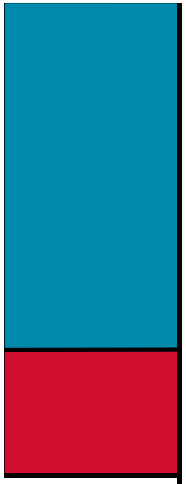
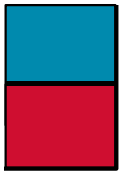


Internet Routing Table Analysis Update

Philip Smith

pfs@cisco.com

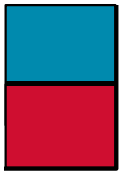
RIPE37, Amsterdam, September 2000



Internet Routing Table Analysis

- Thanks to APNIC for support
- Full view taken from NSPIXP2 in Japan
- Full BGP table

  no filters, no flap dampening
- Snapshot at 4am (+10GMT)



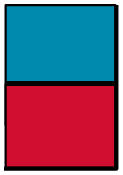
Internet Routing Table Analysis

- **All three Regional Internet Registry address and AS ranges analysed:**

  `http://www.isi.edu/in-notes/iana/assignments/as-numbers`

  `http://www.isi.edu/in-notes/iana/assignments/ipv4-address-space`

- **Exhaustive search of utilisation of former B space included**
- **AS space regionalised - historical allocations by InterNIC distributed between three regions**



Internet Routing Table Analysis

- **Results on APNIC web page**

  http://www.apnic.net/stats/bgp

- **Results to mailing lists**

  daily:

  bgp-stats@lists.apnic.net

  weekly:

  apops@lists.apnic.net

  routing-wg@ripe.net

Some Definitions

- **“available” address space**

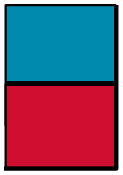
  everything except draft-manning-dsua-03.txt which lists:

  0/8, 10/8, 127/8, 169.254/16, 172.16/12, 192.0.2/24, 192.168/16 and 224/3

- **“allocated” address space**

  everything from “available” which isn’t “IANA reserved”

  currently this amounts to 51% of address space (or 112 /8s)

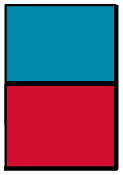


25th March summary

Global summary

Routing Report 25 March, 2000

BGP routing table entries examined	76127
Origin ASes present in the Internet Routing Table	7049
Origin ASes announcing only one prefix	2244
Transit ASes present in the Internet Routing Table	1018
Average AS path length visible in the Internet Routing Table	5.2
Max AS path length visible	13
Illegal AS announcements present in the Routing Table	5
Non-routable prefixes present in the Routing Table	0
Prefixes being announced from the IANA Reserved Address blocks	5
Number of addresses announced to Internet	1119490140
Equivalent to 66 /8s, 186 /16s and 16 /24s	
Percentage of available address space announced	30.2
Percentage of allocated address space announced	60.9
Percentage of available address space allocated	49.6

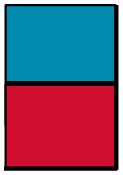


30th August summary

Global summary

Routing Report 30 August, 2000

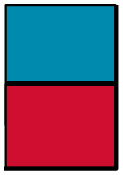
BGP routing table entries examined	87513
Origin ASes present in the Internet Routing Table	8356
Origin ASes announcing only one prefix	2824
Transit ASes present in the Internet Routing Table	1155
Average AS path length visible in the Internet Routing Table	5.3
Max AS path length visible	15
Illegal AS announcements present in the Routing Table	3
Non-routable prefixes present in the Routing Table	0
Prefixes being announced from the IANA Reserved Address blocks	1
Number of addresses announced to Internet	1167938531
Equivalent to 69 /8s, 157 /16s and 83 /24s	
Percentage of available address space announced	31.5
Percentage of allocated address space announced	61.8
Percentage of available address space allocated	51.0



25th March summary

RIPE NCC region summary

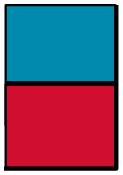
```
RIPE NCC region Report   25 March, 2000

Prefixes being announced by RIPE Region ASes                    12354
Prefixes being announced from the RIPE address blocks            9610
RIPE Region origin ASes present in the Internet Routing Table    1914
RIPE Region origin ASes announcing only one prefix                881
RIPE Region transit ASes present in the Internet Routing Table    367
Average RIPE Region AS path length visible                        5.8
    Max RIPE Region AS path length visible                         13
Number of RIPE addresses announced to Internet                66838412
    Equivalent to 3 /8s, 251 /16s and 223 /24s
    Percentage of available RIPE address space announced          66.4

RIPE AS Blocks      1877 - 1901, 2042, 2047, 2107 - 2136, 2585 - 2614
                    2773 - 2822, 2830 - 2879, 3154 - 3353, 5377 - 5631
                    6656 - 6911, 8192 - 9215, 12288 - 13311,
                    15360 - 16383
RIPE Address Blocks 62/8, 193/8, 194/7 and 212/7
```



30th August summary

RIPE NCC region summary

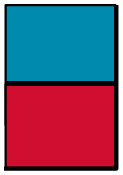
```
RIPE NCC region Report   30 August, 2000

Prefixes being announced by RIPE Region ASes                    13601
Prefixes being announced from the RIPE address blocks           10602
RIPE Region origin ASes present in the Internet Routing Table    2241
RIPE Region origin ASes announcing only one prefix               1082
RIPE Region transit ASes present in the Internet Routing Table    436
Average RIPE Region AS path length visible                        5.9
    Max RIPE Region AS path length visible                         15
Number of RIPE addresses announced to Internet                75312316
    Equivalent to 4 /8s, 125 /16s and 44 /24s
    Percentage of available RIPE address space announced          64.1

RIPE AS Blocks      1877 - 1901, 2042, 2047, 2107 - 2136, 2585 - 2614
                    2773 - 2822, 2830 - 2879, 3154 - 3353, 5377 - 5631
                    6656 - 6911, 8192 - 9215, 12288 - 13311
                    15360 - 16383
RIPE Address Blocks 62/8, 193/8, 194/7, 212/7 and 217/8
```



30th August summary

APNIC region summary

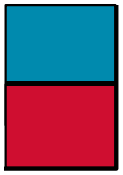
```
APNIC region Report   30 August, 2000

Prefixes being announced by APNIC Region ASes                  13301
Prefixes being announced from the APNIC address blocks         11802
APNIC Region origin ASes present in the Internet Routing Table   991
APNIC Region origin ASes announcing only one prefix              351
APNIC Region transit ASes present in the Internet Routing Table  164
Average APNIC Region AS path length visible                      5.1
    Max APNIC Region AS path length visible                       12
Number of APNIC addresses announced to Internet              53457435
    Equivalent to 3 /8s, 47 /16s and 178 /24s
    Percentage of available APNIC address space announced       62.9

APNIC AS Blocks        4608 - 4864, 7467 - 7722, 9216 - 10239
APNIC Address Blocks   61/8, 202/7 and 210/7
```



30th August summary

ARIN region summary

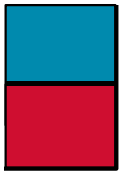
```
ARIN region Report   30 August, 2000

Prefixes being announced by ARIN Region ASes                    60165
Prefixes being announced from the ARIN address blocks           40931
ARIN Region origin ASes present in the Internet Routing Table    5047
ARIN Region origin ASes announcing only one prefix               1391
ARIN Region transit ASes present in the Internet Routing Table    548
Average ARIN Region AS path length visible                        5.2
    Max ARIN Region AS path length visible                         14
Number of ARIN addresses announced to Internet              159804518
    Equivalent to 9 /8s, 134 /16s and 108 /24s
    Percentage of available ARIN address space announced         73.3

ARIN AS Blocks      1 - 1876, 1902 - 2042, 2044 - 2046, 2048 - 2106
                    2138 - 2584, 2615 - 2772, 2823 - 2829, 2880 - 3153
                    3354 - 4607, 4865 - 5119, 5632 - 6655, 6912 - 7466
                    7723 - 8191, 10240 - 12287, 13312 - 15359
                    16384 - 17407
ARIN Address Blocks 63/8, 64/7, 66/8, 199/8, 200/8, 204/6, 208/7
                    and 216/8
```



RIPE NCC Region routing table

RIPE NCC region per AS prefix count summary

ASN	No of nets	/19 equiv	Description
3301	389	297	TeliaNet Sweden
1257	337	264	Swipnet AB
1270	249	397	UUNET Germany
1849	249	337	PIPEX
702	209	381	UUNET Technologies, Inc.
1275	186	914	DFN IP Service
786	181	959	JANET IP Service
719	178	145	LANLINK
5515	171	354	Sonera Finland
517	156	183	Xlink
3320	156	315	Deutsche Telekom AG
3215	130	133	RAIN
2609	128	4	EUnet-TN
9057	128	42	Level 3 public IP n
2856	125	263	BTnet UK Regional network
3303	122	285	Swisscom
8895	114	28	Saudi Arabia AS
1901	101	76	EUnet Austria
1267	93	955	IUnet S.p.A



APNIC Region routing table

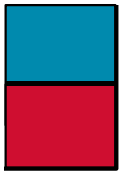
APNIC Region per AS prefix count summary

ASN	No of nets	/19 equiv	Description
1221	911	976	Telstra
2764	460	129	connect.com.au pty ltd
4740	386	88	Ozemail
2907	373	885	SINET Japan
7657	349	15	The Internet Group Limited
4755	319	130	VSNL India
4763	207	43	Telstra New Zealand
9269	205	23	Hong Kong CTI
4618	199	56	Internet Thailand
7545	169	6	TPG Internet Pty Ltd
7474	168	58	Optus Communications
4433	163	125	Access One Pty Ltd
703	155	75	UUNET Technologies, Inc.
9706	150	5	Pusan Metropolitan City Offic
4786	136	7	NetConnect Communications Pty
7496	132	8	Power Up
4134	131	330	Data Communications Bureau
9304	127	15	Hutchcity
7617	122	34	One.Net Pty Ltd

ARIN Region routing table

ARIN Region per AS prefix count summary

ASN	No of nets	/19 equiv	Description
701	2021	5461	UUNET Technologies, Inc.
705	985	47	UUNET Technologies, Inc.
1	920	4511	BBN Planet
7018	808	3073	AT&T
2914	743	1365	Verio, Inc.
1239	683	1593	Sprint ICM-Inria
7046	680	506	UUNET Technologies, Inc.
1785	668	819	Sprint ICM
3561	626	1527	Cable & Wireless USA
174	600	2756	PSINet Inc.
816	520	171	UUNET Canada4
3549	494	427	Frontier GlobalCenter
271	470	380	BCnet Backbone
3908	448	278	Supernet, Inc.
209	444	397	Qwest
3602	435	79	Sprint Canada
4293	422	55	Cable & Wireless USA
2548	410	519	Digital Express Group, Inc.
8151	331	188	UniNet S.A. de C.V.



Global routing table

Global per AS prefix count summary

ASN	No of nets	/19 equiv	Description
701	2021	5461	UUNET Technologies, Inc.
705	985	47	UUNET Technologies, Inc.
1	920	4511	BBN Planet
1221	911	976	Telstra
7018	808	3073	AT&T
2914	743	1365	Verio, Inc.
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7046	680	506	UUNET Technologies, Inc.
1785	668	819	Sprint ICM
3561	626	1527	Cable & Wireless USA
174	600	2756	PSINet Inc.
816	520	171	UUNET Canada4
3549	494	427	Frontier GlobalCenter
271	470	380	BCnet Backbone
2764	460	129	connect.com.au pty ltd
3908	448	278	Supernet, Inc.
209	444	397	Qwest
3602	435	79	Sprint Canada
4293	422	55	Cable & Wireless USA

E-mail output - miscellaneous

List of Illegal AS's

Bad AS	Designation	Network	Transit AS	Description
64602	PRIVATE	63.236.57.0/24	209	Qwest
64601	PRIVATE	63.236.90.0/24	209	Qwest
64605	PRIVATE	208.47.206.0/24	209	Qwest

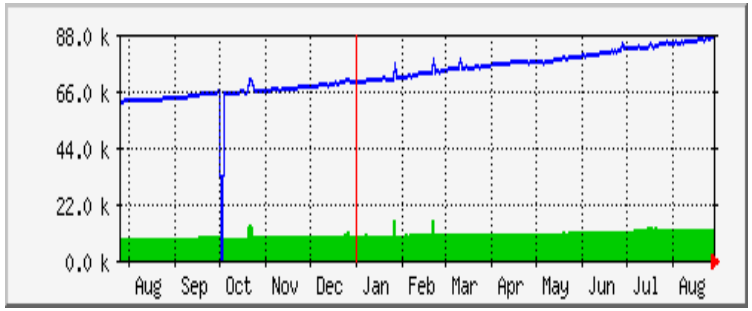
Advertised IANA Reserved Addresses

Network	Origin AS	Description
220.10.56.0/24	3215	RAIN

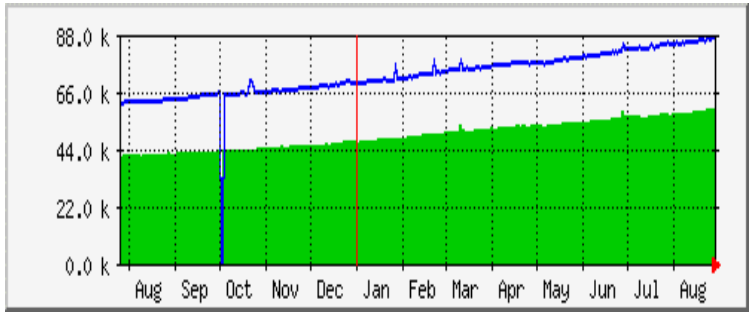
Number of prefixes announced by prefix length

/1:0	/2:0	/3:0	/4:0	/5:0	/6:0
/7:0	/8:22	/9:4	/10:5	/11:9	/12:26
/13:53	/14:178	/15:290	/16:6611	/17:922	/18:1800
/19:5843	/20:3584	/21:3718	/22:5646	/23:7540	/24:50454
/25:145	/26:199	/27:82	/28:68	/29:92	/30:119
/31:0	/32:103				

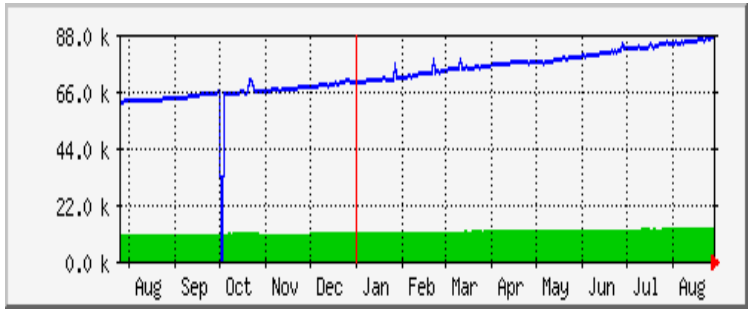
Internet Routing Table size



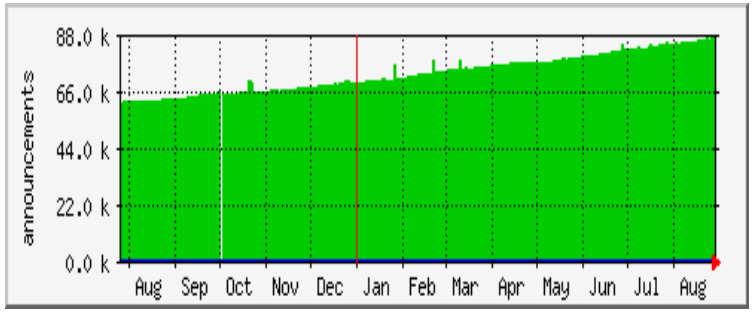
APNIC



ARIN

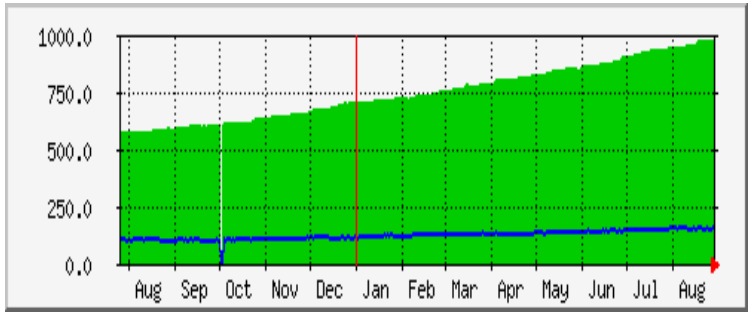


RIPE NCC

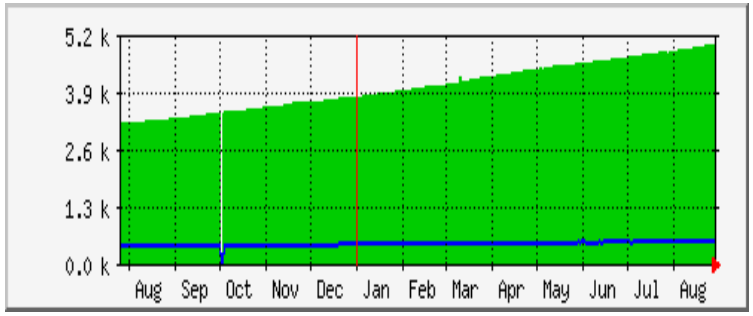


Global

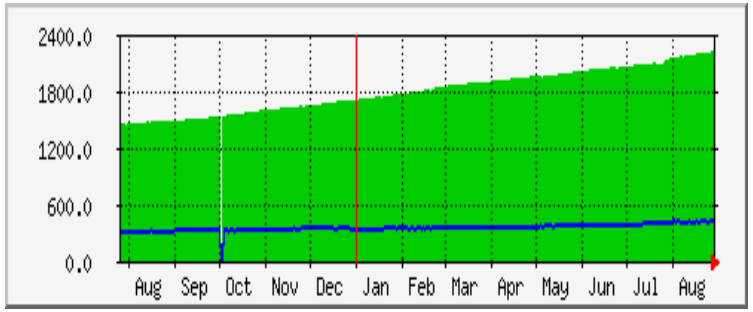
origin versus transit ASes



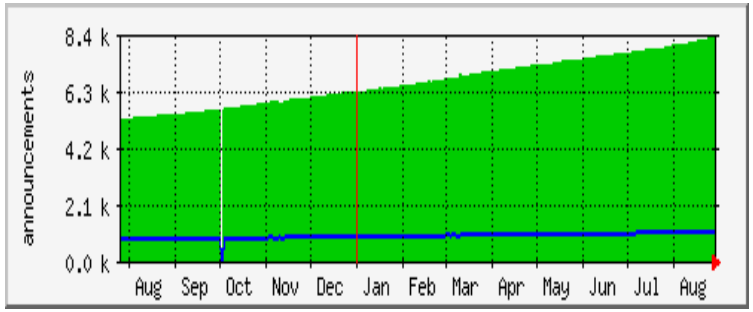
APNIC



ARIN

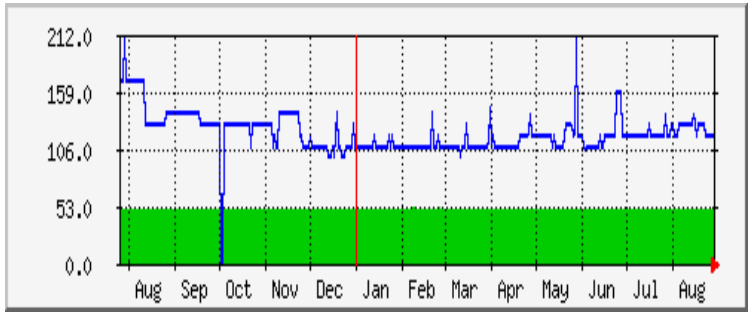


RIPE NCC

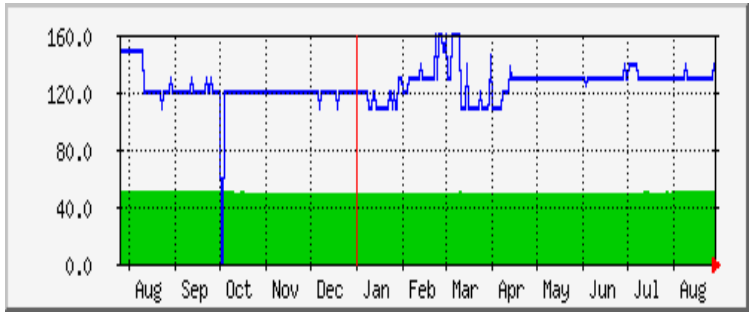


Global

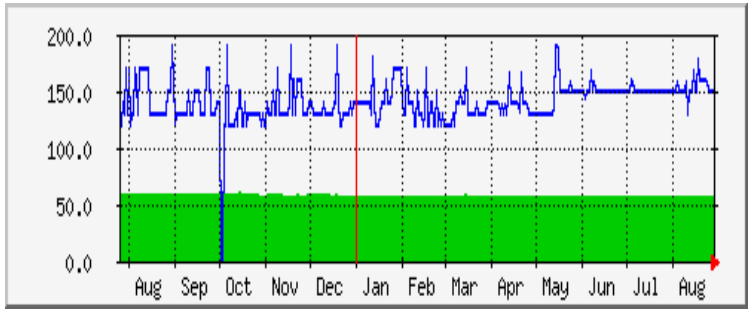
average versus maximum AS path length



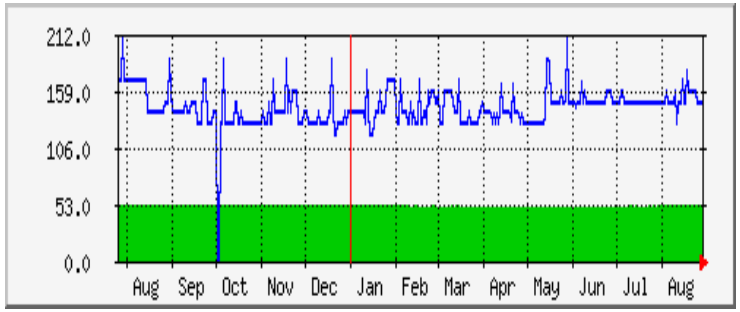
APNIC



ARIN

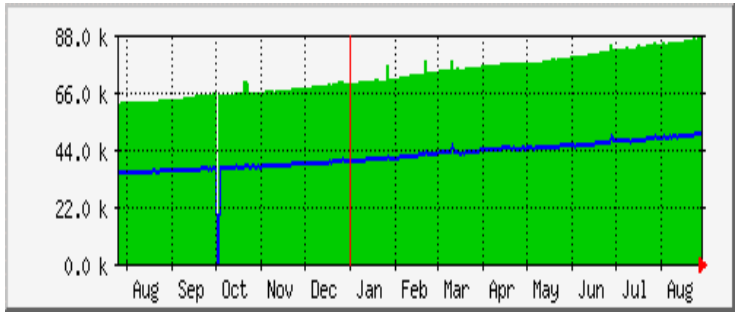


RIPE NCC

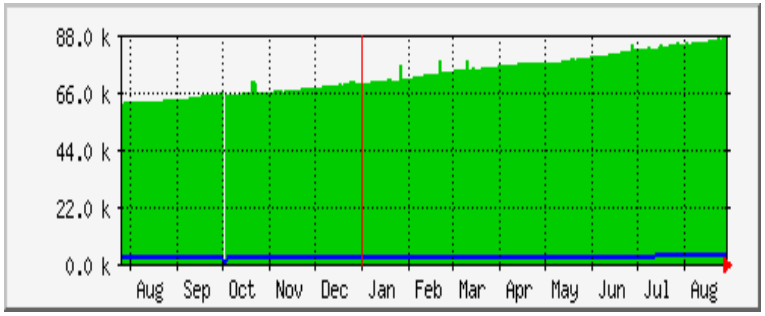


Global

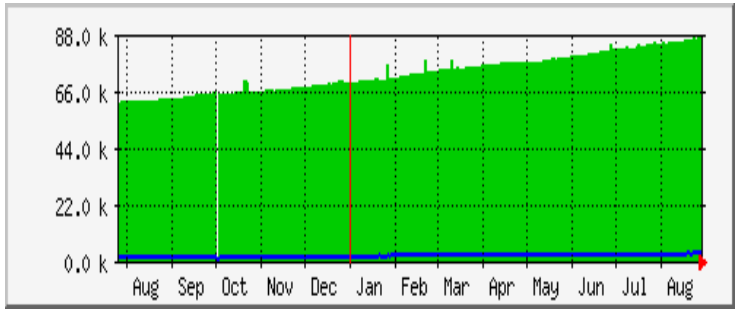
Relative prefix sizes



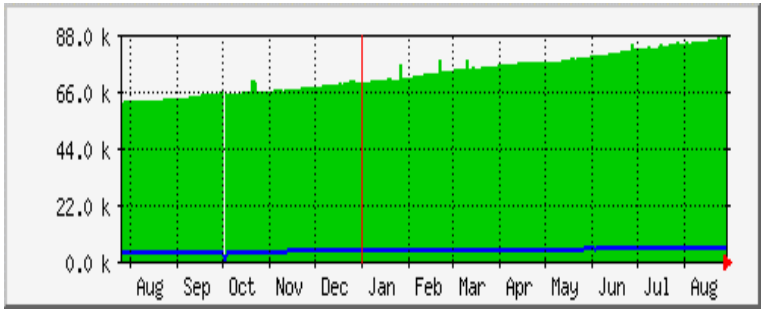
/24s



/21s



/20s



/19s

Observations

- **Current routing table growth rate**

  63600 prefixes on 30-08-1999

  74200 prefixes on 29-02-2000

  87500 prefixes on 30-08-2000

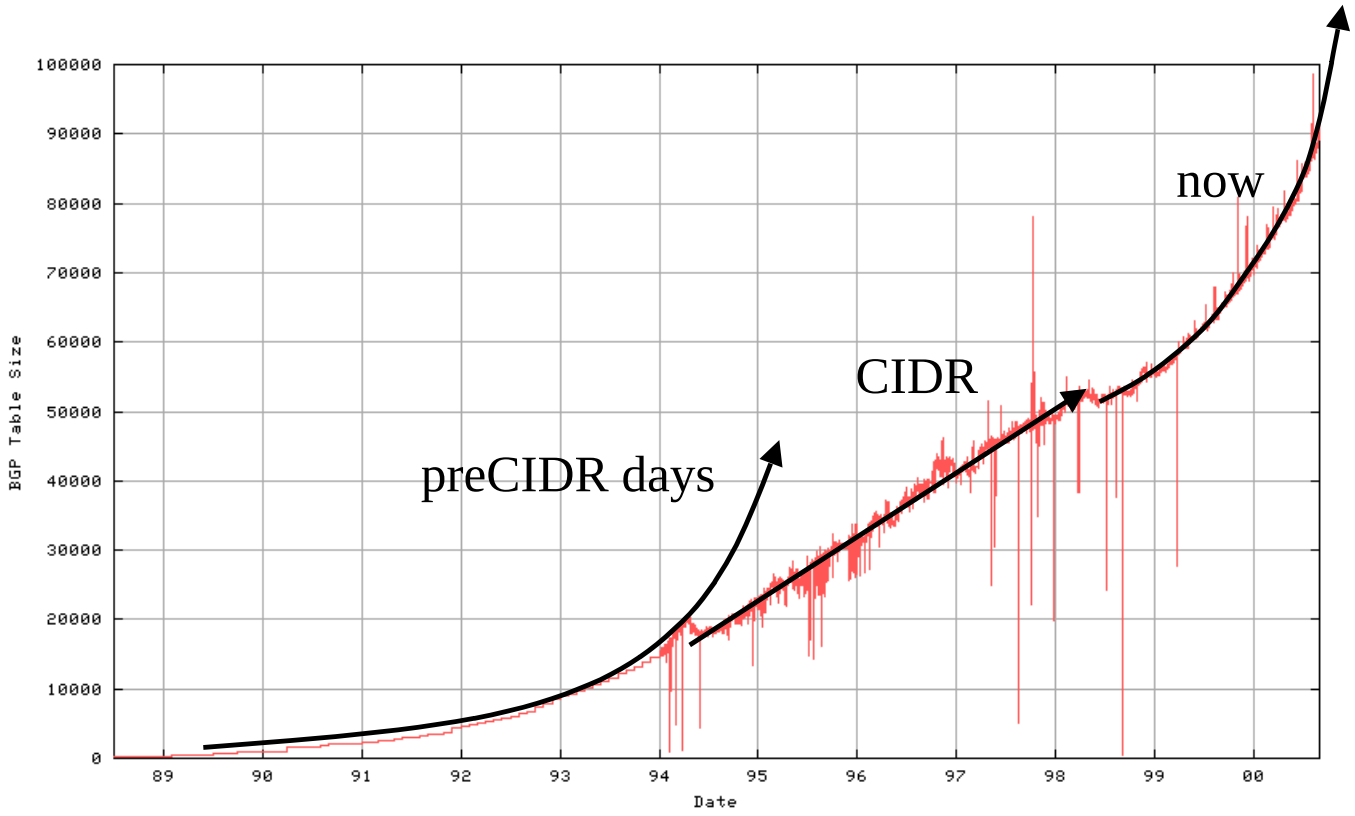
  routing table will reach 100k prefixes by end December 2000

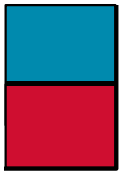
  6 months ago, my prediction was September 2001

  exponential growth has returned

- **Is this a problem?**

www.telstra.net/ops/bgptable.html





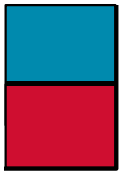
Observations

- **51% of total useable IPv4 address space is allocated**

  equivalent to ~112 /8s

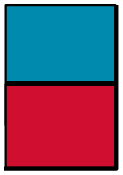
- **Only 61.8% of allocated IPv4 space is announced to the Internet (~68 /8s)**

  where is the rest???



Observations

- **Current AS growth rate**
  - **6000 ASNs on 30-08-1999**
  - **6780 ASNs on 29-02-2000**
  - **8360 ASNs on 30-08-2000**
  - **will reach 10K ASNs by December 2000**
  - **previous prediction July 2001**
- **Around 17000 ASNs have been assigned as of 30/08/2000**
  - **8360 are in use on the Internet**
  - **where are the rest???**

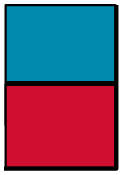


Observations

- **/24s announced to Internet**
  - **36300 on 30-08-1999**
  - **42800 on 29-02-2000**
  - **50500 on 30-08-2000**
  - **8300 new /24s compared with total of 13300 new prefix announcements in last 6 months**
  - **Why? Multihoming? Laziness?**

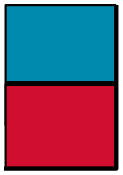
Observations

- **/21s, /22s and /23s announced**
  - **11920 on 30-08-1999, 14904 on 29-02-2000**
  - **16900 on 30-08-2000**
  - **2000 new /21s, /22s and /23s in last 6 months**
- **No obvious impact of ARIN and APNIC min allocation of /20**
  - **2180 on 30-08-2000, 2740 on 29-02-2000**
  - **3584 on 30-08-2000**



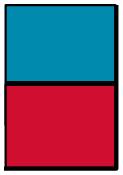
Observations

- **Internet AS Path Length in last 6 months**
  - **average is constant at 5.3 ASNs**
  - **maximum length fluctuated from 11 to 25 ASNs!**



What about…?

- African Regional Registry
- Latin American and Caribbean Regional Registry
- Same statistics produced for those two future registry regions
  - work out location of ASes and calculate accordingly



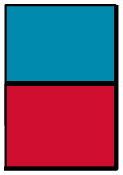
30th August summary

African summary

```
Routing Report   30 August, 2000

Prefixes being announced by AFRINIC Region ASes:                  671
Prefixes being announced from the AFRINIC address blocks:           0
AFRINIC Region origin ASes present in the Internet Routing Table:  45
AFRINIC Region origin ASes announcing only one prefix:             15
AFRINIC Region transit ASes present in the Internet Routing Table:  5
Average AFRINIC Region AS path length visible:                   4.9
    Max AFRINIC Region AS path length visible:                     7
Number of AFRINIC addresses announced to Internet:                 0
    Equivalent to 0 /8s, 0 /16s and 0 /24s
    Percentage of available AFRINIC address space announced:     0.0

AFRINIC AS Blocks       none as yet
AFRINIC Address Blocks  none as yet
```



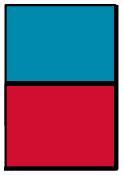
30th August summary

Central+Southern American summary

```
Routing Report   30 August, 2000

Prefixes being announced by LACNIC Region ASes:                    3952
Prefixes being announced from the LACNIC address blocks:              0
LACNIC Region origin ASes present in the Internet Routing Table:    321
LACNIC Region origin ASes announcing only one prefix:               114
LACNIC Region transit ASes present in the Internet Routing Table:    52
Average LACNIC Region AS path length visible:                       5.7
    Max LACNIC Region AS path length visible:                        10
Number of LACNIC addresses announced to Internet:                     0
    Equivalent to 0 /8s, 0 /16s and 0 /24s
    Percentage of available LACNIC address space announced:         0.0

LACNIC AS Blocks        none as yet
LACNIC Address Blocks   none as yet
```



African routing table

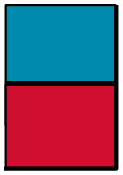
African per AS prefix count summary

ASN	No of nets	/19 equiv	Description
3741	270	353	The Internet Solution ZA
2018	84	100	Foundation for Research Devel
2905	71	128	The Internetworking Company o
5713	43	93	Telkom SA Ltd
6083	18	17	Olivetti Africa
6127	15	13	Information and Decision Supp
7390	15	2	National Lan Suppliers
8452	14	0	GEGA NET Autonomous System
6089	13	3	Intertech Systems
6713	13	7	Itissalat Al-MAGHRIB
6180	11	0	Network Information Services
8524	11	1	AUCEGYPT Autonomous System
10798	11	0	Standard Bank of South Africa
11569	11	10	satellite data networks
11845	8	1	Data Pro Business Online
5710	6	12	Global internet Access CC
8346	6	2	SONATEL-AS Autonomo
13519	5	0	MEDIAPOST CC
5536	4	1	Internet Egypt Network

Southern American routing table

Central+South American per AS prefix count summary

ASN	No of nets	/19 equiv	Description
8151	331	188	UniNet S.A. de C.V.
6429	210	54	RdC Internet
10834	131	25	ADVANCE TELECOMUNICACIONES S.
6503	128	85	AVANTEL, S.A.
4926	94	11	Telintar S.A.
1916	78	273	Fundacao de Amparo a Pesquisa
2277	78	10	ECUANET - CORPORACION ECUATOR
7418	77	39	Proveedora de Servicios de Co
6471	75	44	ENTEL CHILE S.A.
6140	70	14	IMPSAT ARGENTINA, S.A.
1840	61	10	Universidad de las Americas
7993	59	4	Global One Chile
13999	58	2	Mega Cable S.A. de C.V.
7984	57	11	Global One Colombia
4270	54	15	Red de Interconexion Universi
5704	53	3	Caribbean Internet Service, C
3632	49	21	CONACYT Consejo Nacional de C
11992	49	2	Integrated Systems
11415	47	6	IMPSAT Comunicacoes Ltda



Final Slide...

- **Routing table growing exponentially (again)**
  - **should we care, or worry?**
  - **those /24s - arrgh!**
- **AS assignment accelerating**
  - **more multihoming?**
- **What other stats would be interesting?**
- **Any comments?**