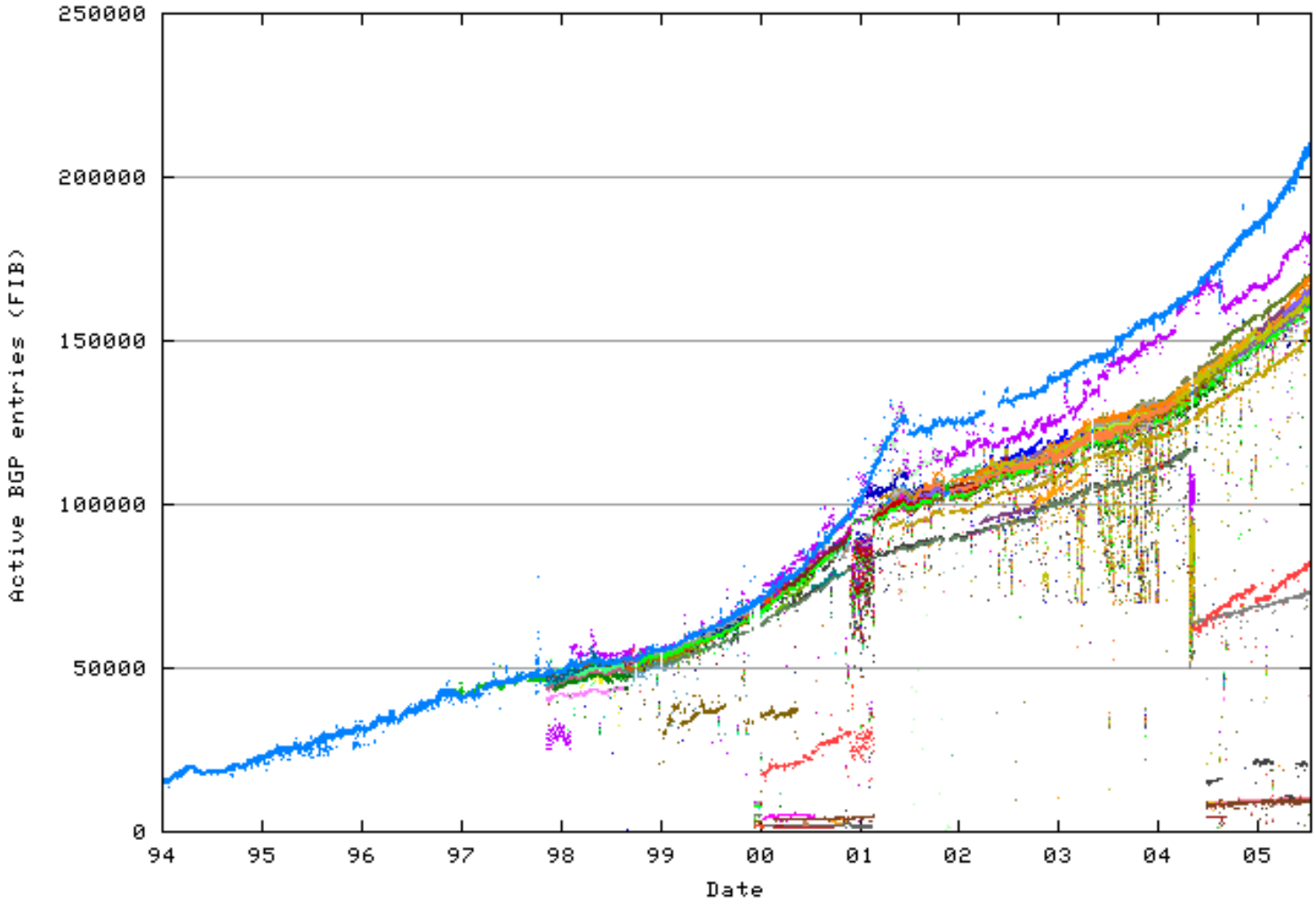
Routing Table Status Report

November 2005

Geoff Huston
APNIC

IPv4 Routing Table Size - Aug



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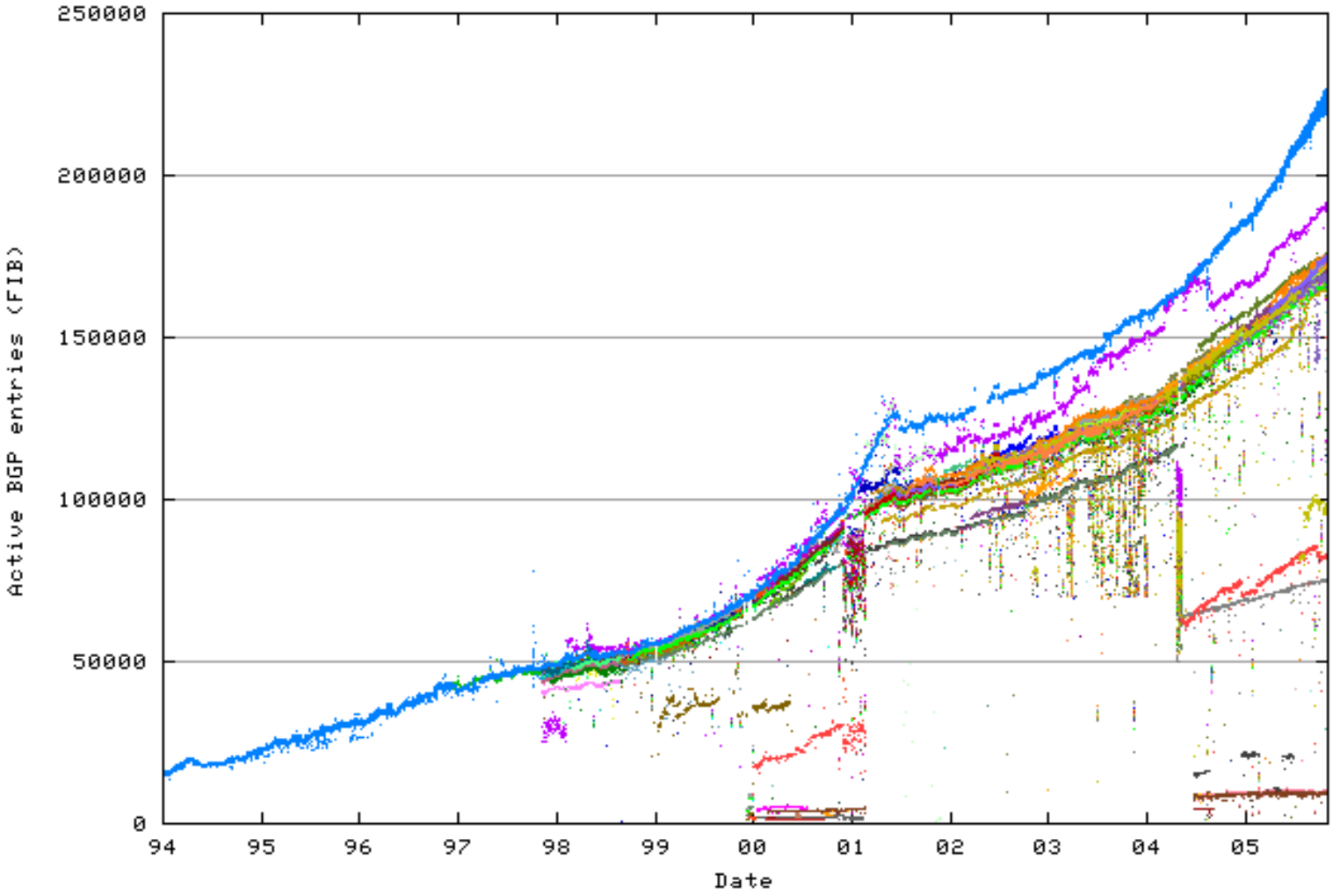
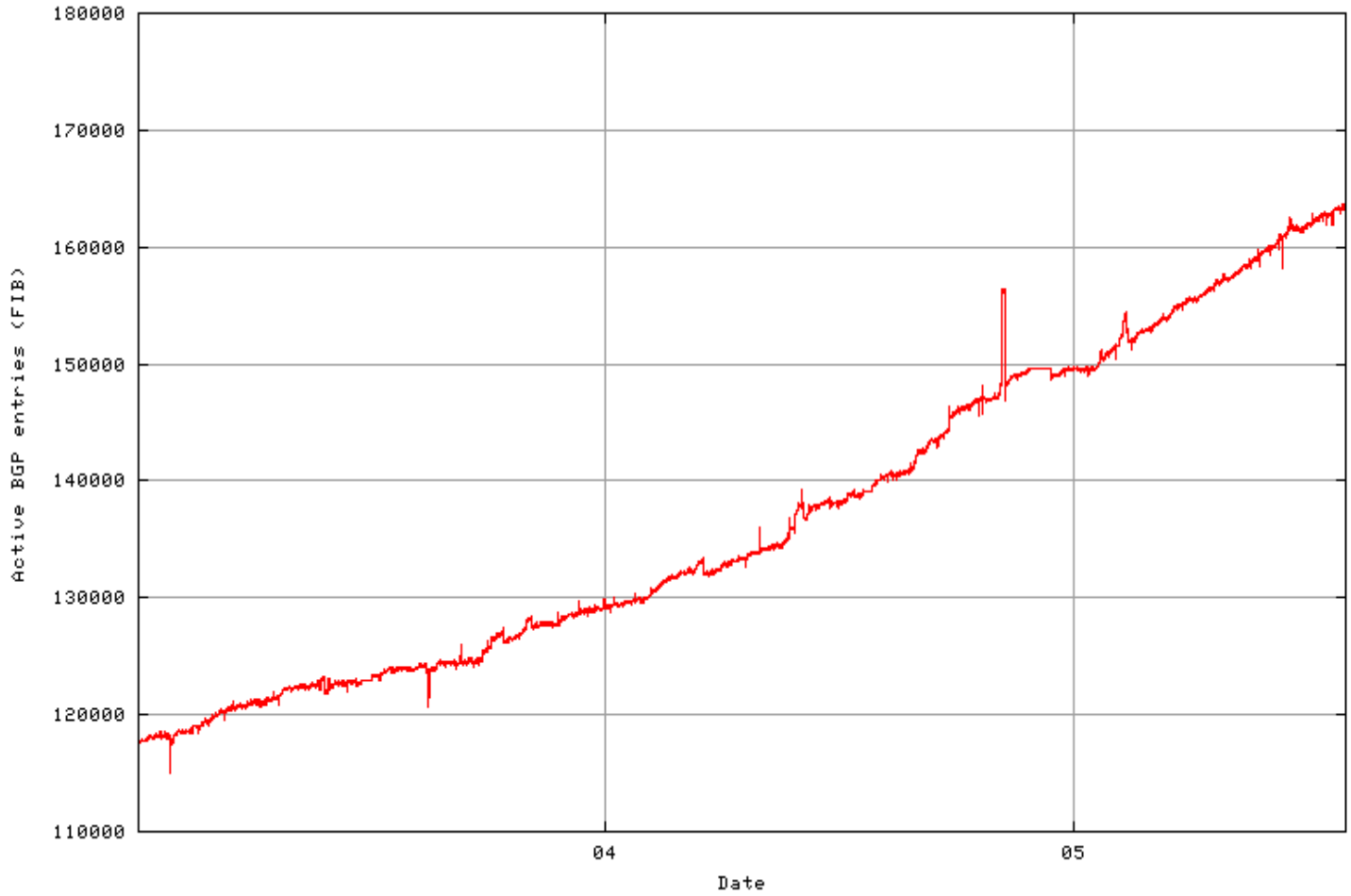


Data assembled from Route Views data. Each colour represents a time series for a single AS.

The major point here is that there is no single view of routing. Each AS view is based on local conditions, which include some local information and also local filtering policies about external views.

2003 to August 2005



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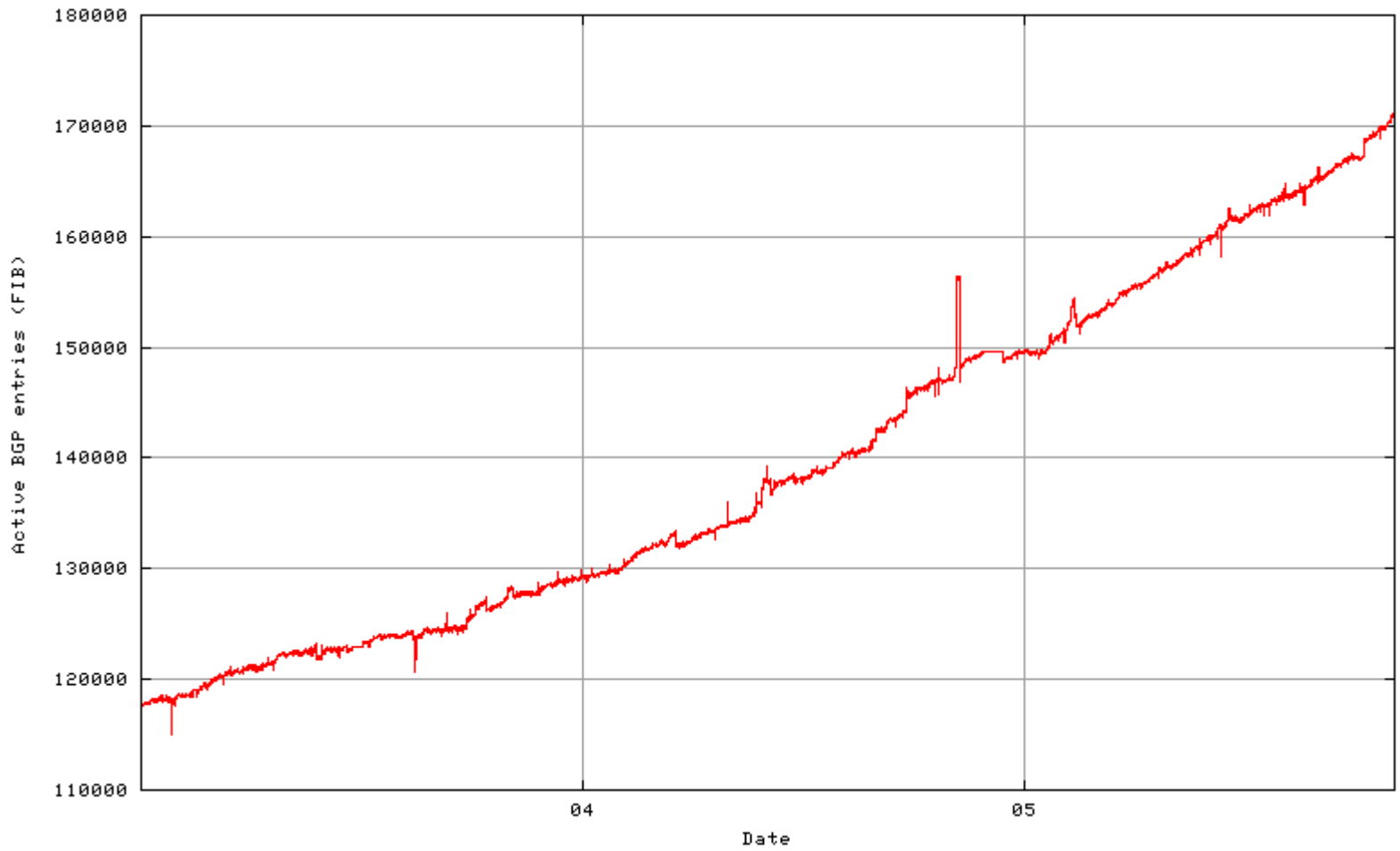
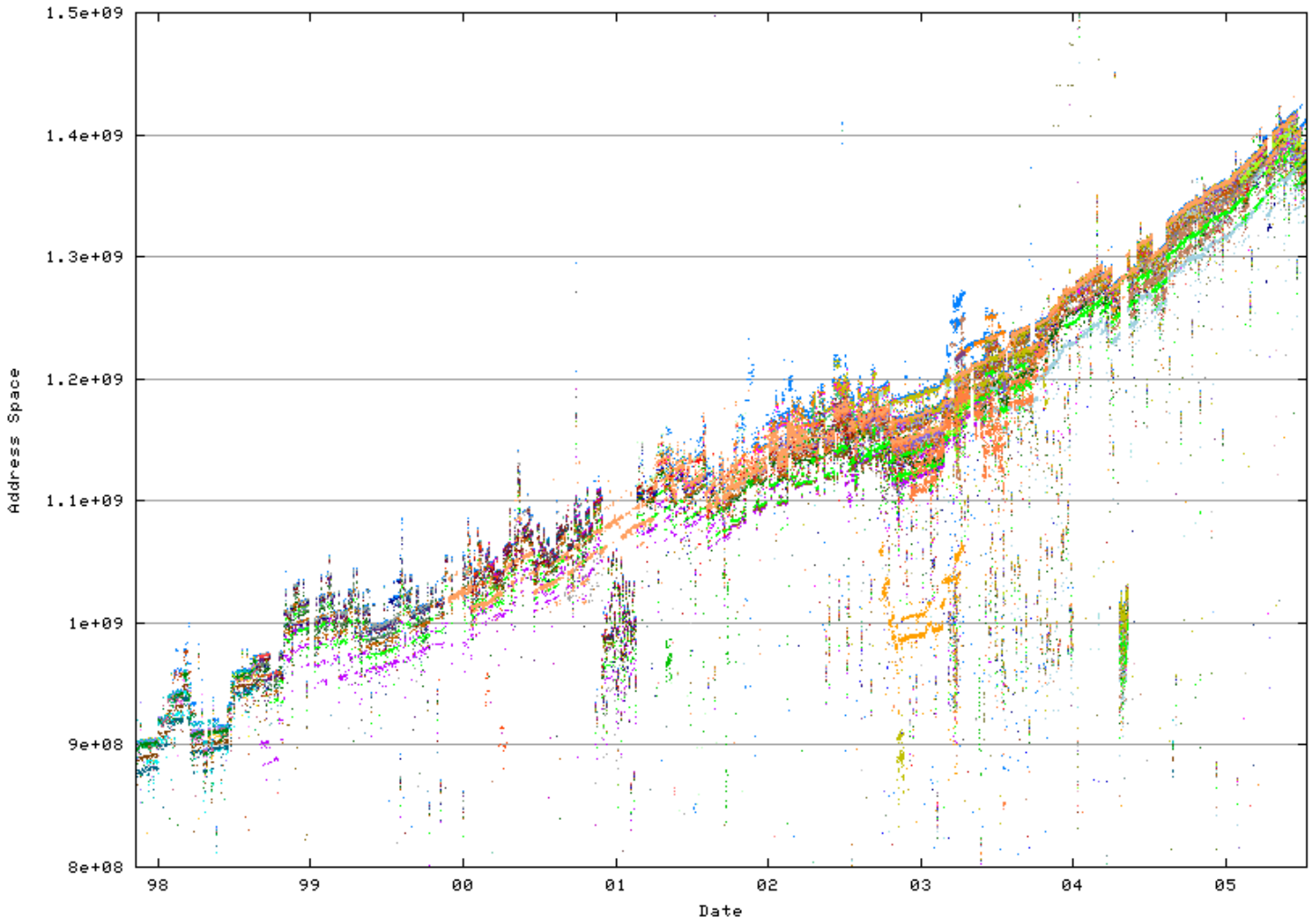


Routing table growth in the last 12 months shows an increasing growth trend, although the rate of growth remains close to linear (or constant) growth rates. This figure indicates that the current table growth rate is some 22,000 entries per year. This data is based on hourly snapshots of the routing table, and the noise in the figures is based downward spikes of lost routing information and upward spikes of transient routing information, possibly due to leakage of local more specific routes. The discontinuities show points of large scale aggregation or dis-aggregation.

IPv4 Address Span - Aug



This figure shows the total amount of address space spanned by the routing table. This is a view derived from the Route-Views archive, where each AS has a single colour. The snapshots are at two-hourly intervals, and span from early 2000 until the present. The strong banding in the figure is spaced 16.7M units apart, or the size of a /8 advertisement There appear to be 3 /8 advertisements that are dynamic. Not every AS sees the same address range, and this is long term systemic, rather than temporary. This is probably due to routing policy interaction, coupled with some cases of prefix length filtering of routing information. The rate of growth declined sharply across 2002 and the first half of 2003, resuming its 2000 growth levels in 2004. The recent trend is increasing growth.

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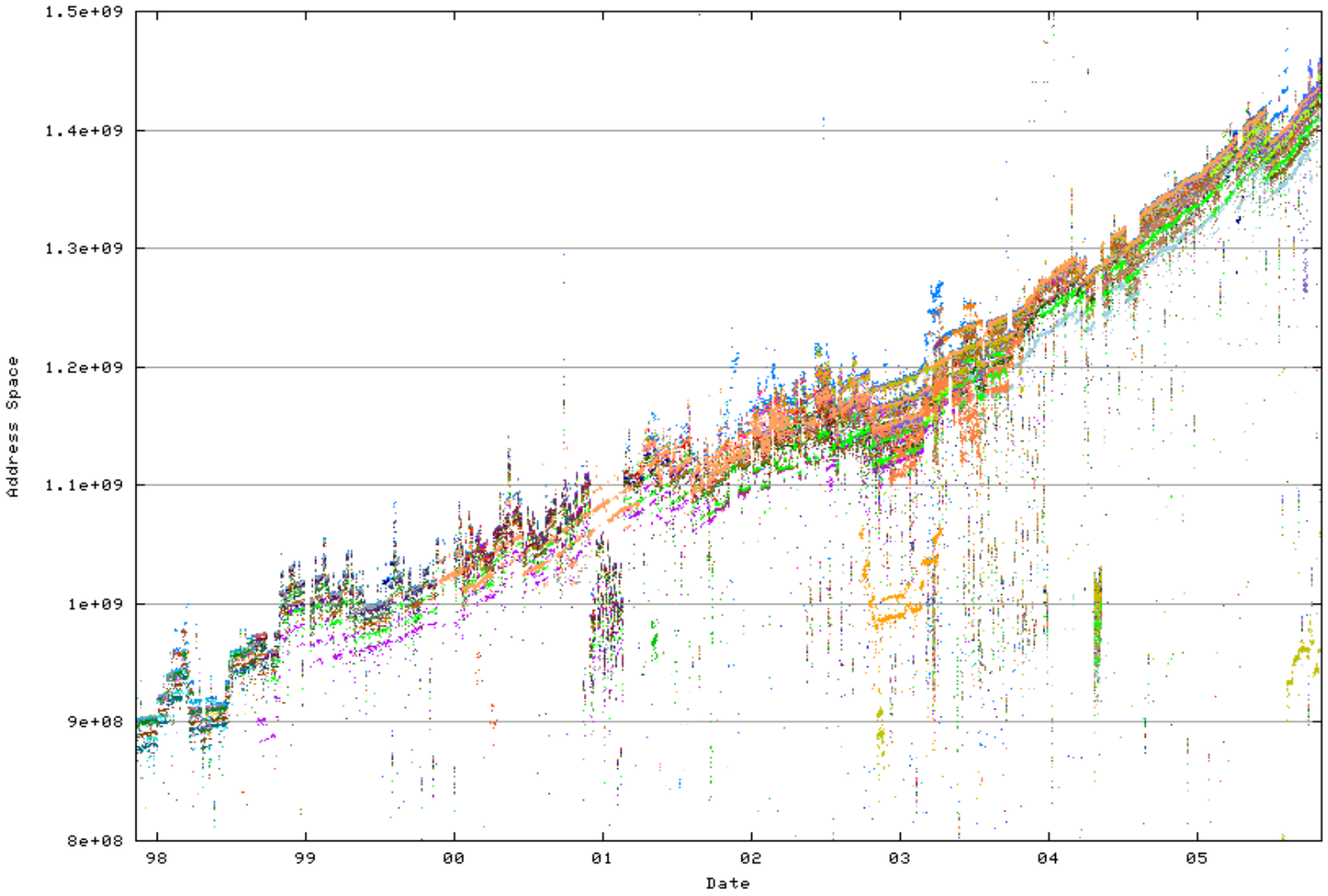

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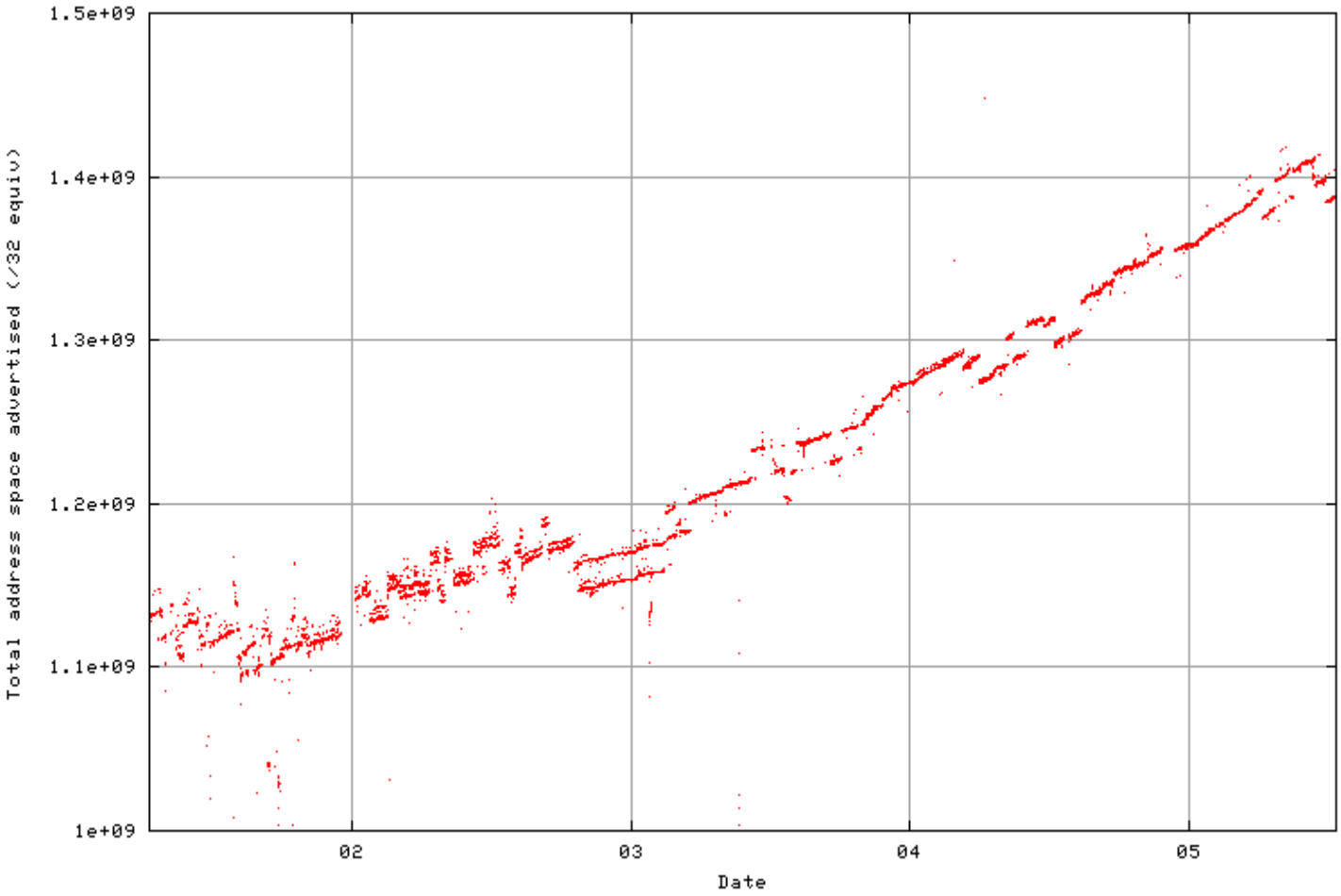

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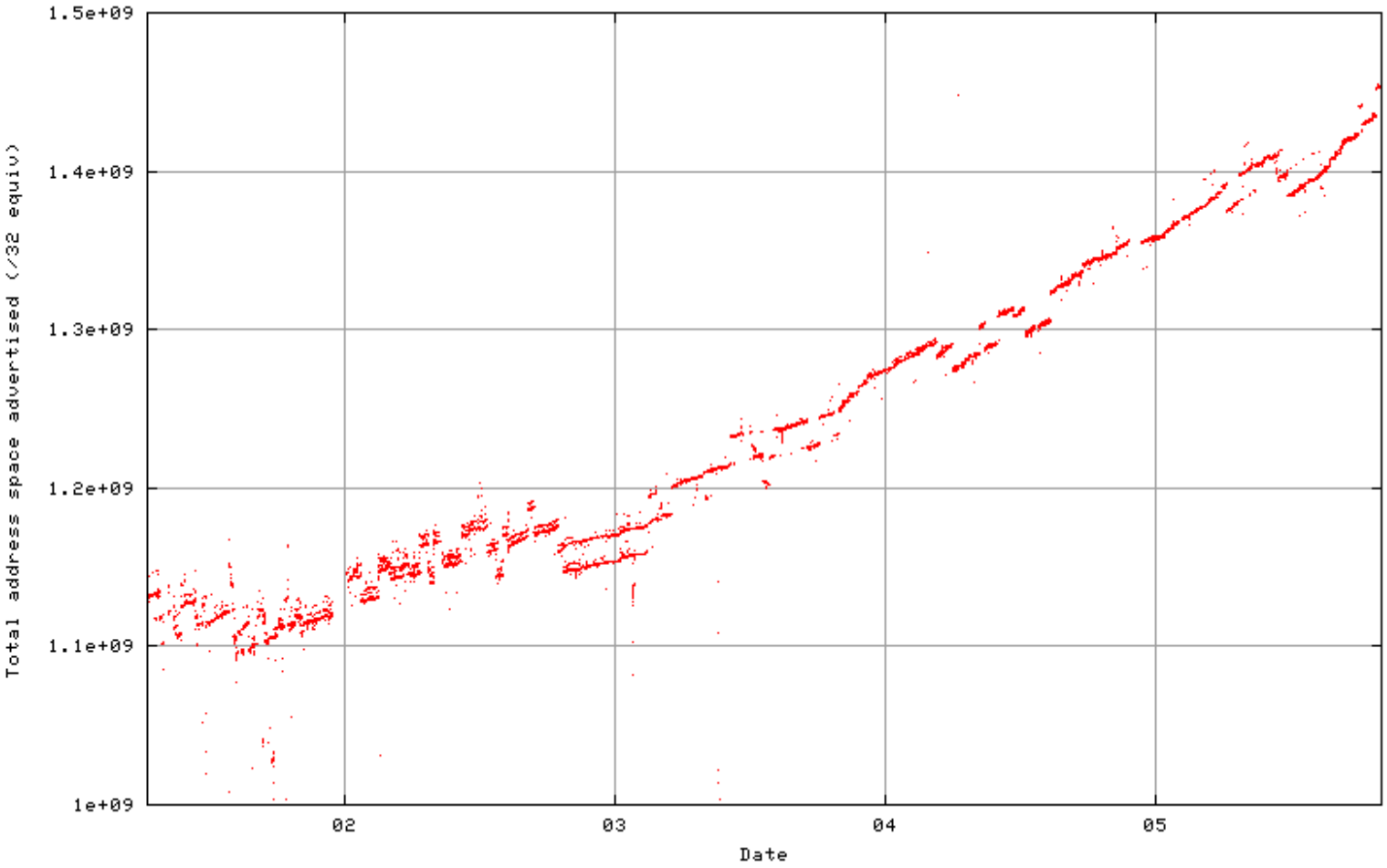
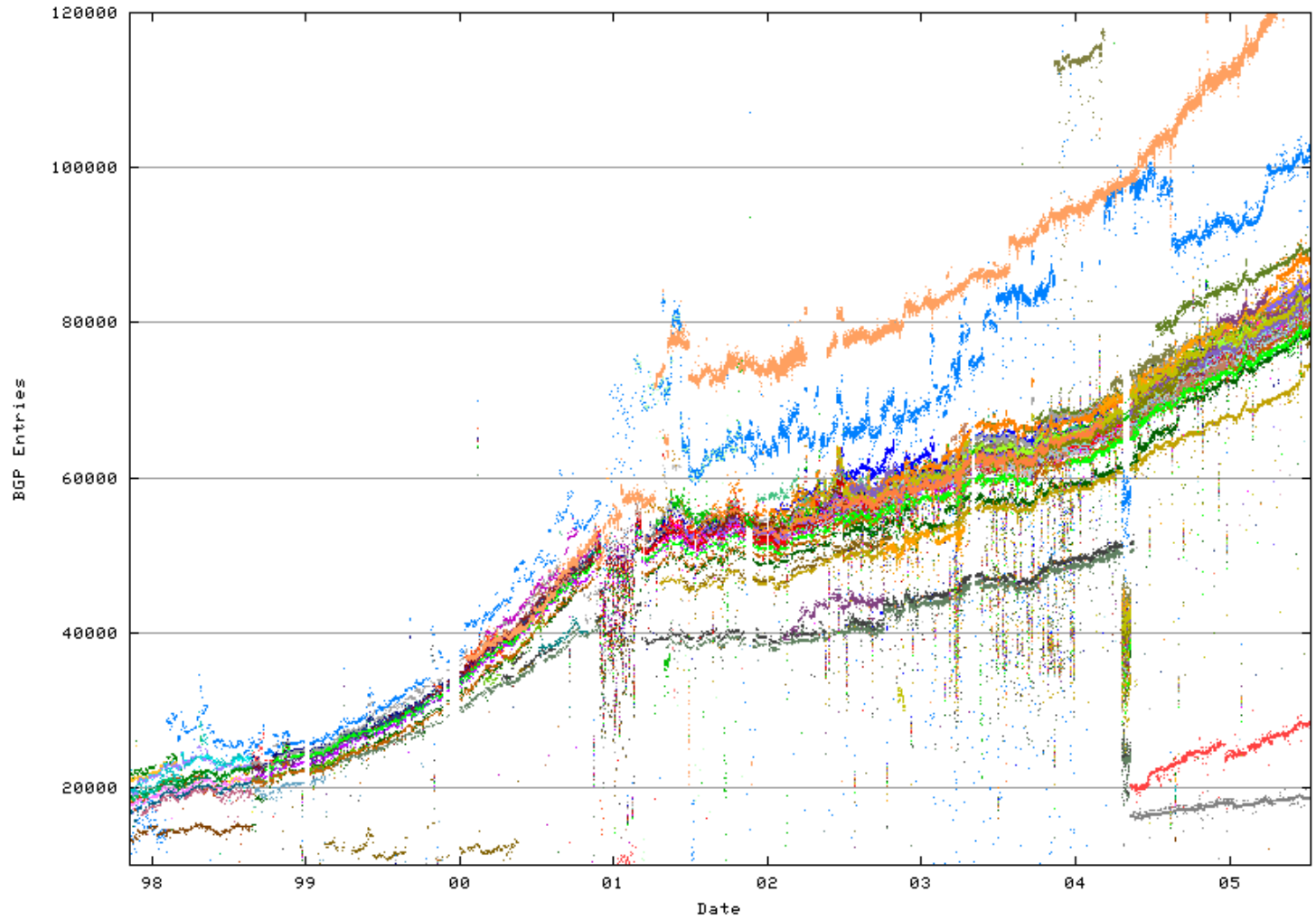


This is the same data for a single AS. It is evident that the number of unstable /8 advertisements has dropped from 3 to 1 over this period. It is also apparent that the rate of growth in 2004 is slightly higher than that of 2000.

When comparing this to the steeply rising number of routing advertisements in 2000 it is likely that the periods of growth in the routing table correspond to periods of dis-aggregation of address blocks. This implies that the large growth periods of the routing table may be closely linked to periods of growth in policy diversity within the ISP sector, coupled with denser levels of interconnectivity.

IPv4 More Specific Advertisements



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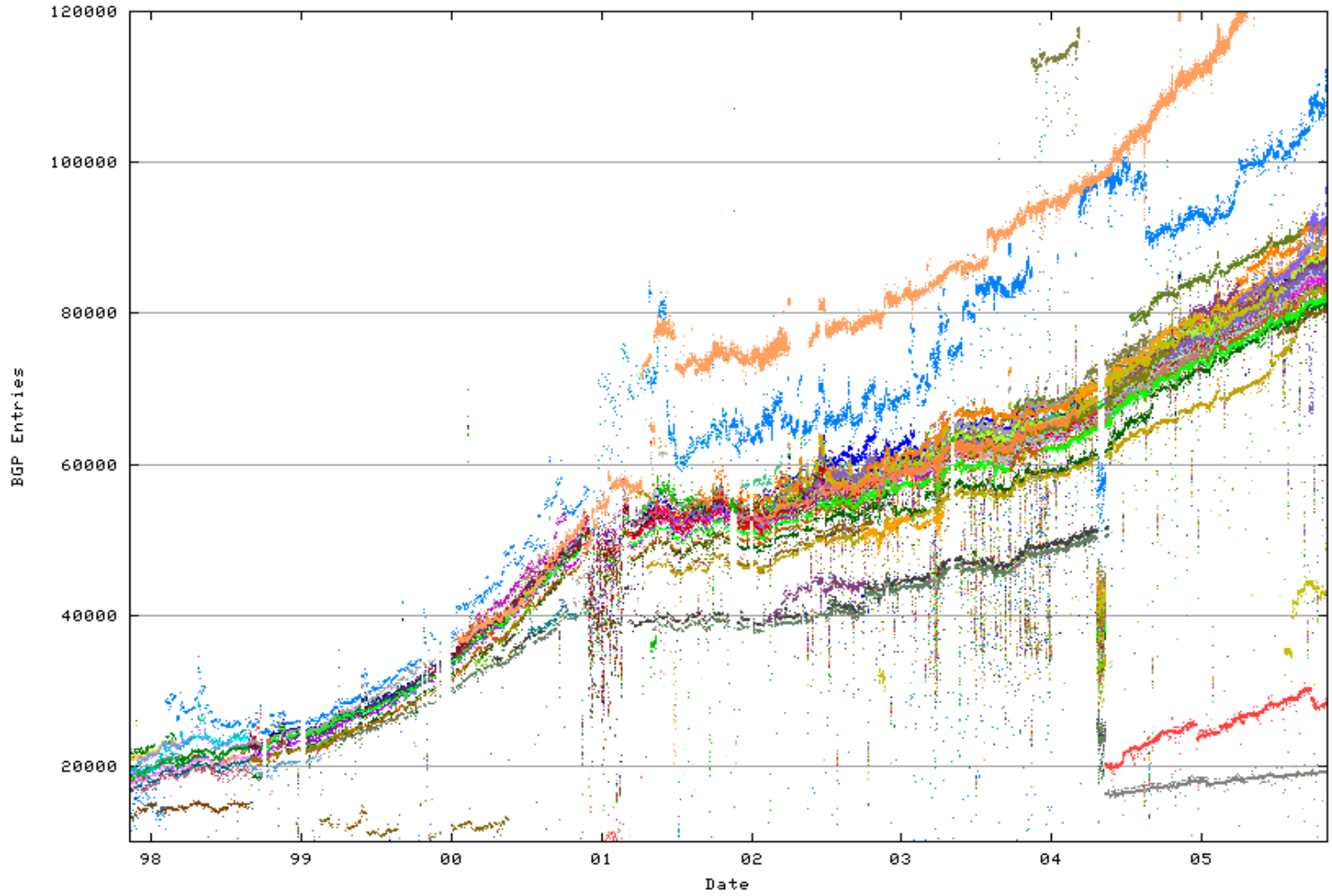
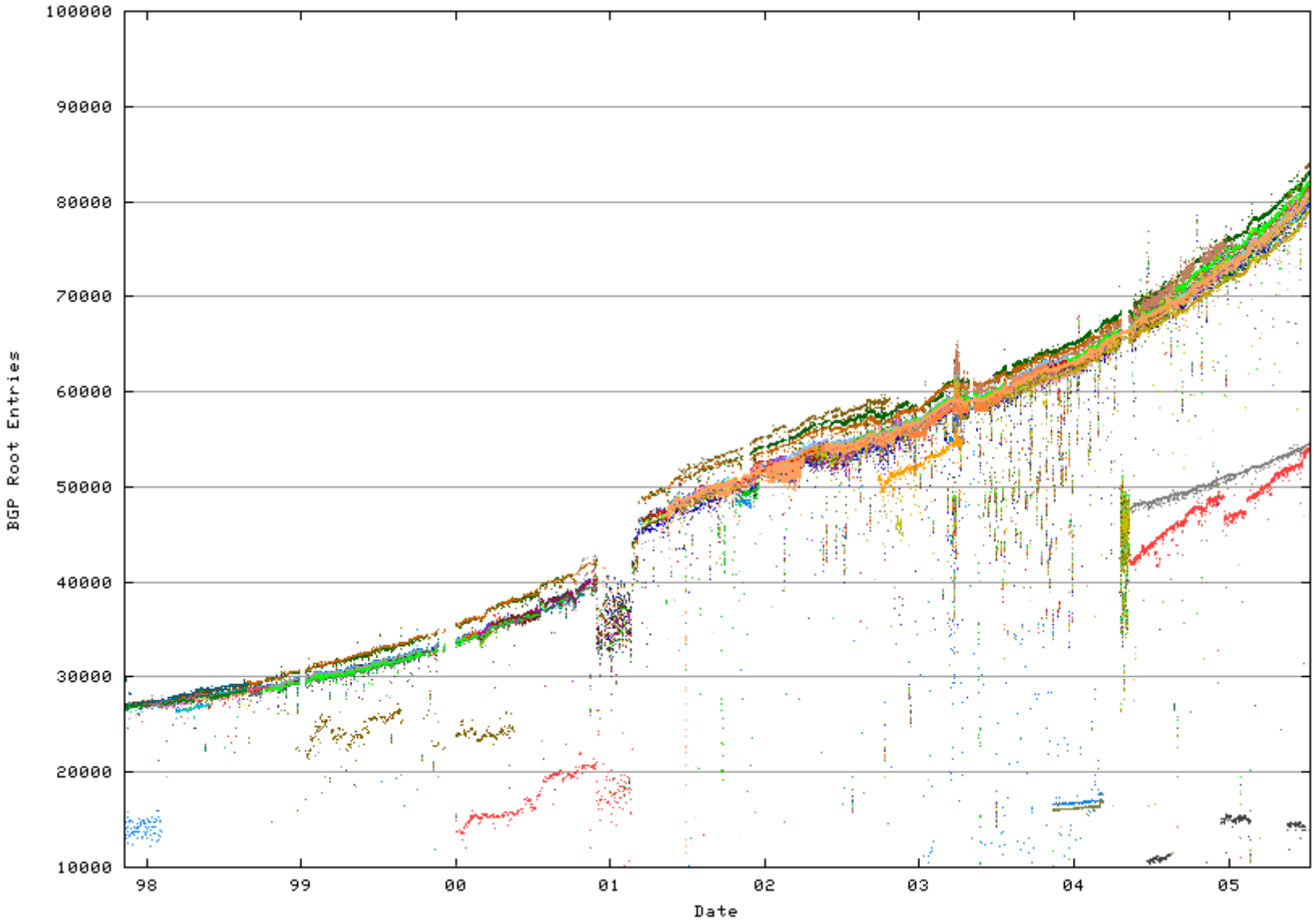


Root Prefixes - Aug



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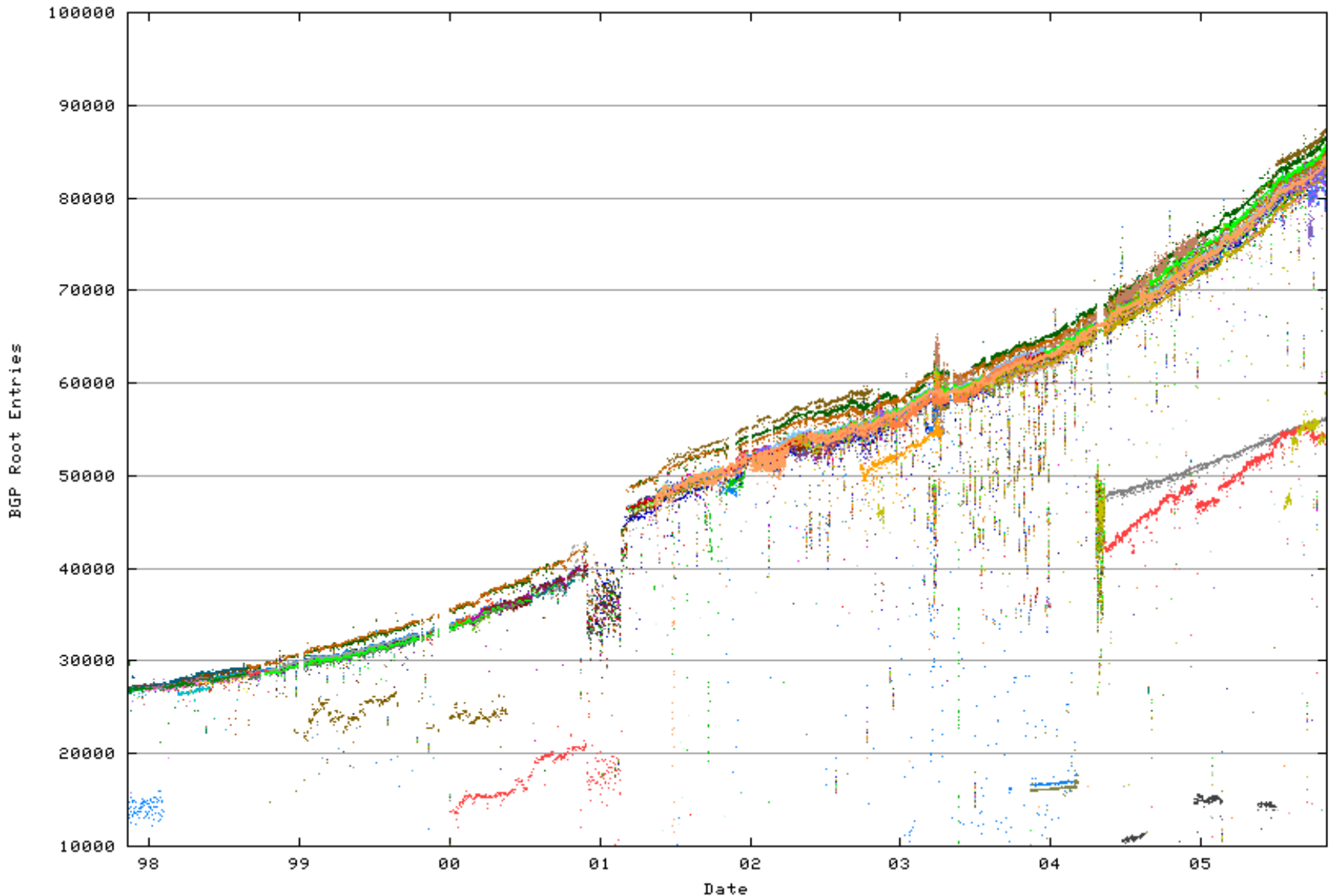
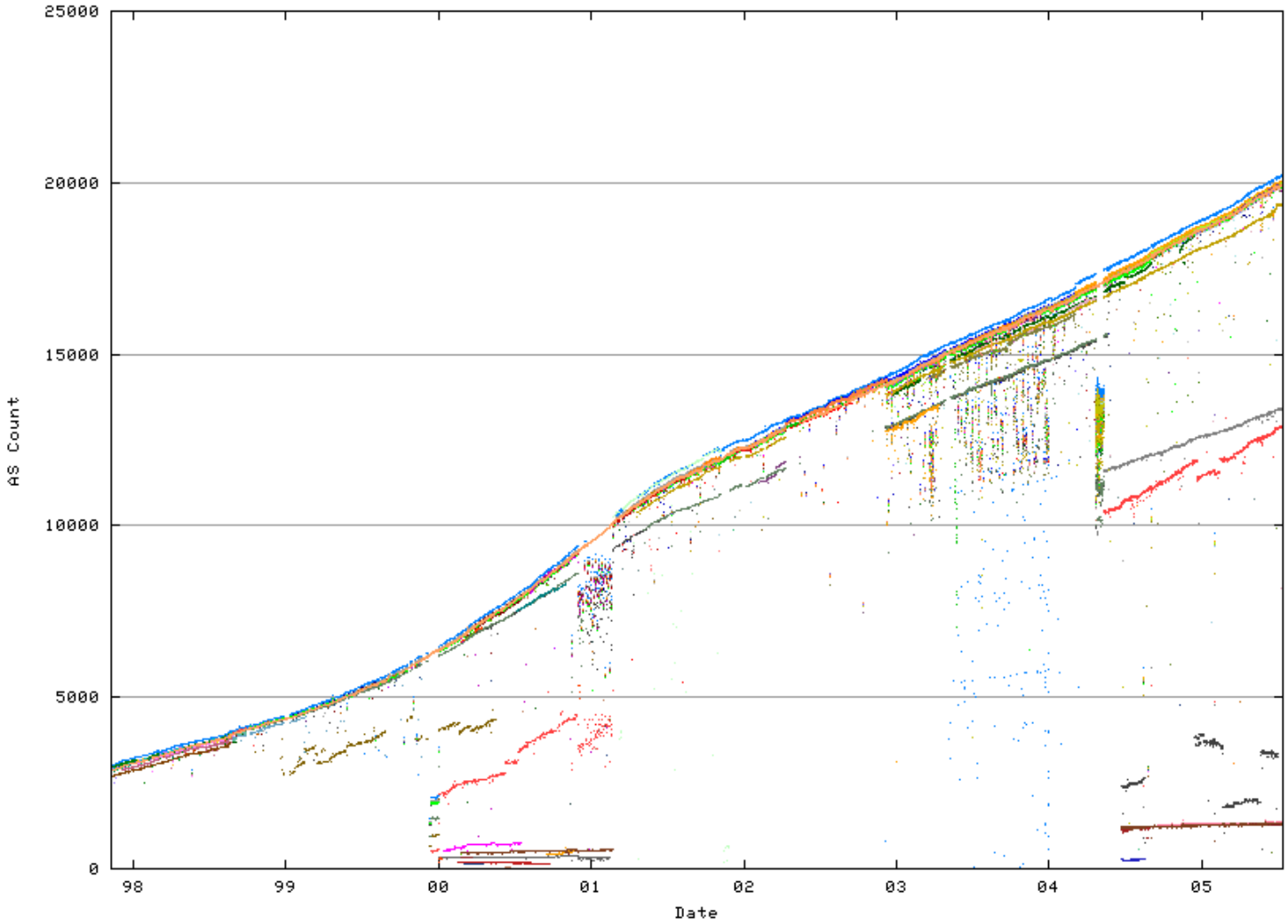


Unique ASNs - Aug



Since early 2001 the number of ASNs in the routing table has been growing at a constant rate, closely matching a linear growth model. New ASNs track the growth of new service providers.

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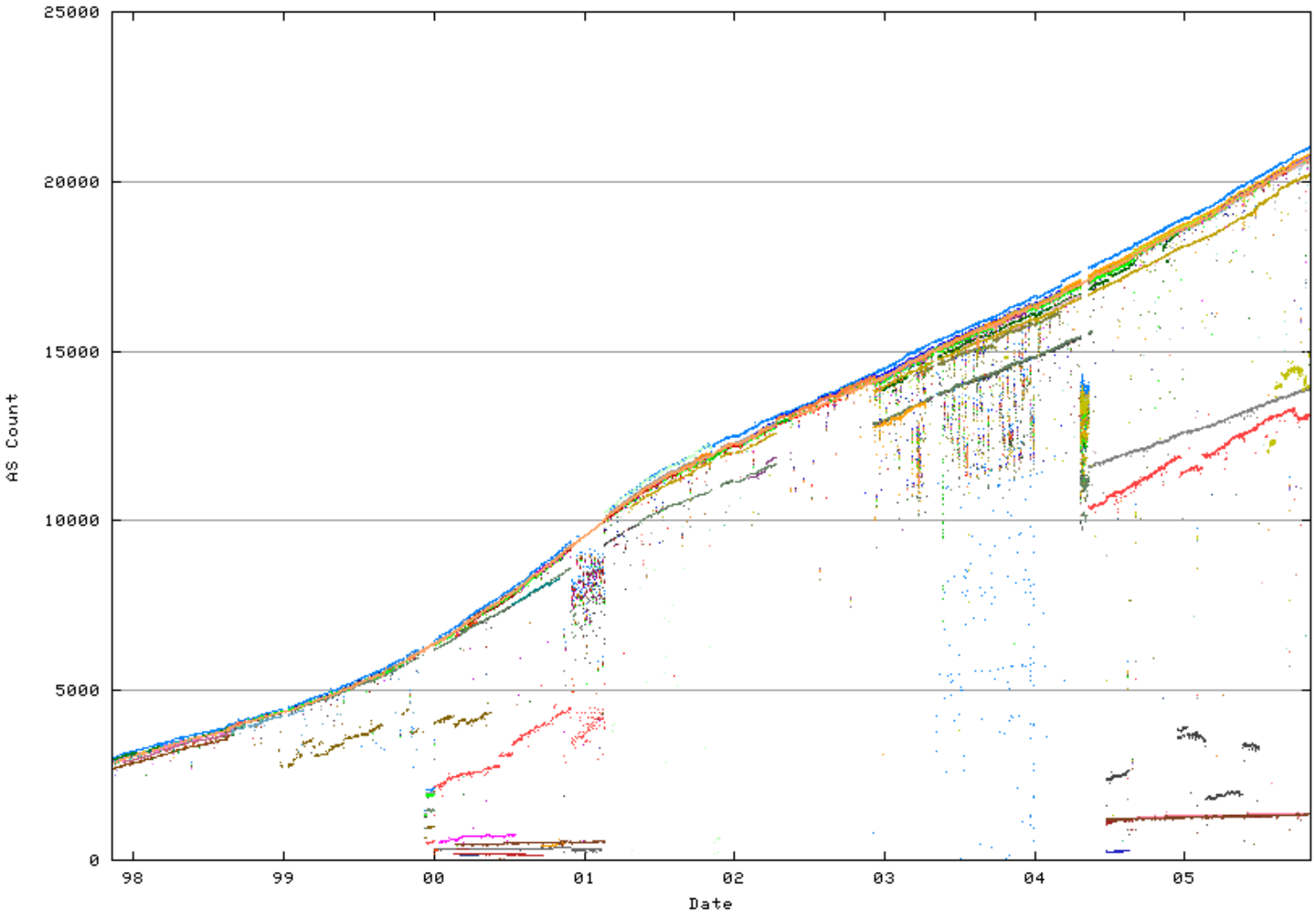

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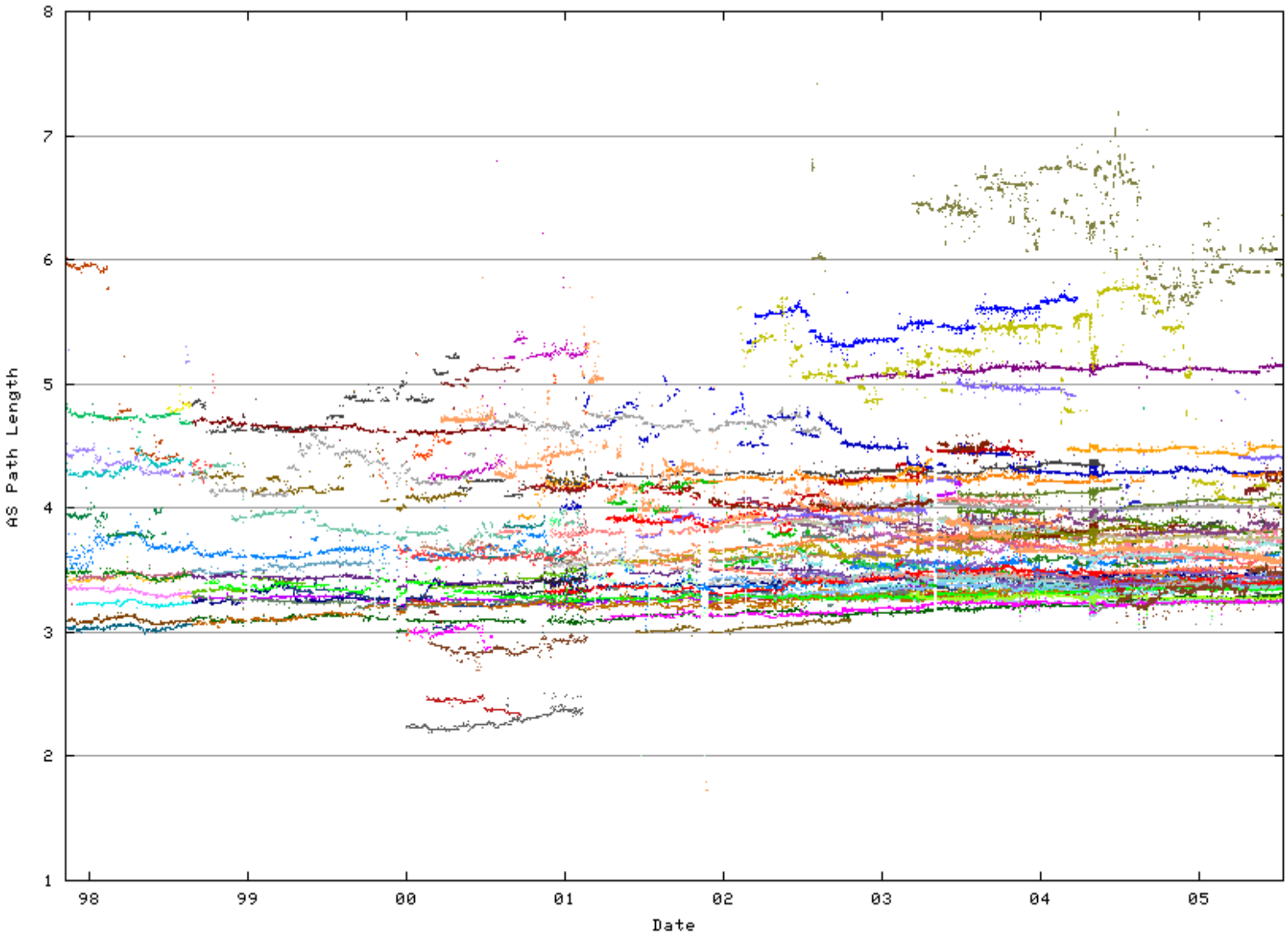

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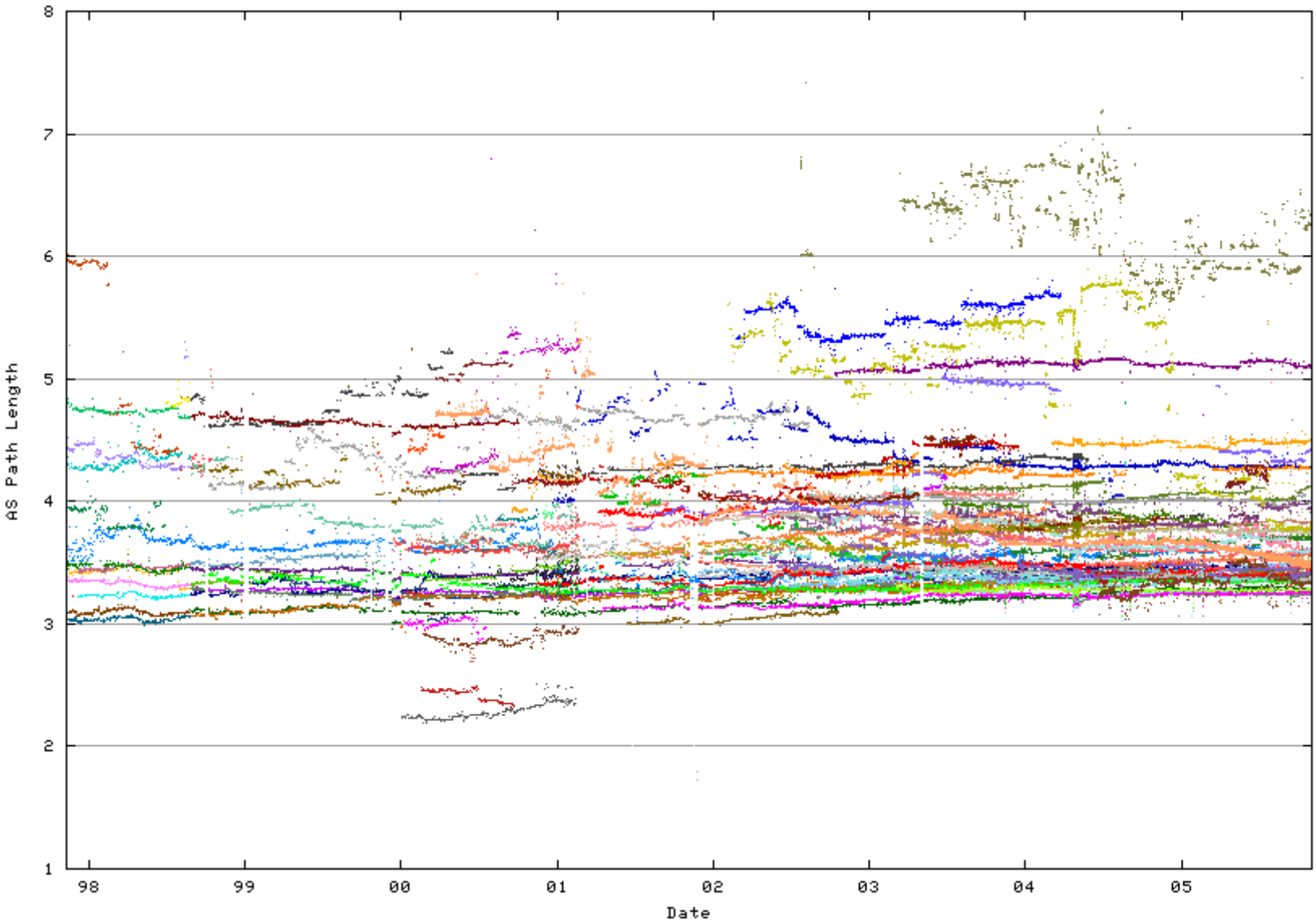
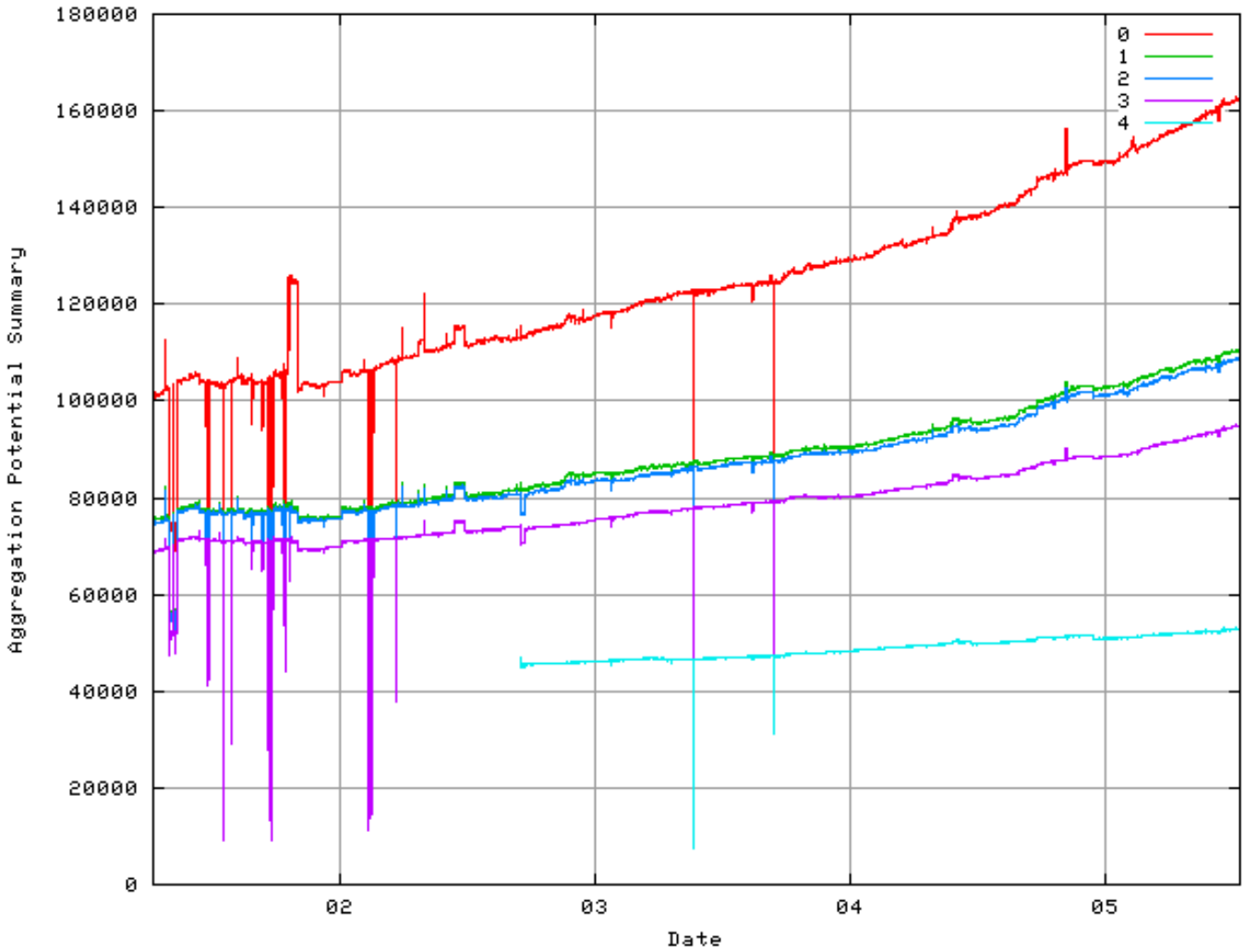


A constantly increasing number of ASNs can be related to average AS path length. The relatively constant AS path length for all AS paths implies that the density of AS interconnection is increasing at a rate proportional to the number of ASNs being added.

IPv4 Aggregation Potential - Aug



This shows the aggregation potential of the entire routing table

0 – the size of the routing table in terms of number of distinct entries
1 – application of an aggregation algorithm that will only remove more specific routing entries if they match the enclosing aggregate in AS Path
2 – as with 1, but with all path prepending removed
3 – aggregation using origin AS match, disregarding AS PATH
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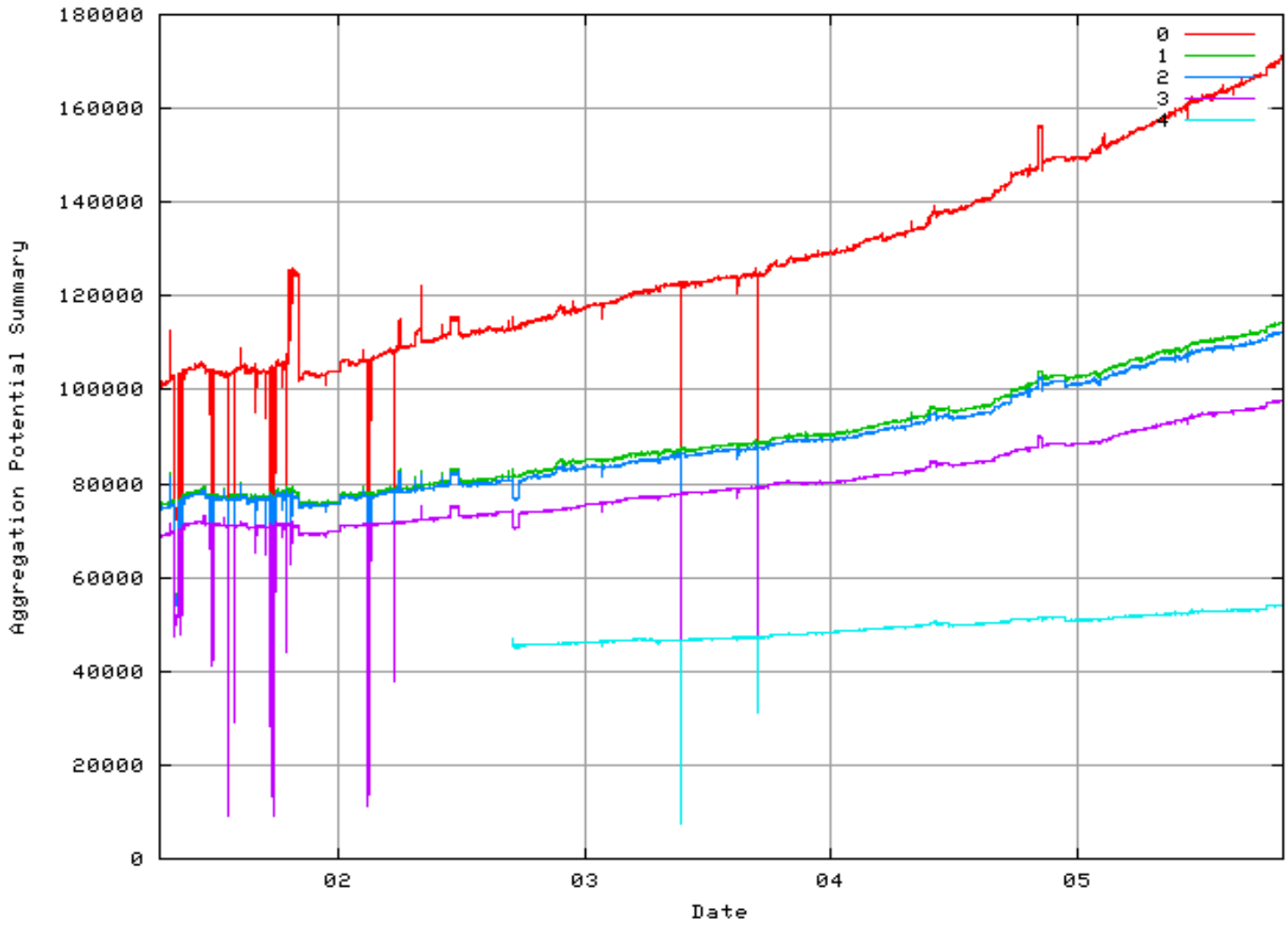

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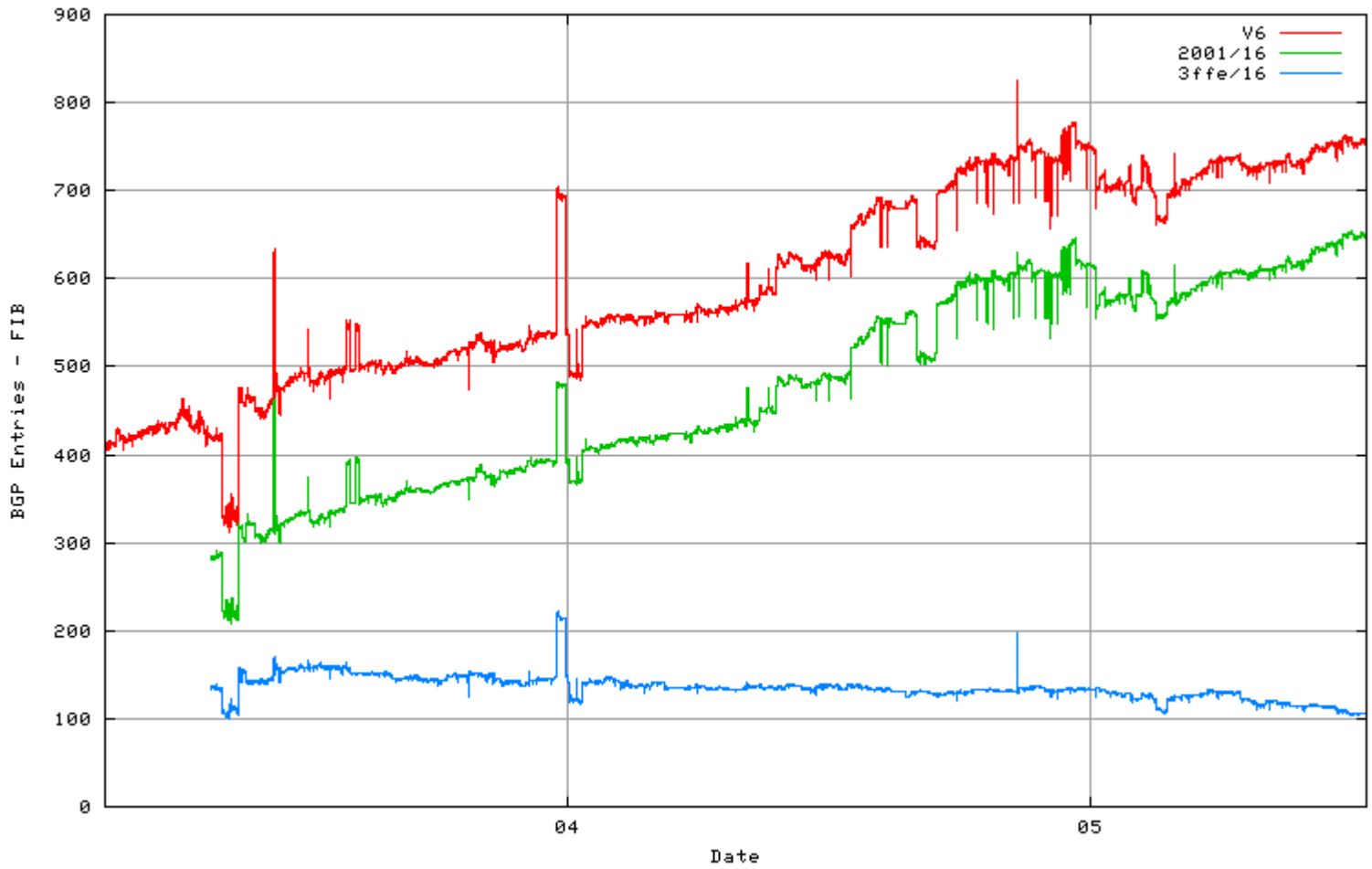
IPv6 Routing Table - Aug



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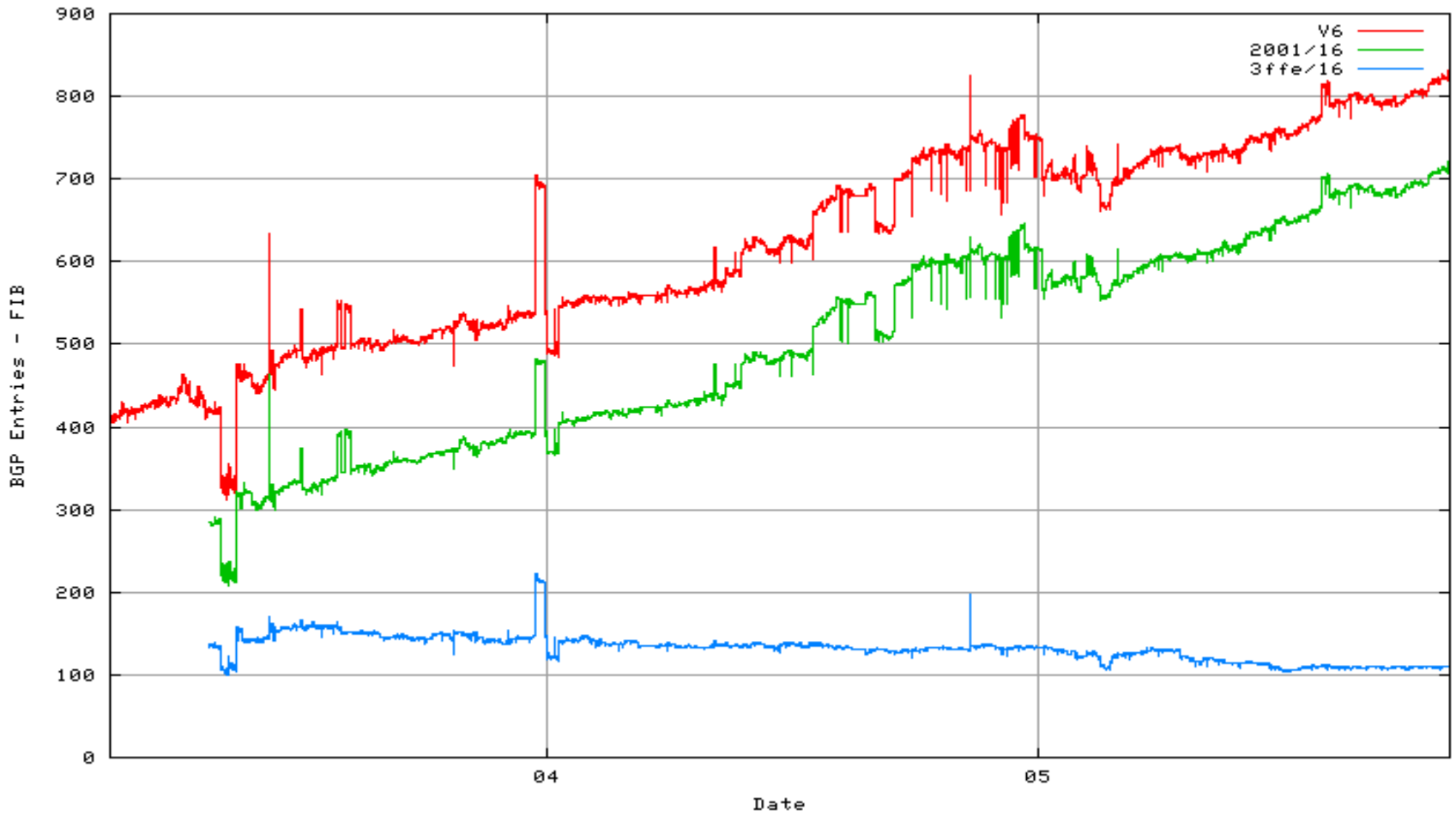
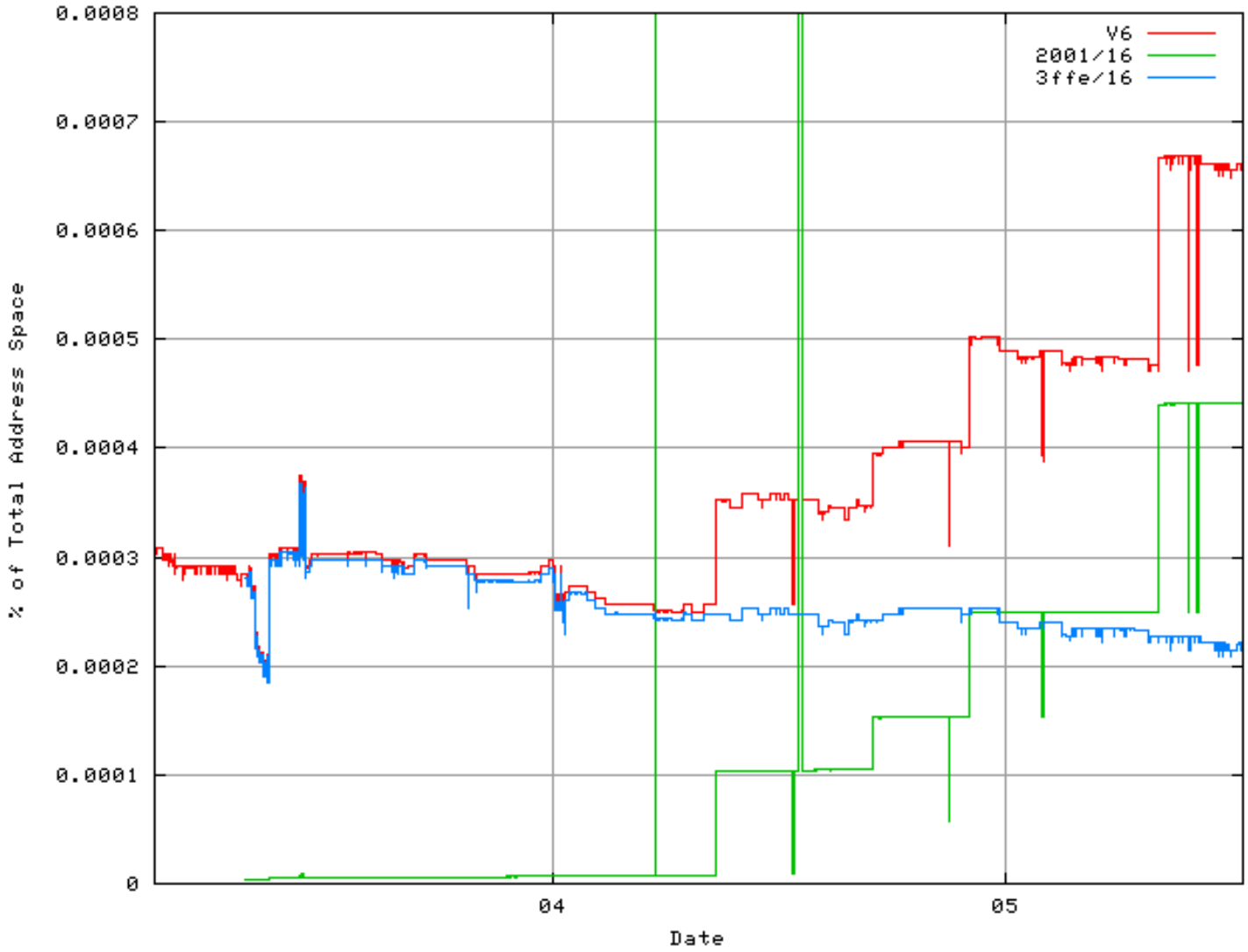


IPv6 Address Span - Aug



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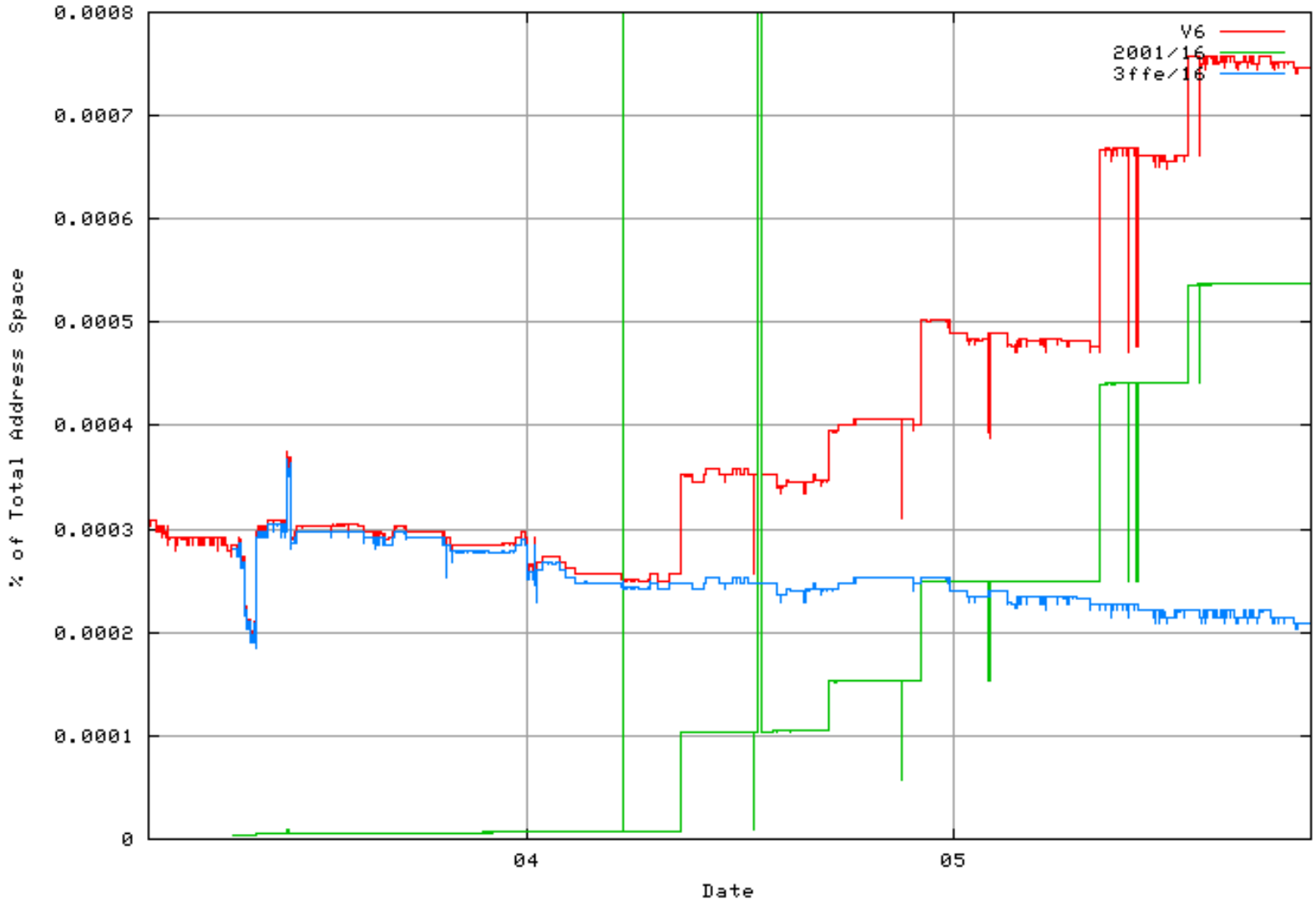

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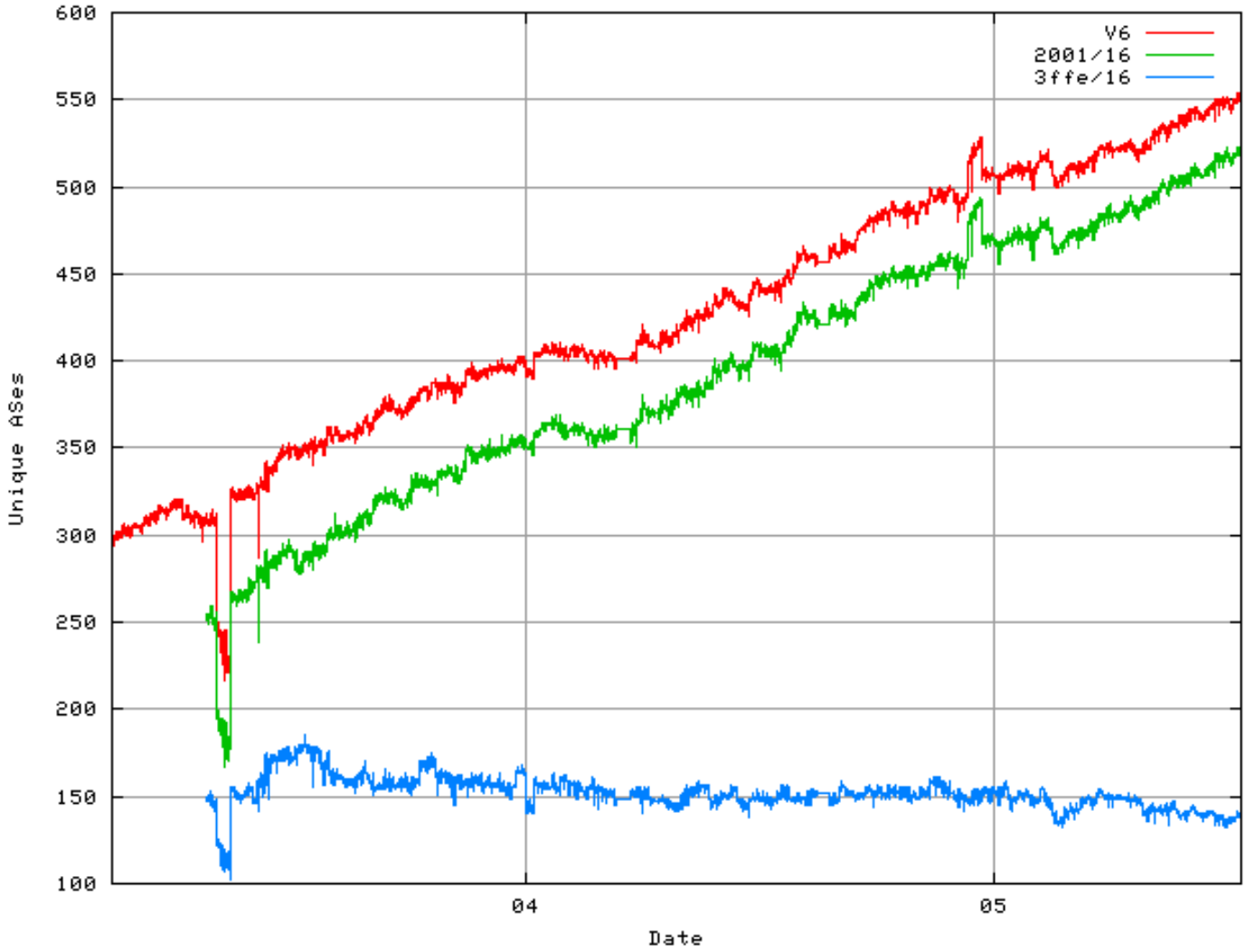

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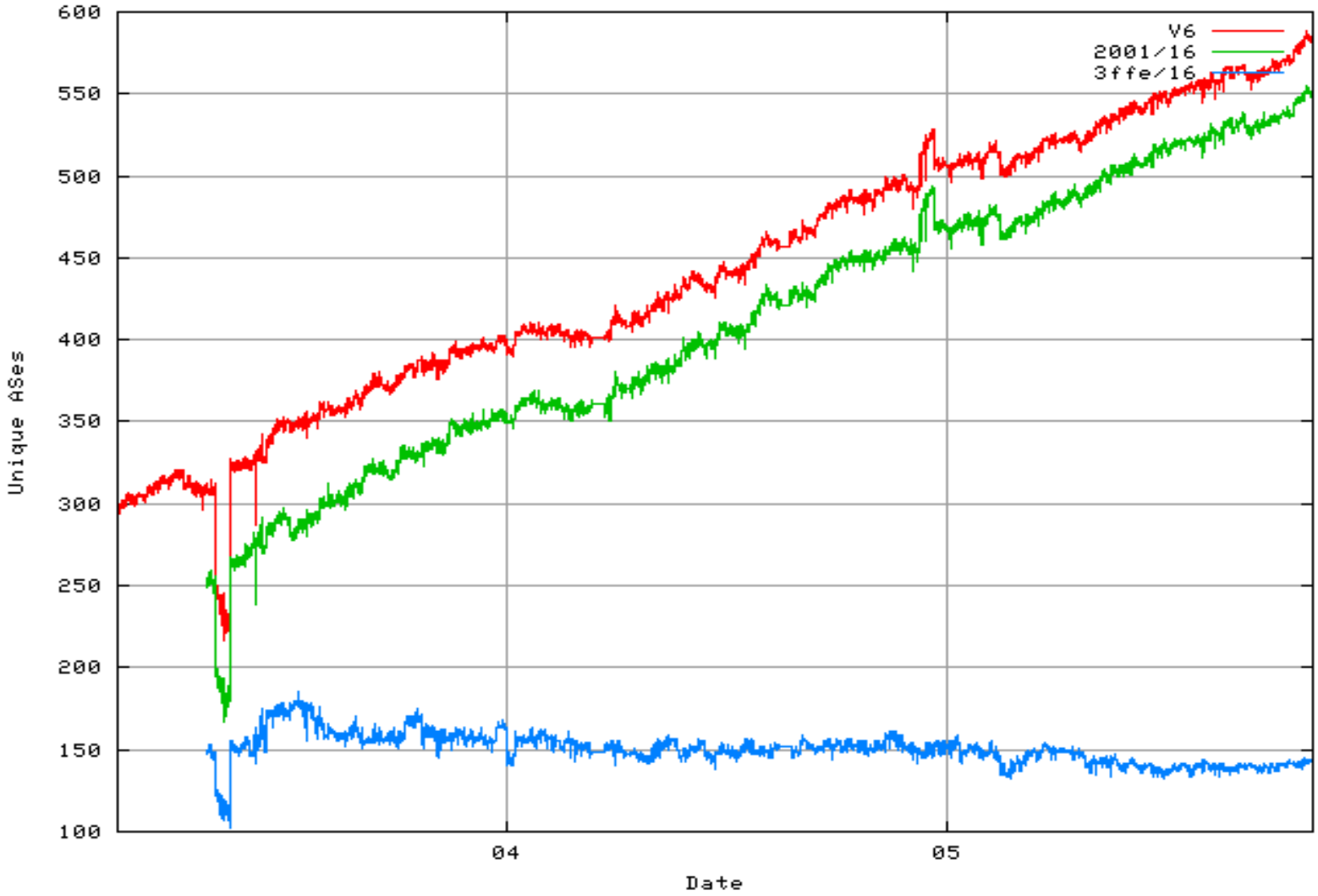

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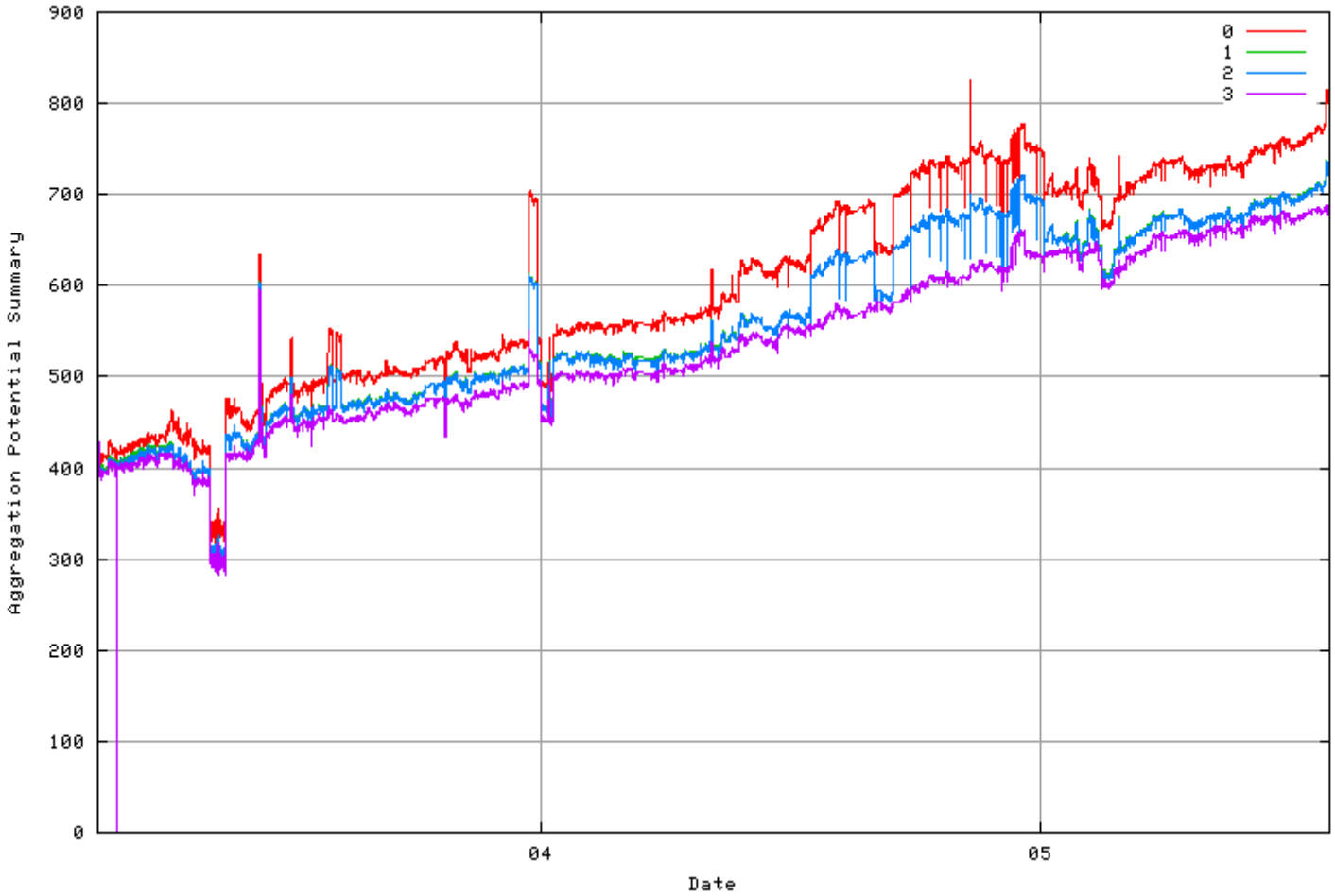

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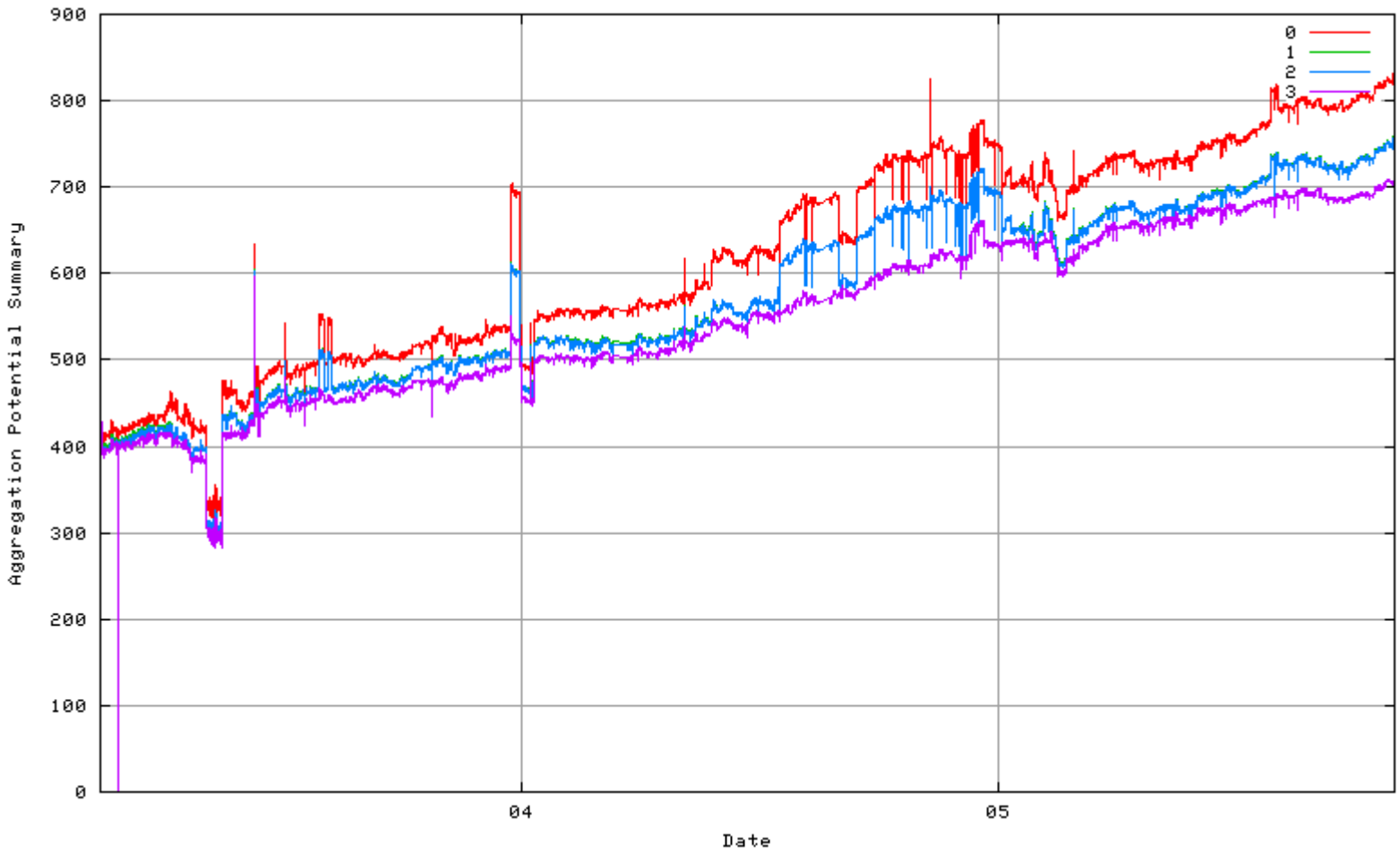

IPv4 Address Space Numerology

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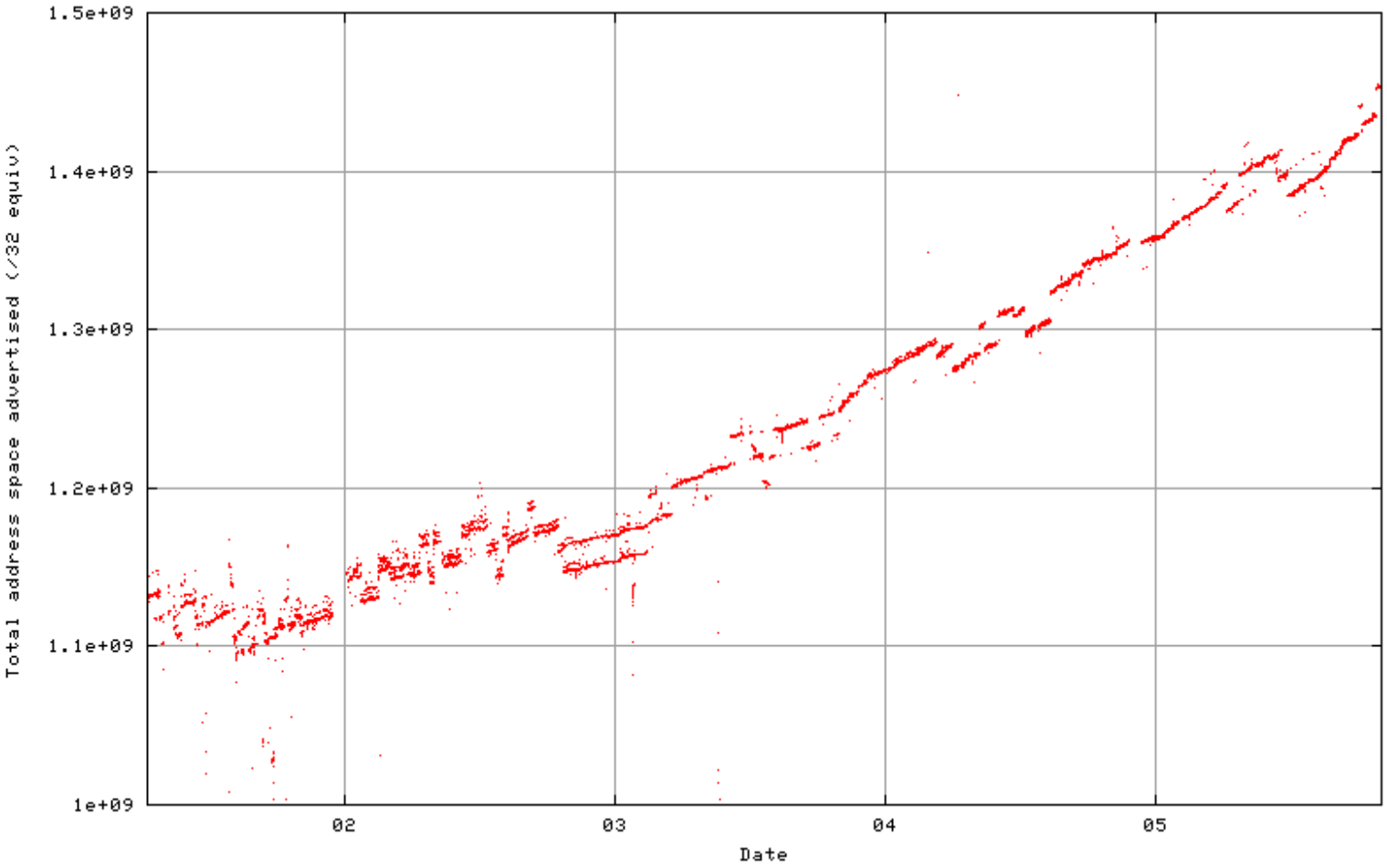

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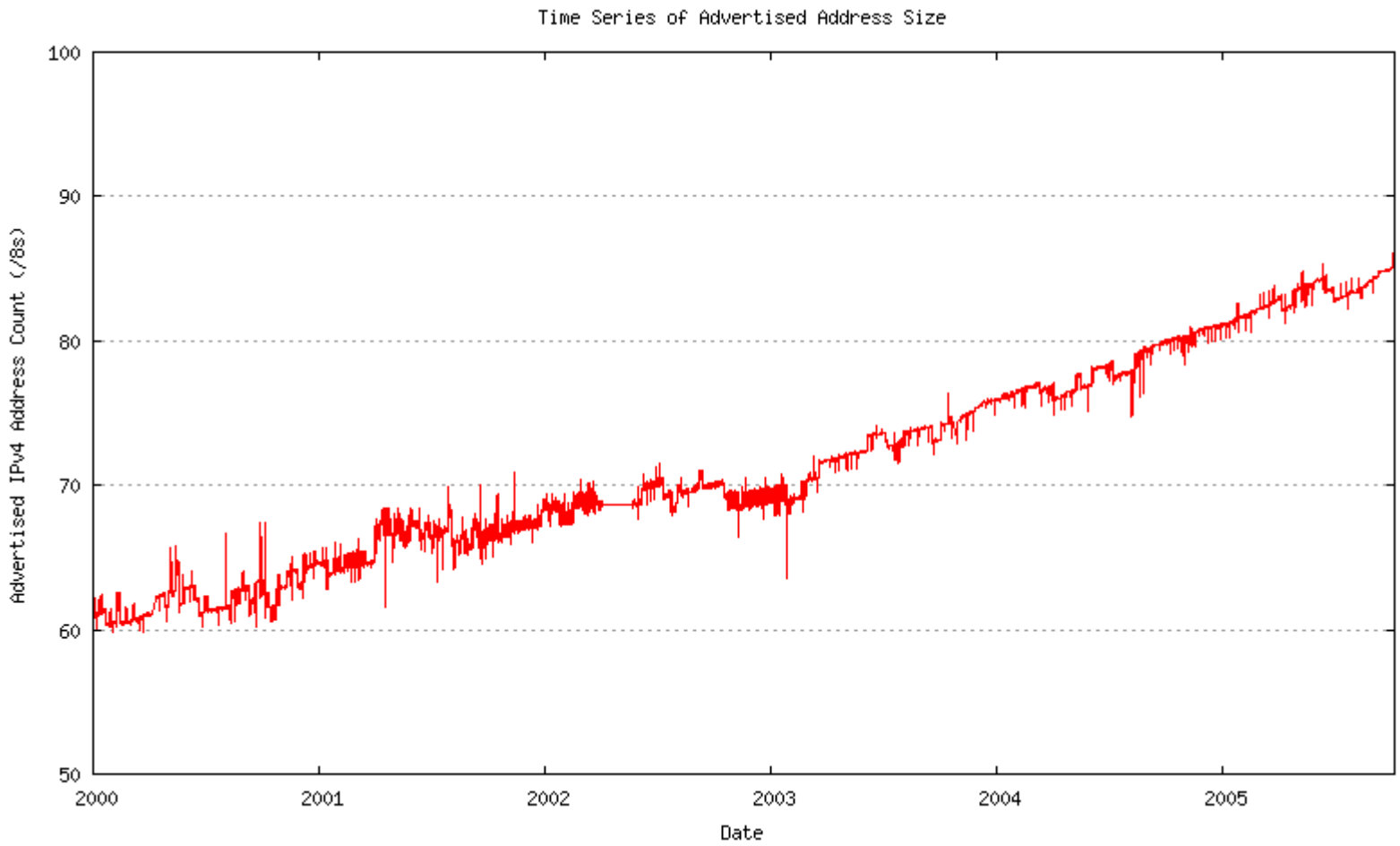

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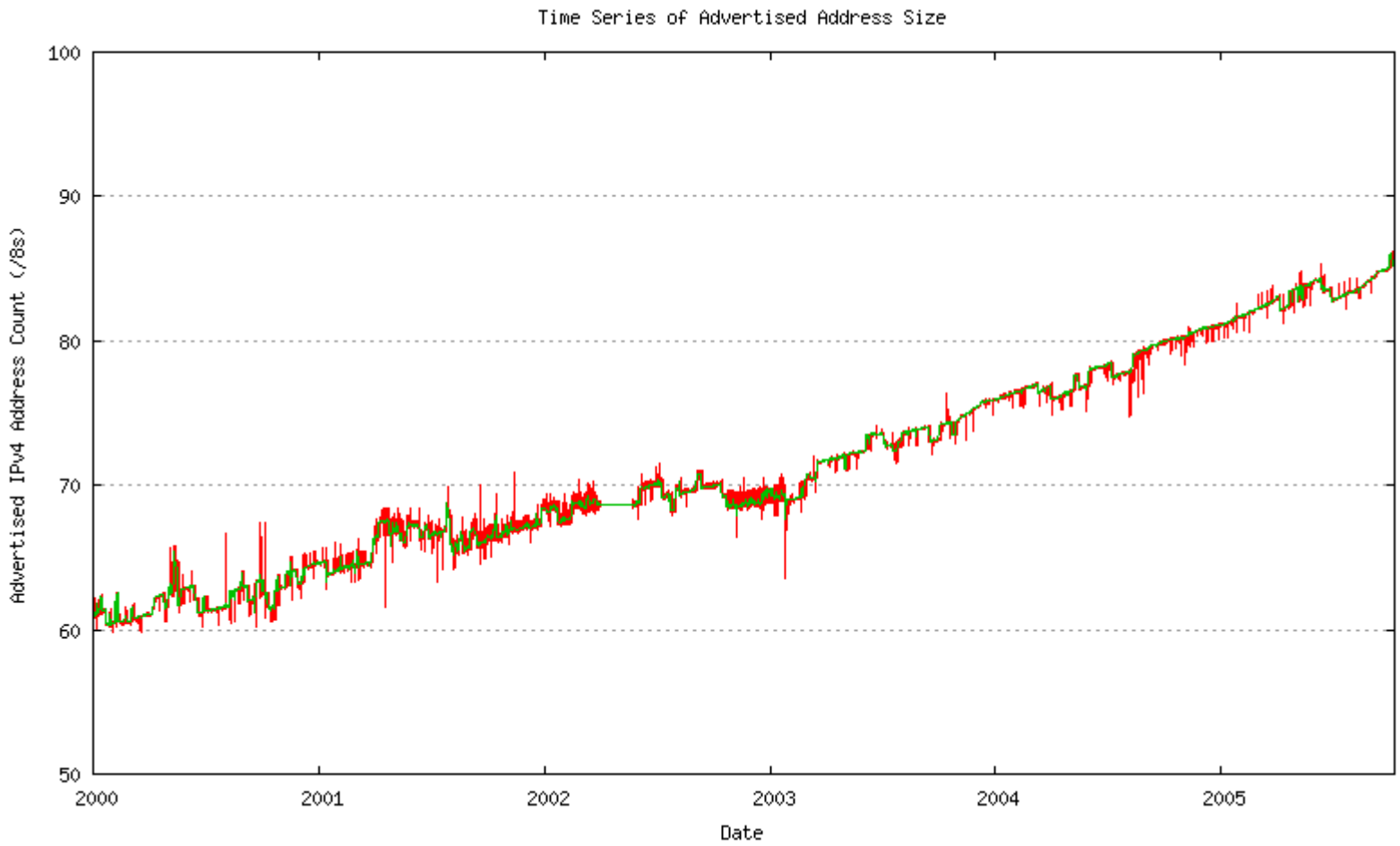

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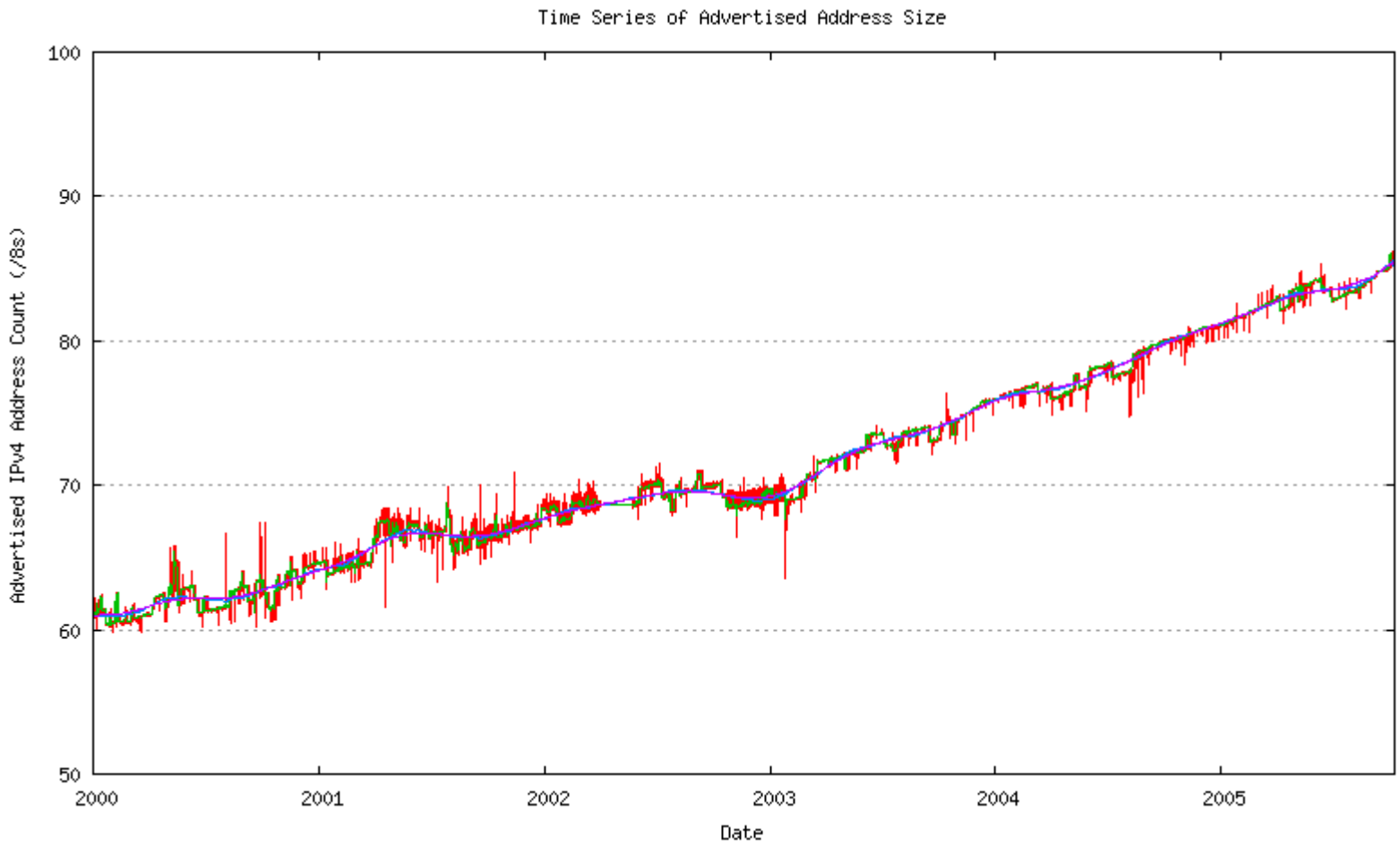

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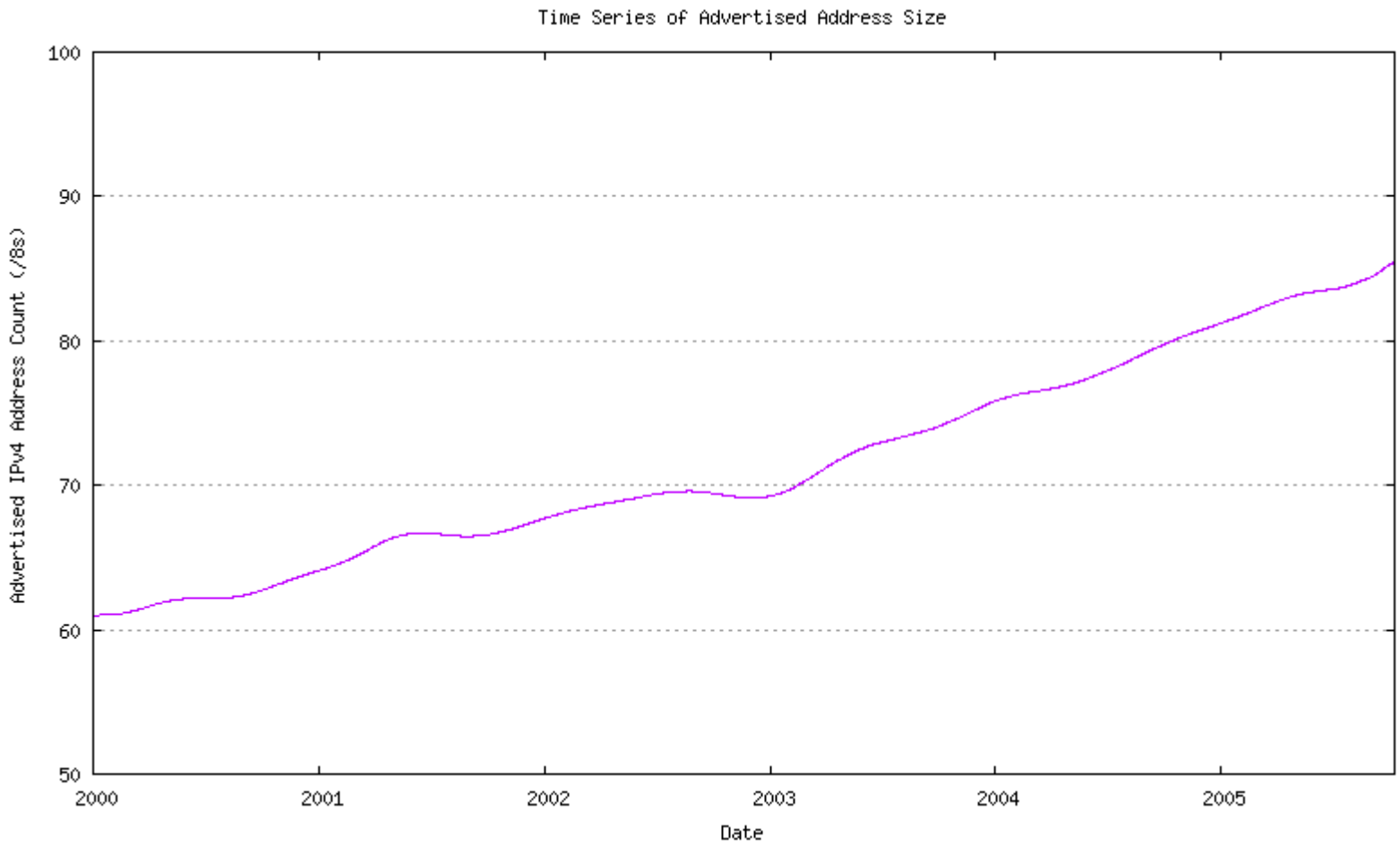
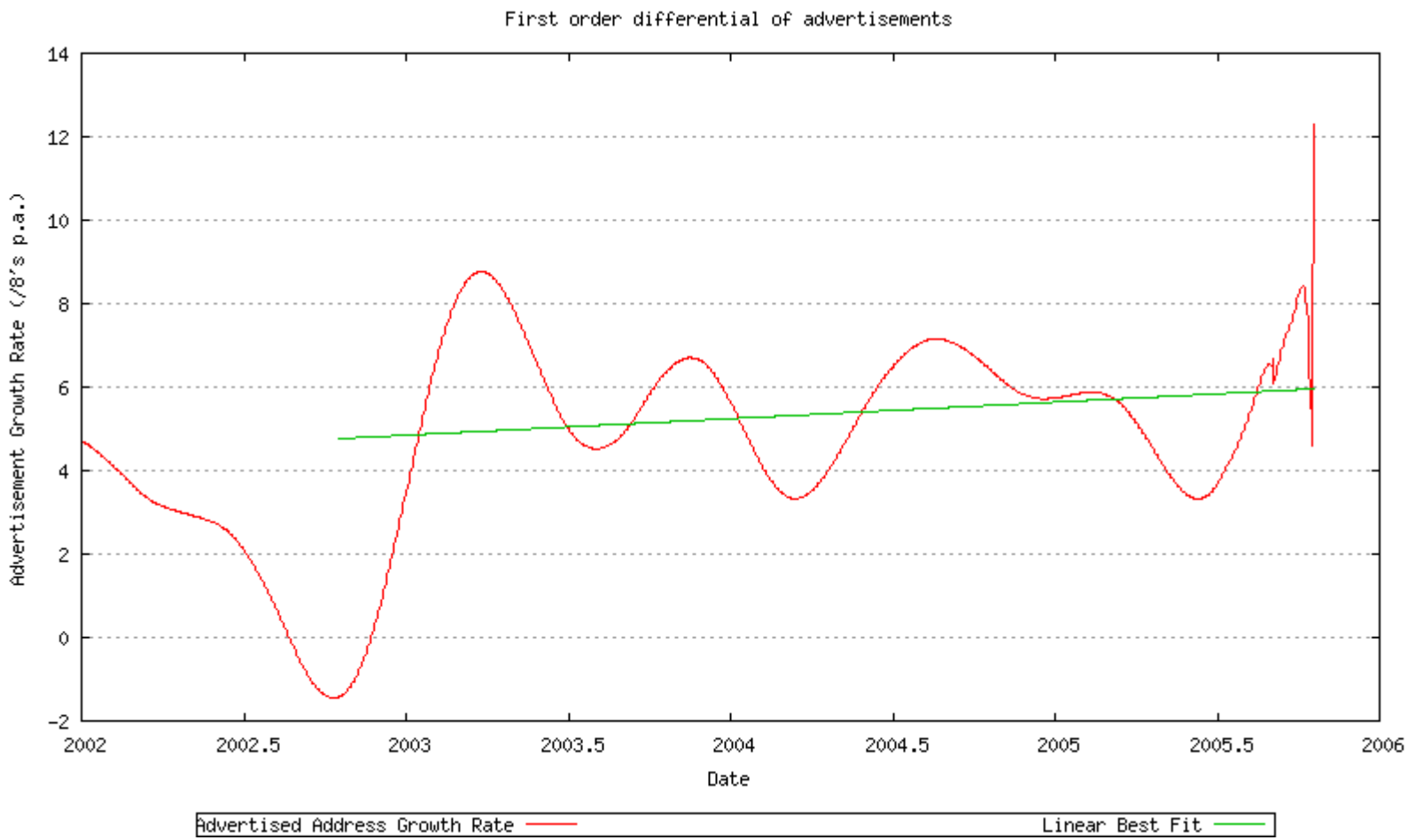


Advertised Address Growth



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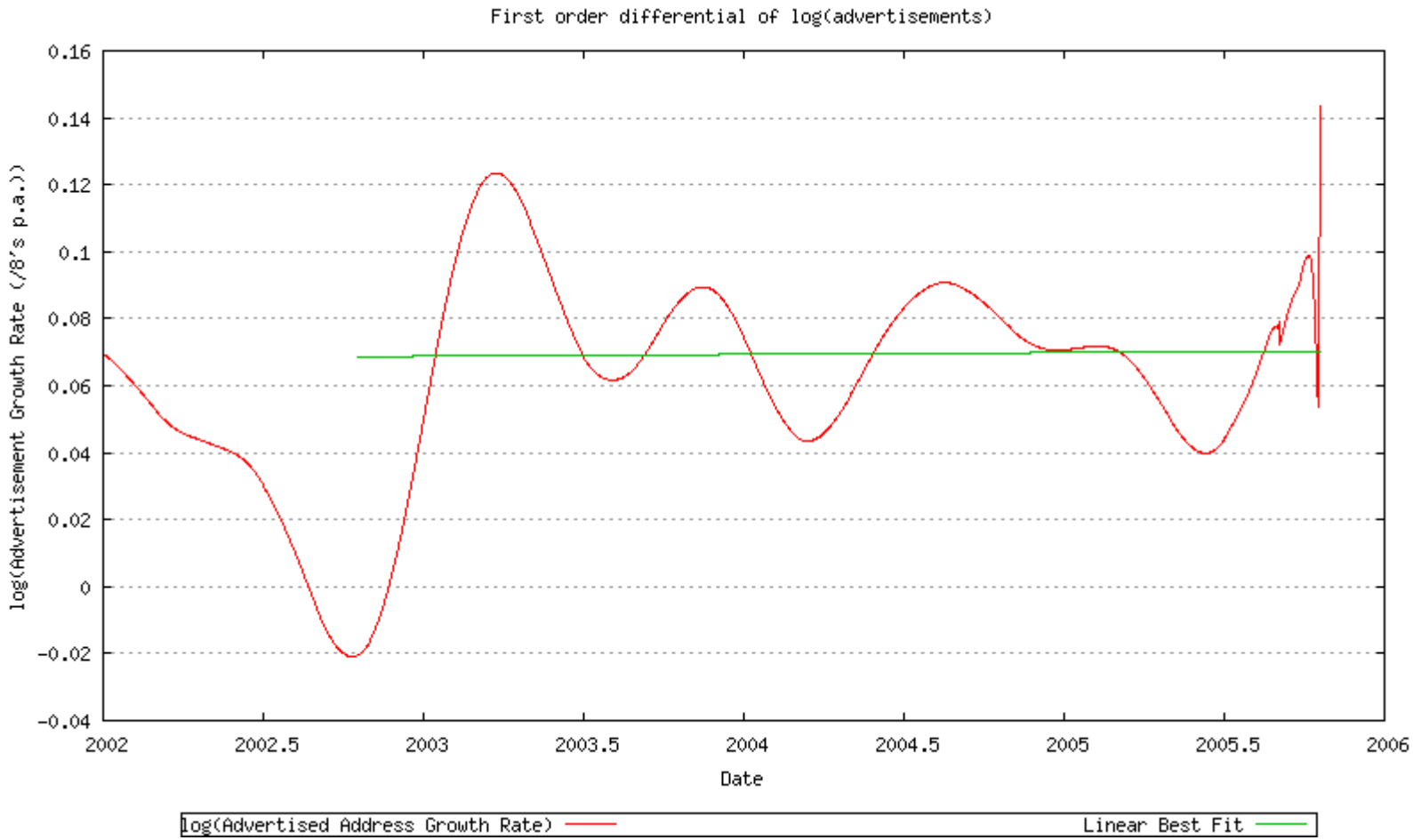
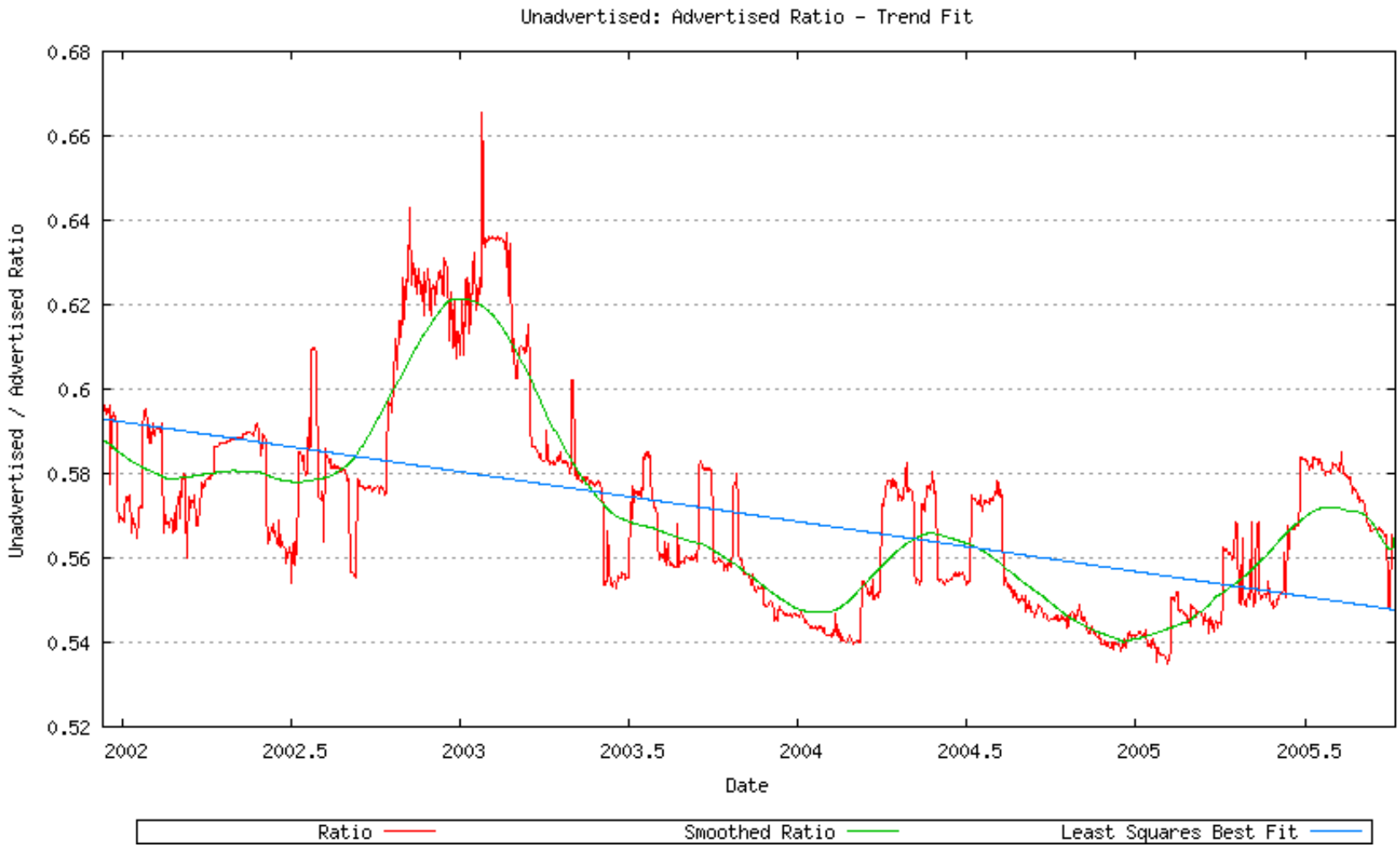


Unadvertised Address Space

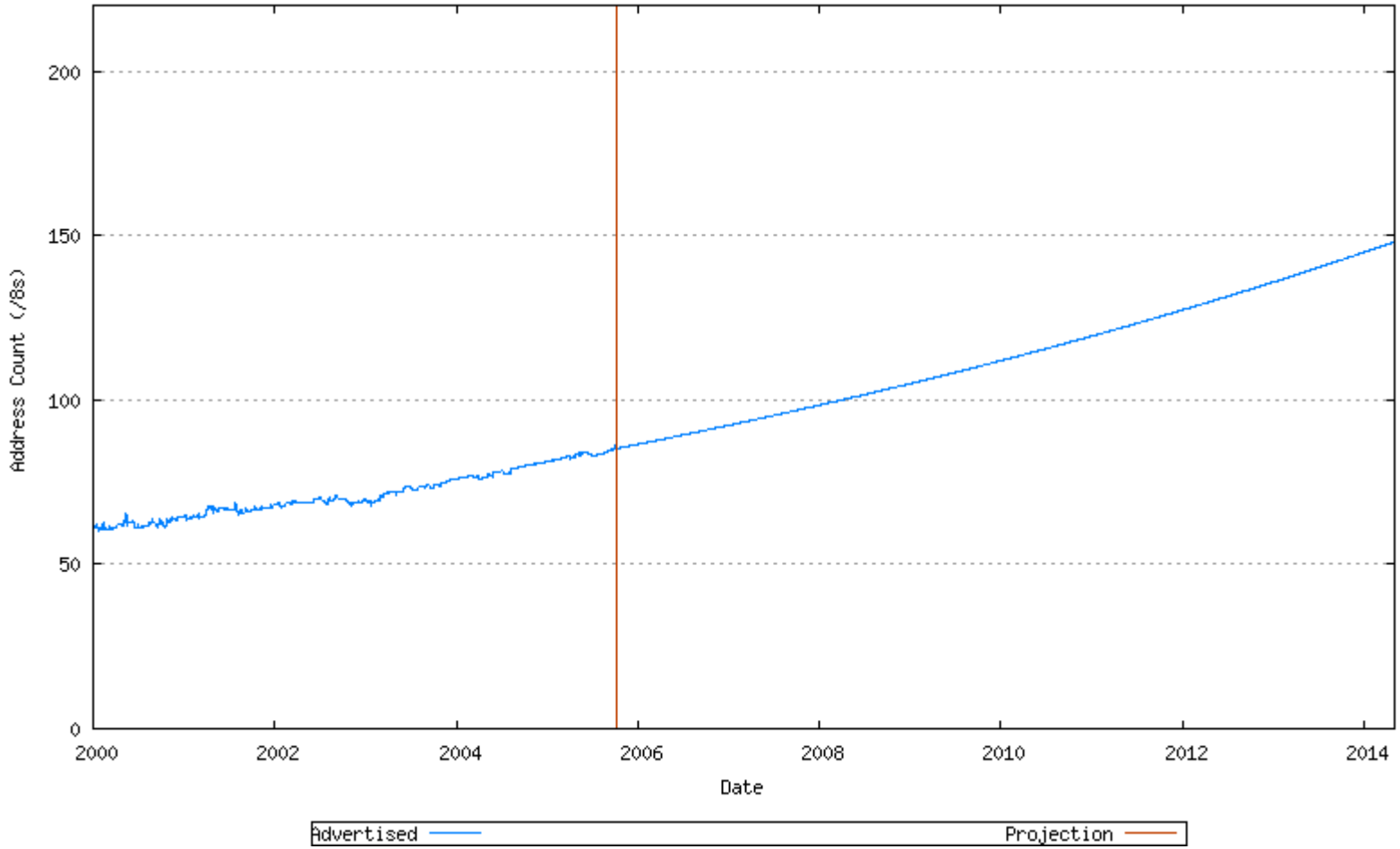
Unadvertised / Advertised Ratio



Modelling Advertised Growth

- Best fit to previous 3.5 years data appears to be a compound rather than constant growth rate
  - Use an exponential growth model ($adv = e^{a*x+b}$)
- Average network growth of some 6 /8's per year - rising
- To reach an 'exhaustion point' the model uses:
  - an exponential growth trend model based on previous 1,200 days (~ 3.5 years) advertised address data
  - a (decreasing) linear trend growth model of the ratio of unadvertised to advertised addresses
  - An assumption that the pooled "various" blocks will be exhausted following IANA pool exhaustion

Advertised IPv4 Addresses



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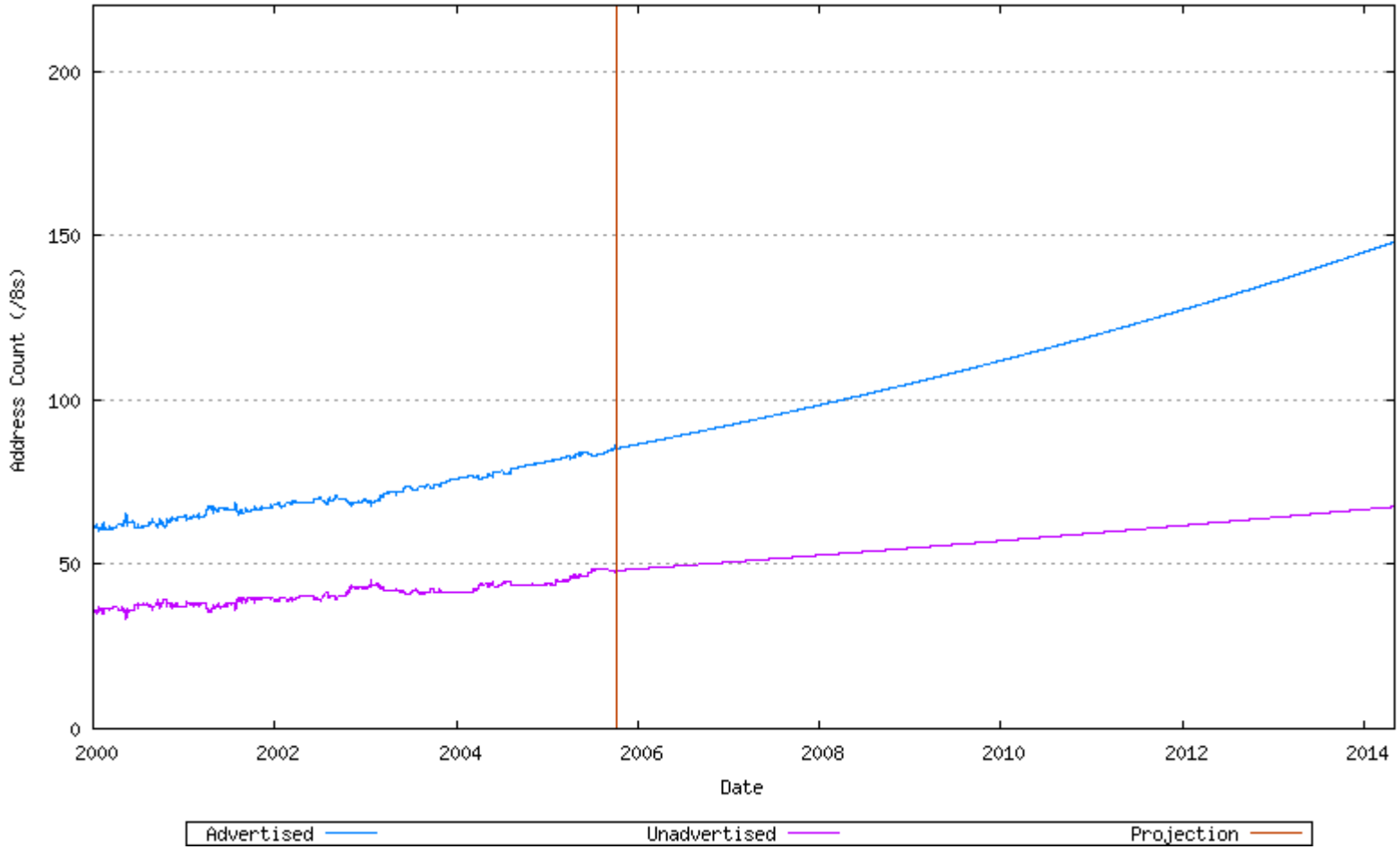
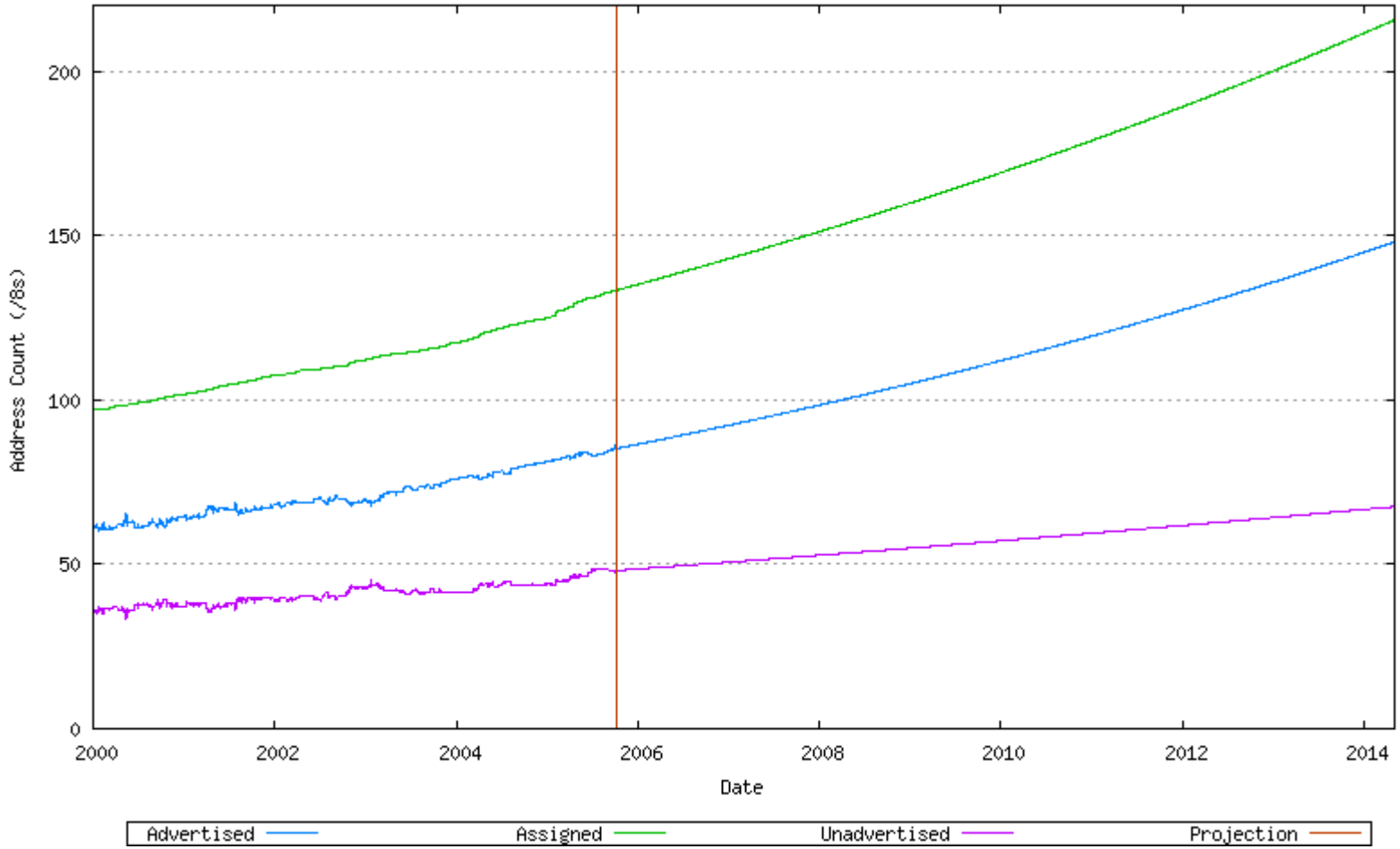
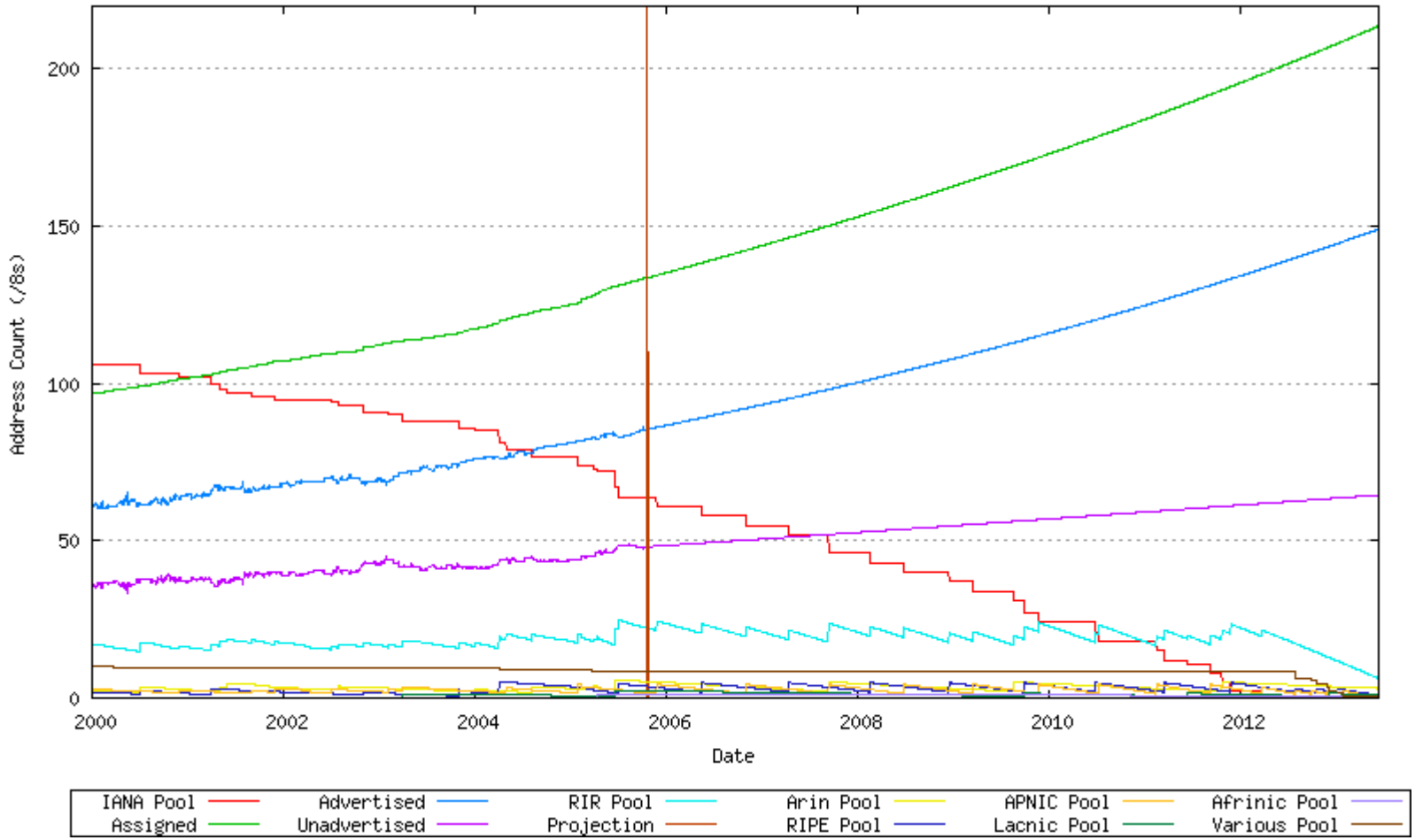


The IPv4 Address Projection



IPv4 Address Consumption Model

Full Model



Some Projections from this Model

- IANA Pool exhaustion
  - 7 May 2012
- RIR Pool exhaustion
  - 20 May 2013

Comment

- This model assumes an orderly procession right up to the point of effective exhaustion of the unallocated address pool
  - This is **highly unlikely** to eventuate
  - Within the current policy framework a more likely industry response will be accelerating demands as imminent exhaustion becomes more ‘visible’
  - It is not possible to model such ‘last chance rush’ behaviours based purely on the historical address allocation and BGP data

The Daily IPv4 Address Report

http://ipv4.potaroo.net