

the Internet as emerging critical infrastructure: what needs to be measured?

cooperative association for internet data analysis

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oecd workshop on the future of the internet

outline of talk

what is critical infrastructure

top problems of Internet

historical context (incongruity)

what have we learned and how can we apply it?

[case study: scalability (separate talk)]

what we (all) can do to help

critical infrastructure

what is it? how does it get that way?

what are common characteristics?

is the Internet one? or will it be soon?

what are the implications for public and private sectors?

underlying goals: innovation, economic strength, democracy, freedom, science, arts, society.

it really is about living in a better world...

16 operational internet problems

- security
- authentication
- spam
- scalable configuration management
- robust scalability of routing system
- compromise of e2e principle
- dumb network
- measurement
- patch management
- “normal accidents”
- growth trends in traffic and user expectations
- time management and prioritization of tasks
- stewardship vs governance
- intellectual property and digital rights
- interdomain qos/emergency services
- inter-provider vendor/business coordination

persistently unsolved problems for 10+ years
(see presentations at www.caida.org)

top Internet problems

why we're not making progress

- top unsolved problems in internet operations and engineering are rooted in **economics, ownership, and trust (EOT)**.
- even the most theoretical computer scientists are convinced.

note: does not mean there are not useful technical problems to work on.

but there will be no technical solutions to these problems that don't solve the EOT issues.

historical context

1966: Larry Roberts, “Towards a Cooperative Network of Time-Shared Computers” (first ARPANET plan)

(we are 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”

(we are still using the same stuff)

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

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

IETF, IRTF. MX records (NAT for mail)

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. kc proposes caida.org

2005: *The Economist’s* cover story: “How the Internet killed the phone business” (September)

what have we done?

we replaced a critical infrastructure with something not designed to be critical infrastructure

historical context explains it but does not address incongruities

and this decade, free markets go up against free speech

what have we learned?

- most important thing we've learn so far: society has decided IP is like water.
- strong implications for an industry structuring itself to sell wine. but that's what the data shows.
- when you want to move water, you care about 4 things: safe, scalable, sustainable, stewardship.

the 4 S's

- **safety**: is the data toxic upon arrival?
- **scalable**: can we route/name/address earth's needs?
- **sustainable**: is it economically viable?
- **stewardship**: will the provisioning and legal frameworks we choose leave our children -- and democracies -- better or worse off?

none of these are purely technical issues,
but they all require deep technical (among other)
understanding to get right.
and they're all connected.

how have we done?

- how safe is the Internet?
 - data doesn't look good
- how scalable is the Internet?
 - data doesn't look good
- how sustainable is the Internet?
 - data doesn't look good
- how did we do on stewardship?
 - data doesn't look good

failure (to measure progress) on 4S's poses risks to economics and democracies:

- that we won't learn from our own history. e.g., not only don't we understand the economics, but we don't understand that we don't understand the economics, and thus must set policy based on unvalidated assumptions
- that we will design another architecture with no actual plan for economic sustainability (much less incenting further innovation in a competitive market!)
- that other forces will "code" innovation into the architecture (free markets vs free speech)

there is good news

- we made something so great, everyone wants it.
- in fact many of us want it more than once! (um..)
- the current industry is a historical artifact of technical and (science & regulatory) policy 'innovations' in the 60s, 70s, 80s, 90s, and 00s
- people are starting to study interplay, but they're undercapitalized
- in the meantime, it became global critical infrastructure. oops.

“science of the Internet”

The wonderful thing about science is that eventually nature tells you when you are fooling yourself. real objects can be measured again and measured by somebody else – false signals will eventually be weeded out.

Robert Kirshner, The Extravagant Universe

but if what you need to measure is economics..

Knowing what to measure and how to measure it makes a complicated world less so. if you learn how to look at data the right way, you can explain riddles that otherwise might have seemed impossible.

Steven Levitt, Freakonomics

understanding and enlightened evolution of the Internet

(1) sound measurement and analysis methodologies were, are, and will always be the key to enlightened policy.

(2) the free market has failed thus far to achieve these goals.

questions, comments
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