the internet service provider economy.
 - Transit providers are thereby tiered.
 - Tier 1s are at the top and in theory should have no upstreams.
 - Tiers change by geographic market.

BGP Peering Business Relationships

- Private Network Interconnect (PNI/SFI): Direct connection to another network that usually is settlement free, but not always.
 - Ideally, there is a mutual benefit seen + reduction of cost.
 - One of the two networks still has to initiate and pay the facility for the cross-connect (xconn).
 - Optics, IPs, and router ports have cost too.

BGP Peering Business Relationships

- IXPs: Comparable to a potluck. You pay a renewing membership fee and then can exchange traffic with everyone in the room.
 - IXPs use "route servers" for everyone to exchange routes over bgp without having to directly peer with every member.
 - You can chose not to use the route server and selectively peer.
 - You can directly peer and use route server simultaneously.

BGP Peering Relationship Summary

- Transits: Middle man network, distant routes, and you pay the highest renewable cost. Often referred to as "upstreams."
- Private Network Interconnects (PNI/SFI): Most control over your capacity. Xconn provider is only third party and cost.
- IXPs: Middle man network and generally pay some renewable costs.
Middle man network implies additional risk of loss.

Sampling Traffic

- Every Nth packet ingressed on a link will have its attributes like source and destination address copied to a collector for analysis.
- Sampling and analyzing network flows (netflow/flow) for sources and destinations help networks with peering decisions.
- Flow also helps in diagnosing issues with routing and attacks.
- You can even use flow to filter and mitigate impact of attacks.

Sampling Traffic

- Requesting to peer with top src/dest ASNs by flows sampled:
 - How much are you paying for those bits via transit?
 - Is the considered network in the same facility or the same IXP as you? If not, how much would it cost to reach?
 - How much are cross connects, optics, IPs, IXP recurring costs?
 - What is the network's peering policy? How much capacity?

BGP Paths and Views

- Paths are unidirectional. Asymmetry of traffic flow is common.
- Redundancy does not imply true diversity!
 - Fiber from different providers on the same pole are vulnerable to a car accident taking out the pole and both cables.
 - Transit from different providers could be reselling same upstreams or have shared-risk fiber routes, or both.

BGP Paths and Views

- Today, internet traffic/demand is strongly centralized to a common set of destination networks. What about the rest?
- Connectivity to a global uniform internet does not exist!
- Every network has different views of paths. Research has shown significant deviation. See [Huston's Desperately Seeking Default](#).
- Per cidr-report, ~60% of networks are only seen via one path!

BGP Traffic Engineering

- Network engineers need to strategically announce and filter BGP path views to best serve their customers.
 - Views may contain geographically distant but short AS paths.
 - Views may contain lossy paths due to congestion or fault.
 - Views may contain tromboning or looped paths.
 - Views may contain adversarial paths!

Advertising BGP Paths

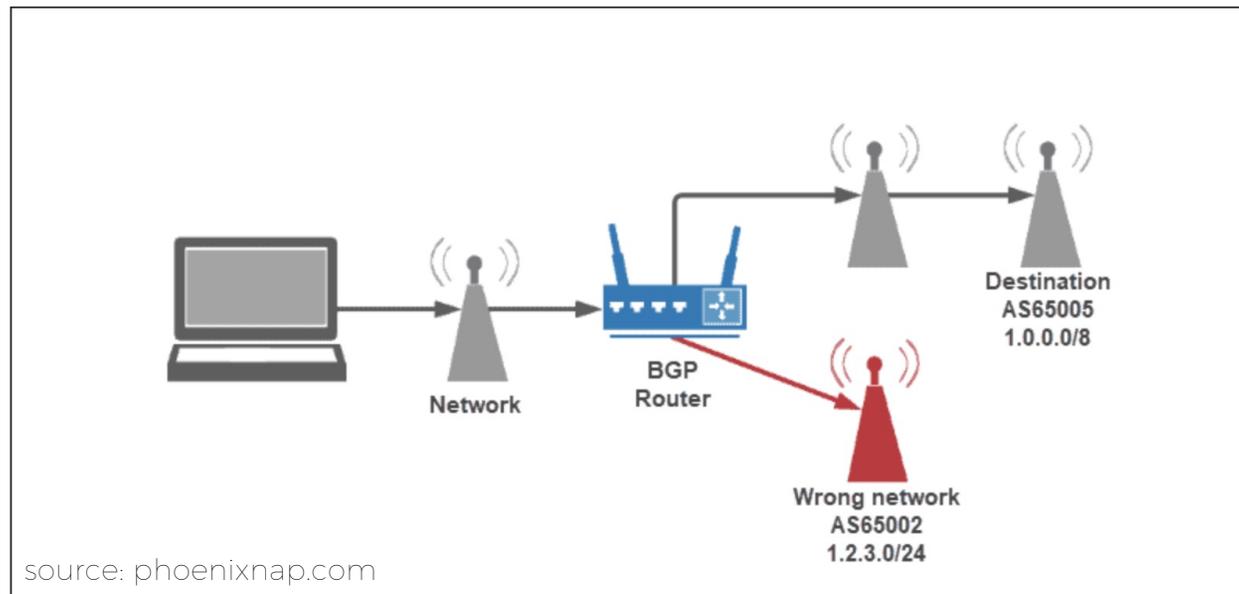
- Selective Announcement: Strategically manipulate reachability.
- Prefix Length (Specificity): Advertise more specifics to attract.
- AS Path Prepending: Artificially lengthen the path to disway.
- Communities (Tags): Attach signal to trigger actions by peers.
 - BLACKHOLE, GRACEFUL_SHUTDOWN, NO_EXPORT
 - Advertise/Don't advertise my prefix to specific networks

Receiving BGP Paths

- Filter against explicit lists and/or attributes:
 - Prefix, Path, and Communities
- Validate route origin ASN and path:
 - RPKI ROA & ASPA
- Verify source address is in table/matches ingress interface:
 - uRPF

Filtering and Validity of BGP Paths

- BGP Paths can be hijacked for either MTM or DoS attacks!



RPKI

- RPKI is a cryptographic framework for signing BGP prefixes with the originating AS number, maxLength, and recently upstreams.
 - The five RIRs act as the root Trust Anchors (aka CAs).
 - ROA records sign a prefix's origin ASN and maxLength.
 - ASPA records sign a ASN's upstream providers.
 - Routers validate if paths are RPKI valid, invalid, or unknown.

MANRS

- Mutually Agreed Norms for Routing Security (MANRS)
 - Filtering: Prevent propagation of incorrect routing info.
 - Anti-spoofing: Prevent traffic with spoofed source IPs.
 - Coordination: Maintain globally accessible contact info.
 - Global Validation: Facilitate validation of routing info.



Observability

Databases

- RIRs' IRRs: Who is who and what are they attesting to route?
- PeeringDB: What facilities networks are in, metadata, contacts.
- RIPEStat: Multitool for historical analysis and resource lookups.
- CAIDA's ASRank and Qrator.Radar: BGP relationships, events, and network size.

RPKI Observability

- NIST RPKI Monitor & CloudFlare's RPKI Portal: Global adoption statistics dashboard and interactive explorer to browse global ROAs and BGP announcements.
- Cloudflare's isbgpsafeyet.com: Test to check if your ISP is dropping RPKI Invalid routes.

Route Archives & Observability

- RouteViews & RIPE RIS: Collects and archives routing data.
- RIPE BGPlay: Visualize BGP route propagation and timing.
- Cloudflare's Radar: Internet trends and anomalies dashboard.
- Georgia Tech's GRIP: BGP Hijacks
- Georgia Tech's IODA: Internet Outages

Route Archives & Observability

- bgproutes.io: Aggregated route collecting databases together.
- bgp.potaroo.net / cidr-report.org: Research, stats, graphs!
- bgp.tools: Network metadata aggregator and route collection.
- kentik.com/blog: Doug Madory's analysis of large scale BGP events such as hijacks, leaks, and blackouts.

Measurement

- RIPE Atlas: Global network of distributed probes for active measurement
 - [Globaltracerooute.com](https://globaltracerooute.com) is a friendly frontend for RIPE Atlas.
- NLNOG Ring: Community of networks providing shell access to internal servers for debugging. Also communities
- [Waveform's](https://www.waveform.com/) Bufferbloat Test: Measure latency under load.

Reputation & Location Sources

- Akamai
- Proofpoint
- Spamhaus
- Team Cymru
- SPUR
- Geofeeds
 - geolocatemuch.com
 - geofeed-finder
- MaxMind



Let's Explore!

Who is networks.cs.ucdavis.edu?

```
medill:~ aatac$ dig +short networks.cs.ucdavis.edu
coe-cs-zea.cs.ucdavis.edu.
169.237.5.191
medill:~ aatac$ whois -h whois.cymru.com " -v 169.237.5.191"
AS      | IP      | BGP Prefix      | CC | Registry | Allocated | AS Name
6192    | 169.237.5.191 | 169.237.5.0/24  | US | arin      | 1995-08-04 | UCDAVIS-CORE - University of California, Davis, US
```

PeeringDB

**PeeringDB**[Advanced Search](#)[Legacy Search](#)[Register](#)[Login](#)

University of California at Davis

[EXPORT](#)

Organization	University of California at Davis
Also Known As	
Long Name	
Company Website	
ASN	6192
IRR as-set/route-set ?	
Route Server URL	
Looking Glass URL	
Network Types	
IPv4 Prefixes ?	
IPv6 Prefixes ?	
Traffic Levels ?	Not Disclosed
Traffic Ratios	Not Disclosed
Geographic Scope	Not Disclosed
Protocols Supported	<input type="radio"/> Unicast IPv4 <input type="radio"/> Multicast <input type="radio"/> IPv6 <input type="radio"/> Never via route servers
Last Updated	2022-07-27T05:33:24Z
Public Peering Info Updated	
Peering Facility Info Updated	
Contact Info Updated	
Notes ?	
RIR Status	ok
RIR Status Updated	2024-06-26T04:47:55Z
Logo ?	

Public Peering Exchange Points

Exchange AZ IPv4	ASN IPv6	Speed Port Location	RS Peer	BFD Support
No filter matches. You may filter by Exchange, ASN or Speed.				

Interconnection Facilities

Facility AZ ASN	Country City
No filter matches. You may filter by Facility, ASN, Country or City.	

ASRank

6192

search

AS number	6192				
AS name	UCDAVIS-CORE				
organization	University of California, Davis				
country	United States				
AS rank	12646				
customer cone	1 asn	6 prefix	229632 address		
AS degree	4 global	0 transit	4 provider	0 peer	0 customer
Spoofers <small>01/2025-01/2026</small>					
Tested IP Blocks	1	0			
Spoofing IP Blocks	0 (0.0%) IPv4 /24s	0 (0.0%) IPv6 /40s			

[see more spoofer data >](#)

[Correction](#)

AS Rank ▾	AS neighbors ▾	Organization		AS customer cone ▾	number of paths	relationship ▲
32	7018	AT&T Enterprises, LLC		2676	244	provider
332	2152	CENIC		151	75	provider
336	33667	Comcast Cable Communic...		148	56	provider
858	2153	CENIC		44	19	provider

ASRank

```
medill:~ aatac$ asnrel 6192  
provider: 7018  
provider: 2152  
provider: 33667  
provider: 2153
```

IRR

```
medill:~ aatac$ bgpq4 -4 AS6192 | egrep -v "no" | sed 's/.*permit //'
128.120.0.0/16
128.120.80.0/24
152.79.0.0/16
168.150.0.0/17
169.237.0.0/16
192.82.111.0/24
medill:~ aatac$ bgpq4 -6 AS6192 | egrep -v "no" | sed 's/.*permit //'
2001:468:e24::/48
2607:f810::/32
2607:f810:330::/44
2607:f810:f30::/44
```

Looking Glasses & Probes

```
medill:~ aatac$ lgripeinfo 169.237.5.191
```

Prefix	Peers	Upstream	Origin	AS-Len	Prepends
169.237.5.0/24	225	7018 (Unknown)	6192 (UCDavis)	4	0
169.237.5.0/24	82	7018 (Unknown)	6192 (UCDavis)	5	0
169.237.5.0/24	25	7018 (Unknown)	6192 (UCDavis)	3	0
169.237.5.0/24	6	7018 (Unknown)	6192 (UCDavis)	6	0
169.237.5.0/24	1	7018 (Unknown)	6192 (UCDavis)	2	0

Looking Glasses & Probes

```
medill:~ aatac$ lgripe 169.237.5.191
```

Prefix	AS Path	Communities
169.237.5.0/24	34854 1299 7018 6192	1299:25000 34854:3001
169.237.5.0/24	59919 9002 3356 7018 6192	9002:9002 9002:64615
169.237.5.0/24	202365 50673 174 7018 6192	174:21000 174:22013 50673:1000
169.237.5.0/24	7018 6192	7018:2000 7018:32112
169.237.5.0/24	50304 1299 7018 6192	
169.237.5.0/24	132825 174 7018 6192	
169.237.5.0/24	206499 34549 174 7018 6192	174:21000 174:22013 34549:100 34549:174
169.237.5.0/24	22652 1299 7018 6192	1299:431 1299:4000 1299:25000 1299:25300
169.237.5.0/24	55720 3491 7018 6192	
169.237.5.0/24	34927 56655 1299 7018 6192	1299:25000 56655:2100
169.237.5.0/24	44393 58057 6939 7018 6192	58057:65010
169.237.5.0/24	20205 1299 7018 6192	1299:25000
169.237.5.0/24	34549 174 7018 6192	174:21000 174:22013 34549:100 34549:174
169.237.5.0/24	216285 8280 6762 7018 6192	17152:1 6762:31 6762:10100 8280:3002
169.237.5.0/24	213241 9002 3356 7018 6192	

Looking Glasses & Probes



Global RIPE Atlas Network Coverage



Global Traceroute v2.6

Select Probe

Probe 1011307: CENIC (AS2152): Redding, California, US

Target type: Trace to user-entered target
 Trace to other probe
 My IP address

Target Address 169.237.5.191

Submit

Reset Filters

```
traceroute to 169.237.5.191 (169.237.5.191) 64 hops max, 76 byte packets
 1 10.233.64.1 (10.233.64.1) [AS???] 0.093 ms 0.028 ms 0.028 ms
 2 198.189.66.252 (198.189.66.252) [AS2152] 0.348 ms 0.319 ms 33.007 ms
 3 rive1-agg-01--fres1-agg-01--200g--01.cenic.net (137.164.11.105) [AS2152] 7.502 ms 7.221 ms 7.207 ms
 4 dc-lax-agg10--rive1-agg-01-800g--01.cenic.net (137.164.11.86) [AS2152] 7.537 ms 7.234 ms 7.244 ms
 5 * * *
 6 * * *
 7 192.205.37.41 (192.205.37.41) [AS7018] 17.302 ms 17.232 ms 17.375 ms
 8 32.130.91.80 (32.130.91.80) [AS7018] 17.983 ms
 *
 9 * * *
10 * * *
11 * * *
12 border-dav--transit1.ucdavis.edu (192.82.111.28) [AS6192] 13.948 ms 13.907 ms 13.862 ms
13 transit1--net4-cdf1.ucdavis.edu (128.120.0.32) [AS6192] 14.281 ms 14.256 ms 14.153 ms
14 * * *
15 * * *
16 * * *
17 * * *
18 * * *
255 * * *
```

Source address is: 198.189.66.253

Looking Glasses & Probes

bgproutes.io IP Prefix Explorer
Start peering with us! Quick setup - public data
Doc

Search in results... 636 entries loaded

#	Vantage Point	Prefix	AS Path	Community
0	ID4 AS39122 IP195.66.226.97 BLACKNIGHT	169.237.5.0/24	39122 1299 7018 6192	1299:431 1299:4000 1299:25000 1299:25100
1	ID13 AS2914 IP195.66.224.138 NTT-DATA	169.237.5.0/24	2914 7018 6192	2914:420 2914:1001 2914:2000 2914:3000
2	ID15 AS3178 IP195.66.227.195 VELOXSERV	169.237.5.0/24	3170 174 7018 6192	174:21000 174:22013 60946:0
3	ID16 AS271253 IP195.66.231.56	169.237.5.0/24	271253 6453 7018 6192	
4	ID25 AS15562 IP165.254.255.2 SNICIDERS	169.237.5.0/24	15562 2914 7018 6192	2914:420 2914:1009 2914:2000 2914:3000
6	ID35 AS287841 IP195.66.227.233 TNFRN0	169.237.5.0/24	207841 61049 3257 7018 6192	3257:10059 3257:30148 3257:50002 3257:51100 3257:51101
6	ID38 AS3491 IP195.66.224.167 CONSOLE-C	169.237.5.0/24	3491 7018 6192	3491:1000 3491:1001 3491:9002 3491:9080 3491:9081 3491:9087
7	ID43 AS35266 IPS.57.81.216 EXBI-AS	169.237.5.0/24	35268 2914 7018 6192	2914:420 2914:1001 2914:2000 2914:3000 35266:80 35266:2914
8	ID44 AS58857 IP194.50.92.251 SECUREBIT	169.237.5.0/24	58057 34549 174 7018 6192	0:34927 0:66382 0:58299 174:21000 174:22013 34549:100 34549:174
9	ID48 AS42473 IP195.66.226.113 AS-ANEXIA	169.237.5.0/24	42473 1299 7018 6192	1299:25000 47147:1502 47147:2000 47147:2112 47147:2300 47147:2416 47147:2600
10	ID49 AS2914 IP157.238.224.285 NTT Amer1	169.237.5.0/24	204092 30781 3356 7018 6192	3356:3 3356:22 3356:86 3356:575 3356:668 3356:903 3356:2011 30781:22003 30781:31000 30781:31010 64496:100
11	ID53 AS34927 IP195.66.227.185 IFog-GmbH	169.237.5.0/24	34927 1299 7018 6192	34927:810
12	ID54 AS17639 IP282.69.166.152 CONVERGE-	169.237.5.0/24	17639 3401 7018 6192	
13	ID58 AS286499 IP45.14.68.69 LOCIX	169.237.5.0/24	286499 34549 174 7018 6192	174:21000 174:22013 34549:100 34549:174
14	ID68 AS62167 IP195.66.225.48 Tlsn1	169.237.5.0/24	62167 3356 7018 6192	
16	ID65 AS917 IPS.57.81.231 MISAKA	169.237.5.0/24	917 60068 174 7018 6192	174:21000 174:22013 917:56020 57695:13000 60068:203 60068:2000 60068:2010 60068:7040
16	ID68 AS29584 IP185.193.84.191 LBCTFREE	169.237.5.0/24	29584 15936 174 7018 6192	174:21000 174:22013 15936:200 15936:202
17	ID73 AS59919 IPS.178.95.294 BRAINBOX	169.237.5.0/24	59919 9002 3356 7018 6192	9002:9002 9002:84616
18	ID77 AS12969 IP195.66.226.232 Vodafone	169.237.5.0/24	12969 1299 7018 6192	1299:431 1299:4000 1299:25000 1299:25100 12969:30 12969:32 12969:1299 12969:30208
19	ID88 AS38801 IP282.159.221.37 NEWMEDIAE	169.237.5.0/24	38801 3491 7018 6192	

All prefixes (1)

169.237.5.0/24

Prefix visibility

Count per origin AS

AS-path length distribution

For hops 1-6 and >6

Top 5 second-hop AS numbers

Prepended AS numbers omitted

Top 5 third-hop AS numbers

Prepended AS numbers omitted

Filters

Prefix (up to 10, v4 or v6)

169.237.5.0/24

Search Reset filters

Full-feeders VPs only On

Date (UTC): Default is now-5min

01/26/2026, 04:51:33 PM

Prefix match type

Exact

Collection of format

All

bgproutes.io

RIPE RIS

PCH

RouteViews

CGTF RIS

e.g., FR_DE

VPs' BMP parent ASNs (BMP only)

e.g., 205755,3356

What to show

Existing and missing entries

AS path regexp

e.g., 3333S

Community regexp

e.g., *65000.* or 3356:666S

Looking Glasses & Probes

Prefix [^] 169.237.5.0/24 [Open prefix explorer](#) Visibility [!] 52.29% [VPs](#) [History](#) Expected origin ⁻ AS6192 UNIVERSITY OF CALIFORNIA, DAVIS Geolocation ⁻ US RPKI status ⁻ Unknown

Routing Status ⁱ [↔]

🕒 At **2026-01-26 08:00:00 UTC**, **169.237.5.0/24** was **100%** visible (by 320 of 320 RIS full peers).

🕒 First ever seen announced by AS6192, on **2026-01-23 08:00:00 UTC**.

Originated by:

AS6192 - RPKI Status: - Route object: **RADB**

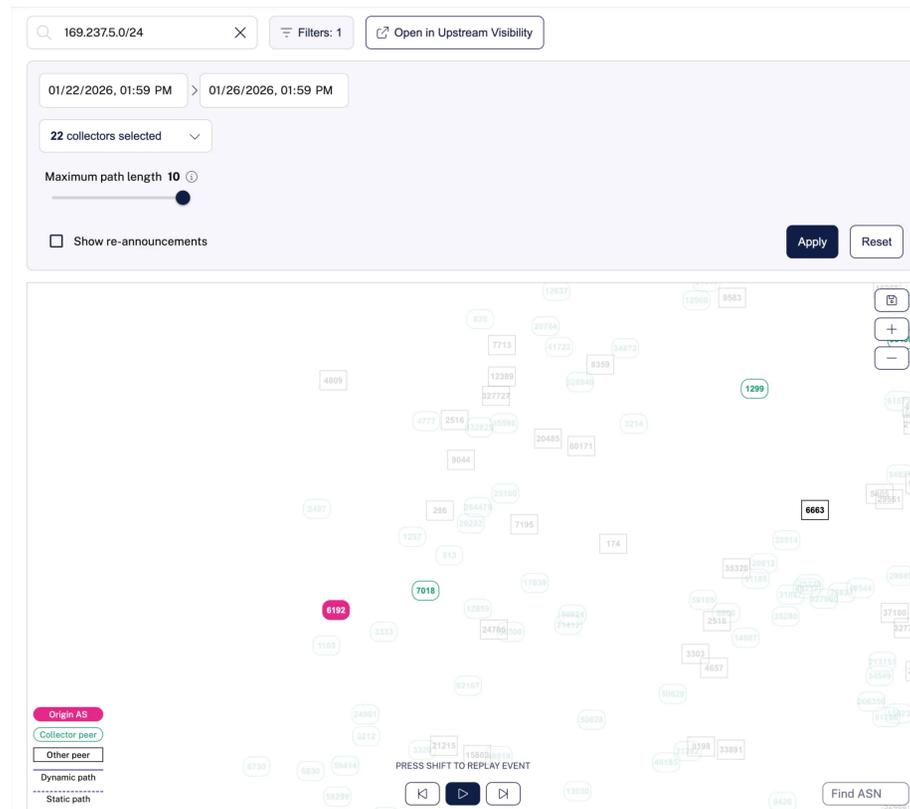
Covering less-specific prefix: 169.237.0.0/16 (announced by AS6192)

▶ Advanced Settings

Showing results for 169.237.5.0/24 as of 2026-01-26 08:00:00 UTC

🕒 Results exclude routes with very low visibility (less than 10 RIS full-feed peers seeing).

Looking Glasses & Probes



Looking Glasses & Probes

Network Degradation

Subscribe

Investigating - UC Davis network is currently experiencing a degradation due to bandwidth constraints.

The NOC is attempting to engineer traffic flows to balance the load across multiple ISPs to stabilize.

IT Express Service Desk

ithelp@ucdavis.edu

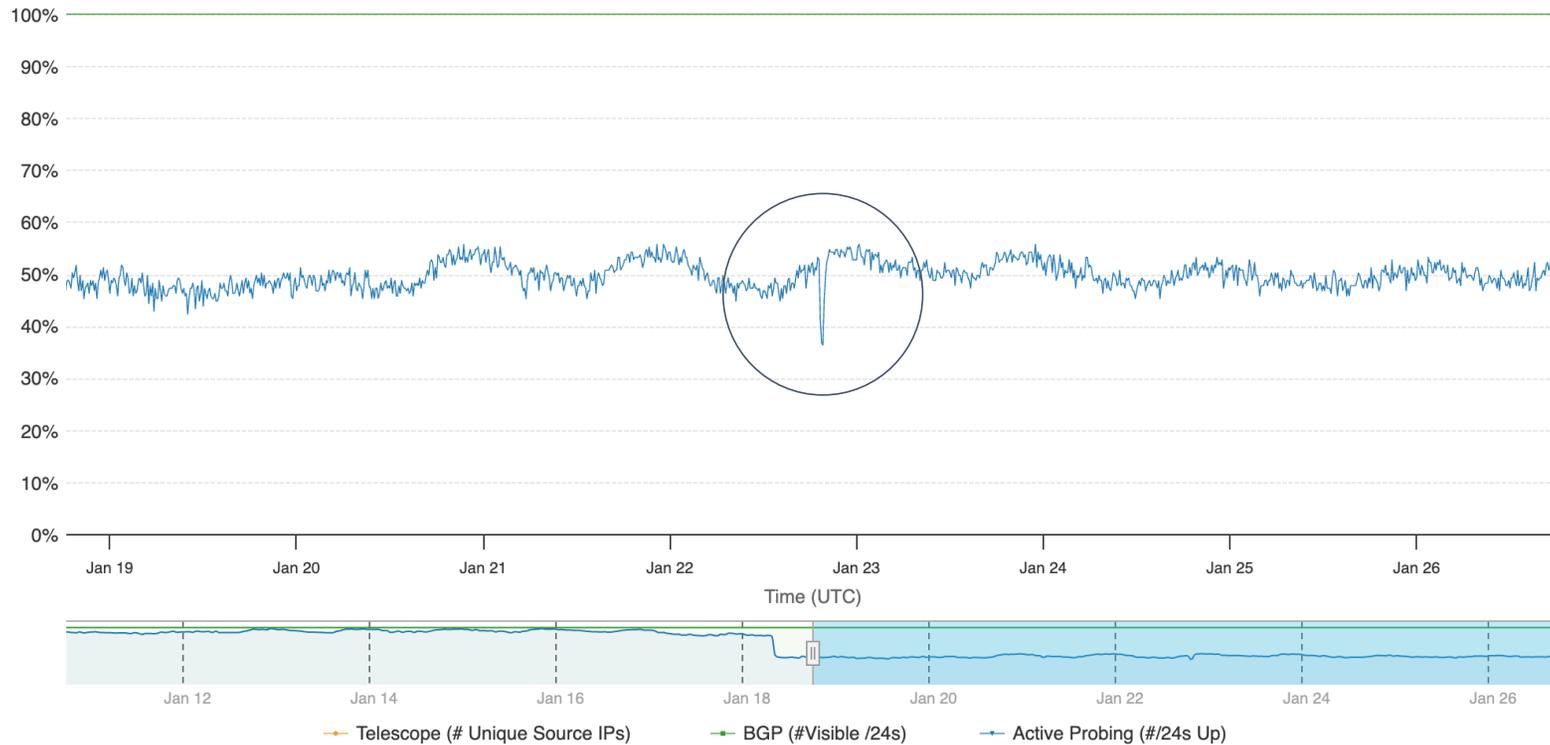
530.754.HELP (4357)

Jan 22, 2026 - 11:11 PST

Looking Glasses & Probes

Internet Connectivity for AS6192 (UCDAVIS-CORE)

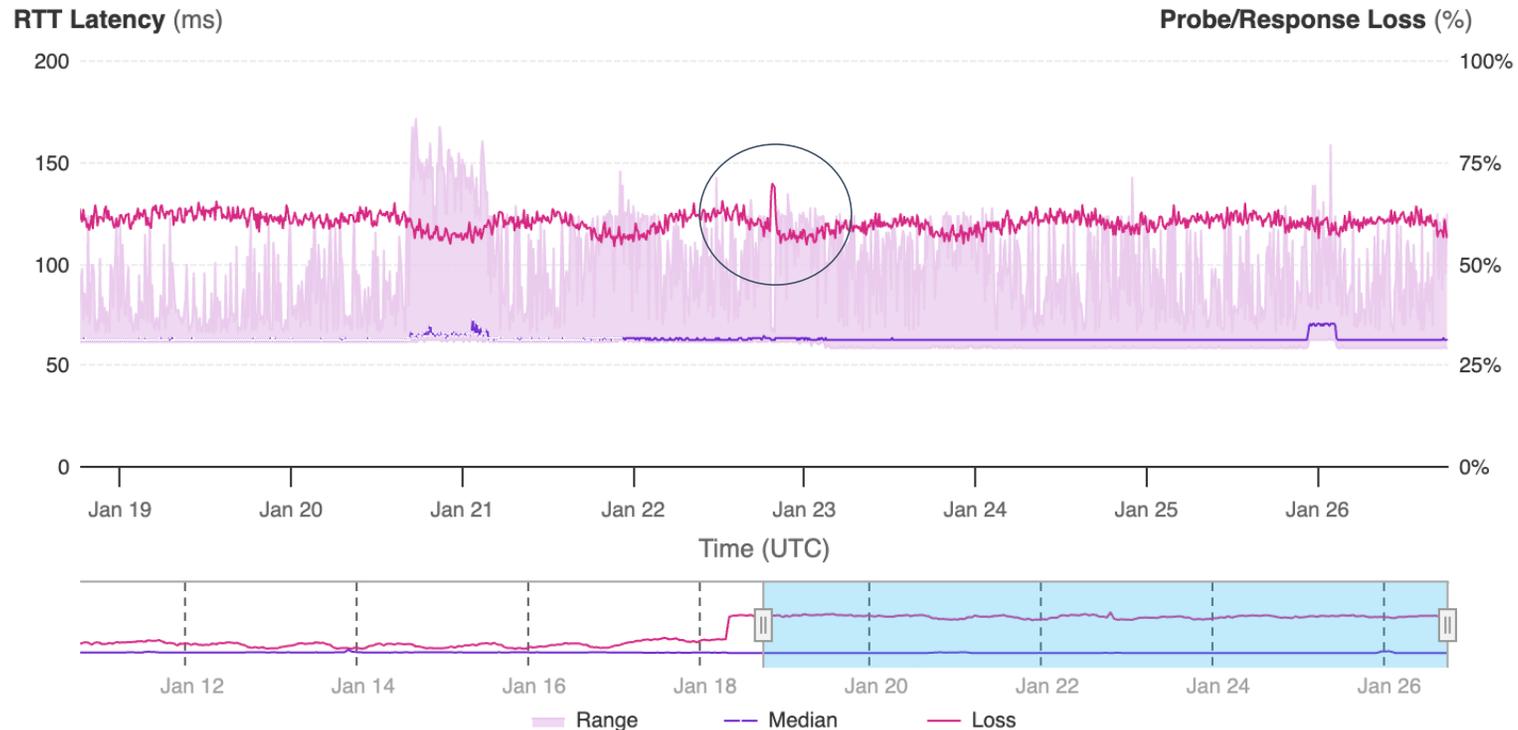
January 18, 2026 6:23pm - January 26, 2026 6:23pm UTC



Looking Glasses & Probes

Active Probing Details for AS6192 (UCDAVIS-CORE)

January 18, 2026 6:23pm - January 26, 2026 6:23pm UTC



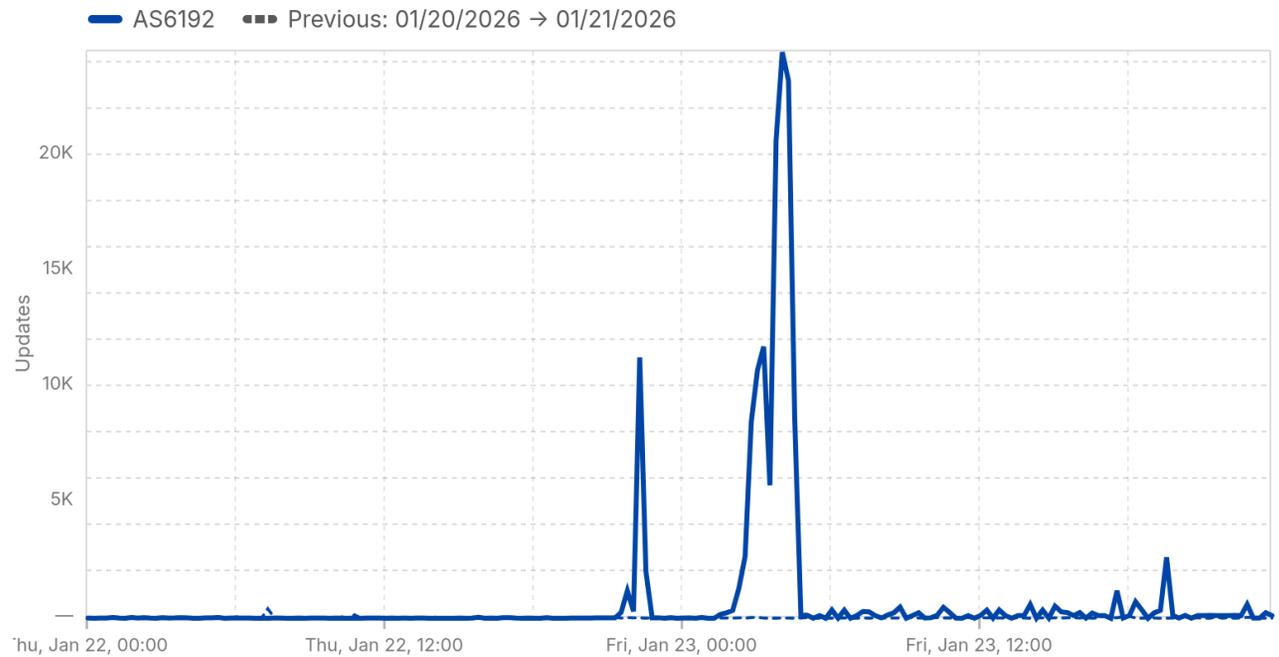
Looking Glasses & Probes

```
medill:~ aatac$ bgpdump -M /Users/aatac/Downloads/bview.20260123.0800.gz | grep 169.237.5.0/24
2026-01-26 11:23:00 [info] logging to syslog
TABLE_DUMP2|01/23/26 08:00:00|B|80.77.16.114|34549|169.237.5.0/24|34549 174 7018 6192|IGP
TABLE_DUMP2|01/23/26 08:00:00|B|165.16.221.66|37721|169.237.5.0/24|37721 5511 7018 6192|IGP
TABLE_DUMP2|01/23/26 08:00:00|B|193.33.94.251|58057|169.237.5.0/24|58057 174 7018 6192|IGP
TABLE_DUMP2|01/23/26 08:00:00|B|195.128.231.254|49432|169.237.5.0/24|49432 48362 1299 7018 6192|IGP
TABLE_DUMP2|01/23/26 08:00:00|B|202.150.221.37|38001|169.237.5.0/24|38001 3491 7018 6192|IGP
TABLE_DUMP2|01/23/26 08:00:00|B|5.255.90.109|202365|169.237.5.0/24|202365 50673 174 7018 6192|IGP
TABLE_DUMP2|01/23/26 08:00:00|B|45.61.0.85|22652|169.237.5.0/24|22652 1299 7018 6192|IGP
TABLE_DUMP2|01/23/26 08:00:00|B|49.12.70.222|44393|169.237.5.0/24|44393 394256 174 7018 6192|IGP
TABLE_DUMP2|01/23/26 08:00:00|B|89.234.186.6|204092|169.237.5.0/24|204092 30781 3356 7018 6192|IGP
TABLE_DUMP2|01/23/26 08:00:00|B|165.254.255.2|15562|169.237.5.0/24|15562 2914 7018 6192|IGP
TABLE_DUMP2|01/23/26 08:00:00|B|193.163.86.231|34800|169.237.5.0/24|34800 58057 50673 174 7018 6192|IGP
TABLE_DUMP2|01/23/26 08:00:00|B|103.212.68.10|55720|169.237.5.0/24|55720 2914 7018 6192|IGP
TABLE_DUMP2|01/23/26 08:00:00|B|178.208.11.4|50628|169.237.5.0/24|50628 1299 7018 6192|IGP
```

Looking Glasses & Probes

BGP time series for AS6192

BGP updates over time

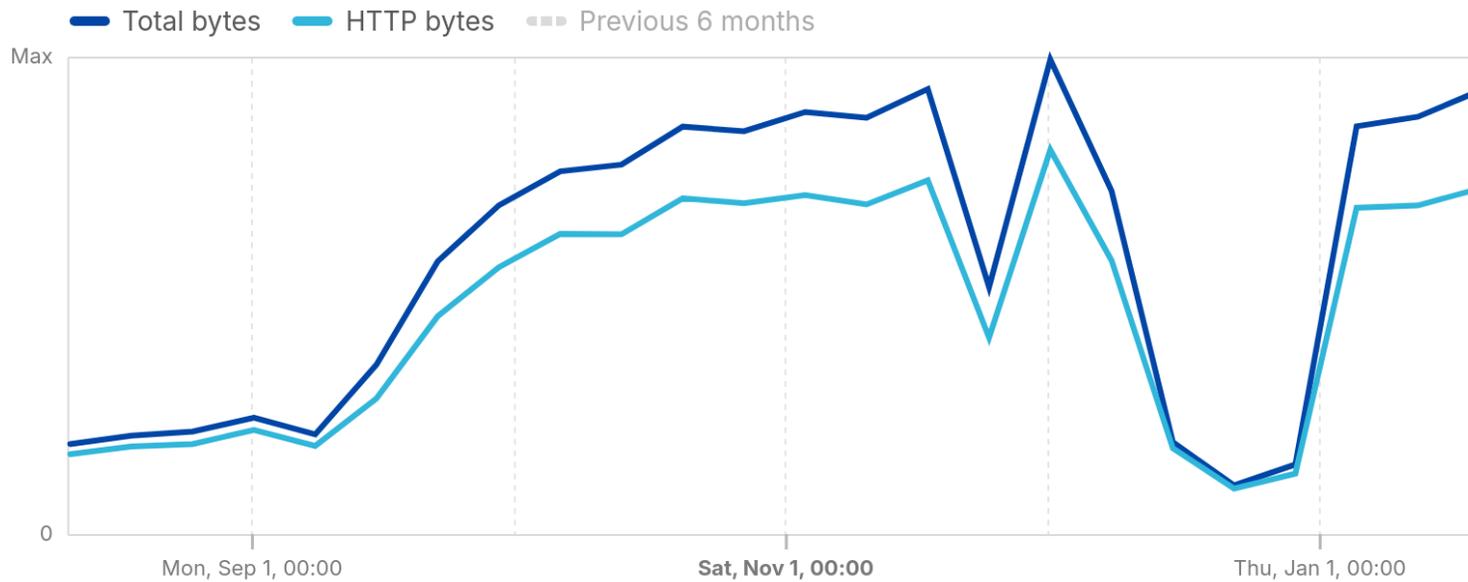


Looking Glasses & Probes

Traffic trends from AS6192

UCDAVIS-CORE — University of California at Davis

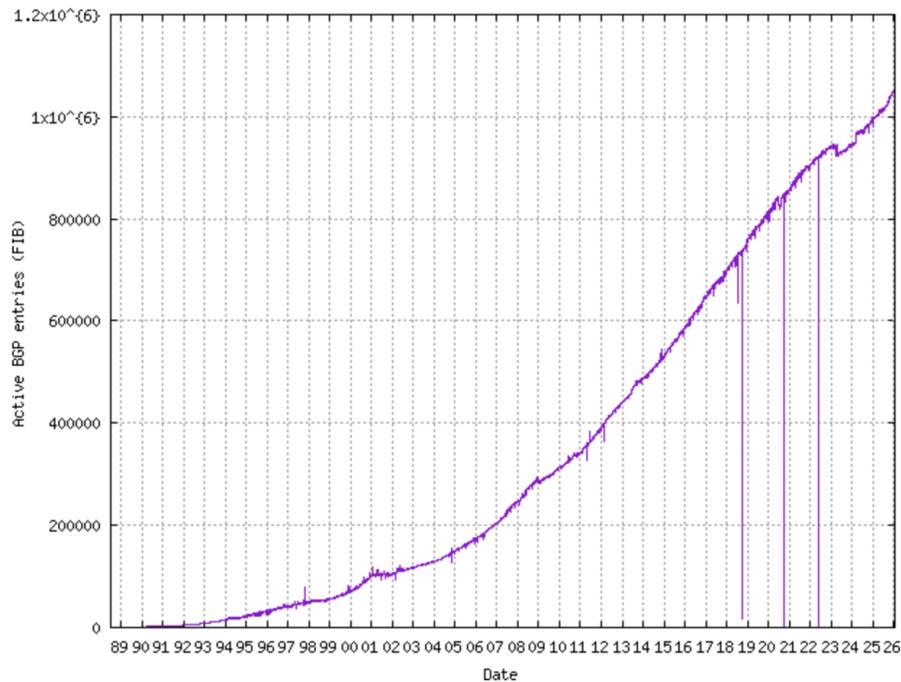
Bytes transferred over the selected time period



Looking Glasses & Probes

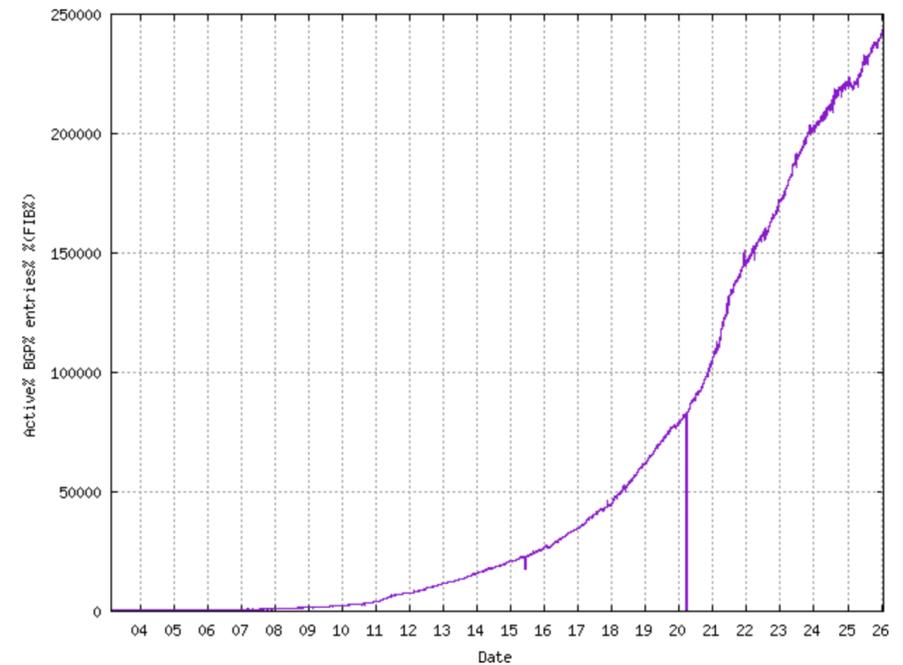
<https://www.cidr-report.org/cgi-bin/plota?fi>

Active BGP entries (FIB)

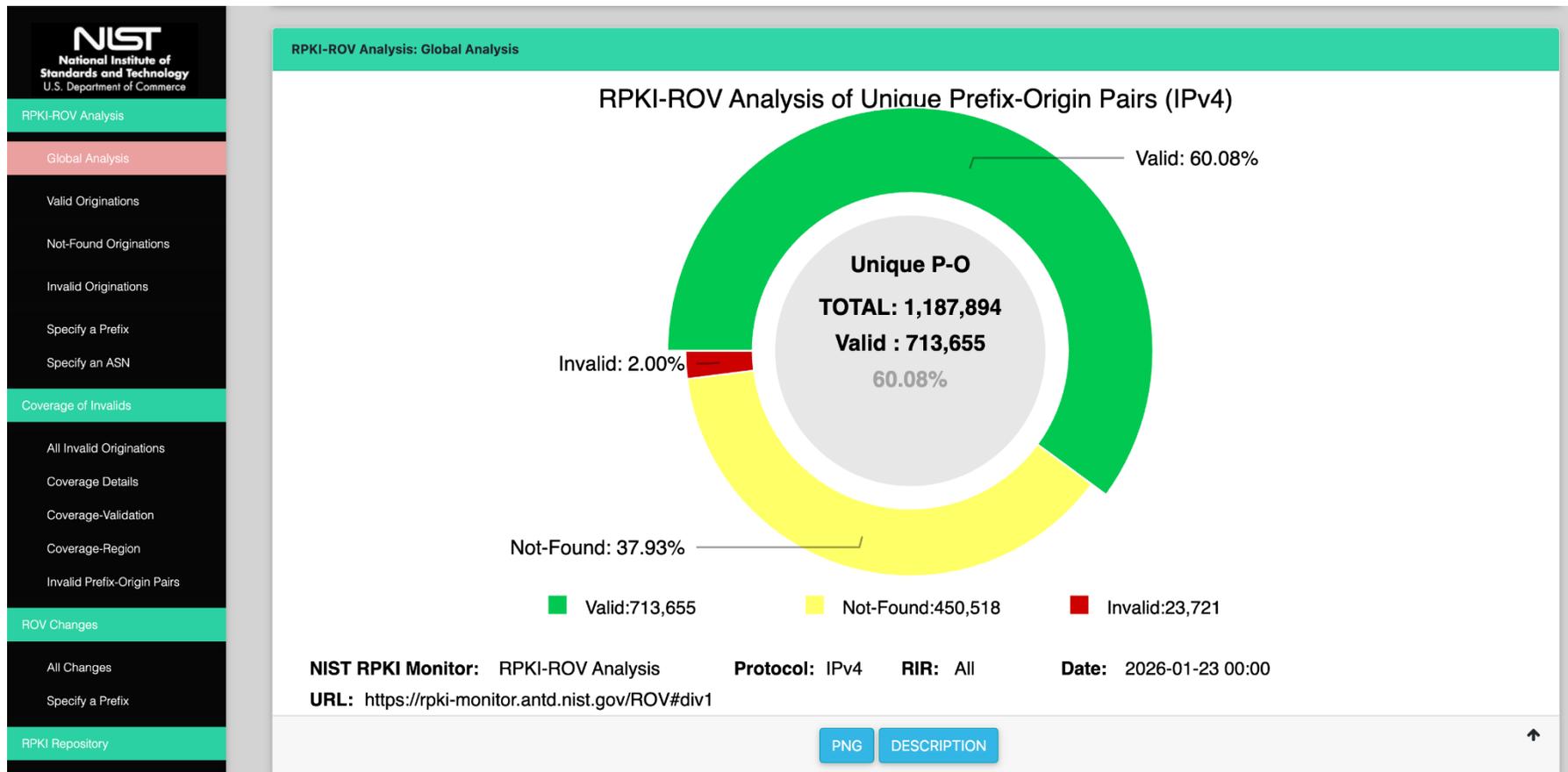


<https://www.cidr-report.org/cgi-bin/plota?file=>

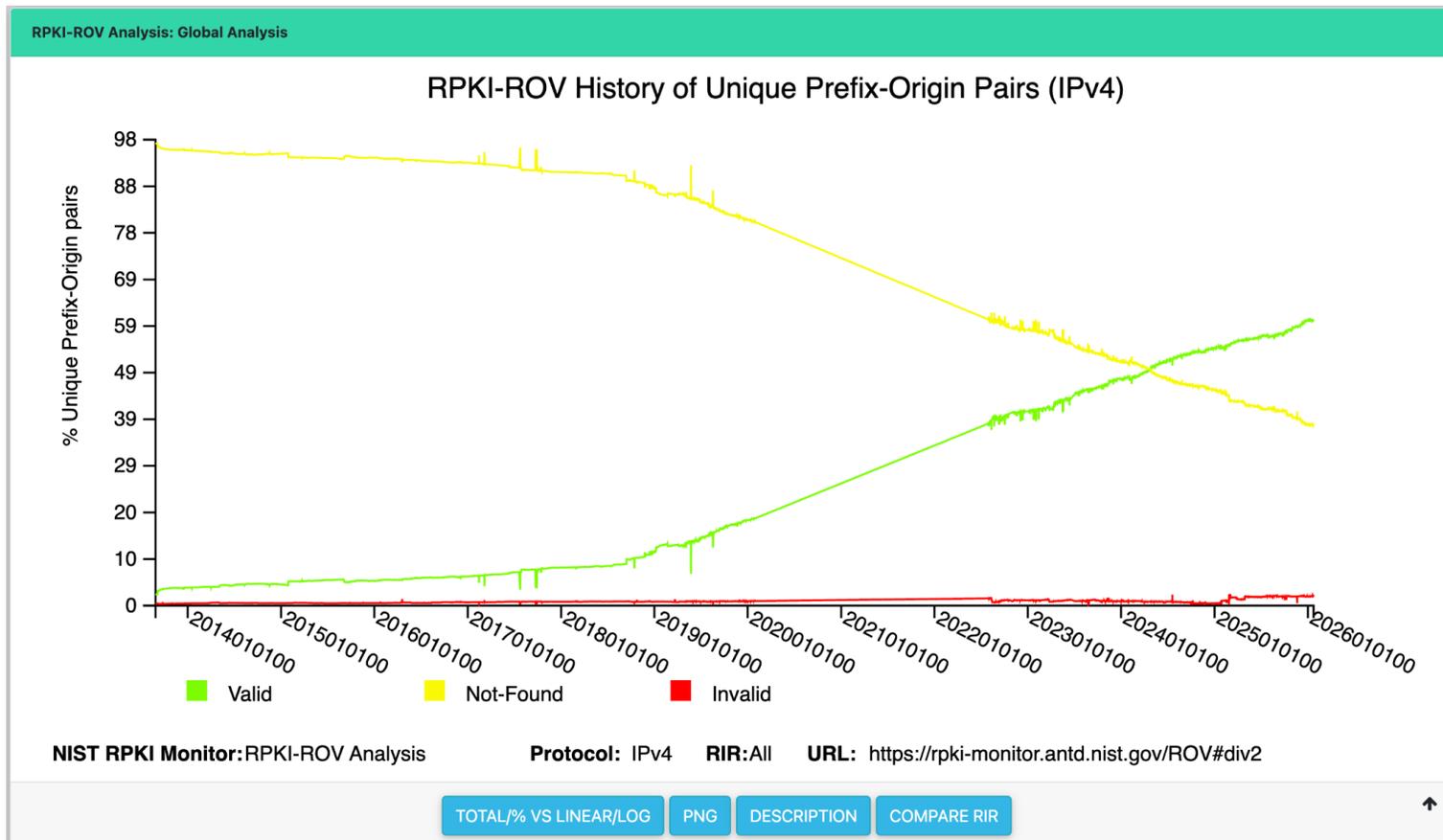
Active% BGP% entries% %(FIB%)



RPKI Observability



RPKI Observability



RPKI Observability

NIST
National Institute of Standards and Technology
U.S. Department of Commerce

NIST RPKI Monitor
Version: 2.0 Last Update : 2026-01-26 00:00 [Feedback](#)

Autonomous System Number: 6192 Address Family: All Region: all Date: 2026-01-26 00:00

Origin AS	PREFIX	TIME	VALIDATION	ROA's Prefix	ROA's C
6192	128.120.137.0/24	2026-01-26 00:00	Not-Found		
6192	128.120.210.0/24	2026-01-26 00:00	Not-Found		
6192	169.237.28.0/23	2026-01-26 00:00	Not-Found		
6192	128.120.229.0/24	2026-01-26 00:00	Not-Found		
6192	128.120.228.0/24	2026-01-26 00:00	Not-Found		
6192	128.120.215.0/24	2026-01-26 00:00	Not-Found		
6192	2607:f810:f30::/44	2026-01-26 00:00	Not-Found		

6192	169.237.5.0/24	2026-01-26 00:00	Not-Found		
------	----------------	------------------	-----------	--	--

RPKI Observability



NIST RPKI Monitor

Version: 2.0 Last Update : 2026-01-26 00:00 [Feedback](#)

Autonomous System Number: 2152 Address Family: All Region: all Da

Origin AS	PREFIX	TIME	VALIDATION	ROA's Prefix
2152	137.145.232.0/23	2026-01-26 00:00	Not-Found	
2152	198.189.70.0/24	2026-01-26 00:00	Not-Found	
2152	207.233.42.0/24	2026-01-26 00:00	Not-Found	
2152	209.129.196.0/24	2026-01-26 00:00	Not-Found	
2152	2607:f380:80f::/48	2026-01-26 00:00	Not-Found	
2152	198.188.11.0/24	2026-01-26 00:00	Not-Found	

- RPKI-ROV Analysis
- Global Analysis
- Valid Originations
- Not-Found Originations
- Invalid Originations
- Specify a Prefix
- Specify an ASN
- Coverage of Invalids
 - All Invalid Originations
 - Coverage Details
 - Coverage-Validation
 - Coverage-Region
 - Invalid Prefix-Origin Pairs

RPKI Observability



NIST RPKI Monitor

Version: 2.0 Last Update : 2026-01-23 00:00 [Feedback](#)

Announcements: [Welcome to version 2 of the RPKI Monitor](#) Reports: [Spike in RPKI-ROV state changes seen on 2024-07-16 12:00](#)

Coverage of Invalids: Invalid Prefix-Origin Pairs Date: Hour: RIR: Validation: Protocol: Origin AS:

Prefix	Origin AS	Region	Validation	Path Count	Covered (Click YES for details)
203.143.68.0/24	10105	APNIC	INVALID:ML	19	<input type="button" value="YES"/>
201.234.187.0/24	10753	LACNIC	INVALID:AS	1	<input type="button" value="YES"/>
69.76.16.0/21	10838	ARIN	INVALID:AS	27	<input type="button" value="YES"/>
148.56.105.0/24	12357	ARIN	INVALID:AS	1	<input type="button" value="YES"/>
148.56.55.0/24	12357	ARIN	INVALID:AS	1	<input type="button" value="YES"/>

RPKI-ROV Analysis

Global Analysis

Valid Originations

Not-Found Originations

Invalid Originations

Specify a Prefix

Specify an ASN

Coverage of Invalids

All Invalid Originations

Coverage Details

Coverage-Validation

Coverage-Region

Invalid Prefix-Origin Pairs

ROV Changes

All Changes

Specify a Prefix

RPKI Repository

RPKI Observability

Is BGP **safe** yet? *No.*

Border Gateway Protocol (BGP) is the postal service of the Internet. It's responsible for looking at all of the available paths that data could travel and picking the best route.

Unfortunately, it isn't secure, and there have been some [major Internet disruptions](#) as a result. But fortunately there is a way to make it secure.

ISPs and other major Internet players (Sprint and others) would need to implement a certification system, called [RPKI](#).

Test your ISP

Read FAQ

SUCCESS

Your ISP (Comcast, AS7922) implements BGP safely. It correctly drops invalid prefixes.

▼ Details

```
fetch https://valid.rpki.isbgpsafeyet.com
```

✓ correctly accepted valid prefixes

```
fetch https://invalid.rpki.isbgpsafeyet.com
```

✓ correctly rejected invalid prefixes

RPKI Observability

```
[medill:~ aatac$ dig +short valid.rpki.isbgpsafeyet.com  
valid.rpki.cloudflare.com.  
104.17.231.6  
104.17.230.6
```

```
[medill:~ aatac$ dig +short invalid.rpki.isbgpsafeyet.com  
invalid.rpki.cloudflare.com.  
103.21.244.8  
103.21.244.9
```

RPKI Observability

Comcast

↓ EXPORT

Organization	Comcast Cable Communications, LLC
Also Known As	Comcast Backbone - 7922
Long Name	
Company Website	https://corporate.comcast.com/
ASN	7922
IRR as-set/route-set ?	RADB::AS-COMCAST-IBONE
Route Server URL	ssh://rviewsxr@route-server.newyork.ny.ibone.comcast.net

RPKI Observability

```
Login with username: rviewsxr

Location:   New York City
Network:   Comcast Route Server
*****

rviewsxr@route-server.newyork.ny.ibone.comcast.net's password:

RP/0/RSP0/CPU0:route-server.newyork.ny.ibone#sh ip bgp 104.17.231.6
Fri Jan 23 15:34:18.245 utc
BGP routing table entry for 104.17.224.0/20
Versions:
  Process          bRIB/RIB  SendTblVer
  Speaker          321970030 321970030
Last Modified: May 10 16:23:57.588 for 36w5d
Paths: (1 available, best #1)
  Not advertised to any peer
  Path #1: Received by speaker 0
  Not advertised to any peer
  13335, (aggregated by 13335 10.34.2.204), (received & used)
    66.208.229.9 from 66.208.229.9 (96.109.22.243)
      Origin IGP, metric 0, localpref 300, valid, internal, best, group-best
      Received Path ID 0, Local Path ID 0, version 321970030
      Community: 7922:403 7922:888 7922:2900
      Originator: 96.109.22.243, Cluster list: 96.109.22.250, 96.109.22.50
RP/0/RSP0/CPU0:route-server.newyork.ny.ibone#sh ip bgp 103.21.244.8
Fri Jan 23 15:34:25.589 utc
% Network not in table
```

RPKI Observability



PeeringDB

Search here for a network, IX, or facility.

[Advanced Search](#)

CENIC / CalREN AS2152

↓ EXPORT

Organization	CENIC / CalREN
Also Known As	CalREN-DC (Digital California)
Long Name	Corporation for Education Network Initiatives in California
Company Website	https://cenic.org
ASN	2152
IRR as-set/route-set ?	AS-CALRENDC
Route Server URL	telnet://route-views2.routeviews.org
Looking Glass URL	https://bgp.tools/lg/2152

RPKI Observability

CENIC - CaIREN

AS Number 2152

BGP

Select BGP Session to query:

All Sessions

Input Prefix:

103.21.244.8

Query

```
103.21.244.0/24      unicast [Los Angeles 0000-00-00] * (?/-) [AS13335]
Type: BGP
BGP.as_path: 2152 13335
BGP.community: [AS2152: Originally learned via a commodity peer] [AS2152: Originally
learned in LAX]
BGP.large_community: (13335, 10000012, 0)
unicast [Sunnyvale 0000-00-00] * (?/-) [AS13335]
Type: BGP
BGP.as_path: 2152 13335
BGP.community: [AS2152: Originally learned via a commodity peer] [AS2152: Originally
learned in SVL]
BGP.large_community: (13335, 10000004, 0)
```

RPKI Observability

Global Traceroute v2.6

IP Version: IPv4
 IPv6

Filters:
Country:
State/Region:
City:
ASN:

Select Probe

Target type: Trace to user-entered target
 Trace to other probe
 My IP address

Target Address:

```
traceroute to 103.21.244.8 (103.21.244.8) 64 hops max, 76 byte packets
 1 10.233.64.1 (10.233.64.1) [AS???] 0.095 ms 0.031 ms 0.022 ms
 2 198.189.66.252 (198.189.66.252) [AS2152] 0.498 ms 0.446 ms 0.224 ms
 3 rive1-agg-01--fres1-agg-01--200g--01.cenic.net (137.164.11.105) [AS2152] 7.333 ms 7.292 ms 7.322 ms
 4 dc-lax-agg10--rive1-agg-01-800g--01.cenic.net (137.164.11.86) [AS2152] 7.317 ms 7.29 ms 7.501 ms
 5 losa4-agg-01--lax-agg10--400g--01.cenic.net (137.164.11.111) [AS2152] 7.3 ms 7.203 ms 7.308 ms
 6 * * *
 7 141.101.72.21 (141.101.72.21) [AS13335] 8.639 ms 8.667 ms 8.098 ms
 8 103.21.244.8 (103.21.244.8) [AS13335] 7.706 ms 7.764 ms 7.734 ms
```

Source address is: 198.189.66.253

Reputation & Location



Client Reputation Overview

Client Reputation provides information to our customers regarding the reputation of IP Addresses to better protect their applications against DDoS and application layer attacks. IP Addresses fall into one of the following malicious categories: web attackers, Denial of Service, and Malware.

Client Reputation leverages advanced algorithms to compute a risk score based on past behavior. It assigns risk scores to each IP Address and allows customers to choose which actions to take based on those scores.

Information that users provide via the Client Reputation Investigation Request shall be used for the purpose of this service.

Results

The IP Address 75.102.246.210 did not receive a bad risk score.

Reputation & Location

proofpoint.

[Platform](#)

[Solutions](#)

[Why Proofpoint](#)

[Resources](#)

[Company](#)

Dynamic Reputation IP Lookup

Not Blocked

This IP address is not blocked.

Reputation & Location



Threat Analysis & IP Context for 75.102.246.211

75.102.246.211 itself does not appear to be part of anonymization infrastructure.

Observed risks Unknown

ASN [20130](#)

Registered to Depaul University

Exit Location  Chicago, Illinois, US

Unknown

Infrastructure type

Not

Anonymous

N/A

Average devices count

Reputation & Location

Geolocate much?

RFC9092/RFC9632 gives to the network operator the power to control the geolocation of its IP resources.

It works by linking geofeed files in whois. This allows geolocation databases and content providers to automatically discover the geofeed files and to import them from a format they are already familiar with. It can be used to set the geolocation of entire prefixes or specific IPs.

It works by simply editing a text file. No need to open tickets or send emails.

At the moment there are **575131** prefixes with geofeeds.

[READ MORE](#)

[TEST YOUR GEOFEED](#)

Adoption

Name	File format	Auto-discovery v4	Auto-discovery v6	Reactivity	Share
Fastah	✓	✓	✓	1 day	Twitter
IPInfo.io	✓	✓	✓	1 day	Twitter
IPData.co	✓	✓	✓	2 days	Twitter
IPGeolocation.io	✓	✓	✓	2 days	Twitter
ipapi.co	✓	✓	✓	2 days	Twitter
IPRegistry.co	✓	✓	✓	3 days	Twitter
BigDataCloud	✓	✓	✓	4 days	Twitter
apiip	✓	✓	✓	4 days	Twitter
db-ip	✓	✓	✓	9 days	Twitter
IPWhois	✓	✓	✓	10 days	Twitter
MaxMind	✓	✓	✓	15 days	Twitter
WhoisXMLAPI	✓	?	?	N/A	Twitter
IP2Location	✓	✗	✗	N/A	Twitter
IPStack.com	?	✗	✗	N/A	Twitter

Rows per page: 100 1-14 of 14 < >

[Report wrong data](#) | [Add my provider to the list](#)

Last update: 2026-01-26

Reputation & Location

```
# whois.arin.net
```

```
NetRange:      23.246.0.0 - 23.246.63.255
```

```
CIDR:          23.246.0.0/18
```

```
NetName:       NETFLIX-SS-3
```

```
NetHandle:     NET-23-246-0-0-1
```

```
Parent:        NET23 (NET-23-0-0-0-0)
```

```
NetType:       Direct Allocation
```

```
OriginAS:
```

```
Organization:  Netflix Streaming Services Inc. (SS-144)
```

```
RegDate:       2013-10-30
```

```
Updated:       2023-08-21
```

```
Comment:       Geofeed https://raw.githubusercontent.com/Netflix/nflx-geofeed/main/geofeed.csv
```

```
Ref:           https://rdap.arin.net/registry/ip/23.246.0.0
```

Reputation & Location

```
# Netflix Geofeed
# This feed is encoded in RFC 8805 format.
#
# This data feed provides approximate geo locations for a subset of
# Netflix IP space and the data included in this feed may be used only
# for improving the accuracy of Geo:IP lookups.
#
23.246.2.0/23,US,US-TX,Dallas-Fort Worth,
23.246.4.0/23,US,US-CA,Sacramento,
23.246.6.0/23,US,US-NY,New York,
23.246.10.0/23,US,US-CO,Denver,
23.246.12.0/23,US,US-TX,Houston,
23.246.14.0/23,US,US-CA,Los Angeles,
23.246.16.0/23,US,US-MA,Boston,
23.246.18.0/23,US,US-VA,Richmond,
23.246.20.0/23,BR,BR-RS,Porto Alegre,
23.246.26.0/23,SE,SE-AB,Stockholm,
23.246.30.0/23,US,US-NJ,Newark,
23.246.36.0/23,US,US-IL,Chicago,
23.246.38.0/23,US,US-AZ,Phoenix,
23.246.40.0/24,US,US-IL,Chicago,
23.246.41.0/24,US,US-MO,St Louis,
23.246.42.0/24,US,US-MO,Kansas City,
23.246.43.0/24,US,US-IL,Chicago,
23.246.44.0/23,US,US-MN,Minneapolis,
23.246.46.0/23,JP,JP-12,Tokyo,
23.246.48.0/23,ES,ES-MD,Madrid,
23.246.50.0/23,IT,IT-25,Milan,
23.246.54.0/23,SG,SG-02,Singapore,
23.246.56.0/23,HK,,Hong Kong,
23.246.58.0/23,US,US-CA,San Jose,
```

Reputation & Location



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Sign In  

GeoIP web services demo **GeoIP databases demo** Locate my IP address

Enter up to 25 IP addresses separated by spaces or commas

169.237.5.191
198.189.66.253
75.102.246.211

View results

IP Address	Location	Network	Postal Code	Approximate Latitude / Longitude*, and Accuracy Radius	ISP / Organization	Domain	Connecti Type
169.237.5.191	Sacramento, California, United States (US), North America	169.237.4.0/22	95819	38.5639, -121.4418 (20 km)	University of California, Davis	ucdavis.edu	Cable/DS
198.189.66.253	Quincy, California, United States (US), North America	198.189.64.0/22	95971	39.9368, -120.9465 (200 km)	California Research and Education Network	-	Cable/DS
75.102.246.211	Chicago, Illinois, United States (US), North America	75.102.244.0/22	60614	41.921, -87.6454 (50 km)	Depaul University	depaul.edu	Cable/DS

Reputation & Location

Global Traceroute v2.6

IP Version: IPv4
 IPv6

Filters:
Country:
State/Region:
City:
ASN:

Select Probe

Target type: Trace to user-entered target
 Trace to other probe
 My IP address

Target Address:

```
traceroute to 103.21.244.8 (103.21.244.8) 64 hops max, 76 byte packets
 1 10.233.64.1 (10.233.64.1) [AS???] 0.095 ms 0.031 ms 0.022 ms
 2 198.189.66.252 (198.189.66.252) [AS2152] 0.498 ms 0.446 ms 0.224 ms
 3 rive1-agg-01--fres1-agg-01--200g--01.cenic.net (137.164.11.105) [AS2152] 7.333 ms 7.292 ms 7.322 ms
 4 dc-lax-agg10--rive1-agg-01-800g--01.cenic.net (137.164.11.86) [AS2152] 7.317 ms 7.29 ms 7.501 ms
 5 losa4-agg-01--lax-agg10--400g--01.cenic.net (137.164.11.111) [AS2152] 7.3 ms 7.203 ms 7.308 ms
 6 * * *
 7 141.101.72.21 (141.101.72.21) [AS13335] 8.639 ms 8.667 ms 8.098 ms
 8 103.21.244.8 (103.21.244.8) [AS13335] 7.706 ms 7.764 ms 7.734 ms

Source address is: 198.189.66.253
```

Thank You!
Questions?