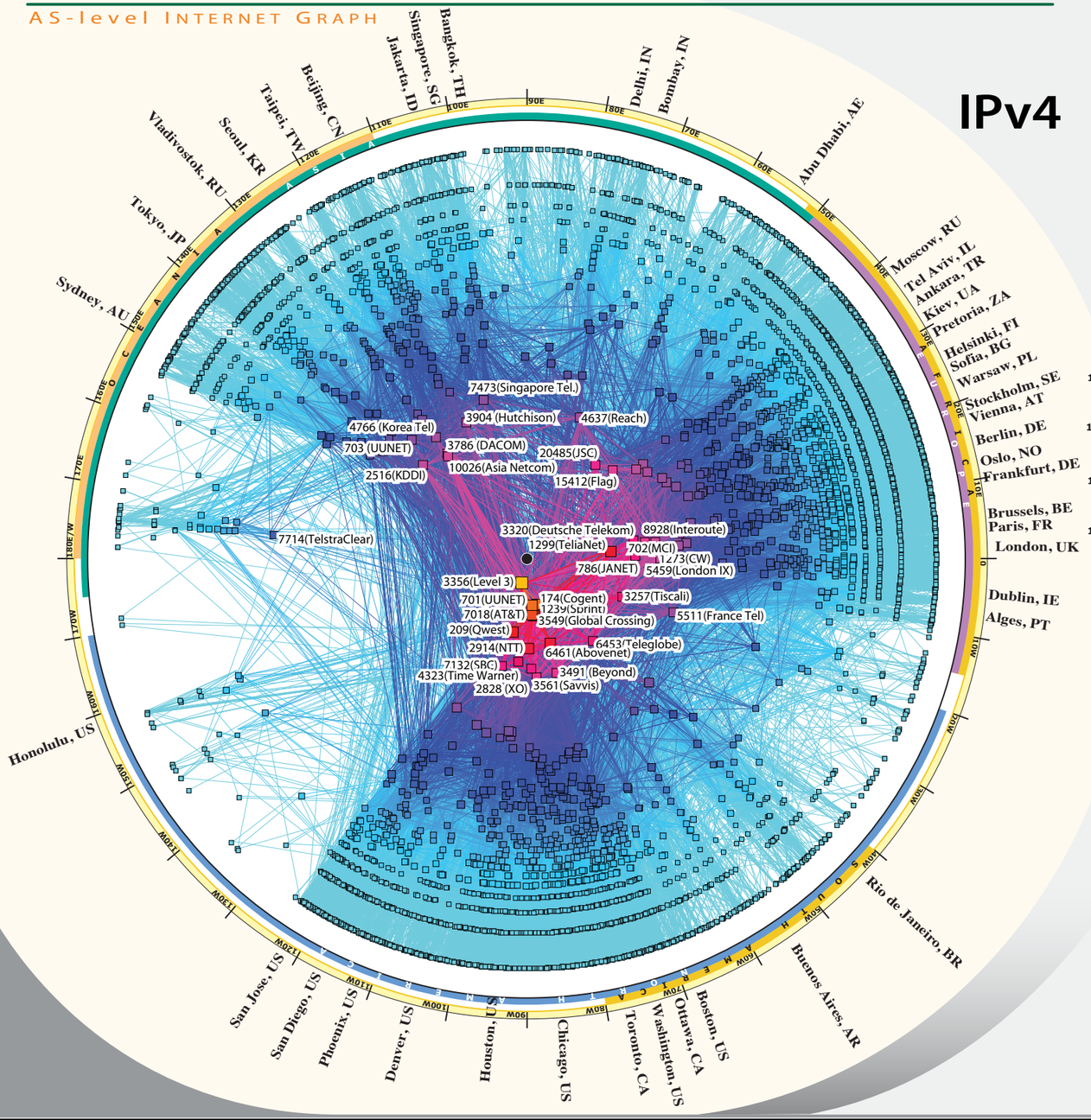
IPv4 & IPv6 INTERNET TOPOLOGY MAP JANUARY 2008

AS-level INTERNET GRAPH

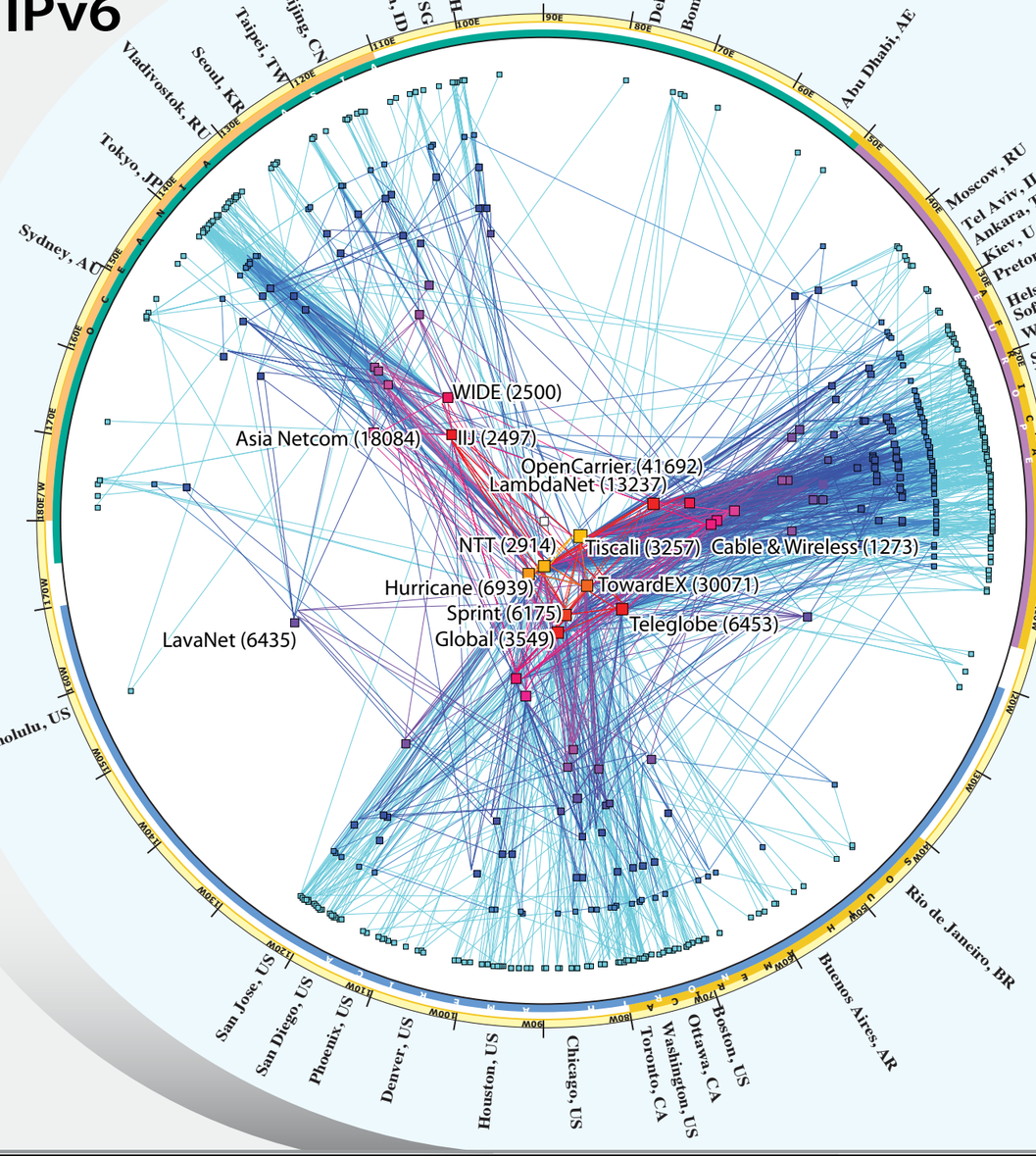
IPv4



Peering: OutDegree

1845	157
1614	137
1383	117
1153	98
922	78
691	58
461	39
230	19
0	0

IPv6



	Dates	Number of IP address	Number of IP links	Number of ASes	Number of ASlinks
IPv4	Jan. 2nd-17th, 2008	4,853,991	5,682,419	17,791	50,333
IPv6	Jan. 1st-8th, 2008	4,752	17,036	489	1,904

ANALYSIS TEAM . Bradley Huffaker . kc claffy
SOFTWARE DEVELOPMENT Young Hyun . Matthew Luckie
POSTER DESIGN Jennifer Hsu

COOPERATIVE ASSOCIATION FOR INTERNET DATA ANALYSIS
San Diego Supercomputer Center . University of California, San Diego
500 Gilman Drive, mc0505 . La Jolla, CA 92093-0505 . 858-534-5000 . http://www.caida.org/

ARK HOSTS . AARNet . APAN . ARIN . ASTI Institute . CANET . CENIC . CNRST . ELTENET . FunkFeuer . HEANet . Iowa State University . KREONet2 . Purdue University . RNP . TKK . Universitat Leipzig . Universitat Politecnica . University of Cambridge . University of Hawaii . University of Waikato

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http://www.caida.org/research/topology/as_core_network/

This visualization represents macroscopic snapshots of the IPv4 and IPv6Internet topologies observed during the first week of January 2008.It simultaneously illustrates the peering richness of each topology and the worldwide distribution of nodes in each routing system.

The IPv4 data was collected between January 2nd and 17th 2008 by 13 CAIDA archipelago monitors located in 13 different cities, 11 countries, and 3continents. The monitors probed paths toward 48M /24 networks spread across 95% of the prefixes seen in Route Views Border Gateway Protocol (BGP) routing tables on 1 January 2008.

The IPv6 data was collected between January 1st and 8th 2008 by volunteers responding to a request sent to the North American Network Operators' Group (NANOG) mailing list. There were 56 contributors, in 53 different cities, 9 countries, and 3 continents. They used the scamper command-line tool to probe 2,358 IPv6 destinations spread across 822 prefixes or 81% of the prefixes seen by RIPE NCC on 1 January 2008.

We aggregated these network views to construct IPv4 and IPv6 Internet graphs at the Autonomous System (AS) level. Each AS approximately corresponds to an Internet Service Provider (ISP). We map each IP address to the AS responsible for routing traffic to it, i.e., to the origin (end-of-path) AS for the IP prefix representing the best match of this address in BGP routing tables. For the IPv4 graph we used the BGP IPv4 routing table collected by Route Views. For the IPv6 graph we used the IPv6 routing table collected by RIPE NCC.

The position of each AS node is plotted in polar coordinates, position (radius, angle) calculated using the following equations:

$$\text{radius} = 1 - \log\left(\frac{\text{outdegree(AS)} + 1}{\text{maximum.outdegree} + 1}\right)$$

$$\text{angle} = \left(\text{longitude of the AS's BGP prefixes in netacq}\right)$$

The outdegree of an AS node is the number of next-hop ASes that were observed accepting our probe traffic from this AS. The link color reflects outdegree, from lowest (blue) to highest (yellow). Toward the center of the graph we have manually labeled some of the higher degree ASes with their associated ISPs.

To determine the longitude of ASes, we used the IPv4 BGP table from Route Views and mapped each AS to its set of announced IPv4 prefixes. (IPv4 tables are currently much larger, facilitating more accurate inference of geographic coverage of an AS.) We subdivided prefixes into the smallest prefixes that Digital Envoy's Netacuity (R) mapped to a single geographic location in January 2008. We calculated the AS angle coordinate from the weighted average (by number of IP addresses in each mapped prefix) of the longitude coordinates of these prefixes.

The IPv6 graph with 486 ASes remains much smaller than the IPv4 graph with 18,753 ASes. While the IPv4 graph's central core is still dominated by American ASes, the IPv6 graph center is more balanced between America and Europe. A European ISP Tiscali (3257) has replaced the previously highest ranking AS, NTT (2914), since our last IPv6 Internet AS core graph in 2005. Although NTT is a Japanese telecommunication company, the address space it uses for AS 2914 comes from the American company Verio, which NTT purchased in 2000. The fact that the largest AS in the IPv6 graph is European and that the other European ASes are comparable in degree to the American ASes reflects the wider adoption of IPv6 outside the United States.