Nontrivial dynamical scaling in the Internet: experiments and a simple model.

I.Papp[1], M. Afifi[1], L. Varga[1], I. Gere[1] and Z. Neda[1]

[1]Babes-Bolyai University, Dept. of Physics,
str. Kogalniceanu 1,
Cluj-Napoca, Romania

zneda@phys.ubbcluj.ro, steve.prst@gmail.com

On router level the Internet is a complex network which is embedded in a geographical space. Alongside its scale-free topological properties [1, 2], it also shows a dynamical scaling: the communication speed has a nontrivial dependency as a function of the geographical distance similar with what was recently discussed for human mobility patterns [3]. Several "ping" and "traceroute" experiments prove that the average speed is increasing with the distance, following a roughly square root trend. To explain this novel scaling law and other measurable topological properties a realistic model has to be created. This kind of model must be based on realistic assumptions on the wiring process and has to reproduce the experimentally measured topological properties of the Internet, including the observed scaling of the communication speed versus distance. Here we present experimental results concerning the topology, the dynamical scaling and a simple model which can reproduce the measured features. For experimental measures we use the ping protocol with coordinate data from different parts of the world [4], and the freely available results of the CAIDA UCSD IPv4 Routed /24 Topology Dataset [5].

References

[1] Barabasi AL, Albert R. 1999 *Emergence of Scaling in Random Networks.* Science Vol. 286, pp. 509-512

[2] Yook SH, Jeong H, and Barabasi AL. 2002 *Modeling the Internet's large-scale topology.* PNAS, vol. 99, pp. 13382–13386

[3] Varga L, Kovacs A, Toth G, Papp I. and Neda Z. 2016 *Further We Travel the Faster We Go.* PLOS ONE, vol. 11, pp. e0148913

[4] The home page of IP Adress Databases http://www.ip2location.com/

[5] The CAIDA UCSD IPv4 Routed /24 Topology Dataset - 2017 http://www.caida.org/data/active/ipv4_routed_24_topology_dataset.xml