

IPv6

The next or the last thing you will see as a network engineer?



What People Say

IPv6 is:

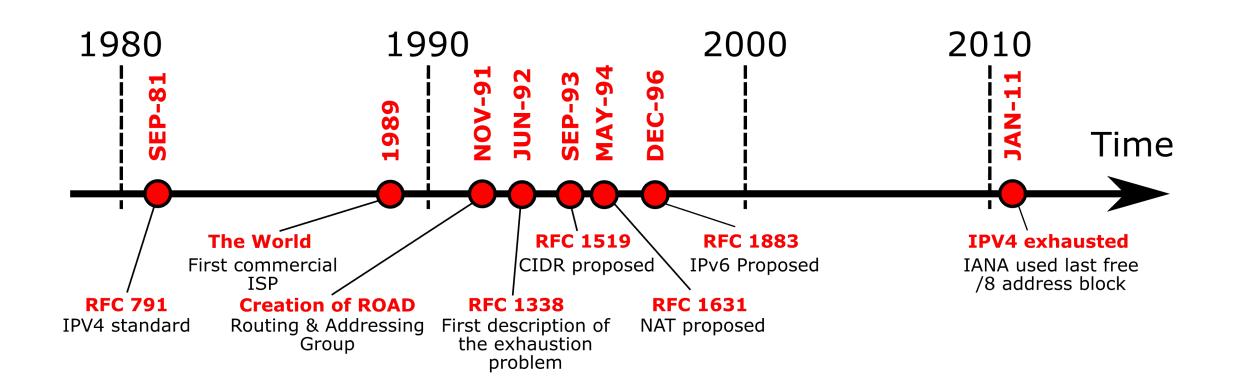
- Faster
- More Secure
- All Routing
- End-to-End Communication
- Firewall
- No NAT
- PI by sponsoring LIR
- Powering the Mobile World
- Better for VoIP and Multimedia

IPv6 is not:

- Using RFC1918
- Less Secure
- Hard to learn
- About addresses
- Hard to get
- Only for nerds or technicians

- Too new
- About extra fees for IPv6

But ...





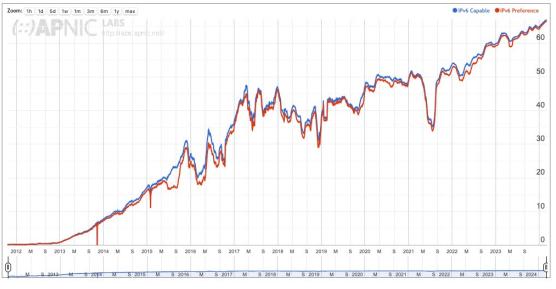
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Use of IPv6 for Ireland (IE)

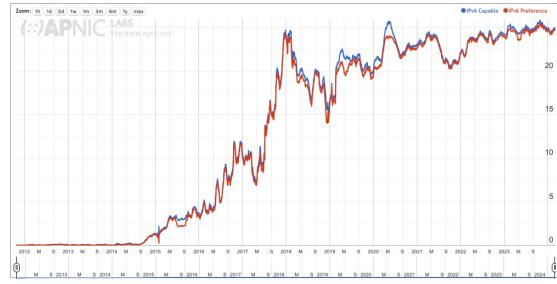
https://stats.labs.apnic.net/ipv6/IE

https://stats.labs.apnic.net/ipv6/DE

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Use of IPv6 for Germany (DE)





RFC 9386 - IPv6 Deployment Status

Table 2: IPv6-	Table 2: IPv6-Capable Users against Total Users (in Millions) as of January 2022									
	Jan 2018	Jan 2019	Jan 2020	Jan 2021	Jan 2022	CAGR				
IPv6	513.07	574.02	989.25	1,136.28	1,207.61	23.9%				
World	3,410.27	3,470.36	4,065.00	4,091.62	4,093.69	4.7%				
Ratio	15.0%	16.5%	24.3%	27.8%	29.5%	18.4%				

Table 3: Usage of IPv6 in Websites (as of January 2022)									
Worldwide Websites	Jan 2018	Jan 2019	Jan 2020	Jan 2021	Jan 2022	CAGR			
% of IPv6	11.4%	13.3%	15.0%	17.5%	20.6%	15.9%			

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RFC 9386 - IPv6 Deployment Status

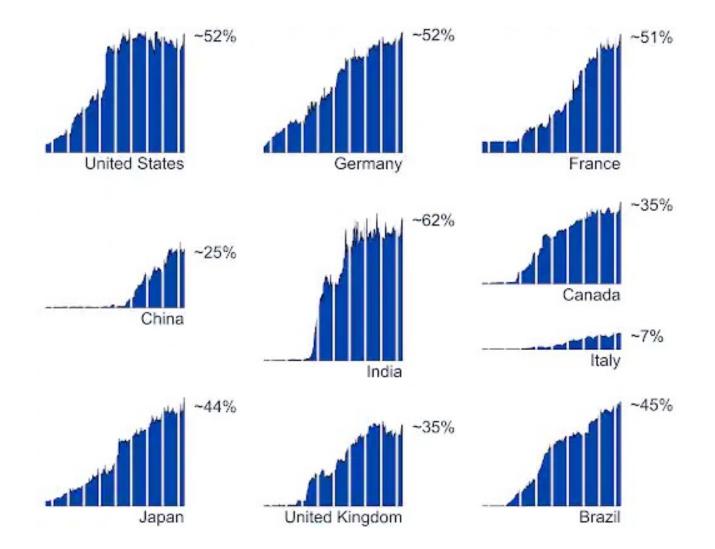
Table 7: IPv6 Support for External-Facing Services across Enterprises (as of January 2022)								
Country	Domains analyzed	DNS	Mail	Website				
China	478	74.7%	0.0%	19.7%				
India	104	51.9%	15.4%	16.3%				
United States of America	1070	66.8%	21.2%	6.3%				



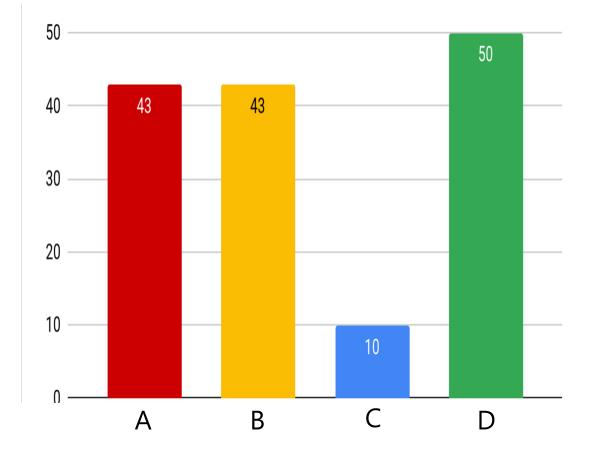
Deployment

2013-2022

Percentage of requests over IPv6 to a subset of dualstack sites on Akamai from July 2013 to May 2022 for top 10 global economies (by GDP in 2022, per IMF).



eco - IPv4/IPv6 Results



Question: "In your opinion, what stumbling blocks stand in the way of broad acceptance?"



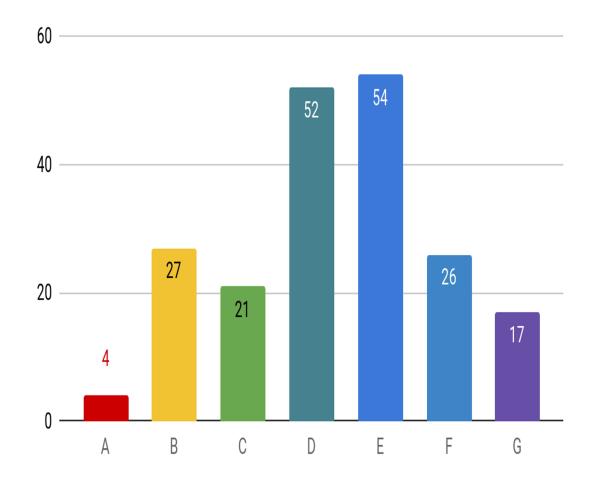
B No necessity

C Cost reasons

D Other

eco

eco - IPv4/IPv6 Results



Question: "Which of the following activities are most likely to apply to you? (multiple choice)"

IPv6 is a hype that we are not currently participating in

B We are still completely on IPv4 and are not currently planning a switchover

We are still completely on IPv4, but have concrete plans to switch to IPv6

D We are "halfway there", so to speak

E We mainly use IPv6, but we cannot do without IPv4 in the next few years

F We use over 90% IPv6

We consider IPv4 to be dispensable for our services from 2026 at the latest

Do you feel sufficiently informed?

I am not aware

of the latest

developments

I feel well

informed

IPv6 in use

since 2013

You have to actively look for information - but IPv6 should be a "debt to be discharged"! nave already successfully implemented several IPv6 projects.

Information from RIPE is known, but difficult to implement have been offering IPv4 and IPv6 in our data center for years

> We have been IPv6 ready for years!

Special topic; not the focus of perception

Manual for

the SOHO

sector would

help

IPv6 is well known. Protocol not a big hit. IPv4 / IPv6 will continue to exist in parallel Shared NAT64/DNS64 are available to our customers to reach IPv4 residual ramp

> We are pioneers in IPv6 introduction (telephone) and migration (DS-Lite+PCP)

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eco

What are the stumbling blocks?

"No know-how" and "costs" are used as an excuse

Inadequate address assignment by provider

No need as long

as IPv4

addresses are

available and

DualStack is

used

No attention in management

Customers

see no need

Perception: "IPv6 is extra work"

No need to exchange, sell or lease IP blocks Vocational schools still teach Class A/B/C networks

No time/resources for implementation!

> Layer 8 problem ;-

Knowledge gaps in the customer environment

Lack of awareness of necessity

too few services are IPv6 only

System compatibility with legacy hardware

eco

eco - Result

- No Know-How
- Vocational schools still teach Class A/B/C networks
- Information from RIPE is known, but difficult to implement
- Costs
- Customer see no need
- Not enough services on IPv6-only
- No attention in management (Layer8)



No Need?

	World IPv6 Launch (2012)	10 years later (2022)
Peak IPv6 traffic	~1 Gbps	41 Tbps (> <i>41,000 Gbps</i>)
Daily IPv6 requests	3.9 billion per day (and 8 million in 2011)	> 4,000 billion per day
IPv6 addresses observed per day	19 million	7.5 billion (across 2.2 billion "/64" prefixes)

How IPv6 traffic on the Akamai CDN has grown in the decade since World IPv6 Launch

https://www.akamai.com/blog/trends/10-years-since-world-ipv6-launch

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Schools - German UNIVERSITIES

IPv6-Status i

Institution	HTTP	DNS	MX	Groupware	IMAP	POP3	Submission	Webmail	VPN	Portal	<u>User-</u> Portal	IDP	NTP
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Duale Hochschule Baden- Württemberg 🗖	×	~	×	×	0	0	×	×	0	×	×	0	0
Hochschule Heilbronn 🛛	 Image: A start of the start of	-	~	×	~	~	✓	×	~	×	×	×	0
Hochschule für Technik Stuttgart 💈	~	~	×	×	×	×	×	×	×	×	0	×	0
Karlsruher Institut für Technologie	~	~	~	✓	✓	~	<	✓	A	~	~	~	~
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Hochschule Offenburg 🗱 🔽	~	~	~	0	~	~	~	×	~	×	0	~	~
Staatliche Hochschule für Gestaltung Karlsruhe * 2	~	~	~	0	~	0	~	✓	0	0	~	0	0

https://status.bwipv6.de

To be reached at: 193.196.32.30 2a00:139e:3:1:250:56ff:fe86:7e0d

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i Dies ist eine Übersicht des IPv6-Status der Projektteilnehmer am Projekt bwIPv6@Academia. Diese Seite gibt nur einen groben Überblick und hat keinen Anspruch, die reale Situtation vollumfänglich widerzuspiegeln. Insbesondere setzt der erfolgreiche Abschluss des bwIPv6@Academia-Projekts nicht die IPv6-Anbindung aller auf dieser Seite gelisteten Dienste voraus.

Kein offizieller Projektteilnehmer Status vom 05.03.24 um 17:00 | <u>Rohdaten (JSON</u>)

German ISP

- e.g. German Telecom (80% IPv6 Deployment 2023)
 - Fixed /48 IPv6 and /29 IPv4 Prefixes for ConnectIP
 - Fixed /56 IPv6 and /32 IPv4 Prefixes for Company PRO (xDSL)
 - Not Fixed /56 IPv6 and DS-Light (CGN) IPv4 Prefixes for Private Customer (xDSL)
- Almost all business operators in Germany offer IPv6 for companies with fixed addresses
- Wikipedia adoption level of 68% by June 2023

https://en.wikipedia.org/wiki/IPv6_deployment

• Google adoption level of 72.01% by March 2024

https://www.google.com/intl/en/ipv6/statistics.html#tab=per-country-ipv6-adoption



Governments

- 2030
 German Gov IPv6only, in 2022
 52% IPv6 Elster Tax
 - (Ripe84 Berlin)
- 2032 6th of June
 Czech Republic Gov IPv6-only
- 2025
 80% of U.S. Federal Networks
 IPv6-only
 (https://www.cio.gov/assets/resources/internet-protocol-version6-draft.pdf)

IPv6-only Websites:

- <u>https://clintonwhitehouse1.archives.gov/</u>
- <u>https://clintonwhitehouse2.archives.gov/</u>



HyperScalers

NETFLIX

... estimated 9 Mio IPv4 Addresses for their deployment at AWS ... only solution was IPv6

AWS

... \$0.005 per hour, \$43.0 per year per IPv4 Address

(<u>https://aws.amazon.com/de/blogs/aws/new-aws-public-ipv4-address-charge-public-ip-insights/9</u>)

Azure

... \$0.0036 per hour, \$31.536 per year per Basic IPv4 Address

Prices for IPv4 Space

• AWS

• AZURE

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IPv4	hour	year	IPv4	hour	year
1 Address (/32)	\$0.005	\$43.80	1 Address (/32)	\$0.0036	\$0.12
6 Addresses (/29)	\$0.03	\$262.80	6 Addresses (/29)	\$0.0216	\$189.22
14 Addresses (/28)	\$0.07	\$613.20	14 Addresses (/28)	\$0.0504	\$441.50
254 Addresses (/24)	\$1.27	\$11,125.20	254 Addresses (/24)	\$0.9144	\$8010.14

IPv6 enables better performance

Studies over the past few years show dramatic IPv6 performance improvements:

- <u>Facebook performed a study</u> in 2015 that showed that websites load 10%–15% faster over IPv6.
- Akamai's customer AbemaTV did a <u>case</u> <u>study in 2019</u>, which showed that IPv6 improved the throughput by 38% on average when compared with connections via IPv4.
- Apple announced <u>during the Worldwide</u> <u>Developers Conference 2020</u> that median connection setup times are 1.4x faster when IPv6 is in use when compared with IPv4.

IPv6 Performance:

- Websites load 10-15% faster
- Stream throughput improved by 38%
- Median connection setup time 40% faster

What could we do ...

- IPv6 mandatory at universities and schools
- Use NAT64 and DNS64 in the office
- Industry IPv6-only Support on Servers and Storage
- Switch Monitoring to IPv6
- Smart documentation cookbook to help the migration
- Supporting the day-to-day operation of IPv6 networks with smart tools and knowledge bases
- Offer more ipv6only services



Smart Cookbook

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Bidground * & Recourses	ation To get started and to efficiently navigate the 1000+ pages that comprise the Smartkit, read the introduction.	
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What are the people not using IPv6

Customer	IPv6 Activation	Fixed IP	lPv6 Präfix	lPv4 Präfix	IPv6 (March 2024)	Numbers (2021)
Consumer	Automatic	No	/56	Shared	72%	37.000.000
Mobile User	Automatic	No	/64	Shared	99%	
Small Business	Automatic	On Request	/56	/32	72 %	465.000
Midsized Business	On Request	Yes	/48	/29	20% ?	80.000
Enterprises	On Request	Yes	/48 (PI)	/28 - /24	0% ?	21.000
IP Transit	On Request	Yes	Supplied by Customer	Supplied by Customer		2.300 (RIPE Routed LIR)

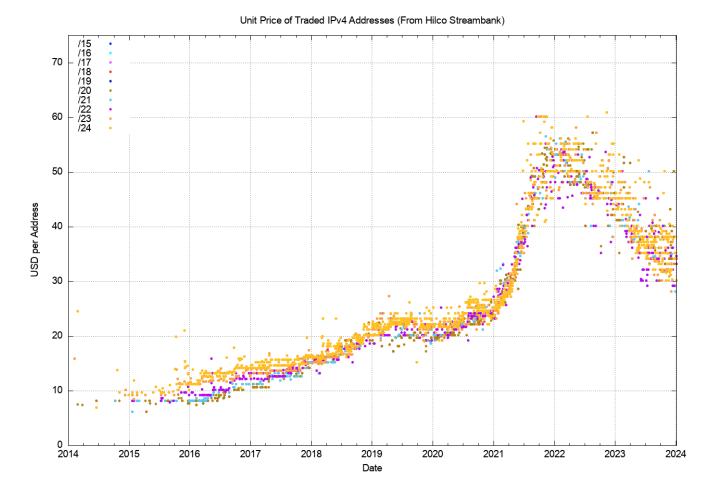
curl --location --request GET "https://stat.ripe.net/data/country-asns/data.json?resource=DE"

What else could we do

- Switch off IPv4 on IXP worldwide?
- Sell all your IPv4 space now!
- Test and use RFC like:
 - o RFC 8950

Advertising IPv4 Network Layer Reachability Information (NLRI) with an IPv6 Next Hop

RFC 7381 Enterprise IPv6 Deployment Guidelines



IPv4 Price Time Series (data from Hilco Streambank) from https://www.potaroo.net/ispcol/2024-01/addr2023.html

The next or the last thing you will see as a network engineer!

Stefan Wahl swahl@route128.net https://www.route128.net

