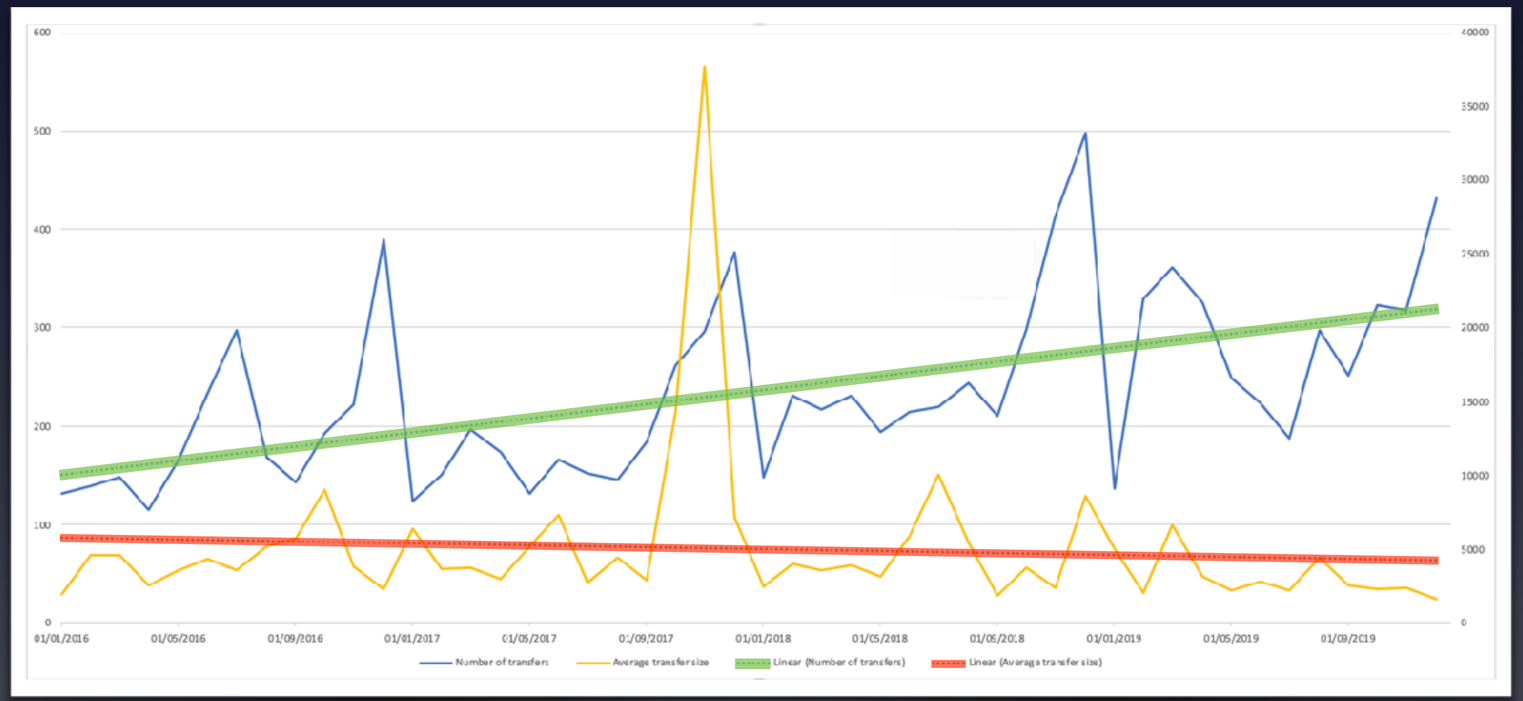
RIPE NCC
RIPE NETWORK COORDINATION CENTRE

A Changing Industry

Recent Developments in the Internet Numbers Space

Chris Buckridge | RIPE NCC Roundtable Meeting | 27 January 2020

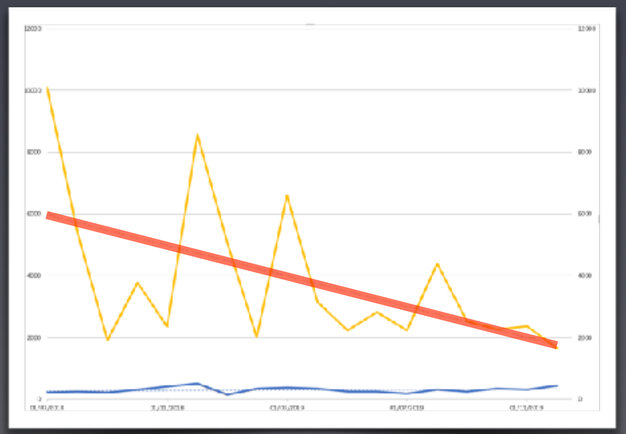
IPv4 Transfers



Evolution since January 2016

- Annual spike in number of transfers at end of year
- Overall, number of transfers increasing
- Average size of transfers now declining

Average transfer size since July 2018



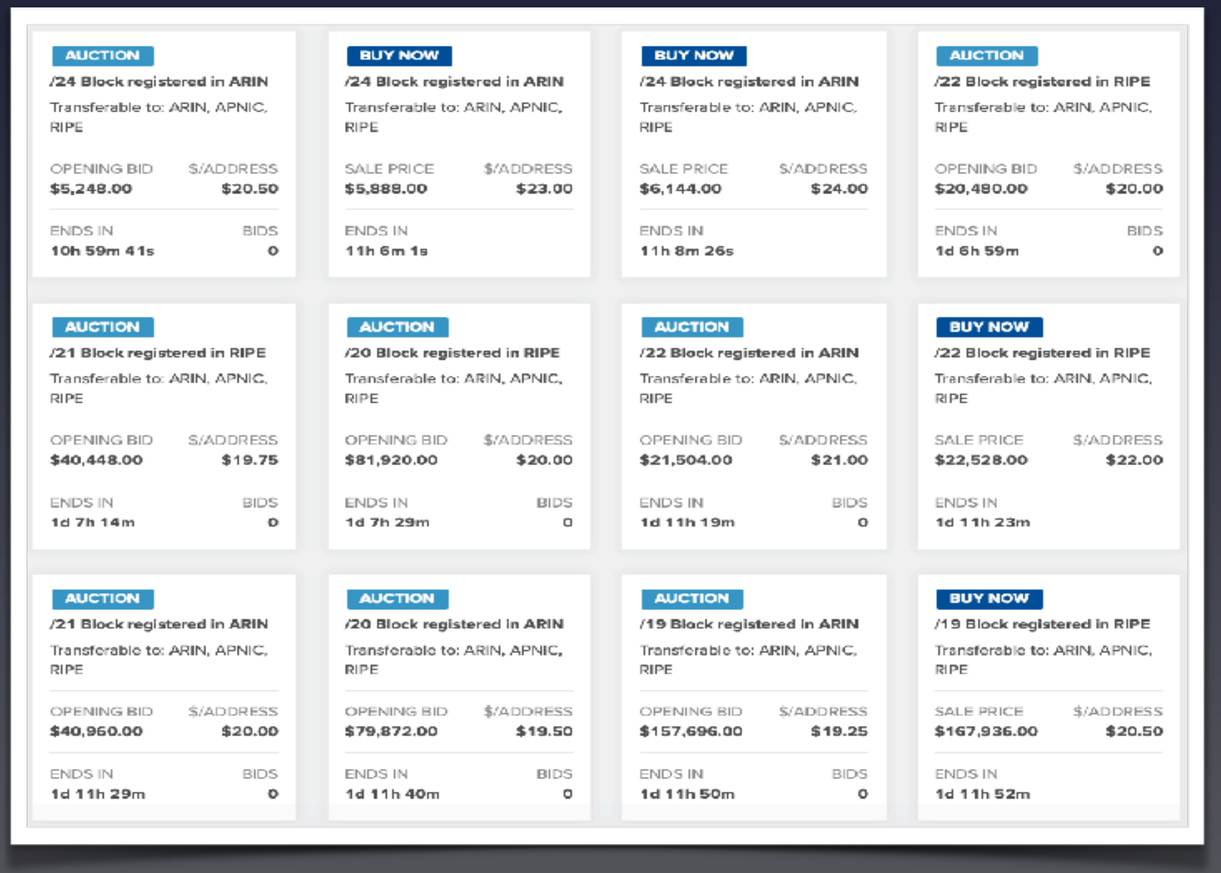
What's Happening?

- Annual spike in December probably due to our fee structure
  - People clean up and remove unneeded LIRs to avoid paying another year
- Change in transfer size might be due to a combination
  - Policy in effect since September 2012 limited new allocations to 1,024 addresses
  - Policy sets a moratorium on transfers for 24 months after allocation
  - Maybe the larger blocks are now gone and subject to the same 24-month lockdown?
  - Maybe the market is becoming more stressed?

The Price of IPv4?

- Last year we saw a range of 18~21 USD per address
- Current range sits around 20~24 USD per address
- Interestingly, larger blocks appear to be slightly cheaper

Reminder: The RIPE NCC has no role in the financial aspects of IPv4 transfers.

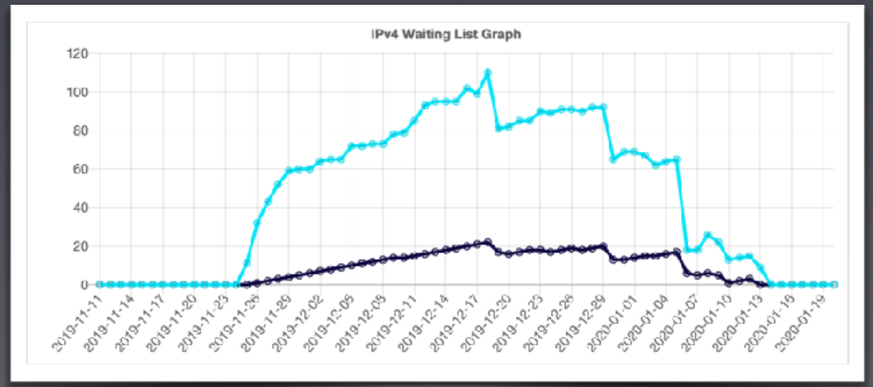


"Live" pricing on a popular IPv4 trading platform
(Source: Hilco Streambank, 20 January 2019)

The RIPE NCC IPv4 “Puddle”

- Our IPv4 pool is “empty”, but small blocks are still returned
  - Addresses are reclaimed or returned, at which point they are placed in “quarantine”
  - LIRs who have not yet received a final allocation can join the waiting list
- Currently, the waiting list is empty
  - And our pool contains a handful of addresses (~25k)
  - We expect to release close to 256k addresses from quarantine this quarter
  - Enough for another 1,100 requests via the waiting list

    https://www.ripe.net/ipv4-waiting-list



Reaching an Equilibrium?

- Over the last few years we saw a rapid increase in membership
  - Every newly opened LIR was entitled to 1,024 addresses from the remaining pool
  - Many considered the sign-up fee and annual costs to be less than market price
- This appears to have changed
  - At the moment we are still adding new members on a daily basis
  - And most of them do request the /24 final allocation (~50 per week)
- What we think is happening
  - **You still need to be a member to receive transfers and register your resources**
  - Meanwhile the current allocation size (256) “is not worth the effort” to open accounts

Expectations for IPv4

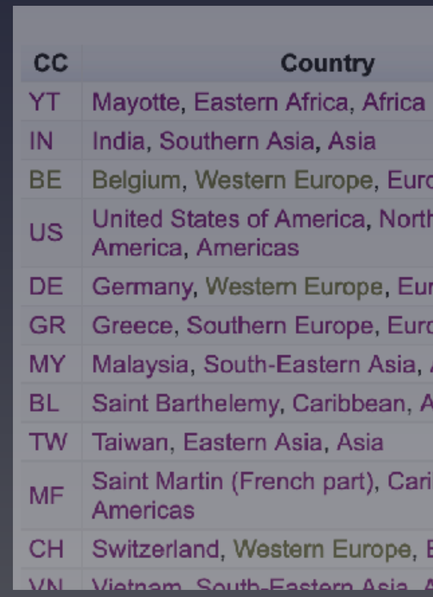
- Price of IPv4 largely depends on supply and we expect it to climb
- There was some news about US DoD releasing some blocks
  - This was removed from the 2020 budget legislation as it passed through Congress
  - If they decide to sell off, the size and rate of release could influence the market
- More blocks allocated by RIPE NCC will pass the 24-month “lock-up”
  - Subsequent transfers will initiate a new 24-month holding period
  - We may see a tipping point between market and entering our waiting list

The USA Department of Defence holds 12 former class A assignments (/8), containing a total of 200 million addresses. The majority is currently not visible on the public Internet.

IPv6

IPv6 Deployment Highlights

- Mayotte, a French overseas territory, is the new leader at 77%
  - This is due to France Telecom/Orange deploying very rapidly
  - Orange is deploying in mainland France but at slower pace
- Greece went from 40% to 50%, due to OTE's deployment
- Vodafone is the second operator to deploy in Portugal
  - We assume that it is their fixed broadband network, but not confirmed
- Recent increase in Sunrise (Switzerland) starting to deploy
- UAE is very rapidly deploying after regulatory changes (28%)



CC	Country
YT	Mayotte, Eastern Africa, Africa
IN	India, Southern Asia, Asia
BE	Belgium, Western Europe, Eur
US	United States of America, North America, Americas
DE	Germany, Western Europe, Eur
GR	Greece, Southern Europe, Eur
MY	Malaysia, South-Eastern Asia,
BL	Saint Barthelemy, Caribbean, A
TW	Taiwan, Eastern Asia, Asia
MF	Saint Martin (French part), Cari Americas
CH	Switzerland, Western Europe,
VN	Vietnam, South-Eastern Asia,

Costs and Benefits of IPv6

- Expanding existing networks by buying IPv4 is likely cheaper
  - The existing IPv4 transfer market and IPv6 adoption rates tell the story
  - Greenfield deployments and market disrupters might have a different view
  - Disadvantage of NAT is such a common problem, the market accepted it
- “IPv6” is not a product for the end-user
  - Customers want websites, email, social media and video streaming
  - There is no commercial advantage in deploying IPv6 to a mass market
- Most efficient way to reduce costs is integration with other projects
  - Needs some long term vision and overcome inertia to changes

Driving Force: Scarcity

- Interestingly, operators flag scarcity in “private” IPv4
  - These addresses are crucial behind Network Address Translators (NAT/CGN)
  - Appears to be an important driver for deployment in mobile broadband
  - Especially in operators with the luxury of “enough” unique public IPv4 addresses
- Overlaps in non-unique blocks can hinder network mergers
  - Consolidation in the market creates the need to combine networks
  - This could act as an additional trigger to deploy IPv6

A small portion of the IPv4 address space is reserved for “internal” use. Originally described by RFC 1918, these blocks are not globally unique and are not meant to be allocated via the RIR system. They are commonly used on the inside of NAT/CGN, the largest single block is 10/8 containing 16 million addresses.

Driving Force: Governments

- Soft regulation, like we have seen in Belgium with “code of conduct"
  - Agreement to mitigate the negative consequences of large Carrier Grade NATs
- Stimulation and coordination via a national IPv6 task force
  - Removing the “first-mover” disadvantage and creating momentum
- Government as a purchaser and user of ICTs
  - Probably the most important tool to stimulate market investments
  - You can reward “good behaviour” and provide return on investment
  - Reduce the dependency on IPv4 for your citizens and industries(!)

The Future of IPv6 in Regulation?

- The next wave of 5G deployment maybe a way forward
  - Current wave is focused on spectrum and radio technology
  - Core network and IP layer of 4G are used to connect 5G antennas
  - The next phase (e.g. slicing) will be more focused on IP network layers
- Aim technology-neutral regulatory solutions
  - Industrial developments usually outpace legislative responses
  - Focus on removing the problem: IPv4 being obsolete and by itself no longer compliant
  - Milestones: Consider setting an end-date for IPv4 instead of a deployment date for IPv6

“Stimulate where you can, regulate where you must”

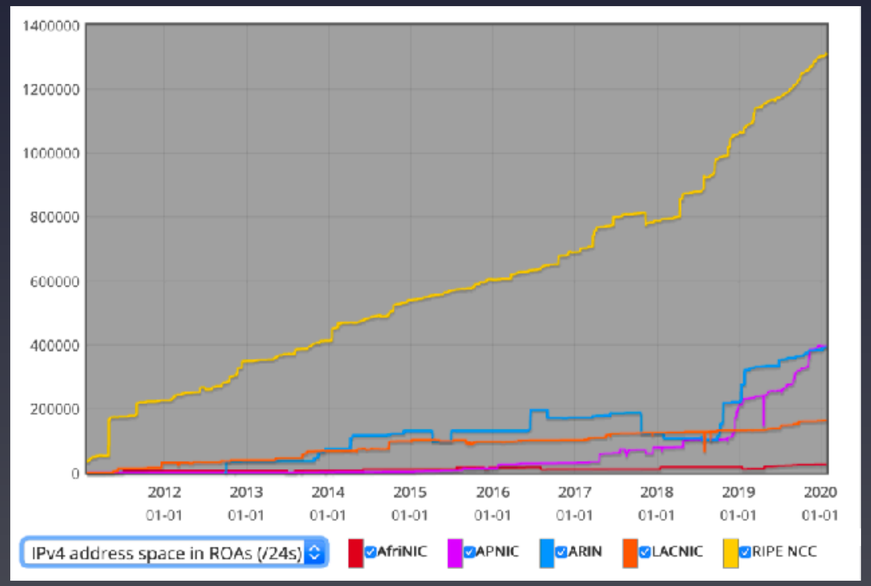
Security and Stability

Resource Public Key Infrastructure

- RPKI is an IETF standard that facilitates automatic route filtering
- Routing information is published using signed certificates
  - The cryptographic signatures are tied to RIR registrations
  - Only a registered holder of resources can create and publish these records (ROAs)
  - ROAs are statements about origin AS and prefix lengths
- Records can be downloaded by network operators
  - Processed for validity by checking the cryptographic signatures
  - Used to verify information received via Border Gateway Protocol (BGP)
  - Filter out those routing announcements that do not match the RPKI information

A Two-tier Approach

- Resource holders need to create and publish the records
  - We have been running awareness campaigns for several years now
  - RIPE NCC members can make use of automated software in our LIR Portal
  - You can also run your own software and keep full control



- Network operators need to start using RPKI for filtering
  - Install and operate the software to download and verify RPKI certificates
  - Modify existing router configurations to filter based on the information

RPKI Deployment Increasing

- Several large operators have started filtering BGP based on RPKI
  - Based on private conversations we expect other “Tier 1” to follow soon
  - It won’t prohibit all routing incidents, but should decrease both the number and impact
- RIPE NCC reviewing and improving the resilience of our RPKI systems
  - Ensuring our operations meet industry quality standards and expectations
- Several organisations have started work on new RPKI software
  - Industry needs more diversity to guard against single point of failures

RPKI and Governments

- The Netherlands are in the process of adding it to comply-or-explain
  - Making RPKI a mandatory feature of all government ICT projects and purchases
- ENISA and national authorities are considering it in the context of NIS
  - Could be considered low-hanging fruit
  - Protects against some, but not all routing attacks
  - Try to avoid too descriptive language - innovation continues!

Security is Top Priority

- Everybody in the industry is well aware of risks and repercussions
  - As long as a project or idea can be linked to security improvements, it is good
  - This risks starving other crucial improvements that are not directly related, e.g. IPv6
- Security is a pretty big field
  - GDPR and data protection has high awareness and seen as high risk
  - Critical infrastructure is getting more attention
  - Other attack vectors receive little to no attention
- A lot of systems and devices can still be used to attack others
  - This is still often overlooked as the risk lies elsewhere

Stability and Safety

- We aim to broaden the security discussion
  - Raise awareness of security issues being a threat to the Internet itself
  - DNS and routing infrastructure is very robust, but needs protection as well
- Internet of Things (IoT) remains a very big concern for industry
  - There is a staggering amount of cheap, insecure and unmaintained devices
  - Mirai probably was only the tip of the iceberg; the problem keeps growing
  - The longer we wait, the harder it becomes to clean up what is out there
- European IoT industry is taking steps
  - But for consumers, cheap too often trumps good!

Questions, discussion

- IPv4 - runout and transfers
- IPv6
- Security (including RPKI)