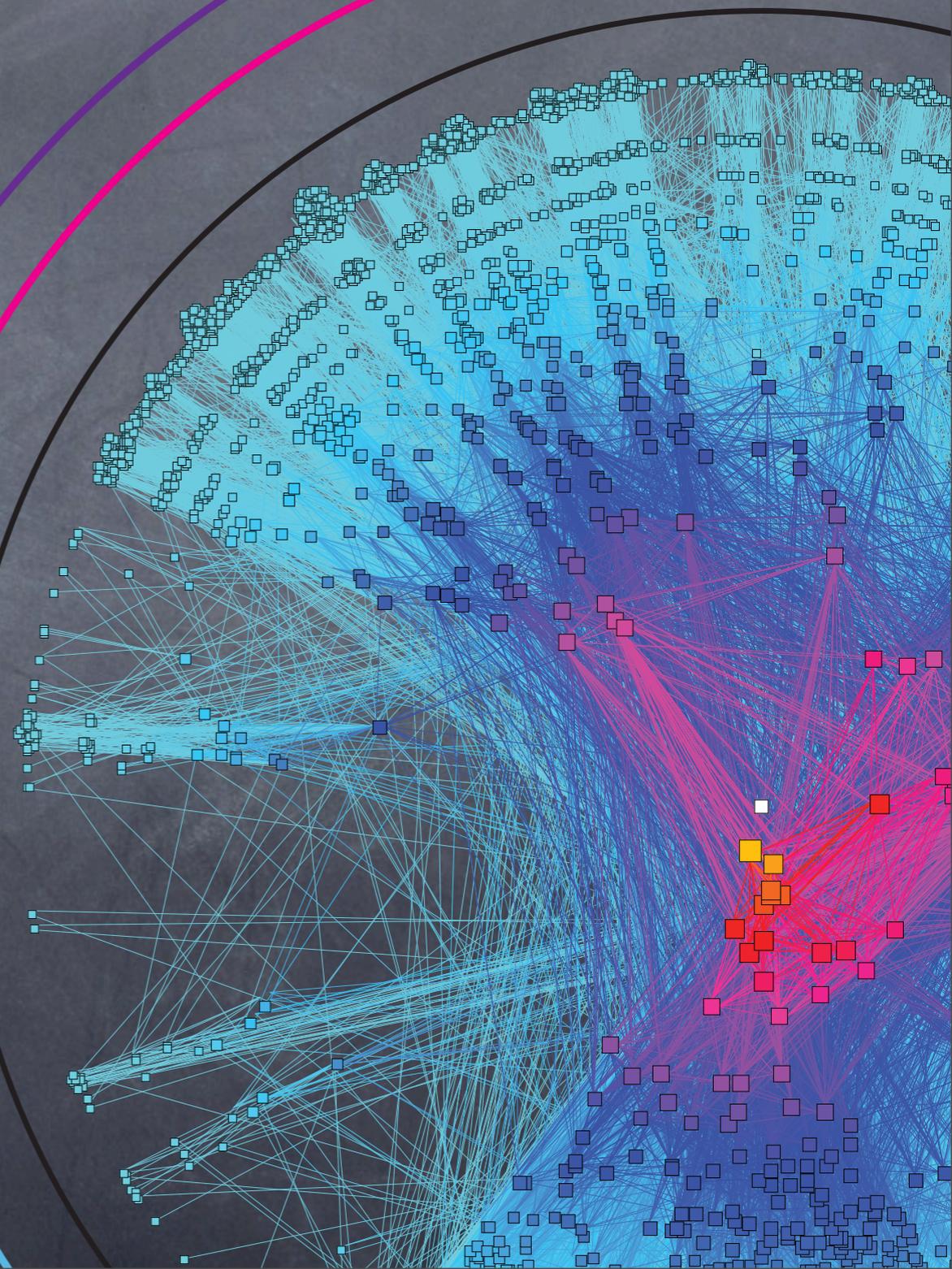


CAIDA Report 2010

Bradley Huffaker
CAIDA/UCSD

CAIDA-WIDE-CASFI
April 24th, 2010
Osaka



Overview



- CAIDA:
 - conducting research
 - building infrastructure
 - data collection and curation
 - tool development
 - informing policy
 - workshops

Research



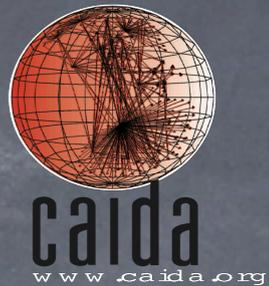
- Macroscopic Topology Project
 - IPv4 and IPv6 topology discovery
 - hostname collection
 - Alias Resolution
 - Router to AS assignment
 - dual graph
 - AS relationships

Research (cont)



- IPv4 and IPv6 topology discovery
 - daily collected
 - available to researchers
- hostnames
 - collected for every IP address in topology
 - released per cycle

Research (cont)



- Alias Resolution

- Collapse interfaces to produce router-level graph
- analysis run across two months of topology data
- additional measurement collected
 - iffinder
 - MIDAR

- publication

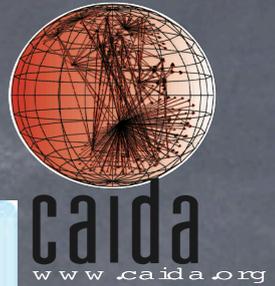
- K. Keys “Internet-Scale IP Alias Resolutoin Techniques”, SIGCOMM CCR, vol 40, no. 1, pp-50-55, January 2010.
http://www.caida.org/publications/papers/2009/as_assignment/

Research (cont)



- Router to AS mapping (presented later)
 - B. Bradley, A. Dhamdhere, M. Fomenkov, kc claffy, “**Toward Topology Dualism**”, PAM 2010.
http://www.caida.org/publications/papers/2009/as_assignment/
- Developing new AS Relationships algorithm
 - improved running time (hours vs days)
 - prevent creation of acyclic components
 - validation by providers (work in progress)

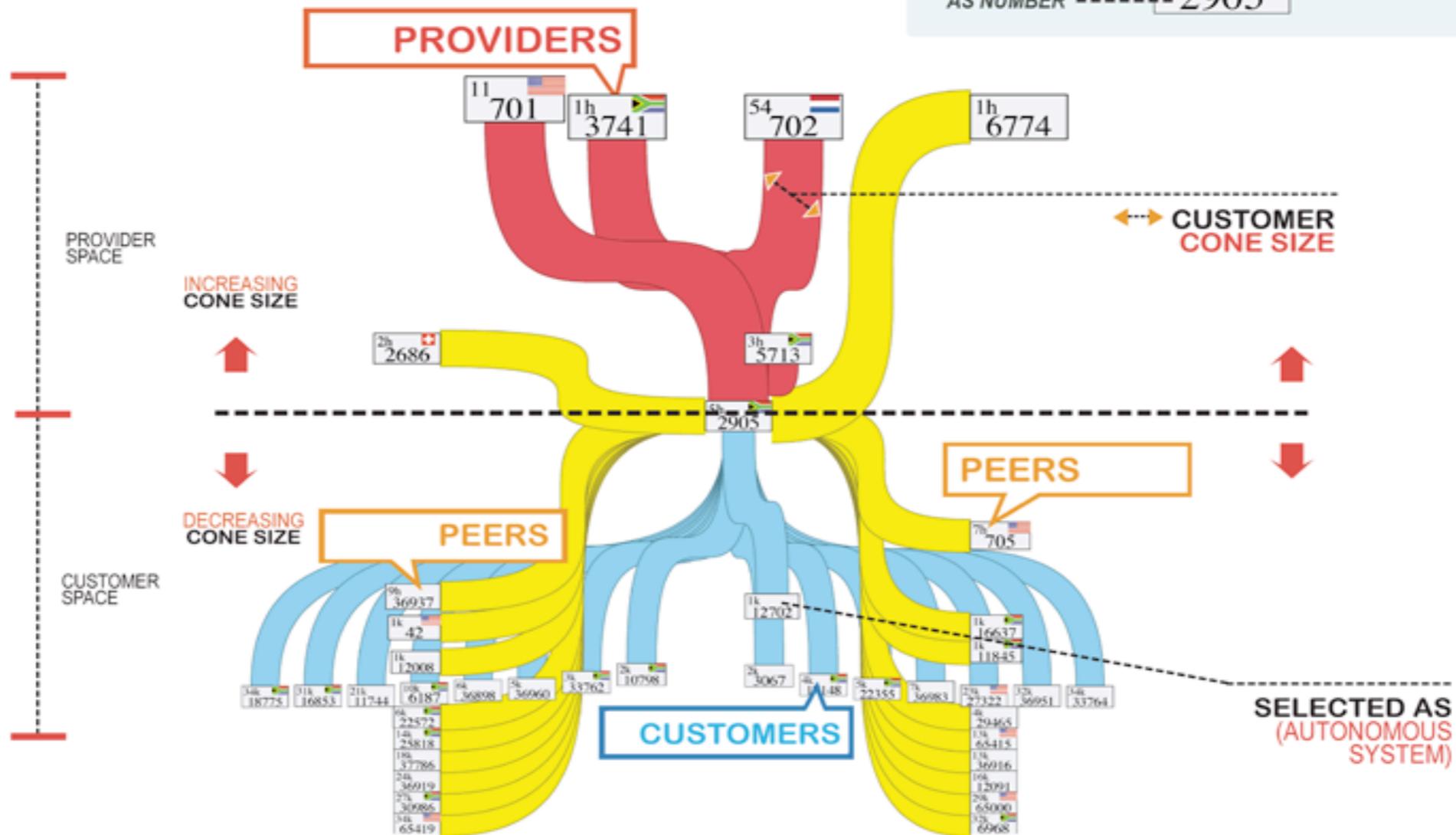
Research



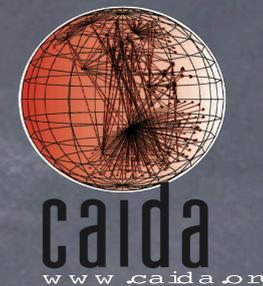
PROVIDERS, PEERS AND CUSTOMERS OF UNNET SOUTH AFRICA (2905)

(Telefonica Autonomous System Backbone)

RANK ----- 5h
 AS NUMBER ----- 2905

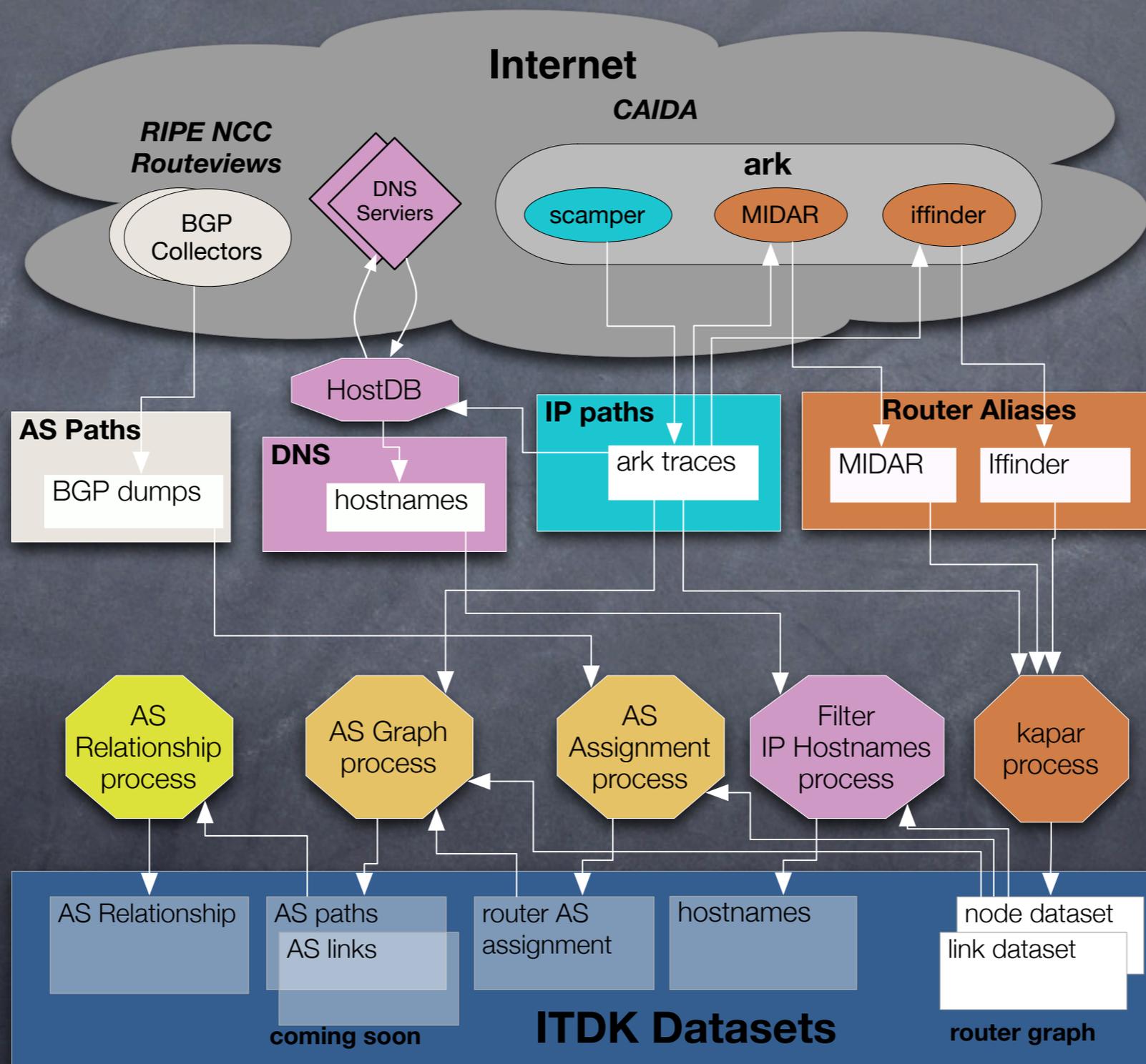


Research (cont)



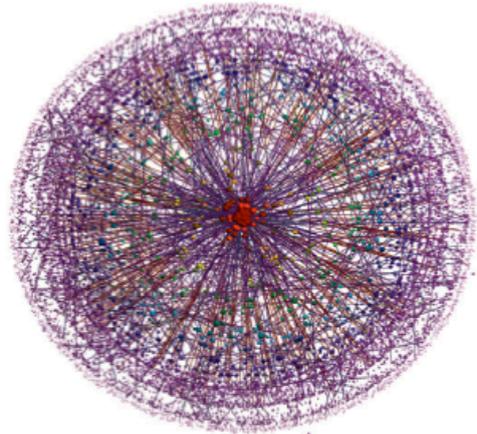
- Internet Topology Data Kit (ITDK) Process

<http://www.caida.org/data/active/internet-topology-data-kit/>

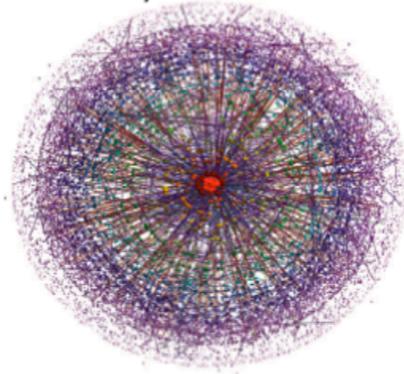


Research (cont)

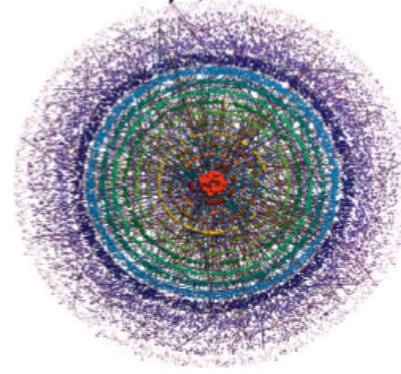
Internet AS topology (BGP tables)



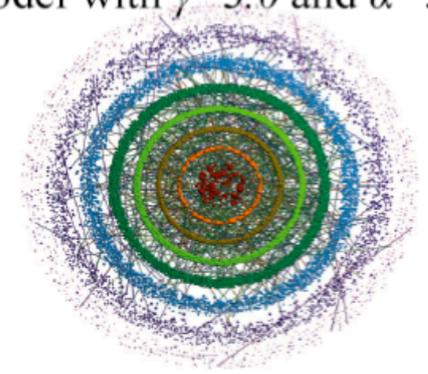
Model with $\gamma=2.2$ and $\alpha=5.0$



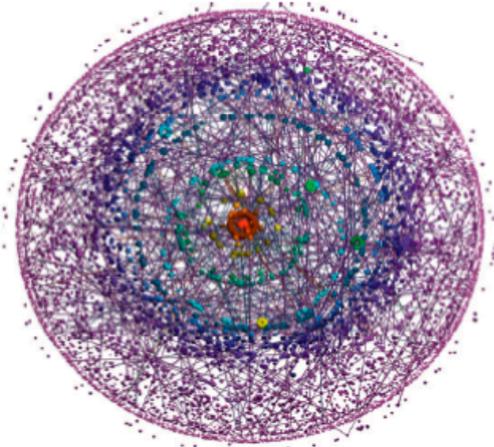
Model with $\gamma=2.5$ and $\alpha=5.0$



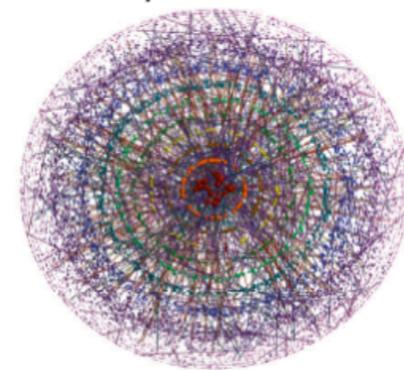
Model with $\gamma=3.0$ and $\alpha=5.0$



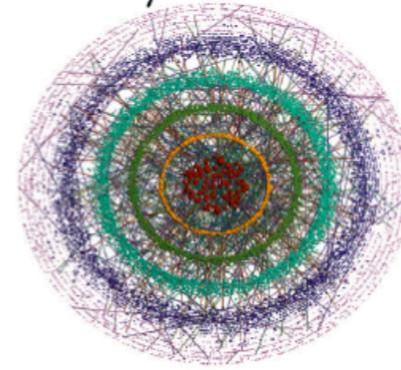
Social trust network (PGP)



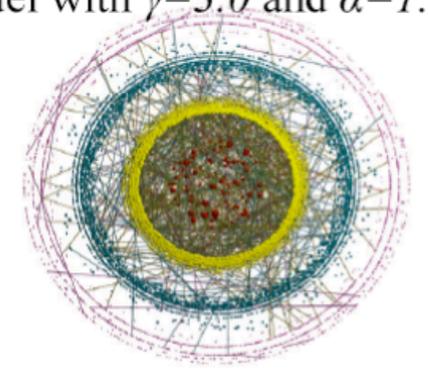
Model with $\gamma=2.2$ and $\alpha=1.1$



Model with $\gamma=2.5$ and $\alpha=1.1$



Model with $\gamma=3.0$ and $\alpha=1.1$



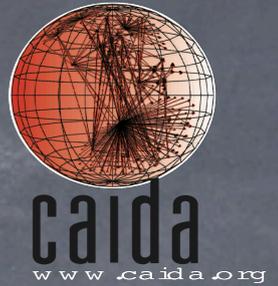
Modeling Complex Networks

Research (cont)



- Modeling Complex Networks
 - Internet AS evolution modeled with multiclass preferential attachment
 - scaling dual graph (router+AS)
 - Internet is made up of ultra small worlds (tiny path relative to number of nodes)
- Routing Complex Networks
 - hyperbolic metric space allows for shortest path routing without global knowledge

Research (cont)



publications

- Curvature and Temperature

- D. Krioukov, F. Papadopoulos, A. Vahdat, M. Boguna, “Curvature and temperature of complex networks”, Physical Review E, v80, 035101(R), 2009.

http://www.caida.org/publications/papers/2009/curv_temp_complex_nets/

- Greedy forwarding

- F. Papadopoulos, D. Krioukov, M. Boguna, A. Vahdat, “Greedy forwarding in scale free networks embedded in hyperbolic metric spaces”, in ACM SIGMETRICS Performance Evaluation Review, vol. 37, no. 2, pp. 15-17, Oct 2009.

http://www.caida.org/publications/papers/2009/greedy_forwarding_embedded/

- Navigability

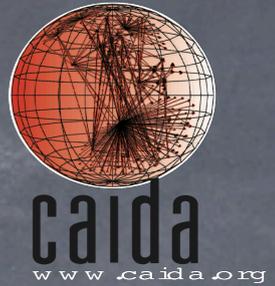
- M. Boguna, D. Krioukov, kc claffy, “Navigability of complex networks”, Nature Physics, v 5, pp-74-80, January 2009.

http://www.caida.org/publications/papers/2009/navigability_complex_networks/

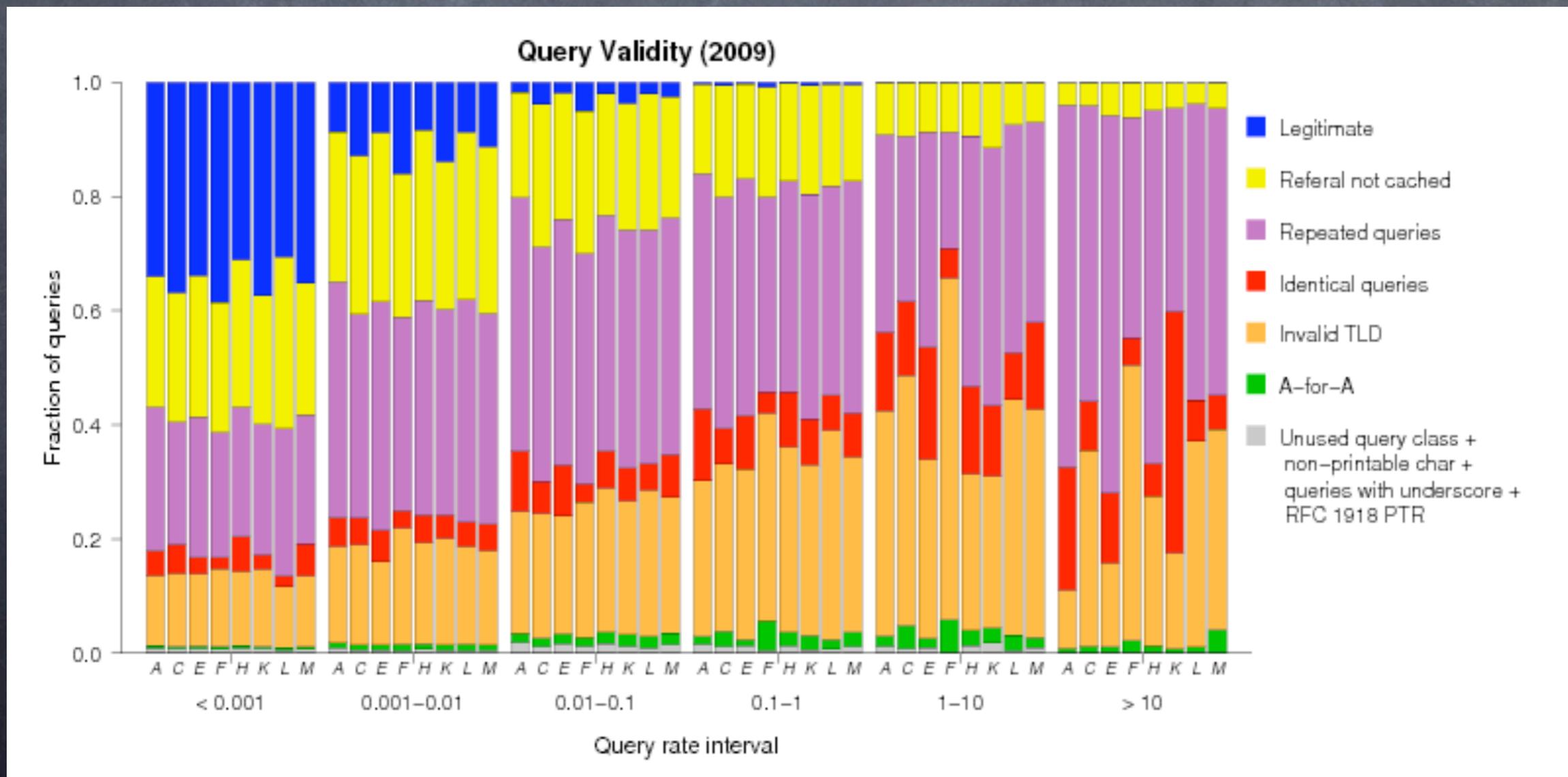
- M. Boguna, D. Krioukov, “Navigating ultrasmall worlds in ultrashort time”, in Physical Review Letters, vol 102, no 058701, 2009.

http://www.caida.org/publications/papers/2009/navigating_ultrasmall/

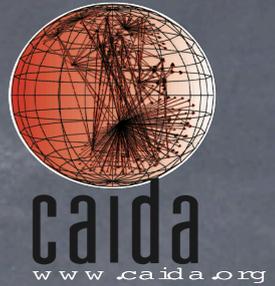
Research (cont)



- Domain Name System (DNS)
- S. Castro, M. Zhang, W. John, D. Wessels, kc claffy, “Understanding and preparing for DNS evolution”, TMA 2010
http://www.caida.org/publications/papers/2010/understanding_dns_evolution/



Research (cont)



- Internet Traffic Analysis

- Traffic classification overview

<http://www.caida.org/research/traffic-analysis/classification-overview/>

- taxonomy of traffic classification papers and data sets
- provides filtering/search/sort functionality to taxonomy
- many media rich entertainment application emerging

- Routing Asymmetry Study

<http://www.caida.org/research/traffic-analysis/asymmetry>

- traffic symmetry does not hold for network location beyond intranet and access links
- W. John, M. Dusi, kc claffy “**Estimating Routing Symmetry on Single Links by Passive Flow Measurement**”, IWCMC June 2010.
http://www.caida.org/publications/papers/2009/as_assignment/

Collaborative Research



- Using Ark to examine source address spoofing
 - how many networks allow packets with spoofed IP addresses to leave their network
 - working on adding IPv6
 - R. Beverly, A. Berger, Y. Hung, kc claffy “Understanding the Efficacy of Deployed Internet Source Address Validation Filtering”, IMC November 2009.
http://www.caida.org/publications/papers/2009/imc_spoofers/
- Improving the efficiency of topology probing
 - implemented Doubletree using Marinda (tuple space)
 - Matthew Luckie and Alistair King

Infrastructure



- Archipelago



- CAIDA's active measurement infrastructure
- 43 monitors – growing 1 or 2 per month
- 11 w/ IPv6 connectivity
- currently used for
 - Team-probing experiment to collect IPv4 and IPv6 topology
 - alias resolution measurements
 - Spoofer experiment

Infrastructure (cont)



- Passive Trace Capture
 - Tier 1 OC192 backbone link packet header captures
- UCSD Network Telescope
 - 2 days of telescope dataset
http://www.caida.org/data/passive/telescope-2days-2008_dataset.xml
 - 3 days of Conficker dataset
http://www.caida.org/data/passive/telescope-3days-conficker_dataset.xml

Data



- **OC192 backbone:** 8.5 TB (3.6 anonymized; 4.9 unanonymized) – curation to quarterlies will reduce
- **UCSD telescope:** 3.4 TB on disk (30 day window) 4.8 T on samqfs
- **topology:** 12.3 TB (skitter+ark uncompressed)
 - **routed ipv4:** 2.3TB since Sep 2007
 - **routed ipv6:** 275MB since Dec 2008

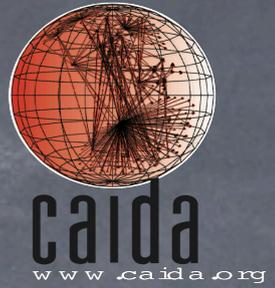
Total: ~30TB (as of 15 Feb 2010)

how many total requests for the data?

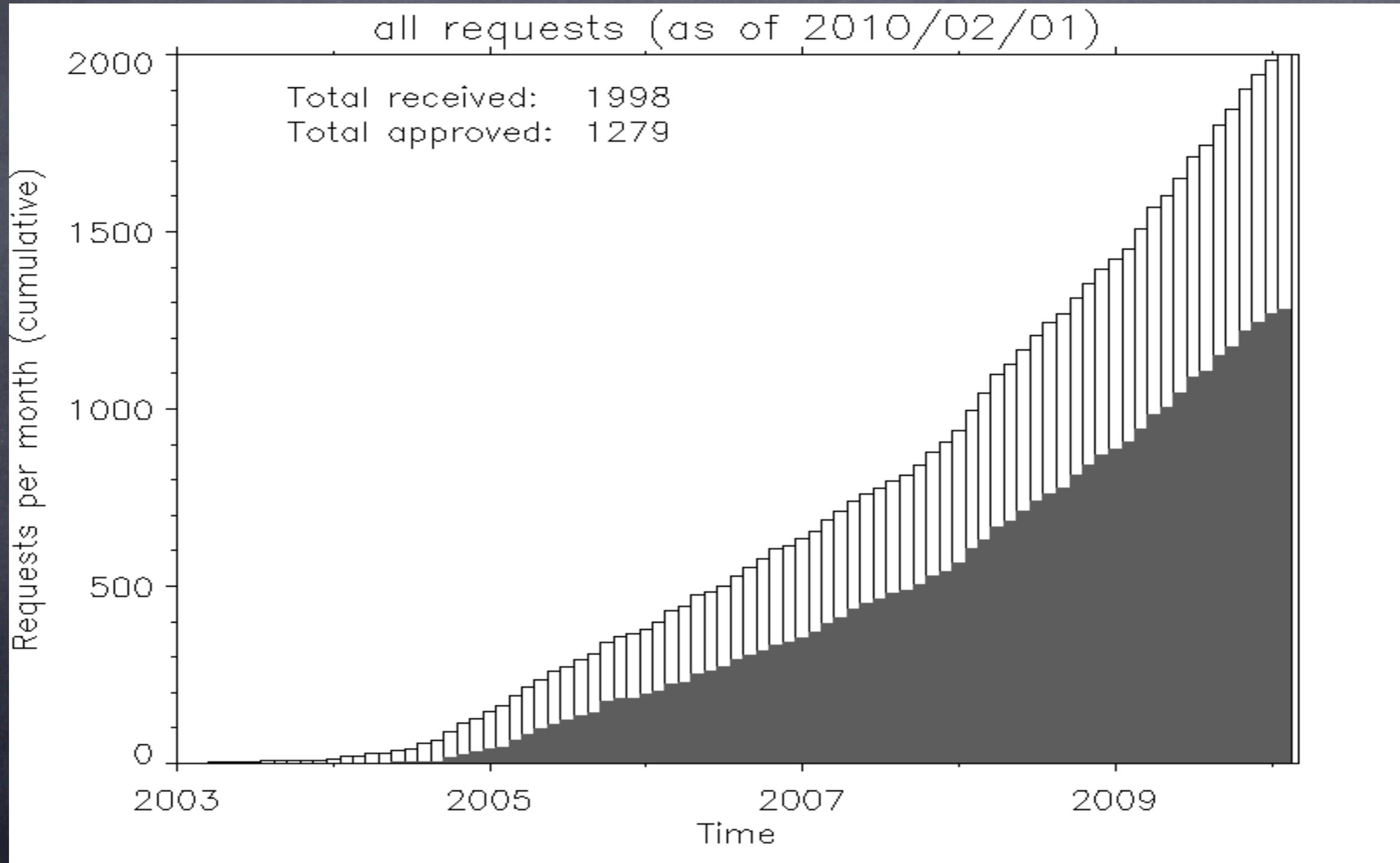


Dataset	Requests	Approved	Accessed	Since
Backscatter	451	241	207	Feb 2003
Passive	799	585	483	Feb 2004
Topology	614	372	290	Jul 2004
Witty	58	38	32	Mar 2008
Telescope	36	20	16	Jul 2009
DNS-RTT	40	23	18	Aug 2006
	1998	1279	1046	

Data request stats



- All requests (cumulative)



Tools

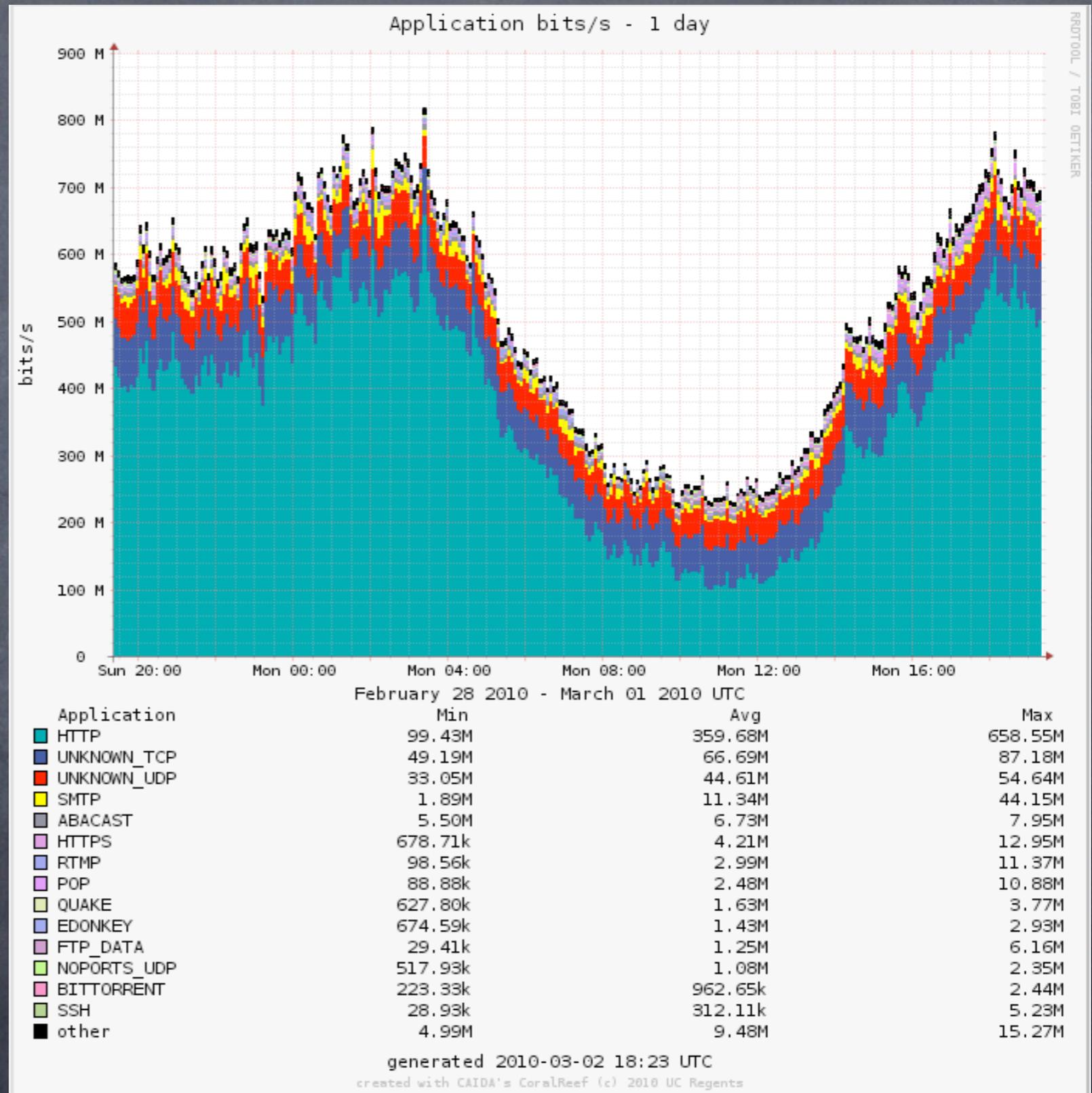


- Coral Reef : software for traffic analysis
 - traffic report generator
- Geocompare : survey of geolocation tools
- topostats : topology statistics web interface
- APAR : software for analytical alias resolution
- RadarGun : software for active measurement alias resolution
- MAARS : software package for alias resolution regularly updated AS-level, router-level and dual graph – ITDKs

Tools (cont)



- Example: Report Generator - Chicago OC192 monitor



Policy



- Policy to support Empirical Internet Research
 - Privacy-Sensitive Data Sharing
 - E. Keneally, kc claffy “An Internet Data Sharing Framework For Balancing Privacy and Utility”, Engaging Data, MIT, October 2009.
http://www.caida.org/publications/papers/2009/engaging_data/
 - Developing Ethical Guidelines for Internet Research
 - E. Keneally, M. Bailey, D. Maughan, “A Framework for Understanding and Applying Ethical Principles in Network and Security Research”, WECSR January 2009.
http://www.caida.org/publications/papers/2010/framework_ethical_research/

Policy (cont)



- Empirical Internet research to Support Policy
 - Advising Regulators on “Network Neutrality” regulation
 - Historical and Architectural context for Internet Traffic Management (relied heavily on .JP and .CA examples)
 - kc claffy, “**Historical and Architectural Context for Traffic Management Needs Today**”, presented at the FCC Technical Advisory Process workshop on December 8, 2009.
http://www.caida.org/publications/presentations/2009/traffic_historical_context/

Workshops



- Active Internet Measurement Systems (AIMS)
- Workshop on Internet Economics
- Joint workshop with WIDE/CASFI

<http://www.caida.org/workshops/>

slides



Please email your slides to CAIDA.

- webmaster@caida.org
- talk title:
- author name:
- workshop:CAIDA-WIDE-CASFI
- topic:

active data, bandwidth estimation, data, dns, eductation, measurement methodology, overview, peer-to-peer, routing, security, software/tools, topology, trends, visualization, workshop report