

AS Level Topology Growth: A Preliminary Measurement

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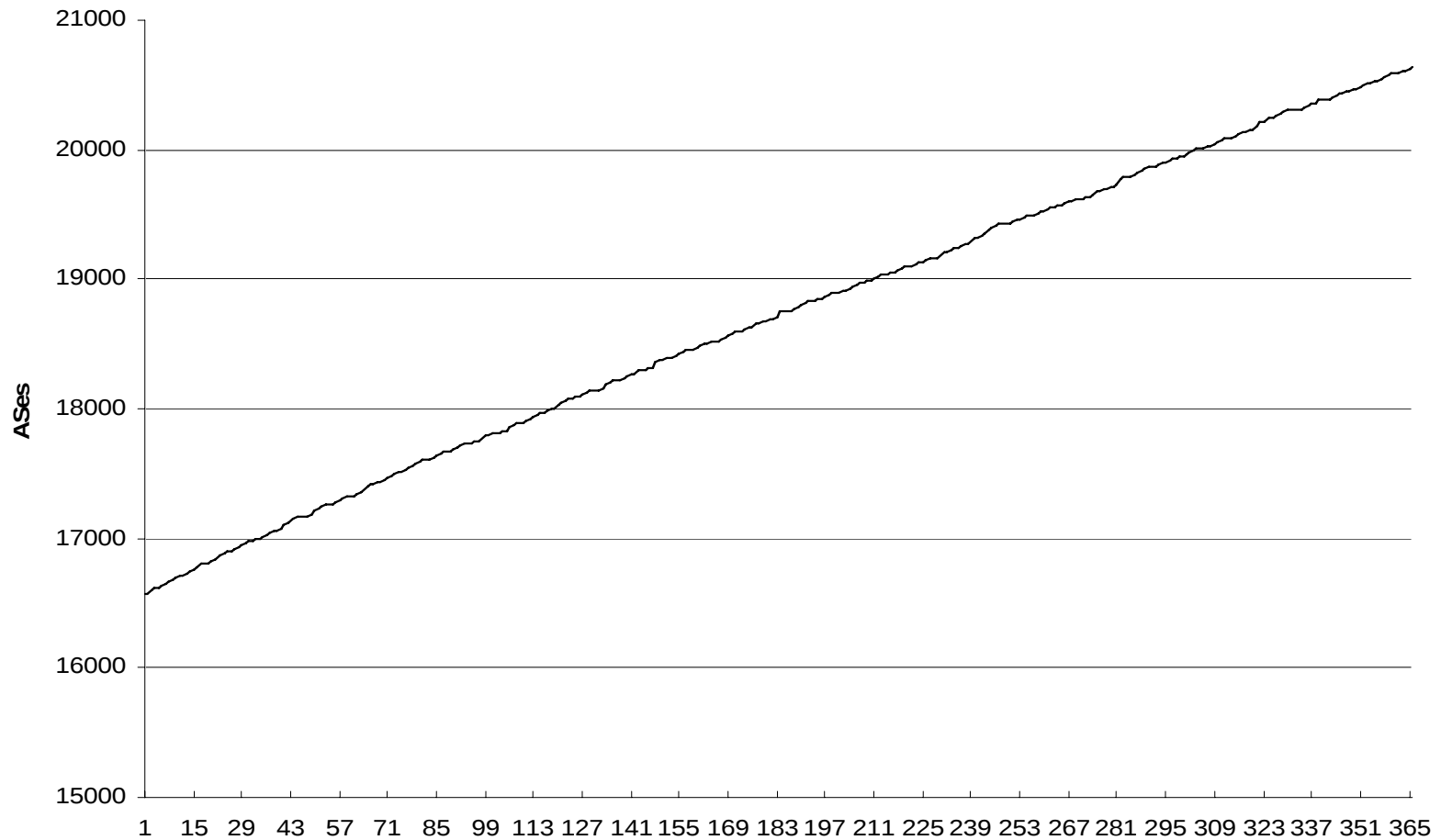
Collecting an AS Level Topology Map

- Take input from publically available BGP data sources
 - BGP Routing table dumps from
 - RouteViews, RIPE, CERNET
 - Route Servers
 - RIPE Routing Registry
 - BGP Routing updates from RouteViews and RIPE
- Infer AS relationships ([J. Xia and L. Gao](#))
 - » <http://rio.ecs.umass.edu/download.htm>
- Rank ASes into tiers based on topology and relationships

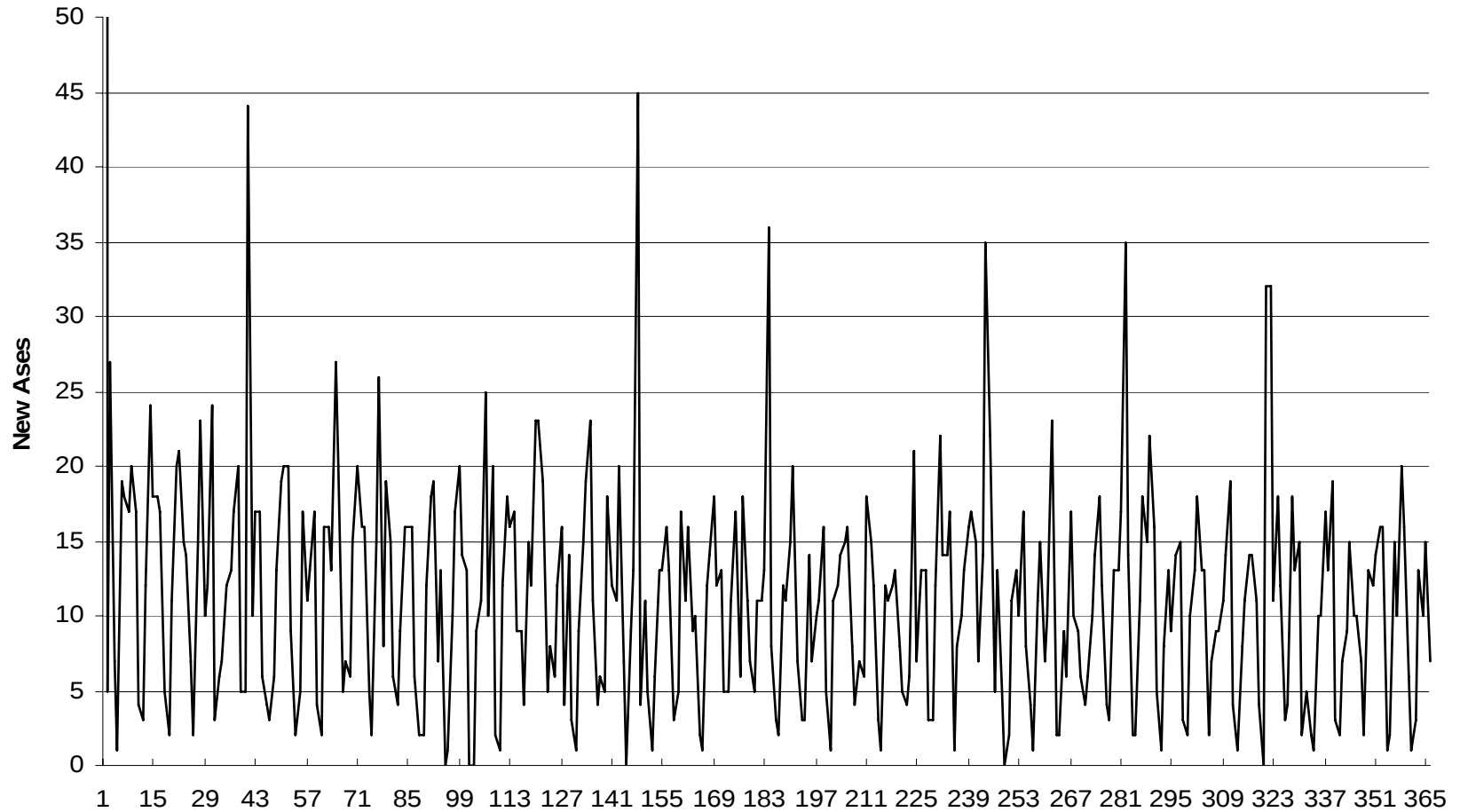
Our Topology

- Our collected topology is available online
<http://irl.cs.ucla.edu/topology>
- File for every day with all ASes and links ever observed with timestamp of last observation

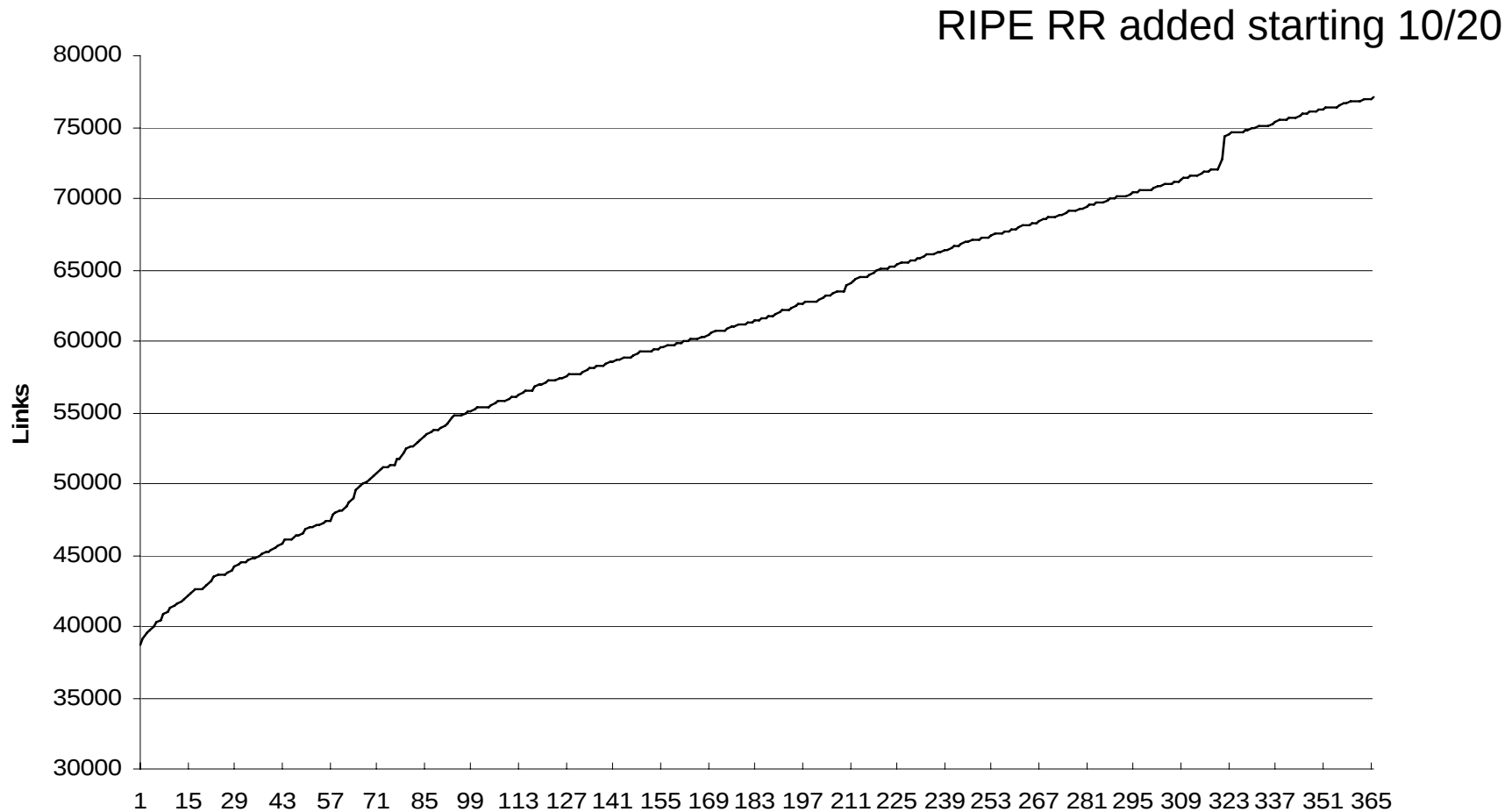
Total # of ASes Seen in 2004



New ASes observed each day

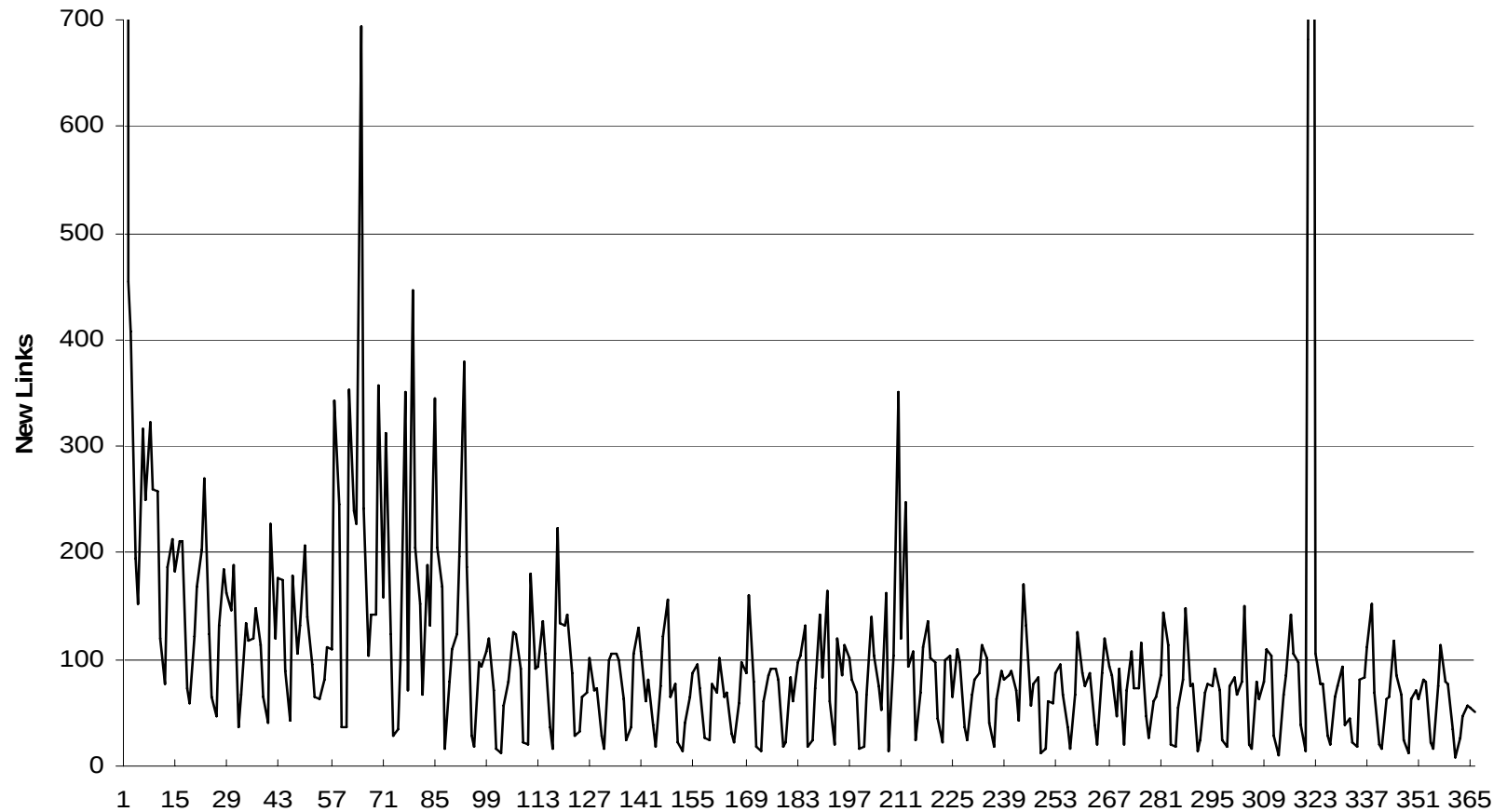


Total # of AS Links seen in 2004



New Links seen each day

RIPE RR added starting 10/20



Where the Growth Occurs

- AS/link considered live at beginning of period if seen during the week before start
- AS/link considered to have disappeared if not seen the last week of the period

Growth 4/1/04 - 6/30/04

Links(+New)

1 15(+0)	2 1088(+5)	3 1495(+35)	4 1438(+32)	5 13218	5n (+869)	Tier ASes(+new)	
98(+0)	3608(+331)	610(+73)	875(+70)	8281(+436)	(+316)	1	15(+0)
	10654(+1746)	2757(+411)	1303(+149)	9670(+672)	(+568)	2	1088(+5)
		1249(+233)	438(+85)	2714(+255)	(+172)	3	1495(+35)
			345(+82)	3156(+354)	(+234)	4	1438(+32)
				48(+18)	(+1)	5	13218
					(+0)	5n	(+869)

Links disappeared

1 15(-0)	2 1088(-1)	3 1495(-15)	4 1438(-19)	5 13218(-291)	Tier ASes(-disappeared)	
2	265	62	68	617	1	15(-0)
	1473	339	131	760	2	1088(-1)
		141	76	293	3	1495(-15)
			62	362	4	1438(-19)
				35	5	13218(-291)

Growth 7/1/04 - 9/30/04

Links(+New)

1 15(+0)	2 1073(+4)	3 1411(+35)	4 1578(+32)	5 13759	5n (+884)	Tier ASes(+new)	
96(+0)	3664(+236)	553(+67)	945(+74)	8411(+680)	(+362)	1	15(+0)
	10871(+2558)	2841(+521)	1419(+139)	9834(+728)	(+519)	2	1073(+4)
		1260(+170)	462(+72)	2707(+221)	(+179)	3	1411(+35)
			444(+80)	3742(+404)	(+258)	4	1578(+32)
				29(+27)	(+3)	5	13759
					(+0)	5n	(+884)

Links disappeared

1 15(-0)	2 1073(-1)	3 1411(-21)	4 1578(-13)	5 13759(-293)	Tier ASes(-disappeared)	
1	222	62	66	557	1	15(-0)
	1688	390	94	748	2	1073(-1)
		242	86	347	3	1411(-21)
			74	448	4	1578(-13)
				23	5	13759(-293)

Growth 10/1/04 - 12/31/04

Links(+New)

1 15(+0)	2 1086(+4)	3 1495(+59)	4 1616(+26)	5 14280	5n (+840)	Tier ASes(+new)	
95(+1)	3641(+319)	606(+77)	974(+74)	8864(+380)	(+308)	1	15(+0)
	11840(+2062)	2823(+529)	1473(+119)	9878(+578)	(+489)	2	1086(+4)
		1183(+296)	535(+65)	3160(+253)	(+200)	3	1495(+59)
ASes 2596(+63) Links 20188(+3284)			449(+81)	3949(+321)	(+251)	4	1616(+26)
					(+5)	5	14280
					(+1)	5n	(+840)
			ASes 15896(+866) Links 29319(+3139)				

Links disappeared

1 15(-0)	2 1086(-8)	3 1459(-18)	4 1616(-20)	5 14280(-314)	Tier ASes(-disappeared)	
0	224	39	54	623	1	15(-0)
	1859	331	127	696	2	1086(-8)
		201	91	439	3	1459(-18)
Nodes -26 Links -2654			77	400	4	1616(-20)
				31	5	14280(-314)
			Nodes -334 Links -2538			

Total ASes 18492+929-360=19061

Total Links 49507+6423-5192=50738

What impact may the topology growth have on BGP operations?

BGP Slow Convergence

- BGP is known to suffer from slow convergence after topological/policy changes
- Slow convergence gets worse with increasing number of alternative paths
- Here we only show a sample
- Quantitative investigation in progress

BGP Slow Convergence

- Beacon 198.32.7.0/24
- Sample (time, type, path)

- A tier-1 AS

40651	A	1239 6461 6939 3066 3066 3944
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40677	A	1239 7018 23518 3066 3944
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40711	W	
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- A lower-tier AS

40664	A	1221 4637 6461 6939 3066 3066 3944
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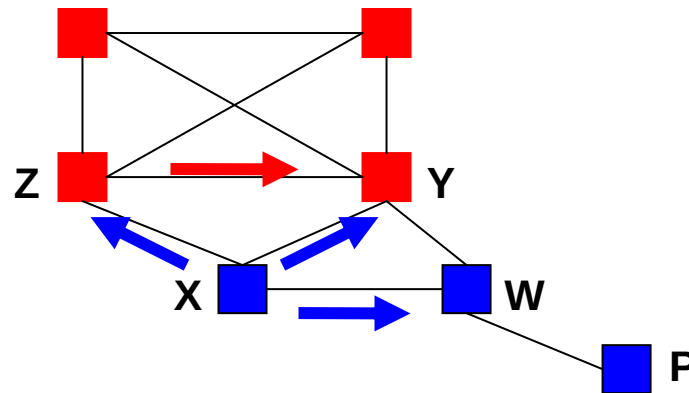
40692	A	1221 4637 1239 7018 23518 3066 3944
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40747	A	1221 4637 701 7018 23518 3066 3944
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40800	W	
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Lower-Tier Sees More Paths

- Due to routing policy, AS-X at lower tier can see more alternate paths than AS-Z at tier-1.
 - via multiple providers
 - via peers



Impact of Topology Growth on Slow Convergence

- Denser connectivity increases the number of alternate paths, potentially making slow convergence worse, especially for lower tiers.

RV peer (AS#)	Jan 2, 2004		Dec 2, 2004		
	#updates	#paths	#updates	#paths	
1239 (tier1)	44	4	37	4	MRAI on
1221	62	8	87	11	
2914 (tier1)	106	6	279	7	MRAI off
3557	102	19	198	39	

Beacon prefix 198.32.7.0/24