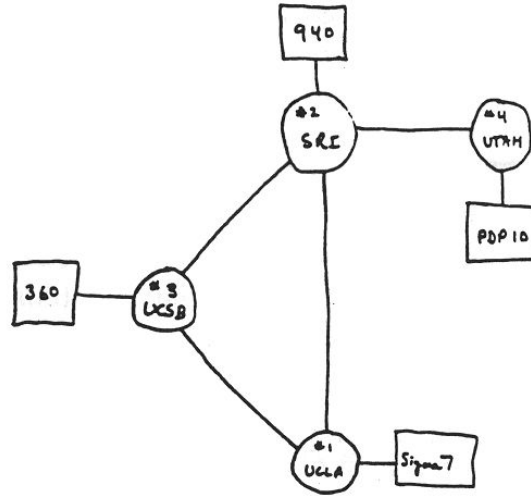


Internet History

Brief History of the Internet

- ARPANet (1966-67)
 - Goal: Network academic computers
 - UCLA, SRI, UCSB, Utah (1969)
- NPLNet in the UK around the same time
- 1971 → ~20 ARPANet nodes

Brief History of the Internet



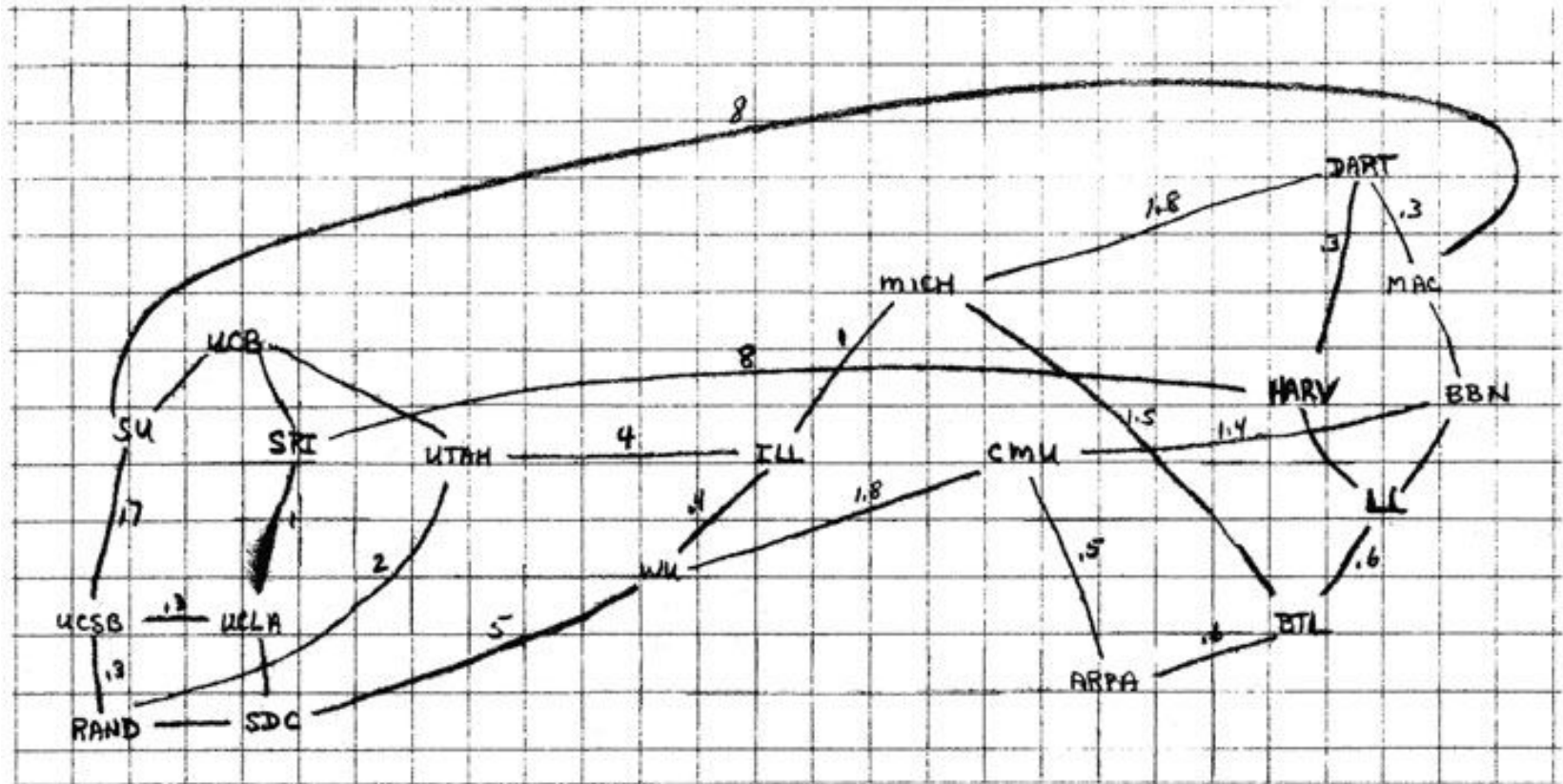
THE ARPA NETWORK

DEC 1969

4 NODES

FIGURE 6.2 Drawing of 4 Node Network
(Courtesy of Alex McKenzie)

Brief History of the Internet



Brief History of the Internet

Aloha Communications System Connects Hawaii to Arpanet

By Sasha Yasnin
Our Hawaii Correspondent

HONOLULU — The University of Hawaii's Aloha system is scoring innovative advances in satellite computer communications with an experimental satellite system which went on-line here recently.

The university also is involved in a joint study with the Advanced Research Projects Agency (Arpa), Bolt Beranek and Newman, Xerox and UCLA to design

Experimenting With Aloha

suitable protocol for packet communications via satellite.

As part of this project, Aloha becomes the first subscriber to a digital communications subsystem installed between the Comsat ground stations at Fausch, Hawaii, and Jamesburg, Calif., last year.

With this installation Aloha becomes the first operational satellite node on Arpanet, via the Intelsat IV satellite over the Pacific.

The Comsat system enables data to be transmitted at the rate of 50 kbit/sec over a single voice-grade channel.

The single satellite channel can provide two up-link and two down-link data channels and each of these four channels could be simultaneously available to any

Comsat ground station in sight of the satellite.

Aloha's director, Norman Abramson, sees the use of voice-grade channels as a big money-saver for computer communications.

As an example of the system's cost-saving potential, Abramson pointed to the possibilities in the next generation domestic satellite system.

"Each of these satellites," he told Computerworld, "will have 12 transponders with a bandwidth of 45MHz or so. If one of the potential carriers were to devote one transponder on the satellite to packet communications, it would be possible to transmit data at about 10 million baud. This single transponder could handle some five million on-line terminals."

"Covering to this kind of communications could save a lot of money. For example, Arpa spends in excess of \$1 million per year for line charges. With this much money it could buy a transponder on a domestic satellite.

"If computer users are ever going to be free of incredibly high costs of transmitting data, some system similar to this has got to be set up," Abramson said.

But Abramson foresees difficulties with potential carriers in the next generation system devoting a transponder to packet data communications. He sees problems with regulatory agencies in determining how to charge for the service.

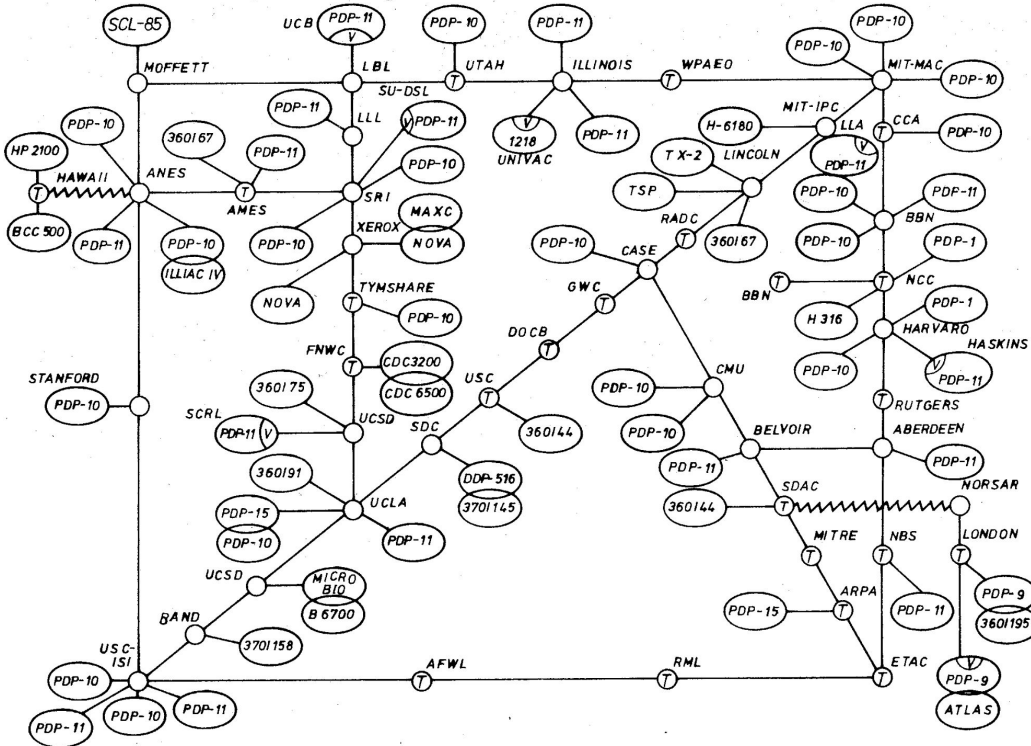
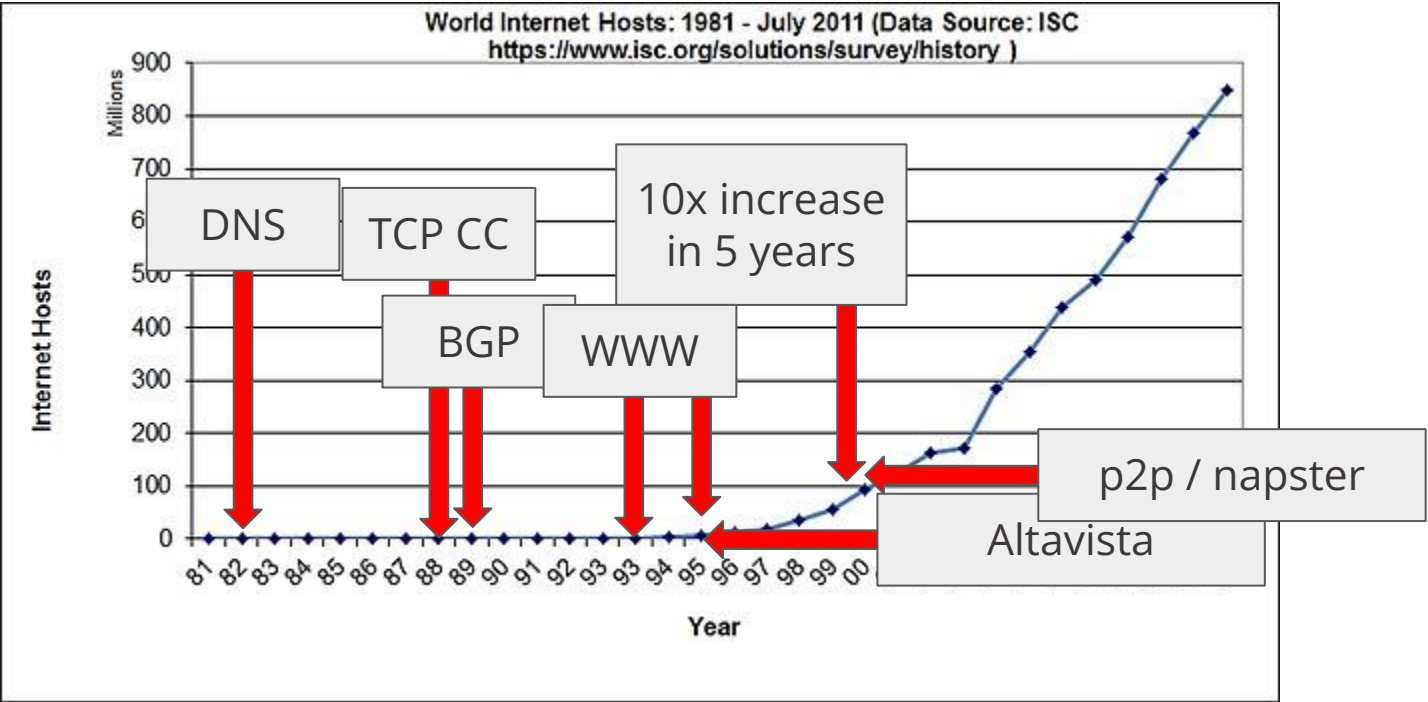
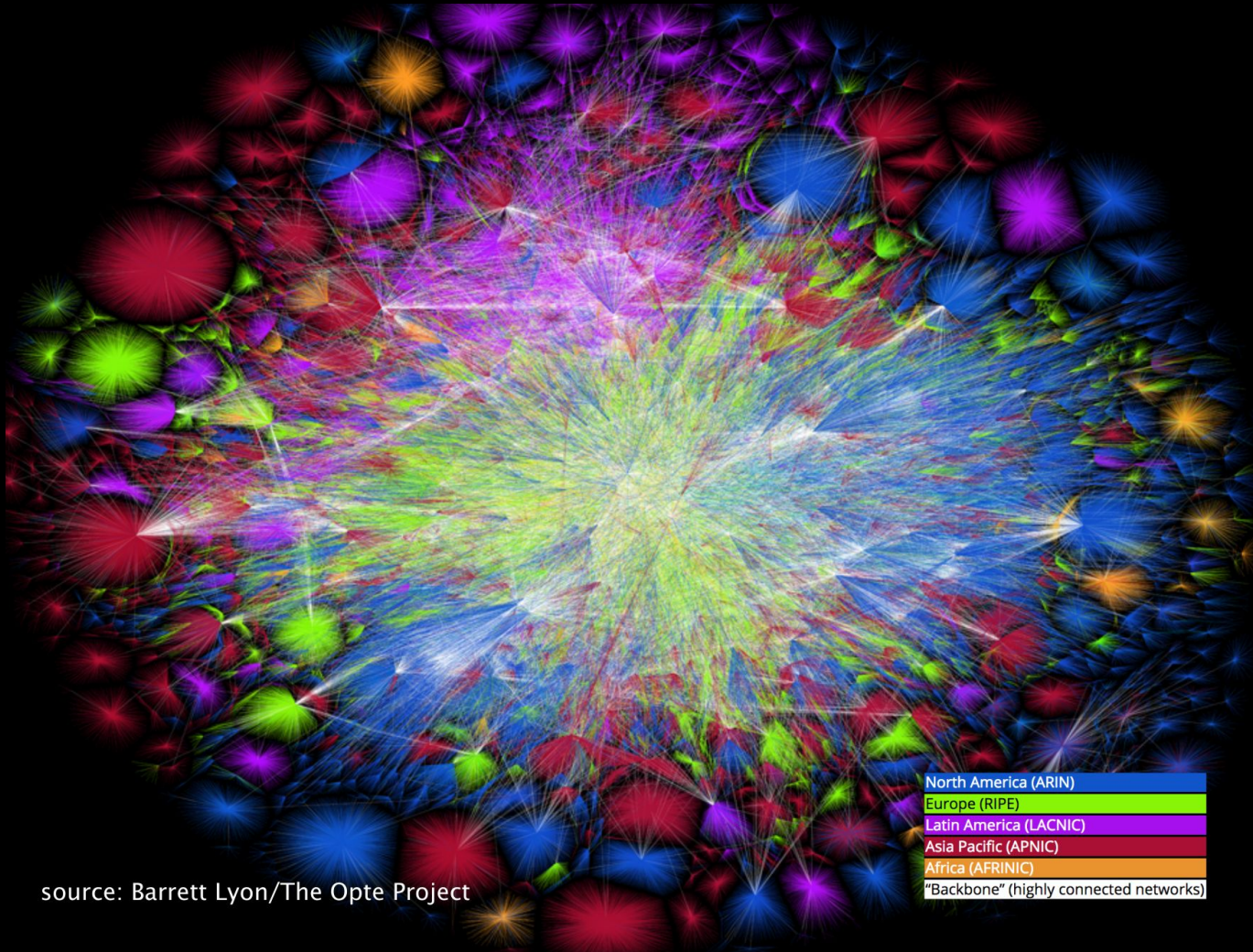


Abb. 4 ARPANET, topologische Karte. Stand Juni 1974.

Brief History of the Internet





source: Barrett Lyon/The Opte Project

North America (ARIN)
Europe (RIPE)
Latin America (LACNIC)
Asia Pacific (APNIC)
Africa (AFRINIC)
"Backbone" (highly connected networks)

Problems and Growing Pains

- Out of addresses (IPv4 only allows for 2^{32} addresses)
- Congestion control
- Routing: no security, easily misconfigured, poor convergence, non-deterministic
- Security: bad at key mgmt, secure software development
- DoS: too easy to send traffic to a destination

The Internet is Massive

- ~22 billion estimated # of Internet connected devices in 2020
- ~30 billion estimated # of Internet connected devices in 2023
- ~4 exabytes **daily** global traffic in 2017

The Internet is Massive

If



= 1 Gigabyte

The Internet is Massive



volume(Great Wall of China) = 1 exabyte

The Internet is Massive

- ~22 billion estimated # of Internet connected devices in 2020
- ~30 billion estimated # of Internet connected devices in 2023
- ~4 exabytes **daily** global traffic in 2017
- ~13 exabytes **daily** global IP traffic in 2022

The Internet is Massive

- ~75% of all Internet traffic is video in 2017

The Internet is Massive

- ~75% of all Internet traffic is **video** in 2017

Upstream		Downstream		Aggregate	
BitTorrent	18.37%	Netflix	35.15%	Netflix	32.72%
YouTube	13.13%	YouTube	17.53%	YouTube	17.31%
Netflix	10.33%	Amazon Video	4.26%	HTTP - OTHER	4.14%
SSL - OTHER	8.55%	HTTP - OTHER	4.19%	Amazon Video	3.96%
Google Cloud	6.98%	iTunes	2.91%	SSL - OTHER	3.12%
iCloud	5.98%	Hulu	2.68%	BitTorrent	2.85%
HTTP - OTHER	3.70%	SSL - OTHER	2.53%	iTunes	2.67%
Facebook	3.04%	Xbox One Games Download	2.18%	Hulu	2.47%
FaceTime	2.50%	Facebook	1.89%	Xbox One Games Download	2.15%
Skype	1.75%	BitTorrent	1.73%	Facebook	2.01%
	69.32%		74.33%		72.72%




Table 1 - Top 10 Peak Period Applications - North America, Fixed Access

The Internet is Massive

- ~75% of all Internet traffic is video in 2017
- ~82% of all Internet traffic is video in 2022

The Internet is Political

≡ **WIRED** BACKCHANNEL BUSINESS CULTURE GEAR IDEAS SCIENCE SECURITY

LILY HAY NEWMAN SECURITY 08.10.2020 06:13 PM

Belarus Has Shut Down the Internet Amid a Controversial Election

Human rights organizations have blamed the Belarusian government for widespread outages.



<https://www.wired.com/story/belarus-internet-outage-election/>

The Internet is Political

BBC | Sign in | Home | News | Sport | Reel | Worklife | Trav

NEWS

Home | Coronavirus | Video | World | UK | Business | Tech | Science | Stories | Entertainment & Arts | Health

Asia | China | India

Myanmar coup: How the military disrupted the internet

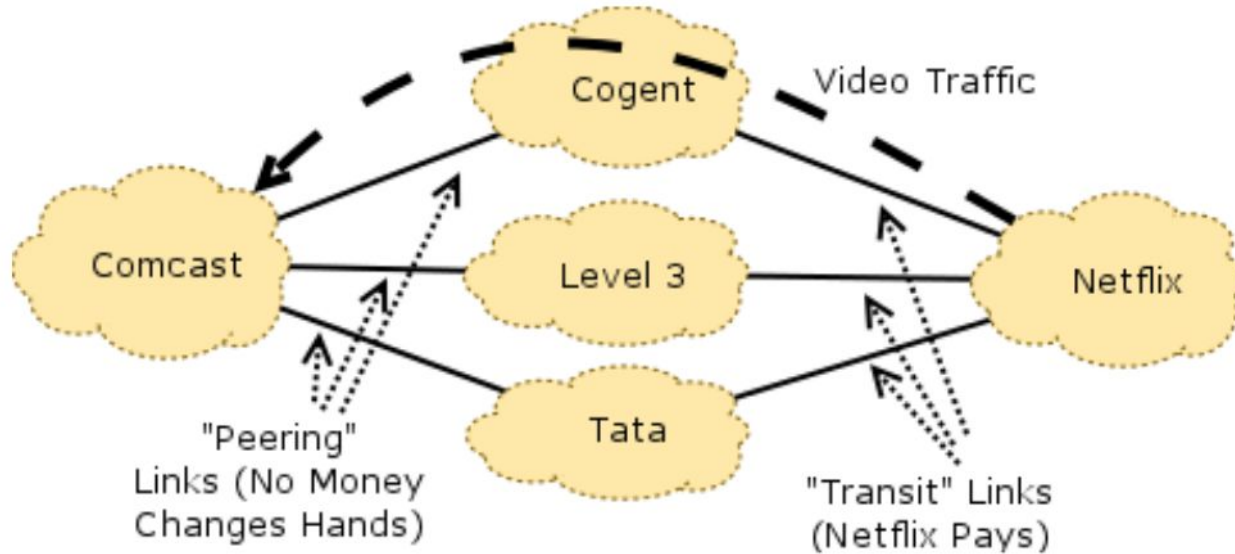
By Christopher Giles
BBC Reality Check

4 February

 Reality Check

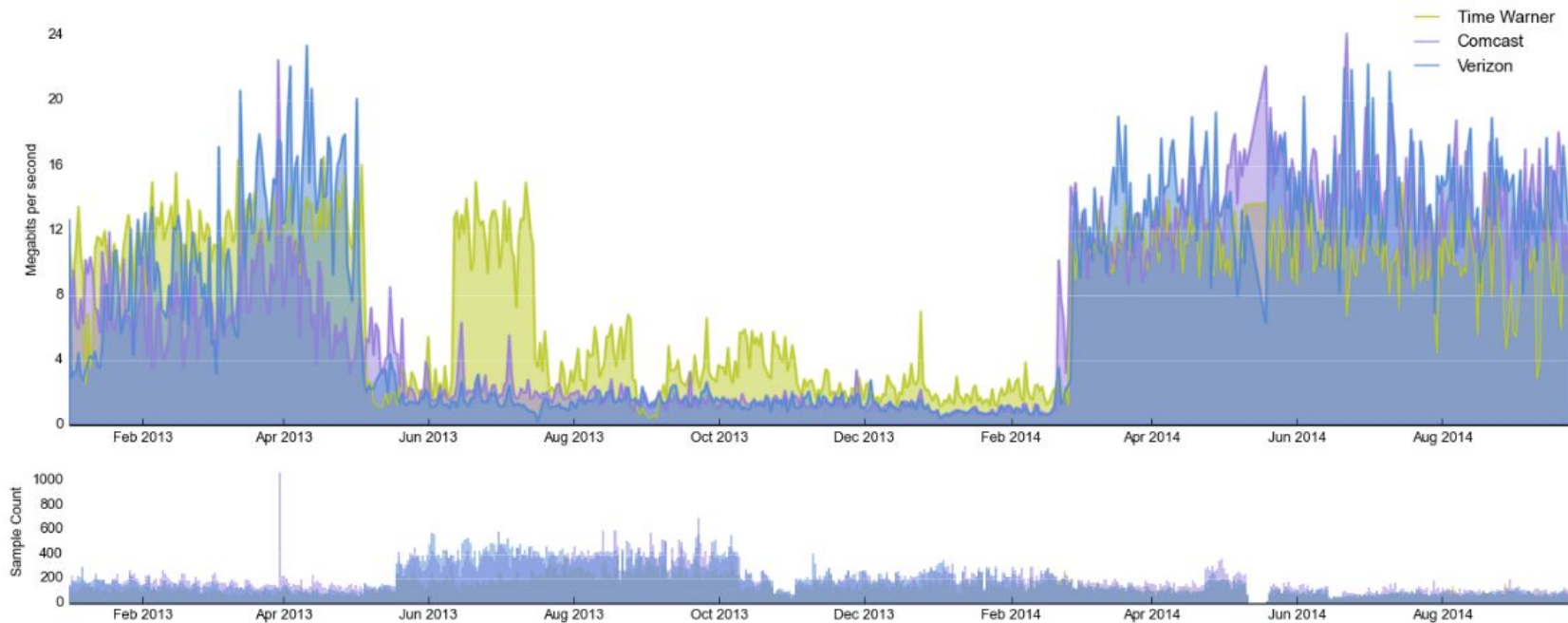


The Internet is Contentious



The Internet is Contentious

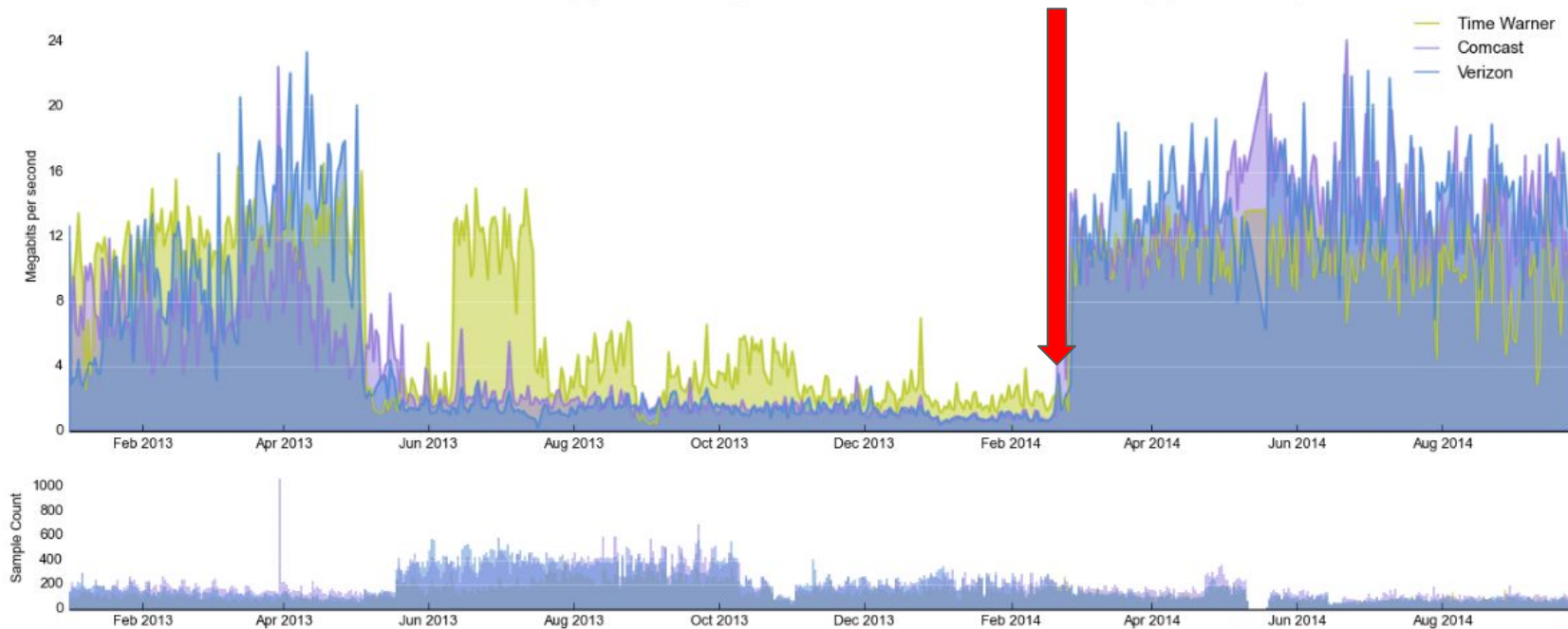
Median download throughput across Cogent in NYC over time from different ISPs (higher is better)



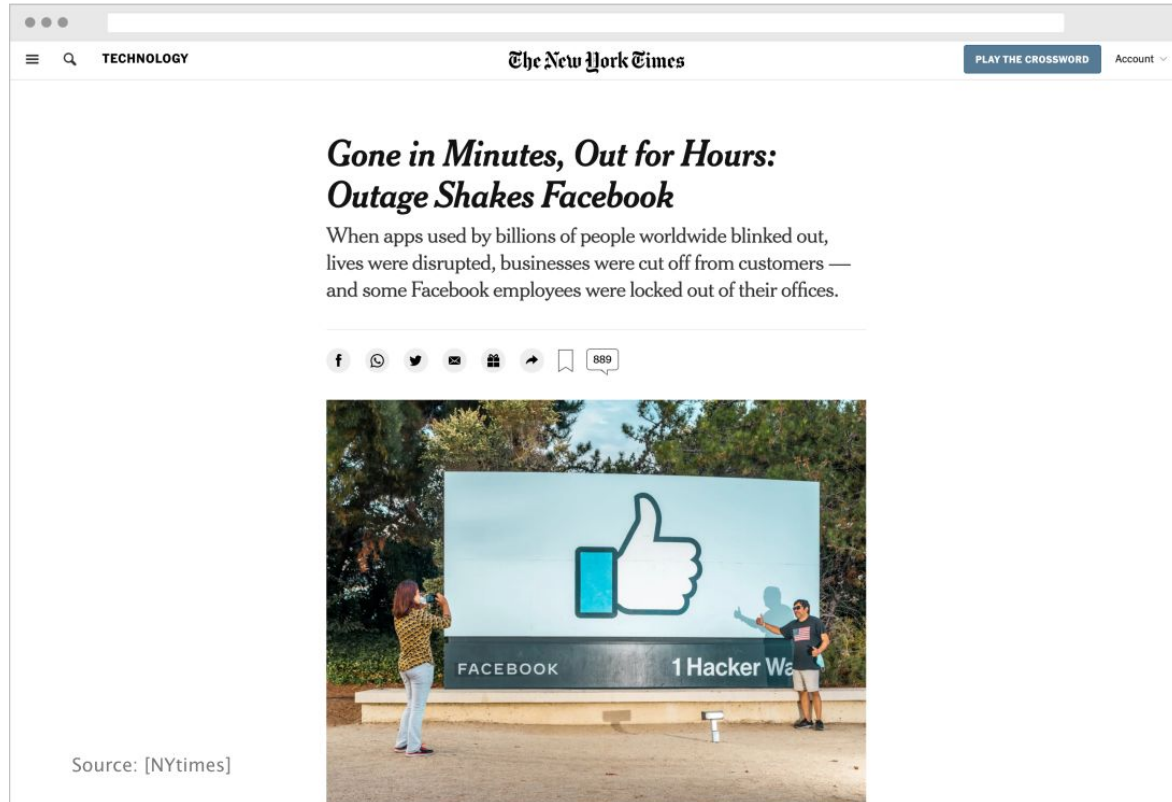
The Internet is Contentious

Netflix begins to pay \$
to Comcast

Median download throughput across Cogent in NYC over time from different ISPs (higher is better)



The Internet is Fragile



The image shows a screenshot of a web browser displaying a New York Times article. The browser's address bar is empty. The page header includes the New York Times logo, a search icon, the word "TECHNOLOGY", a "PLAY THE CROSSWORD" button, and an "Account" dropdown menu. The article title is "Gone in Minutes, Out for Hours: Outage Shakes Facebook". The sub-headline reads: "When apps used by billions of people worldwide blinked out, lives were disrupted, businesses were cut off from customers — and some Facebook employees were locked out of their offices." Below the text are social media sharing icons for Facebook, WhatsApp, Twitter, Email, Print, and a share icon, along with a comment bubble showing "889". The main image shows a large outdoor sign with the Facebook logo and the text "FACEBOOK" and "1 Hacker Wa". A woman is taking a photo of the sign, and a man is standing next to it.

Source: [NYtimes]

The Internet is Fragile

“Our engineering teams have learned that **configuration changes on the backbone routers** that coordinate network traffic between our data centers caused issues that interrupted this communication.

This disruption to network traffic had a cascading effect on the way our data centers communicate, **bringing our services to a halt.**”

[fb.com]

The Internet is Fragile



The Internet is Fragile

The screenshot shows a web browser window with the URL https://www.theregister.co.uk/2017/08/27/google_routing_blunder_sent_japans_internet_dark/. The page features the The Register logo with the tagline "Rising the hand that feeds IT" and a navigation menu with categories like DATA CENTRE, SOFTWARE, SECURITY, DEVOPS, BUSINESS, PERSONAL TECH, SCIENCE, EMERGENT TECH, BOOTNOTES, and LECTURES. The main article is titled "Google routing blunder sent Japan's Internet dark on Friday" with a subtitle "Another big BGP blunder". It is written by Richard Chirgwin on 27 Aug 2017 at 22:35. The article text describes a BGP advertisement error that sent Japanese traffic to a black hole, causing an outage. A "Most read" sidebar on the right lists other articles such as "Helicopter crashes after manoeuvres to 'avoid... DJI Phantom drone'", "That terrifying 'unfixable' Microsoft Skype security flaw: THE TRUTH", "Stephen Elop and the fall of Nokia revisited", "BBC presenter loses appeal, must pay £420k in IR35 crackdown", and "Microsoft's Windows 10 Workstation adds killer feature: No Candy Crush". A cookie notice at the bottom states "The Register uses cookies. Find out more. Close".

Google routing blunder sent Japan's Internet dark on Friday

Another big BGP blunder

By Richard Chirgwin 27 Aug 2017 at 22:35 40 SHARES

Last Friday, someone in Google fat-thumbed a border gateway protocol (BGP) advertisement and sent Japanese Internet traffic into a black hole.

The trouble began when The Chocolate Factory "leaked" a big route table to Verizon, the result of which was traffic from Japanese giants like NTT and KDDI was sent to Google on the expectation it would be treated as transit.

Since Google doesn't provide transit services, as BGP Mon explains, that traffic either filled a link beyond its capacity, or hit an access control list, and disappeared.

The outage in Japan only lasted a couple of hours, but was so severe that Japan Times reports the country's Internal Affairs and Communications ministries [want carriers to report](#) on what went wrong.

BGP Mon dissects [what went wrong here](#), reporting that more than

Most read

- Helicopter crashes after manoeuvres to 'avoid... DJI Phantom drone'
- That terrifying 'unfixable' Microsoft Skype security flaw: THE TRUTH
- Stephen Elop and the fall of Nokia revisited
- BBC presenter loses appeal, must pay £420k in IR35 crackdown
- Microsoft's Windows 10 Workstation adds killer feature: No Candy Crush

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The Internet is Fragile

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The Internet is Fragile

“Human factors are responsible
for 50% to 80% of network outages”