Historical and architectural context for traffic management needs today

kc claffy
UCSD/CAIDA
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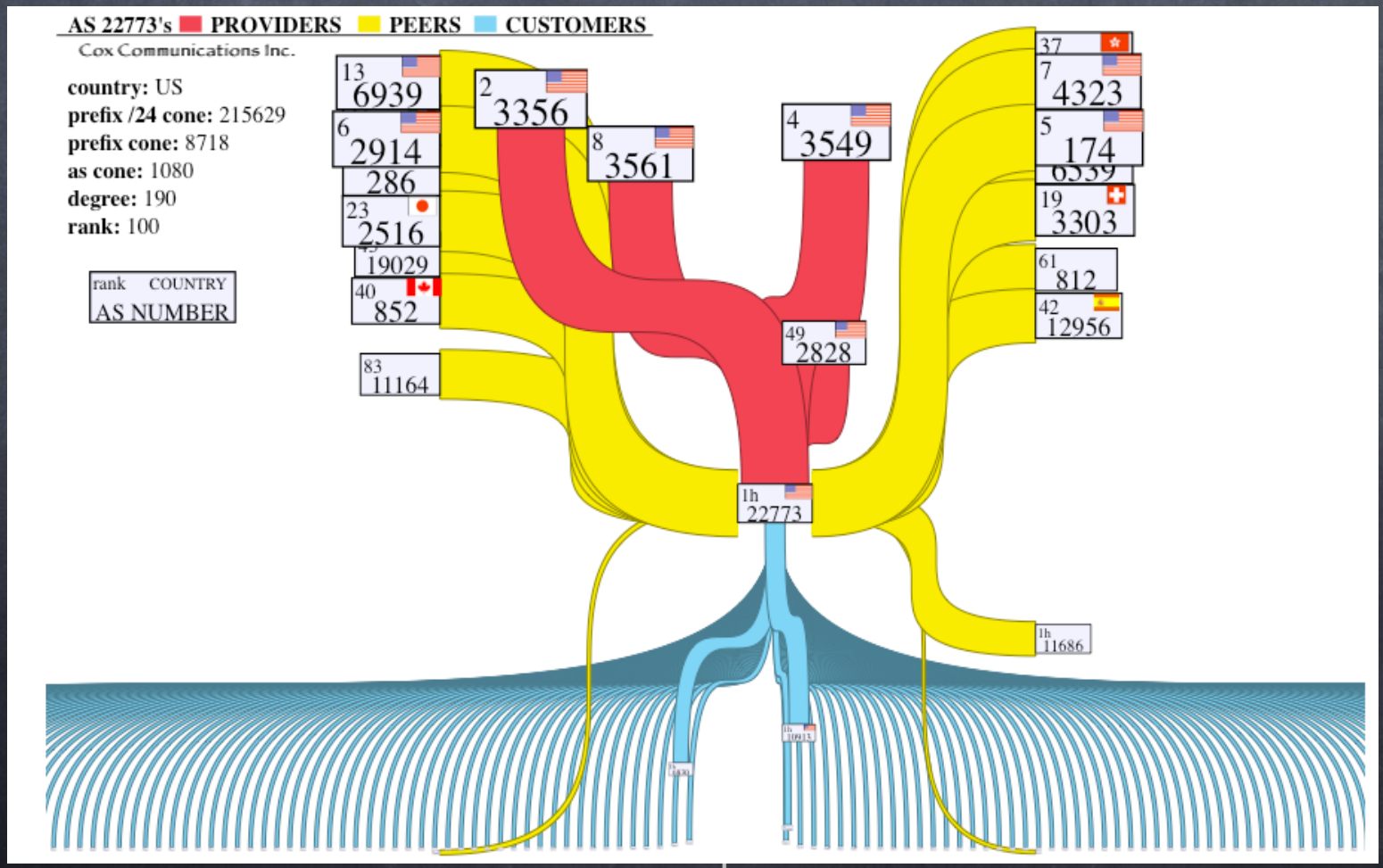
FCC
Washington D.C.
Tech Advisory Wkshp



Executive Summary

- *Status report on "what do we know about traffic management, in historical and architectural context?"*
- *Recommend in short term to protect private property rights as well as consumer/citizen/user rights: transparency, objective data obligations*
- *Recommend in longer term to guide FCC, an Interdisciplinary advisory function*
- *Segmenting technology, policy, and economic advice is a recipe for failure: the Internet connects it all.*

My background

- studying Internet science since 1990
- scoping an (inter)discipline (&community)
- traffic management not a new concern
  - 1993: published "*Mitigating the Coming Internet Crunch*", interdisciplinary work: mgt prof, NSFNET PI (Mich), & PM (NSF)
    http://www.caida.org/publications/papers/1994/mcic/
    (more on this one later)
  - 1994: I*nternet traffic characterization* (thesis, using public traffic data whose collection was mandated by the US govt. researchers cannot reproduce today, unless you're in .jp)

Today we're asking the same questions.

Historical perspective

1966: Larry Roberts, "Towards a Cooperative Network of Time-Shared Computers" (first ARPANET plan) (← still using the same stuff)

1969: ARPANET commissioned by DoD for research

1977: Kleinrock's paper "Hierarchical Routing for large networks; performance evaluation and optimization" *(← still using the same stuff)*

1980: ARPANET grinds to complete halt due to (statusmsg) virus

1986: NSFNET backbone, 56Kbps. NSF-funded regionals. IETF, IRTF.

1991: CIX, NSFNET upgrades to T3, allows .com. web. PGP.

1995: under pressure from USG, NSF transitions backbone to competitive market. no consideration of economics or security. i start caida.

2005: *The Economist* cover: "*How the Internet killed the phone business*" (Sept.);

Local access monopolies buy back AT&T backbone

2006: common carriage and essential facilities obligations diminished in U.S.

2009: Comcast buys NBC, offers paid peering to other content providers

So you can imagine, the answers might have changed.

What didn't change?

Network architecture: still using an architecture built for a cooperative file-sharing environment and relatively low bandwidth applications.

Routing architecture: still using an architecture built for a network shape (topology) we don't have anymore (see http://www.caida.org/data/active/ipv4_routed_topology_aslinks_dataset.xml)

Addressing architecture: and we're almost ***out***!

Transport architecture: although experimentation increases

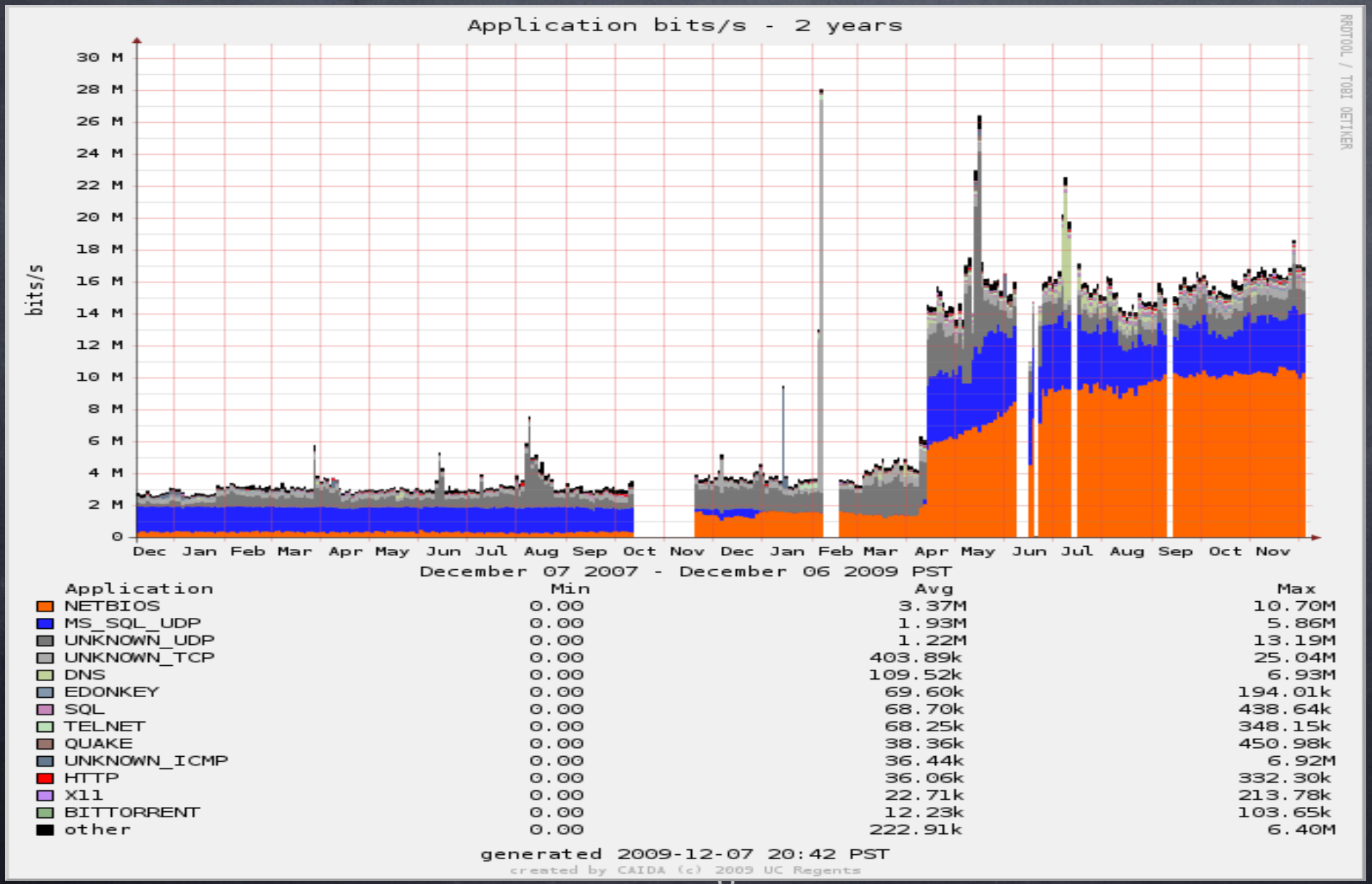
Naming architecture: depends how you measure.

Economic architecture: moving packets still unprofitable endpoints necessarily send/receive much unwanted traffic

Security, Scalability, Sustainability, Stewardship: all still in “painfully incremental” progress

Unwanted traffic

(to address with no machines on them..several GB/hr)



What also hasn't changed

"In such situations of moderate scarcity, however, not all people can have whatever means of communications they want. The means are rationed. The system of rationing may or may not be equitable or just. There are an infinity of ways to partition a scarce resource – egalitarian.. meritocratic.. [recognizing] privilege.. cultural values .. [rewarding] skill and motivation, as that which allows communications institutions to earn profits that depend on their efficiency."

Ithiel de Sola Pool, Technologies of Freedom, 1983, p.240.

What did change?

Industry structural trajectory: inverted from telephone
Bandwidth provisioning efficiency: exponential increase (annually!) in optical multiplexing efficiency (fiber)
Data processing/storage efficiency: also Moore's law'ed
Access provisioning: private, unregulated, opaque
Peering models: voluntary, secret, conditional
Naming provisioning: competitive, unregulated, insecure
Address provisioning: about to experiment with unregulated private ownership of yet another critical input.
Pricing models: monotonic increases, metering emerging
Data access: only select data released, to a select few, under strict NDA
Innovative uses of the network: it has only just begun

What did we recommend in 1993?

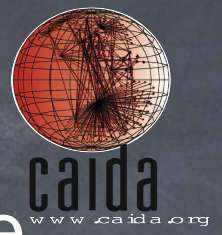
Simple, cooperative solution, using existing fields of IP packet, and wildly academic assumptions. *But we did warn that current architecture was living on borrowed time!*

Subsequent cooperative inter-domain (i.e., competitive) solutions never got traction, convincing operators that academics were losing touch with industry reality. (fortunately we are starting to learn economics)

Intra-domain, the “reasonable traffic management” problem was solved and deployed in a decade. (ask cisco)

→ across ISP's, it's not a technical problem.

What did we recommend in 2009?



- What do we not know about critical infrastructure conditions?
  - Penetration, Peering, Performance, Pricing
- ...and critical infrastructure circumstances?
  - Security, Scability, Sustainability,Stewardship
- Essential: transparency into evolution of economics, traffic, topology, routing. leverage other (local, nsf, dhs) sources
- Openness ideals: enforceable language, experiments that will not happen o/w
- *"To evaluate claims about need for additional revenues... one needs solid cost data and a dynamic model of the industry. At the moment we do not have either one." -amo*

What did NTIA recommend in 2009?

Language on data collection that survived sausage-making into NOFA for $7B broadband funds (not implemented, afaik)

Awardees receiving Last Mile or Middle Mile Broadband Infrastructure grants must report, for each specific BTOP project, on the following:

i. The terms of any interconnection agreements entered into during the reporting period;

ii. Traffic exchange relationships (e.g., peering) and terms;

iii. Broadband equipment purchases;

iv. Total & peak utilization of access links;

v. Total & peak utilization on interconnection links to other networks;

vi. IP address utilization & IPv6 implementation;

vii. Any changes or updates to network management practices.

In lieu of data...

Prevailing risk

Must not incentivize anti-competitive/artificial scarcity-based technologies, i.e., business strategies (as opposed to pro-growth & innovation-driven strategies)

Elephants in room:

1) (private) platform still exhibits natural monopoly economics, 13 years after we legislated otherwise
2) Wire (and wireless) spectrum allocations determined by same tiny handful of facilities owners with monopoly power over network access
3) Lack of transparency prevails: Comcast imposes metering with no tool to measure usage: (released in portland 1 dec, so going in right direction)

Legal status of Internet traffic?

U.S. law does not speak to the legal status of network traffic

(ECPA is about privacy, not equality, and has exceptions to drive a lot of TCP RSTs through, which are not pre-empted by sec 512 of telecomm act (common carrier exception))

- significance of regime matters: private property rights: more absolute (much stronger in U.S.); IP rights: has limits like 'fair use'

none of this resolved in courts yet (and judges are inherently efficient arbiters)
(elephant #4)

What we know about QoS technology, economics, and transparency

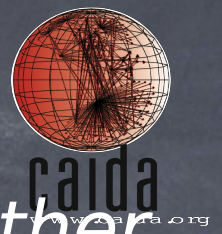
- Inability to study real networks led to unresolvable “scientific” contradictions
- Unresolved: what are costs and benefits of using QOS to support tiered service, to users as well as providers, and how should these service classes be determined?
- Internet2 has stated QoS is a waste of money.
  - Apparently based on their own economics http://qos.internet2.edu/wg/documents-informational/20020503-premium-problems-non-architectural.html
- ATT's insists QoS is critical, but offers no data

  http://web.si.umich.edu/tprc/papers/2007/786/Evolving%20Internet.pdf
- but publishing lot of data on behavioral advertising..

Scientific researchers have not solved the "empirical grounding" problem

- DHS S&T realizes our dearth of empirical understanding of the infrastructure is a national security and public safety problem.
- Working on ameliorating the data-sharing problem (PREDICT project)
- *"Dialing privacy and utility: a proposed data-sharing framework to advance Internet research"*, submitted to IEEE
- *"Ethical Principles and Guidelines for the Protection of Human Subjects of Info. & Communications Technology (ICT) Research"*, writing group finished 2nd meeting last week

Over-honest Cogent report



"In our pricing strategy we compete with other Internet service providers, but..a more global question is the Internet's competition with other forms of telecommunications and that is broadly defined to also include things such as DVD distribution via the mail. ...it is critical that Internet transit prices continue to fall in order to accelerate the adoption of these new business models and increase traffic growth on the Internet in its entirety."

http://seekingalpha.com/article/172306-cogent-communications-group-q3-2009-earnings-call-transcript?page=-1

[except the USPS is bound by a public charter that dictates profit minimization, while the carriers are bound to profit maximization... but enough about elephants]

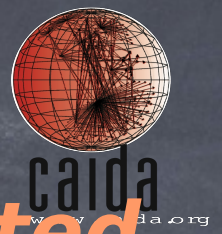
International case: JP deliberations

- Guideline for Packet Shaping, May 2008
  http://www.jaipa.or.jp/other/bandwidth/guidelines_e.pdf
- goal: *In what circumstances is it acceptable to implement packet shaping?*
- Clarifies relationship between “secrecy of communications” and fairness in use under the Business Law by citing specific examples.
- allows packet shaping to
  - (1) facilitate necessary network management
  - (2) protect users

    {similar to US exceptions to ECPA}
- not legally binding, only “industry consensus”.

  (like their traffic data contributions)

.jp industry agreement:



packet shaping should be implemented only in exceptional circumstances!

1) must be in response to congestion of specific heavy users that is degrading, or is likely to degrade service of general users.
2) must be substantiated by objective data (!)
3) admit terms not rigorous, so provide case studies
4) for example, content examination, e.g., looking for copyright infringement based on payload, is ***not*** deemed reasonable (can't do it accurately for a single user, can't do it reasonably for all users)
5) for example, measures against security issues in p2p software should about protecting users, and require informed consent.

Japanese strong notion of “secrecy of communications”

- Broad scope: includes content, names, locations, timestamps, headers, and other artifacts of individuals.
- Acts of infringement include intentionally gaining knowledge of matters that fall under secrecy of comm and use to one's own or another's interests against the parties of original communication.

Is traffic shaping lawful:
3 criteria for ISP's in Japan

1) Legitimacy of purpose: in light of the nature of the business of ISPs, etc.
2) Necessity of action: supported by objective data!
3) Validity of means: Method aims only at (objectively demonstrated) necessity.

Or, user consent (assumes competitive access environment)

Issues for further (.jp) study

1) increase in video content
2) Impact of packet shaping on access networks (bandwidth reduced)
3) Application-specific packet-shaping
4) Paid peering for content (problematic as ISP's expand into content, “in view of ensuring an environment for fair competition”)
5) Information-sharing among players regarding packet shaping implementation
6) P2P protocol efficiency improvement

International case: next door, oct09

- Canada's CRTC requires Internet service providers to be more transparent about their Internet traffic management practices, Oct 2009.
  http://www.crtc.gc.ca/eng/NEWS/RELEASES/2009/r091021.htm
  http://www.wetmachine.com/totsf/item/1692 (kudos to FCC)
- Not only similar to spirit of FCC's reaction to this problem, but congruent with Japan's
  - Minimize harm.
  - Transparent (!) need.
  - Narrowly-tailored (technically “efficient”)
- Challenge: ultimately about defining “reasonable”
  - But targeting content or apps not allowed
  - Base techniques on quantifable data; quantify it

User classification

Goal-oriented stakeholder classes:

- *Open-ists:* preserve e2e+innovation
- *Deregulation-ists:* incent investment
- *Nondiscrimination-ists:* best-of-both-worlds: innovation and investment without oppressive market power or intrusive regulation

Process-oriented stakeholder classes:

- *Vigilant-ists: "t*he price of freedom is eternal..."
- *Erosion-ists*: "by patiently evading and challenging all regulations, we help the system distinguish between the essential and optional"
- *Pollyanna-ists*: "it'll be different this time"

Executive Takeaway

- *Reality: someone needs to pay for infrastructure*

- Recommend in short term to protect private property rights as well as consumer/citizen/user rights: transparency, objective data obligations
- *"To evaluate claims about need for additional revenues... one needs solid cost data and a dynamic model of the industry. At the moment we do not have either one."*
- Nearby case studies suggest FCC asking the right questions, still awaiting fact-based suggestions and explanations for pricing changes
- Entire disciplines, e.g., internet research, qos, could meet their demise if marketed in the absence of legitimately independent review.

References

- *FCC NPRM, FCC-09-93A1.pdf, DA-09-2474A1*
- *Andrew Odlyzko's writings, various*
- *Erin Kenneally, UCSD*
- *Tom Vest, RIPE consultant*
- *Harold Feld, wetmachine essays*
- *Scott Jordan, UC Irvine CS*
- *Dave Clark, "Internet of the Future"*
- *Ivan Seidenberg, Supercomm2009 keynote*
- *Japan's "Guideline for Packet Shaping"*
- *Telecom Regulatory Policy CRTC 2009-657*
- *http://networkmanagement.comcast.net*