



# IPv6 - The next 10 Years...

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## Past, present and future...

Isn't:

- IPv6 cheerleading
- IPv4 sky falling
- An attempt to consider something prescribed

Is:

- A recap of the past 10 years of IPv6
- An objective observation of IPv4 today
- An attempt to get you to consider doing something relevant to your business



## The last 10 years...

### [World IPv6 Day](#) @ 2011

“World IPv6 Day was a technical testing and publicity event in 2011 sponsored and organized by the Internet Society and several large Internet content services to test and promote public IPv6 deployment.”

“World IPv6 Day was announced on January 12, 2011 with five anchoring companies: Facebook, Google, Yahoo, Akamai Technologies, and Limelight Networks.”

### [World IPv6 Launch](#) @ 2012

“Following the success of the original World IPv6 Day, the exercise was repeated on June 6, 2012 as the World IPv6 Launch, this time with the intention of leaving IPv6 permanently enabled on all participating sites. The event was billed as "this time, it's for real!"



# The definition of adoption

Adoption [ uh-dop-shuhn ]:

...the act of accepting, embracing, or starting to use something, as an idea, behavior, characteristic, or principle:

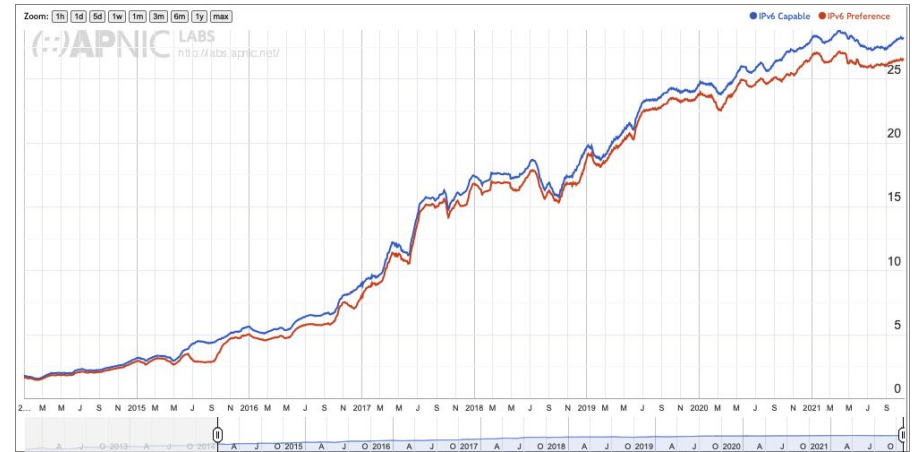
- The interpretation of adoption varies by the adopter
- Specifically for IPv6 business drivers vary widely



# eyeballs

## Adoption over time - Global

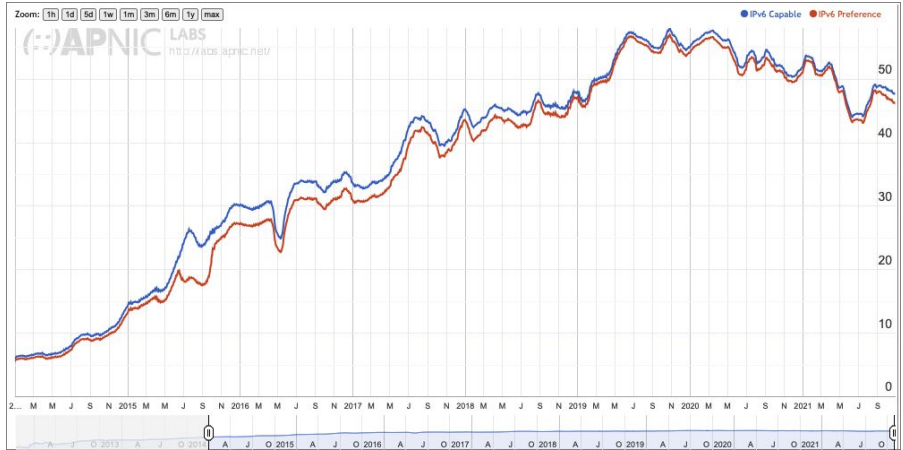
- ~1.66% preferred circa 2014
- ~26.54% @ October 2021
- Peak ~27.13% @ March 2021
- Average ~3.5% adoption per year
- Extrapolates to ~20 years to reach 100% adoption...



**Thank you APNIC!**

# Adoption over time - United States

- ~5.92% preferred circa 2014
- ~46.34% @ October 2021
- Peak ~56.89% @ October 2019
- Average ~5.77% adoption per year
- Extrapolates to ~7 years to reach 100% adoption...



**Thank you APNIC!**



# Revisiting motivations for adoption

In no particular order:

- Availability of IPv4
- Cost of IPv4
- Growth
- Operational efficiencies
- Performance 🤔
- End to end 😬

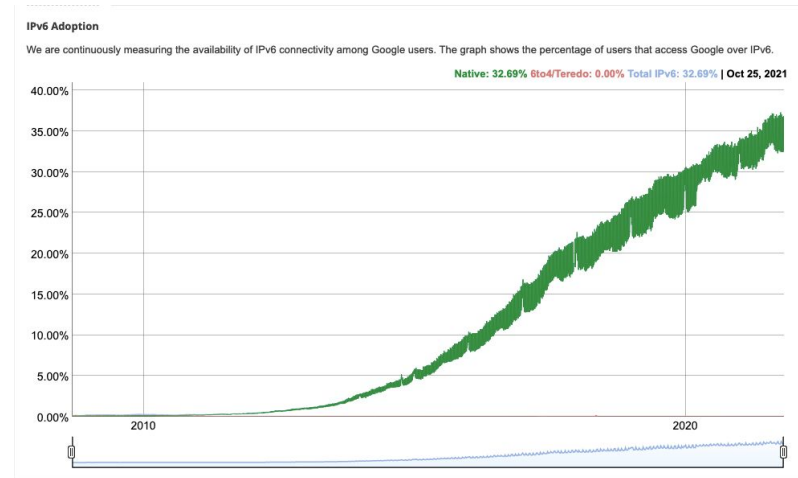




# Content

## More on adoption - Global

- ~0.14% September 2008
- ~32.69% @ October 2021
- Peak ~37% @ October 2021
- Average ~2.5% adoption per year
- Extrapolates to ~27 years to reach 100% adoption...

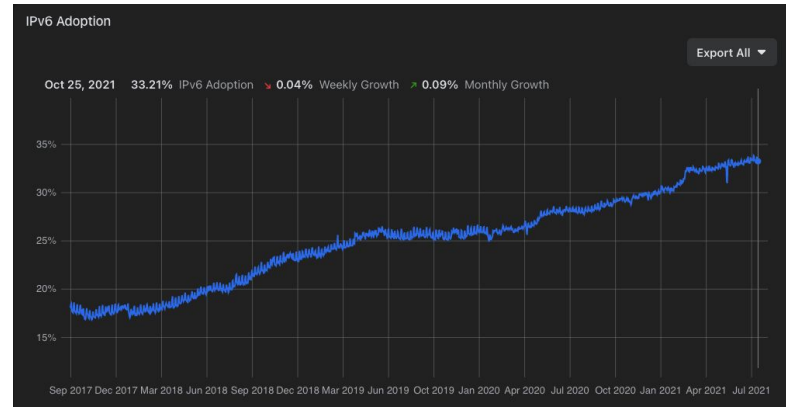


Thanks Google!

## A bit more...

Globally:

- ~18.46% September 2017
- ~33.21% @ October 2021
- Peak ~33.75% @ October 2021
- Average ~3.7% adoption per year
- Extrapolates to ~18 years to reach 100% adoption...

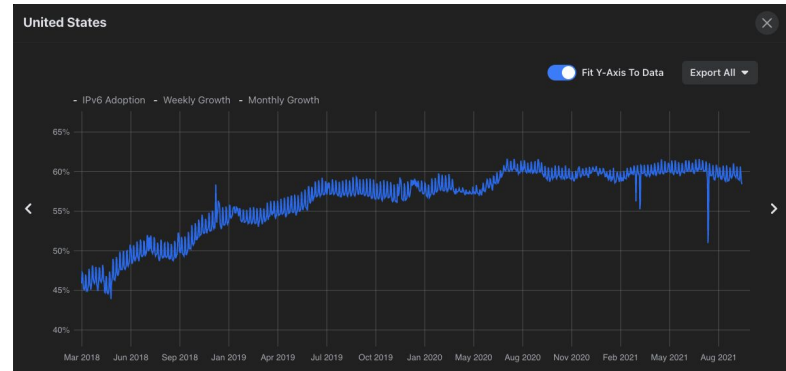


# Thanks Facebook!

## A bit more...

United States:

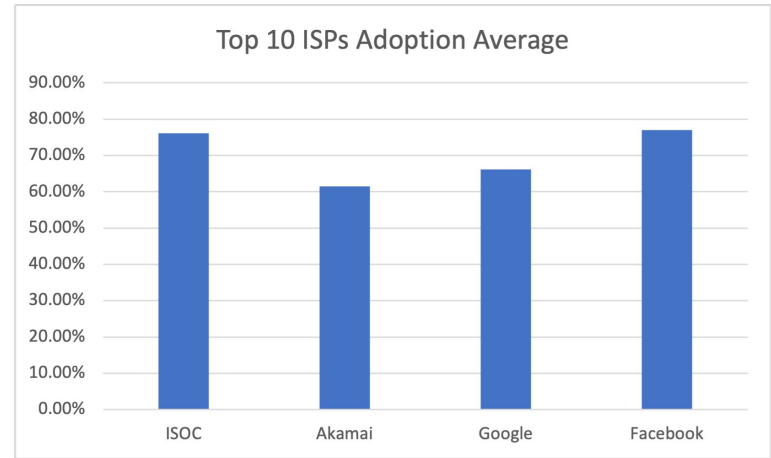
- ~47.13% February 2018
- ~60.61% @ October 2021
- Peak ~61.60% @ June 2020
- Average ~4.49% adoption per year
- Extrapolates to ~8.55 years to reach 100% adoption...



Thanks Facebook!

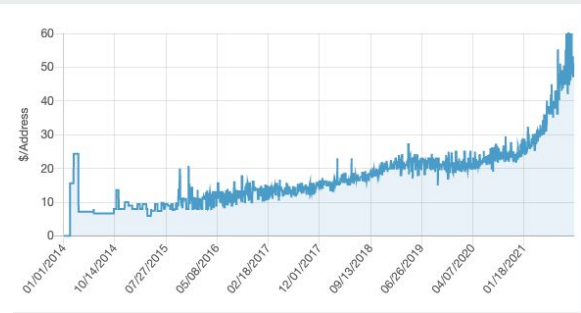
## Last one (I promise)

- Average adoption across the top 10 ISPs
  - From large content networks
  - ISP composition varies by data source
- Average ISP adoption ranges from ~61 to 77%
- Peak adoption reaches across three individual ISPs range from ~91% to over 94%
- So...what the problem?



# Reality check - IPv4

- The State of IPv4 today
  - Recent \$ per address \$51+
  - 7x increase since April 2014
  - 2x increase in the past year alone
- Supply, demand, and means are alive and well - today
  - The acquisition of IPv4 continues...for now.
- Sources:
  - [IPv4.GLOBAL](#)
  - [IPv4 Market Group](#)





## Reality check - IPv6

### Globally

- 2 of the top 10 sites are 100% IPv6 enabled
  - YouTube, Facebook
- Average is ~50% IPv6 enabled
- With one site having no IPv6 support (bug?)
  - Large e-commerce site in Asia

### United States

- 3 of the top 10 sites are 100% IPv6 enabled
  - YouTube, Facebook, Bing (?)
- Average is ~64-68% IPv6 enabled
- All support IPv6

# Thanks Alexa!

(Not that Alexa)



# A slightly different perspective

The specifics:

- Across the top 10 sites GLOBALLY the experience for each site is comprised of:
  - 1 to 120 URLs that point to a unique hostname
  - Average is ~43
  - Does not include relative resources
- Across the top 10 sites in the US the experience for each site is comprised of:
  - 2 to 45 URLs that point to a unique hostname
  - Average is 24-26
  - Does not include relative resources
- The percentage of IPv6 enablement cited previously is the % of the total experience that is IPv6 enabled
- Wait...there is more.





## A deeper dive

### Globally

- Three (3) networks serve over 70% resources embedded in the global top 10 sites
  - Tencent (39-51%)
  - China Telecom (33-45%)
  - Microsoft (28-33%)
- Two (2) support IPv6 today

### United States

- Three (3) networks serve over 79% resources embedded in the global top 10 sites (in order):
  - Amazon (73-75%)
  - Akamai (15-17%)
  - Fastly (9-12%)
- Each of the above supports IPv6 today

**This is NOT a measure of traffic**



# Assessing the experience

- Using the top 10 sites per [Alexa](#)
  - Global
  - United States
- Fetch and extract all embedded URLs from each site
  - Discard relative URLs
  - Determine support for IPv6 (DNS query for AAAA)
- For each hostname embedded within each URL
  - Determine support for IPv6 (DNS query for AAAA)
- For all hostname and IP address combinations (IPv4 and IPv6)
  - Fetch serving network via WHOIS



# Traffic vs Experience

## Traffic

- Illustrates ability to enable support for specific properties
- Does not necessarily illustrate ability to execute on completeness
- Illustrates scalability and performance
  - Addresses early concerns related to infrastructure vintage and implementations
- Does not represent ability to deprecate legacy support

## Experience

- Illustrates ability to execute on delivering a complete experience
  - The details
- End to end operationalization drives ongoing maintenance
  - Eating your own dog food helps
- Extends the confidence instilled achieved through scale and performance (👉)



# Observations

- **Brownfield IPv6 deployments**
  - Building something new that supports IPv6 by default is not hard (today)
  - Building something new that supports IPv6 only by default is hard work (and worth it)
  - Large scale migrations are complex
- **IPv6 not universally operationalized**
  - Applies to all types of networks, some more than others
  - Many companies that are show signs of reliable, comprehensively support for IPv6
- **Centralization is an opportunity, possibly**
  - Can be a advantageous and disadvantageous
  - Can expand IPv6 adoption, including the enterprise



# Transitioning

- Dual stack was just the beginning, not the end
  - Drove scale, performance, and reliability of IPv6
  - Opportunity to learn how to deploy support for IPv6 (for some IPv6 only)
- Transition technologies ARE being deployed
- Many will rely on IPv6 only
  - MAP-E/T
  - DS Lite
  - 464XLAT
- Result will be increased operationalization of IPv6



## Built on IPv6

- IPv6 only?
  - It depends.
- Innovation and simplification
  - Will not necessarily require wholesale, infrastructure-wide upgrades
- IPv6 Segment Routing (SR)
  - Requires IPv6
  - Does not require IPv6 SR support universally
  - IPv6 SR and multicast
- IPv6 only Kubernetes
  - IPv6 only Kubernetes networking
  - Dual stack ingress/egress



# June 6, 2032

3,868 days

- ★ Broad operationalization of IPv6
  - Motivated by costs associated with IPv4
  - Cloud driving the next phase
- ★ Comprehensive IPv6 experiences
  - Will vary globally
  - 100%?
- ★ Fueling innovation

...and

- ★ IPv4
  - Will exist, probably carried over IPv6
  - Will be monetized as a service

**Thank you!**

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