

IPv4 White Paper

State of the Market & Predictions

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Introduction

The American Registry for Internet Numbers (ARIN) ran out of IPv4 addresses in 2015. While this was widely expected by industry experts, it served as a wakeup call to corporations that were un-informed and reluctant to deploy IPv6

The precedent for the private market for IPv4 was established when Microsoft purchased 666,626 IPv4 addresses from Nortel Networks in 2011. Since then, the depletion of IPv4 address space in four of the five Regional Internet Registries (RIRs) and the growing needs of corporations who wish to serve their clients are now responsible for a bustling secondary market for available IPv4 assets. While the sale price per IP has steadily climbed over the last few years, past behavior cannot be a guarantee of future performance due to a combination of factors. Chief among them is the continued, albeit slow, adoption of IPv6 which has enough address space to meet the world's growing needs for connectivity and has the potential to eventually obviate the need for IPv4 space.

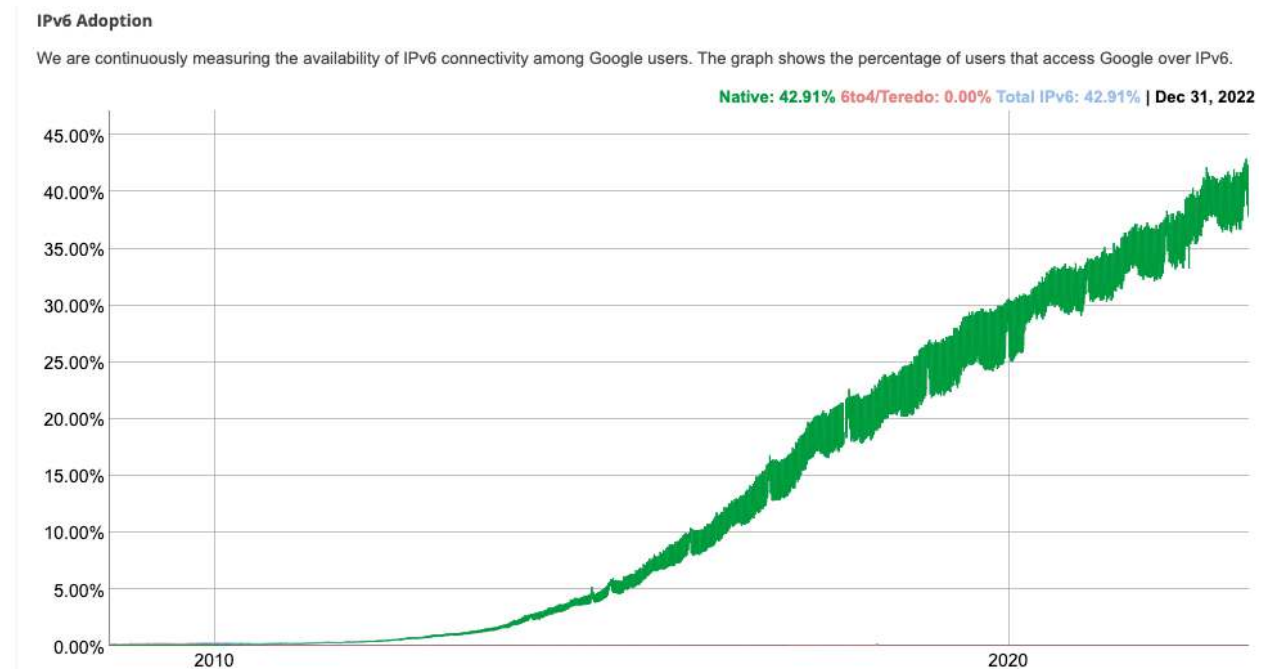
Therefore, a balance will continue to unfold over the next few years in which the factors of supply and demand will determine the price of IPv4 assets. In this whitepaper, we will study historical data and make informed predictions which will serve as a guideline to help you make the best decisions for your business, regardless of whether you are buying or selling IPv4 assets.

IPv4 and IPv6 Backstory

The IPv4 protocol was developed in 1974 by Vince Cerf and Bob Kahn, and was established as the standard in 1981 with 4.3 billion IP addresses available. The population of the world in 1974 was only 4 billion, so the decision was made to go with 32-bit address space which would allow for the entire population to be connected.

In the early days, the Internet Assigned Numbers Authority (IANA) managed and distributed free IPv4 addresses to organizations that seemed to show a need. In fact, they would basically give out class B networks to anyone who wanted to participate in the internet at that time. In the late 1990's and early 2000's, five Regional Internet Registries were created worldwide to deal with issuance of IPv4 addresses around the world. These were named American Registry for Internet Numbers (ARIN), Réseaux Internet Protocol Européens (RIPE), Asia Pacific Network Information Centre (APNIC), Latin America and Caribbean Network Information Centre (LACNIC), and African Network Information Centre (AFRINIC). As network providers and corporations increasingly came online, the need for IPv4 space grew exponentially faster than originally expected. Over the last two decades, efforts by governments and corporations to expand internet connectivity to the masses, and the drastic increase in mobile devices and IoT, have caused exhaustion of freepool IPv4 space in four of the five Regional Internet Registries.

In response to the looming shortage of IPv4 addresses, the IPv6 protocol was launched to account for the world's growing needs. IPv6 allows for 340 trillion³ available addresses. While the new protocol was formalized as the successor to IPv4 in 1998, IPv6 adoption has been slow due to a number of reasons, some of which are listed in a later section. According to Google statistics, global adoption of IPv6 sits at only 40%. India leads the pack with 50%, the United States is at 36% adoption, while most countries are far behind. These statistics demonstrate the continued demand for IPv4 needed to support network development globally. Figure 1 below shows the IPv6 adoption trend worldwide.



To date, four of the five Regional Internet Registries have depleted their free IPv4 space. The depletions occurred on the following dates:

- APNIC (Asia Pacific Region): 15th April, 2011
- RIPE (European Region): 14th September, 2012
- LACNIC (Latin American Region): 10th June, 2014
- ARIN (North American Region): 24th September, 2015

ARIN, RIPE and APNIC have always had inter RIR agreements to allow for IPv4 transfers between their 3 regions. As of 2022, LACNIC created a policy to allow for inter-RIR transfers with ARIN, RIPE and APNIC as well and continue to grow their IPv4 transfer contributions.

There is some IPv4 space available in AFRNIC RIR, which is scheduled to be allocated to African region. However, AFRNIC IPv4 users typically have many issues and AFRNIC does not have inter-RIR agreements with any region, which prevents them from transferring IP ranges to ARIN, RIPE, APNIC or LACNIC. Therefore, any available IPv4 within AFRNIC holds far less value, if any, in the global IPv4 marketplace.

Secondary Market Is Born

As the Regional Internet Registries (RIR's) started to run out of IPv4 address space, many corporations, cable companies, ISP's and data hosting providers came to a realization that they needed to secure additional IPv4 addresses to fuel and support growth. Microsoft led the pack in 2011 when it paid Nortel Networks \$7.5 Million dollars for 666,626 IPv4 addresses. Since then, the private market has materialized and continues to grow year over year.

There are a few reasons for the private or secondary market. It is widely known that many IPv4 allocations were issued in the early days of the internet, when there was relatively small demand and most of the IPv4 address blocks were available for distribution. This led to large IPv4 subnet allocations to organizations who didn't actually have a need. Many of those blocks were unused, in-efficiently used, and even forgotten about as corporations grew, were acquired or ceased to exist. The IPv4 private market created financial incentives for companies to invest in efficiently renumbering their IPv4 blocks so they can sell their unused IPv4 inventory to organizations who have a need.

Regional Internet Registries track and maintain a list of IPv4 blocks and respective assignments as a protector of a company's claim to the underlying IPv4 asset. For any IPv4 transfer to occur on the private market, the Regional Internet Registries must review, approve and update their assignments of the IPv4 space to the new owner.

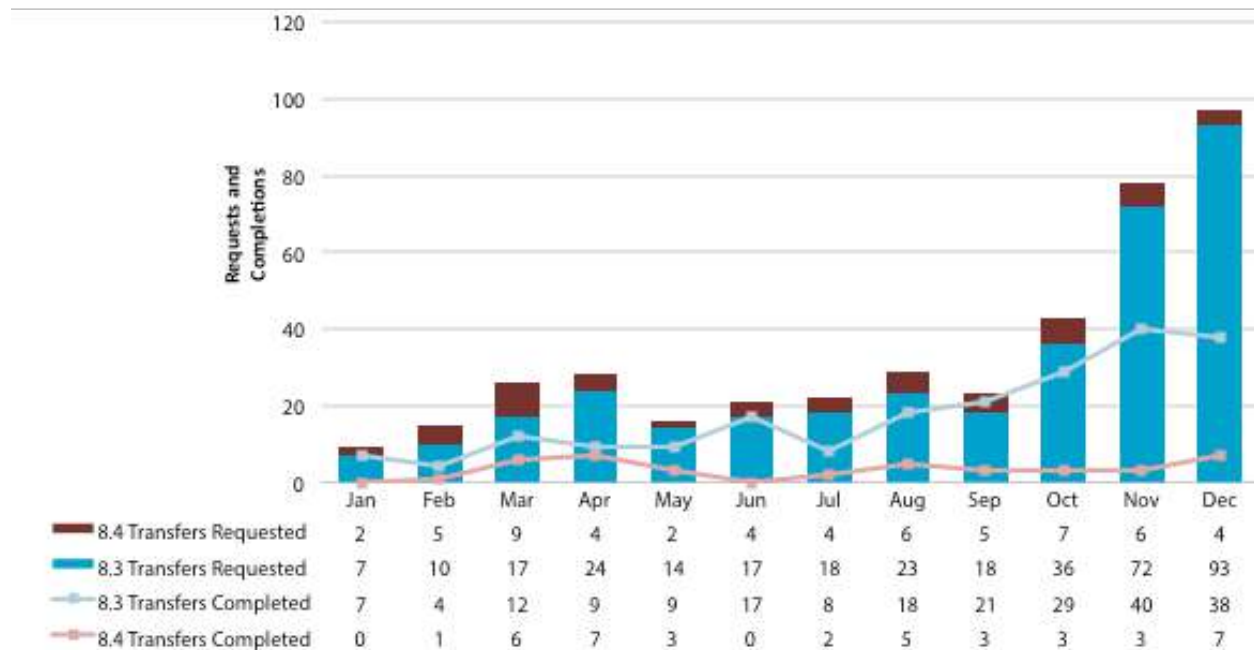
IPv4 Trends: Digging into Market Data

We analyzed ARIN's publicly available market data to get a sense of the industry trends. The data sets provided by ARIN below include 8.3 (transfer within ARIN region) and 8.4 (ARIN to RIPE or APNIC) transfers. For the sake of keeping this analysis simple, we will focus on 8.3 which focuses only on ARIN to ARIN. Number of transfers requested refers to the demand, while transfers completed refers to the supply.

2015 Market Summary

Let's start by looking at the chart below which displays transfer data from 2015. This was the year that ARIN announced that IPv4 reached exhaustion. You can see the excitement and true necessity of IPv4 as the 8.3 transfer requests increased rapidly over the year. Most noticeable, the 200+ requests for IPv4 in Q4 of 2015, which was 250% higher than the average of the first 3 quarters.

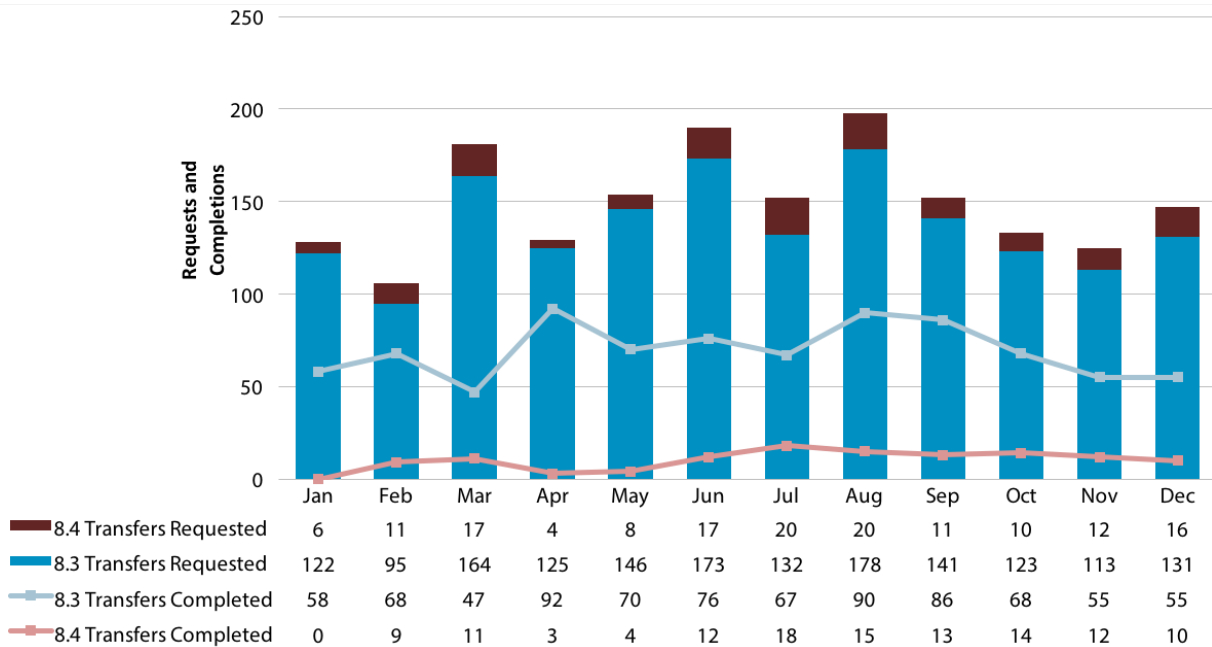
This was the first indication that we had strong market demand in the making. At this time the market was new, with relatively little information available. Compared to the high number of requests, the number of actual completed IPv4 transfers was only around 60% for the entire year. This left over 130 companies that needed IPv4 waiting on the ever-expanding list of underserved transfer requests.



2016 Market Summary

The first quarter of 2016 started out strong with an increase in demand of IPv4 of 90% in Q1 over Q4 of 2015. The first quarter would see a completion rate of only 45%, which would be a strong indication of an underserved market and things to come. The remainder of the year would see a steady growth of demand for IPv4, with a consistent lack of completions.

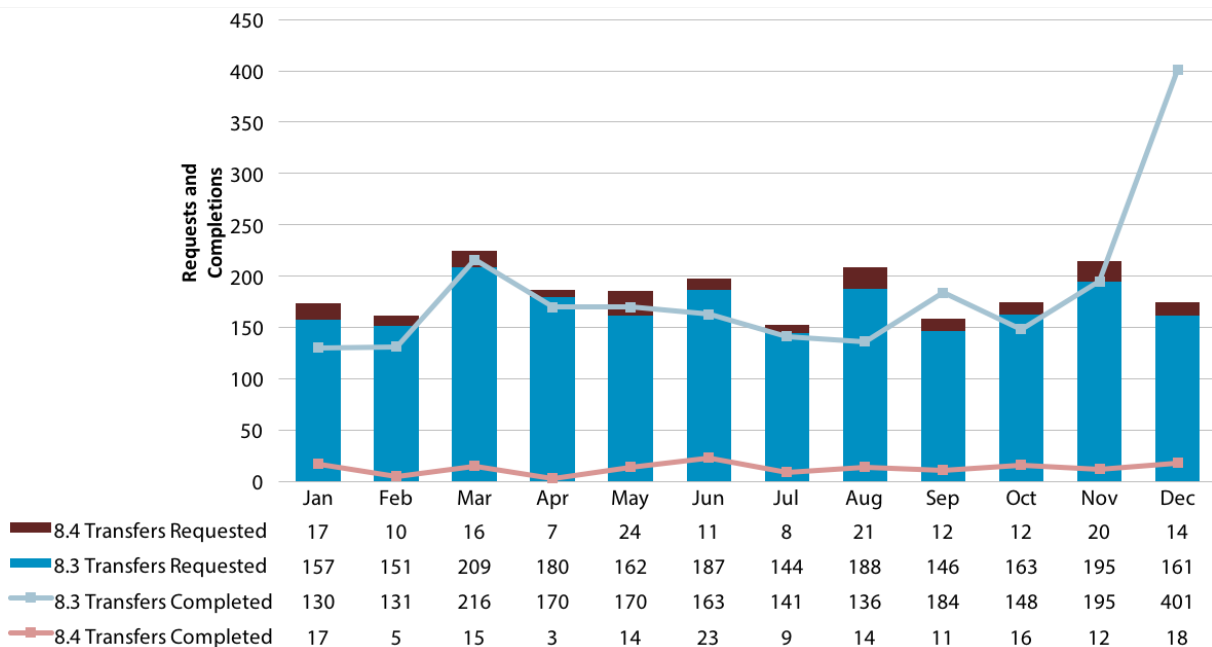
By the end of the year in 2016, the total number of requests exploded to 1643 vs only 349 in 2015, demonstrating an increase of around 370% year over year growth in demand. Once again, the market fell short in supplying the requested IPv4, which only allowed 50% of the requests to be filled.



2017 Market Summary

2017 continued to demonstrate a very strong growth in demand for IPv4. Q1 had a 41% increase of IPv4 requests over the previous quarter ending 2016. We also see for the first time that completions reached over 90% in Q1. This was the first year we had an indication that the awareness of IPv4 was catching up, and more supply was entering the marketplace. The remainder of the year continued to see all-time highs in number of requested IPv4, however we would also see the completions rate finally reaching over 95% in Q2 and Q3.

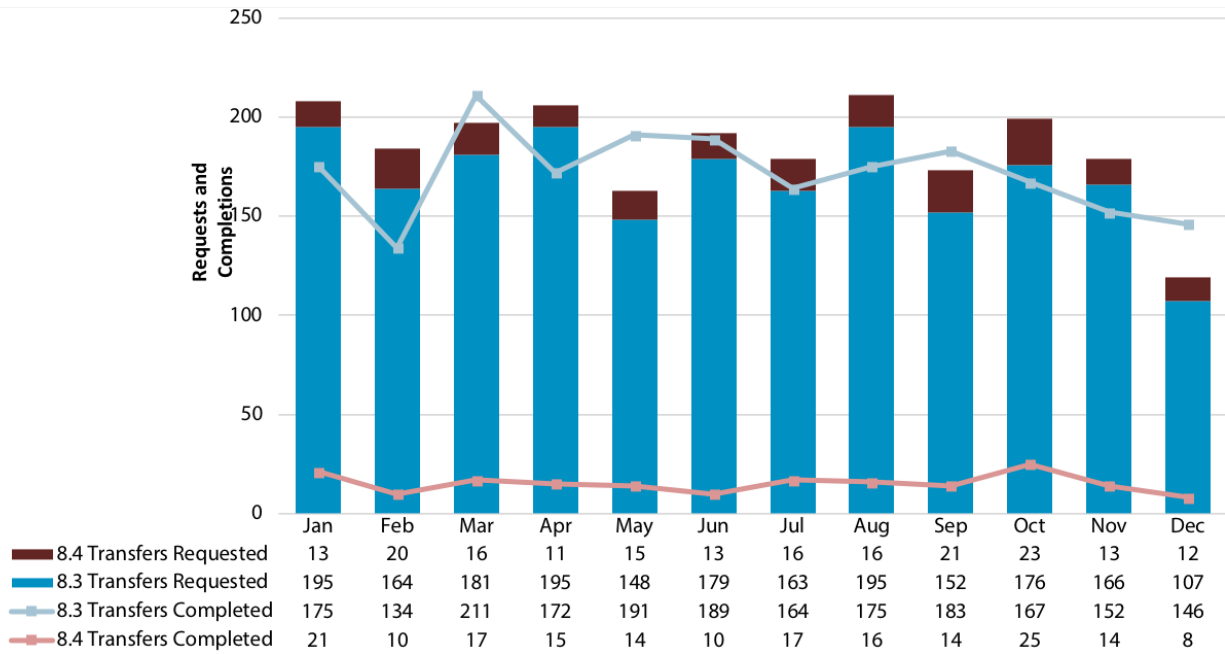
2017 ended with an interesting twist in Q4, with over 150% completions of the requested IPv4 in that period. Overall 2017 had a 23% increase of IPv4 requests over the previous year, showing another strong year for demand. However, there were over 109% completed IPv4 transfers at year end, marking an important milestone in the ever-changing IPv4 marketplace.



2018 Market Summary

2018 started out strong once again with a 10% increase in IPv4 requests in Q1 over Q4 in 2017. The rest of the year however, for the first time, saw a decrease of IPv4 requests in Q2, Q3 and Q4 over previous quarters total requests for IPv4. Furthermore, we also see that completions once again average over 102% for the entire year.

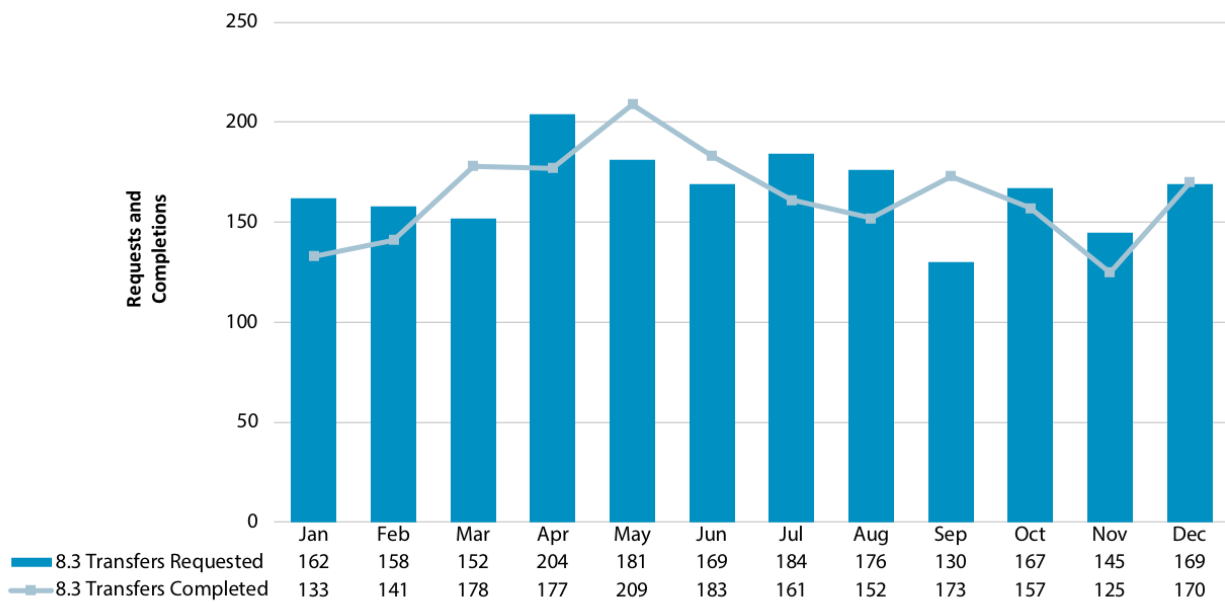
This would show that there was an abundance of suppliers who started offloading their IPv4 and indicate signs of a possible shift in the supply and demand market dynamics. Another suggestion of market normalization was while the demand was still at an all-time high with a total of 2021 IPv4 requests, however, it was only a 0.4% increase compared to the previous year.



2019 Market Summary

2019 has been the most interesting to see unfold. The demand started out a bit weaker with only a 5% increase in Q1 over Q4 of 2018. However, the year over year requests for IPv4 in Q1 2019 compared to Q1 2018 were actually -13%. In fact, the market shows a decrease in year over year demand percentages since Q2 of 2018, with 2019 being the first time to demonstrate a double-digit decrease in any given quarter. The year over year requests average in 2019 was -1.2% over 2018. Looking at this as an isolated event, doesn't seem to be very impactful. However, when you look at the previous years, 2018 saw a 0.4% increase, 2017 saw a 23% increase and 2016 saw a 371% increase. The delta in demand has continued with a negative trend, which explains market consolidation and pricing resistance from buyers.

This is the first time the market has a negative trend in IPv4 demand since its inception in 2015. On the other hand, the rate of IPv4 completed transactions continues to stay above 98% year to date, which has had a longer running positive trend since Q1 of 2017. The inverse relationship seems to be an indication of the dynamics shifting to a buyer driven market.

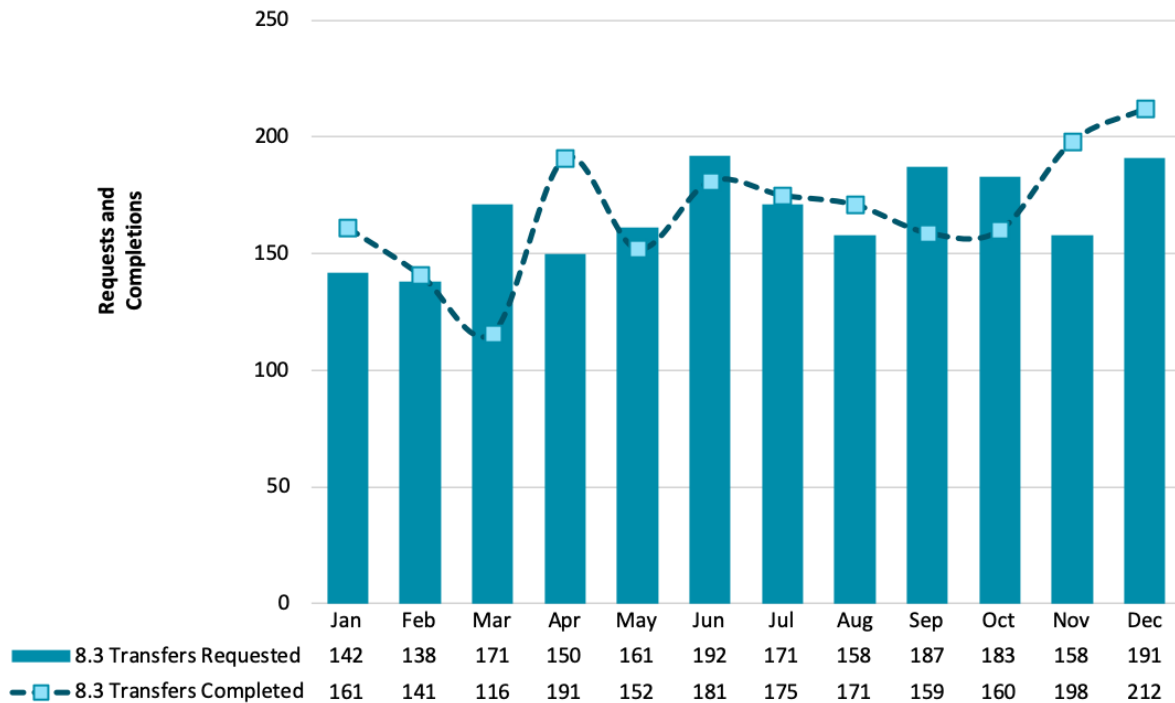


2020 Market Summary

With the end of a roller coaster of a year, 2020 had some interesting movement in the IPv4 sector as well. Due to the increased demand for people to stay indoors, we saw a surge of requests to buy ip addresses shortly after the pandemic hit. Even more interesting, was the companies that were ready to sell IPv4 leading into the pandemic, were sidetracked by Covid response efforts. This caused the IPv4 market to go into a frenzy as the supply wasn't able to keep up with demand.

In Q4 2020 we saw only a +3% increase of the number of requests over Q3 of 2020. Even more interesting, is the transfer completion rate increase to 107%. It would seem that the suppliers who were delayed earlier in the year, were finally able to refocus back on IPv4 re-addressing and bring their IP addresses for sale into the market. Another interesting metric to point out is that we see a significant double digit increase of demand for IPs when you compare Q4 of 2020 to Q4 of 2019, with an overall +11% spike.

Overall, 2020 represented a very strong and healthy IPv4 market, especially when you compare it to most industry sectors. The IPv4 transfer market demand stayed stable with less than +1% growth over 2019. And the transfers that were actually completed increased by around +3% over 2019.



2021 Market Summary

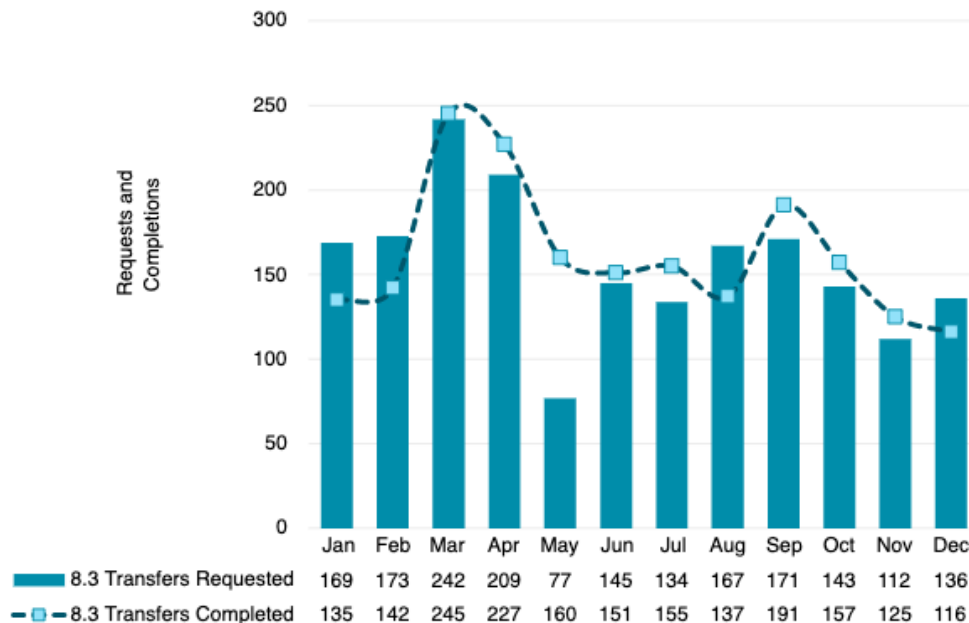
Due to the volatility of the IPv4 transfer market in 2021, our team was eagerly waiting to see the results of the ARIN transfers from December to complete our analysis of the entire year. There could have been a few different predictions based on the limited market supply, COVID variants, the mysterious transfer of [175 Million IP addresses by the U.S. Pentagon](#) and [China's plan to eliminate IPv4 usage](#) starting 2023.

There was a rather large delta in transfer requests from April to May, dropping by a shocking -62%. This information could have potentially led us to believe the IPv4 market was going to decline. However, from May to June, we saw an increase in demand of +88%. After analyzing the final 6 months of the year, we gathered more data points to make a better assessment. Since the crash in May, the average number of transfers requested was 135. Before the crash, in the first 4 months of 2021 the average number was 198, which was a decrease of -32%. If we compare the average since the May crash to the previous 3 years consistent average of 167 transfer requests, we are also still down -19%.

This leads us to believe that we may experience market stabilization or a decrease in 2022. For instance, in the previous 3 years of having relatively no volatility in IP transfer requests, we saw a steady increase in IPv4 prices of around 25% per year. With the overall large dip in May of 2021 and the overall decrease of transfer requests 2021, market prices are unlikely to increase at a similar pace in 2022. Much like other market fundamentals, after a 100% year-over-year growth, a correction is likely to follow.

One of the largest factors to the drastic increase in pricing over the last 12 months was the pandemic's impact on suppliers' ability to place unused IPv4 into the market. Since companies are now able to better navigate the pandemic, far more IPv4 address blocks are being made available in the market.

2021 8.3 Transfers Requested and Completed



2022 Market Summary

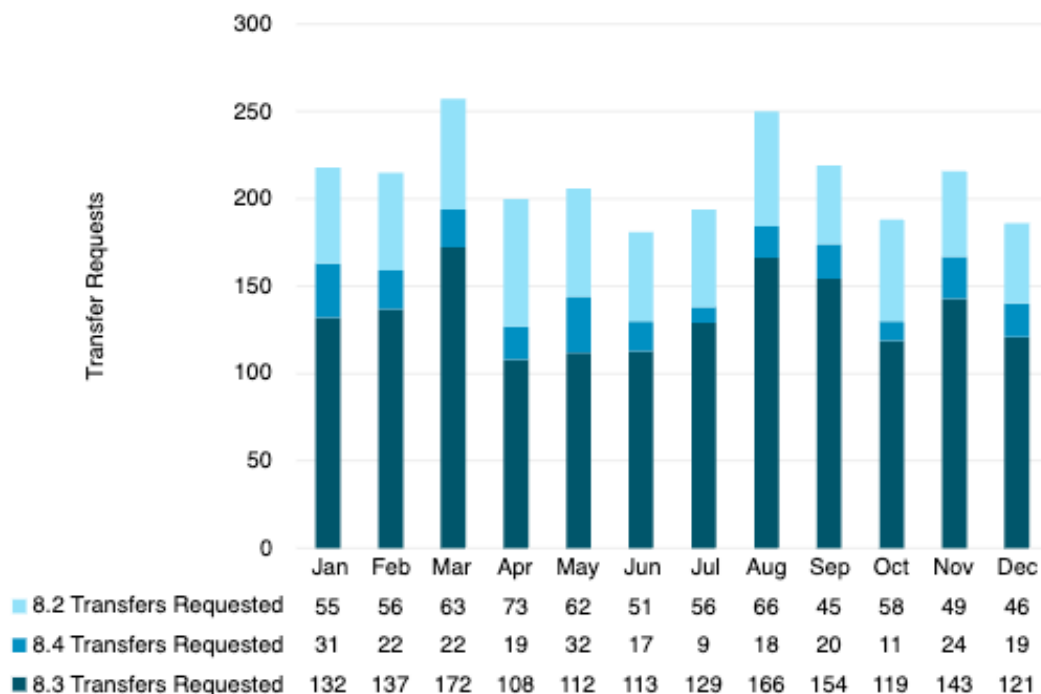
2022 demonstrated that even the most business-critical products and marketplaces can experience pricing volatility. IPv4 addresses certainly possess all the key traits of a resilient market, but under extreme circumstances, have proven they can fluctuate and fall subject to pricing resistance. Let's discuss the leading factor that contributed to the fluctuations this year.

COVID caused prices to rapidly increase in 2020 and 2021. During the pandemic, many organizations that would have re-addressed and sold IPv4 had to refocus efforts on COVID contingency plans. At the same time, most ISPs, Cloud Operators and Hosting companies had an influx of client demand due to the quickly shifting work-from-home culture. These organizations were forced to over-purchase IPv4 addresses due to fear of future shortage, large client usage projections and rising IPv4 prices. The lack of supply combined with an increase in demand caused IPv4 prices to spike more than 100% in 2021.

In 2022, there was a pendulum swing in IPv4 supply once most organizations had control over COVID-related projects. They reallocated efforts to focus on IPv4 re-addressing projects to take advantage of the inflated IPv4 prices. During this same time in the beginning of 2022, we began to see a consistent decrease in buyer demand. These 2 events combined caused market stabilizing and ultimately pricing resistance of around -15% from all-time highs.

As of December 2022, there were 121 IPv4 transfer requests. Compared to the Q4 average of 127, the market had a decrease of around -5%. Compared to the 2022 yearly average of 134 requests per month, December was down around -9%. Most notably, compared to the 163 average IPv4 transfer requests from 2019 - 2021, there was a significant decrease of -18%.

Transfer Requests



Pricing and Value Trends

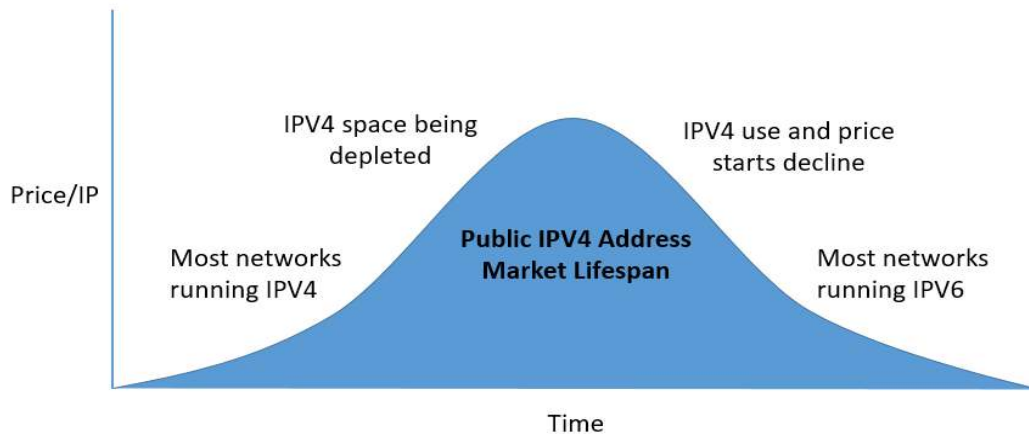
While prices IPv4 prices spiked in 2022, the second half of the year averages decreased significantly to around \$40 - \$47 per IP. According to traditional market fundamentals, we could only expect prices to begin to increase again if the demand for IPv4 is consistently over 160 transfer requests per month.

If we continue to see an increase in IPv4 availability, and do not have increased buyer demand to offset, we could see some additional pricing decreases. Our team will provide our client base with market updates and pricing strategy on <https://brandergroup.net/ipv4-news/>

Predictions for the next 3- 6 years

IPv4 space will continue to become scarce due to an increasingly limited number of suppliers with unused IPv4 addresses, slow adoption of IPv6, an exponential number of the world population coming online, widespread use of mobile and always-on devices, and the internet of things. IPv6 will be able to handle the current and projected needs of the planet's population, and the price of IPv4 will likely continue to be significantly influenced by the speed of IPv6 adoption.

However, since IPv6 adoption only has an increase of 5-8% a year, we have at least a decade before a serious pendulum swing. Once the adoption gets past the tipping point, IPv4 address space will start to free up and due to the law of supply and demand, the prices will more than likely decline, as demonstrated in the chart. However, IPv4 will always play a part in the world of the internet as there are too many legacy systems embedded with IPv4.



Since much of the supply side of the equation depends on both large carrier usage of IPv4 and the pace of IPv6 adoption, let's turn our attention to the market forces shaping IPv6 adoption. Overall, it appears that IPv6 adoption is progressing, albeit at a much slower pace than was previously anticipated. The causes are many: Switching to IPv6 is expensive, Network Address Translation (NAT) allows organizations to use fewer public IP's thereby extending IPv4 lifetime, and lack of compatibility with the IPv4 protocol forcing operators to run both IPv4 and IPv6 thereby increasing cost of operations.

We will continue to actively work with industry leaders, suppliers and buyers to help provide guidance in future reports as market dynamics shift. We encourage anyone with any thoughts on current data and future market trends to email us at info@brandergroup.net