

2018

State of the IPv4 Market



Welcome to Avenue4's 2018 State of the IPv4 Market Report

The 2018 IPv4 market started off on strong footing. On the heels of several large block trades, trading volumes and prices rose sharply over the year.

The shortage of large blocks—which had a significant effect in 2017—continued to heavily influence the market in 2018. In response to the shortage, buyers employed aggressive acquisition strategies, which successfully stimulated considerable additional market supply during the first three quarters of the year. Although the number of transactions remained relatively static in 2018 when compared to 2017, the volume of IPv4 numbers traded reached an all-time high while large-block unit prices were hitting their peak levels to date.

The extreme scarcity-driven dynamics of the large block market isn't the only storyline for 2018. Small block trading continued to make steady gains, with all signs pointing toward long-term robust performance. With the largest inter-RIR transfer in the North American market ever recorded, the inter-RIR market showed some life after softening in 2017.

2018 was also another good year for Avenue4. We are committed to consistently reading the market objectively, providing value-based guidance, sharing knowledge openly, and acting transparently and ethically in all of our dealings. These principles enable us to not just observe and report on the market but positively impact it and thereby benefit those whom we serve. We have delivered well over \$200 million in market value to our clients.

This fourth Annual Report closely examines 2018 market trends, encapsulates important insights, and looks ahead to what you should expect in 2019. We hope it provides you with actionable intelligence, whether you are an experienced participant or venturing into the market for the first time.



Marc Lindsey
President
Avenue4 LLC



Janinel Goodman
Vice President
Avenue4 LLC



ARIN Activity in 2018

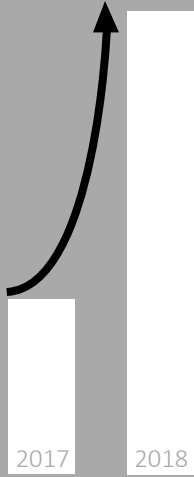
44,717,568

IPv4 numbers traded



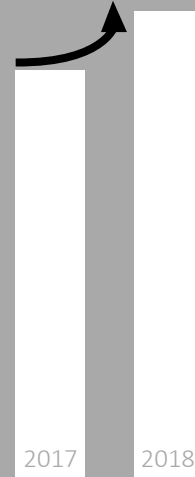
Total IPv4 block transfers

5%
INCREASE



IPv4 numbers transferred to/from APNIC and RIPE

172%
INCREASE



IPv4 numbers traded

15%
INCREASE

Relative average price/number by block size, Q4

\$20.00

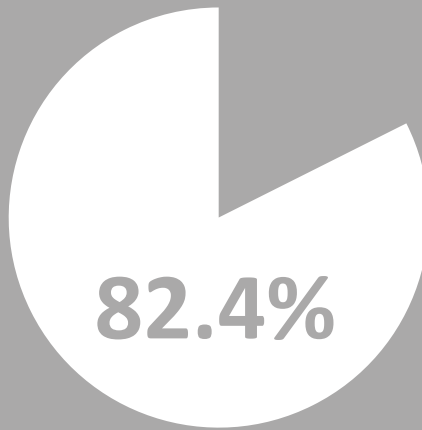
Blocks of ≤4k numbers

\$17.50

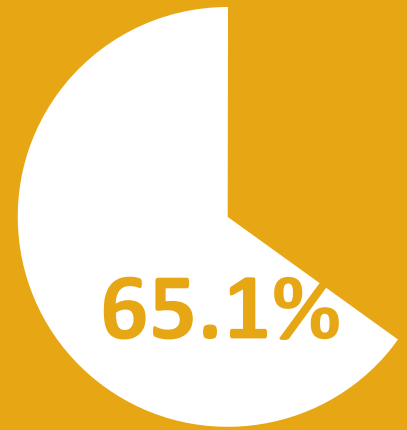
Blocks of 65K-130K numbers

\$22.50

Blocks of ≥1m numbers



IPv4 numbers traded in transactions > 1M



IPv4 block transfers involving blocks <4K



AVENUE4 LLC
INTERNET ASSETS

2018: Running the Numbers

Overview of North American Market Activity in 2018¹

Transaction Quantity and Volume of Address Space Traded

Trading in the IPv4 market reached all-time highs in 2018. The total volume of numbers traded was significantly higher than the prior year’s total, while the overall number of intra- and inter-RIR transactions² involving organizations in the ARIN region increased moderately in 2018. The year started and ended quietly but there was heavy activity in Q2 and Q3—the most active 6-month period in the history of the market.

Since inception of the market, the number of IPv4 transactions has trended steadily upward. Although that trend continued in 2018, the rate of increase dropped markedly (see Table 1.)³ Between 2016 and 2017, the aggregate annual number of transactions (transaction volume) jumped by over 25%, whereas the total annual transaction volume increased

1 This report (other than pricing) uses publicly available data provided by three regional Internet registries: ARIN, RIPE NCC and APNIC. Although many IPv4 transactions involve RIR approval, some transactions occur outside of the RIR transfer policies. Buyers and sellers occasionally decide, under various transaction structures, to trade numbers without seeking RIR approval or updating the registrant of record in the RIR registry. Although not insignificant, these “dark” transactions do not materially distort the rest of the market nor do they impair an effective analysis of it. For purposes of this report, we believe Avenue4 source data and the public RIR data, taken together, reasonably reflect the market even if they underestimate total market activity.

2 We measure market activity both by the volume of IPv4 numbers transferred, and the volume of transactions. We count trades conducted solely within the ARIN region pursuant to Section 8.3 of ARIN’s Number Resource Policy Manual (NRPM) or inter-RIR trades conducted pursuant to Section 8.4 of the NRPM, where at least one party is in the ARIN region and the other party is either in the APAC or European regions. For purposes of the analysis in this report, a single transaction represents a transfer of numbers (which may include multiple blocks) between the same parties over a time period (not to exceed 6 months) where the nature of the blocks transferred suggest they were likely part of the same negotiation (e.g., contiguous blocks).

3 Unless otherwise noted, all Tables include data on both intra- and inter-RIR transactions under Sections 8.3 and 8.4 of the NRPM respectively.

Table 1: Total Number of Transactions 2014-2018

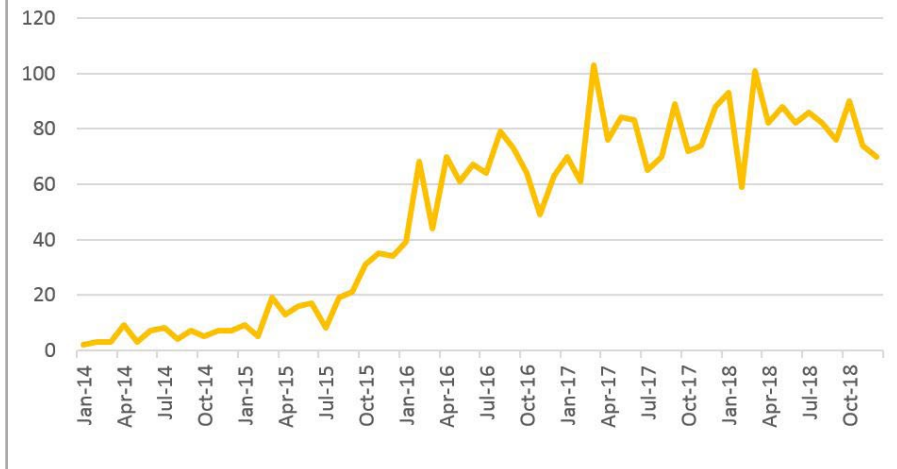
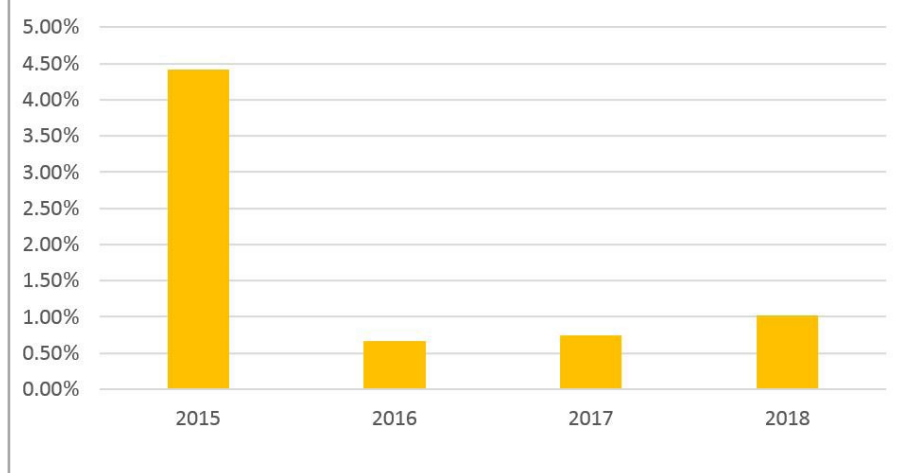


Table 2: Percentage of Large-Block Transactions Relative to the Entire IPv4 Market



by a little over 5% between 2017 and 2018.

Since 2015—the year ARIN’s pool of free IPv4 numbers dwindled to “0” and traded volumes skyrocketed—most of the overall growth in transaction volumes has been attributable to small block trades of less than 4,000 numbers. In 2015, just over 56% of transactions comprised fewer than 4,000 numbers (i.e., /24–/21 sized blocks). By 2018, nearly 70% of transactions fell into this small-block range. In real numbers, small block transactions have more than quadrupled between 2015 and 2018 (129 in 2015 versus 673 in 2018). In contrast, the aggregate annual

number of large block transactions has oscillated over the same period, with a maximum of 10 in 2015 and 2018, and major dips in 2016 and 2017. As a percentage of the total number of transactions, the portion of market activity attributable to large block transactions shrunk dramatically from 2015 to 2016 but has remained nearly flat since (see Table 2).

From 2015 to 2018, the total volume of numbers traded on a quarter by quarter basis fluctuated. But on a year to year basis, market activity was strong, except in 2016 when the supply of large blocks dried up after heavy large-block trading in 2015 (see Table 3).

Table 3: IPv4 Addresses Transferred 2014-2018



Table 4: Percent of Annual Total of Numbers Traded Attributable to /8 Block Activity

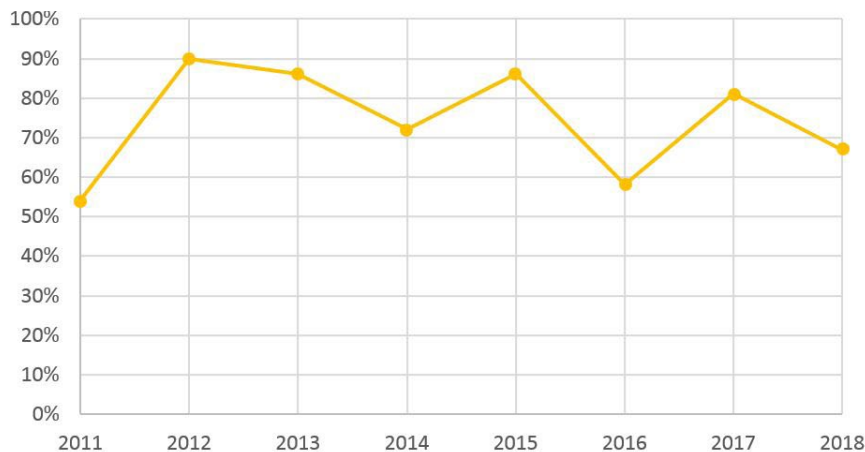
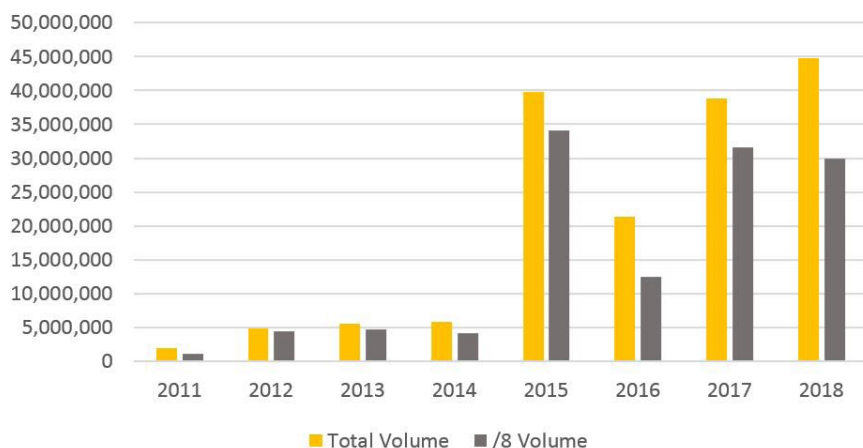


Table 5: /8 Block Activity



In response to large-block scarcity experienced over 2016, the large-block market responded with price hikes, greater market maturity (reducing transactional risks), and wide-spread use of transactional flexibility (e.g., multi-phased releases of address space over time to accommodate renumbering schedules). These stimuli spurred more large-block sellers to add their supply to the market in 2017 and 2018. /8 block holders were particularly active during this period.⁴

A high of nearly 45 million numbers were sold in 2018. This reflects a nearly 13% increase in volumes traded since 2015, the year experiencing the highest traded volume before the high mark in 2018. More than 80% of the 45 million numbers sold in 2018 were purchased by just three buyers.

Sales by /8 block holders have heavily influenced the market. Since the market’s 2011 inception, address space drawn from /8 blocks has comprised anywhere from 54% to 90% of the annual total of numbers traded (see Table 4). The jump in market activity from 2014 to 2015 corresponds to an increase in the number of /8 holders participating in the market (3 versus 5) as well as a sharp increase in /8 supply (see Table 5) occurring in the same year ARIN exhausted its free pool of IPv4 numbers. In 2014, just over 4 million numbers were sold from /8 blocks. In 2015, that number grew more than 8 times to over 34 million numbers—the largest quantity of numbers sold from /8 blocks in any one year.

Also in 2018, large telecommunications providers with excess IPv4 supply entered the market as sellers for the first time—enticed by the high market prices and confident in their internal IPv4 utilization forecasts and IPv6 migration planning. Nearly 25% of the total of all numbers sold in ARIN (inter-RIR and intra-RIR) were sourced from Level 3, AT&T and Verizon.

⁴ Prior to ARIN’s assumption of allocation and registration responsibilities, the IANA and other various Internet registries acting under contract with the United States Government issued 110 “legacy” /8 blocks. Each /8 block contains 16,777,216 IPv4 addresses. Of these blocks, 23 were allocated to 20 non-governmental/non-RIR organizations. With the exception of the United Kingdom Government of Works and Pensions, which has sold approximately 30% of its /8 block, no other government entity has participated in the IPv4 market.

Impact of Block Size

The most frequently transferred block size was the /24 (256 numbers), more than double the /22 (1,024 numbers), which was the second most heavily traded block (see Table 6). In 2018, ARIN transfer records reflected transfers of nearly 900 small blocks (/24 - /21), a 40% increase since 2016. However, small block transactions represent a very minor portion of the overall numbers sold, contributing less than 1.5% of the total annual volume of numbers transferred.

Continuing a trend that began in

2016, large block buyers have been willing to accept smaller block sizes as part of their transactions as the supply of large aggregate blocks has tightened (see Table 7). In 2015, none of the large block buyers purchased blocks smaller than a /16. In 2016, only one large block buyer dipped below the /16 block size to buy a handful of /17s (32,768 numbers). By 2017, 78 blocks ranging from /24s to /17s were purchased by large block buyers. In 2018, this number more than doubled, to 170. This trend may begin to reverse as large block buyers satisfy their projected need.



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Table 6: 2018 Volume and Number of Transfers by CIDR

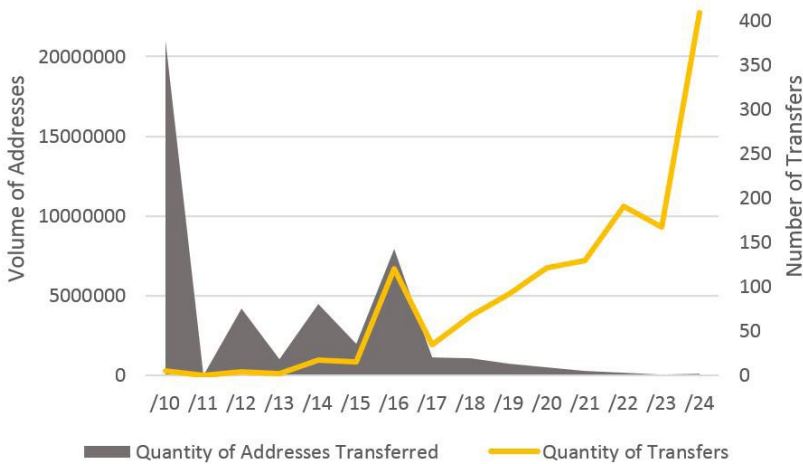
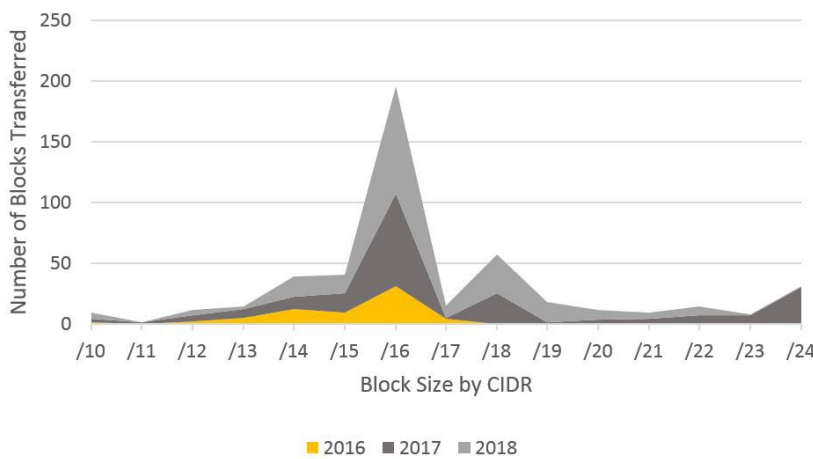


Table 7: Composition of Large Block Buyer Procurements



Pause in the Decline of ARIN's Inter-RIR Market

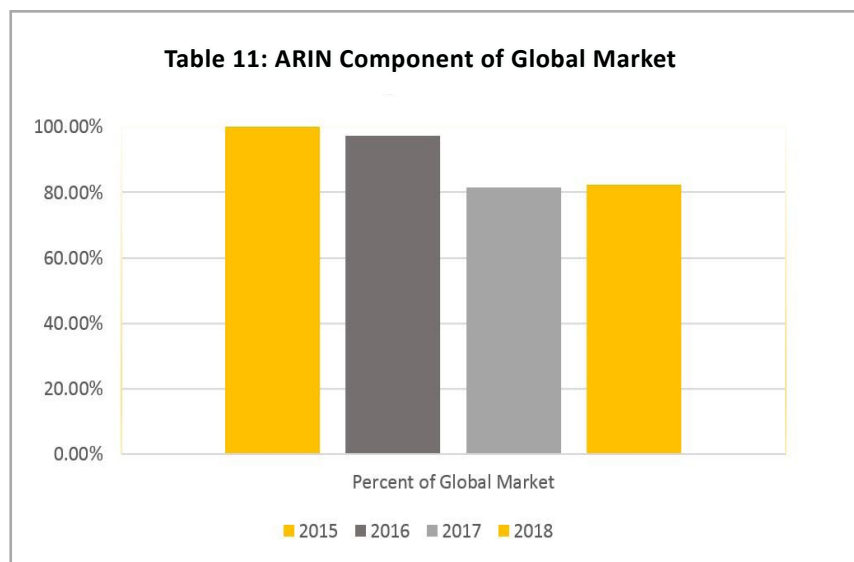
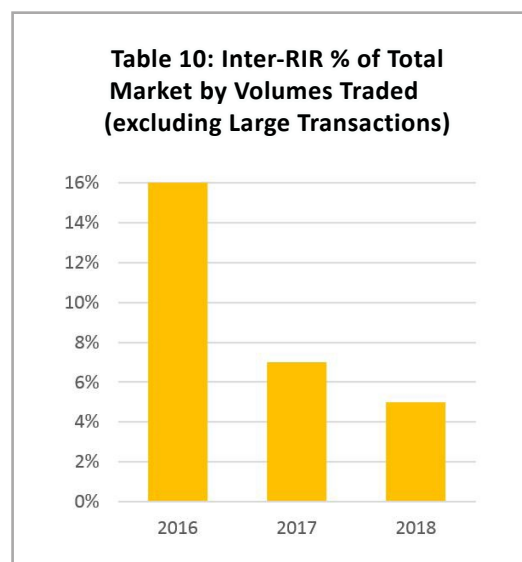
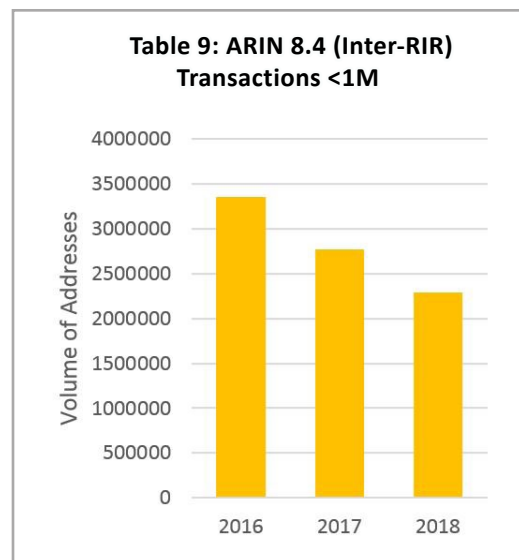
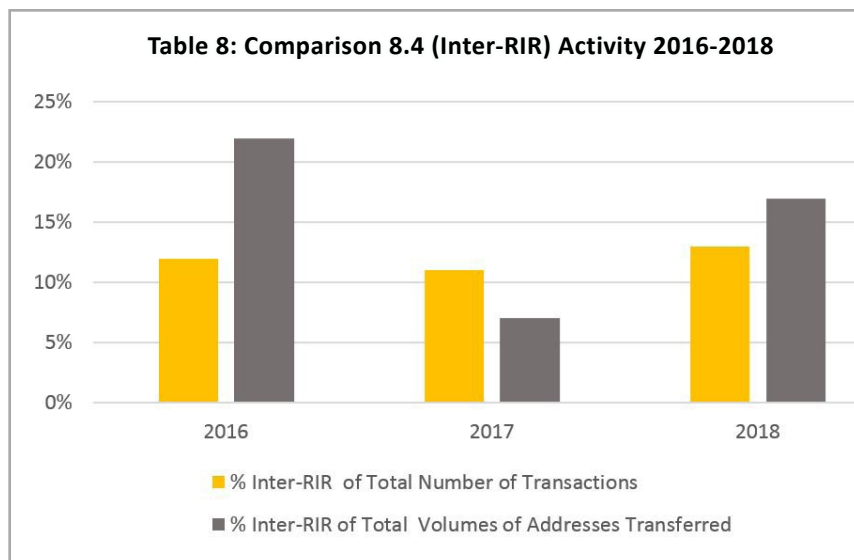
The inter-RIR transfer market weakened substantially in 2017. Although the quantity of inter-RIR transactions increased somewhat between 2016 and 2017, the quantity of numbers transferred fell by over 40%. In 2017, inter-RIR transactions comprised a smaller portion of the ARIN IPv4 market than any year since we began tracking this data in 2014. In 2018, the inter-RIR market bounced back, substantially due to a single APAC buyer's purchase of over 5 million IPv4 numbers from telecommunications giant Level 3. The 2018 inter-RIR market, in proportion to the market as a whole,

was still not as robust as in 2016 (see Table 8) but there were some signs of a recovery—though less impressive as a leading indicator after removing the single large transfer by Level 3 as a potential outlier.

In our 2017 report, we noted that a major factor contributing to the inter-RIR market's lackluster performance was the absence of large block buyers in the inter-RIR market. In 2016 and again in 2018, there was a single transaction of more than 1 million numbers, whereas in 2017 the largest block size purchased was a single /14 (262,144 numbers). Excluding these two large block transactions from the analysis reveals an overall decline in the

inter-RIR market in terms of volume of numbers traded between 2016 and 2018 (see Table 9) and a sharp decline in the percentage of inter-RIR transferred numbers relative to the total volume of numbers traded involving organizations in the ARIN region (see Table 10). At the same time, there has been a slight rise in the number of transactions. The relative percentage of inter-RIR transactions compared to the market as a whole between 2017 and 2018 was up slightly from 11% to 13%.

In terms of the broader global market, ARIN 8.4 transfers comprised 82% of the total volume of numbers traded on a global basis in 2018 (see Table 11).



Transactions between APNIC and RIPE NCC began after RIPE NCC implemented a policy permitting inter-RIR transfers in September 2015. Since then, this segment of the global transfer market has been steadily growing but it is small. In 2018, there were only 25 transactions between APNIC and RIPE NCC compared to 130 transactions between these regions and ARIN.

Both AFRINIC and LACNIC have transfer policy proposals under consideration that would permit inter-RIR transfers with other regions. If these proposals are adopted, we may finally see a truly global market. However, we anticipate that ARIN-based sources will continue to dominate the global market if and when LACNIC and AFRINIC join because the bulk of excess supply is located in the ARIN region.

Overall Market Direction

In our 2017 Annual Report, we projected that the small block market will continue to thrive for the foreseeable future but that the large block market may start to recede by the end of 2020 after the shrinking

pool of legacy /8 holders sell off the last of their excess inventory in response to significantly improved pricing conditions. Based on current market indicators, our projection remains unchanged.

As noted above, large block market activity has historically been driven by the availability of inventory from /8 blocks. In our 2017 annual report, we observed that of the 23 /8 blocks held by non-governmental/non-RIR organizations (see note 4), 10 blocks had been partially or mostly sold in the market. That number is now at 13 and, in the aggregate, just over 50% of the address space from those /8s has been sold.

We expect a burst of /8 activity in 2019 heading into early 2020. As market prices escalate even further over this period, /8 holders who have adopted a “wait and see” approach or who must demonstrate a sizable return on investment to justify renumbering their space should finally engage. Release of this next and likely last significant wave of large block supply will begin to fully retire the demand of the few buyers competing for large blocks in this sector of the market.

Pricing Trends

In 2018, unit prices increased consistently throughout the year following the same trend observed over 2017. The rate of change for small to medium blocks was considerably less than the rate of change observed for large block trades. Applying an even longer lens illustrates that noticeable differences in these rates of change have been a stable feature of the market since 2015.

Table 12 shows median pricing during the last quarter of each year between 2015 and 2018 across the various block categories. For all block sizes, prices on average increased, but the greatest escalation appears in the large block market.

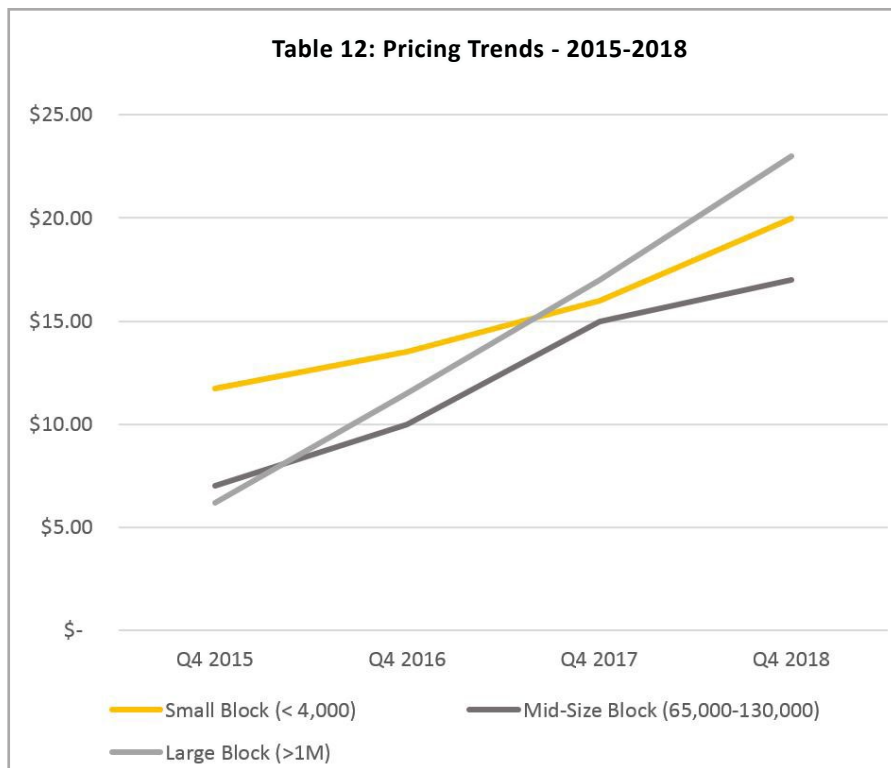
Relying on our primary source data as of the publication of this report,⁵ unit pricing for large blocks at the end of 2018 (in the \$20 to \$23 per number range) surpassed small and medium block unit pricing (in the \$17 to \$20 per number range).

Large block pricing has surged due to a shortage of supply while demand remains strong. This imbalance—which we expect to continue into 2019—has caused the limited population of large block buyers to aggressively compete on price when each new large block entered the market. This segment of the market is, however, subject to considerable volatility due to the small number of dominant participants.

Because there is more supply in the small to mid-sized block markets and a larger pool of global buyers, the unit pricing has been more stable. As a result, we anticipate that the historic rate of price increases in these market segments will extend predictably for at least another three to four years.

⁵ Several years into the market, there is still a lack of transparency regarding pricing even though the market has matured as many of its participants experience success, and transactional norms gain wider acceptance. To provide our pricing guidance, we draw from our own extensive portfolio of active leads, bidding process results, open offers, and closed transactions. We augment our primary data with secondary sources, including print media research and direct interviews with our network of active market participants.

Table 12: Pricing Trends - 2015-2018



IPv6 Adoption and its Market Impacts

Global IPv6 adoption⁶ slowed somewhat in 2018 compared to prior years (see Table 13).⁷ The data reflects some acceleration in adoption between 2015 and 2016. 2017 progressed in fits and starts, but overall adoption rates mirrored those in 2016. 2018 proved sluggish, however. Over the span of 2018, IPv6 adoption crept up by just over 4.5% whereas adoption in 2016 and in 2017 exceeded 6%.

This decline in progress may seem discouraging. The Internet governance community and network hardware providers have heavily promoted IPv6 migration over the last several years. Despite the apparent slowdown in adoption, APNIC Scientist Geoff Huston found some encouraging developments toward the end of 2018.

6 Unless otherwise noted, general references to IPv6 adoption measurements are based on the number of users connecting to IPv6 enabled websites as reflected in Google's native IPv6 statistics at <https://www.google.com/intl/en/ipv6/statistics.html>.

7 Table 13 measures IPv6 end user adoption from 1/1 to 12/31 of each year. In general, IPv6 traffic has been 3-4% higher on weekends and holidays than during business days. By using two days that are likely to be high traffic days each year, we are better assured a more accurate measurement of year to year progress.

In Huston's recent report on IPv6 in China,⁸ he observed that, in the last couple of months of 2018, there was evidence of significant deployment of IPv6 services in China. Because China has a substantial Internet user population, Huston predicts this localized uptick could eventually stimulate more vigorous IPv6 adoption globally.

The deceleration in migrations in 2018 has had an effect on long term IPv6 adoption predictions. Last year, data showed that global IPv6 adoption would likely hit 50% globally sometime between early 2020 and mid-2021, and 80% by 2023.⁹ One year later, these dates have been pushed out by a few months, with global adoption reaching 50% between late 2020 and early 2022, and 80% between 2023 and 2024. As in the past, there remain stark regional

8 <http://www.potaroo.net/ispcol/2018-12/chinav6.html>

9 The model at <https://www.vyncke.org/ipv6status/project.php?metric=p&timeforward=365&timebackward=365&country=ww> provides the option to apply several different regression formulas to predict future IPv6 adoption measurements. The Quadratic 2nd Order regression predicts more delayed adoption (and reflects the later date above). The S-curve, which is commonly accepted as the best fit for a technology adoption pattern, projects a more aggressive IPv6 adoption timetable.

variations underlying these global figures, spanning anywhere from 0% in parts of Asia and Africa to over 50% in Europe.

Historically, the United States has long been a leader in IPv6 adoption. Although the year was bookended by traffic peaking around 40%, for most of 2018, U.S. adoption struggled, hovering mostly in the mid-30 percent range (see Table 14).¹⁰ IPv6 content in the U.S. has also stalled. It reached just above 50% at the end of 2017 and has not made much progress since.¹¹

As demonstrated by Table 14, there is, so far, no correlation between growth in IPv6 adoption and the North American IPv4 market. Often a migration to native IPv6 includes transitioning to dual stack environments (i.e., operating IPv6 and IPv4 networks concurrently). Thus, the lack of correlation between increased IPv6 adoption and IPv4 market activity is not necessarily surprising. This will likely change when IPv6 becomes the dominant Internet protocol. ■

10 As noted, IPv6 traffic is typically 3-4% higher on weekends and holidays than during business days. For purposes of Table 10, we measured adoption on the last Wednesday of each month to ensure a more accurate representation of progress throughout the year.

11 See <http://6lab.cisco.com/stats/> (Web Content).

Table 13: Percentage Annual Progress in Global IPv6 Adoption

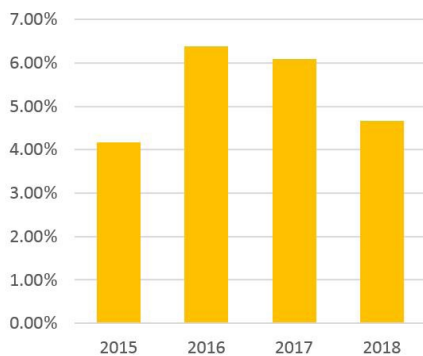
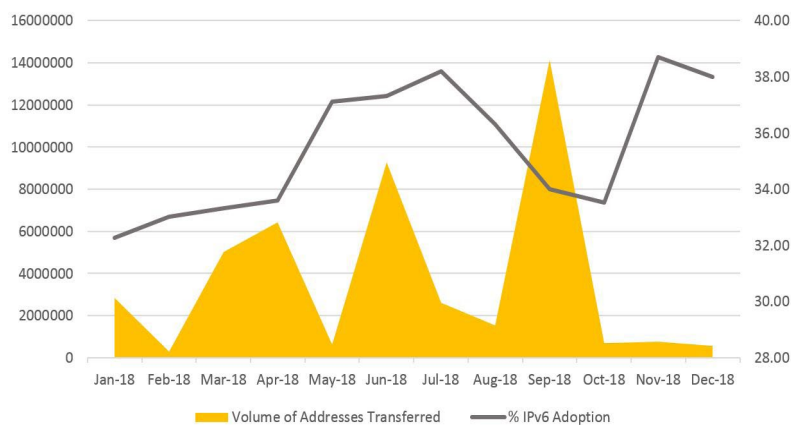


Table 14: Addresses Transferred via 8.3 and 8.4 and Native IPv6 Adoption in US



Key Takeaways

- The small block market continues to represent a dominant and growing portion of the total IPv4 market.
- There was a steady influx of large block supply in 2018, particularly from /8 holders, but this surge points to an extended period of limited large block supply in early 2019.
- Large block buyers are now readily purchasing smaller block sizes (/16 and smaller) in order to meet their forecasted need.
- Unit prices across all block sizes rose steadily, but unit prices in the large block segment increased at a materially higher rate than all other segments and ended 2018 consistently higher than prices for all other block sizes – reversing a trend that has been a staple in the market since 2014.
- Inter-RIR activity involving ARIN buyers and sellers is the source of over 80% of volumes traded in the global market, but overall traded volumes have been trending downward for transactions comprising fewer than 1 million addresses.
- IPv6 adoption progress has slowed compared to prior years, and continues to have no observable effect on the market demand for IPv4 address space.

Predictions for 2019

- The aggregate number of transactions (8.3 and 8.4) will experience growth of less than 5%.
- At least two /8 holders will enter the market and sell 4 million or more numbers, but this could be the last year when address space from more than one legacy /8 is available for sale.
- Two buyers from outside the ARIN region will purchase large blocks from ARIN sources via inter-RIR transfers.
The volume of addresses traded in small and medium block inter-RIR transactions will trend upwards as AFRINIC and LACNIC finally adopt policies that permit inter-RIR trades, making the IPv4 market a truly global market.
- By year end, prices for small blocks will reach \$25/number, medium blocks will stay just shy of \$20/number and large blocks pricing will approach \$30/number during the year.
- Global IPv6 deployment will reach a high of 33%.

How Accurate Were Our 2018 Predictions?

We predicted...	At the end of 2018...
The aggregate number of intra-regional transactions would grow by 25% but average transaction size would shrink.	Both intra-regional transactions and average volumes remained relatively flat, with only very slight growth.
Total annual volume would remain flat.	We thought the market was hot in 2017 and didn't think it could get much hotter but with Alibaba's massive purchase of numbers, total volume grew by over 15%.
Inter-RIR market activity would recover from a dip in 2017 with at least one international buyer purchasing numbers from the US.	Spot on. With Alibaba's purchase of 5M+ numbers from Level 3, the inter-RIR market experienced a rebound.
Prices for medium and large blocks would surpass the \$20 mark.	Spot on for large blocks. Not quite for medium blocks, which are still under \$20.
Global deployment would reach a high of 29%.	Not quite. Global deployment peaked at just under 27%.



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Avenue4 was founded in September 2014 by Marc Lindsey and Janine Goodman. Together, Janine and Marc have consulted some of the most demanding market participants and closed many of the largest deals in the market to date. Avenue4 helps its clients strategize and execute IPv4 transactions in an opaque and rapidly evolving market. We provide advice on managing, preserving and monetizing IPv4 numbers as an asset.

We dedicate our reputation, knowledge, experience and resources to minimize risk and deliver value for our clients.

In 2017, Avenue4 brought this same knowledge, experience and expertise to the small and mid-size block markets with the launch of ACCEL8, a transformational IPv4 trading solution.

Our custom services include:

- Conducting due diligence
- Developing go-to-market strategies
- Matching buyers with sellers
- Identifying value enhancing opportunities
- Structuring, negotiating and closing transactions
- Facilitating registration transfers
- Maintaining IPv4 registry records and preserving entitlements