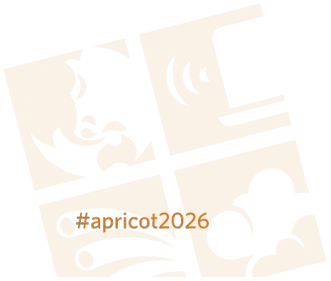
BGP in 2025

Geoff Huston
APNIC Labs

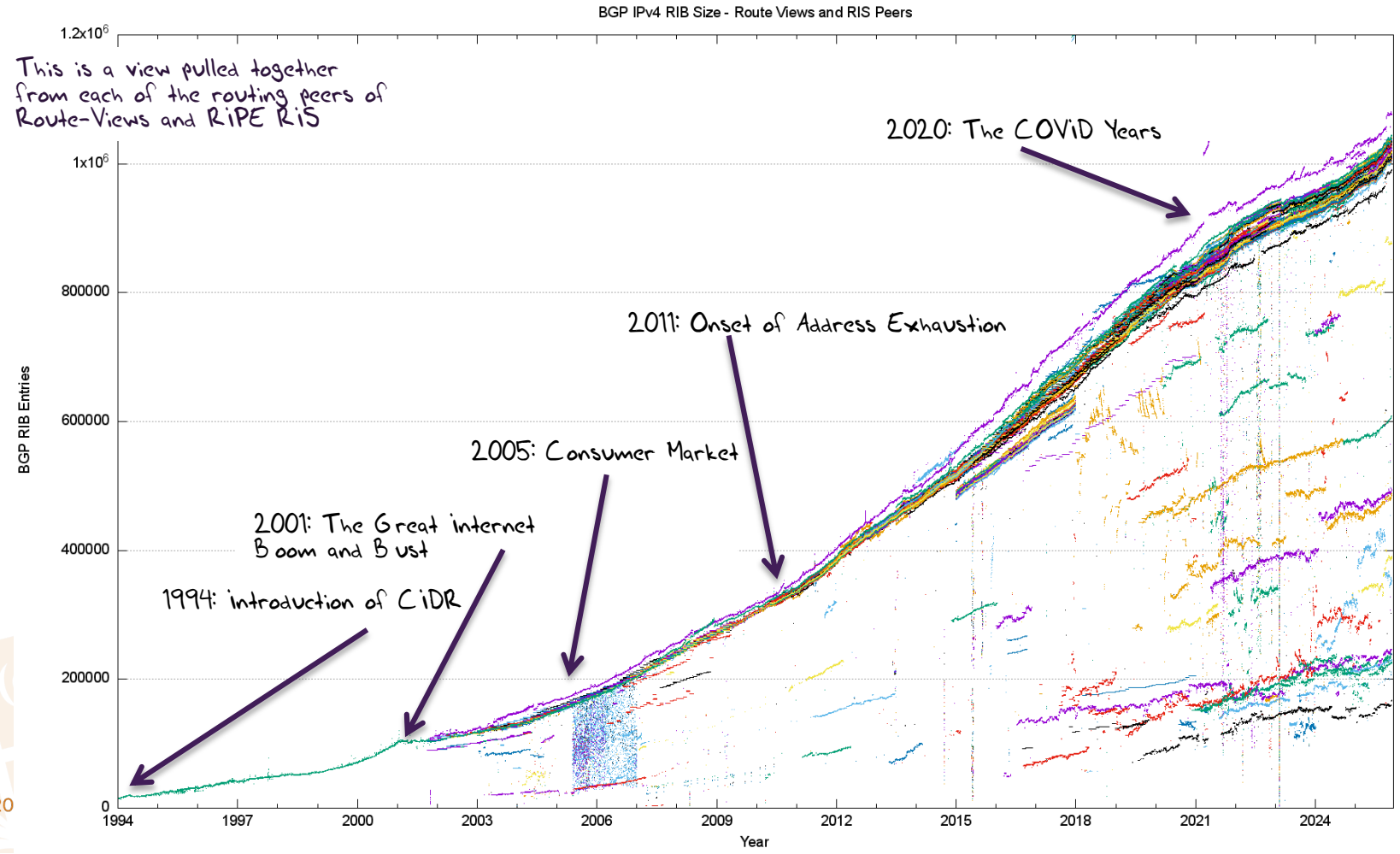




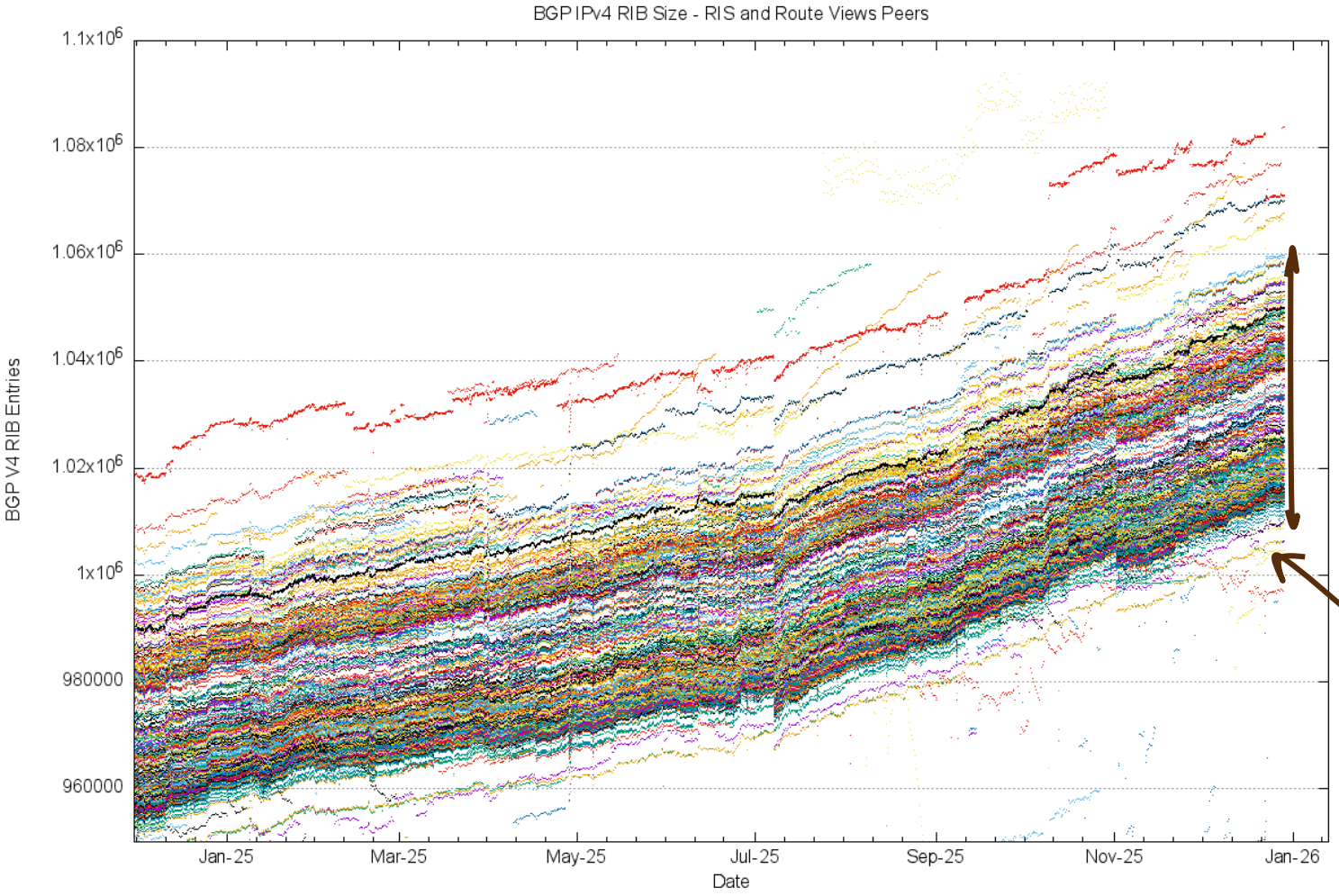
This presentation

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- Conclusions

32 Years of Routing the IPv4 Internet: FIB Count



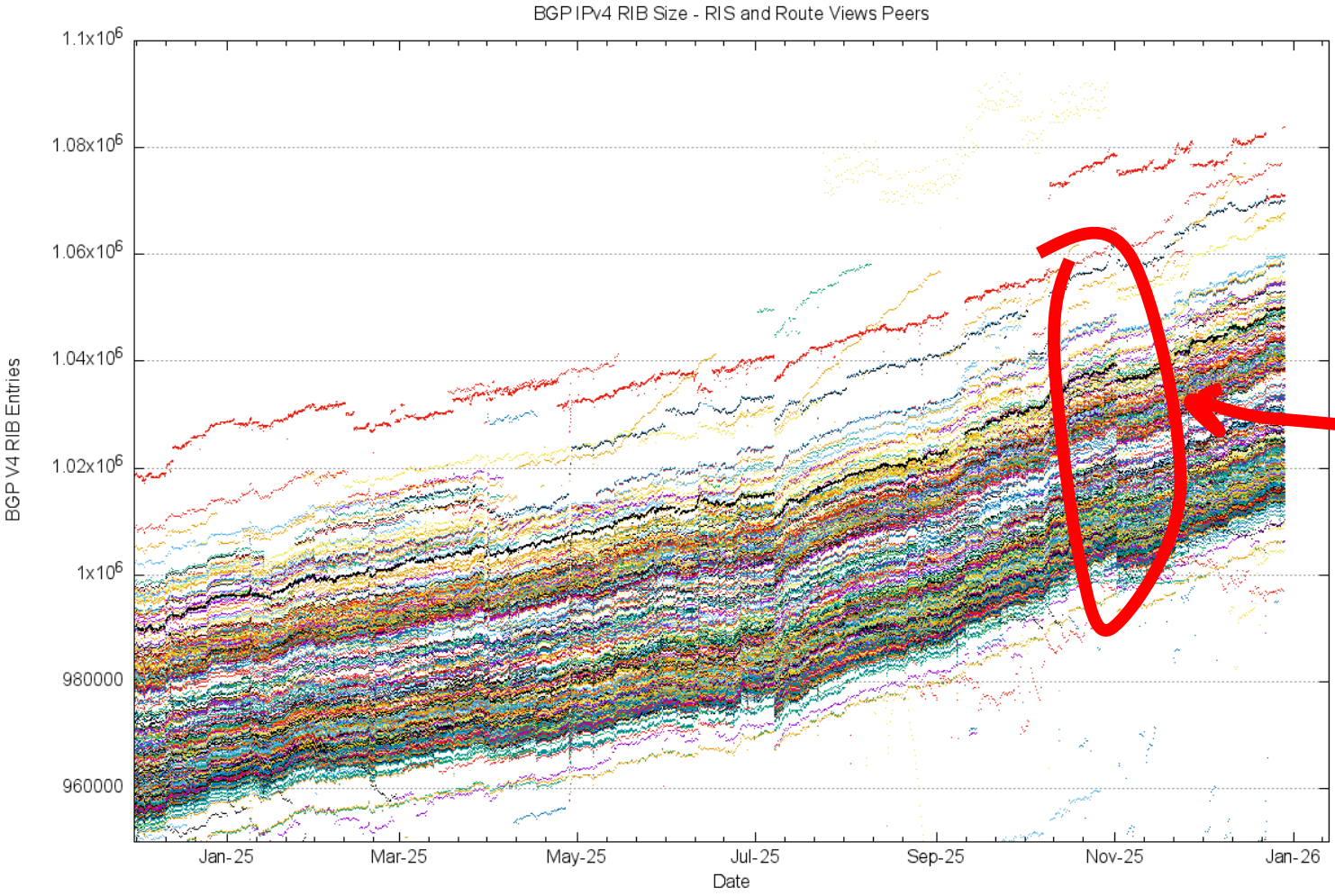
IPv4 in 2025



45K entry variation

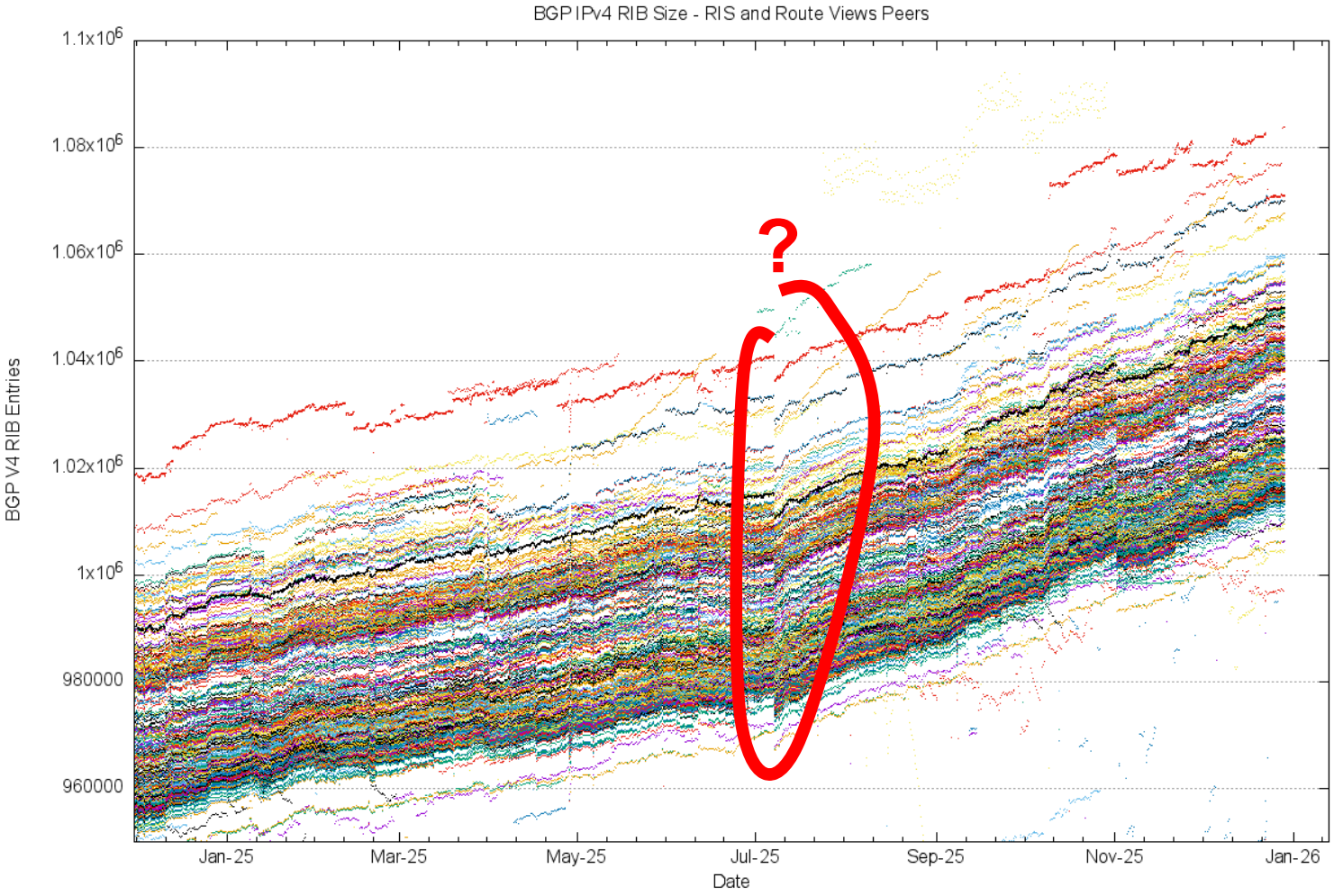
The DFZ now exceeds 1M entries for ALL BGP peers

IPv4 in 2025

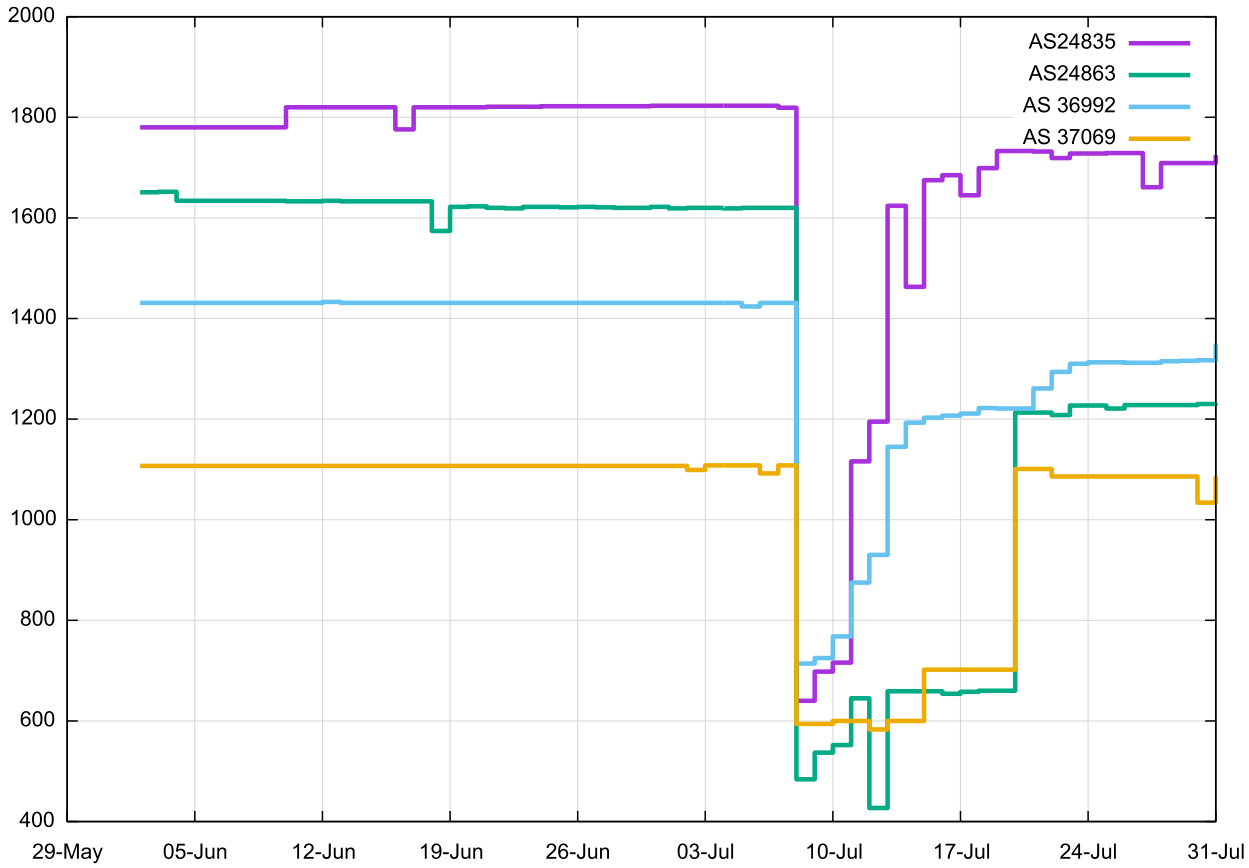


AS4155 – USDA
WDL 3,122 pfxs on 1-Nov

IPv4 in 2025


BGP IPv4 RIB Size - RIS and Route Views Peers
BGP V4 RIB Entries
1.1x10^6
1.08x10^6
1.06x10^6
1.04x10^6
1.02x10^6
1x10^6
980000
960000
?
Jan-25
Mar-25
May-25
Jul-25
Sep-25
Nov-25
Jan-26
Date

7 July 2025 - Egypt



On July 7, 2025, a major fire broke out at the Ramses Central building in Cairo, a critical telecommunications hub. The fire resulted in four deaths, dozens of injuries, and significant disruptions to Egypt's internet and telecommunications services. The incident also led to a temporary suspension of trading on the Cairo stock exchange and caused severe traffic congestion due to street clos



Daily News Egypt

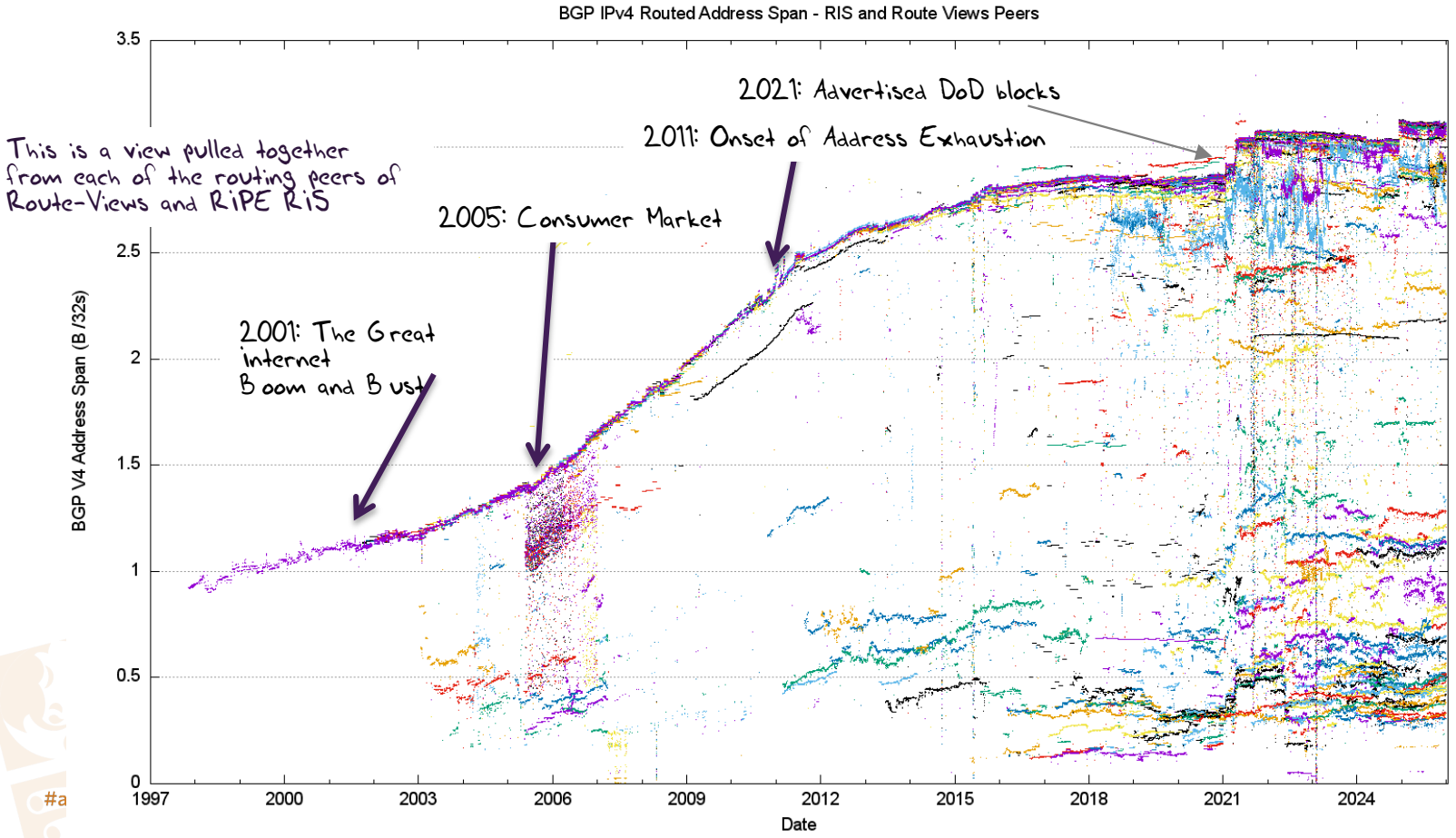
#apricc
2026 APNIC 61

Announced Prefix Changes in 2025

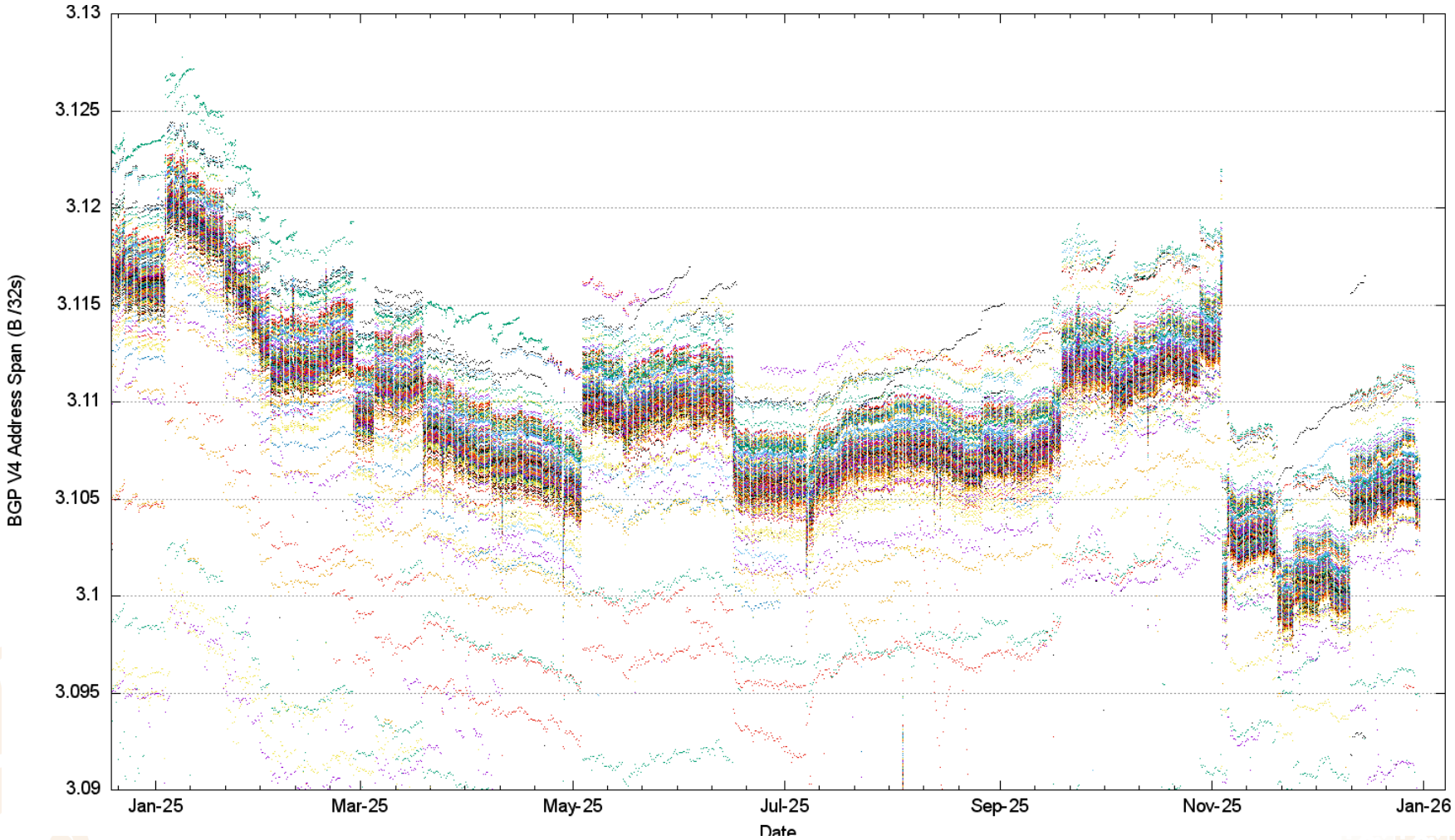
AS Num	Change	1-Jan	31-Dec	AS Name
AS9808	3,283	10,099	13,382	China Mobile, CN
AS17561	1,886	948	2,834	Larus, HK
AS56046	1,771	1,630	3,401	China Mobile Jiangsu, CN
AS16509	1,531	12,473	14,004	AMAZON-02,US
AS398781	1,193	41	1,234	OSL-188,US
AS22773	1,173	3,574	4,747	Cox Comms, US
AS8151	1,130	11,563	12,693	UNINET,MX
AS11404	1,121	168	1,289	AS-WAVE-1,US
AS6079	1,100	602	1,702	RCN-AS,US
AS7459	1,063	463	1,526	GRAND ECOM,US
AS9304	978	507	1,485	Hutchison, HK
AS56045	927	-	927	China Mobile Jiangxi, CN
AS44559	875	267	1,142	ITHOSTLINE, CY
AS834	870	516	1,386	IPXO,US
AS7029	756	1,775	2,531	WINDSTREAM,US

AS Num	Change	1-Jan	31-Dec	AS Name
AS7018	-2,605	3,245	640	AT&T, US
AS4155	-2,268	2,291	23	USDA-1, US
AS174	-1,276	4,231	2,955	COGENT, US
AS28202	-1,116	1,126	10	MASTER SA, BR
AS984	-945	1,280	335	OWS-NETWORK, US
AS367	-704	2,510	1,806	DNIC, US
AS8100	-647	670	23	QUADRANET, US
AS6389	-578	633	55	BELLSOUTH, US
AS45271	-510	905	395	Vodafone Idea, IN
AS140224	-473	498	25	NEBULA, US
AS6503	-441	1,167	726	Axtel, MX
AS203999	-428	521	93	GEEKYWORKS, IN
AS12479	-420	7,700	7,280	UNI2, ES
AS29571	-398	1,470	1,072	ORANGE COTE-IVOIRE, CI
AS15133	-384	404	20	EDGECAST, US

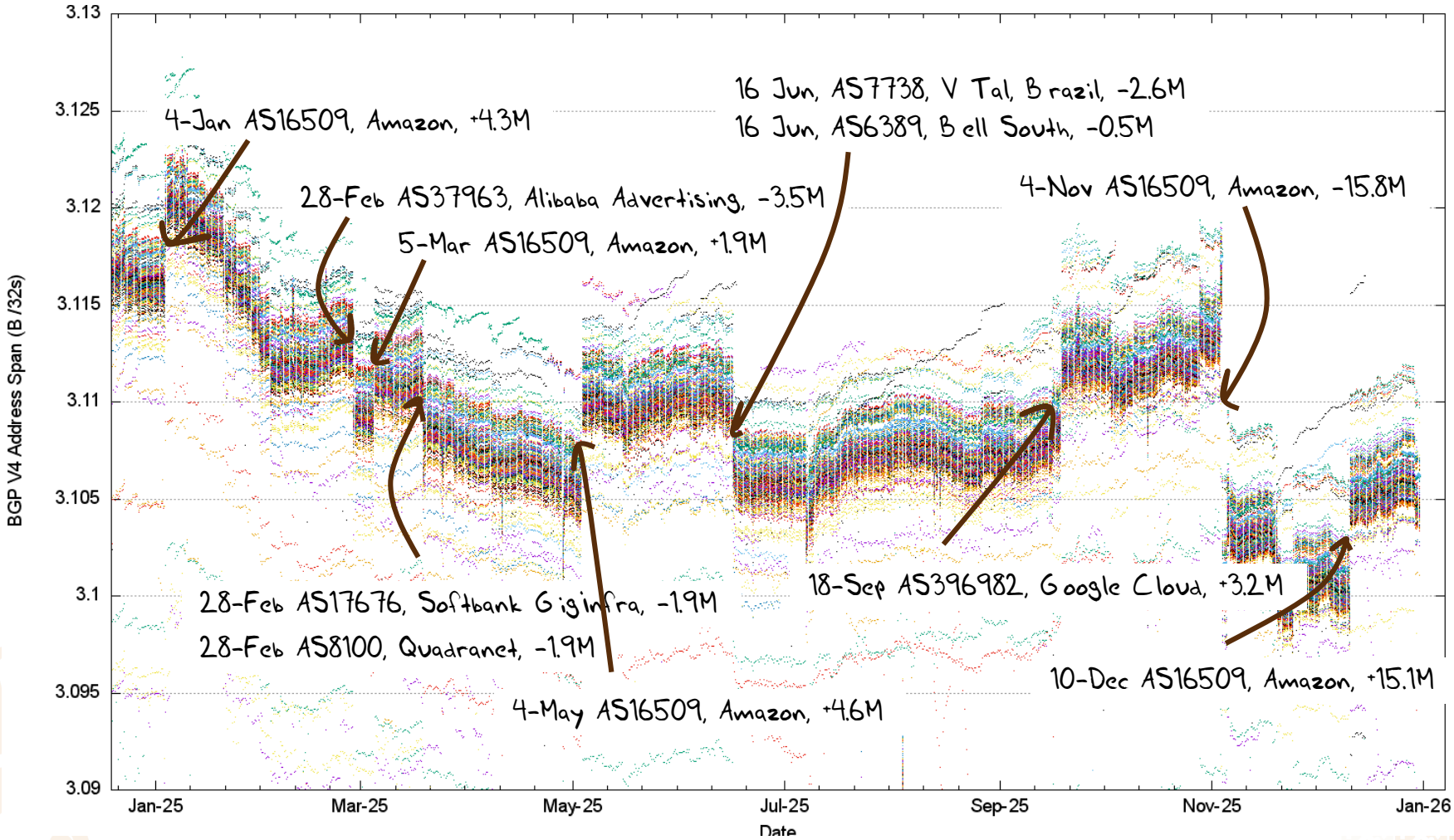
32 Years of Routing the IPv4 Internet: Advertised Address Span



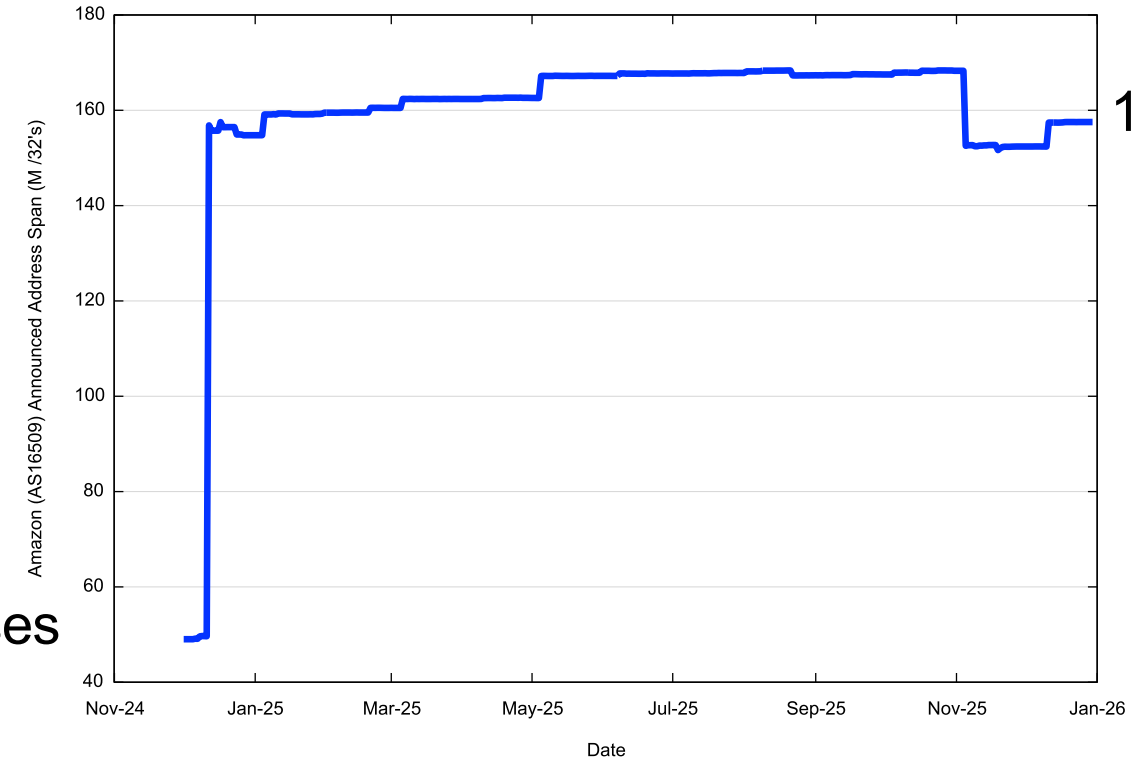
Advertised Address Span: 2025 in Detail



Advertised Address Span: 2025 in Detail



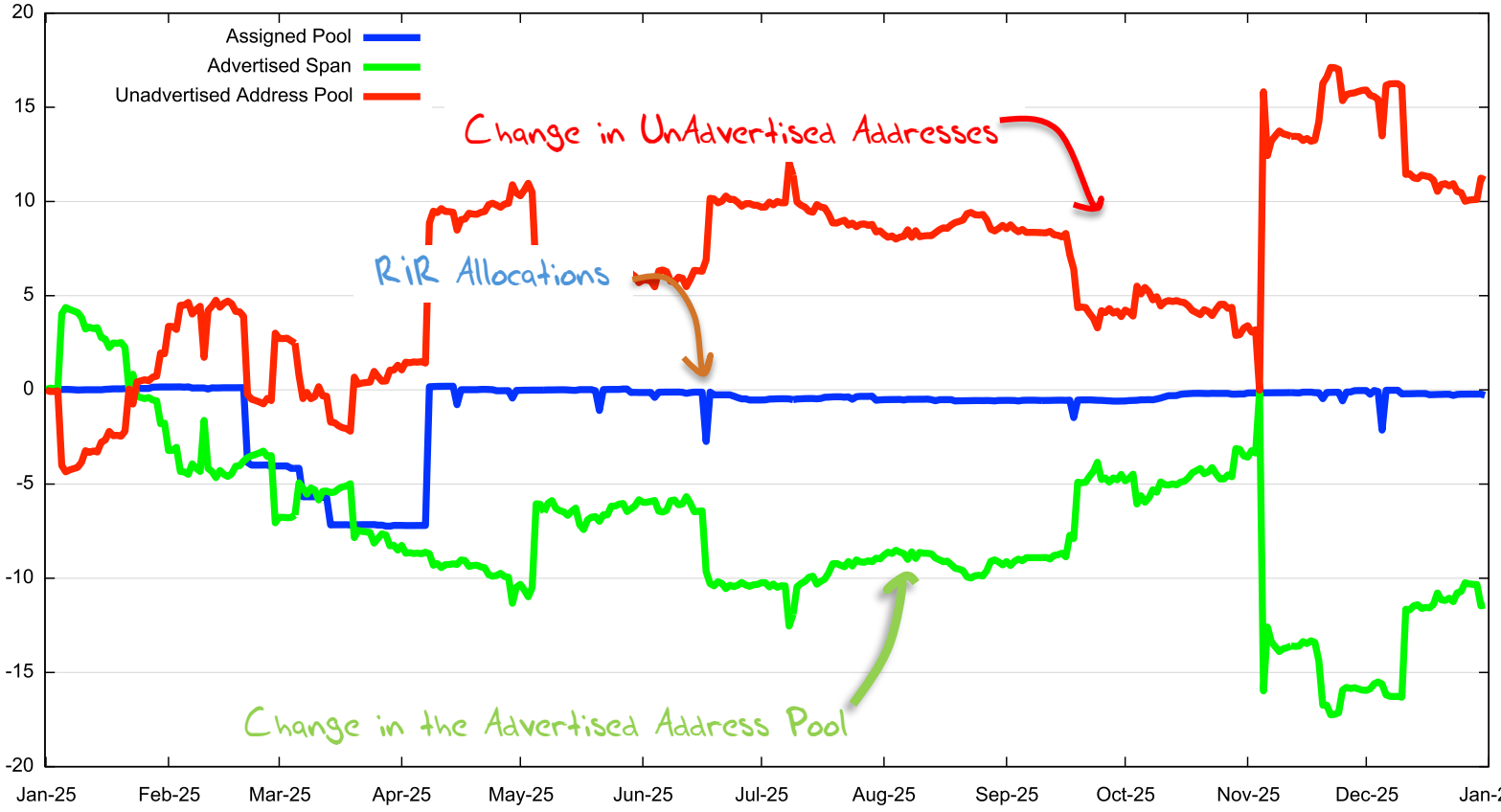
AS16509 – Amazon in 2025



158M addresses

50M addresses

2025: Assigned vs Recovered Addresses



580M unadvertised
+10M delta

3.7B assigned
-0.25M

3.1B advertised
-11M delta

Announced Address Span Changes in 2025

AS Num	Change	1-Jan	31-Dec	AS Name
AS396982	4,935,168	14,976,000	19,911,168	GOOGLE-CLOUD, US
AS56	3,946,752	3,818,496	7,765,248	DNIC, US
AS2856	3,627,776	12,266,240	15,894,016	BTnet, GB
AS6167	3,142,400	13,937,408	17,079,808	CELLCO, US
AS8434	2,646,016	-	2,646,016	TELENOR, SE
AS4155	2,478,848	668,928	3,147,776	USDA, US
AS56045	1,968,128	-	1,968,128	China Mobile JIANGXI, CN
AS9141	1,607,680	4,608	1,612,288	P4 Play, PL
AS31898	1,275,136	3,305,472	4,580,608	ORACLE, US
AS14618	1,234,944	18,201,344	19,436,288	AMAZON-AES, US
AS6079	1,152,512	1,728,768	2,881,280	Astound Broadband, US
AS25019	1,149,952	4,317,440	5,467,392	SAUDI NET, SA
AS11404	1,145,600	763,136	1,908,736	AS-WAVE, US
AS1540	1,144,832	-	1,144,832	DNIC, US
AS45102	1,112,064	3,658,240	4,770,304	Alibaba, CN

AS Num	Change	1-Jan	31-Dec	AS Name
AS15169	-7,266,816	9,153,024	1,886,208	GOOGLE, US
AS367	-4,268,544	12,336,640	8,068,096	DNIC, US
AS7738	-3,534,848	7,400,448	3,865,600	Vtal, BR
AS7018	-3,494,912	96,310,272	92,815,360	AT&T, US
AS12576	-3,493,888	3,564,032	70,144	EE, GB
AS17676	-2,830,080	40,431,872	37,601,792	GIGA INFRA SoftBank, JP
AS37963	-2,816,768	12,052,992	9,236,224	Alibaba, CN
AS2119	-2,648,320	6,895,616	4,247,296	TELENOR, NO
AS16509	-2,355,712	154,764,288	152,408,576	AMAZON-02, US
AS7922	-2,084,864	70,110,720	68,025,856	COMCAST, US
AS6830	-1,637,120	2,761,984	1,124,864	Liberty Global, NL
AS6389	-1,311,232	5,899,520	4,588,288	BELLSOUTH, US
AS37518	-1,113,344	1,114,112	768	FIBER GRID, SC
AS984	-1,037,312	1,207,808	170,496	OWS, US
AS721	-996,352	73,097,472	72,101,120	DNIC, US

The advertised table shrunk by 11M /32's over 2025

Announced Address Span Changes in 2025

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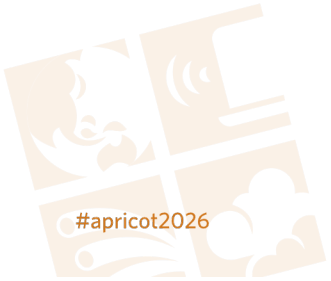
The advertised table shrunk by 11M /32's over 2025

What Happened in 2025 in V4

- The size of the FIB table is growing, but the span of advertised addresses is declining
- V4 Address use in access networks is declining in some markets, notably the US
- V4 address use in Cloud infrastructure is still increasing, noteably by Amazon
- Use of more specific entries in IPv4 fell from 52.9% of all advertised V4 prefixes to 51.8%

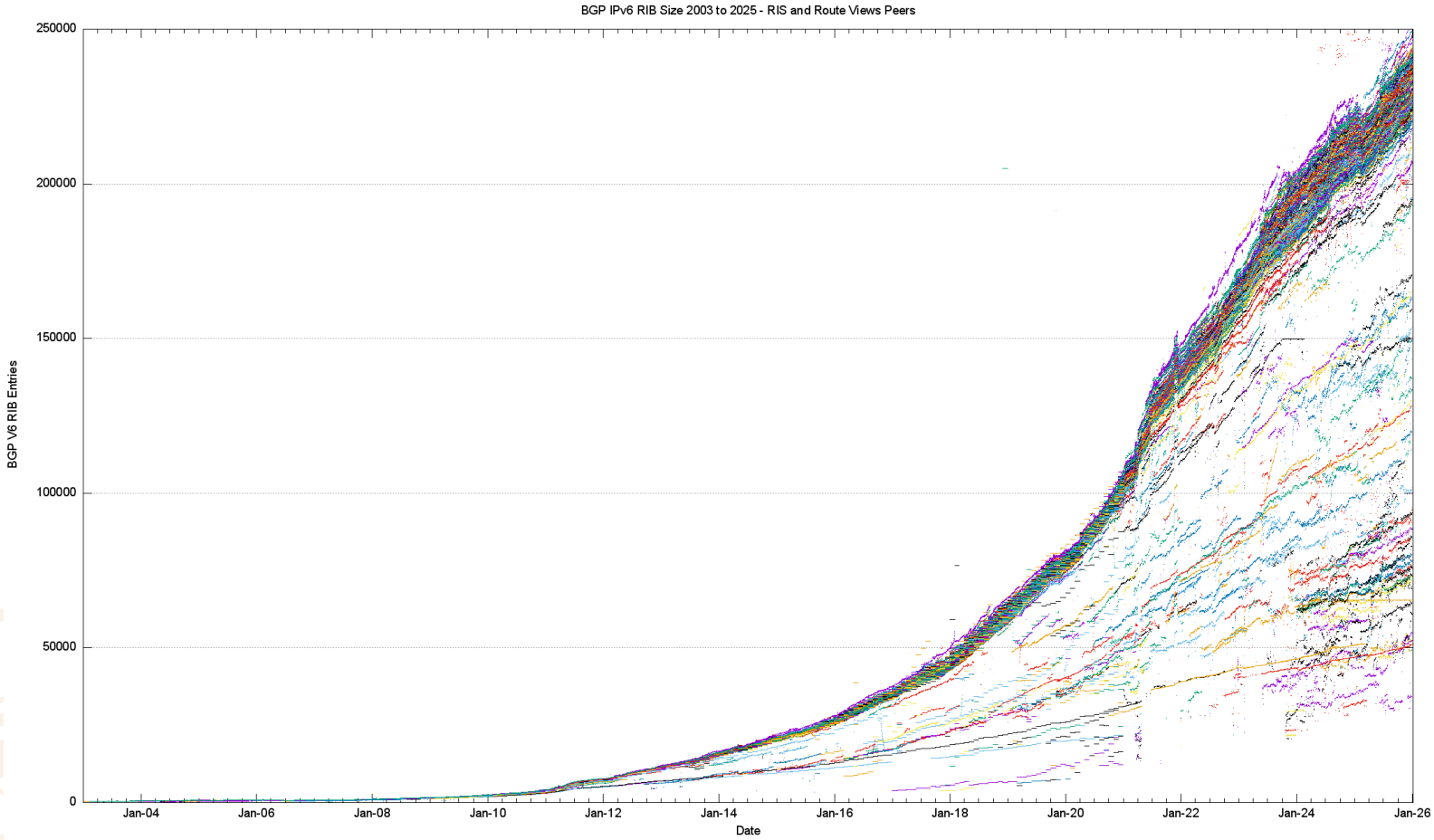
This presentation

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- IPv6 Routing Table
- FIB Projections
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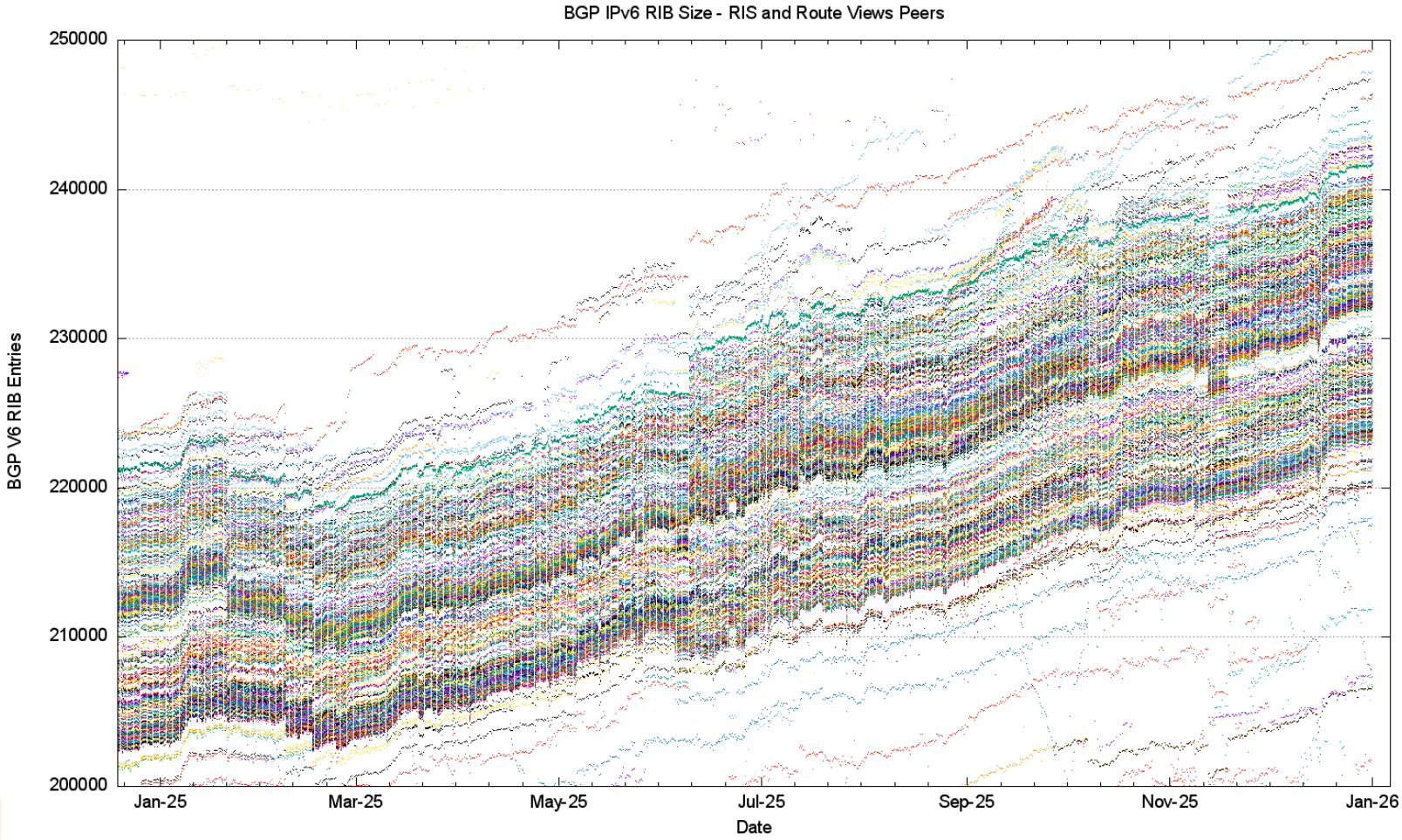




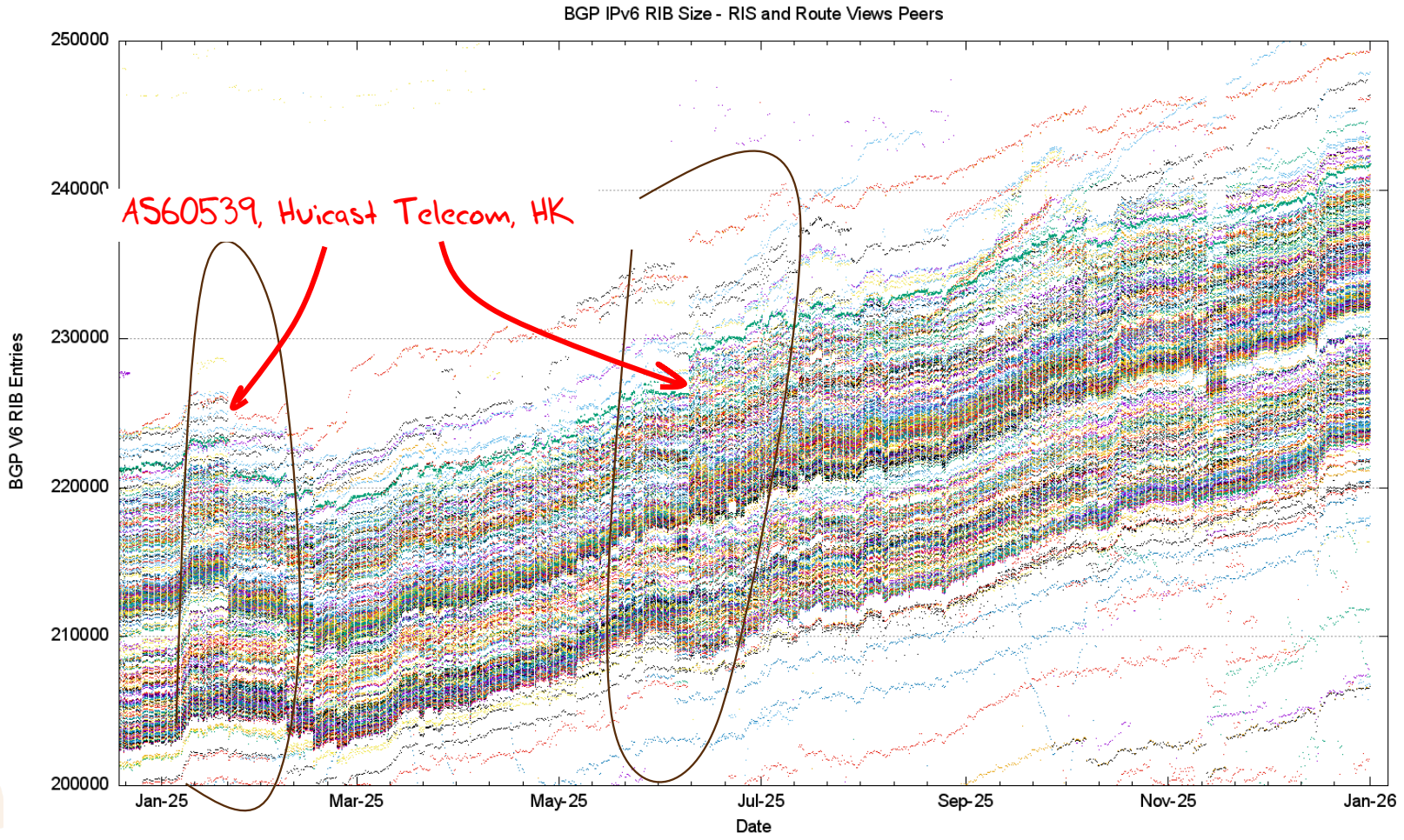
The 20-Year View of IPv6



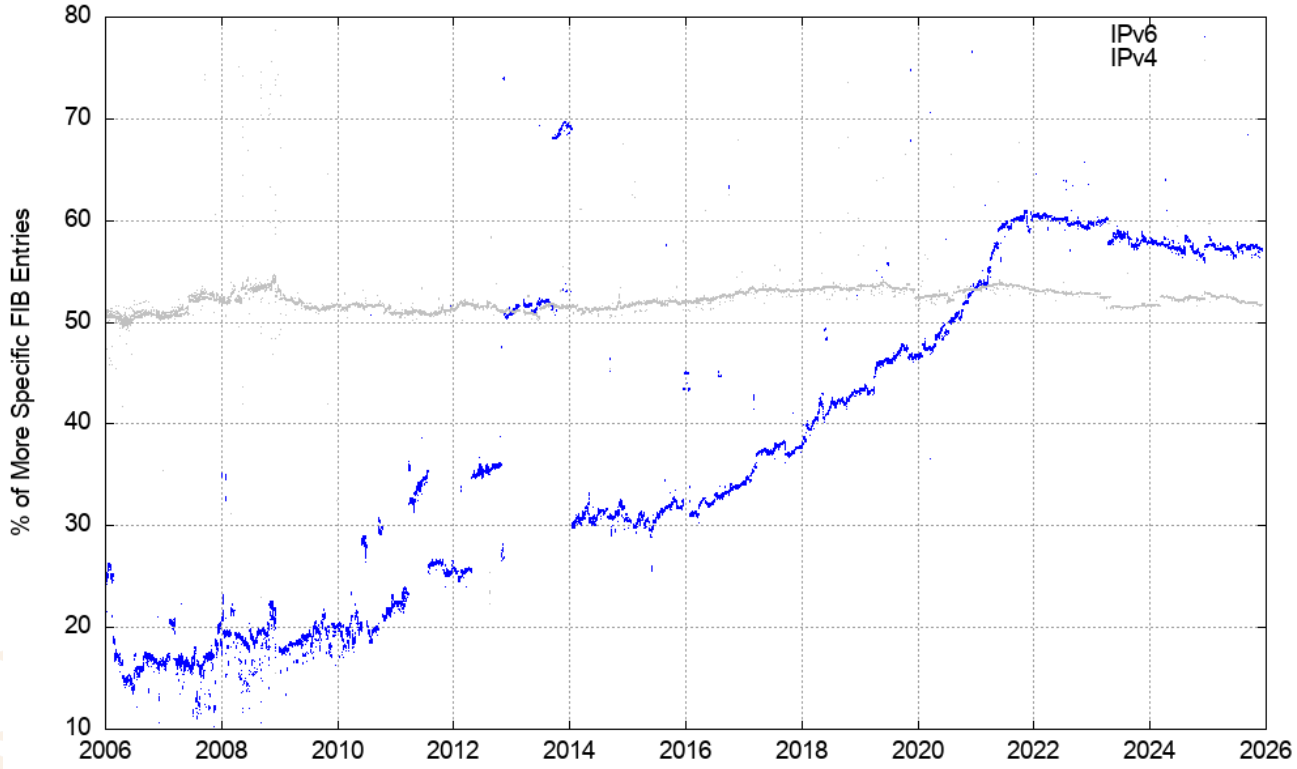
IPv6 in 2025


BGP IPv6 RIB Size - RIS and Route Views Peers
BGP V6 RIB Entries
250000
240000
230000
220000
210000
200000
Jan-25
Mar-25
May-25
Jul-25
Sep-25
Nov-25
Jan-26
Date

IPv6 in 2025


BGP IPv6 RIB Size - RIS and Route Views Peers
AS60539, Huicast Telecom, HK
BGP V6 RIB Entries
250000
240000
230000
220000
210000
200000
Jan-25
Mar-25
May-25
Jul-25
Sep-25
Nov-25
Jan-26
Date

More Specifics in IPv6

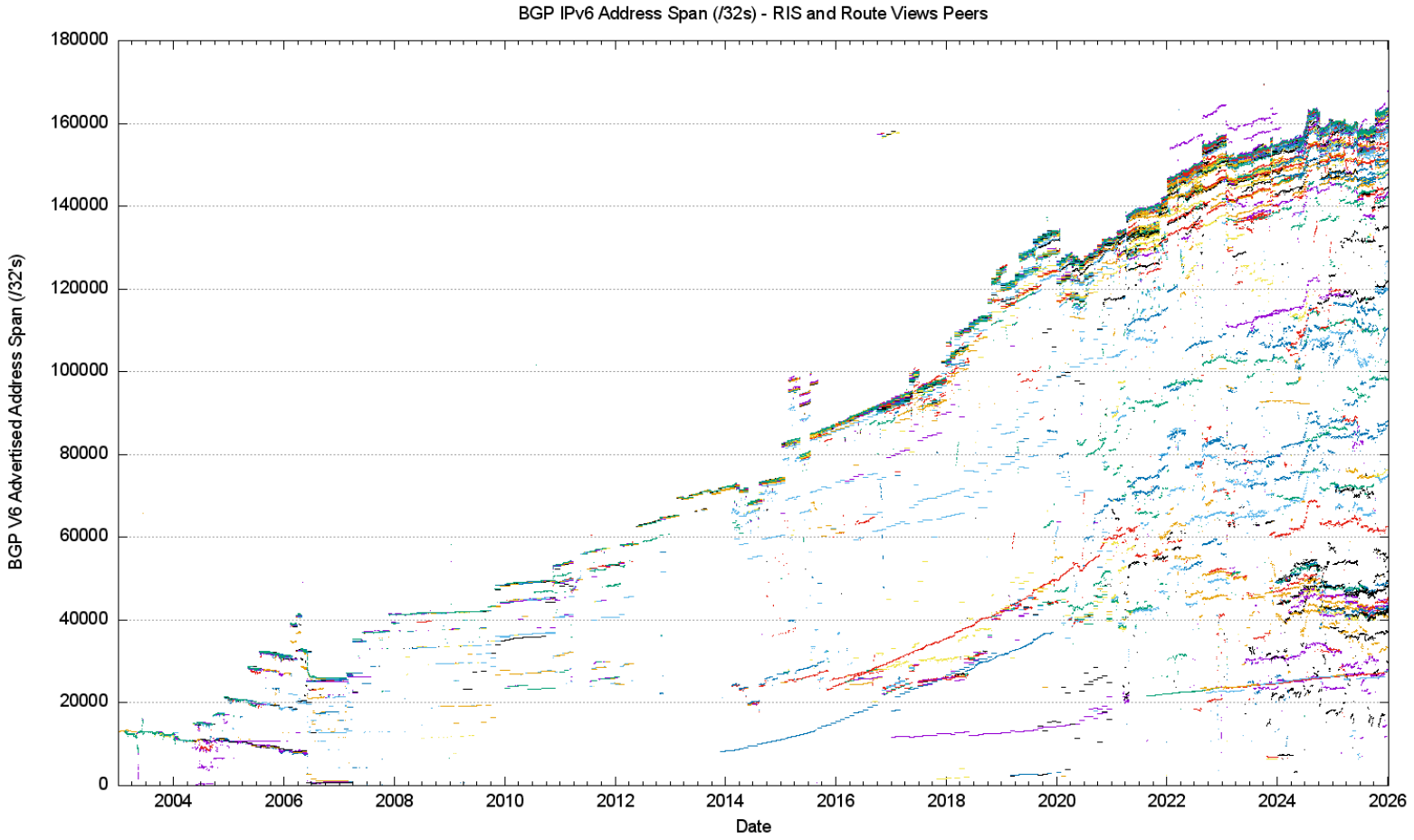


IPv6

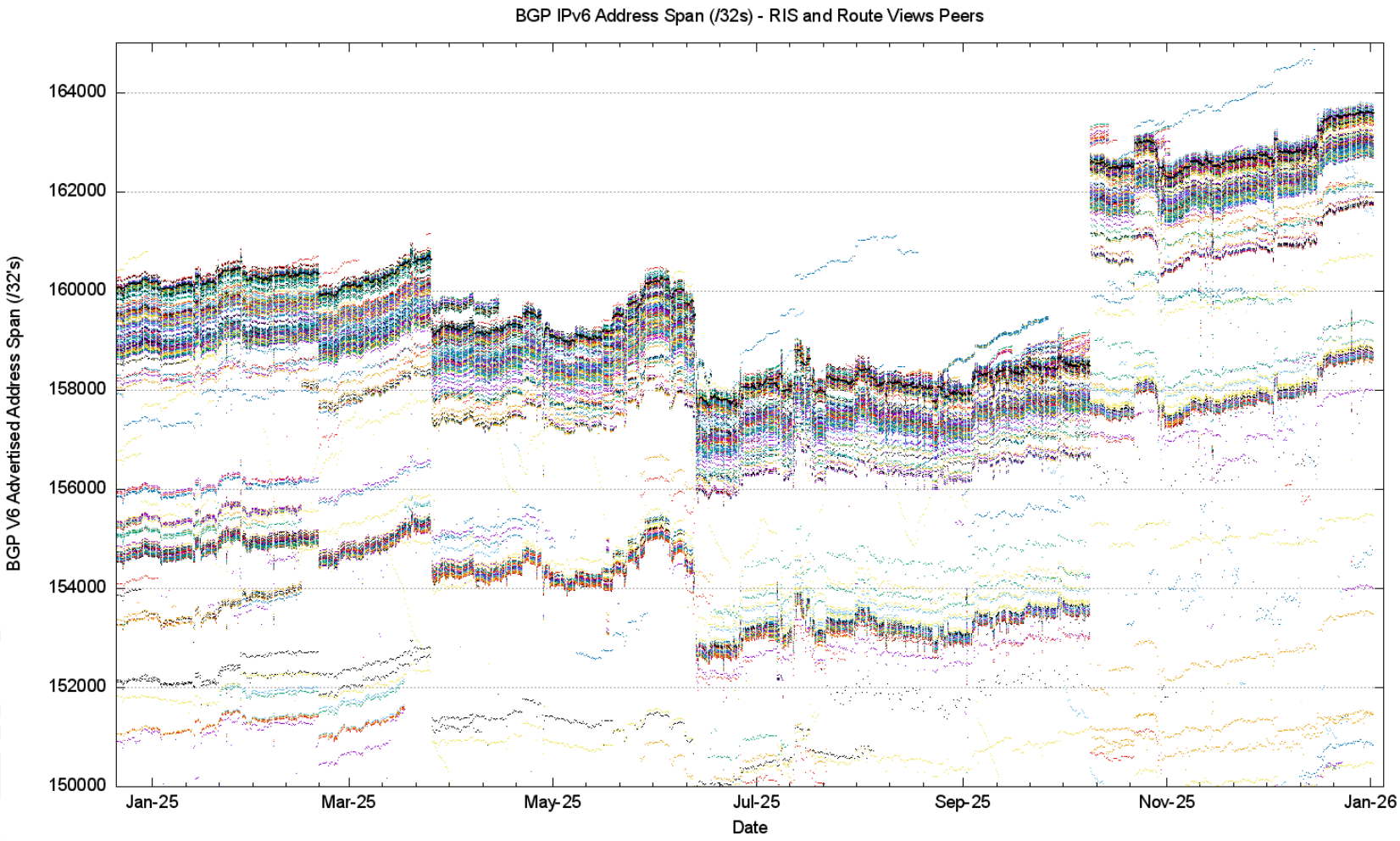
IPv4

45÷ of all IPv6 prefixes are /48's

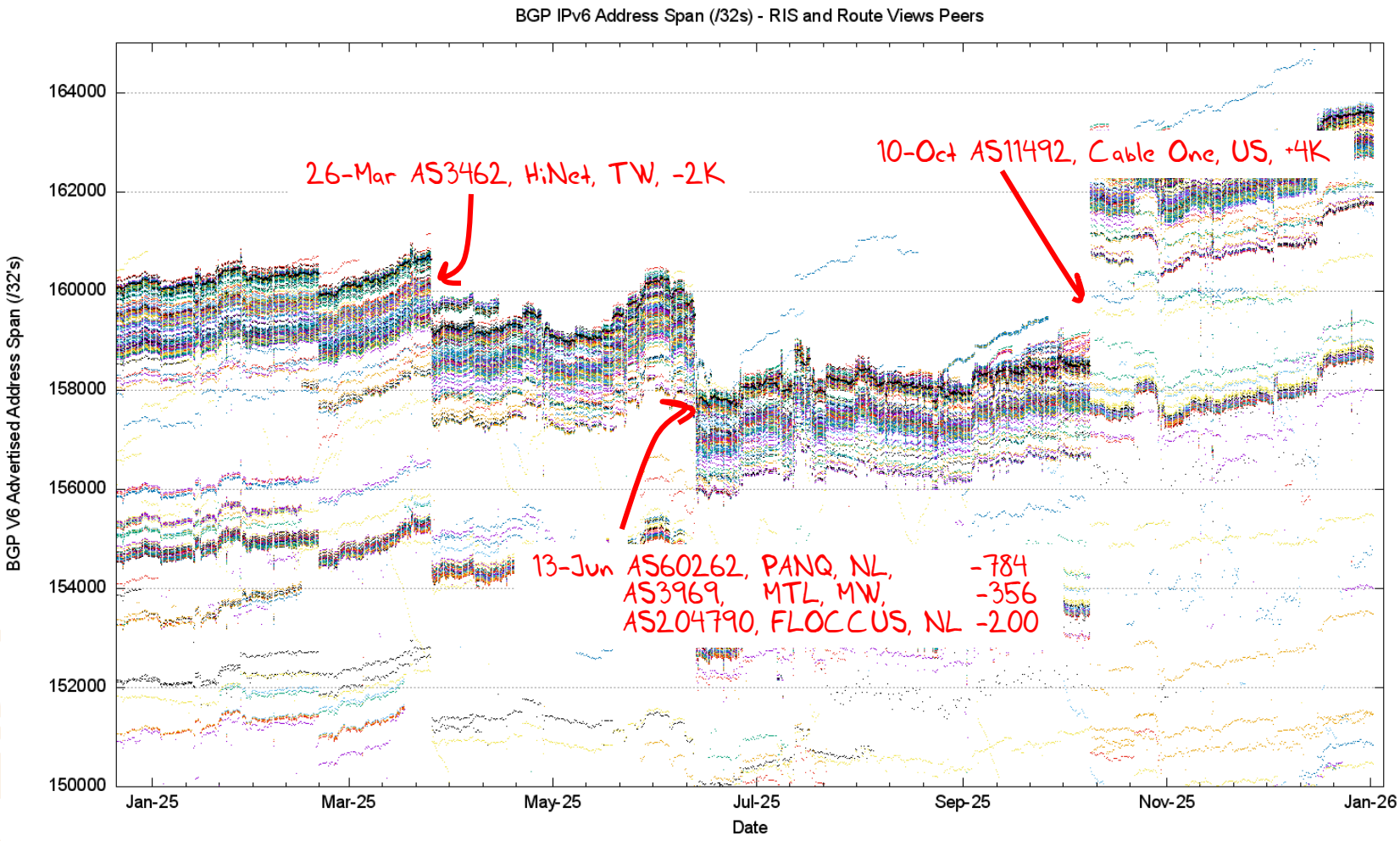
20-Year IPv6 Advertised Address Span



IPv6 Advertised Address Span in 2025



IPv6 Advertised Address Span in 2025

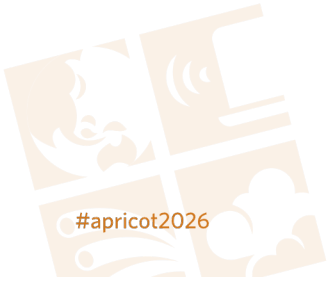


IPv6 in 2025

- Overall IPv6 Internet growth in terms of BGP FIB size is still increasing, and is currently at some **20,000 route entries p.a.** (10%)
- The advertised address span grew by just 4K /32s (thanks to Cable One!)
- There were 2096 new AS's advertising IPv6 prefixes through 2025, and 956 AS's ceased advertising IPv6 prefixes
- IPv6 is still expanding – slowly!

This presentation

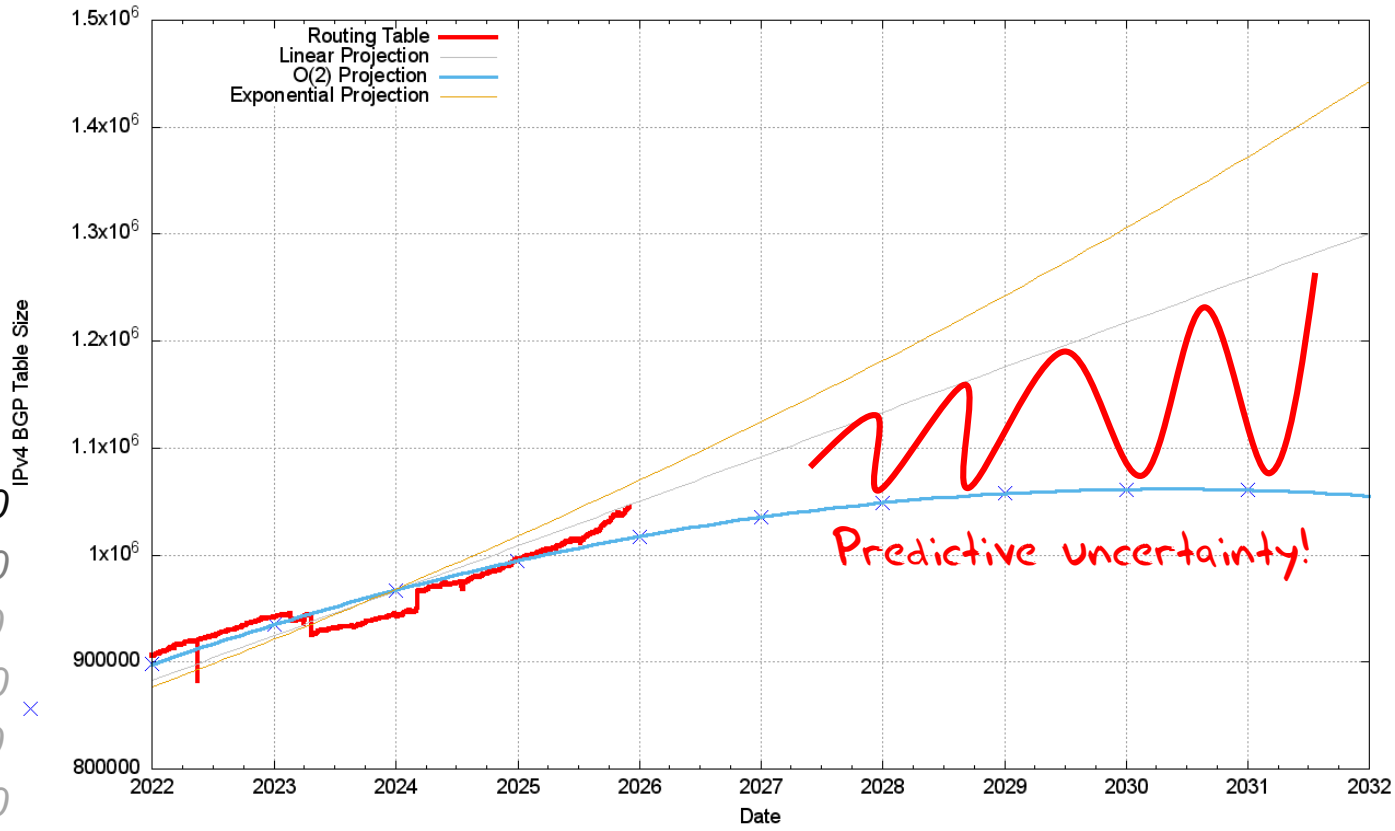
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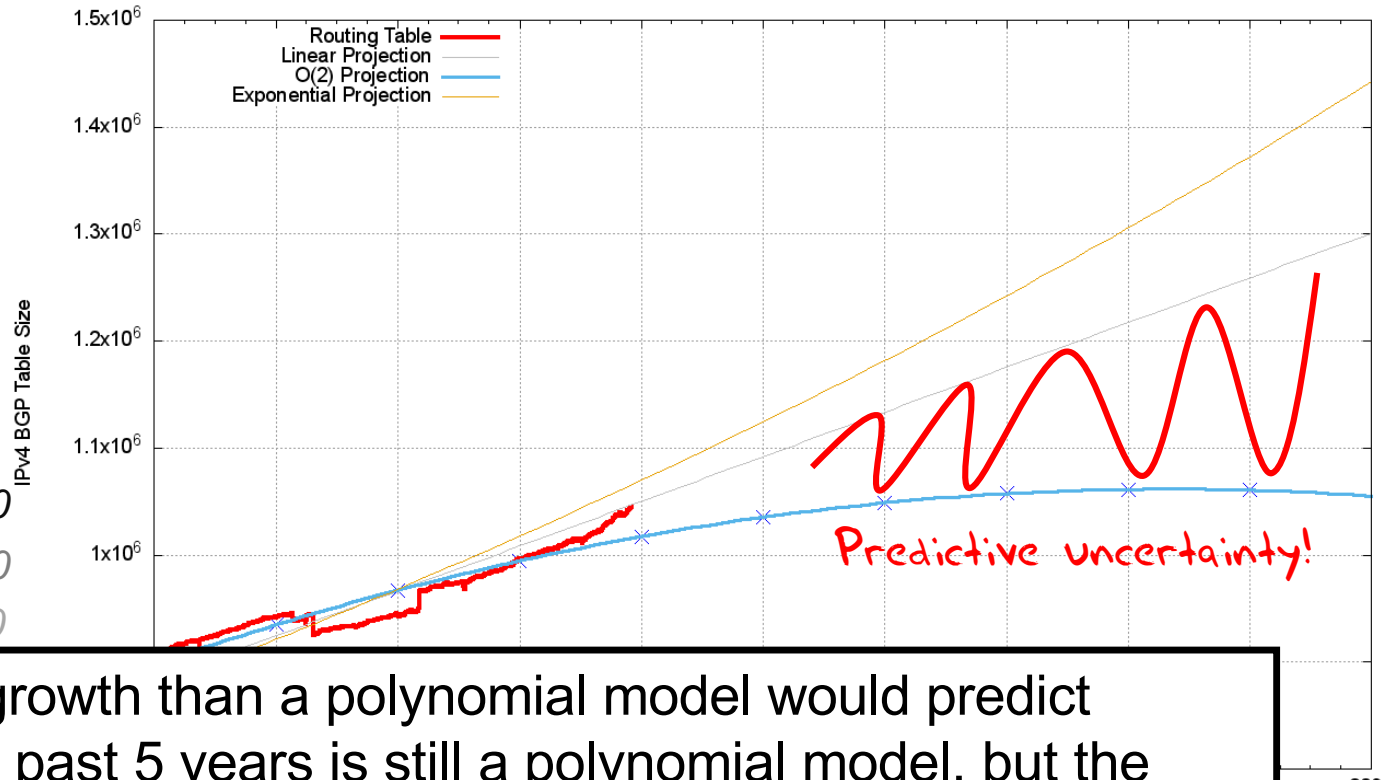
V4 BGP Table Size Predictions

Year	RIB Size	Prediction
2019	760,000	
2020	814,000	
2021	856,000	
2022	906,000	
2023	942,000	
2024	944,000	
2025	996,000	994,000
2026	1,040,000	1,101,000
2027		1,035,000
2028		1,048,000
2029		1,057,000
2030		1,060,000



V4 BGP Table Size Predictions

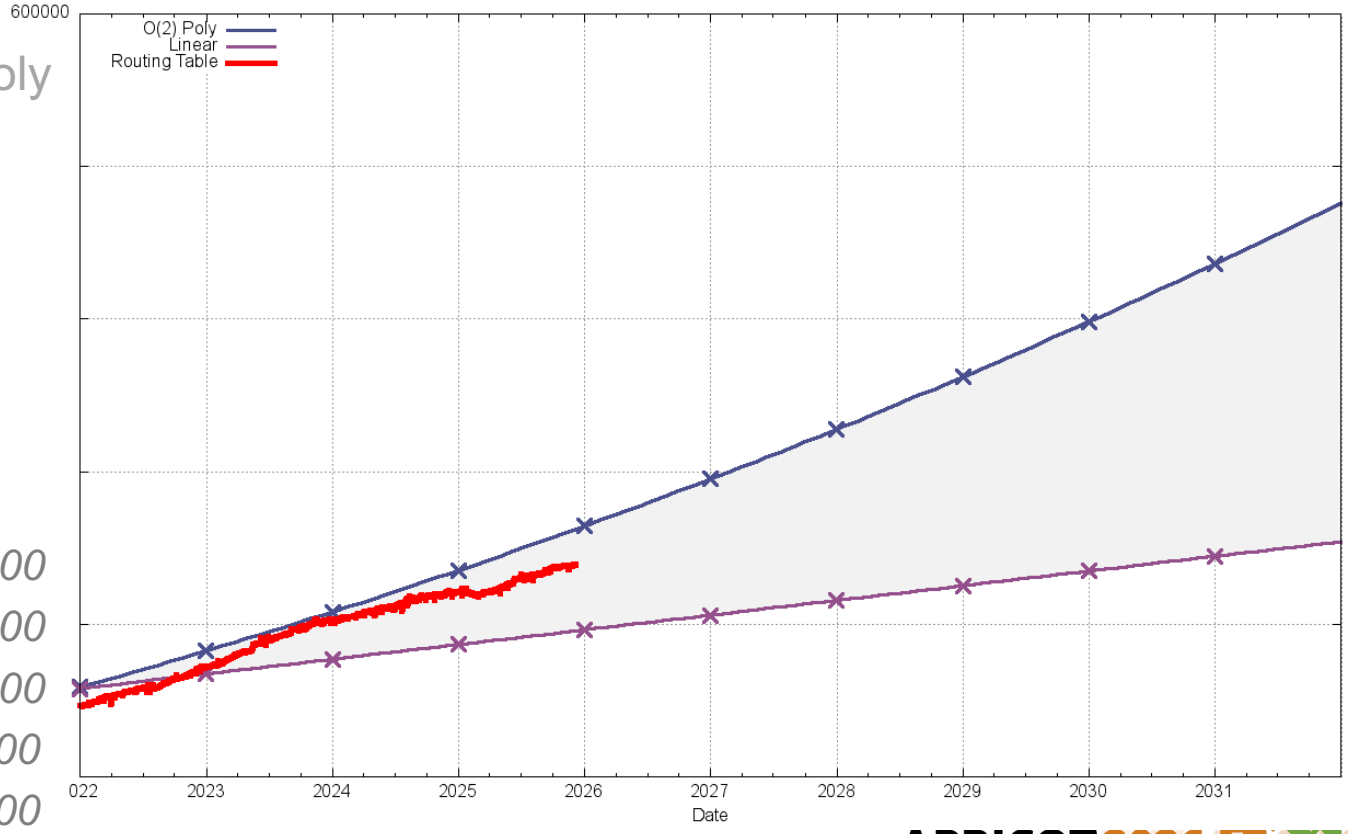
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2026	1,040,000	1,101,000
2027		1,035,000
2028		
2029		
2030		



2025 saw a higher growth than a polynomial model would predict
The best fit over the past 5 years is still a polynomial model, but the best fit over the past 3 years is a linear model

V6 BGP Table Size Predictions

Year	RIB Size	Linear	O(2) Poly
2019	*62,000*		
2020	*79,000*		
2021	*106,000*		
2022	*147,000*		
2023	*172,000*		
2024	*201,000*		
2025	*222,000*		
2026	*250,000*	*245,000*	*254,000*
2027		*271,000*	*286,000*
2028		*296,000*	*319,000*
2029		*322,000*	*353,000*
2030		*348,000*	*388,000*



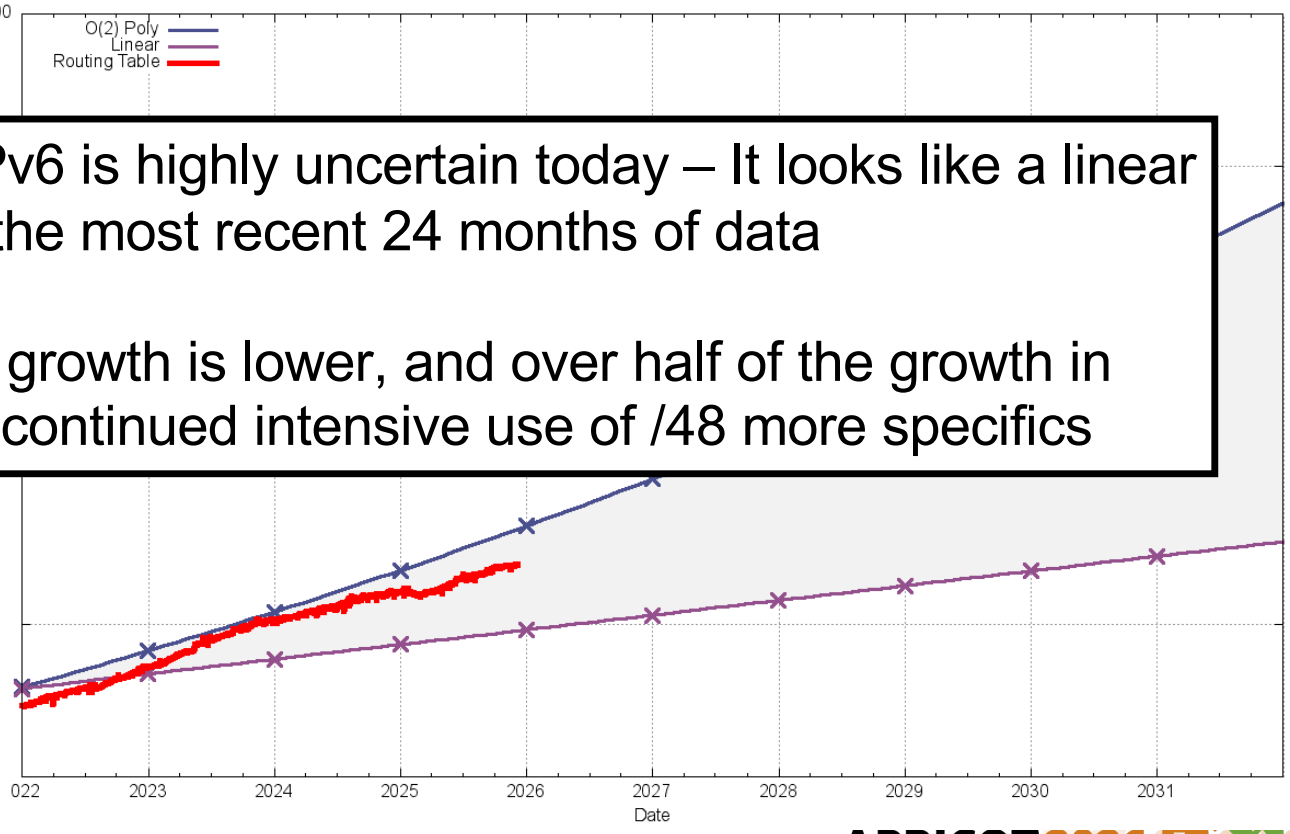
Note that the IPv6 tables are 128bits wide – i.e. 4x the size of the IPv4 tables!

V6 BGP Table Size Predictions

Year	RIB Size	Linear	O(2) Poly
2019	6		
2020	7		
2021	10		
2022	14		
2023	17		
2024	20		
2025	222,000		
2026	250,000	245,000	254,000
2027		271,000	286,000
2028		296,000	319,000
2029		322,000	353,000
2030		348,000	388,000

The growth model for IPv6 is highly uncertain today – It looks like a linear growth model matches the most recent 24 months of data

The underlying network growth is lower, and over half of the growth in this model is due to the continued intensive use of /48 more specifics



Note that the IPv6 tables are 128bits wide – i.e. 4x the size of the IPv4 tables!

BGP Table Growth

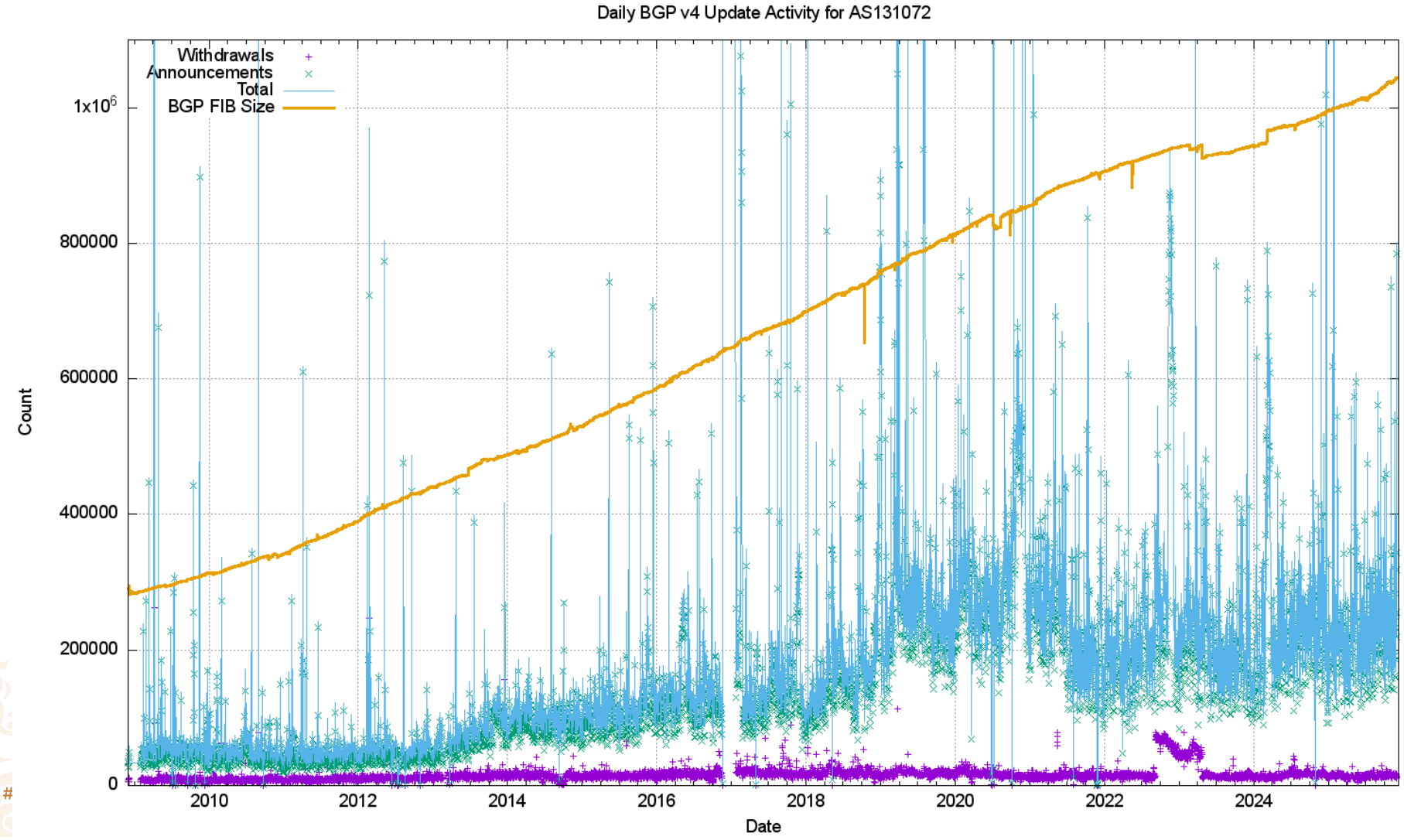
The good news …

As long as we are prepared to live within the technical constraints of the current routing paradigm, the Internet's use of BGP will continue to be viable for some time yet

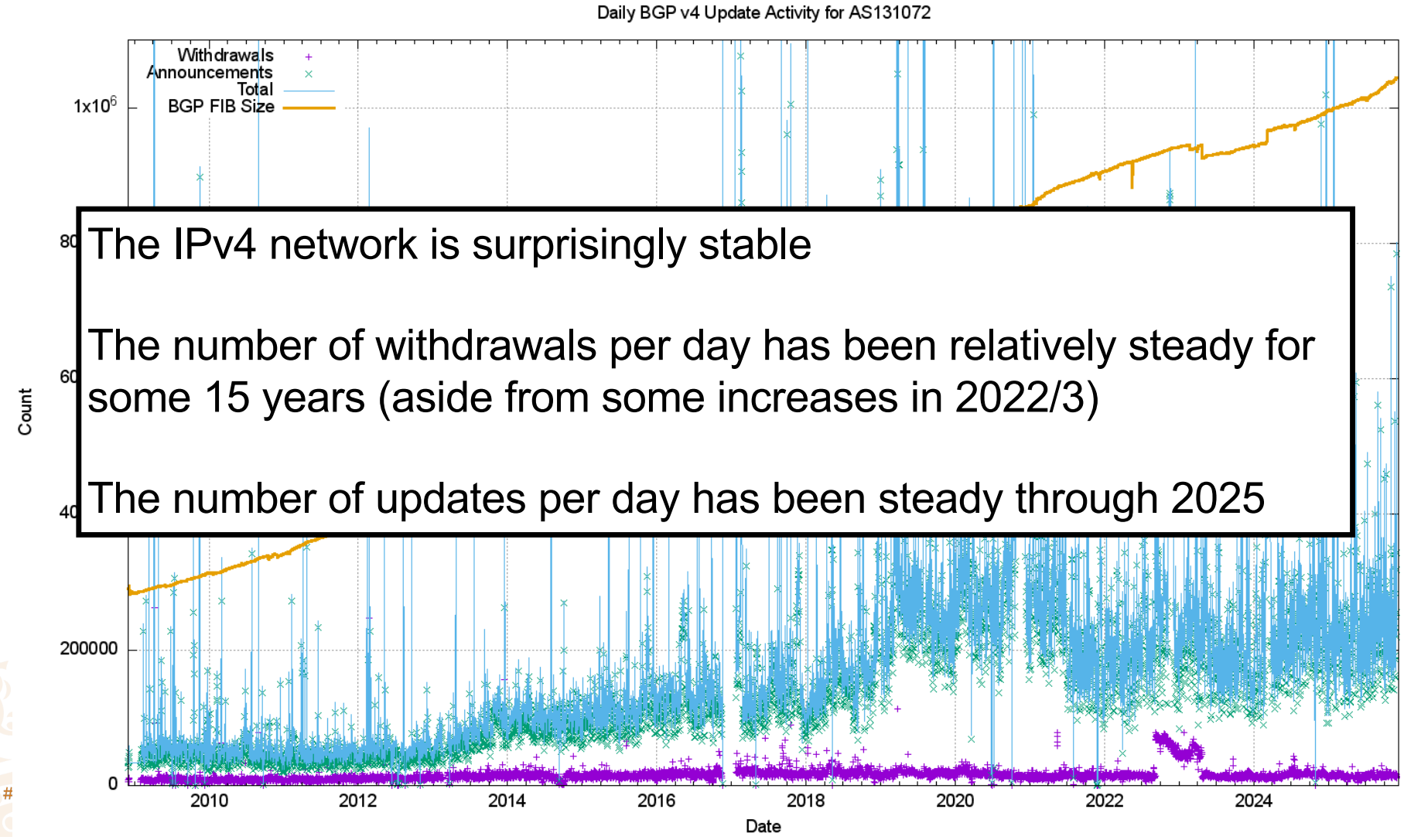
The Highlights

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- IPv6 FIB Summary
- FIB Projections
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- Conclusions

IPv4 BGP Updates – Daily Updates



IPv4 BGP Updates – Daily Updates

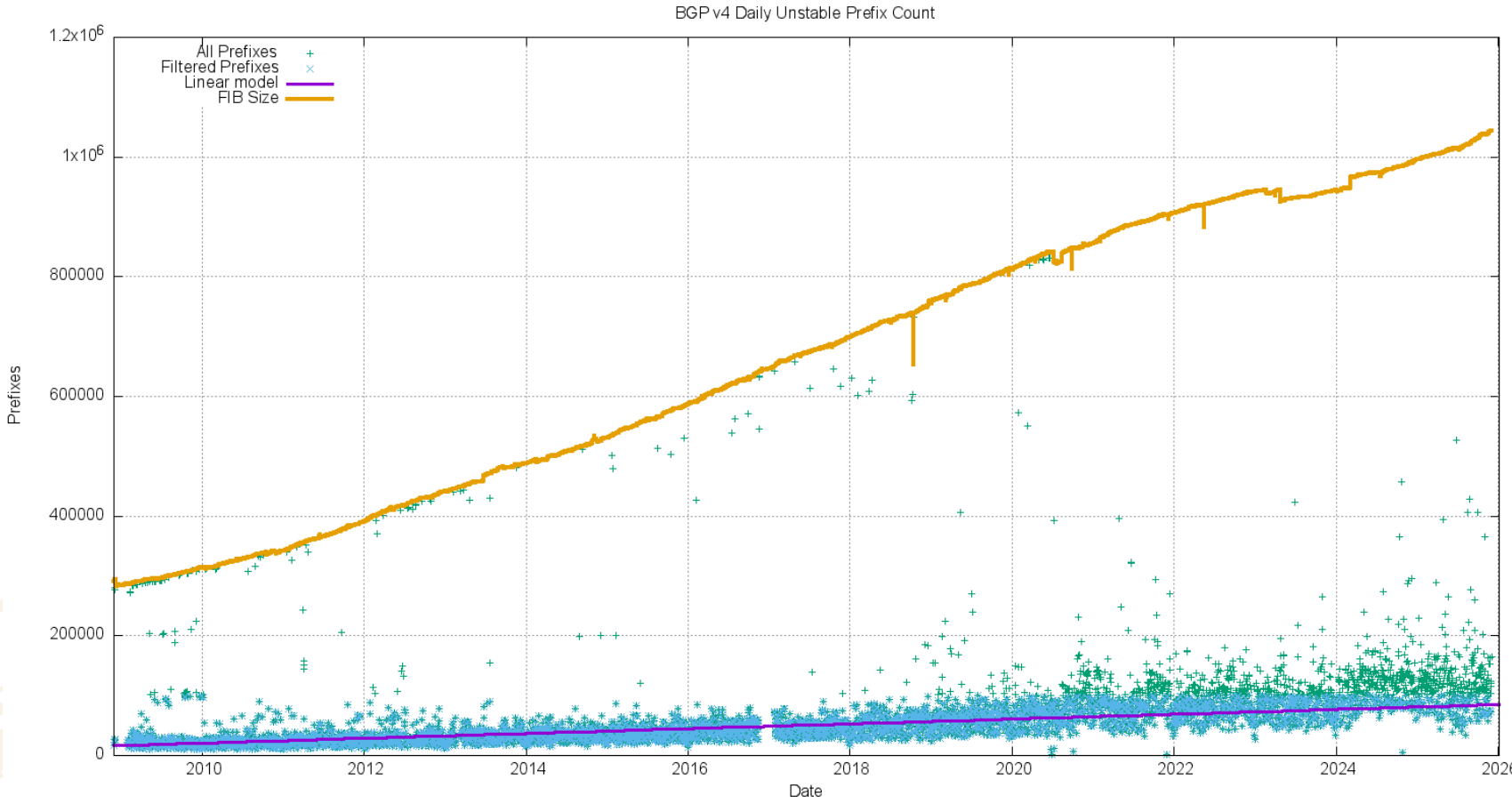


The IPv4 network is surprisingly stable

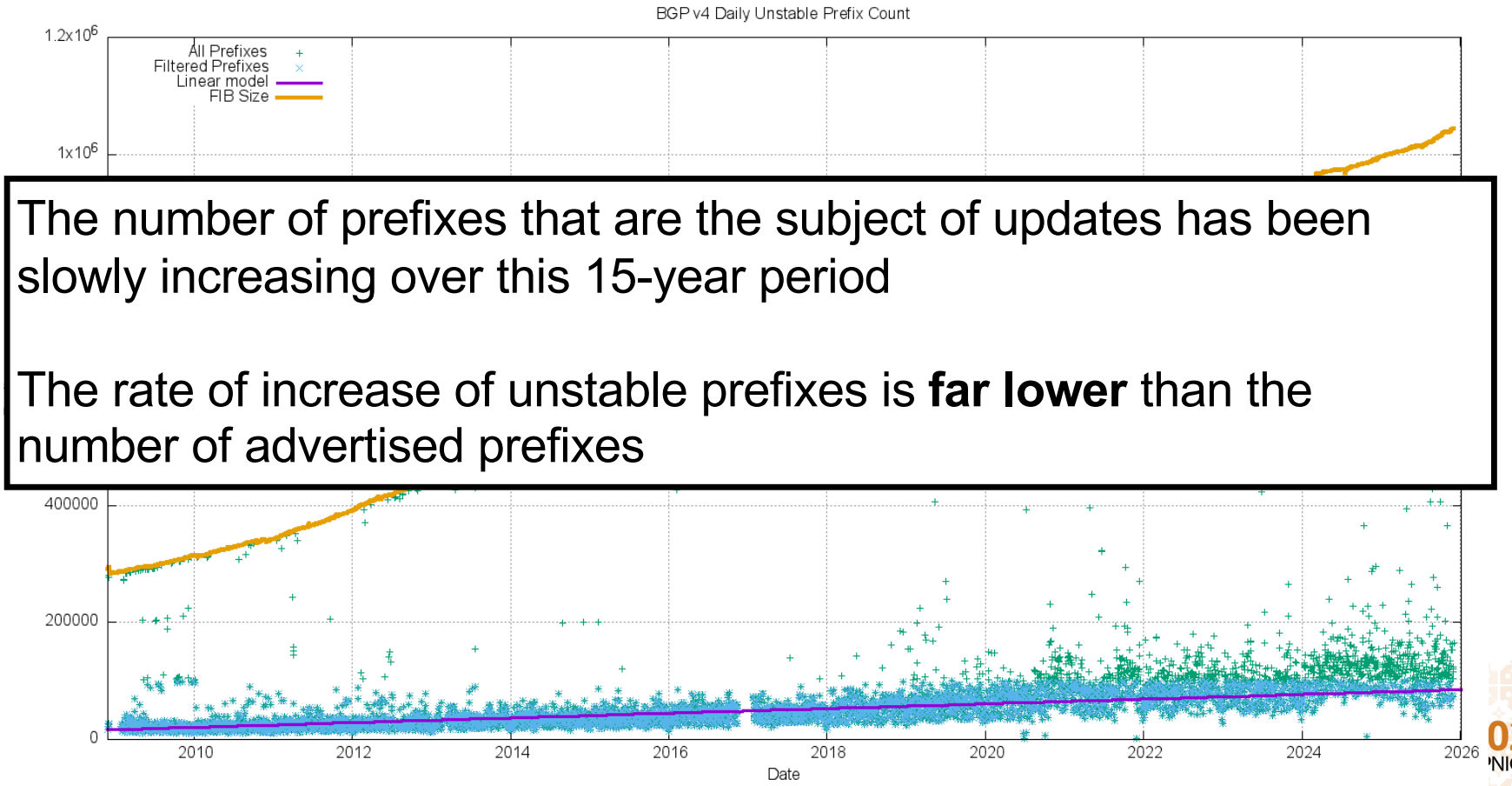
The number of withdrawals per day has been relatively steady for some 15 years (aside from some increases in 2022/3)

The number of updates per day has been steady through 2025

IPv4 Unstable Prefixes per Day



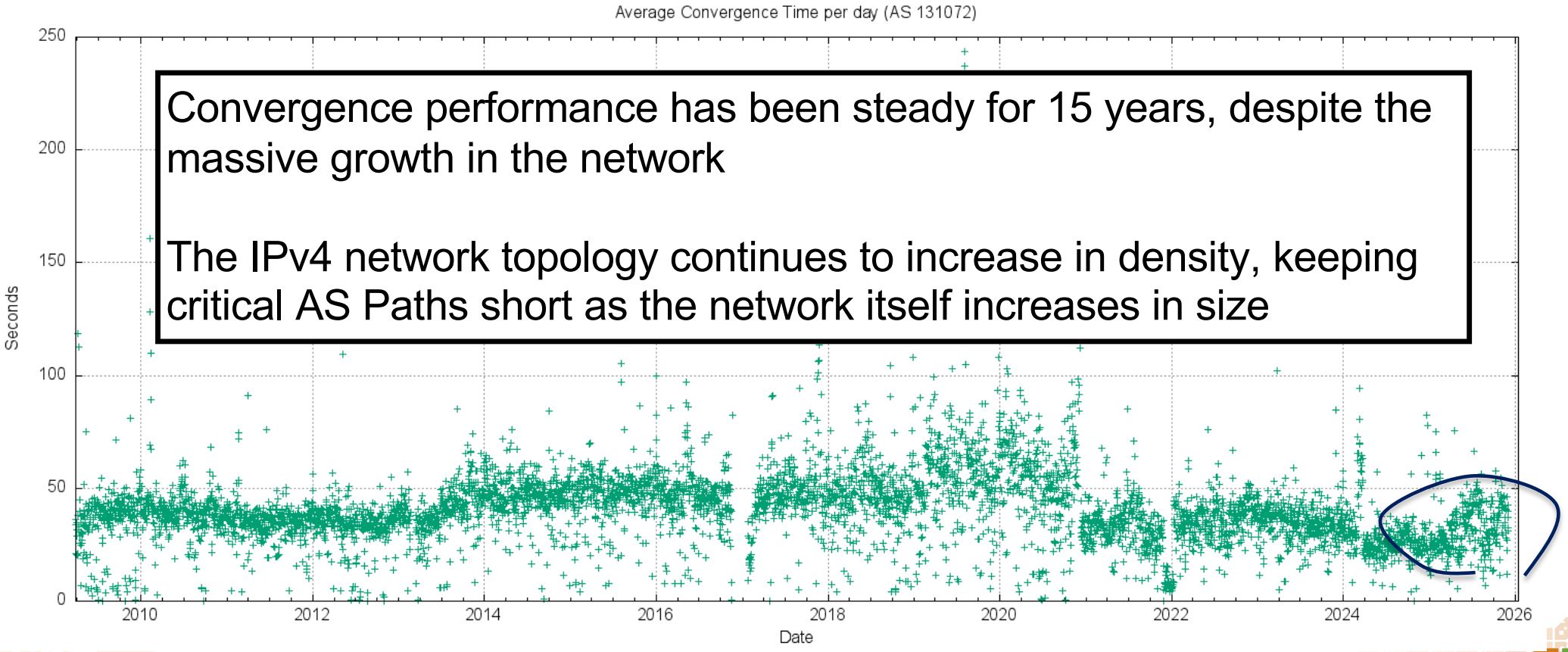
IPv4 Unstable Prefixes per Day



The number of prefixes that are the subject of updates has been slowly increasing over this 15-year period

The rate of increase of unstable prefixes is **far lower** than the number of advertised prefixes

IPv4 BGP Convergence Performance



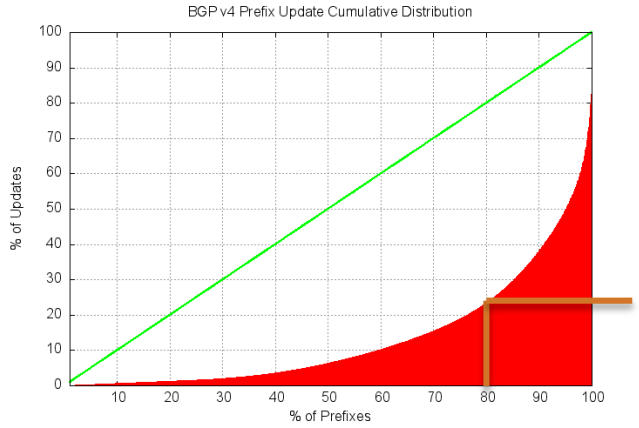
Convergence performance has been steady for 15 years, despite the massive growth in the network

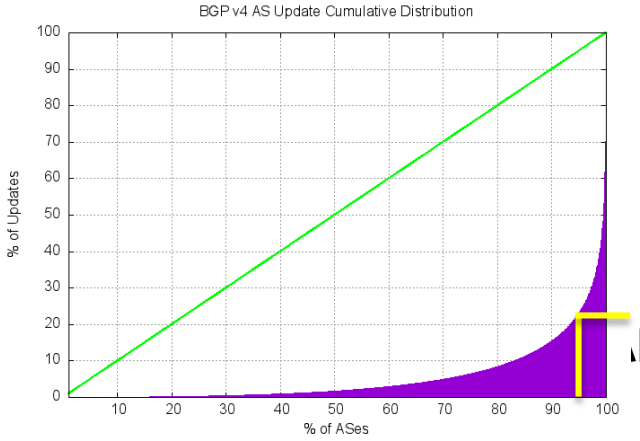
The IPv4 network topology continues to increase in density, keeping critical AS Paths short as the network itself increases in size

Updates in IPv4 BGP

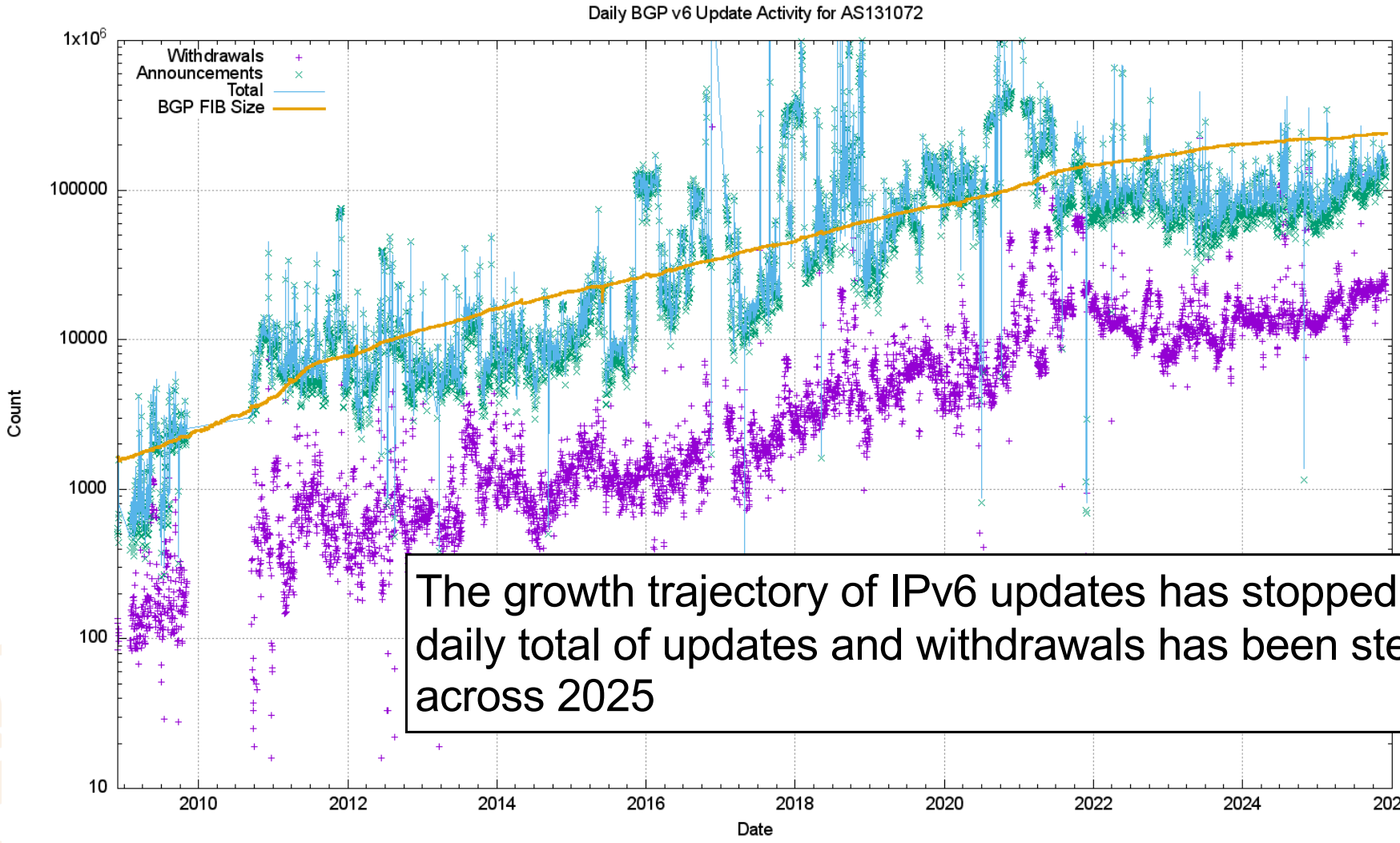
The IPv4 inter-domain routing system is highly stable …

- The number of updates per instability event and the time to converge to a stable forwarding state has been relatively constant for many years
- 20% of prefixes generate 77% of all updates. Less than 5% of all origin networks are linked to 78% of all updates. **Routing instability is concentrated in a small number of highly unstable cases.**





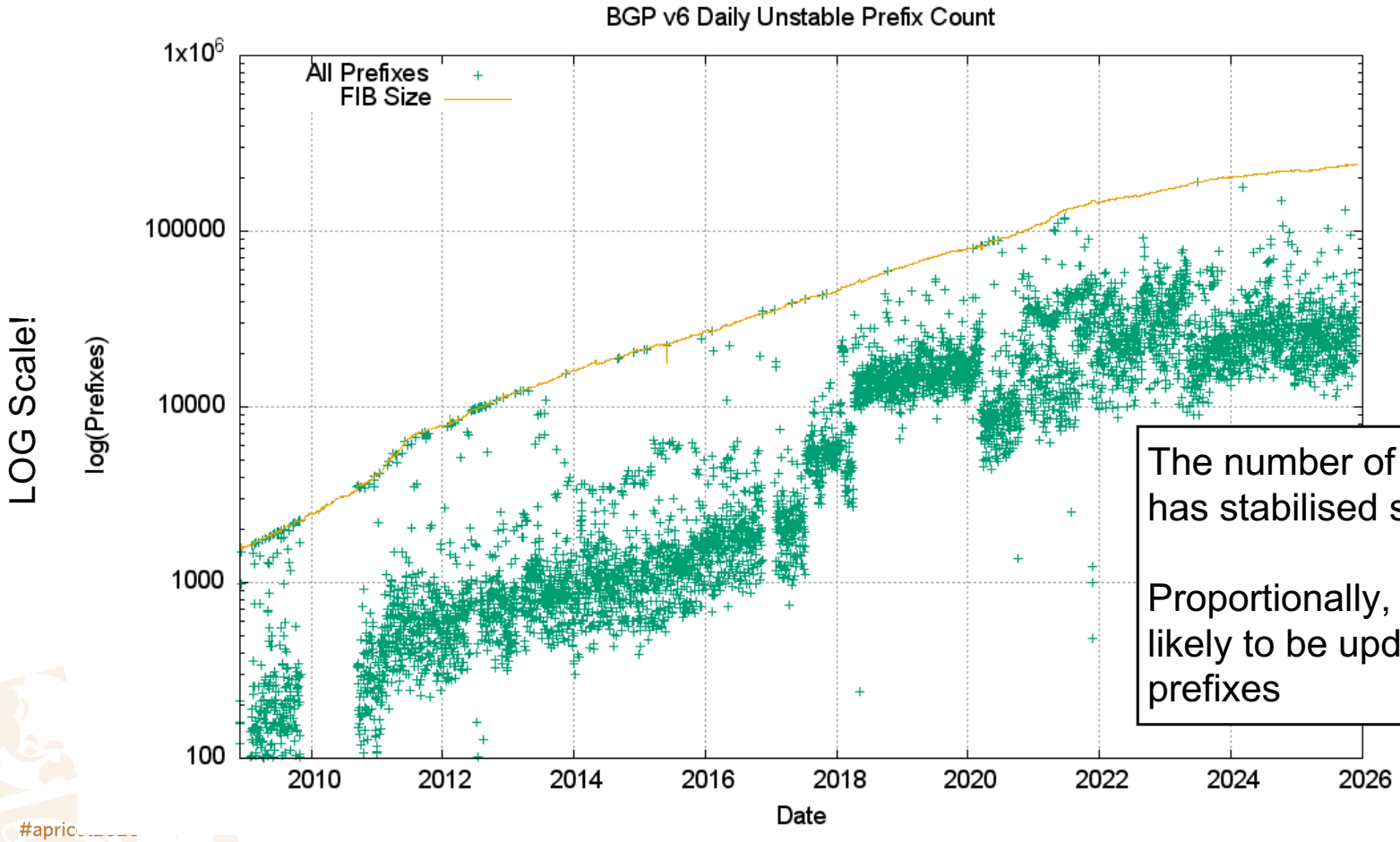
V6 BGP Updates



LOG Scale!

The growth trajectory of IPv6 updates has stopped, and the daily total of updates and withdrawals has been steady across 2025

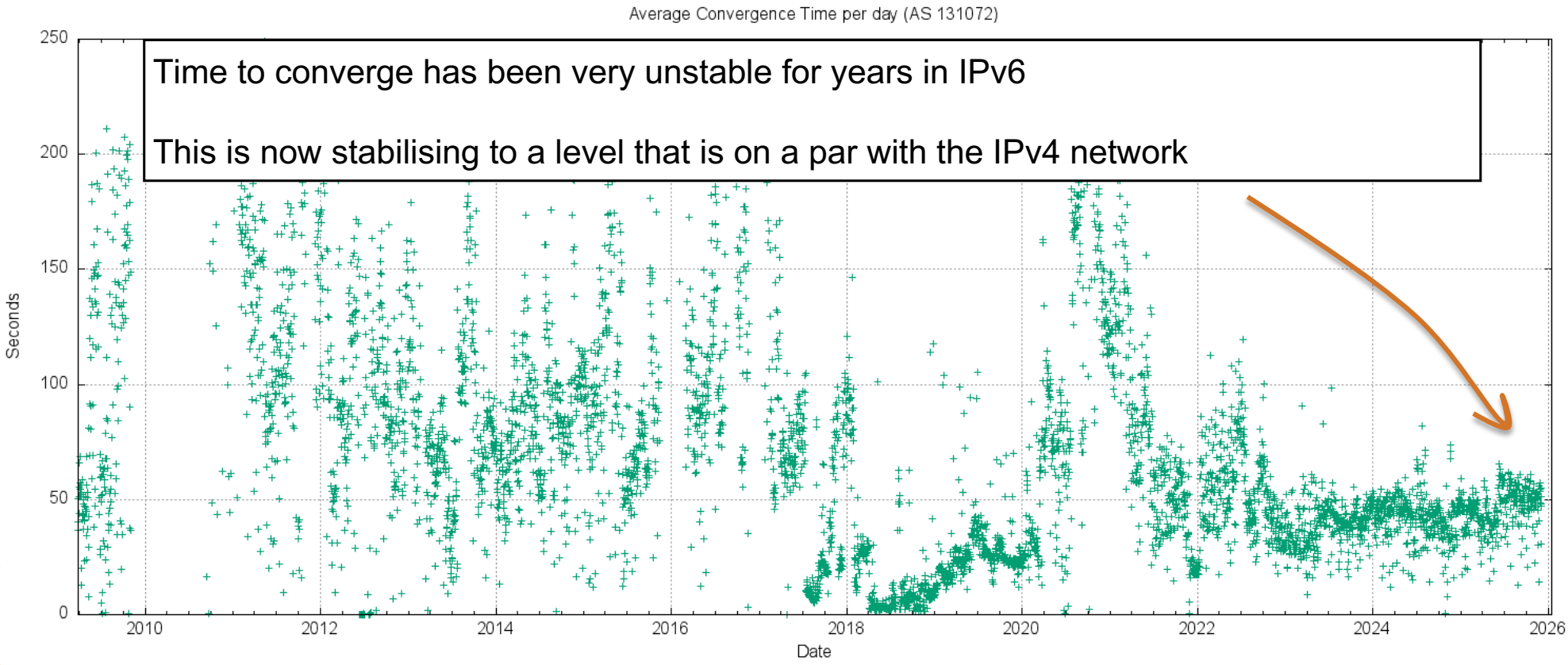
V6 Unstable Prefixes



The number of unstable address prefixes has stabilised since 2023

Proportionally, IPv6 prefixes are ~2x more likely to be updated as compared to IPv4 prefixes

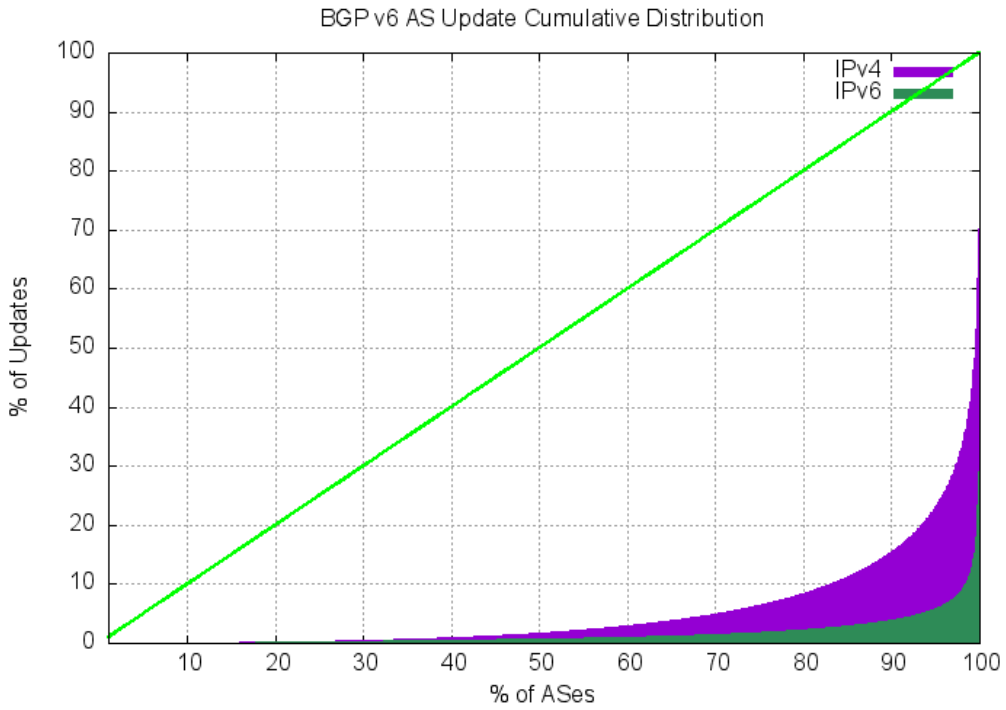
V6 Convergence Performance



Updates in IPv6 BGP

- Compared to IPv4, the IPv6 network has exhibited a high level of skew of routing instability, where a small number of networks contribute disproportionately to the overall level of BGP updates in IPv6.
- Just 3 AS's generated 20% of the BGP IPv6 update load in early December 2025. IPv6 routing instability is still concentrated in a small number of pathologically unstable cases.

https://www.potaroo.net/bgpupds/reports/v6-bgpupd.html



The Highlights

- IPv4 FIB Summary
- IPv6 FIB Summary
- FIB Projections
- Churn
- Conclusions

Routing Futures

- There is no further acute scaling pressure from BGP as a routing protocol – the relatively compressed inter-AS topology and stability of the infrastructure links tend to ensure that BGP remains effective in routing the internet.

- Instability levels are high, generally driven by a small set of highly unstable “super update generators”

Routing Futures

- The frenetic pace of expansion in the routing infrastructure of the Internet has slowed down in recent years. The IPv4 BGP network grew slightly in 2025, while IPv6 FIB size growth has slackened off

- The drivers for growth were the product of the population of networks with discrete routing policies and the need to balance incoming traffic across multiple paths (traffic engineering) – the rapid increase in the use of CDN platforms has reduced the dependence on transit routes to provide content and services to end users.

- Much of the overall volume of long-haul traffic has shifted to privately operated cloud platforms, and the demands on the public routed common infrastructure are in relative decline

Some Practical Suggestions

For those network operators whose service needs are dependent on the BGP network to some extent (which is mostly everyone)

Know your network's limits:

- Understand your routing FIB capacity in the default-free parts of your network
- There may be some default max prefix setting of ~1M FIB entries which will cause a BGP session shutdown when tripped
  - AS 4804 (Optus) in Australia appeared to encounter this situation in October 2023
- Use a max prefix exceeded setting which avoids session shutdown where possible

Some Practical Suggestions

Know your network's limits

Review your routers' settings

- Review your IPv4 / IPv6 portioning in the FIB tables - a dual-stack eBGP router will conservatively need a 1.2 M 32-bit IPv4 slots and 350K 128-bit IPv6 slots for a full eBGP routing table in line cards by 2026 if they are using a complete uncompressed eBGP FIB load (plus internal routes of course). That's roughly the same memory footprint for IPv4 and IPv6!

Some Practical Suggestions

Know your network's limits

Review your routers' settings

Default routes can be helpful

- Judicious use of **default** routes in your internal network may allow you drop this high-speed line card memory requirement significantly

Some Practical Suggestions

Know your network's limits

Review your routers' settings

Default routes can be helpful

Time for hot caching in line card FIBs?

- Using a hot cache for line card FIB cache would reduce the high-speed TCAM memory requirement significantly without visible performance cost

That's it!



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