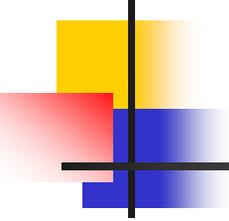


# Allocation vs Announcement

---

A comparison of RIR IPv4 Allocation  
Records with Global Routing  
Announcements

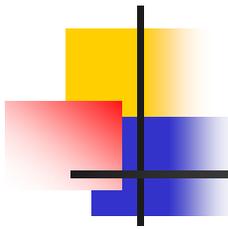
Geoff Huston  
February 2004  
(Supported by APNIC)



# Motivation

---

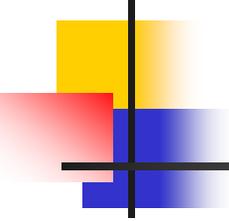
- Some years back a number of ISPs introduced prefix length filters on the routes they accepted from their peers
- This practice was taken up by others and is now widespread across the Internet
- The filters are typically based on observations of minimum allocation sizes of RIR allocations within /8 address blocks



# Implications

---

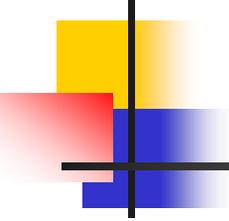
- The generic assumption behind the use of these filters is that ISPs should globally advertise the RIR allocated address block as a single aggregate
- If more specific fragments of an RIR allocation are advertised for local resilience and traffic engineering reasons these should be scoped such that they do not spread globally



# Question

---

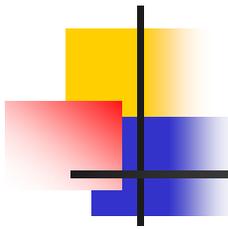
- How accurate is this assumption that allocations and advertisements are aligned?
- Has this changed in recent times?



# Methodology

---

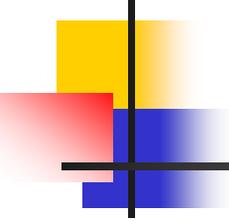
- Compare the prefixes listed in the RIR delegated files (a log of allocations) with the prefixes contained in a dump of the BGP routing table



# Recent RIR and BGP Data

---

- 4506 RIR IPv4 allocations (1 Jan 2003 - 12 Feb 2004)
  - 865 allocations are NOT announced as yet
  - 3641 allocations are announced
  - 10904 routing advertisements are used to span these 3641 allocations
- 
- Each RIR allocation generates an average of 3.0 routing advertisements



# 2003/2004 Data

---

3641 RIR allocations are advertised

Of these:.....

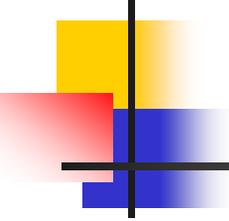
2938 Advertisements precisely match the RIR  
Allocation

7966 Advertisements are more specific of 1206 RIR  
allocations

- 80% of RIR allocations are directly advertised as routing advertisements
- 20% of RIR allocations generate more specific advertisements
- Where more specifics are advertised there are 6.6 more specific advertisements for each RIR allocation

# Prefix Length Distribution

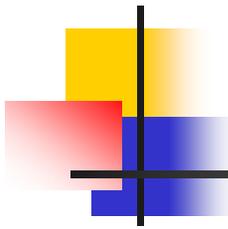
Allocation	Advertisements																
Size	Total	Total	More Specifics	/11	/12	/13	/14	/15	/16	/17	/18	/19	/20	/21	/22	/23	/24
/11	6	79	75	4					65	2		8					
/12	15	1003	999		4	1	1	3	58	13	71	92	63	71	103	91	432
/13	26	327	315			12	9	9	39	9	12	31	56	44	52	19	35
/14	32	233	212				21		19	8	21	62	67	5	7	8	15
/15	54	365	330					35	16	13	41	38	29	33	29	21	110
/16	859	1729	973						756	49	69	106	92	147	109	92	309
/17	125	608	517							91	40	47	57	68	47	54	204
/18	236	806	629								177	70	69	66	68	39	317
/19	529	1654	1235									419	125	118	138	95	759
/20	845	2168	1527										641	126	139	154	1108
/21	48	79	35											44	2	0	33
/22	186	298	150												148	21	129
/23	219	281	104													177	104
/24	411	409	0														409
Total	3591	8957	6027	0	0	12	30	44	830	170	360	773	1136	651	739	680	3532



# Limiting the sample to 2004

---

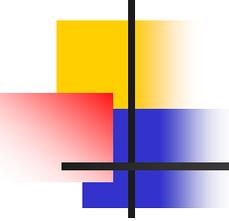
- Is this level of fragmentation of RIR Allocated address blocks getting better or worse in recent times?
- One way to look at this is to use a smaller data pool of very recent data and compare it with the larger pool already presented



# 2004 Data

---

- 520 RIR IPv4 allocations (up to 12 Feb 2004)
- 217 allocations are NOT announced as yet
- 303 allocations are announced
- 576 routing advertisements are used to span these 303 allocations
- Each RIR allocation generates an average of 1.9 routing advertisements



# 2004 Data (cont)

---

303 RIR allocations are advertised

Of these:...

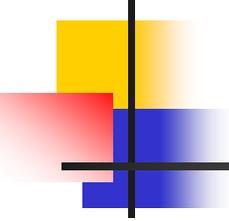
257 Advertisements precisely match the RIR Allocation

309 Advertisements are more specific of 67 RIR allocations

- 78% of RIR allocations are directly advertised as routing advertisements
- 22% of RIR allocations generate more specific advertisements
- Where more specifics are advertised there are 4.6 more specific advertisements for each RIR allocation

# 2004 Data – Prefix length Distribution

Allocation Size	Advertisements														
	Total	Total	More Specifics	/13	/14	/15	/16	/17	/18	/19	/20	/21	/22	/23	/24
/13	2	5	3	2			3								
/14	1	2	1		1										1
/15	3	28	26			2	2	8		16					
/16	93	192	106				86	5	9	6	6	42	6	9	23
/17	11	15	6					9	2	1	2	1			
/18	15	36	23						13		2		2	1	18
/19	32	55	30							25	8	2	6	3	11
/20	73	146	89								57	5	9	1	74
/21	7	7	0									7			
/22	13	19	9										10	2	7
/23	14	15	5											10	5
/24	35	35	0												35
Total	299	555	298	2	1	2	91	22	24	48	75	57	33	26	174



# Trends of Fragmentation of Allocations

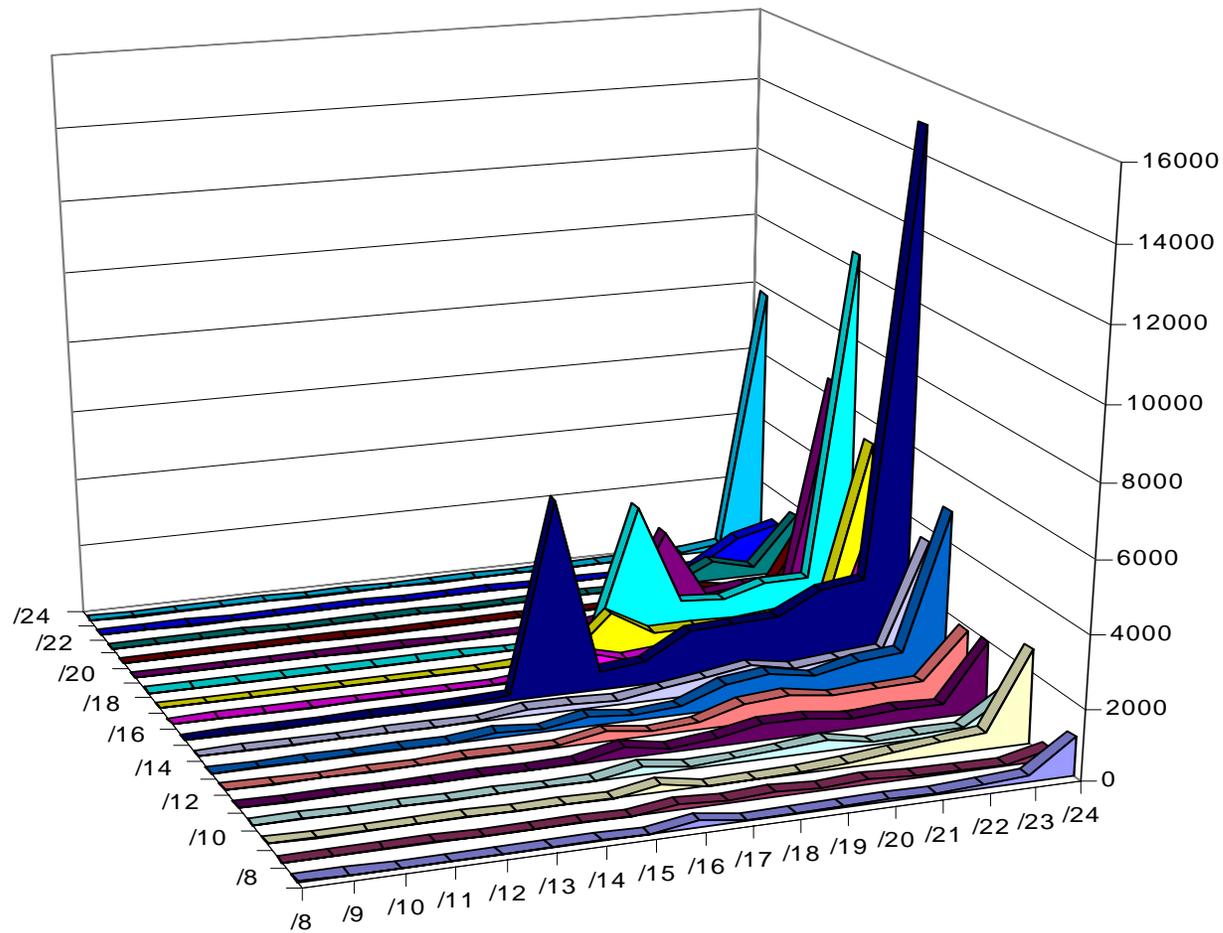
---

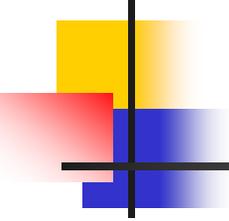
- The following graphs look at the entire data set of all RIR allocations and compare these to the current state of the routing table. The dates used in the analysis are the dates of the RIR allocation.

# Prefix Length Distribution

Allocation Size	Total	Not Advertised	Advertisements																																	
			Total	More Specifics	/8	/9	/10	/11	/12	/13	/14	/15	/16	/17	/18	/19	/20	/21	/22	/23	/24	/25	/26	/27	/28	/29	/30	/31	/32							
/8	44	13	1864	1845	19	4	1	1	7	5	10	10	206	15	24	48	62	49	120	195	1088															
/9	4		1064	1064				1		3		7	132	67	133	80	154	84	62	33	308															
/10	16	2	4136	4133			3	2	9	7	6	7	203	6	11	56	124	240	353	476	2632		1													
/11	33	4	2202	2193				9	6	3	6	10	248	57	121	192	292	72	129	147	910															
/12	89	14	4656	4637					19	13	10	31	323	106	222	466	450	288	379	364	1985															
/13	172	17	5512	5460					3	49	39	44	290	119	202	591	676	489	536	576	1897		1													
/14	340	19	9783	9629	1				2	6	145	57	266	136	226	707	848	624	893	997	4875															
/15	431	33	7136	6927						2	9	198	182	123	283	463	647	412	532	648	3637															
/16	9481	2805	30361	24634			2	2	12	16	56	131	5508	516	629	1351	1439	1464	2125	2305	14805															
/17	1227	116	8261	7525						1	1	2	87	645	289	423	528	530	957	689	4102		6													
/18	2077	257	9395	8142								1	9	44	1199	505	515	478	634	666	5343														1	
/19	5813	797	18236	14354							2	3	3	10	87	3777	855	774	1136	1150	10430											4		3		
/20	4879	991	11022	8328							1		2	1	4	176	2510	542	641	701	6441														2	
/21	1783	702	2745	2397								1	1				4	5	337	181	196	2020														
/22	2425	1011	2590	2004											1	1	2	2	2	578	278	1726														
/23	2665	1262	1875	1093														1	1	5	775	1093														
/24	27392	19233	8205											7	1	3	9	18	43	95	241	7788														
/25	42	39	3																		1	2														
/26	29	27	2																																	
/27	21	20	1																																	
/28	11	10	1																																	
/29	5	5																																		
Total	58915	27377	115128	90493	20	4	6	15	58	105	285	502	7467	1847	3434	8851	9126	6430	9356	10438	71084	0	8	2	1	1	4	0	6							

# Prefix Distribution



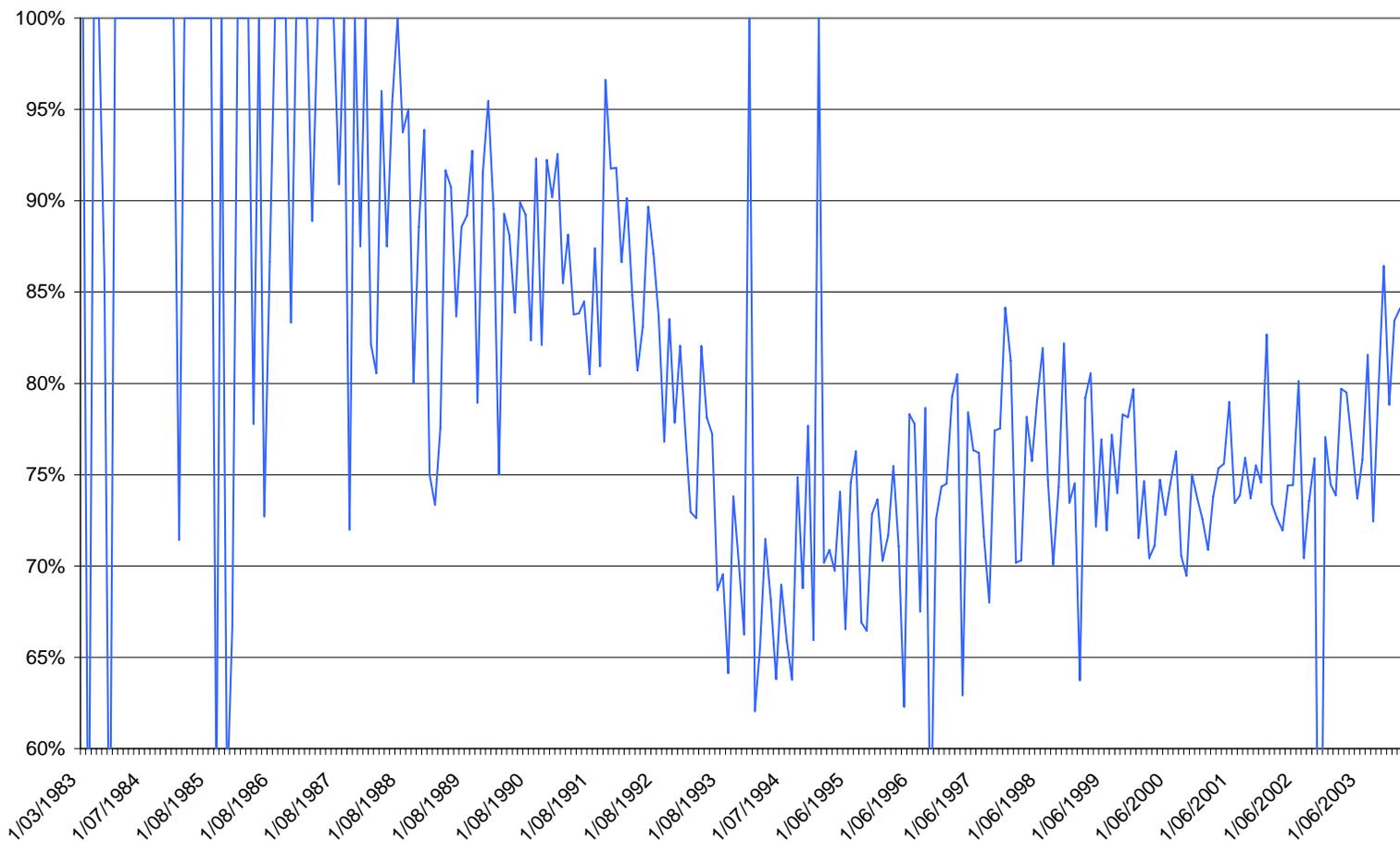


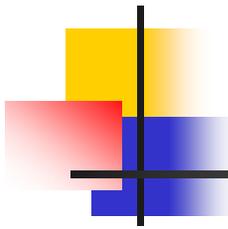
# Allocations Advertised 'as is'

---

- This graph plots the proportion of address allocations that are advertised as allocated. The lower the proportion the greater the amount of allocations that are advertised only as fragments. The higher the number the better (in terms of reduction in advertisement fragmentation)
- This has been improving since August 2000

# Allocations Advertised 'as is'



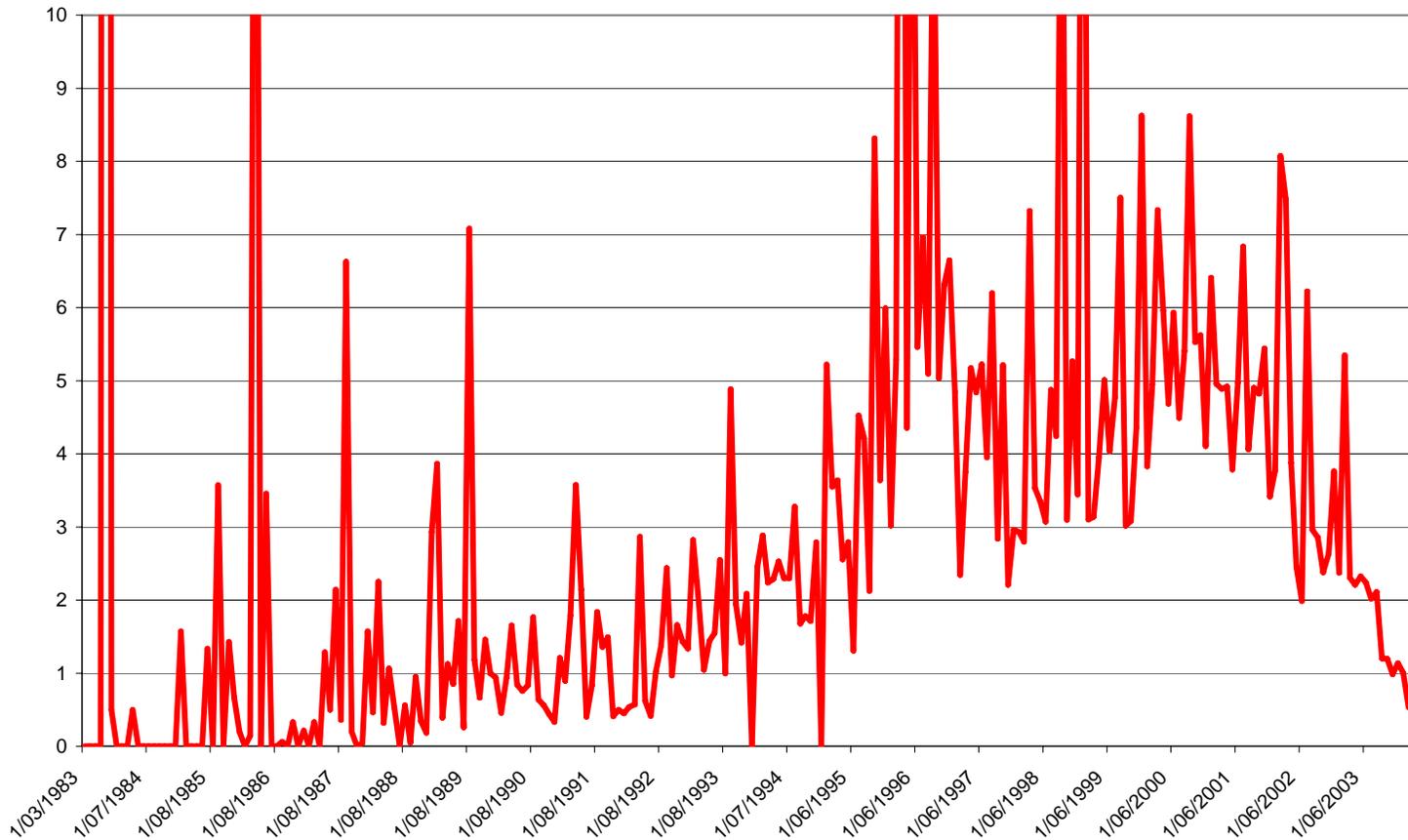


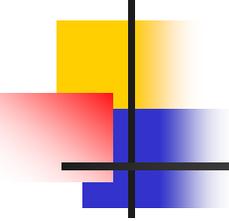
# Number of Fragmentary Advertisements as a proportion of Allocations

---

- This compares the number of fragmentary advertisements to the number of RIR allocations. The lower the number, the better
- The proportion of fragmentation of allocated blocks has been dropping since August 2000

# Number of Fragmentary Advertisements as a proportion of Allocations



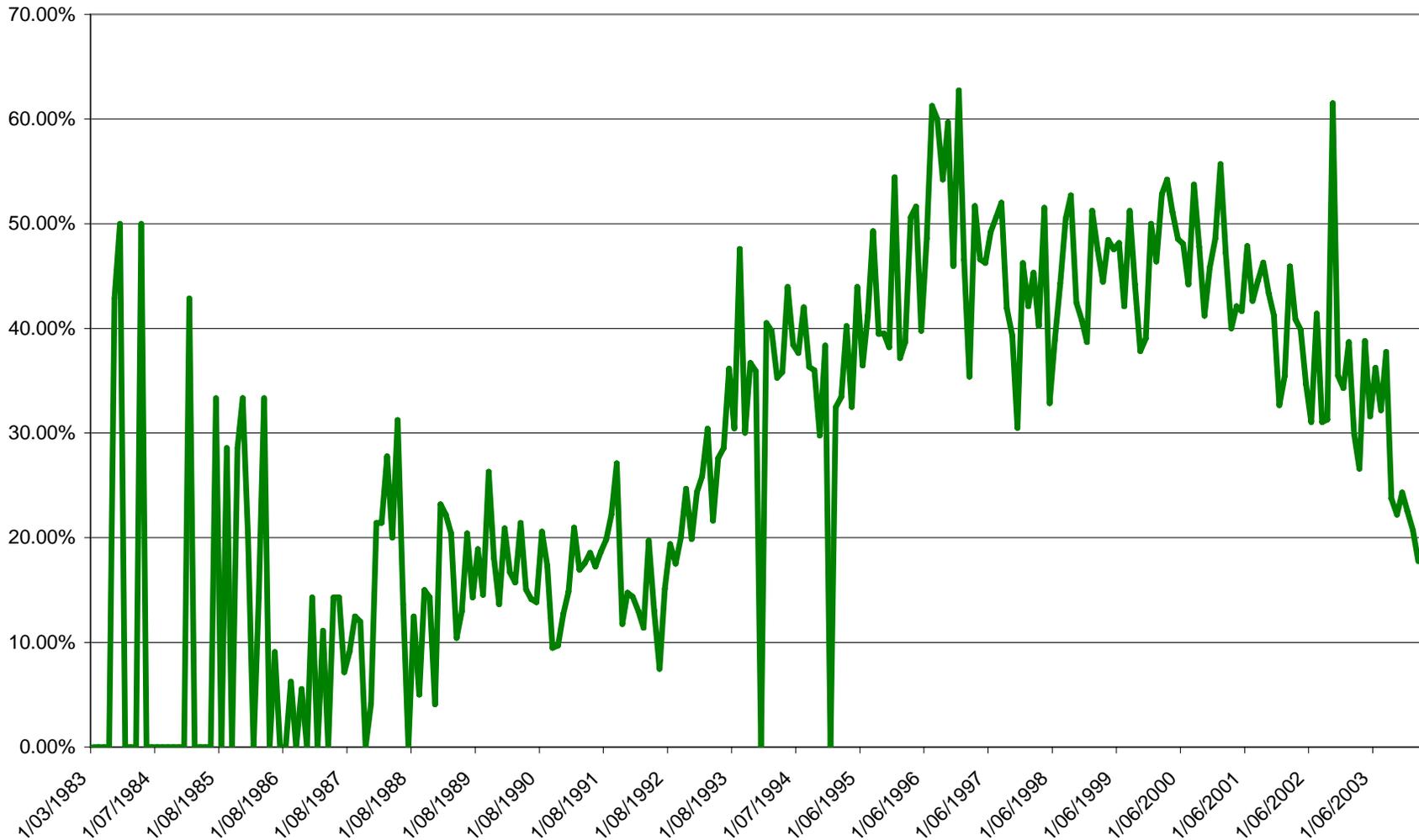


# Proportion of Allocations that are advertised in Fragments

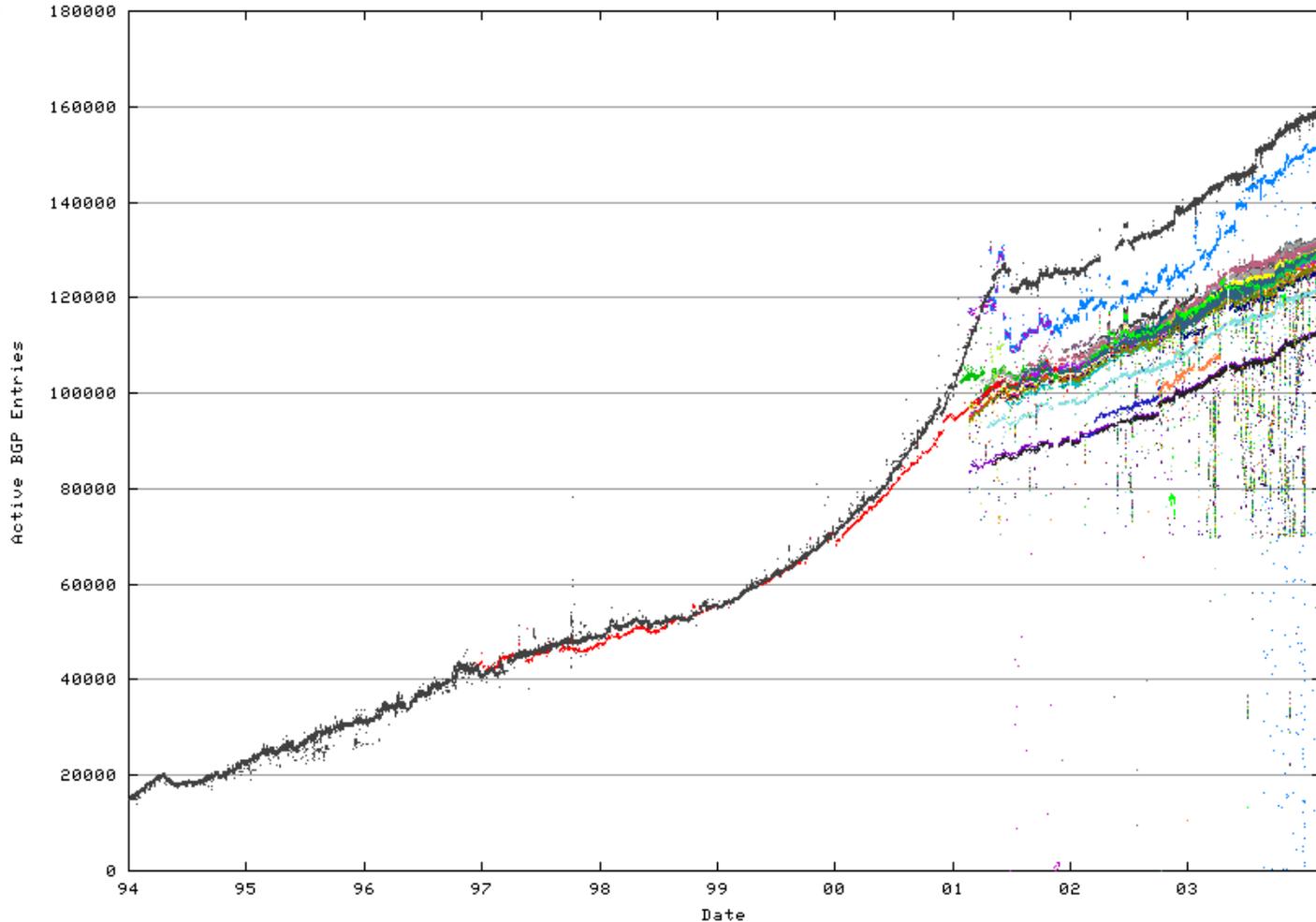
---

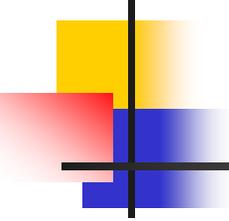
- This compares the number of allocations against the number of allocations that are advertised in one or more fragments. The lower the number the smaller the amount of fragmentation of allocations
- Again there is a noticeable decline since August 2000

# Proportion of Allocations that are advertised in Fragments



# Just a reminder – BGP Routing Table Growth

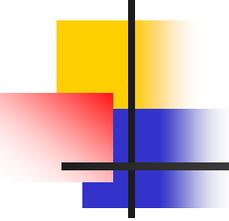




# Observations

---

- It appears that the major contributor to the growth of the routing table is the amount of advertisement fragmentation that occurs in allocated address space.
- This form of advertisement fragmentation peaked from 1997 – 2000
- The levels of advertisement fragmentation have been improving since late 2000.



# Observations

---

- Taking an allocated block and advertising more specific /24 address prefixes is the predominate form of advertising a split allocation block in fragments
  - Many of these more specifics appear to be local (i.e. could be masked with NOEXPORT)
- One fifth of allocations are fragmented in this fashion, and, on average there are 6.6 additional advertisements of fragments of the address block
- /21, /22, /23 allocations have proportionately less advertised fragmentation than larger prefix sizes
- Levels of fragmentation of advertisements have been improving since late 2000, corresponding with a return to linear growth of the BGP routing table size.