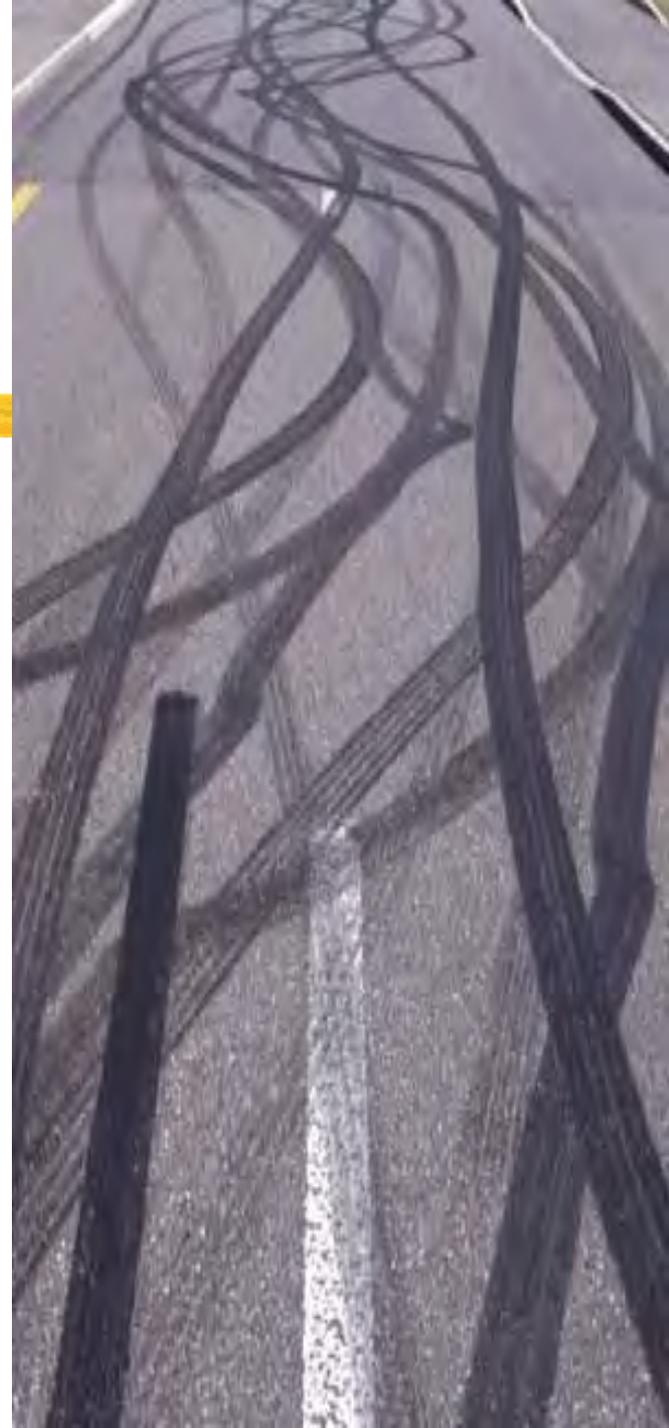


Tire Tracks

Ed Lazowska

Bill & Melinda Gates Chair in
Computer Science & Engineering
University of Washington

Chair, Computing Community Consortium



Reiteration of overall messages



- ⌘ Our leadership is the result of a complex ecosystem involving government, university, and industry.
- ⌘ Just about every instance of a billion dollar market segment bears the clear stamp of Federal research investment.
- ⌘ Unanticipated impacts are often as important as, or more important than, anticipated impacts.
 - ⊞ The goal of research in timesharing was to share expensive systems, not to invent email and instant messaging.



⌘ The interaction of research ideas multiplies their effects.

⌘ I'll talk later about the interplay of simultaneous DARPA investments in VLSI design, computer graphics, operating systems, and networking.

⌘ Remarkable program managers often play a huge role.

⌘ It often takes 15 years from research breakthrough to billion dollar market segment.



⌘ The vast majority of corporate R&D is focused - entirely appropriately - on the engineering of the next release of a product.

- ☒ Most modern IT companies have no significant expenditure that looks out more than one product cycle.
- ☒ Even at Microsoft - one of the few companies that has such an investment - this investment represents less than 5% of overall R&D expenditures.
- ☒ So it's important not to confuse corporate R&D with fundamental research.

Elements of eCommerce



- ⌘ The Internet
 - ⌘ Graphical web browsers
 - ⌘ Public key cryptography for secure credit card transactions
 - ⌘ Back-end enterprise data management
 - ⌘ Web-scale systems
- ⌘ These illustrate each of the overall messages

"Oh s**t - he's not really going to talk about the Internet, is he?"

Monday, July 23, 2012 As of 9:49 PM New York 87° | 74°

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Gordon Crovitz: Who Really Invented the Internet?

By L. GORDON CROVITZ

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Contrary to legend, it wasn't the federal government, and the Internet had nothing to do with maintaining communications during a war.

Article

Comments (649)

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A A

A telling moment in the presidential race came recently when Barack Obama said: "If you've got a business, you didn't build that. Somebody else made that happen." He justified elevating bureaucrats over entrepreneurs by referring to bridges and roads, adding: "The Internet didn't get invented on its own. Government research created the Internet so that all companies could make money off the Internet."

It's an urban legend that the government launched the Internet. The myth is that the Pentagon created the Internet to keep its communications lines up even in a nuclear strike. The truth is a more interesting story about how innovation happens—and about how hard it is to build successful technology companies even once the government gets

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Who Really Invented the Internet?
The Wall Street Journal, 7/23/2012

<http://online.wsj.com/article/SB10000872396390444464304577539063008406518.html>

[Quoting, with some elipses to save time:]

A telling moment in the presidential race came recently when Barack Obama said: ... “The Internet didn't get invented on its own. Government research created the Internet so that all companies could make money off the Internet.”

It's an urban legend that the government launched the Internet.

[Then there are a few paragraphs of erroneous history. Following that, a blogger I've never heard of is quoted as an authority:]

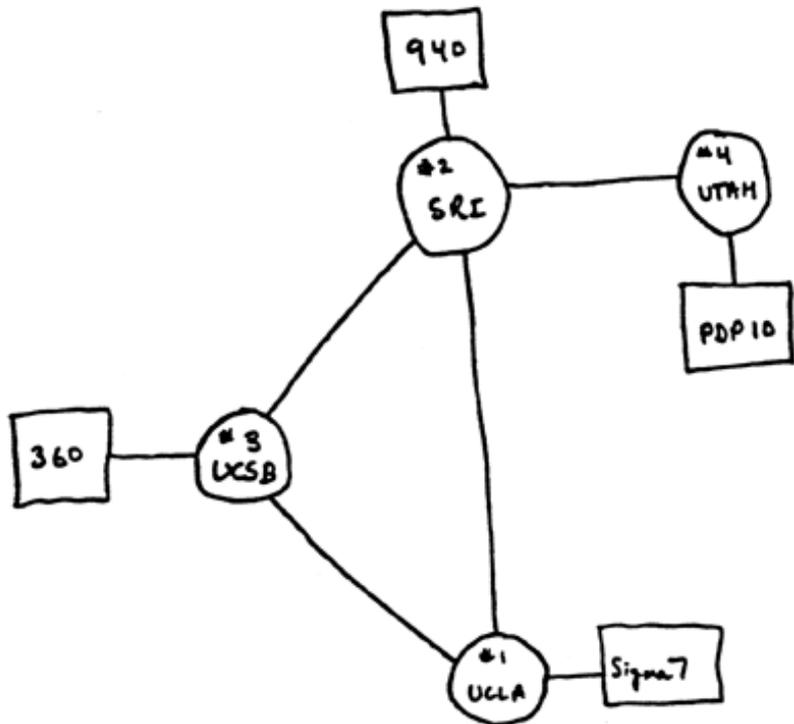
“The Internet, in fact, reaffirms the basic free market critique of large government. Here for 30 years the government had an immensely useful protocol for transferring information, TCP/IP, but it languished. In less than a decade, private concerns have taken that protocol and created one of the most important technological revolutions of the millennium.”

[The opinion piece then concludes:]

It's important to understand the history of the Internet because it's too often wrongly cited to justify big government. It's also important to recognize that building great technology businesses requires both innovation and the skills to bring innovations to market. Those who do this – not the government – deserve the credit.

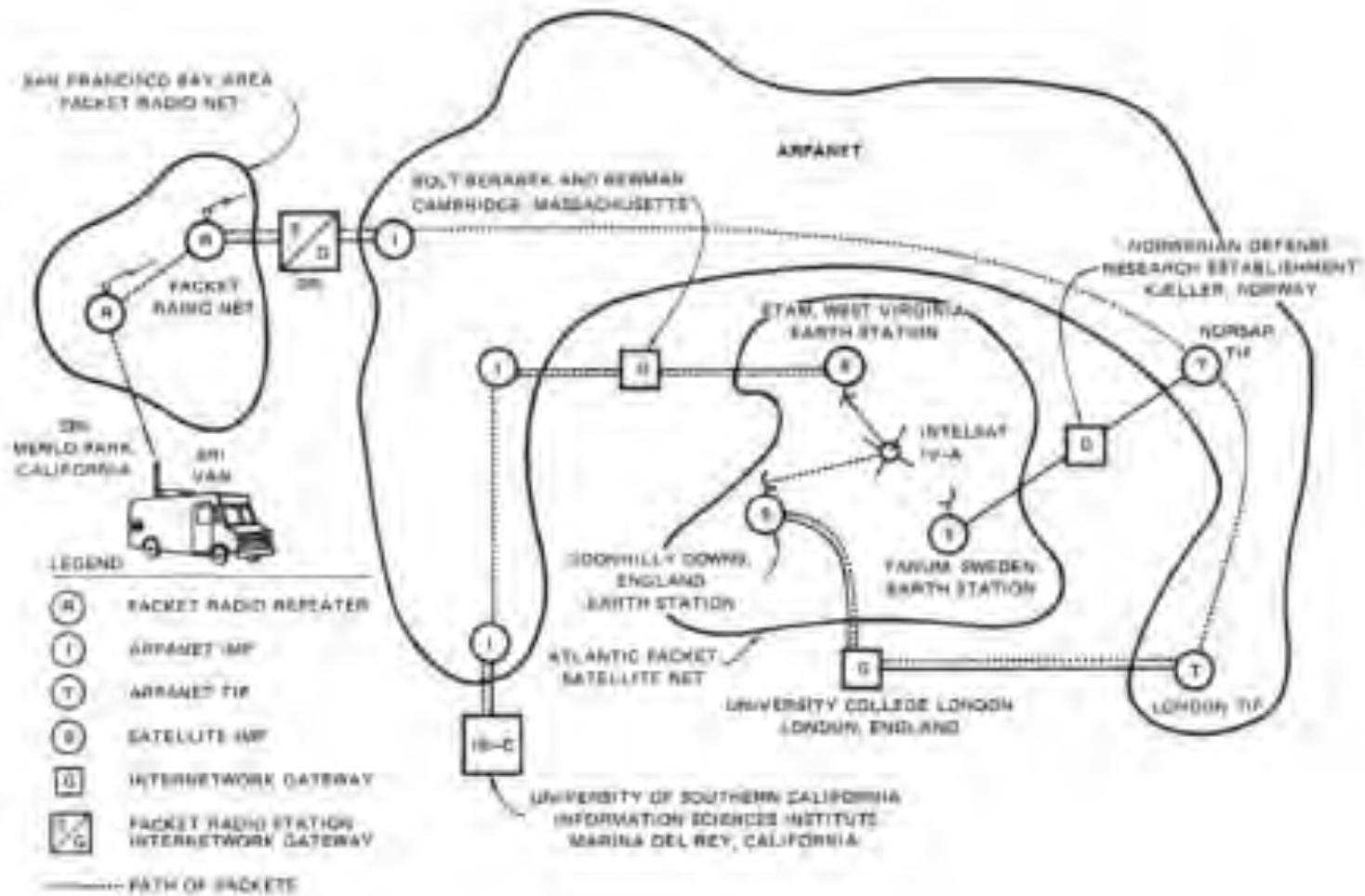
The Real Story of the Internet

- ⌘ 1966: First experiments in digital packet switched technology
- ⌘ 1968: ARPA (under Bob Taylor) issues RFQ for IMPs
 - ☒ AT&T says it'll never work, and even if it does, no one will care
- ⌘ 1969: ARPANET inaugurated with 4 hosts
 - ☒ Len Kleinrock's student/programmer Charley Kline attempts remote login from UCLA SDS Sigma 7 to SRI SDS 940
 - ☒ System crashed partway through - thus, the first message on the Internet was "lo"



29 OCT 69	100	LOADED OP. PROGRAM FOR BEN BARKER BRV	CSK
22:30		Talked to SRI Host to Host	CSK
		Left op. program running after sending a host dead message to imp.	CSK

- 
- ⌘ 1974: Cerf/Kahn TCP paper
 - ⌘ 1974: Ethernet, PUP at Xerox PARC (under Bob Taylor)
 - ⊞ Note that Ethernet was heavily influenced by the ALOHAnet
 - ⌘ 1975: ARPANET has 100 hosts
 - ⌘ 1977: Crufty internetworking demonstration
 - ⊞ 4-network demonstration of ARPANET, SATNET, Ethernet, and PRnet - from a truck on 101 to England



- 
- ⌘ 1980: Design of TCP/IP completed
 - ⌘ 1983: ARPANET conversion to TCP/IP completed
 - ☒ Routers allowed full internetworking - “network of networks”
 - ☒ Roughly 500 hosts
 - ⌘ 1986: NSFNET launched
 - ☒ Regional networks established
 - ☒ Backbone speed 56kbps
 - ☒ Roughly 5,000 hosts and 200 networks
 - ⌘ 1989: CNRI interconnects MCI mail to the Internet
 - ☒ Wise policy choice

⌘ 1990: Backbone speed increased to 1.5Mbps by IBM and MCI

☑ Roughly 250,000 hosts and 1,500 networks

☑ Note: There still was “a backbone”!

⌘ 1992: NCSA Mosaic stimulates explosive growth of WWW

⌘ 1995: WebCrawler sold to AOL



☑ AOL was a timesharing system in Northern Virginia!

⌘ 1995: Full commercialization, at 45Mbps

☑ 6,000,000 hosts, 50,000 networks

⌘ 2005: 400,000,000 hosts

⌘ 2010: 800,000,000 hosts



⌘ From the 1970s through the 1990s, there were many competing incompatible corporate proprietary networking technologies

☒ IBM SNA

☒ DECNET

☒ Netware

☒ NetBios

☒ AppleTalk

☒ Honeywell DSA

☒ X.25 (not corporate proprietary)

⌘ How (aside from being vastly superior) did TCP/IP prevail?

DARPA IPTO under Bob Kahn, 1979-85



⌘ VLSI program

- ☒ Mead-Conway methodology
- ☒ MOSIS (Metal Oxide Silicon Implementation Service)

⌘ Berkeley Unix

- ☒ Needed Unix with virtual memory for the VLSI program (big designs) and the Image Understanding program (big images)
- ☒ Also a Trojan horse for TCP/IP
- ☒ And a common platform for much systems and application research



⌘ SUN workstation

- ☒ Baskett said no existing workstations could adequately handle VLSI designs (Bechtolsheim's frame buffer approach was unique)
- ☒ Kahn insisted that it run Berkeley Unix (and thus TCP/IP)

⌘ Clear byproducts

- ☒ Sun
- ☒ SGI
- ☒ RISC (MIPS, SPARC)
- ☒ TCP/IP adoption
- ☒ Internet routers (Cisco, 3com)

This pattern repeated as recently as yesterday

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VMware To Buy Nicira For \$1.26 Billion Adding Network Software

By Dina Bass and Sarah Frier - Jul 23, 2012 10:01 PM MT



0 COMMENTS

QUEUE



VMware Inc. (VMW) is buying Nicira Inc. for \$1.26 billion in cash and equity, adding technology that helps networks run more efficiently to broaden its appeal to companies seeking to cut hardware costs.



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