

Measuring IPv6 Network Quality

1 dual-stack node discovery

Table 1: IPv6 prefixes extracted

| prefix | prefix use | 2004/06 | 2004/08 | 2005/01 |
|-----------|--------------------------------|---------|---------|---------|
| 2001::/16 | Aggregatable Global Unicast | 6,585 | 6,665 | 4,394 |
| 3ffe::/16 | 6bone | 1,762 | 1,459 | 291 |
| 2002::/16 | 6to4 | 241 | 216 | 112 |
| ::ffff/96 | IPv4-mapped IPv6 address | 97 | 43 | 6 |
| ::/96 | IPv4 compatible IPv6 address | 31 | 9 | 1 |
| fe80::/10 | Link-local Unicast | 6 | 11 | 2 |
| fec0::/10 | Site-local Unicast | 2 | - | - |
| other | reserved or unassigned address | 3,110 | 154 | 32 |

Table 2: IPv6 prefixes by country code (June 2004)

| | | | | | |
|---------|-------|-------|-------|------|------|
| JP:1155 | ID:79 | NO:34 | KR:17 | LU:9 | PH:4 |
| NL:497 | FI:68 | CZ:30 | MY:17 | RU:8 | TN:4 |
| US:464 | IT:68 | DK:29 | BR:16 | TH:8 | YU:4 |
| DE:431 | SK:68 | TW:27 | HU:13 | ZA:8 | AR:2 |
| FR:251 | CH:59 | AT:25 | LT:13 | BE:6 | RO:2 |
| UK:186 | PL:57 | EU:21 | CN:10 | SG:6 | CL:1 |
| CA:144 | AU:41 | EE:18 | MX:10 | GR:4 | IL:1 |
| SE:93 | IE:39 | PT:18 | ES:9 | HK:4 | |

Table 3: IPv6 prefixes by country code (August 2004)

| | | | | | |
|---------|-------|-------|-------|------|------|
| JP:1212 | ID:77 | NO:31 | PT:18 | ES:9 | YU:4 |
| NL:483 | SK:66 | EU:30 | MY:16 | LU:9 | GR:3 |
| US:480 | FI:64 | CZ:29 | HU:13 | ZA:8 | TN:3 |
| DE:419 | IT:63 | DK:28 | LT:13 | RU:8 | RO:2 |
| FR:219 | CH:58 | TW:27 | BR:12 | SG:5 | IL:1 |
| UK:203 | PL:57 | EE:26 | TH:10 | HK:4 | CL:1 |
| CA:125 | AU:43 | AT:24 | CN:9 | BE:4 | AR:1 |
| SE:88 | IE:41 | KR:18 | MX:9 | PH:4 | |

Table 4: IPv6 prefixes by country code (January 2005)

| | | | | | |
|--------|-------|-------|-------|------|------|
| JP:846 | CA:44 | AU:26 | EU:15 | BE:4 | YU:2 |
| US:193 | FI:43 | IE:26 | EE:13 | TH:4 | MX:2 |
| NL:165 | CH:39 | TW:21 | HU:12 | HK:3 | ZA:1 |
| DE:134 | IT:39 | DK:19 | MY:9 | SG:3 | RO:1 |
| UK:112 | PL:38 | CZ:18 | RU:8 | PH:3 | IL:1 |
| FR:107 | SK:36 | CN:16 | BR:7 | GR:2 | IN:1 |
| ID:49 | AT:32 | PT:16 | ES:6 | TN:2 | AR:1 |
| SE:46 | NO:28 | KR:15 | LT:5 | HR:2 | |

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Table 5: the numbers of unreachable and reachable nodes (June 2004)

| IPv6 | | unreach | unreach | OK | OK |
|-------|----------------|---------------|----------------|----------------|-----------------|
| IPv4 | | unreach | OK | unreach | OK |
| total | 4086 (100%) | 370 (9.0%) | 634 (15.5%) | 384 (9.4%) | 2698 (66.0%) |
| jp | 1155 (100%) | 83 (7.2%) | 126 (10.9%) | 72 (6.2%) | 874 (75.7%) |
| apnic | 213 (100%) | 37 (17.4%) | 28 (13.2%) | 68 (31.9%) | 80 (37.6%) |
| arin | 645 (100%) | 80 (12.4%) | 168 (26.1%) | 38 (5.9%) | 359 (55.7%) |
| ripe | 2042 (100%) | 162 (7.9%) | 306 (15.0%) | 204 (10.0%) | 1370 (67.1%) |

Table 6: the numbers of unreachable and reachable nodes (August 2004)

| IPv6 | | unreach | unreach | OK | OK |
|-------|----------------|----------------|----------------|---------------|-----------------|
| IPv4 | | unreach | OK | unreach | OK |
| total | 4081 (100%) | 446 (10.9%) | 608 (14.9%) | 359 (8.8%) | 2668 (65.4%) |
| jp | 1212 (100%) | 103 (8.5%) | 116 (9.6%) | 80 (6.6%) | 913 (75.3%) |
| apnic | 213 (100%) | 35 (16.4%) | 27 (12.7%) | 68 (31.9%) | 83 (39.0%) |
| arin | 636 (100%) | 91 (14.3%) | 149 (23.4%) | 33 (5.2%) | 363 (57.1%) |
| ripe | 1989 (100%) | 213 (10.7%) | 304 (15.3%) | 177 (8.9%) | 1295 (65.1%) |

Table 7: the numbers of unreachable and reachable nodes (January 2005)

| IPv6 | | unreach | unreach | OK | OK |
|-------|----------------|---------------|----------------|---------------|-----------------|
| IPv4 | | unreach | OK | unreach | OK |
| total | 2224 (100%) | 130 (5.9%) | 434 (19.5%) | 168 (7.6%) | 1492 (67.1%) |
| jp | 846 (100%) | 46 (5.4%) | 81 (9.6%) | 50 (5.9%) | 669 (79.1%) |
| apnic | 150 (100%) | 22 (14.7%) | 22 (14.7%) | 34 (22.7%) | 72 (48.0%) |
| arin | 248 (100%) | 14 (5.7%) | 68 (27.4%) | 10 (4.0%) | 156 (62.9%) |
| ripe | 961 (100%) | 48 (5.0%) | 256 (26.6%) | 73 (7.6%) | 584 (60.8%) |

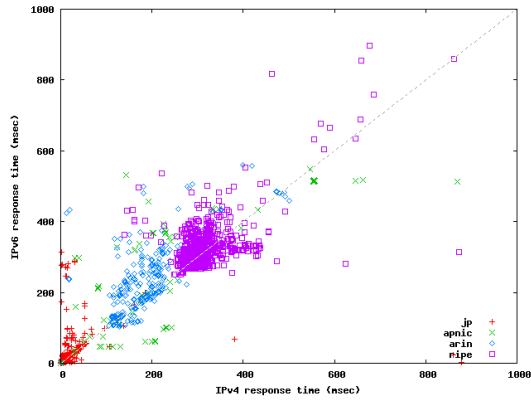


Figure 1: dual-stack ping results from WIDE (June 2004)

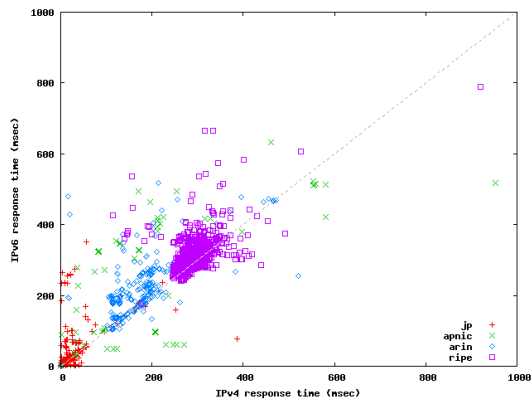


Figure 2: dual-stack ping results from WIDE (August 2004)

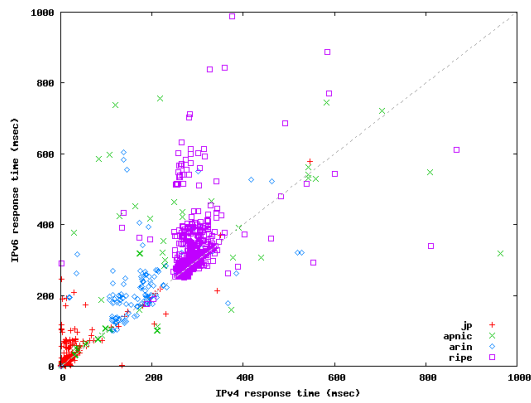


Figure 3: dual-stack ping results from WIDE (January 2005)

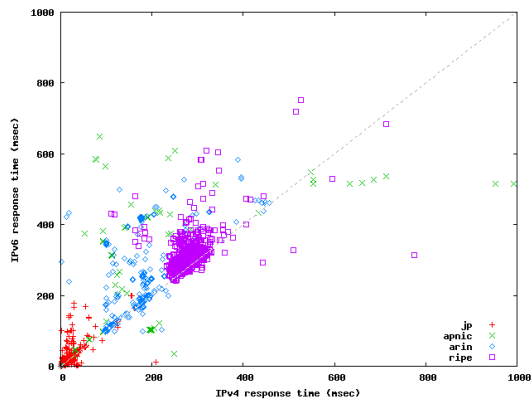


Figure 4: dual-stack ping results from IIJ (June 2004)

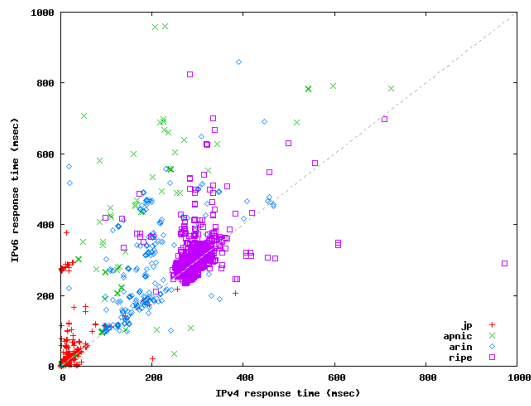


Figure 5: dual-stack ping results from IIJ (August 2004)

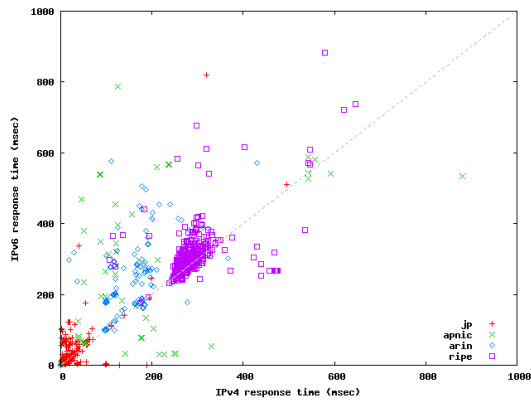


Figure 6: dual-stack ping results from IIJ (January 2005)

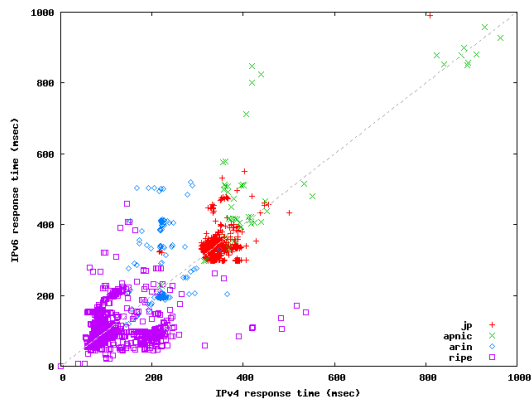


Figure 7: dual-stack ping results from ES (June 2004)

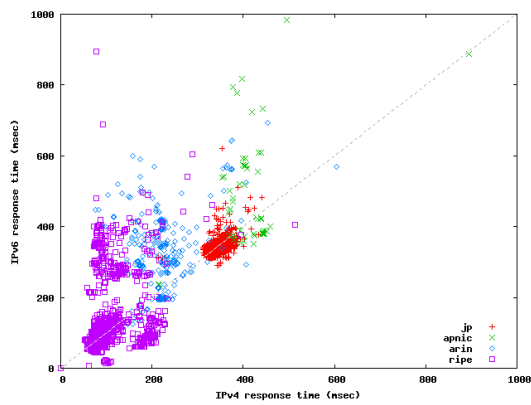


Figure 8: dual-stack ping results from ES (August 2004)

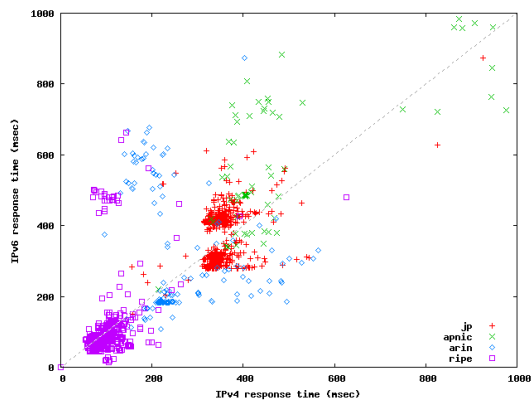


Figure 9: dual-stack ping results from ES (January 2005)

Table 8: distribution of Path MTU (June 2004)

| PMTU | IPv4 | | | IPv6 | | |
|---------|------|-----|-----|------|-----|-----|
| | WIDE | IIJ | ES | WIDE | IIJ | ES |
| 1500 | 815 | 751 | 732 | 166 | 76 | 33 |
| 1492 | 6 | 6 | 8 | - | - | - |
| 1480 | 2 | 2 | 1 | 163 | 96 | 15 |
| 1476 | 3 | 1 | 1 | 16 | 2 | - |
| 1472 | 1 | 1 | 1 | 1 | - | - |
| 1456 | - | - | 1 | - | - | - |
| 1454 | 92 | 95 | 82 | - | - | - |
| 1450 | - | - | - | 2 | 2 | - |
| 1448 | 2 | 2 | 2 | - | - | - |
| 1446 | 1 | 1 | 1 | - | - | - |
| 1400 | - | - | 1 | - | - | - |
| 1280 | 1 | 1 | 1 | 511 | 622 | 500 |
| 1258 | 1 | - | 1 | - | - | - |
| unknown | 46 | 43 | 44 | 29 | 21 | 83 |
| unreach | 421 | 417 | 433 | 547 | 501 | 679 |

Table 9: distribution of Path MTU (August 2004)

| PMTU | IPv4 | | | IPv6 | | |
|---------|------|-----|-----|------|-----|-----|
| | WIDE | IIJ | ES | WIDE | IIJ | ES |
| 16436 | - | - | 1 | - | - | 1 |
| 1500 | 732 | 726 | 777 | 200 | 40 | 96 |
| 1492 | 5 | 6 | 5 | - | - | - |
| 1480 | 3 | 3 | 1 | 181 | 39 | 306 |
| 1476 | 2 | 2 | 2 | 21 | 1 | 56 |
| 1472 | - | - | 1 | - | - | 1 |
| 1464 | - | - | 1 | - | - | - |
| 1450 | - | - | - | - | - | 2 |
| 1454 | 92 | 94 | 68 | - | - | - |
| 1450 | - | - | - | 2 | - | - |
| 1448 | 1 | 1 | 1 | - | - | - |
| 1446 | - | - | 1 | - | - | - |
| 1444 | - | - | - | - | - | 1 |
| 1280 | 2 | 2 | 1 | 395 | 694 | 269 |
| 1258 | 1 | 1 | 1 | - | - | - |
| unknown | 37 | 34 | 41 | 28 | 22 | 43 |
| unreach | 443 | 426 | 442 | 492 | 499 | 568 |

Table 10: distribution of Path MTU (January 2005)

| PMTU | IPv4 | | | IPv6 | | |
|---------|------|-----|-----|------|-----|-----|
| | WIDE | IIJ | ES | WIDE | IIJ | ES |
| 16436 | - | - | 1 | - | - | 1 |
| 1500 | 645 | 623 | 659 | 122 | 67 | 133 |
| 1499 | - | - | - | - | - | 1 |
| 1492 | 4 | 4 | 9 | - | - | - |
| 1480 | 3 | 2 | 3 | 112 | 63 | 134 |
| 1479 | - | - | - | - | - | 1 |
| 1476 | 2 | 2 | 3 | 9 | - | 63 |
| 1475 | - | - | - | - | - | 1 |
| 1472 | - | - | 1 | - | - | - |
| 1464 | - | - | 1 | - | - | - |
| 1460 | - | - | 1 | - | - | - |
| 1456 | - | - | 1 | - | - | - |
| 1454 | 90 | 90 | 79 | - | - | 1 |
| 1452 | - | 1 | 3 | 5 | 5 | 1 |
| 1448 | 1 | 1 | 1 | - | - | - |
| 1428 | - | - | 1 | - | - | - |
| 1280 | 1 | 2 | 2 | 426 | 571 | 191 |
| 1278 | - | - | - | - | - | 1 |
| 1258 | 1 | 1 | 1 | - | - | - |
| 1224 | - | - | - | - | - | 1 |
| 1005 | - | - | - | - | - | 1 |
| unknown | 36 | 26 | 19 | 19 | 14 | 15 |
| unreach | 367 | 389 | 364 | 459 | 422 | 598 |