IP Addresses

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APNIC

Addresses are not Property

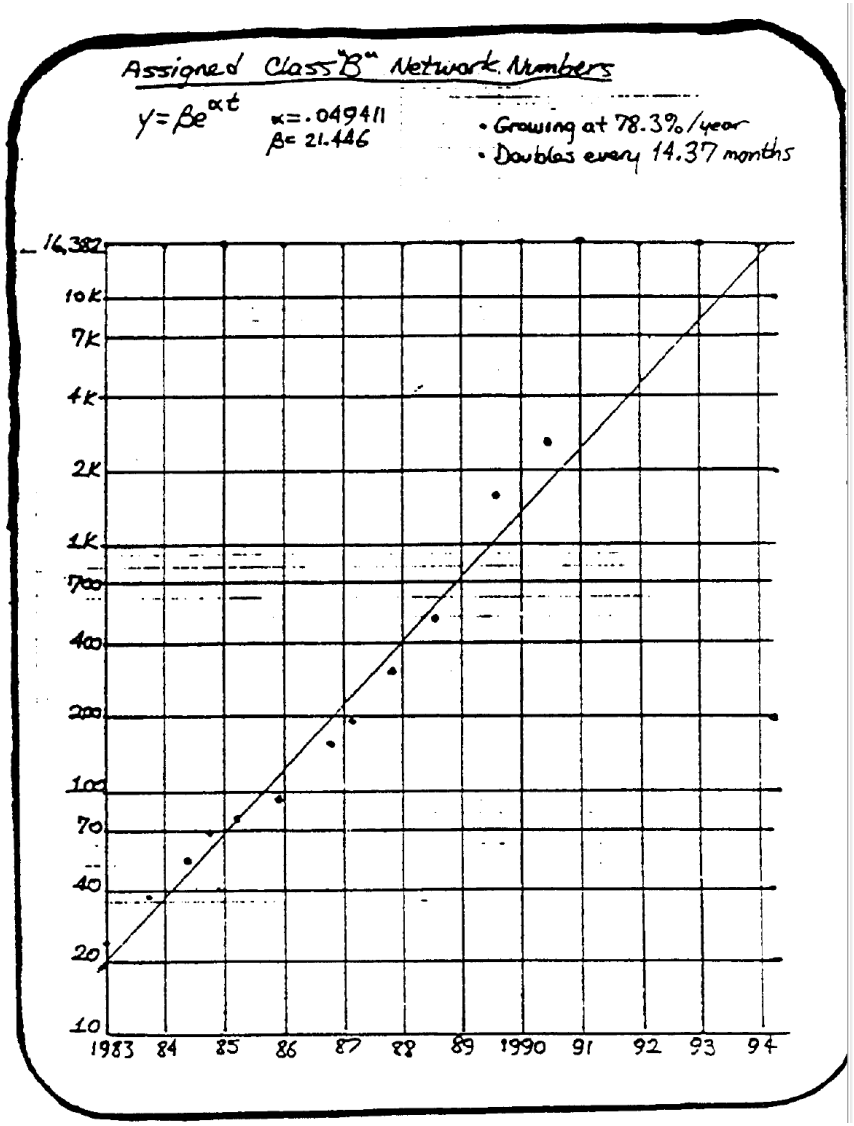
- The original view of IP addresses is that they were merely enabling tokens to access the common Internet network
- The critical resource was the network – addresses were mere identification tokens without intrinsic value
- Address blocks were allocated to entities on the basis of:
  - Unhindered availability (free)
  - First come first served
  - In perpetuity
- Address “security” was largely non-existent
  - The registry *whois* service provided little in the way of practical security
  - Hijacking of an unused addresses was largely ignored

“Free” Addresses

Consequences:

- Free availability supressed the formation of any form of secondary market in addresses
- Continued free availability provided no natural incentives for efficient utilisation, and no incentive to counter hoarding, which exacerbated consumption
- The finite resource pool could not withstand infinite demand

- But we recognised all this 30 years ago and forecast the result



Depletion Dates

• Assigned Class "B" network numbers	Mar. 11, 1994
• NIC "connected" Class B network numbers	Apr. 26, 1996
• NSFnet address space*	Oct. 19, 1997
• Assigned Class "A-B" network numbers	Feb 17, 1998
• NIC "connected" Class A-B network numbers	Mar. 27, 2000
• BBN snapshots*	May 4, 2002

* all types: may be earlier if network class address consumption is not equal.

"Internet Growth" Frank Solensky, Proc. IETF, Aug 1990

Public Good Economics

How should we distribute a finite public good?

- Rationing
  - Allocate a fixed amount to each consumer
  - Leads to random outcomes through over and under allocation, and a secondary redistribution market
- Auctions
  - Provide incentives to the most efficient exploitation model that applies a maximum exploitative value to the resource
  - Does not necessarily cater to fairness or common beneficial public outcomes
- Pricing
  - Either outright purchase (freehold) or leasehold
  - Price setting in the absence of a market often leads to distortions, particularly if the price is not aligned to market expectations

Addresses are still not Property

- RIR Model – Rationing and Pricing
  - Conservative consumption principles
  - Deliberately designed to constrain demand pressures
  - Attempted to prevent the creation of an aftermarket in addresses

- Consequences
  - Development of policies by incumbent address holders ran the risk of creating self-perpetuation of advantage held by early adopters
  - Was the large scale use of NATs in mobile environments an unforced decision or an outcome of a constrained position by a late market entrant?

Exhaustion

NEWS

Running out of Internet addresses: What IPv4 exhaustion means for you

ARIN's announcement that it has run out of IPv4 addresses has hastened the long-awaited move to IPv6. Here's what you need to know about the changeover.

DYLAN TWENEY BUSINESS 02.03.11 09:58 AM

NO EASY FIXES AS INTERNET RUNS OUT OF ADDRESSES

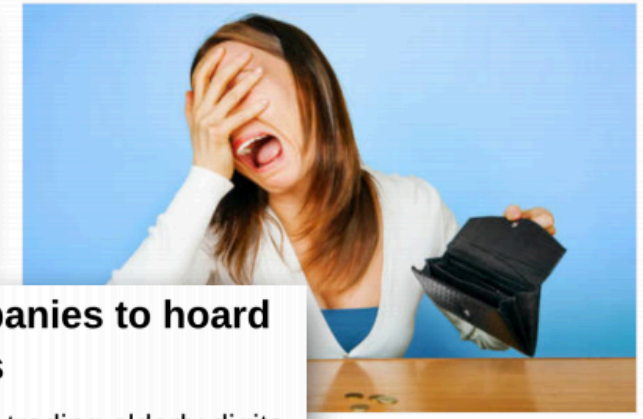
6 years on, IPv4 still dominates IPv6

It's been six years since the official launch of IPv6 on "World IPv6" day in 2012, but the newest version of the Internet Protocol still doesn't account for the majority of online traffic, according to the Internet Society.

OK, this time it's for real: The last available IPv4 address block has gone

Now for the last time, will you all please shift to IPv6?!

By Kieren McCarthy in San Francisco 18 Apr 2018 at 22:10 211 SHARE ▼



Crashed RadioShack flogs off its IPv4 stash

Old-skool addresses worth about $400,000 at

20:04 46 SHARE ▼

Microsoft pays Nortel $7.5 million for IPv4 addresses

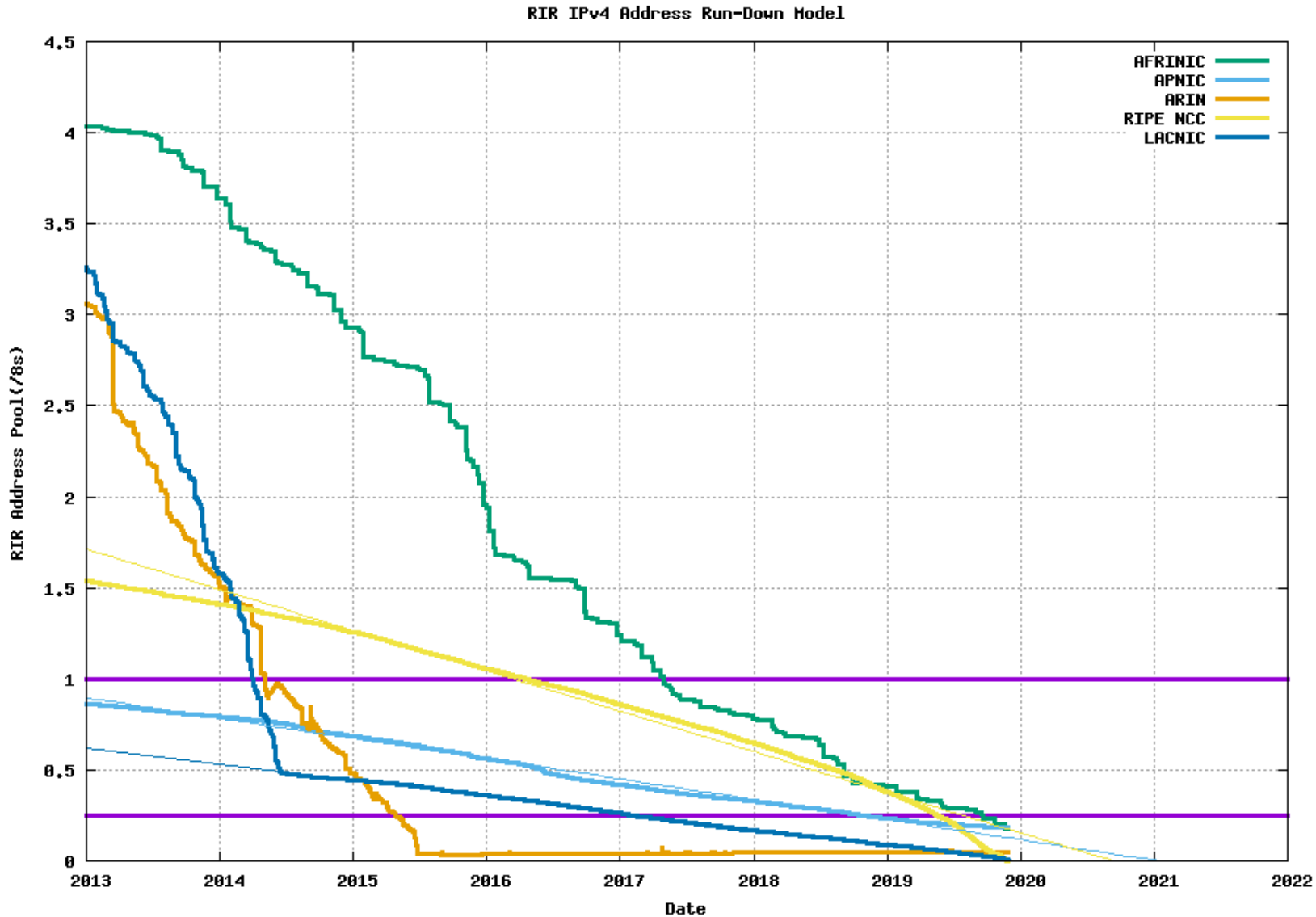
Bankrupt Nortel finds a buyer for 666K of its legacy IPv4 addresses, raising questi
the IPv4 black/grey market has arrived.

Crims set up fake companies to hoard and sell IPv4 addresses

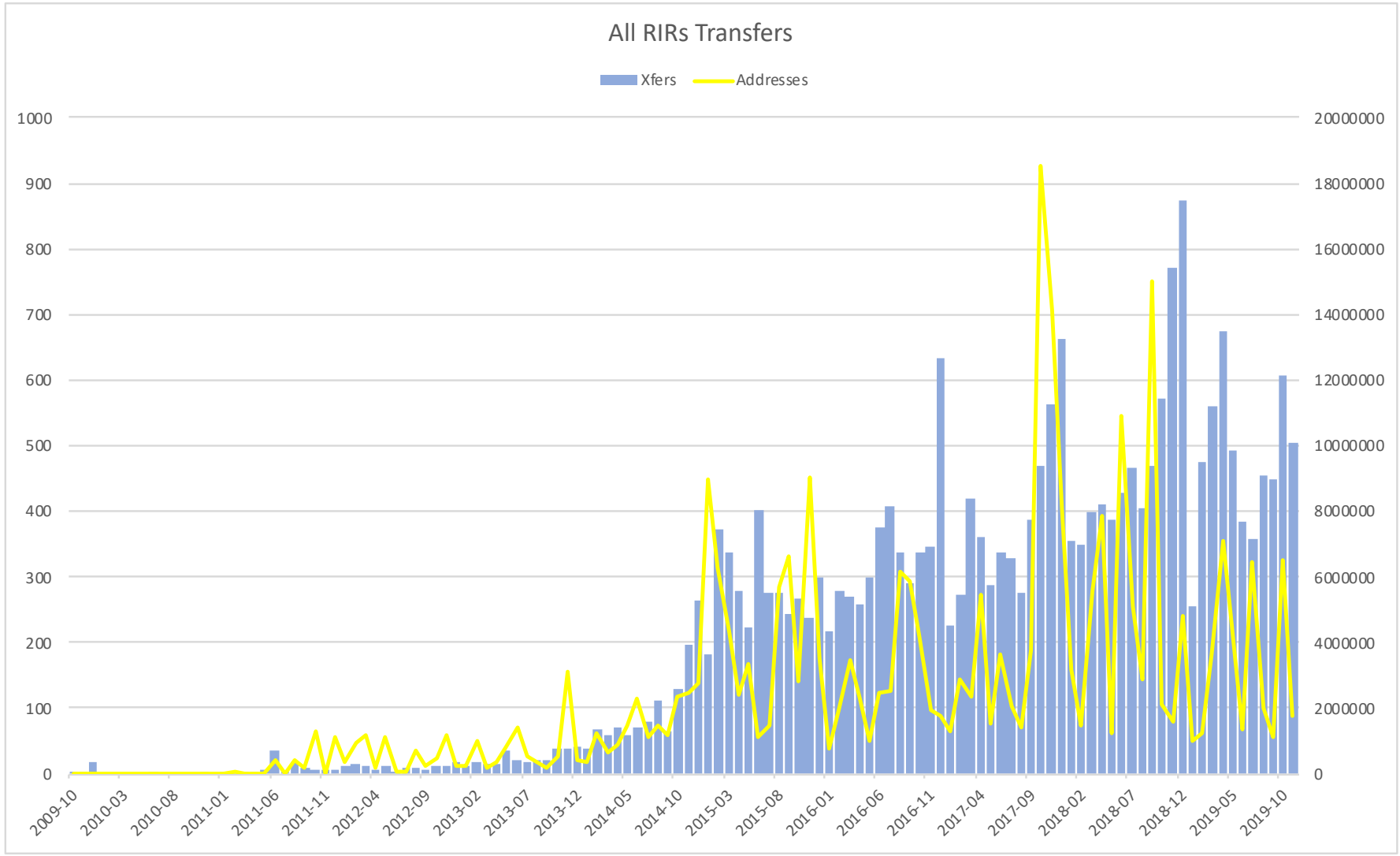
Dot-com pirates play dirty while trading elderly digits

By Simon Sharwood 16 Jun 2016 at 10:59 57 SHARE ▼

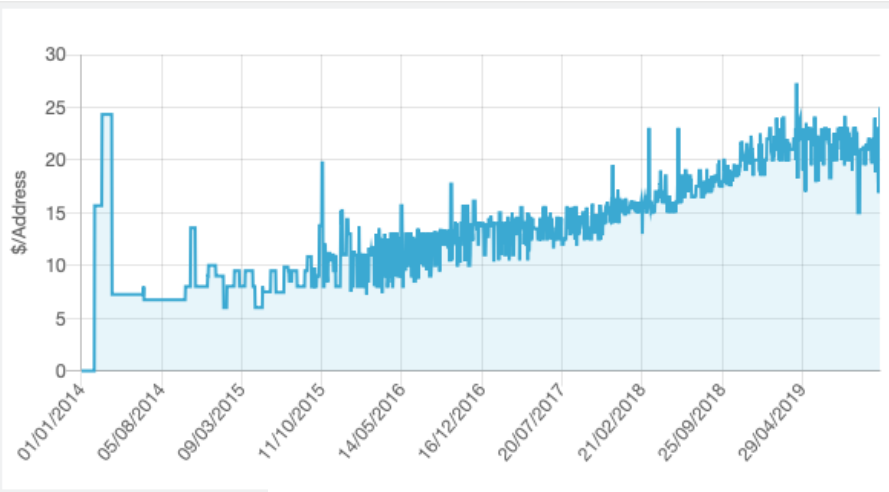
IPv4 Exhaustion

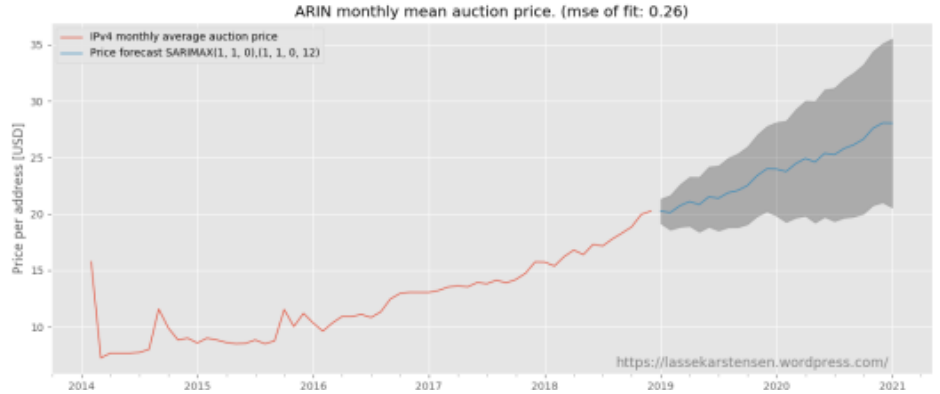


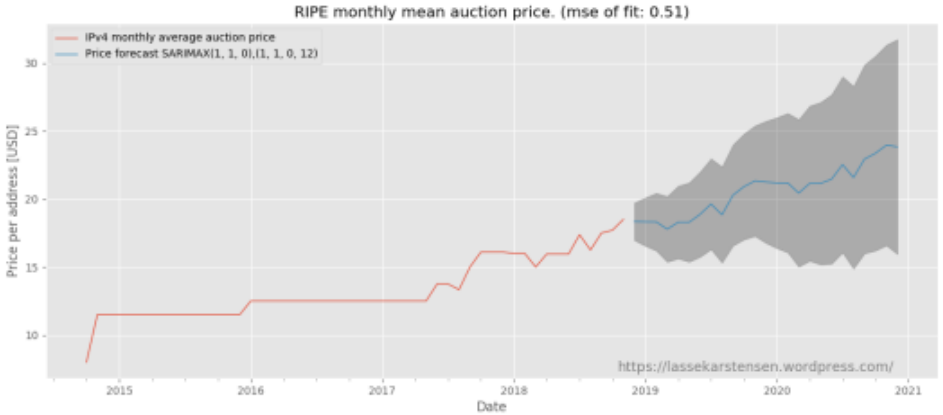
Address Transfers



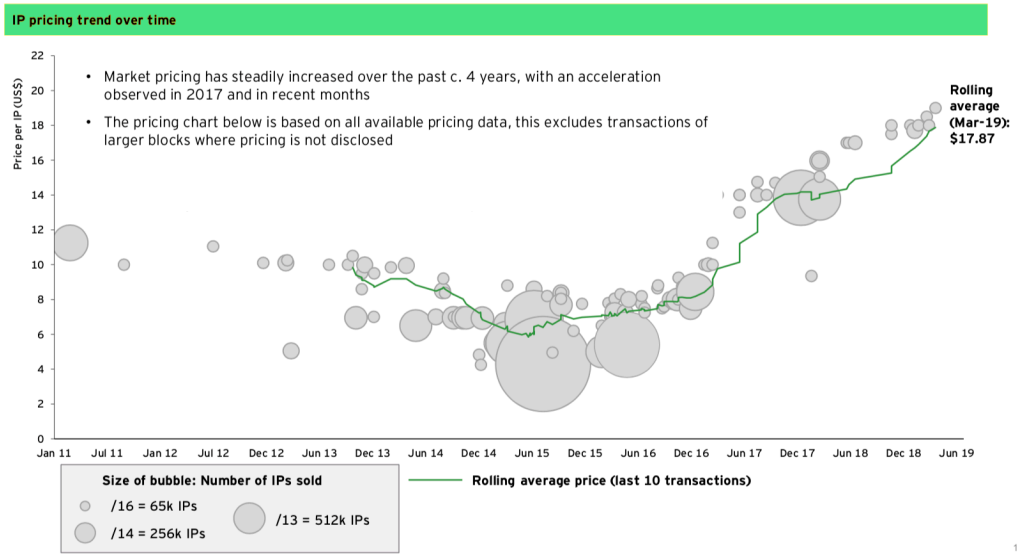
Market Behaviour







https://lassekarstensen.wordpress.com/2019/01/03/some-ipv4-address-price-forecasting/



http://ipv4marketgroup.com/ipv4-price-trends/

What just happened?

- The network lost its dependence on unique addressing as a universal host identification token
- The architecture of the network is now fully client/server
- The application layer has subsumed the service identification function

- **There is no compelling evidence of significant escalation in scarcity pressure on addresses**

Observations

- Did masking a scarcity premium in IPv4 address pricing stall the V6 transition?
- Evidently we didn’t need V6 then and still don’t need V6 now
- By the time we run out of V4 we will have outgrown V6
- The IMEI / Sim is the endpoint identity space of the future network