

How does Internet Behave?

Mostly stable

Changes can be Quivers

Routing policy changes, mis-configs

Peering changes

or Quakes

Disasters, human and otherwise

Bombings, viral and military

Fibre cuts

Power outages

Representation of Internet

Find out what's out there

Population

Interconnections

Continuously update model

Provide visualization

Monitor “health”

Detect and respond to events

Internet Nervous System

Constantly providing feedback

Continuously

Probe key points

Compare to baseline behavior

Signal pain

Mobilize emergency responses to pain

Raise alarms

Provide focus on root causes

Who Benefits?

Cops

What might the bad guys be doing?

From where?

To whom?

Users

How do I determine what providers to use?

Providers

Who should I peer with?

How do I show how good I am?

How's It Going?

Good so far

MIDS

Lumeta

CAIDA

rocketfuel

others (Akamai, ...)

But

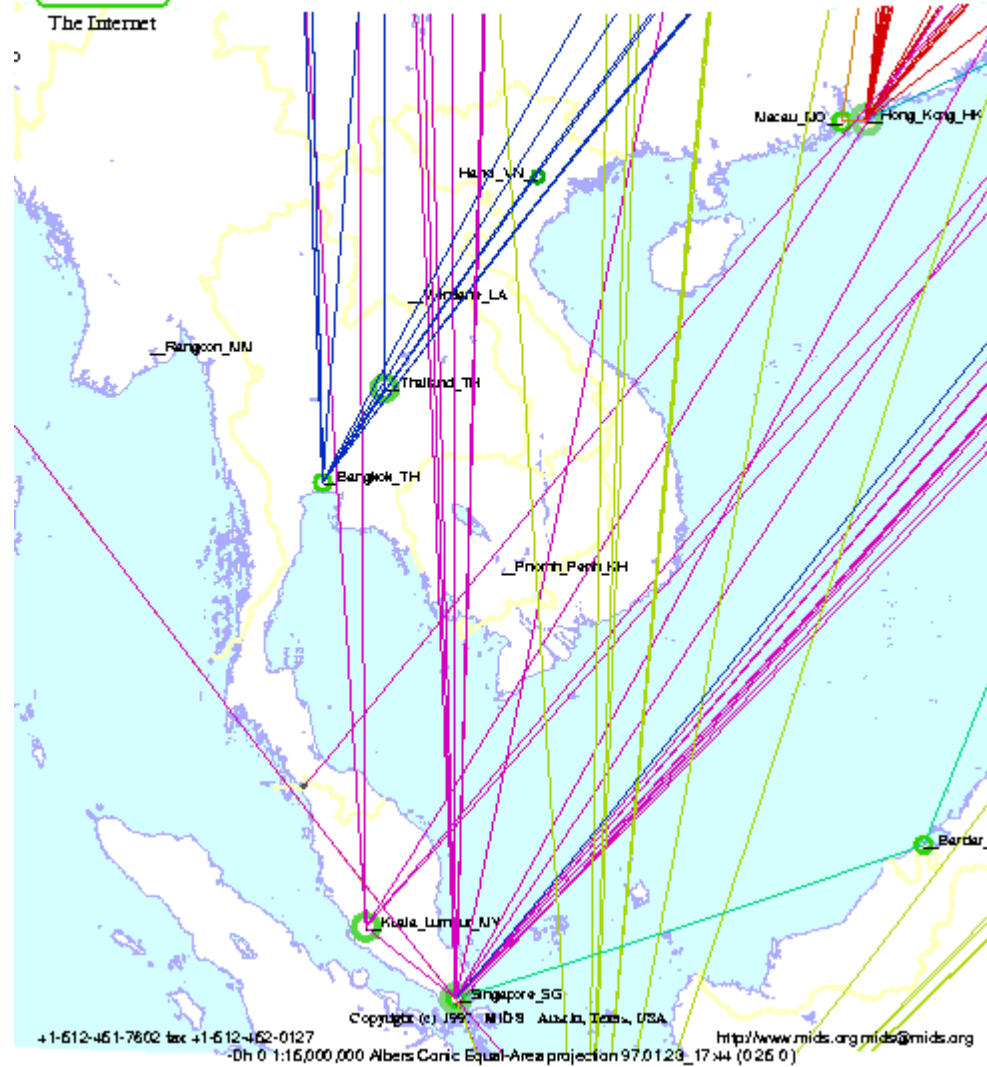
Problems...

The Internet (hosts July 1996 links Sep-Oct 1996)



Mainland Southeast Asia

Great circle lines are IP links,
with a different color per country.

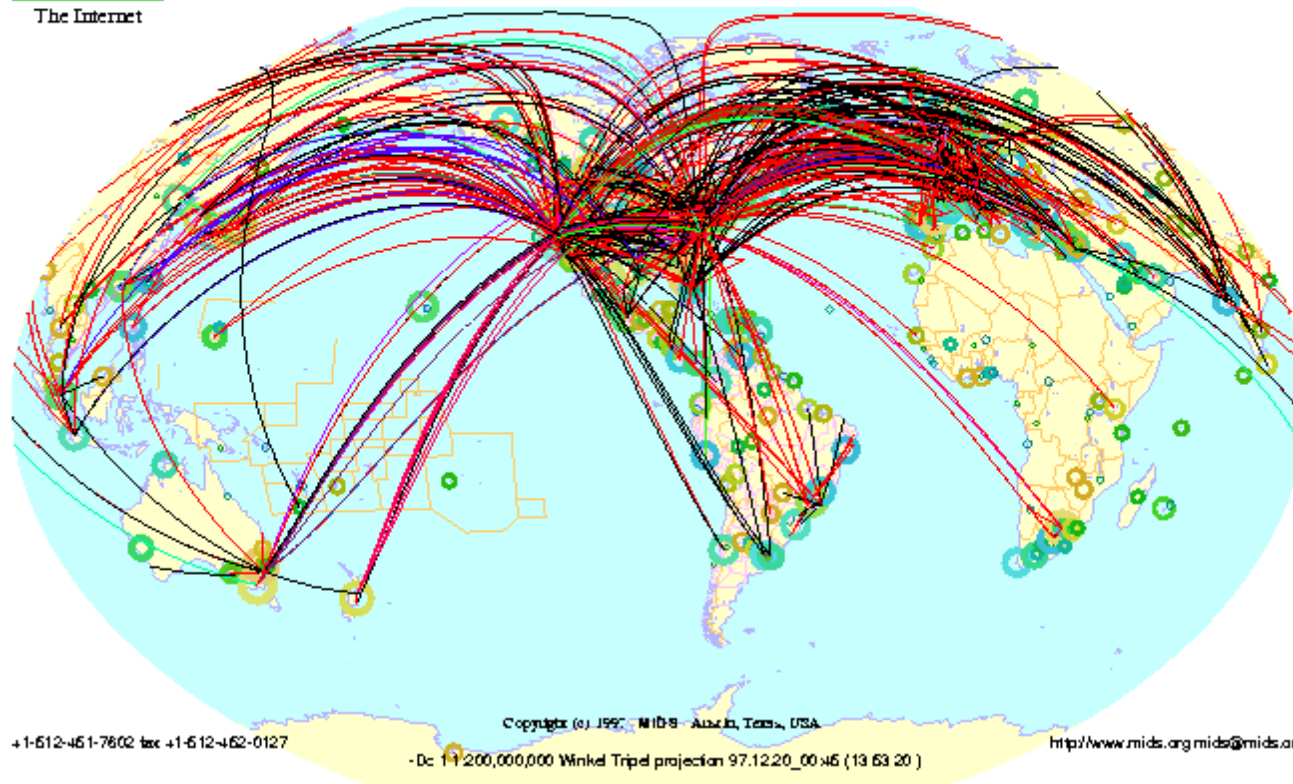


The Internet January 1997

World



The Internet

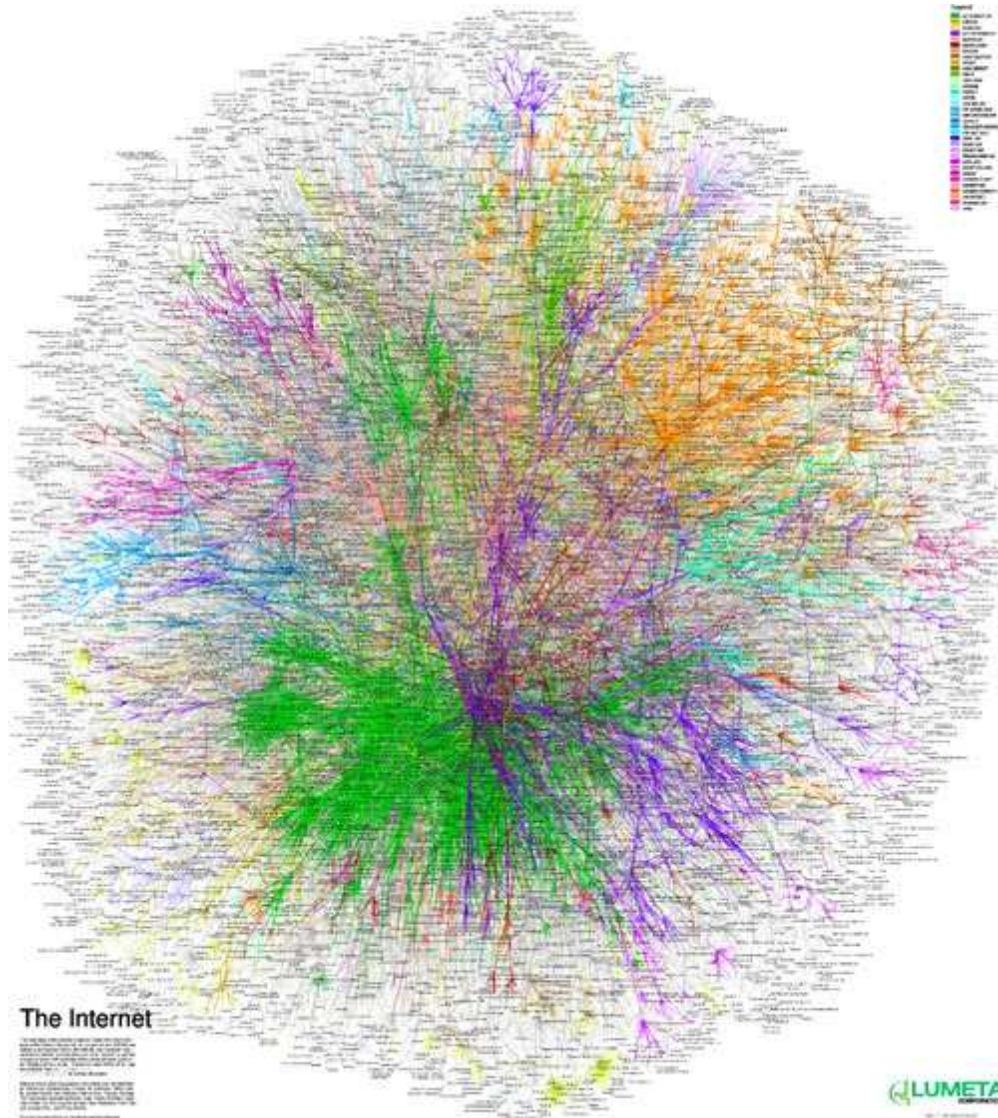


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<http://www.mibs.org> mibs@mibs.org

-Dc 1:200,000,000 Winkler Tripel projection 97.12.20_00.v6 (13.63.20)



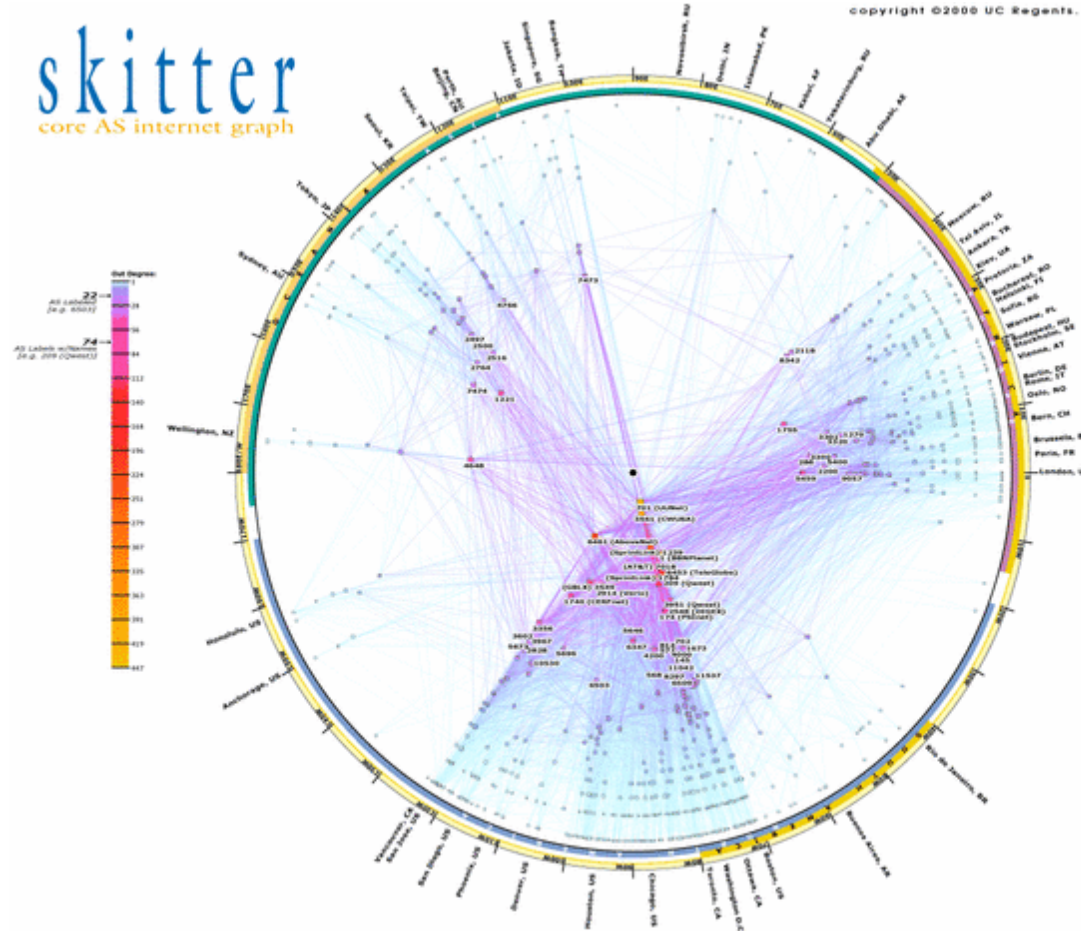
The Internet

Source: www.lumeta.com
 Date: 10/10/2010
 Time: 10:10:10
 Version: 1.0.0

skitter

core AS internet graph

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cooperative association for internet data analysis san diego supercomputer center university of california, san diego
 9500 gilman drive, mc0505 la jolla, ca 92093-0505 tel. 858-534-5000 http://www.caida.org



CAIDA is a program of the University of California's San Diego Supercomputer Center (UCSD/SDSC)
 skitter is supported by DARPA NCI Cooperative Agreement N66001-98-2-8922, NSF ANIR Grant NCR-9711092 and CAIDA members

Measurement Techniques

Population and structure determination

Traceroute

Analysis of BGP information

Enhance with DNS data

Operational health determination

Ping

Internet Averages

Internet Weather Report

Traceroute – Quarterman

Traceroute

in parallel

from single source

to 300 destinations

Reduce traceroute data to

Find all hops in paths

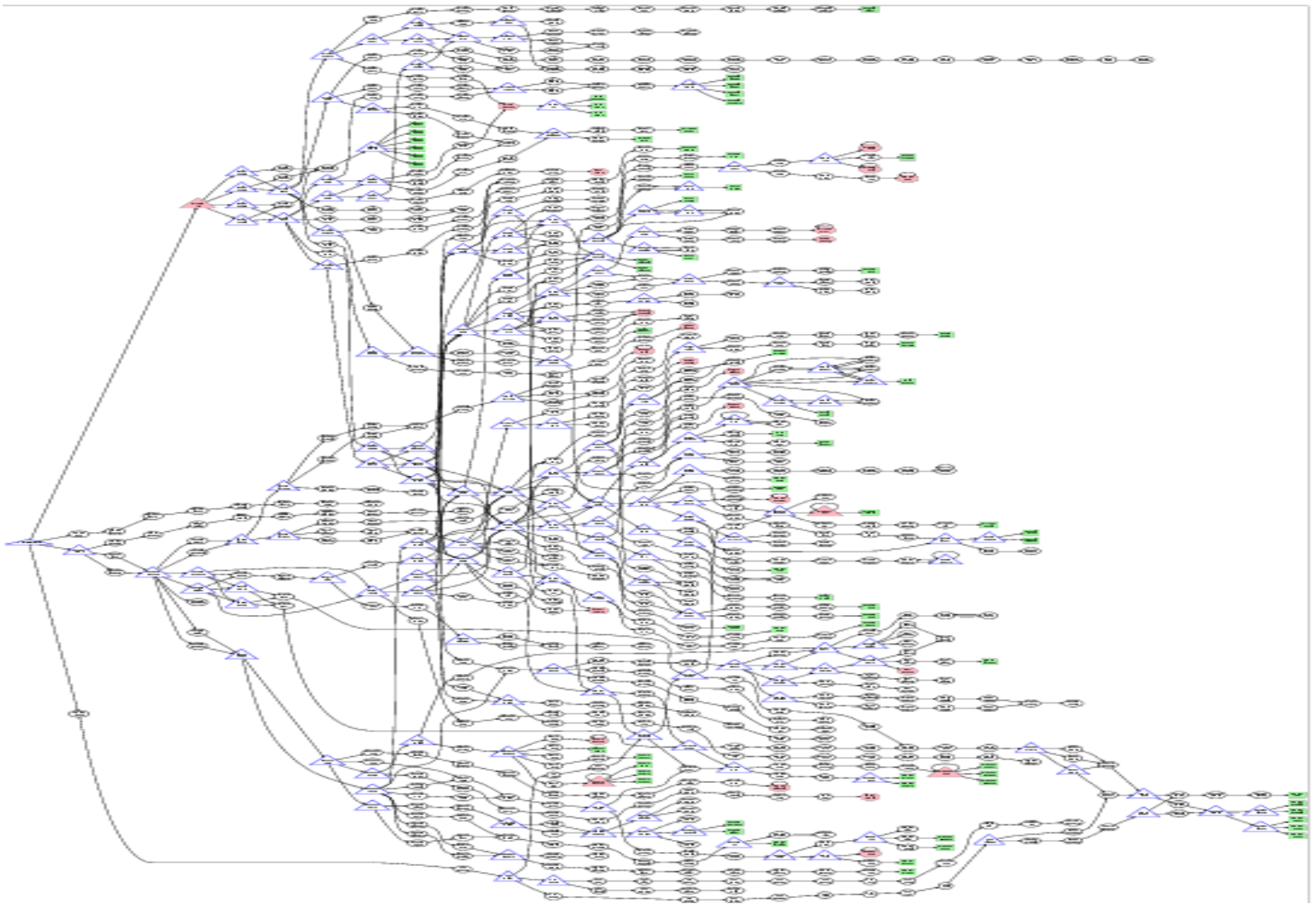
Represent each hop as an element of a graph

Upstream IP as node

Downstream as node

Edge as a path between the two

Draw graph using [graphviz](#)





Traceroute Example – Lumeta

From single source

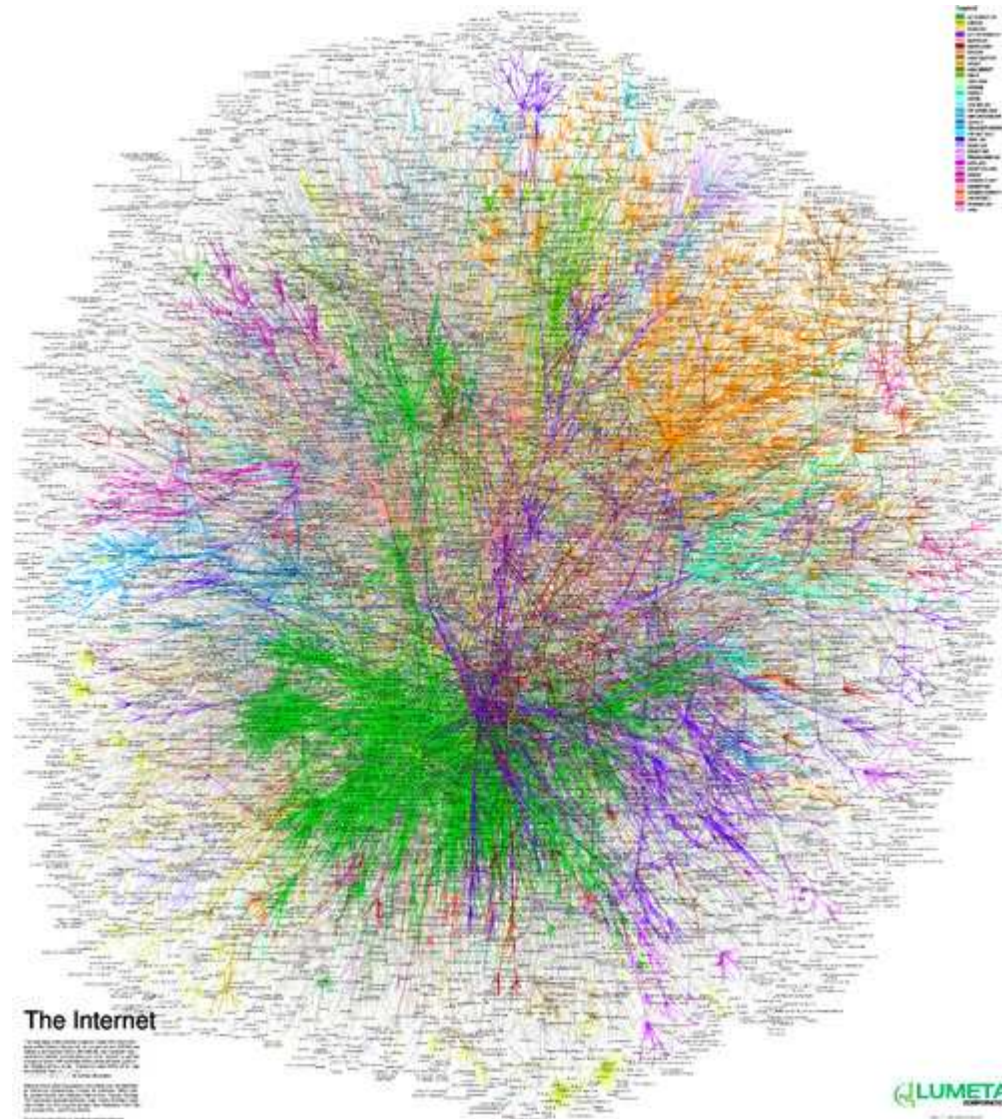
Reactive traceroute program

Periodically

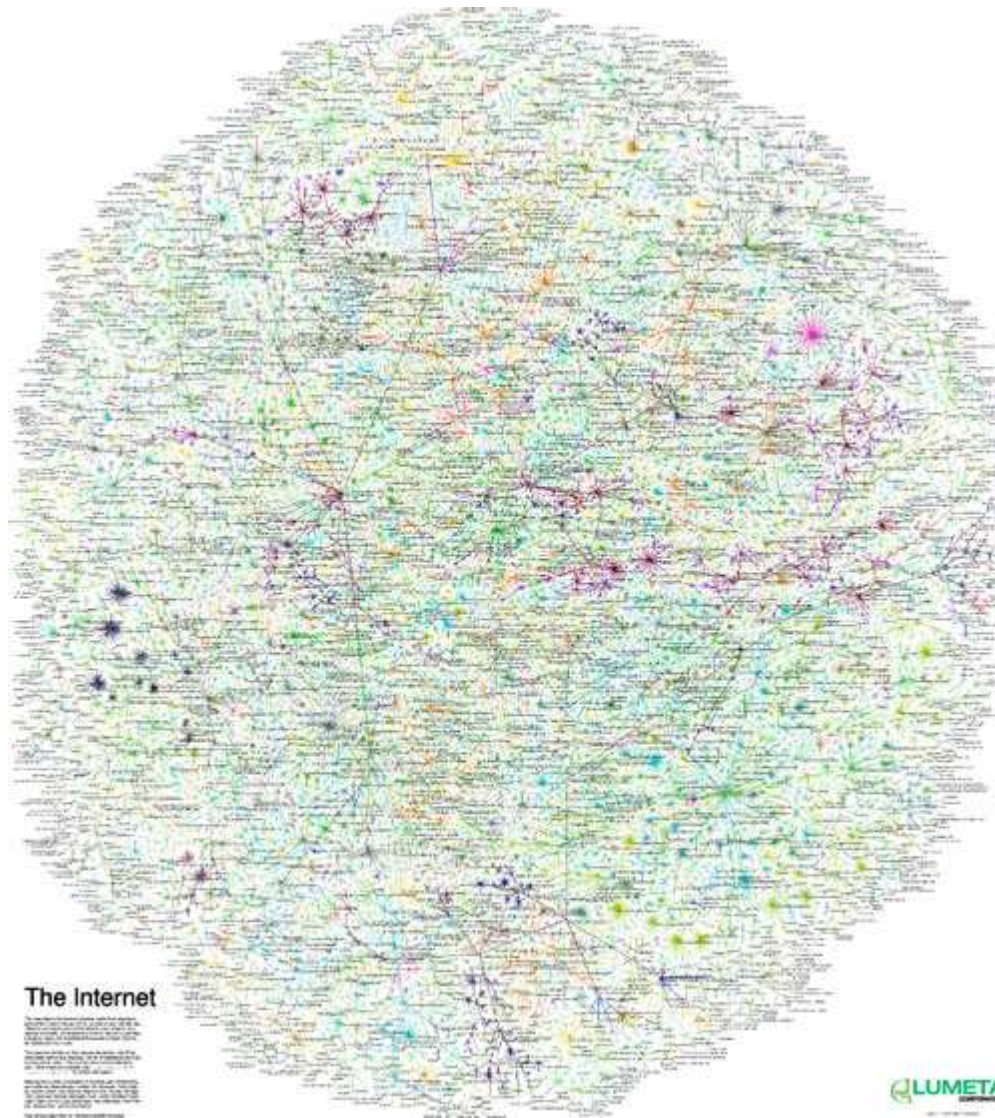
to many (130,000) judiciously selected destinations

See [paper](#) in IEEE Computer Society's Internet Computing

Lumeta Internet (“all”)



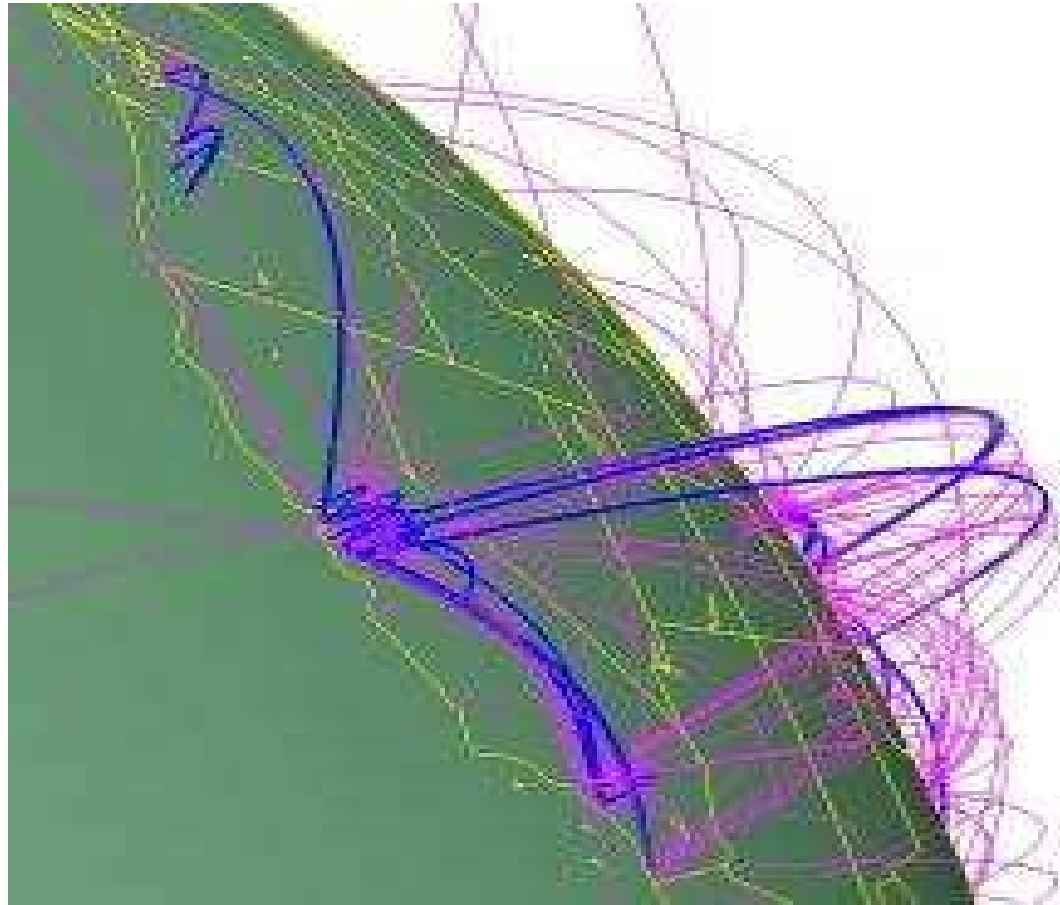
Lumeta Internet (min. distance)



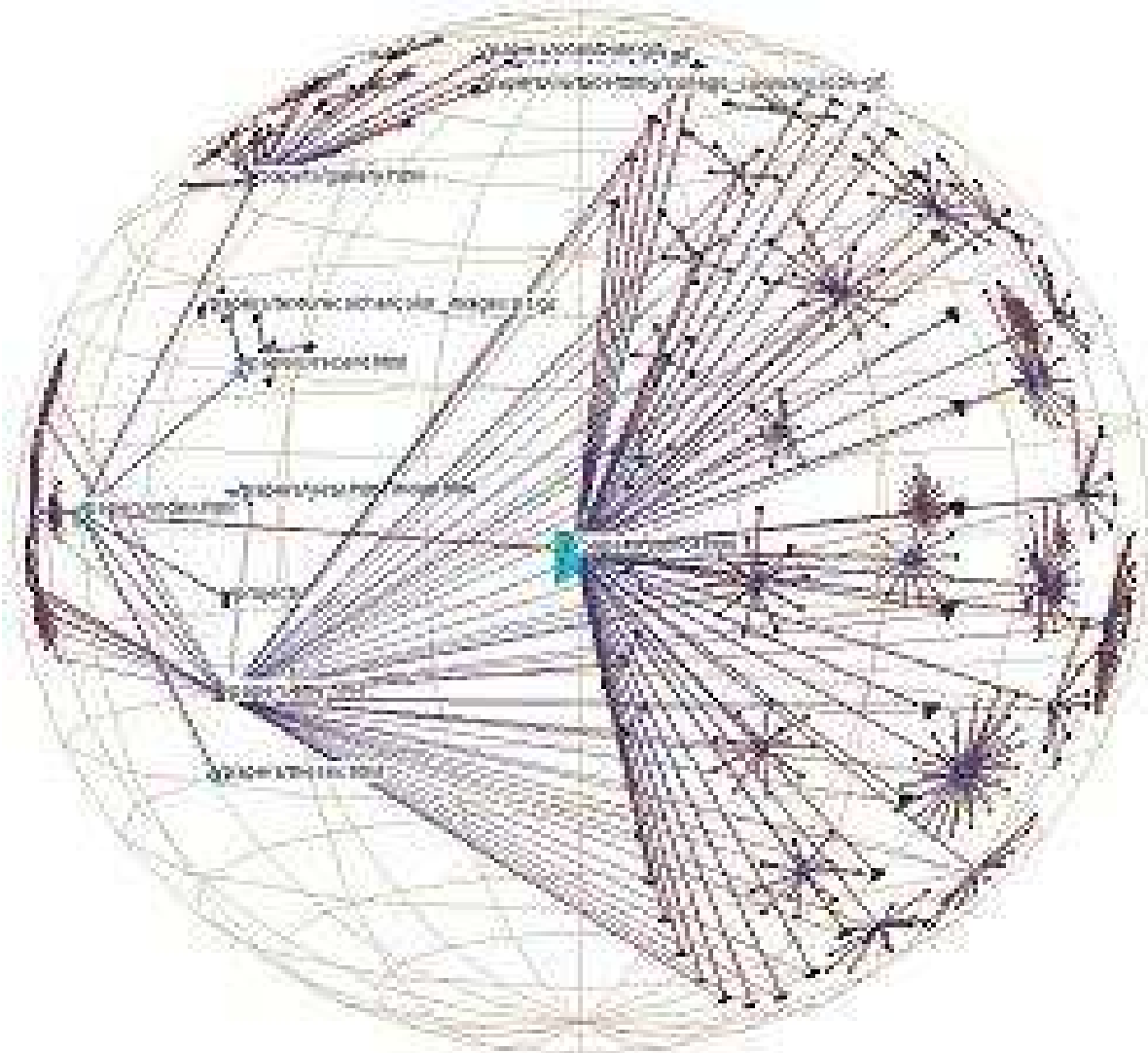
Paths wrt Geography

- Tamara Munzner and colleagues are visualising the global topology of the MBone using 3D global geographic models.

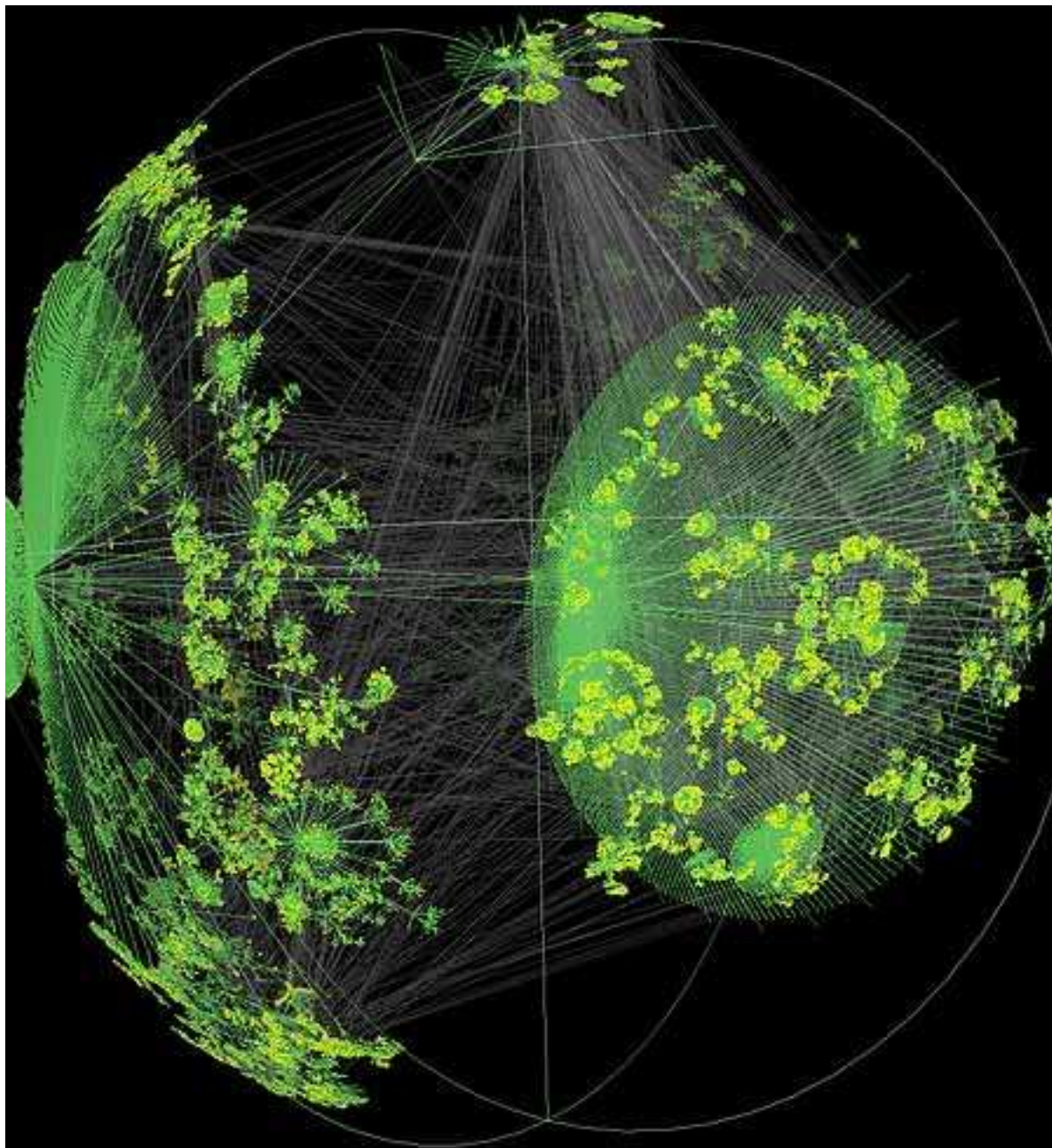
Paths in Mbone



three-dimensional hyperbolic



CAIDA Walrus project



Beyond Steady State

Internet Quakes

Disasters, human and otherwise

Bombings, viral and military

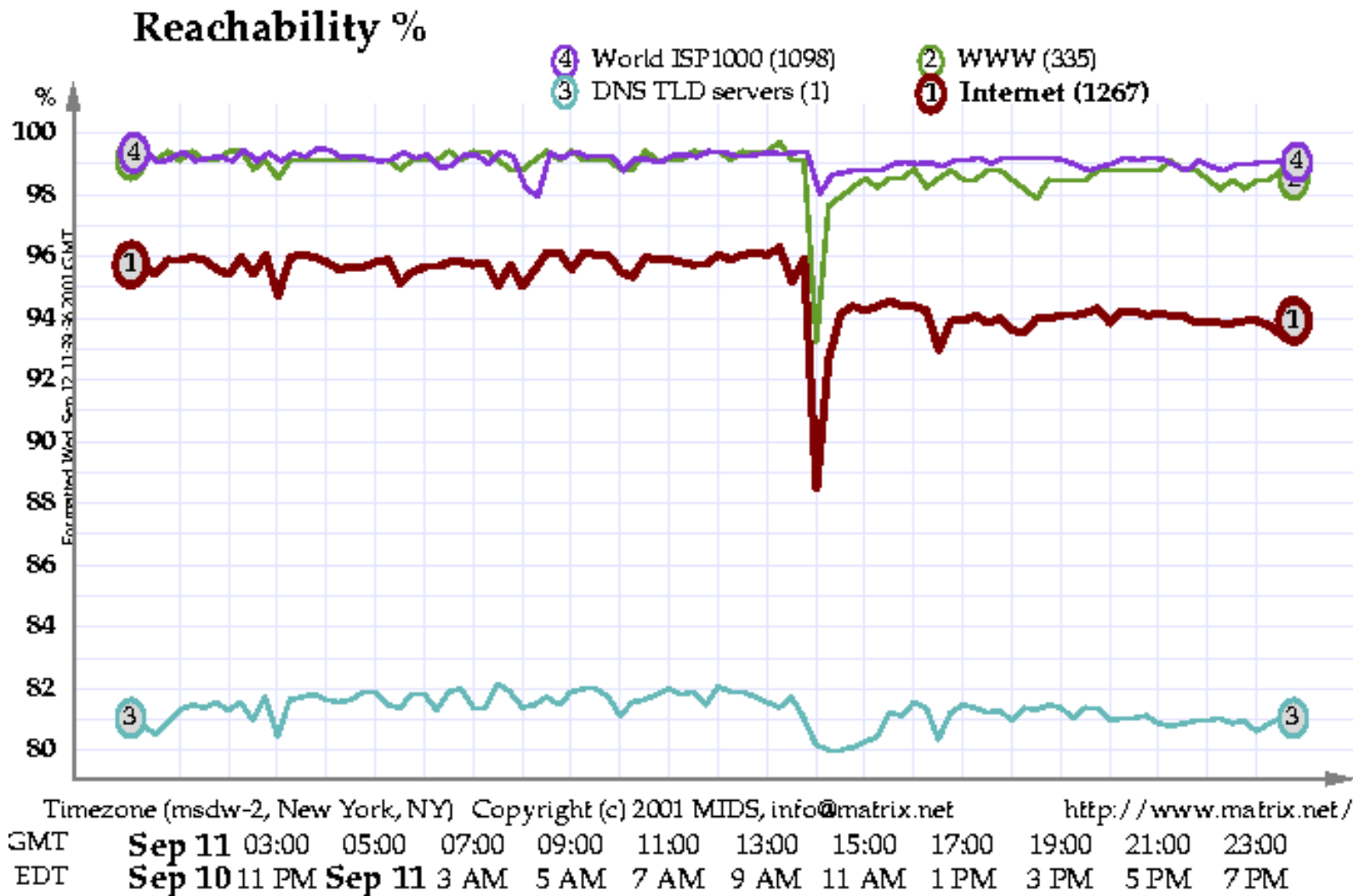
Paths to Yugoslavian Networks, Day 39 of Conflict



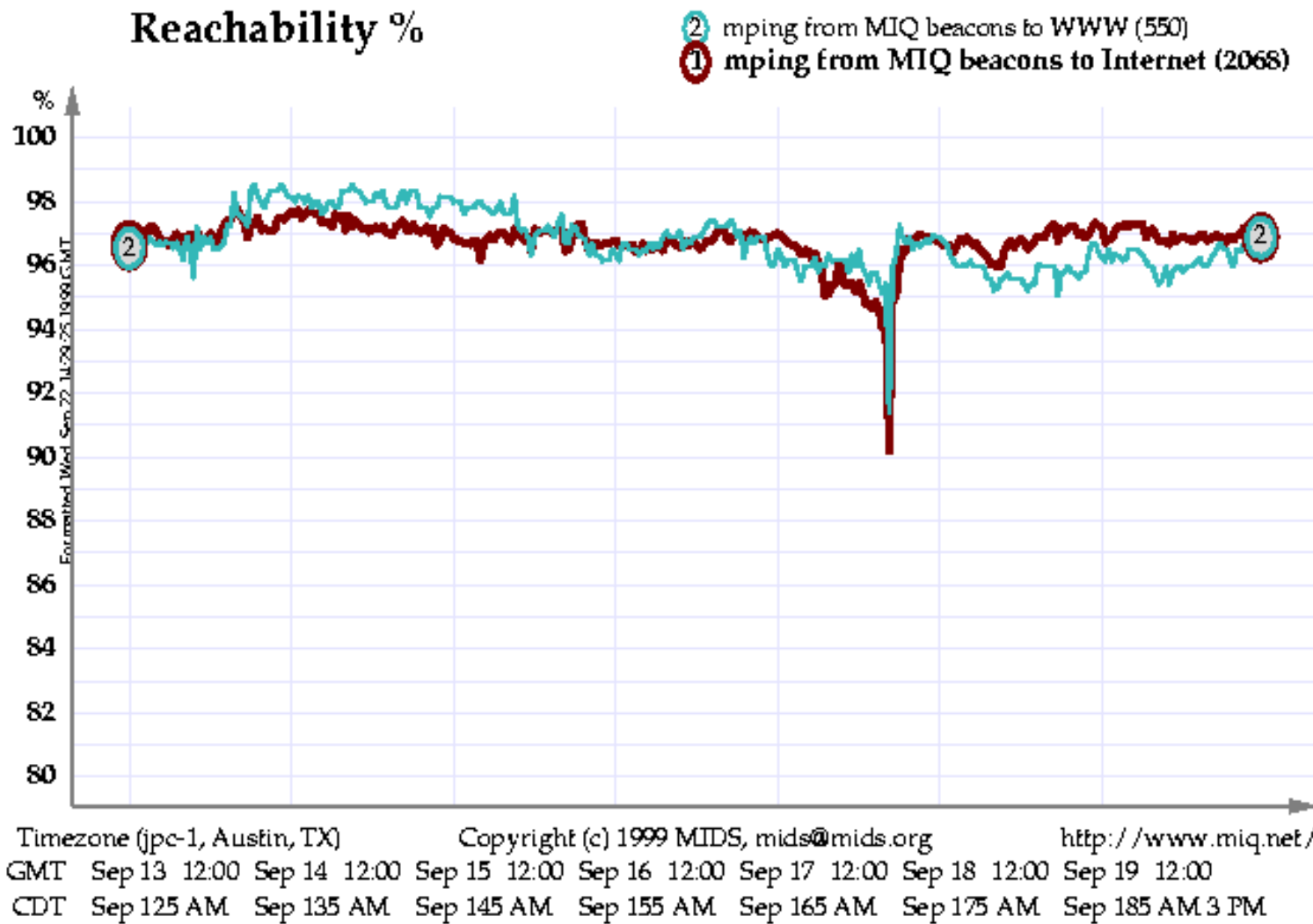
Paths to Yugoslavian Networks, Day 40 of Conflict



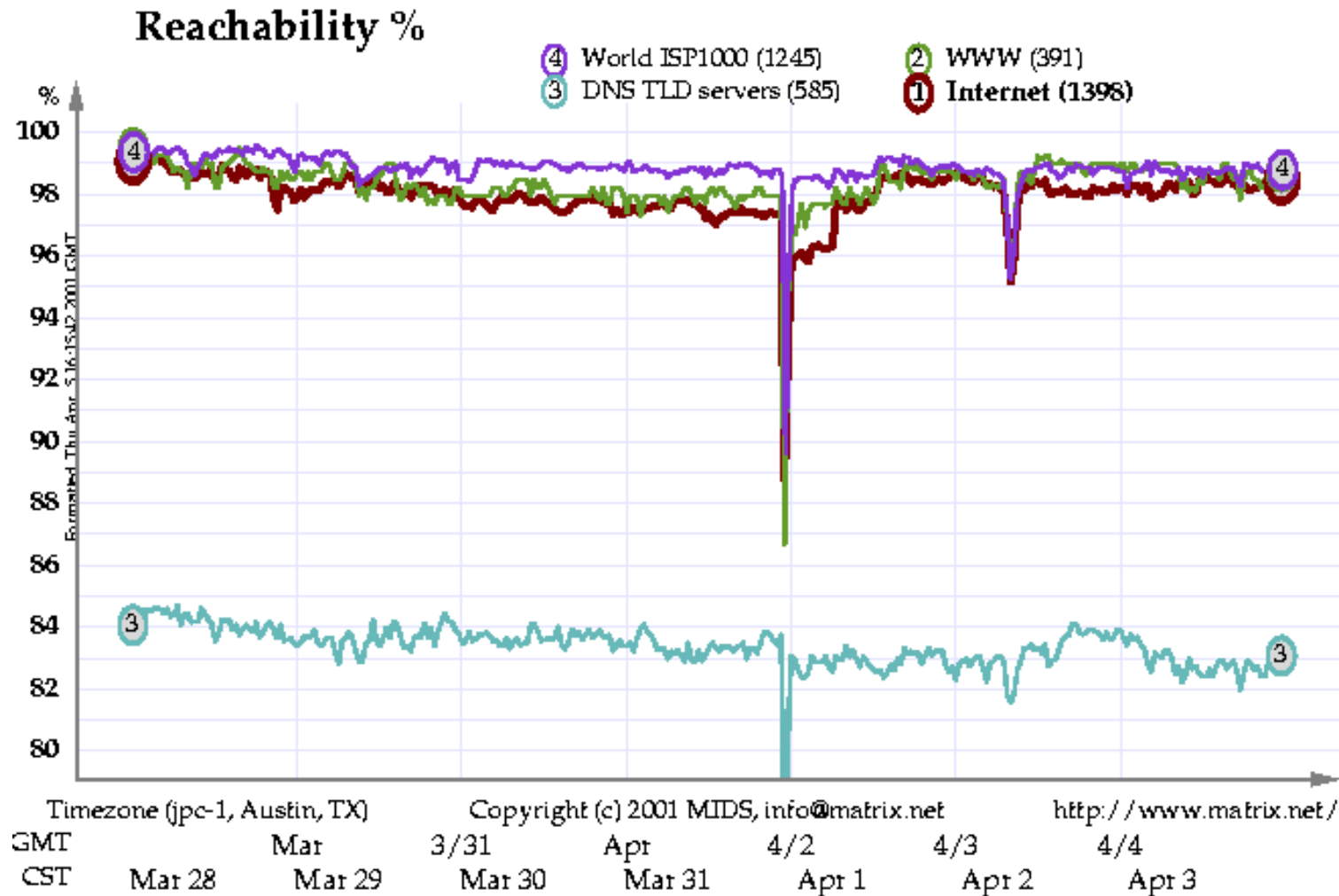
WTC #1 & #2 Struck



Hurricane Floyd (1999)



The 'April Fool' Virus (2001)



Problems?

Vern Paxson *says*:

Data collection is ad hoc and subjective (goal-driven)

Interpretation of results deserve lots more scrutiny

Data sets are often full of holes, lack context, are incomprehensible and/or hard to get at

Traceroute and BGP path incongruities
(CAIDA)

Where from here?

Possible to develop a CDC or WHO for
Internet (Vern Paxson *et al*)?

References

Walrus: http://mappa.mundi.net/maps/maps_020/

Vern Paxson

Problems: <http://www.icir.org/vern/talks/>

CDC idea:

<http://www.usenix.org/publications/library/proceedings/sec02/stanford.html>

Lumeta:

<http://www.cheswick.com/ches/papers/mapping.ps.gz>

CAIDA, Traceroute and BGP path incongruities:

<http://www.caida.org/outreach/papers/2003/ASP/>

References(cont'd)

<http://www.acm.org/sigcomm/sigcomm2002/papers/rocketfuel.pdf>