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

cooperative association for internet data analysis

10 sept 07

kc@caida.org

outline of talk

the Internet becomes critical infrastructure...

top problems of Internet

historical context (incongruity)

what have we learned and how do we apply it?

[asking: dhs, ncs, nist, doe, fcc, ftc, nsa, gao, nsf]

what we (all) can do to help

The Twenty Most Critical Interne

Version 6.01 Nov

Questions /

To link to the Top 20 List, use

AccessIT GROUP

-----Jump To Index of Top 20 Vulnerabilities -----

Introduction

The SANS Top 20 Internet Security Vulnerabilities

Four years ago, the SANS Institute and the Nation
Center (NIPC) at the FBI released a document sum
Internet Security Vulnerabilities. Thousands of org
expanded Top-20 lists that followed one, two, and
their efforts so they could close the most dangero
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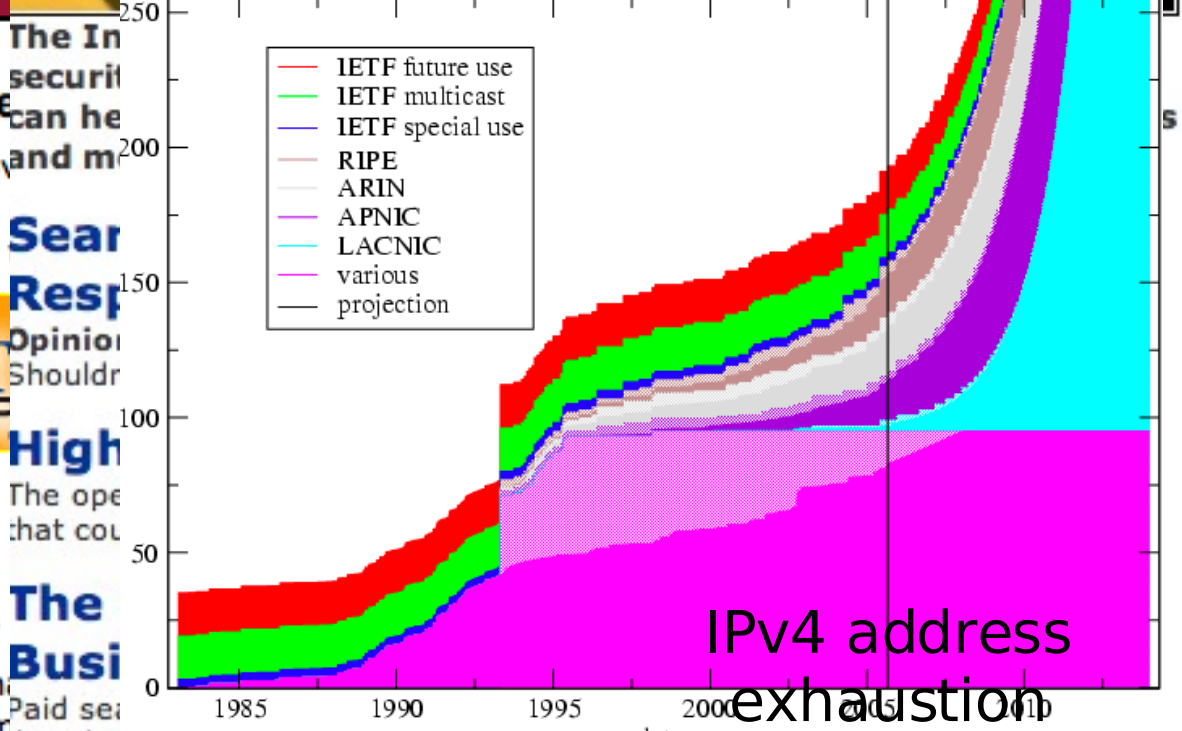

IPv4 address exhaustion

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there's a major downside for users. A new study by McAfee's SiteAdvisor finds sponsored search results contain two to four times as many dangerous sites as organic results.

Adobe Plugs Dreamweaver SQL Injection Flaw

Home >> China

China adds top-level domain names

China's Ministry of Information domain name system in accor Regulations.

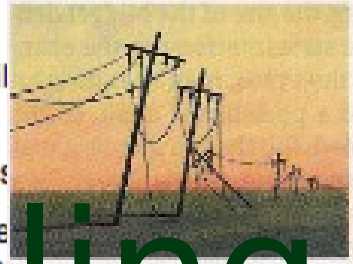
After the adjustment, ".MIL" wil "CN".

A new Internet domain name s

Under the new system, besi "NET" are tempo arily se It servers under the manageme Numbers (ICANN) of the Unite

How the internet killed the phone business

Almost-free internet phone calls herald the slow death of traditional telephony



THE term "disruptive technology" is popular, but is widely misused. It refers not simply to a clever new technology, but to one that undermines an existing technology—and which therefore makes life very

market, as the marginal price of making phone calls heads inexorably downwards.

VOIP makes possible more than just lower prices, however. It also means that, provided you have a broadband connection, you can choose from a number of providers of VOIP telephony and related add-on services, such as voicemail, conferencing calling or video. Many providers allow a VOIP account to be associated with traditional telephone numbers, with multiple numbers. So you can associate a San Francisco number, a New York number and a London number with your computer or VOIP phone—and then be reached via a local call by anyone in any of those cities.

Furthermore, your phone (or computer) will ring wherever

falling bits of sky

International Telecommunication Union

Building Partnerships for Progress

All match

More

Home : Office of the Secretary General : SPU

Next Generation Networks

Home: OECD > OECD ICCP Workshop: "The Future of the Internet", Paris, 8 March 2006

OECD ICCP Workshop: "The Future of the Internet", Paris, 8 March 2006

Send Print

IPv6

From Wikipedia, the free encyclopedia

Internet Protocol version 6 (**IPv6**) is a network layer standard used by electronic devices to exchange data across a packet-switched internetwork. It follows IPv4 as the second version of the Internet Protocol to be formally adopted for general use.

IPv6 is intended to provide more addresses for networked devices, allowing, for example, each cell phone and mobile electronic device to have its own address. IPv4 supports 4.3×10^9 (4.3 billion) addresses, which is inadequate to give one (or more if they possess more than one device) to every living person. IPv6 supports 3.4×10^{38} addresses, or 5×10^{28}(50 octillion) for each of the roughly 6.5 billion people alive today.

Invented by Steve Deering and Craig Mudge at Xerox PARC, IPv6 was adopted by the Internet Engineering Task Force in 1994, when it was called "IP Next Generation" (IPng). (Incidentally, IPv5 was not a successor to IPv4, but an experimental flow-oriented streaming protocol intended to support video and audio.)

THE INTERNET.COM

Fight for Internet Freedom

the coalition f.a.q. press

THE LATEST....

Moby Speaks Out on Internet Freedom

At a press event in Washington today, Grammy-nominated musician Moby (along with

RESEARCH CENTER:

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NetworkWorld.com > Convergence / VoIP >

What IMS promises enterprises and carriers

Internet Protocol Multimedia Subsystem called key to converged, expanded services.

By Stephen Lawson, IDG News Service, 09/26/05

here we are

[Dr.] Clark.

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sundry "solutions"

public sector resuming inquiry

DHS: data to validate security tools, SBGP, DNS
NIST: ways to measure DNSSEC penetration
DOE: way to estimate available bandwidth
FCC: way to measure outage
FTC: how to inform network neutrality debate
NCS/NSA: topology data for information assurance
GAO: cost of Internet katrina
NSF: can’t we just start over and do it right?

entire muni & community wireless networking movement....

The Future of the Internet

In a decade, the Net will dig deeper into our lives.

April 10, 2006 Issue

Credit: Dave Cutler

http://www.redherring.com

"While the business case for the carriers may be disappearing, a host of new business and investment opportunities is being created with far greater economic wealth creation," Mr. Arnaud writes in his blog. "Our biggest concern is that governments will be distracted by the complaints of the old industry such as carriers and penalize the new economy industries of the Internet."

"We don't presently have a roadmap of where we are trying to go with the Internet," says MIT's Mr. Clark. Instead of worrying about backward compatibility and migration issues, the focus has shifted to "where we would like to be in 10 to 15 years," he explains. "If the story is compelling enough, people will figure out how to get there."

National Science Foundation
DIRECTORATE FOR
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The GENI Initiative

The Directorate for Computer and Information Science and Engineering (CISE) is planning an
Environment for Networking Innovations or GENI to explore new networking capabilities that
stimulate innovation and economic growth. The GENI Initiative responds to an urgent and imp
Century to advance significantly the capabilities provided by networking and distributed syste

The GENI Initiative envisions the creation of new networking and distributed system architectu

- Build in security and robustness;
- Enable the vision of pervasive computing and bridge the gap between the physical
  mobile, wireless and sensor networks;
- Enable control and management of other critical infrastructures;
- Include ease of operation and usability; and
- Enable new classes of societal-level services and applications.

The GENI Initiative includes:

- A research program; and
- A global experimental facility designed to explore new architectures at scale.

CISE is encouraging a broad community effort that engages other agencies, other countries, a

THE GENI RESEARCH PROGRAM

(US) NSF's hand

top Internet operational 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)

why we're not making progress

- if providers are broke, they can't invest in long-term health of infrastructure.
- so add to list of problems: **sustainability**
- top unsolved problems in internet operations and engineering are rooted in **economics, ownership, and trust (EOT).**

does not mean there aren't useful technical problems to study. 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. kc gives first talk on net to ATT.

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

result: free markets up against free speech

network economics: dismal science(s)

known: economics of current architecture need study

- have never been a priority.
- conversations for last 15 years have been private
- enlightened policy impossible

our misunderstanding the economic architecture threatens an architecture we hold much more dear..

[how] can the academic community help?

cataloguing lessons

- although the Internet has over-achieved on plenty, it has underachieved on: security, scalability, sustainability, and stewardship. substantial oversights.
- our ability to measure is surprisingly abysmal, although policy history explains
- cooperative, data-sharing approaches to sound measurement and analysis are key to enlightened policy

we have learned more from our failures than from our successes...

the 4 S’s of critical infrastructure

- 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 are purely technical, but all require technical 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 economies & democracies:

- that we won't learn from our own history, won't admit 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

not that we haven’t been trying

e.g., all caida projects are on the 4 S’s:

1) safety: security, DNS, PREDICT, telescope
2) scalability: routing and topology research
3) sustainability: EOT, DNS, COMMONS
4) stewardship: address consumption, trends, all measurement & data activities

measurable progress on real Internet eludes us

NAS report on ‘network science’

1) networks are everywhere and thus important

2) we don't yet have any predictive power over complex networks

3) funding situation backwards: domain-specific (splintered) rather than fundamental

NAS report on ‘network science’

identifies as top three challenges:

1) characterization of dynamics and information flow in networked systems

2) modeling, analysis, and acquisition of experimental data for extremely large networks

3) rigorous tools for the design and synthesis of robust, large-scale networks

http://fermat.nap.edu/books/0309100267/html

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.

measurement accuracy is the only fail-safe means of distinguishing what is true from what one imagines, and even of defining what true means.

..this simple idea captures the essence of the physicist's mind and explains why they are always so obsessed with mathematics and numbers: through precision, one exposes falsehood.

a subtle but inevitable consequence of this attitude is that truth and measurement technology are inextricably linked.

-- robert b laughlin, a different universe,