

We're out of IPv4 addresses... Now what?

Owen DeLong Akamai Technologies SCALE 14x, Pasadena, January, 2016







- Where have we been?
- Where are we?
- Let's have some fun...
- How can we motivate content providers?
- Q&A

Where have we been?



A Brief (mostly accurate) History of the Internet

- 1967 Larry Roberts publishes plan for ARPANET
- 1969 First host on network (can you call it a network with 1 host?)
- 1971 15 hosts on network Now that's more like it.
- 1972 First email program on ARPANET
- 1977 First Multi-Network demonstration
- 1980 213 hosts on the network Um, those 8 bit addresses are getting cozy.
- 1981 CSNET and BITNET are established
- 1982 TCP/IP and EGP are established
- 1983 RFC-33 makes January 1, 1983 NCP no longer supported day (Flag Day).

Where have we been?



- 1984 DNS is introduced (locally managed domains instead of a global "host file")
- 1987 10,000 hosts on the network Yeah, we needed more than 8 bits (256 hosts) for sure, but 32 ought to be enough (3.2 billion hosts).
- 1988 NSFNET upgraded from 56Kbps to T1 (1.544Mbps)
- 1989 100,000 hosts on the network That's right, 10x growth in just 2 years.
- 1991 NSFNET upgraded from T1 to T3 (45Mbps) That's right, 30x growth in just 2 years.
- 1992 1,000,000 hosts on the network, MOSAIC introduced
- 1994 4,000,000 hosts on the network IPNG Working Group Proposed and chartered... Perhaps we need to start rethinking this 32-bit idea.



Most of these are probably familiar

- 1943 Thomas J. Watson, president of IBM "I think there is a world market for maybe five computers".
- 1989 William Gates, CEO of Microsoft "I have to say that in 1981, making those decisions, ... a move from 64 K to 640 K felt like something that would last a great deal of time."
- 1995 Robert Metcalfe, Journalist "I predict the internet will soon go spectacularly supernova and in 1996 catastrophically collapse."

HE EDITOR IN CHIEF · SANDY REED Fulfilling his promise, columnist Bob Metcalfe dines on his own words

nfoWorld columnist Bob Metcalfe may not have eaten crow, but he definitely ate the column in which he predicted that the Internet "will soon go spectacularly supernova and in 1996 catastrophically collapse." (See From the Ether, Dec. 4, 1995, page 61.) Appropriately, Metcalfe consumed the column ear-

lier this month in front of 1,000 people at the Sixth International World Wide Web Conference in Santa Clara, Calif.

It was at the group's 1995 conference



in Boston that he made the original pledge to eat his column if the massive collapse didn't come to pass.

Metcalfe handled the situation with his usual

flair. Even though the major outage he predicted didn't occur, he argued, he should not have to eat his words because, in fact, millions of people were affected by numerous

Internet collapses throughout the year.

Despite his arguments, the crowd voted loudly for him to dine on stage. Metcalfe produced a cake decorated to look like his weekly column,



but audience members would have none of that. So he then took out a blender he had

hidden on stage at the Santa Clara Convention Center, ripped a page from a Dec. 4, 1995, copy of InfoWorld, tore his column into pieces, put it into the blender with water, and whipped it into the kind of goop you get when you mix paper, ink, and water. (See photo, below left.)

He then took out a spoon and ate his words. Actually knowing that he might have



to do that, Metcalfe had checked with InfoWorld's production experts to make sure that the ink was nontoxic.

trates why Bob Metcalfe is a great columnist. He says what

he means, means what he says, and follows through all the time, not just when it's easy.

Sandy Reed is editor in chief of InfoWorld. Contact her at sandy_reed@ infoworld.com.



Excerpt from InfoWorld April 28,





Famous quotes about scaling



- 1997 Anonymous Exodus Facilities planner "400 Watts per square foot should be enough for any datacenter ever."
- 2007 Steve Ballmer, CEO of Microsoft "There is no chance that the iPhone is going to get any significant market share."





What do all of these have in common?

Each and every one of them was 100% wrong.

We are bad at predicting how things will scale. Very very bad.



Internet addresses over Time



Interestingly, each time we run out, we square the square and hope it's enough.

- We started with 8 bits (NCP) which supported 256 hosts
- We went to 32 bits (256*256*256*256 hosts, but after subtracting various non-unicast addresses, we only made about 3.2 billion addresses available)
- In IPv6, we again go to 4 times as many bits... 128 bits or a total of 4 billion * 4 billion * 4 billion * 4 billion = 3.4*10^38 (340 undecillion).

Where are we now?



We are out of IPv4 addresses (mostly).

- 4 out of 5 RIRs are no longer making conventional allocations or assignments
- 1 RIR has some addresses, but if you're not operating in Africa, that doesn't really matter.
- IPv6 now accounts for just over 10% of internet traffic globally.
- IPv6 now accounts for more than 37% of US Mobile traffic
- Apple will stop accepting IPv4-based applications in the App store this year.

What are our choices?



Now that we're out of IPv4...

- MOAR NAT Nat's are good!
- Stop all internet growth and live with the internet we have today forever.
- Start taking people off the internet in favor of "higher priority" uses.
- IPv6 This is the only solution which doesn't involve second class citizenry or exclusion

Ask your ISP for IPv6 — It's fun!!



Scenario 1: Owen calls large \$CABLECO about his residential service in 2008

Scenario 2: AT&T Cellular (and Apple) 2013

Scenario 3: Technically not an ISP, but Software Vendor at Trade Show, 2012



How to encourage your favorite content provider



Scenario 1: (SUCCESS) IPv6 Buddy — An IPv6 Keyboard

Scenario 2: (FAIL!) Amazon

Scenario 3: (Some SUCCESS) Blizzard Entertainment

If you are a content provider and prefer NOT to be featured in one of my talks, the following are required:

1. Implement IPv6 for at least a significant portion of your content.

2. Request not to be included by sending an email to owen at delong dot com.

Questions?



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More information: Peering: http://as20940.peeringdb.com http://as32787.peeringdb.com Akamai 60sec: http://www.akamai.com/60seconds