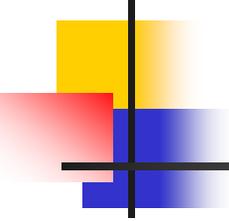


# Tracking the Internet's BGP Table

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Geoff Huston  
Telstra

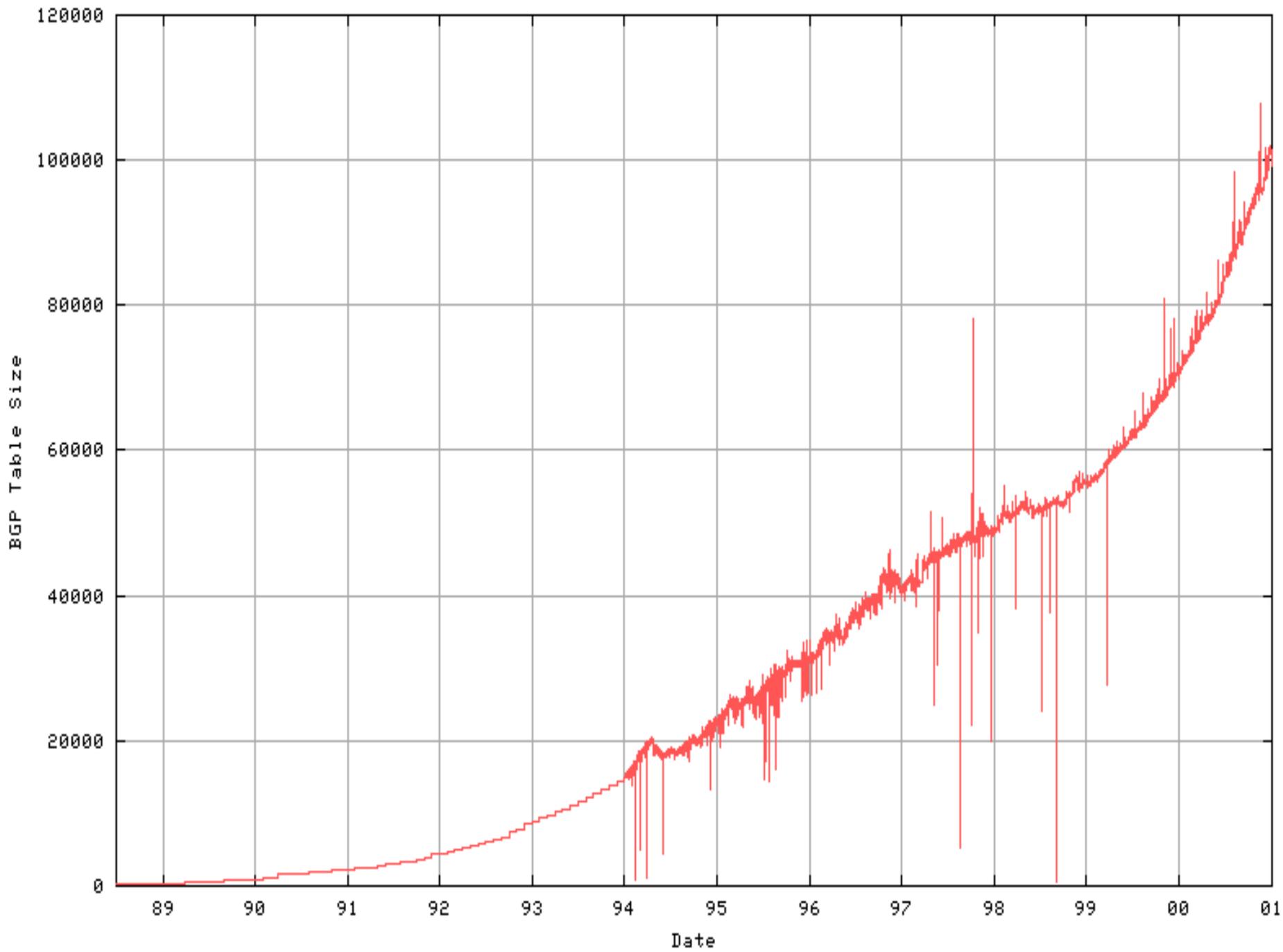
January 2001



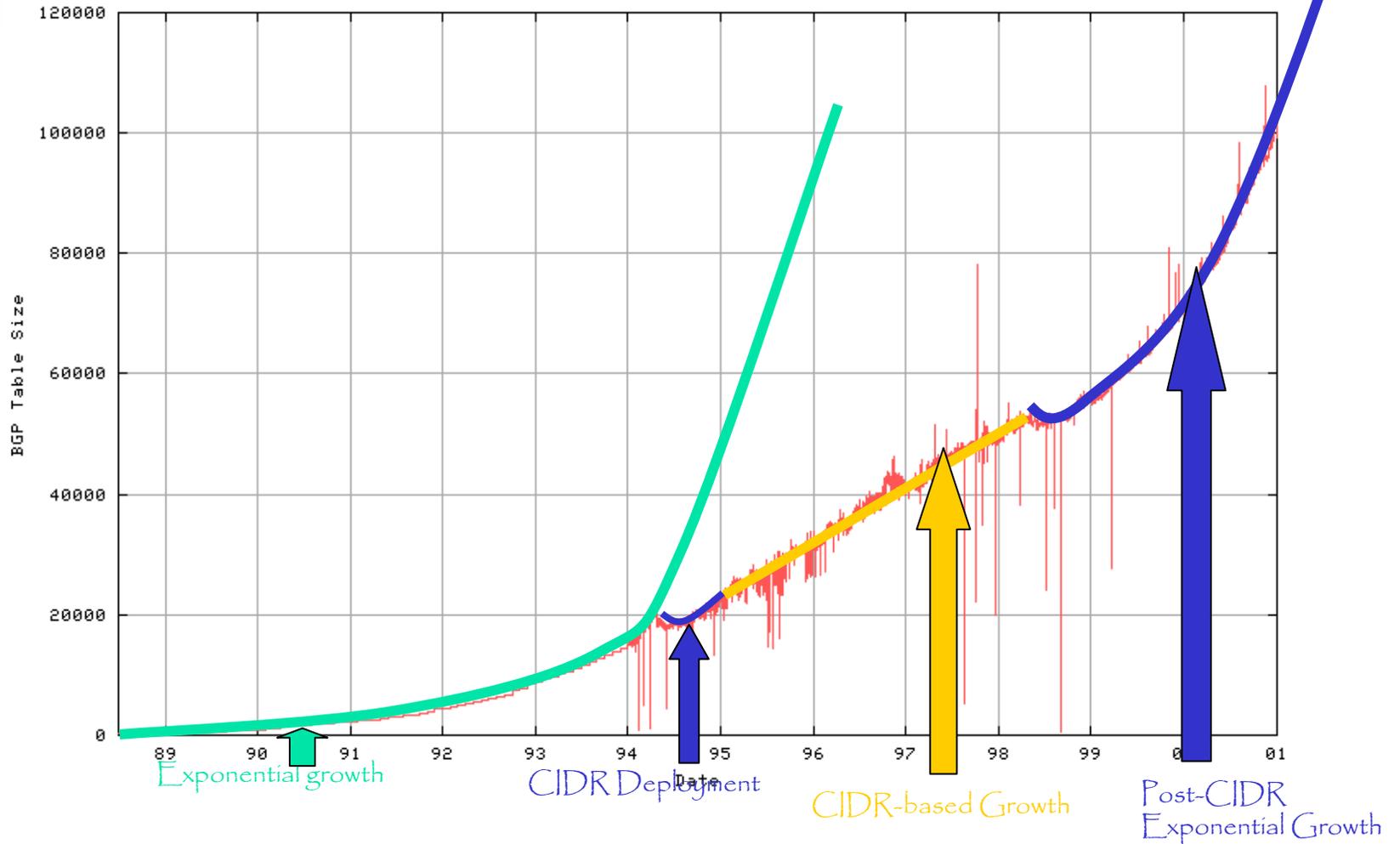
# Methodology

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- The BGP table monitor uses a router at the boundary of AS1221 which has a default-free eBGP routing table
  1. Capture the output from “show ip bgp” every hour
  2. Perform analysis of the data  
(and then discard the raw dump!)
  3. Update reports at [www.telstra.net/ops/bgp](http://www.telstra.net/ops/bgp)

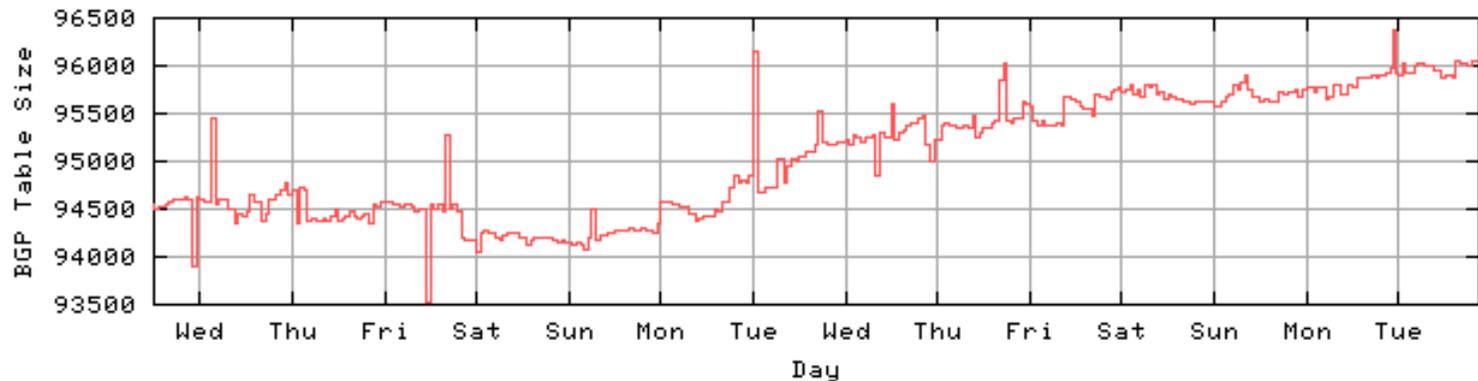


# Phases of Growth

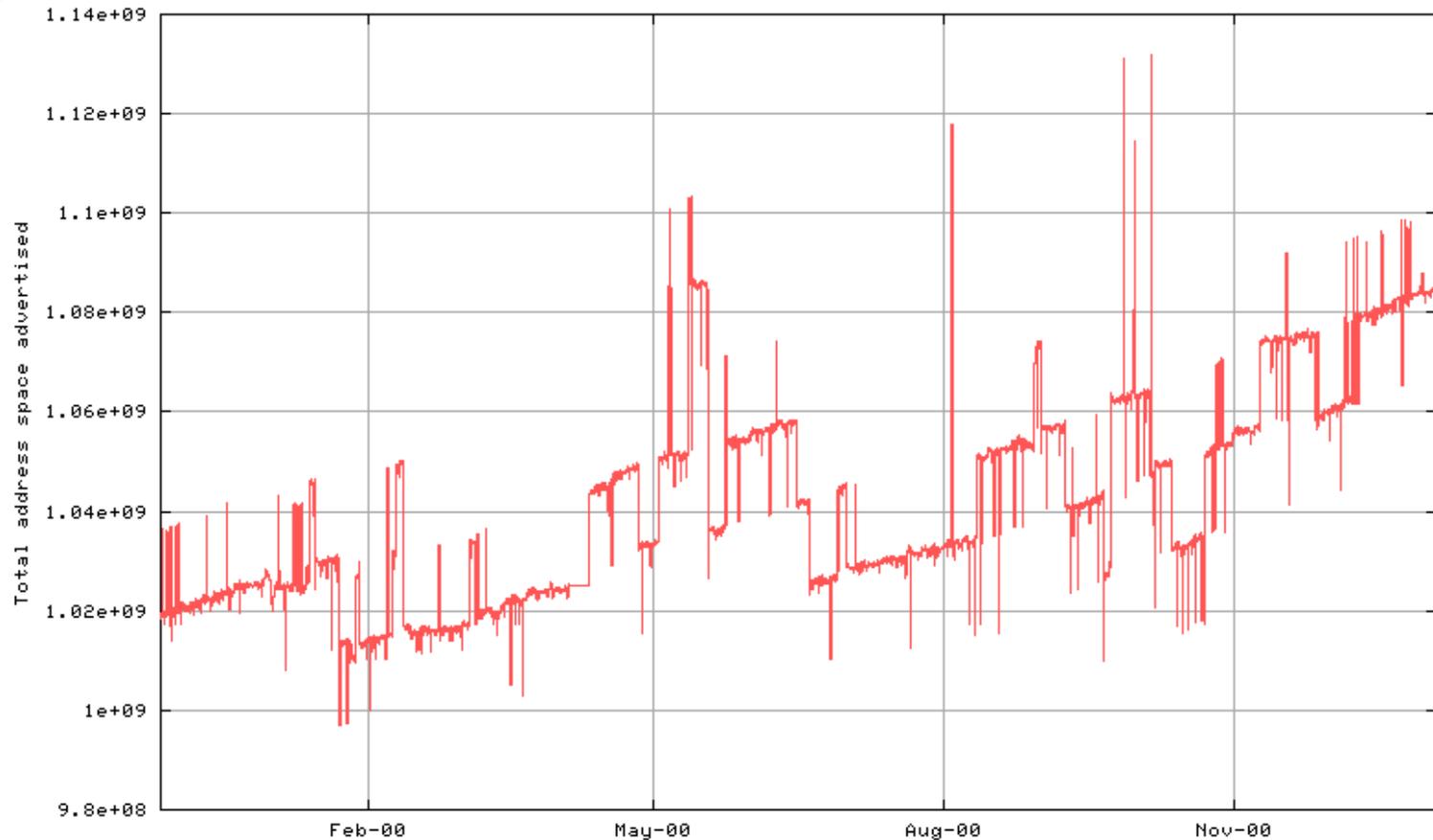


# Growth Characteristics

- Short term route fluctuation is an absolute value (not a % of total routes) of 1,000 – 2,000 routes



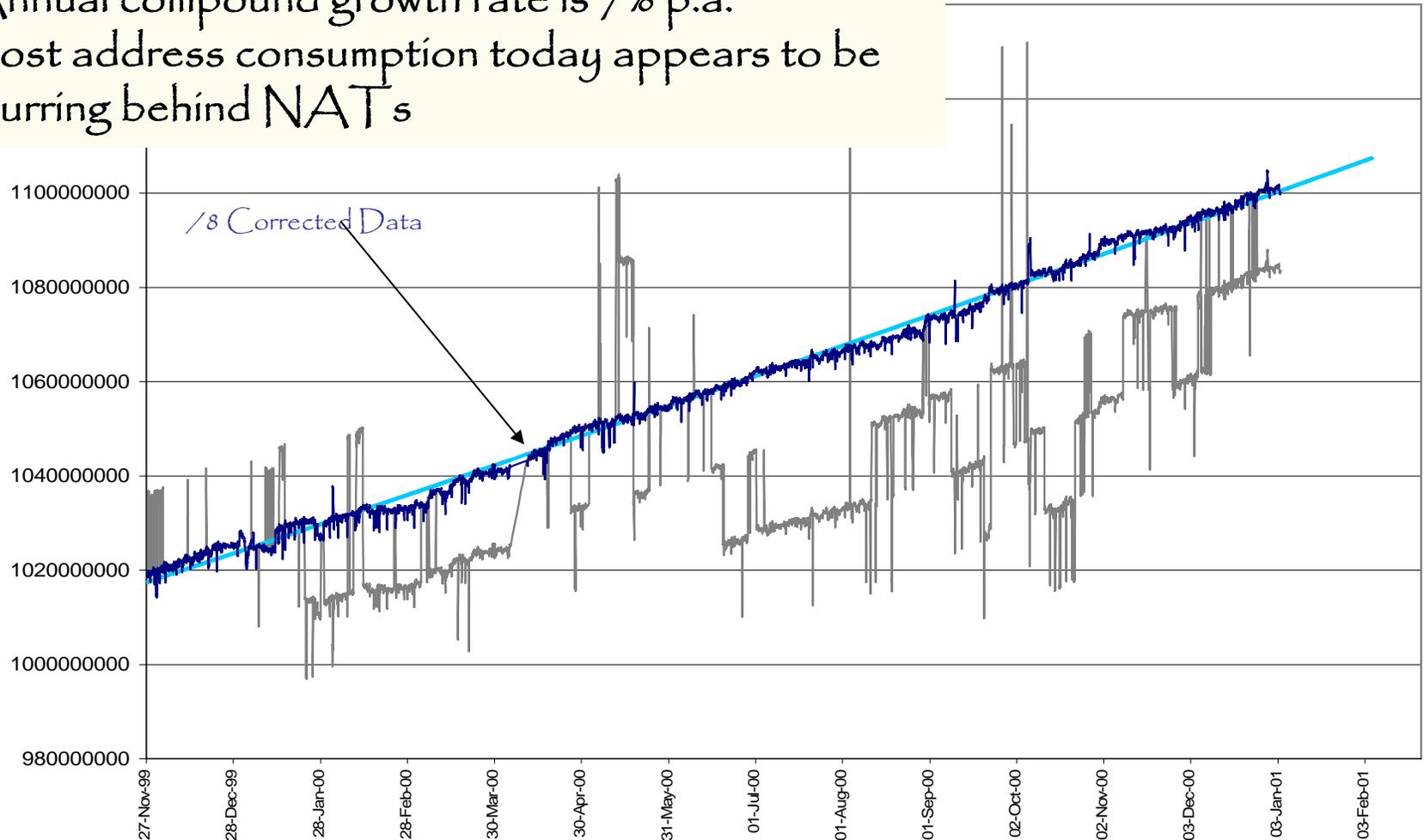
# Routed Address Space



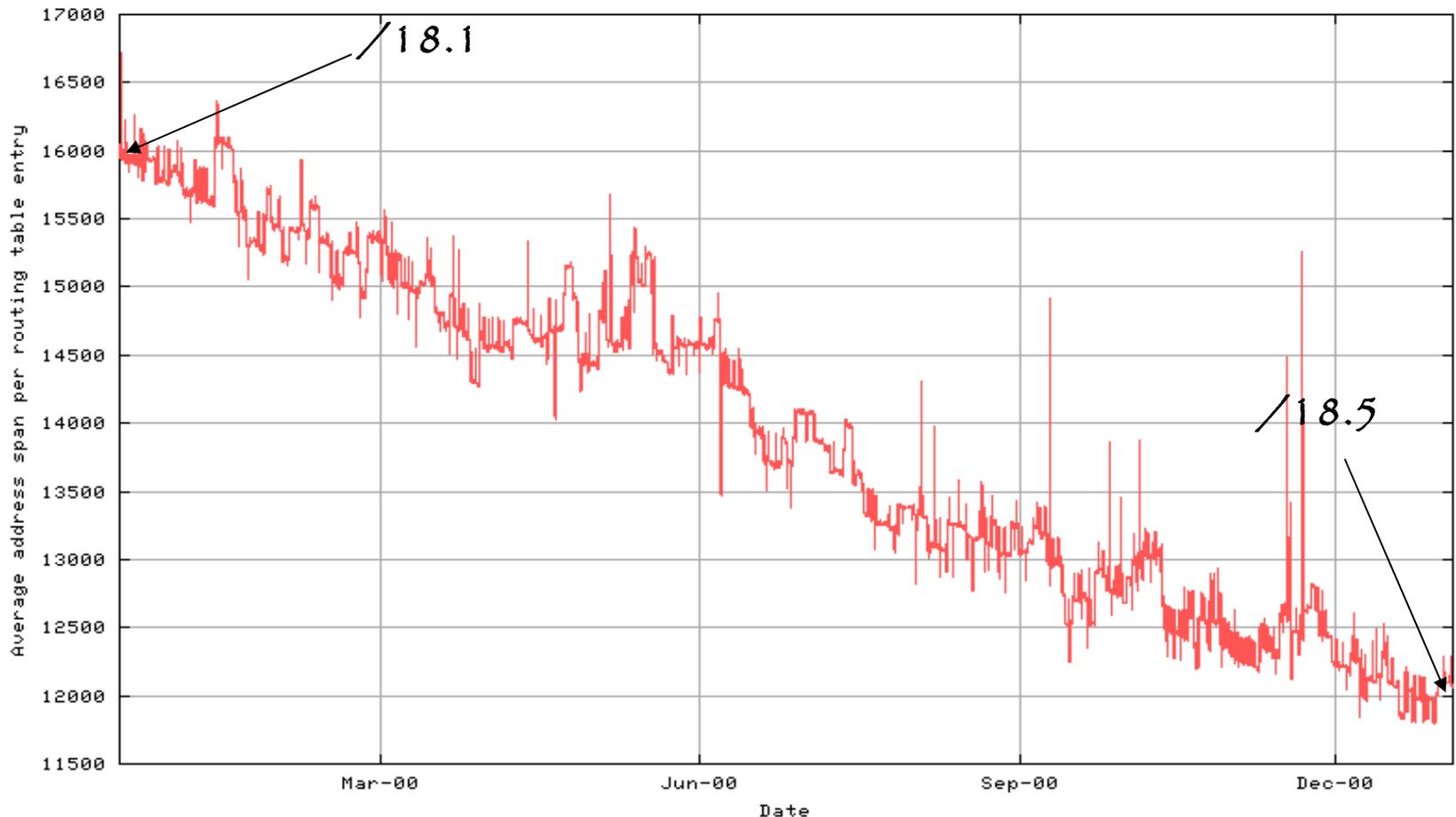
Large fluctuation is due to announcement / withdrawals of /8 prefixes  
12 months of data does not provide clear longer growth characteristic

# Routed Address Space (/8 Corrected)

Annual compound growth rate is 7% p.a.  
Most address consumption today appears to be occurring behind NATs

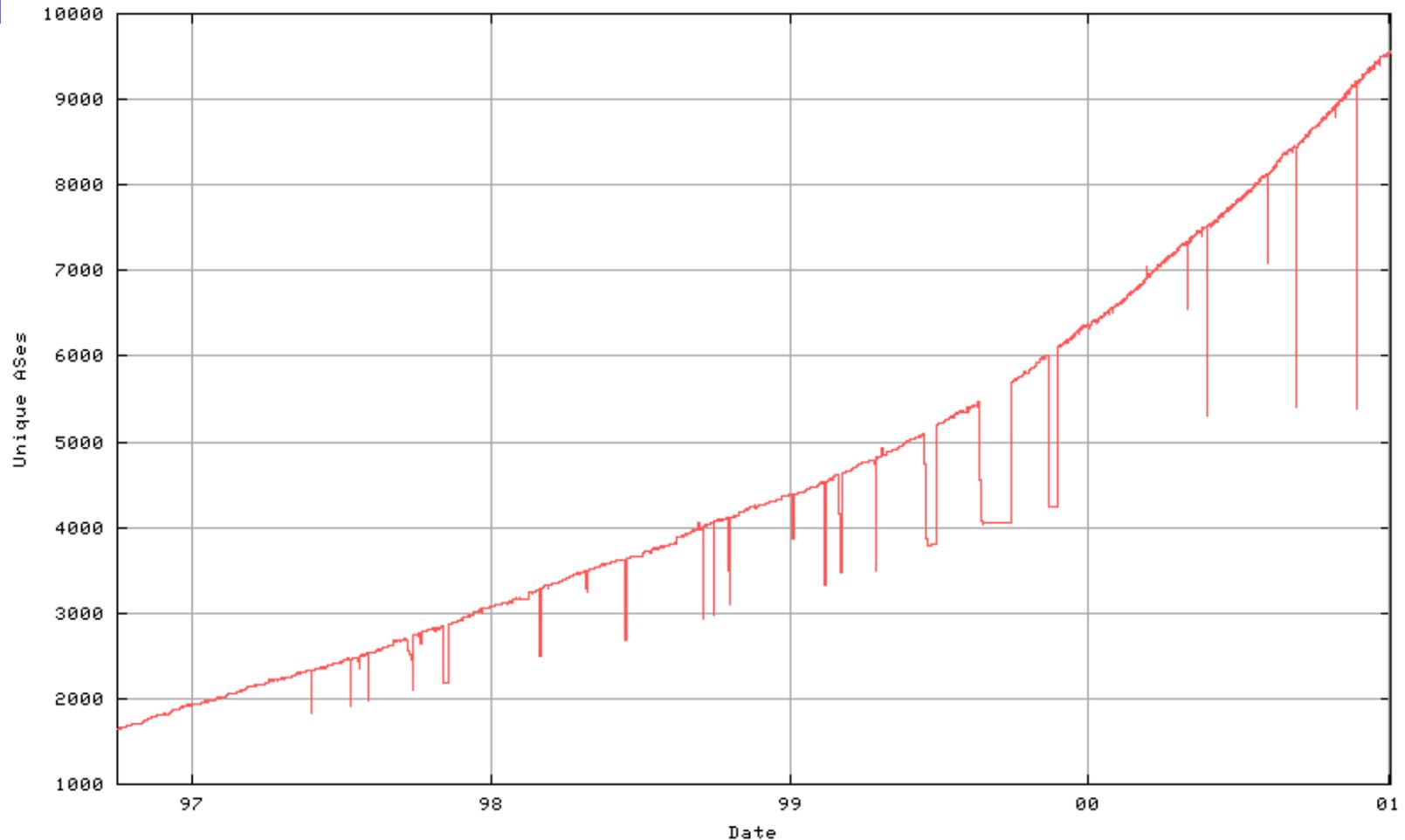


# Average size of a routing table entry



The BGP routing table is growing at a faster rate than the rate of growth of announced address space

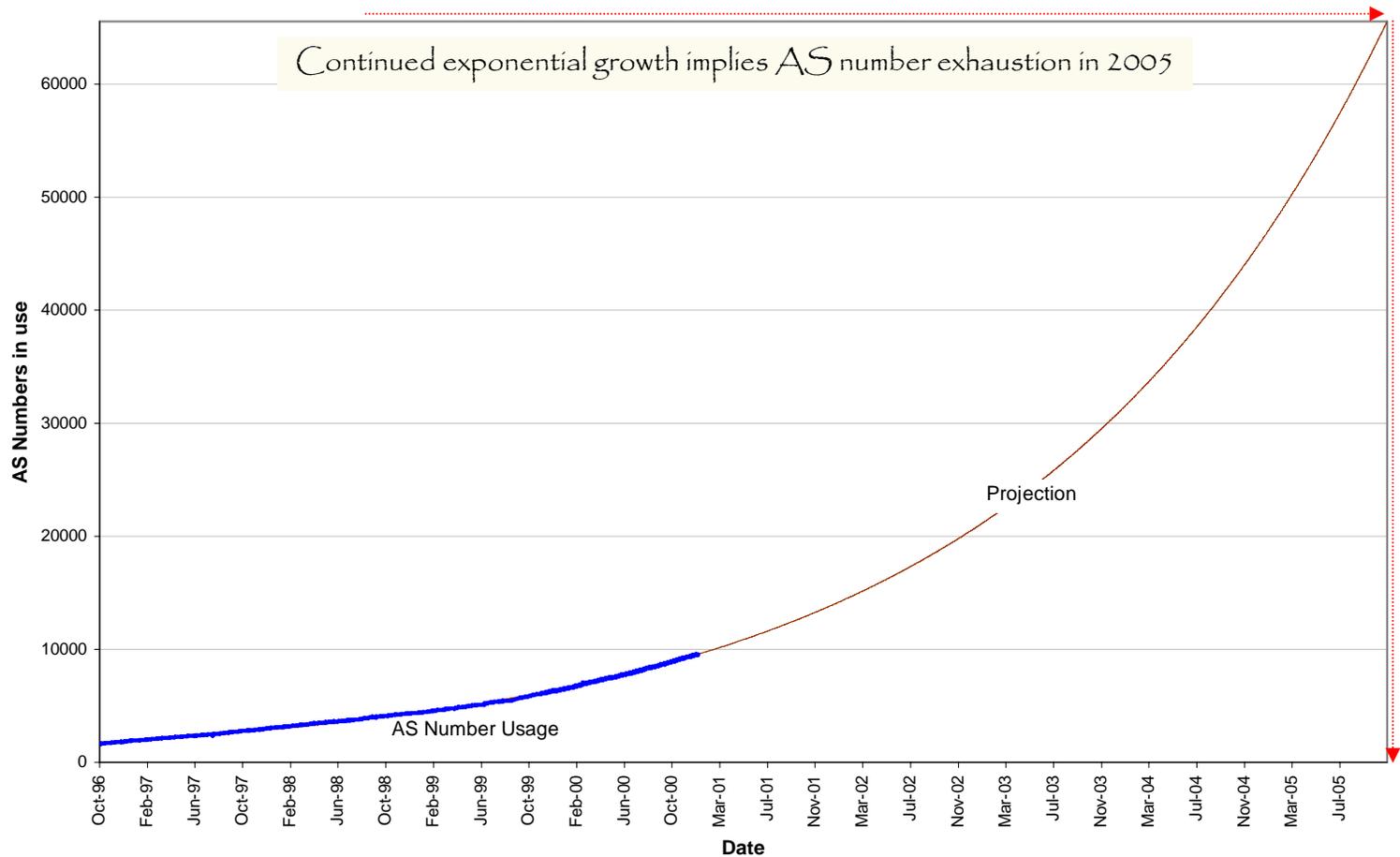
# Number of AS's in the table



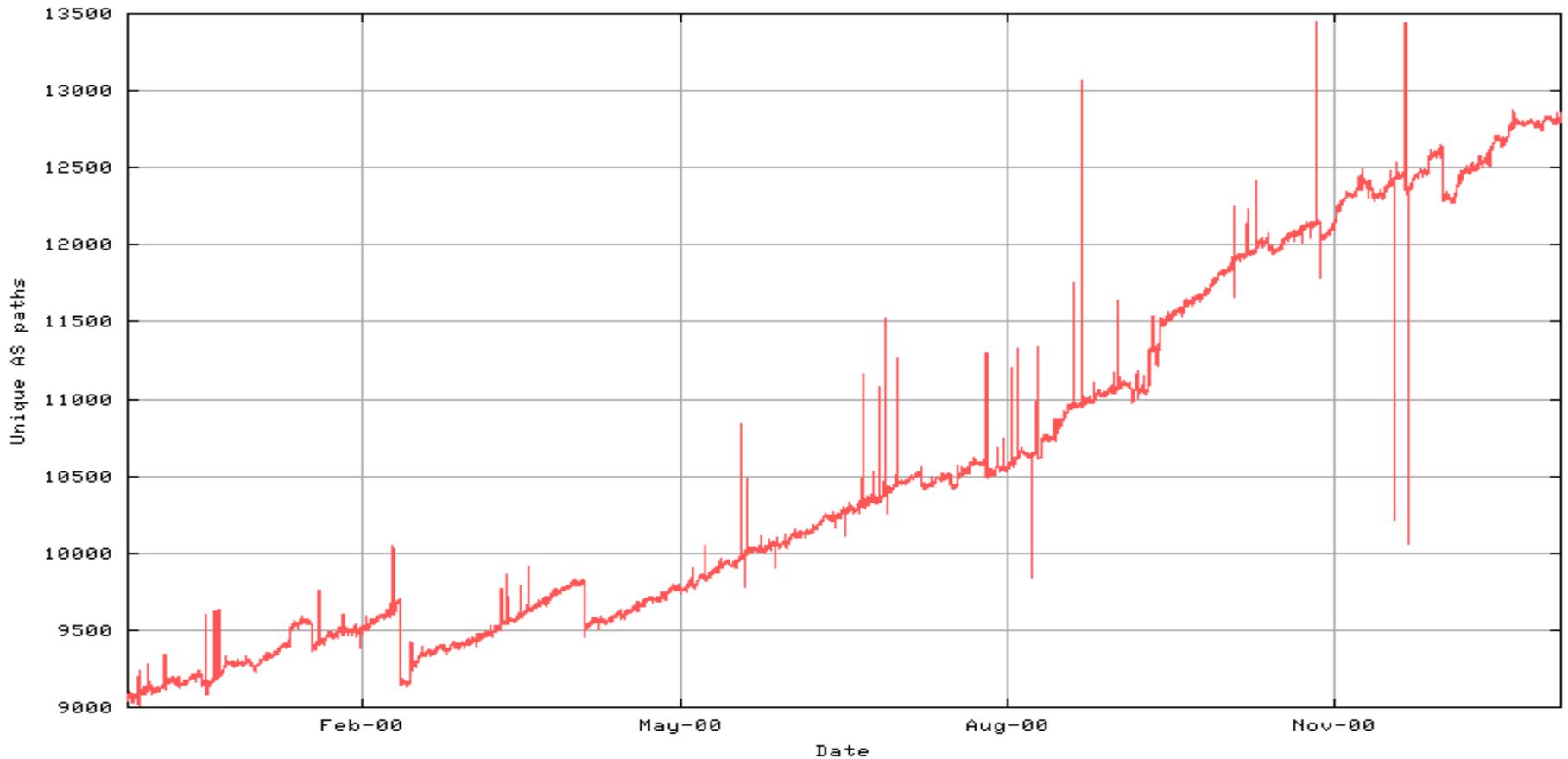
Exponential growth is evident in a longer term view of the AS deployment rate

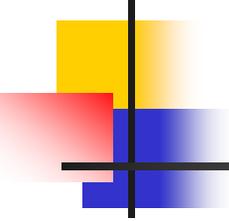
# AS Number Use - Extrapolation

AS Number Usage Projection



# Number of distinct AS Paths





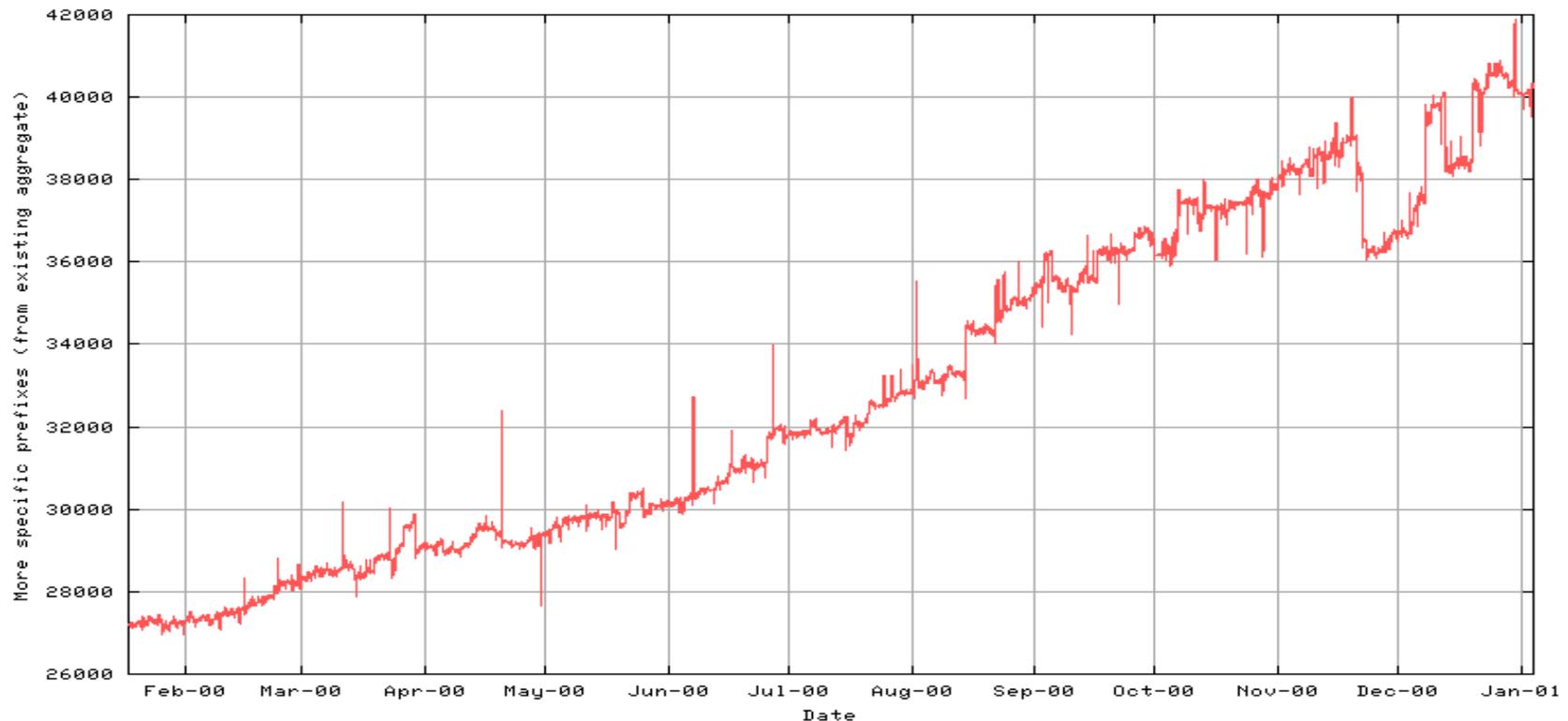
# Observations for 99/00

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- Low growth in the number of routed addresses  
0.6% growth / month (7% / year)
- High growth in number of route advertisements  
3% growth / month (42% / year)
- High growth in number of AS's  
3.5% growth / month (51% / year)

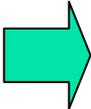
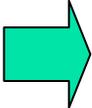
# Multi-homing on the rise?

- Track rate of CIDR "holes" – currently 40% of all route advertisements are routing 'holes'



This graph tracks the number of address prefix advertisements which are part of an advertised larger address prefix

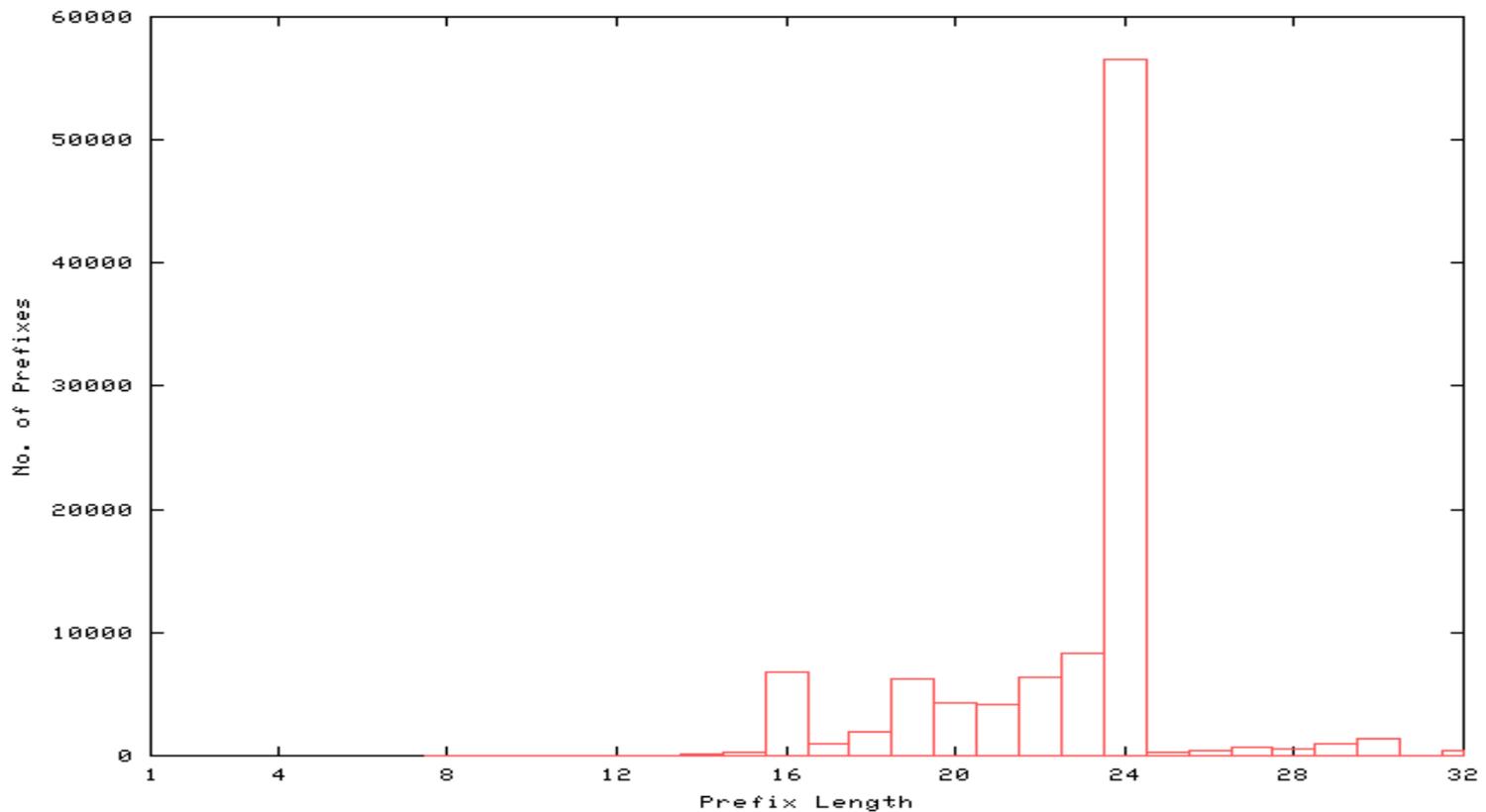
# Prefix Growth – Aug 00 to Oct 00

/16	6553	->	6670	absolute growth =	117,	relative =	1.79%
/17	889	->	936	absolute growth =	47,	relative =	5.29%
/18	1763	->	1884	absolute growth =	121,	relative =	6.86%
/19	5704	->	5984	absolute growth =	280,	relative =	4.91%
	<b>/20</b>		<b>3423 -&gt; 3854</b>	<b>absolute growth =</b>	<b>431,</b>	<b>relative =</b>	<b>12.59%</b>
/21	3621	->	3856	absolute growth =	235,	relative =	6.49%
/22	5415	->	5870	absolute growth =	455,	relative =	8.40%
/23	7298	->	7788	absolute growth =	490,	relative =	6.71%
/24	49169	->	52449	<b>absolute growth =</b>	<b>3280,</b>	relative =	6.67%
	<b>/25</b>		<b>208 -&gt; 436</b>	<b>absolute growth =</b>	<b>228,</b>	<b>relative =</b>	<b>109.62%</b>
/26	334	->	606	absolute growth =	272,	<b>relative =</b>	<b>81.44%</b>
/27	469	->	667	absolute growth =	198,	<b>relative =</b>	<b>42.22%</b>
/28	357	->	452	absolute growth =	95,	<b>relative =</b>	<b>26.61%</b>
/29	579	->	764	absolute growth =	185,	<b>relative =</b>	<b>31.95%</b>
/30	746	->	1026	absolute growth =	280,	<b>relative =</b>	<b>37.53%</b>

The largest significant relative growth in recent times is /20, tracking the allocation policy change in the RIRs

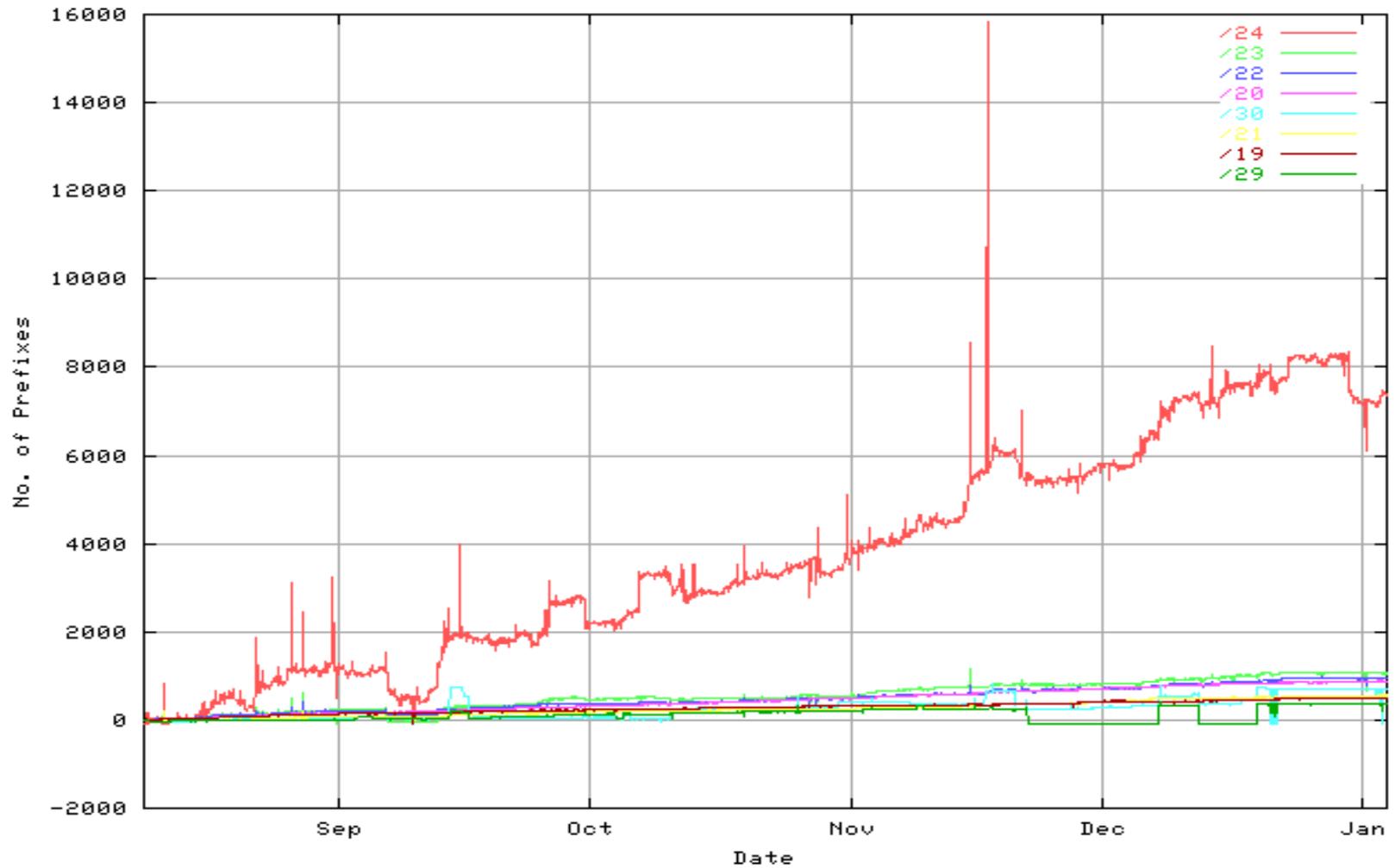
While the absolute number is low, the largest relative growth is in /25 prefixes, and /25 to /30 represent the greatest area of prefix growth in relative terms

# Prefix Distribution

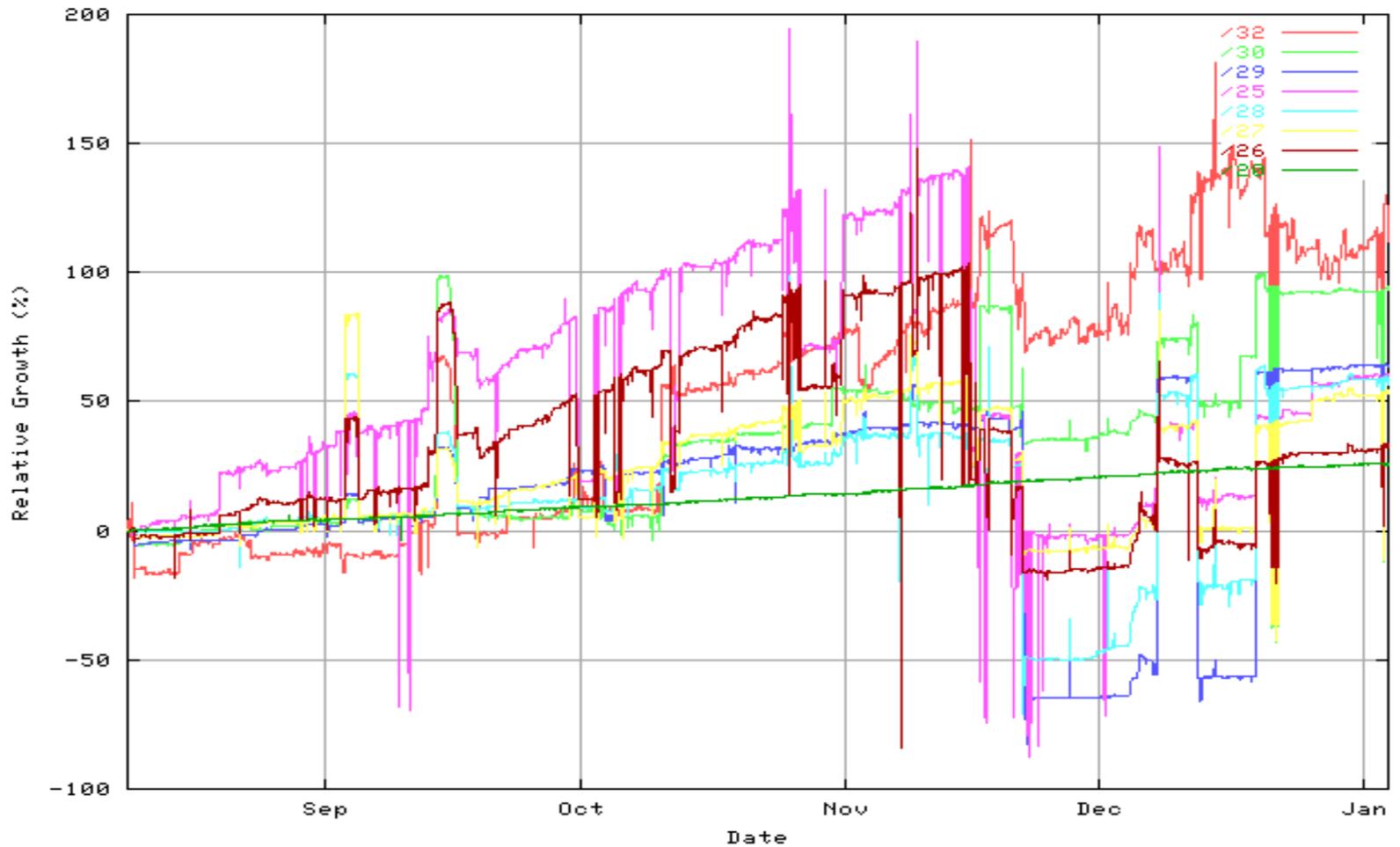


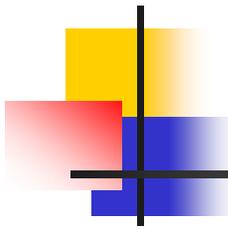
/24 is the predominant routing prefix

# Prefix Growth Aug 00 – Jan 01



# % growth Aug 00 – Jan 01

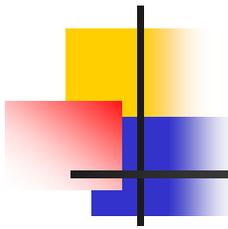




# Conjectures....

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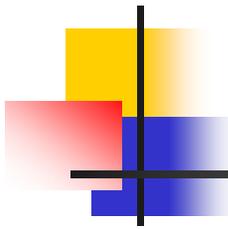
- BGP table size will continue to rise exponentially
- Multi-homing at the edge of the Internet is on the increase
- The interconnectivity mesh is getting denser
  - The number of AS paths is increasing faster than the number of AS's
  - Average AS path length remains constant
- AS number deployment growth will exhaust 64K AS number space in August 2005 if current growth trends continue



## More conjecturing....

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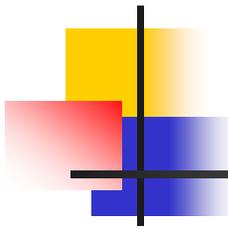
- Inter-AS Traffic Engineering is being undertaken through routing discrete prefixes along different paths -- globally (the routing mallet!)
- RIR allocation policy (/19, /20) is driving one area of per-prefix length growth in the aggregated prefix area of the table
- BUT - NAT is a **very** common deployment tool
- NAT, multihoming and Traffic Engineering is driving even larger growth in the /24 prefix area



# And while we are having such a good time conjecturing...

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- Over 12 months average prefix length in the table has shifted from /18.1 to /18.5
- More noise (/25 and greater) in the table, but the absolute level of noise is low (so far)
- Most routing table flux is in the /24 to /32 prefix space – as this space gets relatively larger so will total routing table flux levels
  - “Flux” here is used to describe the cumulative result of the withdrawals and announcements



# This is fun – lets have even more conjectures...

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- CIDR worked effectively for four years, but its effective leverage to dampen route table growth and improve table stability has now **finished**
- Provider-based service aggregation hierarchies as a model of Internet deployment structure is more theoretic than real these days

i.e. provider based route aggregation is leaking like a sieve!