WHITE PAPER

The Insider's Guide to IPv6 and IP Decisioning Data

What the Latest Protocol Means for IP Decisioning Data, Your Industry and Your Network

neustar®

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OVERVIEW

About This White Paper

This white paper presents the insights and information you need to better understand the impacts of IPv6 on IP decisioning data, and on your industry and your enterprise:

- The many ways businesses gain value from IP decisioning data
- Insights into how quickly IPv6 is replacing IPv4
- How IPv6 addresses differ from IPv4, and what it means
- How IPv6 impacts IP decisioning data
- How IPv6 will impact key industries – and your enterprise
- Why the choice of provider for IP decisioning data is particularly critical now

IP decisioning data provides important insights into website or network visitors as they connect, whether registered or not, based on the IP address of their device.

Increasingly, those addresses use the IPv6 specification – and if your business relies on IP decisioning data, it's important to understand the implications of this new protocol.

IP decisioning data has been helping businesses with independent insights into users connecting to their digital assets for more than 20 years.

In that span of time, providers of this data such as Neustar have refined their expertise and processes to extract an expanding array of valuable insights, including geographic location, Internet connection data and more (see page 5).

Since none of these insights are revealed by the IP address on its own, Neustar has invested significant resources in a range of proprietary data collection practices, analytical algorithms, and data review procedures to uncover and enrich reliable, accurate data.

These investments ensure that our customers can power their decisioning engines with confidence.

So when the specifications for IP addresses change as dramatically as they are now with IPv6, those practices and procedures face an entirely new set of challenges.

As the market leader in IP decisioning data, we believe users of this data should understand these challenges, how they could affect decisioning data, and how providers can tackle them effectively to deliver ongoing accuracy and reliability in IP decisioning data.

CRUCIAL INSIGHTS, IMPORTANT APPLICATIONS

Every connected business has an interest in knowing something about the devices and people that connect to its online resources – especially when users connect anonymously.

IP decisioning data provides critical insights into all website or network visitors. These insights help organizations reduce fraud and comply with regulatory and licensing requirements while improving and personalizing customer interactions.

IP decisioning data delivers instantaneous information about each new user as they connect, independent of their input or participation, and compliant with global privacy regulations.

This information provides critical data that powers automated decisioning flows in a range of important business functions.

- **Fraud prevention,** by helping to identify potentially fraudulent logins and transactions so they can be flagged for review or even blocked
- **IT security and threat intelligence,** by helping to identify potential threats to the infrastructure and preventing access by unauthorized or suspect users
- **Legal and regulatory compliance,** by restricting or blocking unauthorized access to a website or content that could result in fines or penalties
- **OTT and streaming media content,** by ensuring eligibility for access to copyrighted, geographically licensed or otherwise restricted content
- **Gaming and gambling,** by preventing prohibited access by users in restricted or non-licensed locations
- **Customer experience and marketing,** by enabling geographically localized and targeted content, reducing friction throughout the online experience, and enriching user insights

Because of its versatility – and because the insights it provides during and after user sessions are simply not obtainable through any other non-intrusive source – IP decisioning data is in constant use in industries from financial services to retail and eCommerce, from OTT and streaming media to government.

What Insights Are Available?

Experienced providers have created an extensive tool kit of data gathering and analysis techniques to derive a surprising number of insights for each IP address.

Neustar UltraGeoPoint, for example, offers over 40 data points for any given IP:

- **The geographic location** of the device, from country down to postal code, with Confidence Factors that quantify the likelihood the location is accurate (see Building Confidence in Geolocation Data for more)
- **Connection information,** including how the device is connected to the Internet as well as line speed and routing type
- **Ownership data,** including the organization responsible for the IP address, the autonomous system number and top and second level domains
- **Proxy and anonymizer insights,** including VPN and corporate proxy information and anonymizer status

IPv6 ADOPTION RATES

The draft specification for IPv6 was first proposed in the last century (1994). Almost 20 years passed before it was launched into permanent production, in 2012.

However, after this slow start its adoption has grown steadily, with no sign of slowing. Many enterprises have not kept up.

IPv6 is no longer just the protocol of the future. It's here, and serving a significant and growing number of Internet users.

In August 2021, global IPv6 adoption stood at about 36%,[1] measured by users accessing Google's global platform. More importantly, the growth is trending steadily and inexorably upward. The current adoption rate is up from around 31.5% in August 2020, and from 27.5% in August 2019.

As the table on the next page shows, there are enormous disparities in adoption rates in different countries. But the trend is universally upward.

Behind the shift to IPv6. The reason for the expansion of the new protocol is simple: There's no alternative. The explosion in mobile and connected IoT devices, coupled with the constant addition of new Internet users, has exhausted the IPv4 address space. Evidence of this shortage can be found in steadily rising prices for IPv4 addresses available for transfer[2] – now up to approximately $40 per address.

In addition, IPv6 incorporates desirable security and transmission features as core components of the protocol, introducing some technological advantages over IPv4 (see page 8). In short, the shift to IPv6 will not slow, let alone change direction.

The enterprises challenge. The Google user data also shows a remarkable pattern of weekly spikes and dips, week in and week out. The dips occur during the work week; the spikes arrive every weekend. The reason, it turns out, is that more weekday traffic originates from enterprises that are still using IPv4 only. On weekends, more people use residential broadband services and mobile devices with IPv6 access.

The fact that enterprises are the cause of the pattern was confirmed by the effect of lockdowns for the COVID-19 pandemic, which are clearly visible in the data. In mid-March 2020, the dips suddenly became less pronounced as fewer people logged in to their IPv4-only enterprise network.[3]

Dubbed the "enterprise effect," the pattern is evidence of how much work still needs to be done in adapting enterprise networks to IPv6. Many organizations are clearly lagging behind.

1 Google has been tracking the availability of IPv6 connectivity among users since 2008.
2 This IP broker has charted cost data since 2014, when IPv6 began its steady growth.
3 The shift is evident in the Google data cited above, or see this blog post.

IPv6 Around the World

The prevalence of IPv6 varies widely by country. Generally North America and south and east Asia have the highest usage, while Africa and the middle east have the lowest.

This data for July 2021 is drawn from two sources: Google, which measures adoption[4]; and APNIC (Asia Pacific Network Information Center), which measures capability rate.[5]

India	74.95% (APNIC)
United States	49.49% (Google)
France	48.25% (Google)
Saudi Arabia	44.97% (Google)
Thailand	43.40% (APNIC)
Germany	41.43% (Google)
Japan	39.11% (APNIC)
Canada	38.73% (Google)
Brazil	38.67% (Google)
United Kingdom	33.05% (Google)
Australia	29.66% (APNIC)
China	19.02% (APNIC)
Russia	10.12% (Google)

4 Per-County IPv6 Adoption
5 IPv6 Capable Rate by Country

A CLOSER LOOK AT IPv6

The address space for IPv4 – the well that has run dry – comprises more than 4 billion possible addresses:

4,294,967,296

The IPv6 address space accommodates more than 340 undecillion possibilities:

340,282,366,920,938,463,463,374,607,431,768,211,456

It's a big difference, with major implications for IP decisioning data providers.

It's safe to say the address space for IPv6 won't run out. That's a good thing, as we may never need to adapt to another new protocol.

Another good thing: IPv6 has been designed to incorporate as part of the protocol a number of useful and important functionalities that are add-ons for IPv4, if they are incorporated at all. They include:

- More efficient routing without fragmenting packets
- Built-in quality-of-service functions
- Elimination of Network Address Translation (NAT)
- Built-in network-layer security
- Improved header structure that requires less processing overhead

IPv6 addresses have a completely different data structure. They use a 128-bit hexadecimal string of digits (0-f) instead of IPv4's 32-bit numeric (0-9) string. An IPv6 address also has many more characters, arranged in a different sequence and separated by different characters.

IPv4 format:
###.###.###.###

IPv6 format:
xxxx:xxxx:xxxx:xxxx:xxxx:xxxx:xxxx:xxxx

The switch from numeric to hexadecimal characters, along with the significant increase in character count, are necessary to accommodate the huge number of potential addresses. It also means that an IPv6 address carries far more data than IPv4 addresses could – with possible positive implications for the accuracy of IP decisioning data.

In addition to dictating a new addressing schema, the size of the address space has also led to dramatic changes in the way that CIDR (classless inter-domain routing) blocks will function.

As the accompanying table shows, IPv4 networks were divided into three classes for address distribution. CIDR blocks were distributed accordingly, with blocks of seven different sizes covering the three classes.[6]

Under IPv6, however, there are no formal network classes, and CIDR blocks are distributed in just two common sizes that are vastly larger – larger than the entire IPv4 address space in fact.

BIG differences, BIG implications. For decisioning data providers, adapting to IPv6 is almost like starting over in many important ways.

Consider the role of CIDR blocks. Over the years providers like Neustar have gained valuable real-world experience in the specific ways that different organizations distribute blocks of IP addresses. This experience has enabled providers to leverage CIDR prefixes to identify IPs that are likely to share important characteristics.

No such base of experience exists to help understand how organizations will handle the much larger blocks of IPv6 addresses, because organizations are still defining their distribution practices.

Similarly, while the greater data capacity of IPv6 addresses offers the promise of more granular information for decisioning data, the sheer volume of data involved presents a processing challenge many orders of magnitude greater than that for IPv4.

With IPv6, decisioning data providers seeking to identify insights for active IP addresses are now searching for roughly the same number of needles in a haystack that's about 10 billion times larger.

Address Block Sizes

Sometimes there's just no substitute for seeing numbers written out. This comparison of address block distribution sizes under the two protocols illustrates the enormous capacity of the IPv6 address space.

Common CIDR distribution sizes, IPv4

Network Size	No. of Addresses	CIDR Prefix
Class A (large)	16,777,216	/8
Class B (med)	65,536	/16
Class C (small)	4096, 2048, 1024, 512 or 256	/20 - /24

Common CIDR distribution sizes, IPv6

No. of Addresses	CIDR Prefix
79,228,162,514,264,337,593,543,950,336	/32
1,208,925,819,614,629,174,706,176	/48

6 See "IP Address Block Size Equivalents in Classful Addressing, IPv4 and IPv6," American Registry for Internet Numbers

THE IMPACT ON IP DECISIONING DATA: ACCURACY

Organizations rely on IP decisioning data for accurate, instantaneous insights into registered and unregistered users alike. Accuracy is vital to drive decisioning engines governing important functions.

IPv6 brings a new data structure for addresses and new patterns in address distribution and allocations – all in a vastly larger address universe. How will these changes impact accuracy?

There is no simple answer. The fundamental challenge for decisioning data providers has always been that IP addresses reveal very little useful information – geographic or otherwise – on their own. That won't change just because an address has more bits carrying more data.

Accurate determinations require providers to ingest, analyze and correlate data from a wide range of sources. For each IP address, for example, Neustar begins with proprietary data from a global data collection network that includes the address itself, traceroutes for data traveling to and from it, the routing type in use to reach the Internet, and information about the organization that registered it.

This data is processed and analyzed by sophisticated algorithms, and in many cases supplemented with third-party data from trusted sources, such as mobile carriers and ISPs, that provides important additional contextual information.

Answering the Accuracy Questions

Yes, the increased data density and granularity of a 128-bit address structure should allow IP decisioning data to become more accurate, thanks to greater specificity in each address – but only if your provider creates the processes to translate the denser data into more accurate insights.

Conversely, new practices in how organizations handle IP addresses will scramble existing processes to analyze IP address data for insights. That could introduce more uncertainty and inaccuracy – unless your provider is working overtime to create new processes specifically tailored to the IPv6 environment.

Your provider is the key to accuracy.

IPv6 doesn't change the need for this wealth of data. It does, however, change almost everything about the processes involved in converting it into accurate and useful insights.

As an example, consider the allocation of IP addresses. Under both protocols, addresses are allocated to organizations – ISPs, businesses or schools, government agencies, and the like – by a Local Internet Registry (LIR), National Internet Registry (NIR) or Regional Internet Registry (RIR).

But the allocations under the two protocols are not directly comparable, because with IPv6 organizations will receive huge blocks of addresses from the registries. As a consequence, the way organizations manage and assign IP addresses to users or devices will be very different:

- Under IPv4, a home with a cable modem generally receives a single IP address from an ISP
- Under IPv6, that same home may well be assigned a /64 subnet with more than **18 million trillion addresses**

How will the fact that a single home can now be assigned millions of trillions of addresses affect IP decisioning data – and the confidence of providers and users that it is accurate? It could work in opposite directions.

More confident: It may reduce reallocations: With addresses at a premium under IPv4, organizations are quick to reallocate to different users any addresses that become available. Decisioning data providers, therefore, have to constantly review their data to ensure than the insights for every active IP address have not changed due to a reallocation.

These kinds of reallocations will not be necessary under IPv6, so once location data and other information has been determined for an IP address, the insights are likely to remain accurate if the address remains active.

Persistence in allocations should improve accuracy.

Less confident: It will change range definitions: Ingesting and processing data to develop accurate attributes for billions of IP addresses is a big job. In the IPv4 world, providers have developed proven techniques that help focus their efforts and streamline these processes.

One such technique involves grouping IP address ranges into logical blocks that share the same or very similar attributes. This practice improves efficiencies with virtually no impact on accuracy as long as the address ranges are compact – typically fewer than 256 addresses.

With IPv6, when a single residence may have a range of trillions of addresses, providers must completely recalibrate their definition of a "compact" range. Doing so will require them to review, rethink and revise or reinvent their data practices as they gain experience with the way allocation ranges are working in the real world.

IP decisioning data providers must conduct this kind of recalibration and reinvention across all the processes affected by IPv6. A provider's commitment to this challenging and time-consuming work is the most important factor governing the value of their IPv6 data.

THE IMPACT ON IP DECISIONING DATA: PRIVACY AND USABILITY

For many organizations, the privacy compliance of IP decisioning data is almost as important as its accuracy.

IP decisioning data uses a non-invasive methodology, and when properly handled can be fully compliant with privacy laws and regulations around the world. Could IPv6 affect privacy compliance? And how will it impact data usability?

The impact of IPv6 on IP decisioning data is not limited to accuracy. The new protocol is affecting many other dimensions of this data as well.

Privacy issues. With the dwindling number of IPv4 addresses, ISPs and other organizations regularly reallocate them as a routine business practice, ensuring optimal usage of a limited resource. As recently as a few years ago, **5% to 7% of residential IP addresses changed every week.**[7]

While this practice creates more work for providers in checking and rechecking data accuracy to account for reallocations, is also means that IP addresses are unlikely to be persistently linked to users.

With IPv6, limitations on addresses no longer exist, and as a result, reallocations may become a thing of the past. We already considered the positive impact that persistent address allocations are likely to have on accuracy.

At the same time, however, persistent IP addresses could have different designation under the General Data Protection Regulation (GDPR) that governs data privacy in the EU, as well as other regulations such as the California Consumer Protection Act (CCPA), currently the de facto regulation in the US.

If an IP address can be persistently linked to a user, it could have a significant impact on the privacy compliance of IP decisioning data. As IPv6 continues to gain traction, this issue could drive ISPs to periodically reallocate addresses simply to address the privacy concern, but that remains to be seen.

Along the same lines, CIDR allocations, specifically the size of subnets and ranges, may have implications for privacy compliance; the smaller and more limited the range or subnet, the more likely the IP addresses associated with it could be linked to a specific user. Again, because industry practices are just beginning to take shape, the actual implications are not yet clear.

7 Based on a 2017 Neustar study of residential IP addresses

While the impacts may not be clear, the take-away is. If privacy compliance is important to your organization, make sure your compliance team tracks developments with IPv6 and PI – and make sure your IP decisioning data provider is doing the same.

Usability concerns. It's not only decisioning data providers that face challenges stemming from the size of the IPV6 address space. Users could be challenged as well. The potential issue is the sheer size of the IP decisioning data files that support decisioning engines.

We discussed the data processing efficiencies providers gain by grouping IP addresses into a single logical block, as long as they are part of a compact range and share the same attributes.

That practice also enables providers to condense their data files, reducing them from a possible 4.3 billion rows (one per IPv4 address) to several tens of millions of rows. The smaller file is obviously easier to work with at every step of the data handling process, for providers and users alike.

Now imagine the usability issues that would arise from an IP data file with 340 undecillion rows!

Providers like Neustar are already working on this issue, balancing the priorities of accuracy and granularity on the one hand against usability on the other.

Neustar and Privacy

According to the United Nations, 128 countries have legislation that protects consumer data and privacy. Violations often involve significant fines and penalties, as well as the potential loss of customer goodwill.

IP decisioning data has never been designed to locate devices to a specific home or business, or to identify a specific user. With the possible address persistence of IPv6, however, users of this data are far more likely to risk exposure to regulatory violations involving PI – unless your provider is taking steps to ensure that any PI is stripped from your data.

Neustar UltraGeoPoint data is fully compliant with GDPR, CCPR and other privacy laws and regulations. We have adhered to the principles of "Privacy by Design" in our products.

IPv6 IN INDUSTRY VERTICALS

IPv6 is universal and becoming more so. Sooner or later every enterprise will adopt it. The organizational goals and operational imperatives in different industries, however, mean the impact of IPv6 – and the benefits it can bring – differ.

What will IPv6 bring to your industry?

IPv4 is a legacy technology with a limited lifespan. It also is (or was) native to every network in every organization around the world, so its continued existence is supported by a lot of inertia.

However, the reasons to embrace IPv6 are persuasive: It is the protocol of the future – the only option for growth in users and IoT devices – and it offers technological advantages as part of its design.

The primary argument to adopt IPv6 is to serve more users through their native protocol, and that goal is common to every industry. Moreover, as the IPv6 share of Internet traffic continues to expand, manufacturers are increasingly likely to prioritize IPv6 connectivity in their most advanced and innovative devices.

Both reasons are strong arguments to embrace IPv6. In addition, specific technological advantages of the new protocol add benefits that are uniquely applicable to different industries.

- **Online gambling and multiplayer gaming.** The inclusion of network-layer security in IPv6 is important for online gaming and gambling operators. Longer persistence in IPv6 address allocations will also support more effective decisioning for regulatory and legal compliance, since a cleared IP address is far less likely to be reallocated to a new user who may be ineligible. IPv6 also improves performance with some gaming consoles, so IPv6-enabled gaming sites could enjoy a competitive advantage.

- **OTT and streaming content distribution.** As in the gaming and gambling industry, the persistence of IPv6 addresses will enable more effective compliance with geographic and other licensing restrictions. Streaming performance may also improve thanks to more efficient routing characteristics and quality-of-service features built into IPv6.

- **Healthcare.** The use of medical IoT devices was already climbing. The enormous surge in telehealth adoption driven by the COVID-19 pandemic has only accelerated that growth, with healthcare organizations adding everything from connected video monitors to wearable biosensors to smart thermometers. New devices will surely be built around the new protocol, making an IPv6-compatible infrastructure an imperative. The additional security features are also important in healthcare.

- **Retail.** The desire to accommodate the ever-growing number of IPv6 shoppers may be paramount, but improved network performance with IPv6 can also add incremental revenue in ecommerce applications, since every millisecond delay in a page load leads to higher abandonment rates.

- **Government.** A 2005 US federal government initiative regarding IPv6 was instrumental in helping to jump-start adoption of the protocol. Recently, the government's goals for IPv6 were accelerated. Now, by the end of FY2023, US government agencies are required to use IPv6 only in at least 20% of their IP-enabled assets. The requirement grows to 80% just two years later.[8] The principal motivations for the new policy are the technological advantages of IPv6 and the faster pace of innovation in IPv6 networking devices and components.

8 US Office of Managmenet and Budget memorandum, November 19, 2020

IPv6 IN YOUR ENTERPRISE

Your organization is undoubtedly planning an IPv6 adoption strategy, or has already implemented one.

A detailed consideration of the issues and options involved is well beyond the scope of this whitepaper. But we highlight a few noteworthy issues regarding implementation and security.

Most enterprises begin the transition to IPv6 capability using either network address translation-protocol translation (NAT-PT), which translates IPv6 packets to IPv4, or "tunneling" IPv6 by encapsulating its packets within packets of IPv4. Both options accept IPv6 traffic in an IPv4-only infrastructure.

There is also a kind of super NAT – carrier grade network address translation (CGNAT) – that has been adopted by some ISPs. This technology uses a private network to proxy multiple users behind a single IP address. However, this approach introduces latency issues from the additional proxy layer that particularly affect gamers, financial traders and any other users who rely on genuinely immediate responses.

The next step up from the stop-gap solutions of translations and tunneling is a dual-stack installation, in which network devices (computers, switchers, routers) run both protocols, with IPv6 generally preferred. Currently, virtually all recent operating systems and network devices employ dual stacks.

Dual stack is unquestionably a more robust approach to IPv6, but it introduces significant additional complexity into network applications and security. In mandating the accelerated shift to an IPv6-only infrastructure, the US government – no stranger to complexity – recognized the dual stack approach is "overly complex and unnecessary."[9]

9 US Office of Managmenet and Budget memorandum, November 19, 2020

Security concerns. IPv6 isn't inherently more or less secure than IPv4; the built-in security features of the new protocol have generally been applied as after-the-fact additions to IPv4.

However, any new technology – particularly one as fundamental as an Internet protocol – expands security risks by introducing new vulnerabilities. In addition, many of the operational details and security implications of IPv6 are new to IT security teams, increasing the chances of inadvertent lapses or an error in security design and practice, which are responsible for the vast majority of security failures.

IPv6 has important differences that security teams must consider. For example, the new protocol supports address autoconfiguration, which can result in network endpoints accepting IPv6 traffic without your team even realizing it's happening.

Another example: in IPv6, the vast size of Autonomous Systems provides bad actors with many more places to hide, increasing the chances of an undetected breach.

IT security teams must recognize that they are facing new challenges with IPv6, learn the new vulnerabilities it introduces, and identify tools, data and solutions that will be help them address the issues and ensure their IPv6-enabled infrastructure is secure.

IP DECISIONING DATA IN THE IPv6 FUTURE

For 20 years, IP decisioning data has delivered essential insights that support instantaneous decisioning for critical online applications – all while respecting stringent privacy regulations.

IPv6 introduces significant new challenges. Can you continue to rely on accurate IP-derived insights for your applications?

The answer hinges on your provider.

There has never been an absolute truth set for the geographic and other insights provided by IP decisioning data. Accuracy, and therefore value, has always been driven by the quality and depth of the data sources, analytical tools, and review and confirmation practices of individual providers.

All of this is more true now than ever.

The characteristics of IPv6 bring the potential for both enhanced accuracy and granularity, and for significant challenges to accuracy, coverage and utility.

How these interrelated characteristics ultimately affect the value of the data your organization uses every day depends almost entirely on your provider, and on the investments they make in adapting their processes, practices and expertise to IPv6.

- **Investing time to gain experience.** Testing and refining data collection practices and location assignment algorithms to address the challenges of IPv6 is time-consuming, iterative work. Neustar began the process in 2015.

- **Investing in data resources to improve accuracy.** Providers must amplify their public or proprietary data sources with additional information only available from reputable, trusted third party sources, such as ISPs and mobile carriers, to unravel many of the questions associated with the new protocol.

- **Investing in human resources to refine processes.** Resolving the ambiguities inherent in IP decisioning data requires informed, experienced human judgement. At Neustar, our Network Geography Analysts are leveraging their considerable experience in routing technologies and network topologies to refine and improve our IPv6 decisioning insights.

- **Above all, investing in accuracy.** Now more than ever, providers must be fully committed to continually review and improve the accuracy of their IP decisioning data. They should incorporate controls over data sourcing and processing that include automated error detection and regular reviews against manual mapping to check and refine algorithms. And they should have established procedures to enable clients to provide direct feedback when inaccuracies are discovered.

Accurate IP decisioning data is too important to leave to chance. If your provider isn't on top of the implications of IPv6 – and already working to deal with them – the quality, accuracy and completeness of the insights you depend on are already suffering.

If you provider is making these investments, you can expect your IP decisioning data to continue gaining in accuracy and value in the new world of IPv6.

LEARN MORE

To learn more about how Neustar UltraGeoPoint can support your business needs during the transition to IPv6, **click here**, email us at **risk@team.neustar**, or call us at **1-855-898-0036 x4** in the US and at **+44 1784 448444** in the UK.

ABOUT NEUSTAR

Neustar is an information services and technology company and a leader in identity resolution providing the data and technology that enables trusted connections between companies and people at the moments that matter most. Neustar offers industry-leading solutions in Marketing, Risk, Communications, and Security that responsibly connect data on people, devices and locations, continuously corroborated through billions of transactions. Neustar serves more than 8,000 clients worldwide, including 60 of the Fortune 100. Learn how your company can benefit from the power of trusted connections here: https://www.home.neustar.

WP-SEC-343452-09.27.2021