



# BGP Aggregation & The Deaggregation Report

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# Route Aggregation Recommendations

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- LINX attempted aggregation policy for members
  - It failed even though most members voted for policy
- RIPE Routing Working Group work item from early 2006
  - Based on early LINX concept
  - Authored by Philip Smith, Mike Hughes (LINX) and Rob Evans (UKERNA)



# Route Aggregation Recommendations

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- RIPE Document — RIPE-399
  - <http://www.ripe.net/ripe/docs/ripe-399.html>
- Discusses:
  - History of aggregation
  - Causes of de-aggregation
  - Impacts on global routing system
  - Available Solutions
  - Recommendations for ISPs



# History:

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- Classful to classless migration
  - Clean-up efforts in 192/8
- CIDR Report
  - Started by Tony Bates to encourage adoption of CIDR & aggregation
  - Mostly ignored through late 90s
  - Now part of extensive BGP table analysis by Geoff Huston
- Introduction of Regional Internet Registry system and PA address space



# Deaggregation: Claimed causes (1):

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- Routing System Security
  - “Announcing /24s means that no one else can DOS the network”
- Reduction of DOS attacks & miscreant activities
  - “Announcing only address space in use as rest attracts ‘noise’”
- Commercial Reasons
  - “Mind your own business”



# Deaggregation: Claimed causes (2):

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- Leakage of iBGP outside of local AS
  - eBGP is NOT iBGP – how many ISPs know this?
- Traffic Engineering for Multihoming
  - Spraying out /24s hoping it will work
  - Rather than do any **real engineering**
- Legacy Assignments
  - “All those pre-RIR assignments are to blame”
  - In reality it is both RIR and legacy assignments



# Impacts (1):

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- Router memory
  - Shortens router life time as vendors underestimate memory growth requirements
  - Depreciation life-cycle shortened
  - Increased costs for ISP and customers
- Router processing power
  - Processors are underpowered as vendors underestimate CPU requirement
  - Depreciation life-cycle shortened
  - Increased costs for ISP and customers



## Impacts (2):

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- Routing System convergence
  - Larger routing table → slowed convergence
  - Can be improved by faster control plane processors — see earlier
- Network Performance & Stability
  - Slowed convergence → slowed recovery from failure
  - Slowed recovery → longer downtime
  - Longer downtime → unhappy customers





# Solutions (1):

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- CIDR Report
  - Global aggregation efforts
  - Running since 1994
- Routing Table Report
  - Per RIR region aggregation efforts
  - Running since 1999
- Filtering recommendations
  - Training, tutorials, Project Cymru,...
- “CIDR Police”



## Solutions (2):

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- BGP Features:
  - NO\_EXPORT Community
  - NOPEER Community
    - RFC3765 — but no one has implemented it
  - AS\_PATHLIMIT attribute
    - Still working through IETF IDR Working Group
  - Provider Specific Communities
    - Some ISPs use them; most do not



# RIPE-399 Recommendations:

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- Announcement of initial allocation as a single entity
- Subsequent allocations aggregated if they are contiguous and bit-wise aligned
- Prudent subdivision of aggregates for Multihoming
- Use BGP enhancements already discussed
- (Oh, and all this applies to IPv6 too)



# Looking at Deaggregation

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- CIDR Report
  - [www.cidr-report.org](http://www.cidr-report.org)
  - Encourages aggregation following CIDRisation of Internet
  - Today: extensive suite of reports and tools covering state of BGP table
- Routing Report
  - BGP table status on per RIR basis
  - Original CIDR Report and a whole lot more



# Deaggregation Factor

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- Routing Report
  - One summary takes BGP table and aggregates prefixes by origin AS
    - Called “Max Aggregation” in report
  - Global and per RIR basis
    - <http://thyme.apnic.net/current/>
- New **Deaggregation Factor**:
  - Measure of Routing Table size/Aggregated Size
  - Global value has been increasing slowly and steadily since “records began”



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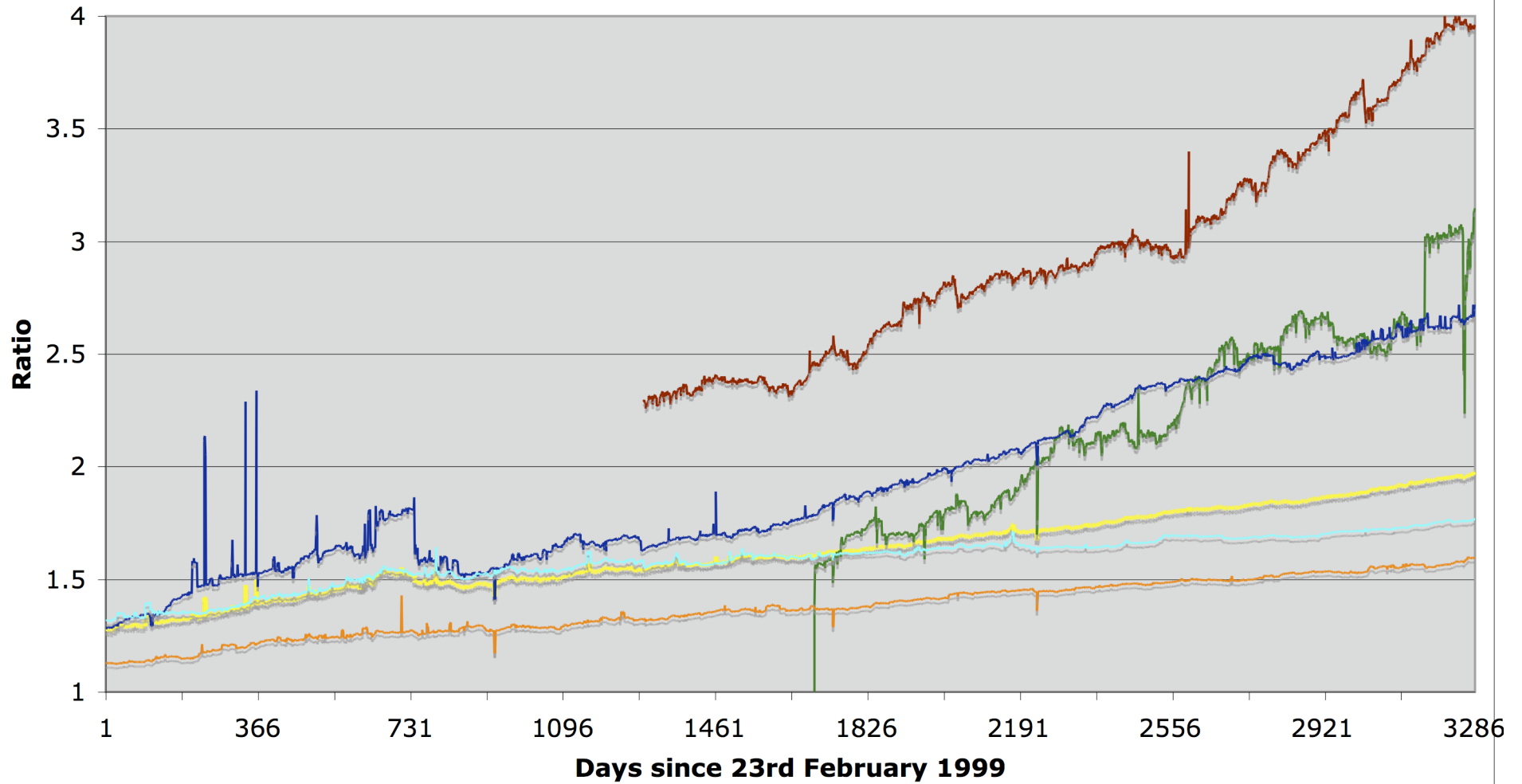
## Total Prefixes

- Global BGP Table
  - 247k prefixes
- Europe & Middle East
  - 53k prefixes
- North America
  - 116k prefixes
- Asia & Pacific
  - 57k prefixes
- Africa
  - 4k prefixes
- Latin America & Caribbean
  - 19k prefixes

## Deaggregation Factor

- Global Average
  - 1.96
- Europe & Middle East
  - 1.60
- North America
  - 1.77
- Asia & Pacific
  - 2.72
- Africa
  - 3.15
- Latin America & Caribbean
  - 3.96

# Deaggregation: RIR Regions vs Global



Global AfriNIC APNIC ARIN LACNIC RIPE

## Africa Aggregation Savings Summary

ASN	No of Nets	Poss Savings	Description
24863	443	412	LINKdotNET AS number
20858	211	207	EgyNet
2018	245	134	Tertiary Education Network
6713	143	132	Itissalat Al-MAGHRIB
33783	130	114	EEPAD TISP TELECOM & INTERNET
5536	121	105	Internet Egypt Network
33776	99	92	Starcomms Nigeria Limited
24835	90	83	RAYA Telecom - Egypt
29571	80	73	Ci Telecom Autonomous system
20484	69	65	Yalla Online Autonomous Syste
23889	78	62	MAURITIUS TELECOM
3741	282	58	The Internet Solution
15706	58	54	Sudatel Internet Exchange Aut
15475	51	47	Nile Online
21152	32	31	AS for the uplinks of Soficom
12455	33	30	Jambonet Autonomous system
16637	54	27	Johnnic e-Ventures
10798	27	26	Standard Bank of South Africa
33774	52	23	AS Number for Telecom Algeria
21280	26	21	Swift Global Kenya Ltd.Is an

<http://thyme.apnic.net/current/data-CIDRnet-AFRINIC>



## Asia & Pacific Aggregation Savings Summary

ASN	No of Nets	Poss Savings	Description
9583	1149	1127	Sify Limited
9498	1135	1071	BHARTI BT INTERNET LTD.
17488	992	903	Hathway IP Over Cable Interne
18101	708	646	Reliance Infocom Ltd Internet
9829	596	585	BSNL National Internet Backbo
4134	852	539	CHINANET-BACKBONE
4668	524	514	LG-EDS Systems Inc.
4766	856	510	Korea Telecom (KIX)
4812	554	466	China Telecom (Shanghai)
17676	508	442	Softbank BB Corp.
7545	473	405	TPG Internet Pty Ltd
17974	411	394	PT TELEKOMUNIKASI INDONESIA
4808	511	388	CNCGROUP IP network: China169
9443	443	370	Primus Telecommunications
4802	463	295	Wantree Development
7552	298	294	Vietel Corporation
4780	327	282	Digital United Inc.
9929	316	264	China Netcom Corp.
9394	271	258	CHINA RAILWAY Internet (CRNET)
9304	280	248	Hutchison Telecom (HK)

<http://thyme.apnic.net/current/data-CIDRnet-APNIC>

## North America Aggregation Savings Summary

ASN	No of Nets	Poss Savings	Description
11492	1209	1177	Cable One
18566	1042	1032	Covad Communications
4323	1377	1013	Time Warner Telecom
6478	927	815	AT&T Worldnet Services
22773	874	809	Cox Communications, Inc.
19262	883	732	Verizon Global Networks
5668	679	649	CenturyTel Internet Holdings,
6389	667	606	bellsouth.net, inc.
6517	637	595	Yipes Communications, Inc.
15270	605	534	PaeTec.net -a division of Pae
2386	1367	526	AT&T Data Communications Serv
6197	995	520	BellSouth Network Solutions,
19916	555	519	OLM LLC
855	554	501	Canadian Research Network
7011	1066	453	Citizens Utilities
6140	610	449	ImpSat
33588	476	444	Bresnan Communications, LLC.
3356	849	433	Level 3 Communications, LLC
7018	1419	429	AT&T WorldNet Services
20115	887	403	Charter Communications

<http://thyme.apnic.net/current/data-CIDRnet-ARIN>

## Latin America Aggregation Savings Summary

ASN	No of Nets	Poss Savings	Description
8151	1171	953	UniNet S.A. de C.V.
11830	555	546	Instituto Costarricense de El
16814	426	416	NSS, S.A.
7303	445	389	Telecom Argentina Stet-France
6471	399	359	ENTEL CHILE S.A.
14117	352	337	Telefonica del Sur S.A.
11172	397	332	Servicios Alestra S.A de C.V
10620	367	318	TVCABLE BOGOTA
22047	323	309	VTR PUNTO NET S.A.
10481	301	291	Prima S.A.
6147	258	236	Telefonica Del Peru
11556	235	231	Cable-Wireless Panama
7738	246	221	Telecomunicacoes da Bahia S.A
28573	228	204	NET Servicos de Comunicacao S.A
20299	228	197	NEWCOM AMERICAS
23216	235	184	RAMtelecom Telecomunicaciones
14522	178	172	SatNet S.A.
8163	177	167	METROTEL REDES S.A.
19169	183	164	Telconet
10834	195	154	ADVANCE TELECOMUNICACIONES S.

<http://thyme.apnic.net/current/data-CIDRnet-LACNIC>

## EU & Middle East Aggregation Savings Summary

ASN	No of Nets	Poss Savings	Description
8452	390	383	TEDATA
8866	291	267	Bulgarian Telecommunication C
5462	263	237	Telewest Broadband
8551	278	236	Bezeq International
3352	257	216	Ibernet, Internet Access Netw
9155	218	207	QualityNet AS number
12479	203	196	Uni2 Autonomous System
29357	199	195	WATANIYA TELECOM
9121	205	180	TTnet Autonomous System
3215	273	179	France Telecom Transpac
3269	235	165	TELECOM ITALIA
9198	175	165	Kazakhtelecom Data Network Ad
9116	177	150	Goldenlines main autonomous s
6830	186	145	UPC Distribution Services
29049	131	129	AzerSat LLC.
5486	144	127	Euronet Digital Communication
3300	224	125	AUCS Communications Services
5384	133	123	Emirates Internet
15471	168	115	SNR - Societatea Nationala de
16229	104	99	ThunderNet Ltd

<http://thyme.apnic.net/current/data-CIDRnet-RIPE>



# Observations

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- Range of operational “practices” between RIR regions
  - “Newer” Internet is growing rapidly
    - As is the deaggregation there
- RIPE-399 is only a recommendation
  - Hopefully all the RIRs will include pointers with each address allocation
  - Hopefully more ISPs will pay attention to it
  - Training is there — most ISPs choose to ignore it



# Conclusion

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- Make RIPE-399 your BGP good practice document