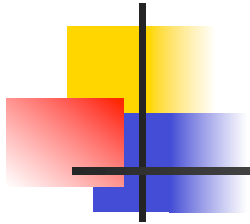


EyeP: Visualizing IPv4 Address allocation and usage



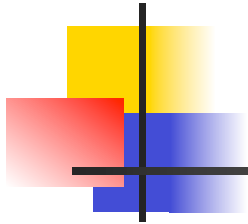
Lucas (Jiangzhe) Wang
Internet Research Lab, UCLA

Joint work with
Ricardo Olivera (Thousand Eyes)
Lixia Zhang (IRL, UCLA)



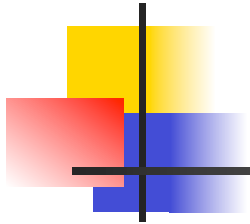
Motivation

- IPv4 address space is running out, but how are they being utilized?
 - Are prefixes announced in the same size of allocation
 - Are all allocated prefixes announced?
 - Are any unallocated prefixes announced, and if so for how long?
- Need to visualize address space utilization
 - Show the big picture yet also enable one to drill down into individual blocks



What EyeP can help with

- Provide a comprehensive picture in overall IPv4 address allocation
- Relations between allocation and routing announcements
 - allocated but not observed in DFZ
 - announced but not allocated
 - allocated and announced, in many different forms



Data Source

- Whois database
- RIR address allocation records
 - Daily allocation snapshot from Feb, 2005
- RouteViews BGP routing snapshots
- RIPE BGP routing snapshots



Data updated on:
2010-06-14

- ☐ RIRs Allocation
- ☐ Seen in BGP

Input IP Range:

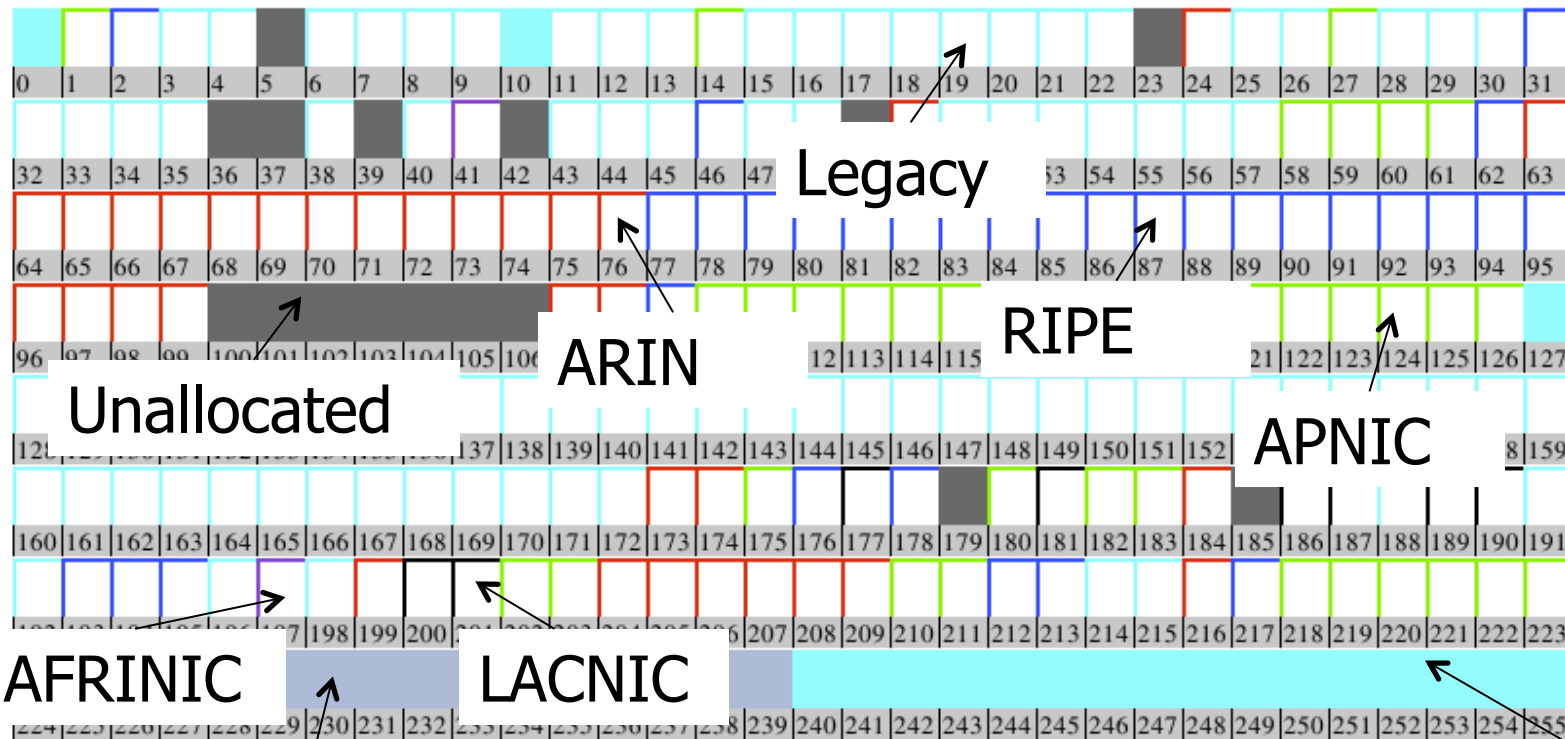
Organization Name:

Input ASN:



From:0.0.0.0 To:255.255.255.255

/8



Unallocated

Legacy

ARIN

RIPE

APNIC

AFRINIC

LACNIC

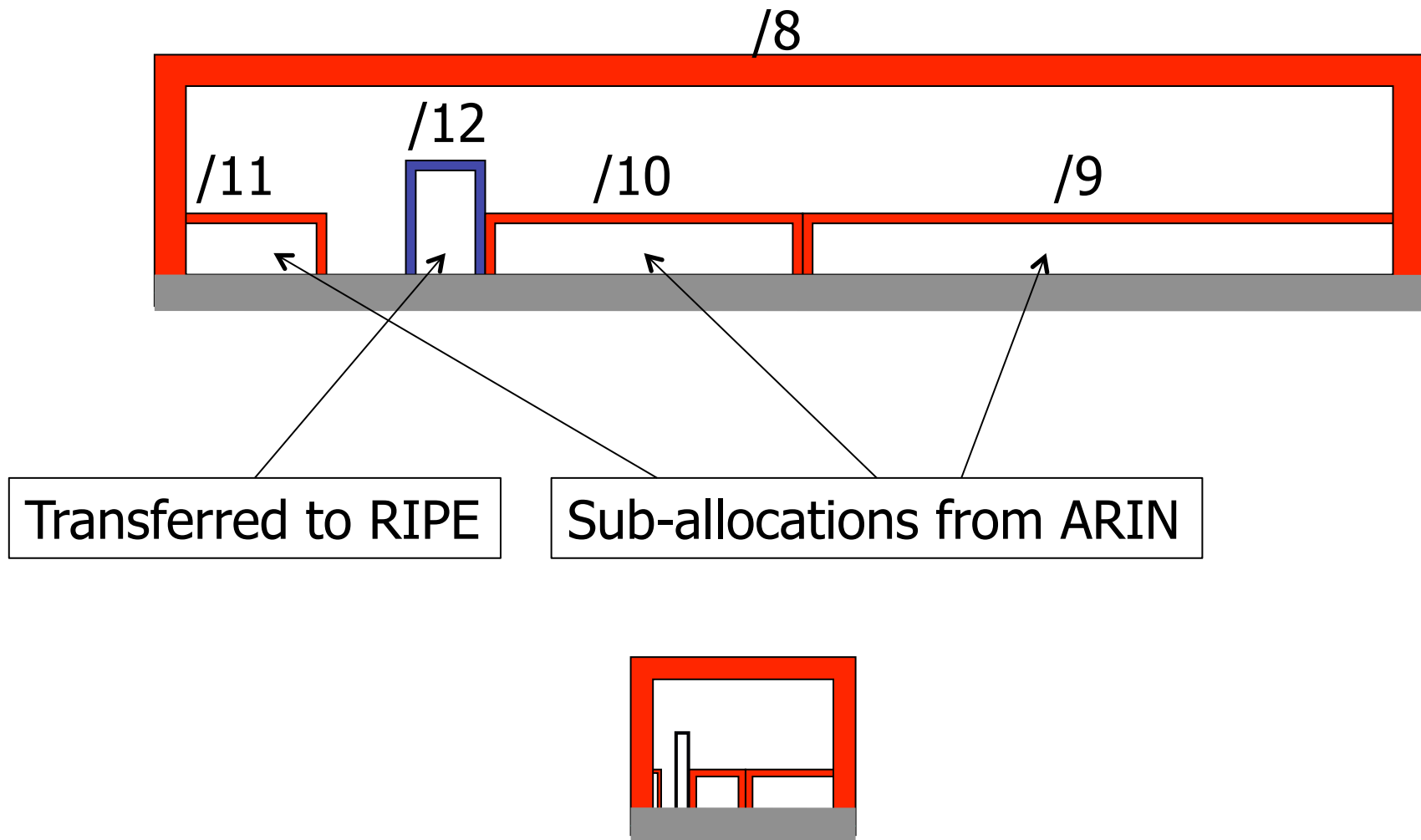
Multicast

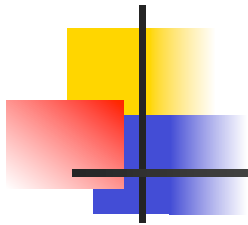
Reserved



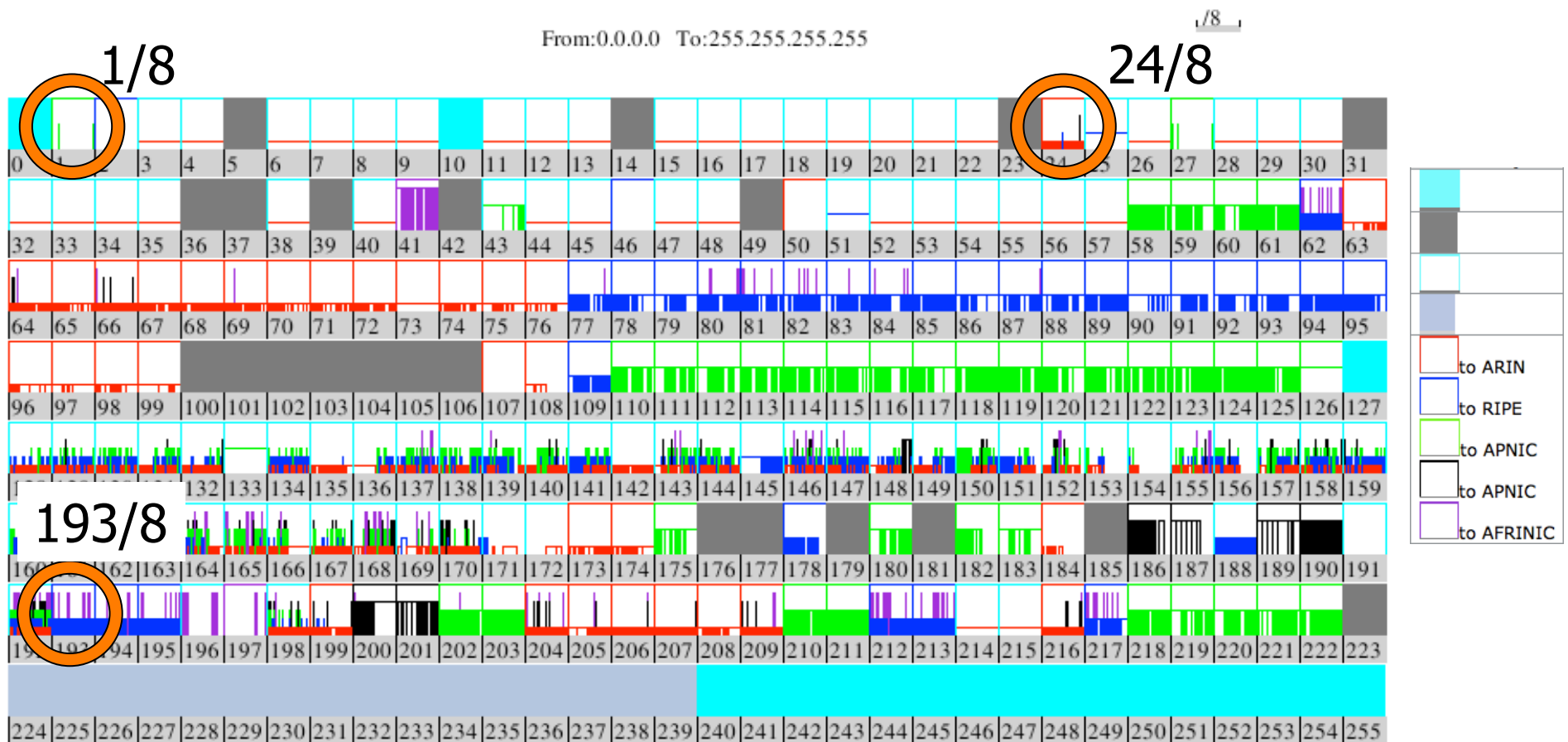


Visualizing sub-block allocations





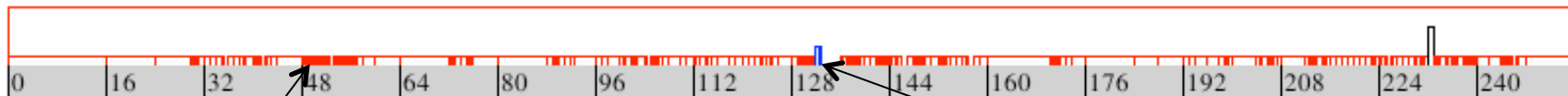
Color Bars: Allocations managed by 5 RIRs



Further Zoom in to See More Detail

From:24.0.0.0 To:24.255.255.255

/12



ARIN sub-allocations

Transferred to RIPE

From:193.0.0.0 To:193.255.255.255

/12

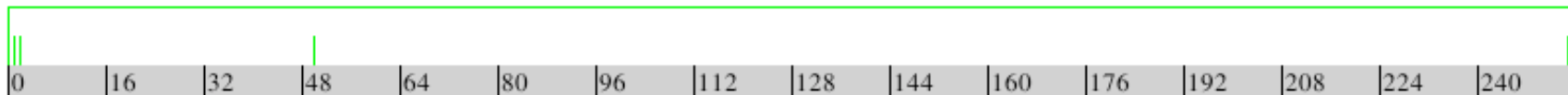


RIPE sub-allocations

Transferred to AFRINIC

From:1.0.0.0 To:1.255.255.255

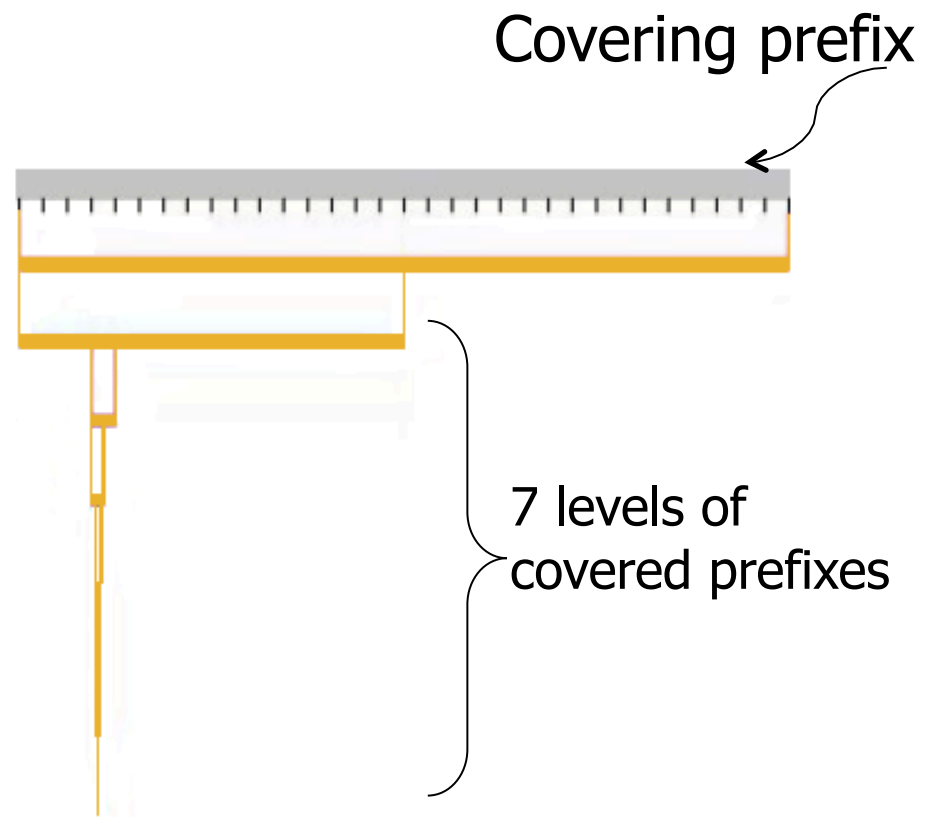
/12



One way to turn one allocated block into multiple announcements

Seen in BGP:

222.32.0.0/11
222.32.0.0/12
222.35.0.0/16
222.35.0.0/17
222.35.64.0/19
222.35.64.0/20
222.35.72.0/21
222.35.76.0/22



Correlation between # of allocations and # of announcement

From:97.0.0.0 To:97.255.255.255

/12

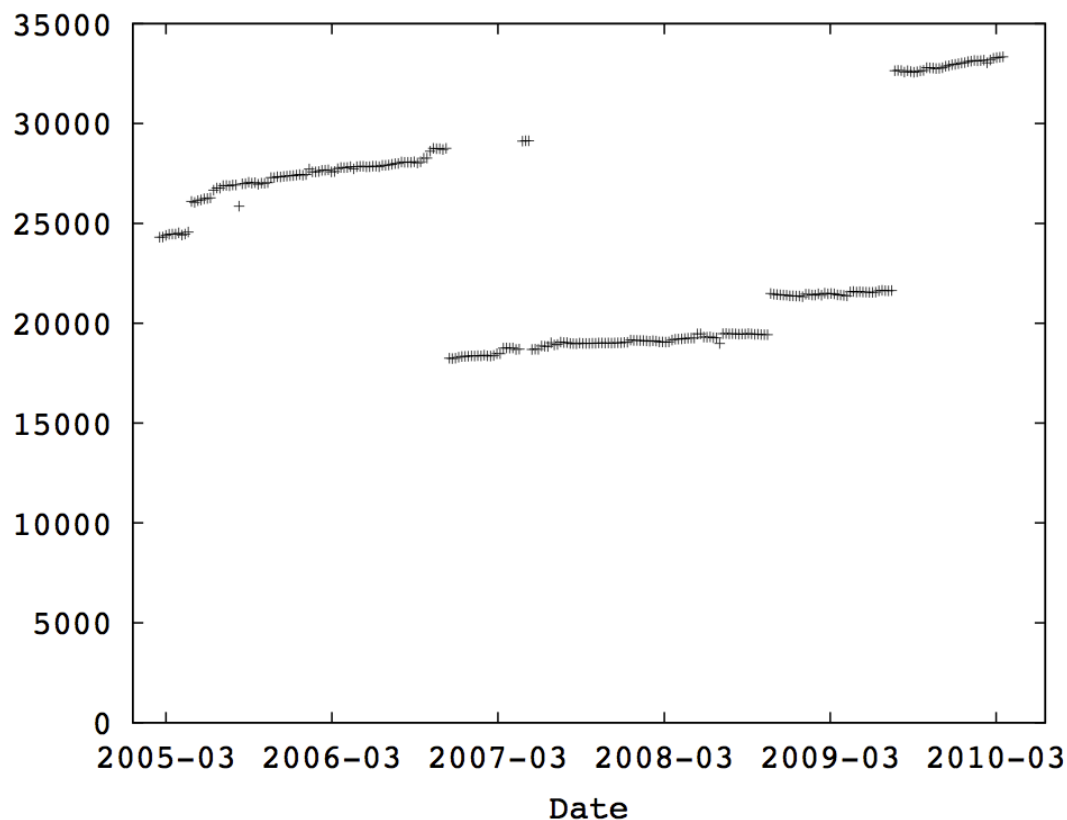


Total of 36 row(s)

CIDR↓	Allocation Date	RIR	Organization	Country	City	# of Covering Prefixes	Exact Match	# of Covered Prefixes
97.0.0.0/10	2007-01-22	arin	Cellco Partnership DBA Verizon Wireless	US	Bedminster	0	1	38
97.64.0.0/17	2009-04-08	arin				0	1	0
97.64.128.0/17	2009-04-13	arin				0	0	77
97.65.0.0/16	2008-05-14	arin	tw telecom holdings, inc.	US	Littleton	0	1	127
97.66.0.0/15	2007-06-05	arin	ITC^Deltacom	US	Anniston	0	0	37
97.68.0.0/14	2007-04-19	arin	BRIGHT HOUSE NETWORKS, LLC	US	Riverview	0	0	20
97.72.0.0/15	2007-08-03	arin	Hughes Network Systems	US	Germantown	0	0	15
97.74.0.0/16	2008-08-14	arin	GoDaddy.com, Inc.	US	Scottsdale	0	1	62
97.75.0.0/18	2008-08-14	arin	Rogers Cable Communications Inc.	CA	Toronto	0	1	0
97.75.64.0/18	2010-02-19	arin				0	1	0
97.75.128.0/20	2009-11-30	arin				0	1	0
97.75.160.0/19	2009-12-01	arin				0	1	0
97.75.192.0/19	2009-12-02	arin				0	1	0
97.75.224.0/19	2009-12-03	arin				0	0	4
97.76.0.0/14	2007-09-11	arin	Road Runner HoldCo LLC	US	Herndon	0	0	12
97.80.0.0/12	2007-03-21	arin	Charter Communications	US	St. Louis	0	0	127
97.96.0.0--97.107.0.0	2007-04-09	arin				0	0	0
97.107.0.0/20	2008-12-04	arin	Managed Network Solutions, Inc.	US	Bryan	0	0	0
97.107.16.0/20	2008-12-04	arin	Yesmail Inc	US	Portland	0	1	0

Allocated but unannounced address blocks

Number of allocated but unannounced address block



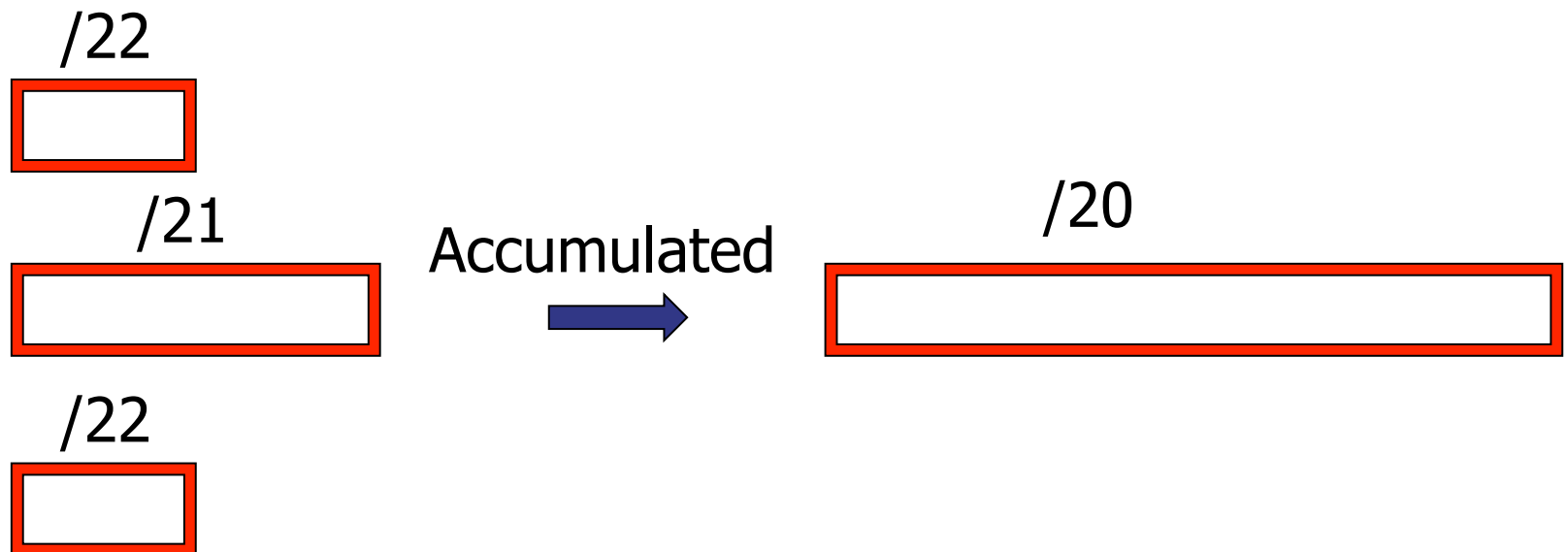
- Significant decrease from Nov 28 to Dec 5, 2006 was mainly because AS 3303 (SWISS COMM) started announcing the following prefixes

24.0.0.0/8
62.0.0.0/8
63.0.0.0/8
76.0.0.0/8
199.0.0.0/8
216.0.0.0/8
217.0.0.0/8
222.0.0.0/8

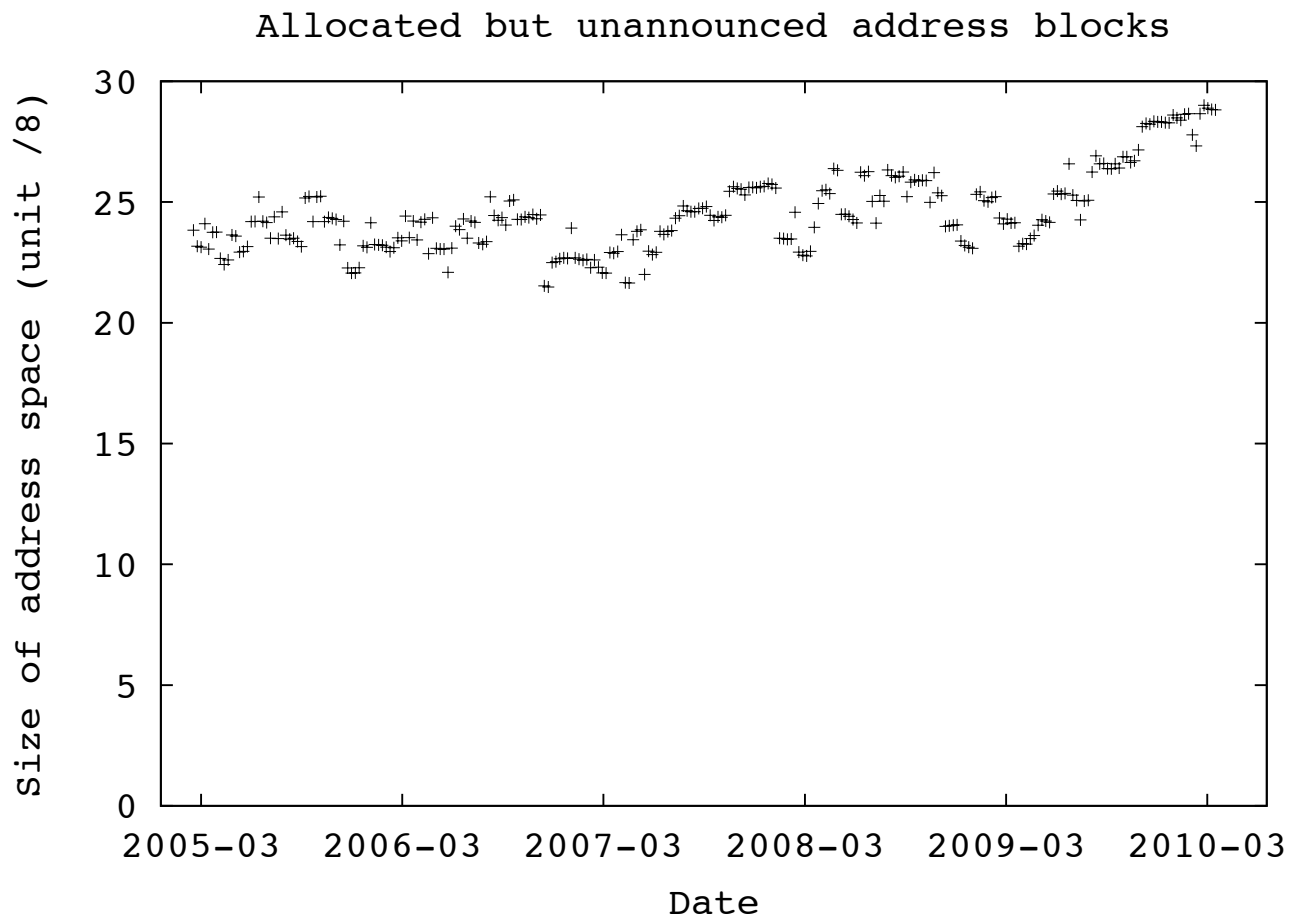
- SWISS COMM withdrew these /8 prefixes at the end July, 2009



Aggregated space size

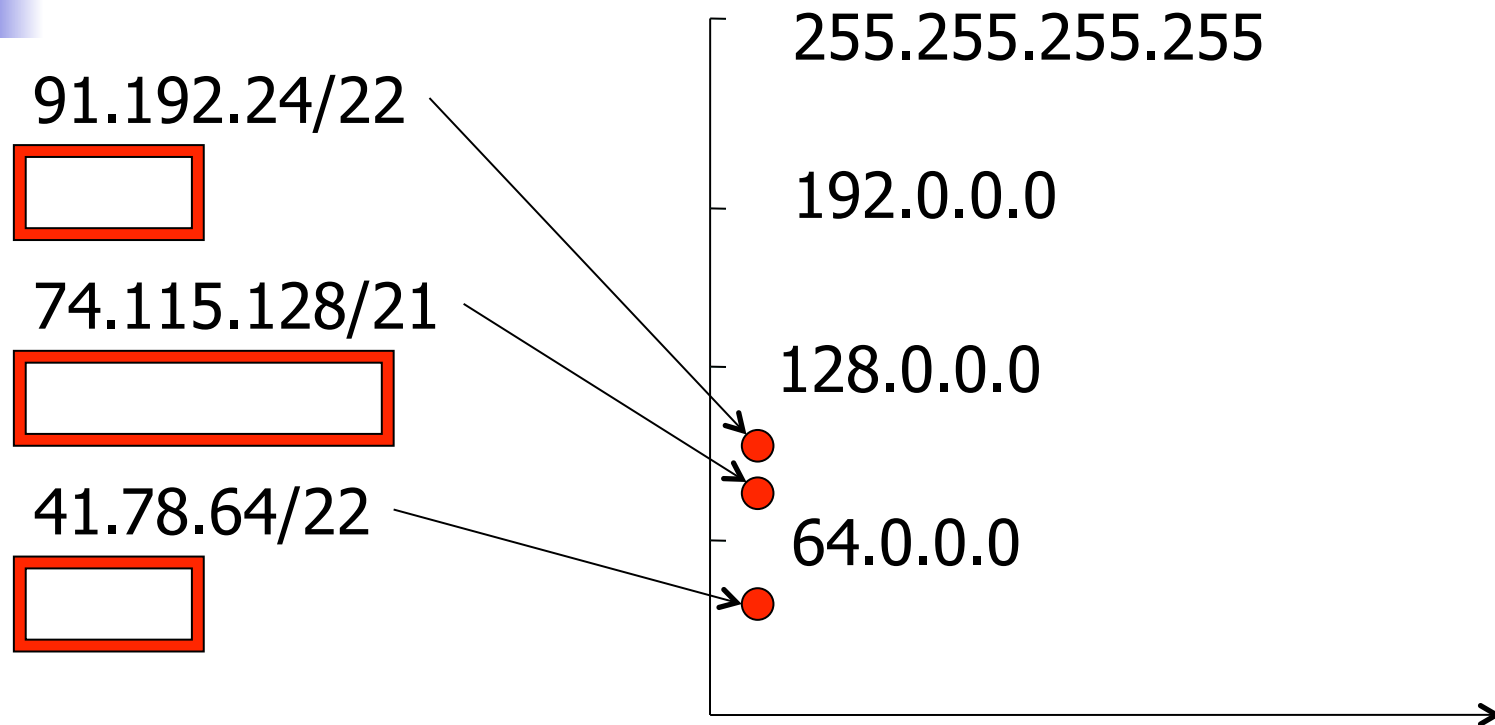


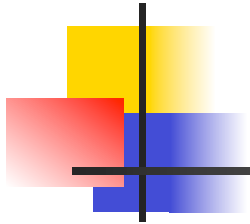
Space size of allocated but unannounced addresses



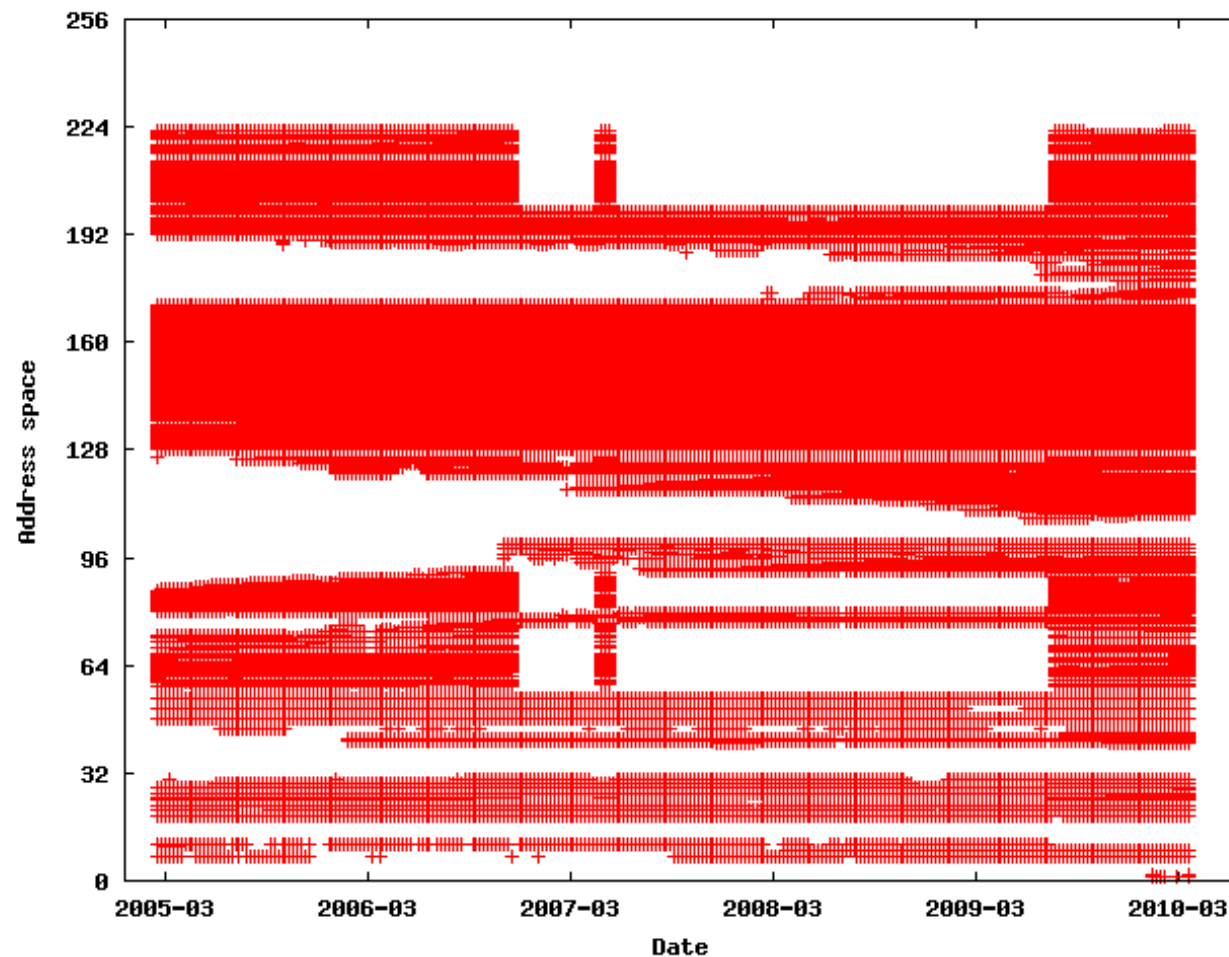


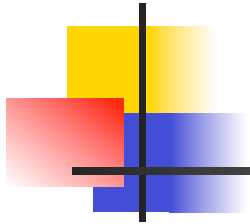
Position of DFZ-invisible blocks





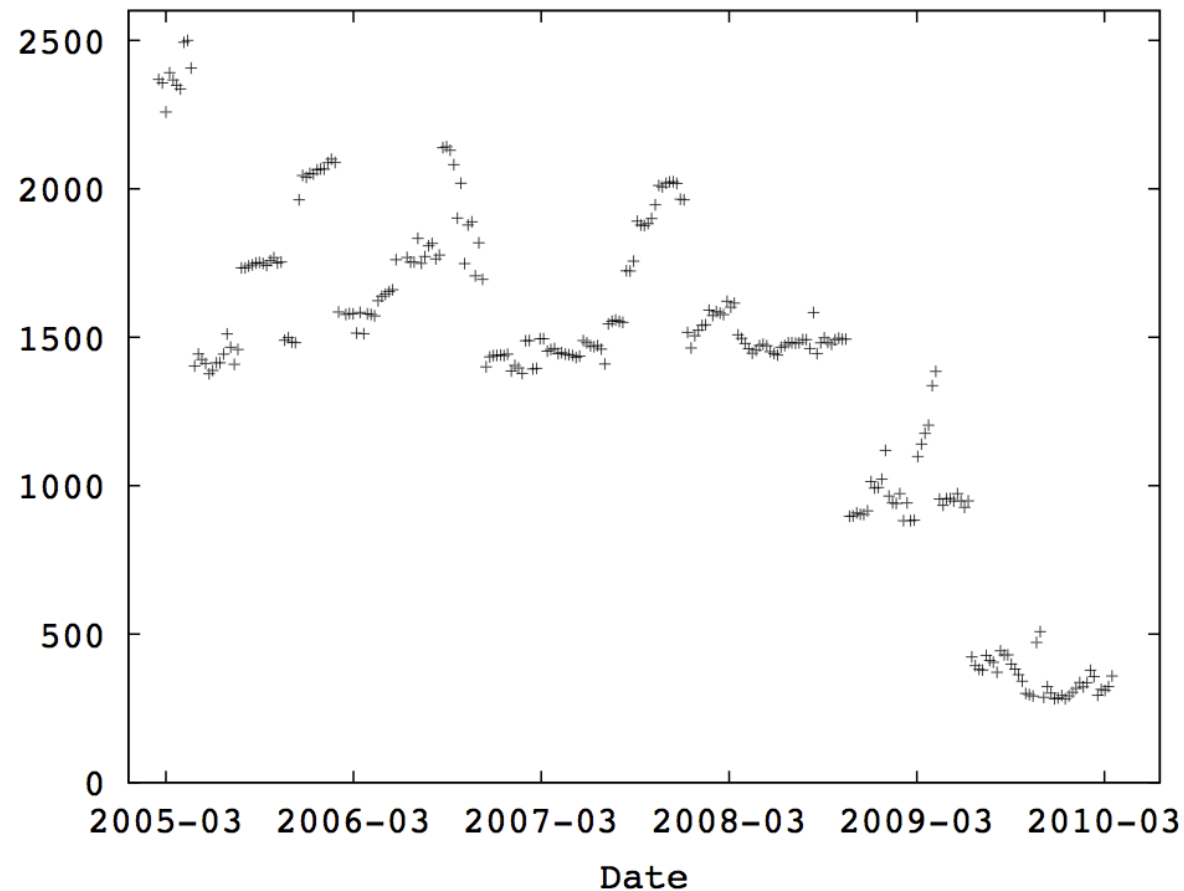
Where are the DFZ-invisible blocks



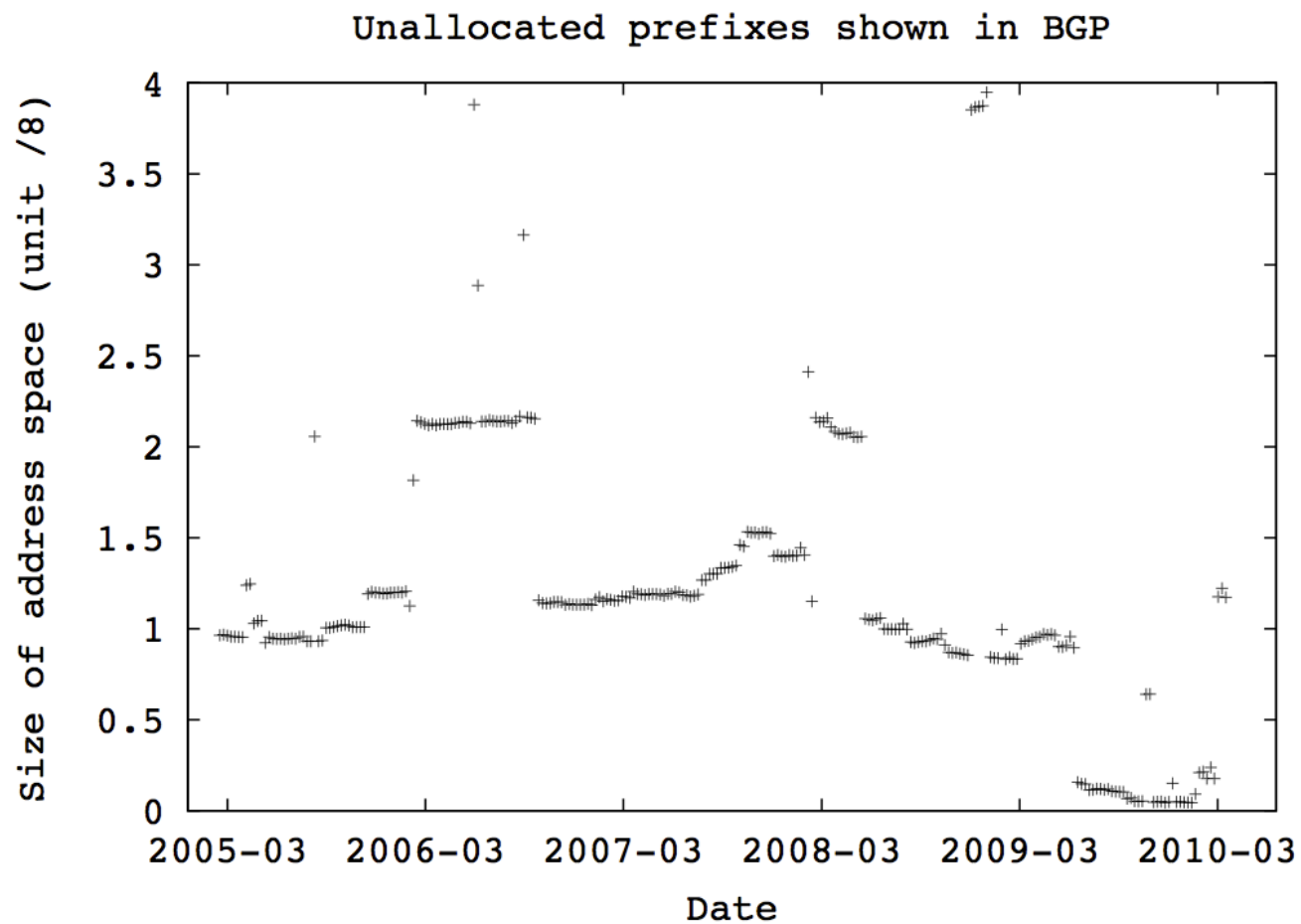


Unallocated prefixes shown in BGP

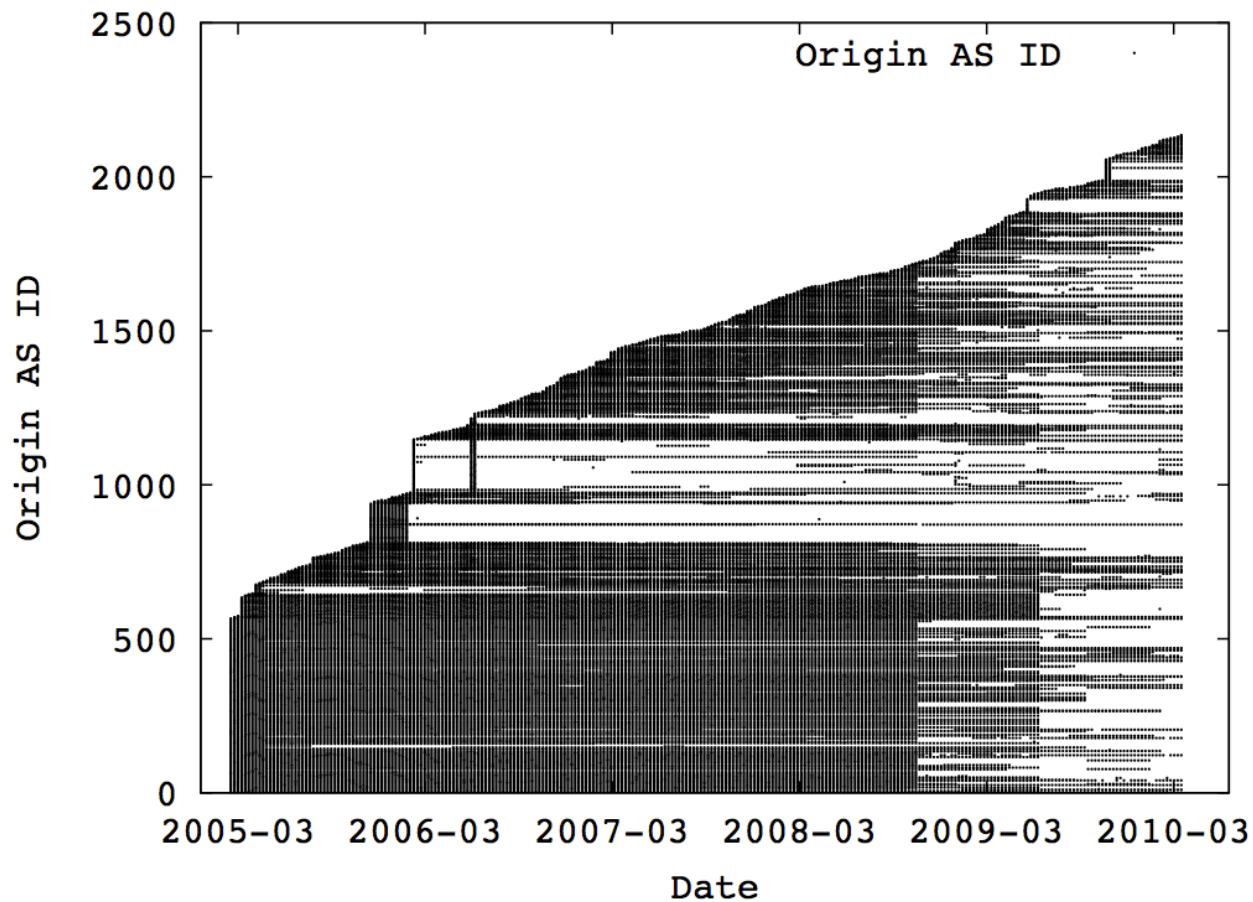
Number of announced but unallocated BGP prefixes

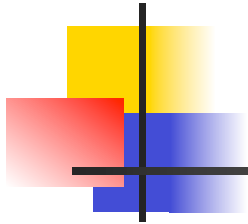


Amount of Unallocated Addresses Announced



Origin ASes who announced unallocated prefixes



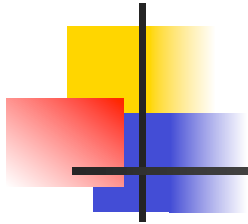


Anomaly case studies

Period	Origin ASN	Number of Unallocated /8 Prefixes announced	Monitors saw the event
07/12/2005 – 08/02/2005	2905	50+	196.7.106.245
05/02/2006 – 06/20/2006	16215	60+	192.65.185.191 80.81.192.143

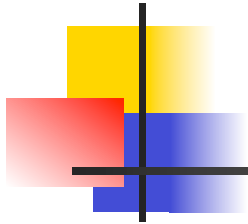
And even more...

06/05/2007 – 12/25/2007	25418
05/12/2009 – 06/09/2009	10026
07/28/2009 – 08/25/2009	29449

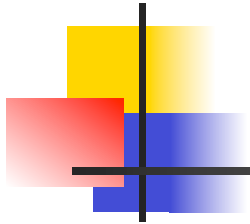


Summary

- EyeP visualizes both IPv4 address allocation and routing table prefix tree.
- EyeP helps us understand the relationship between address allocation and their usage in routing tables.
- Around 25 /8 amount of allocated addresses are not visible in DFZ.
- 1 ~ 1.5 /8 amount of unallocated prefixes are observed by BGP monitors
 - A few BGP monitors captured unallocated /8 prefixes



Thank you
Questions / suggestions?
lucas@cs.ucla.edu



Prefix visibility among BGP monitors

