

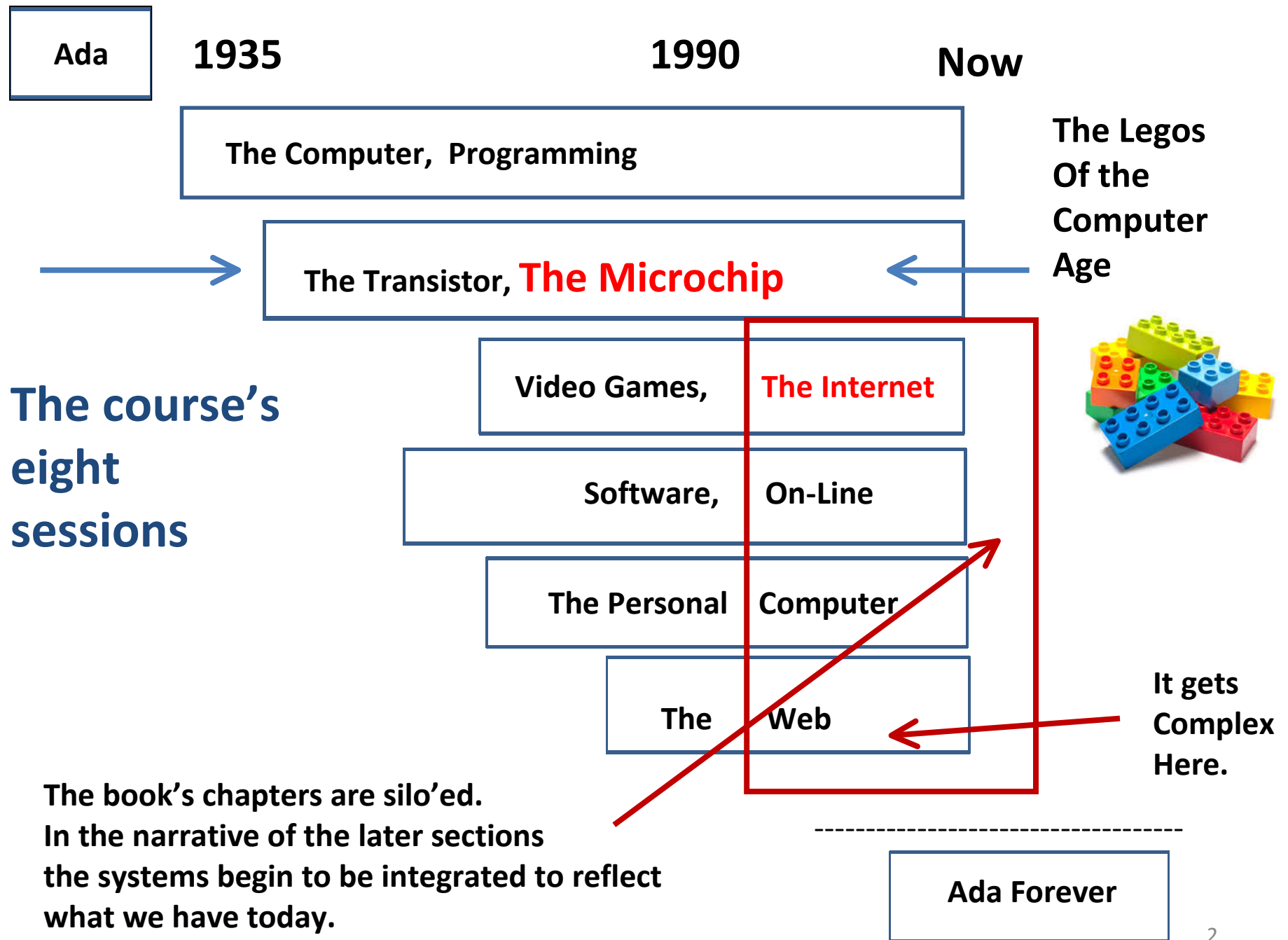
“The Innovators”

The Age of the Digital Revolution

“How a Group of Hackers, Geniuses and Geeks Created the Digital Revolution.”



Session 4

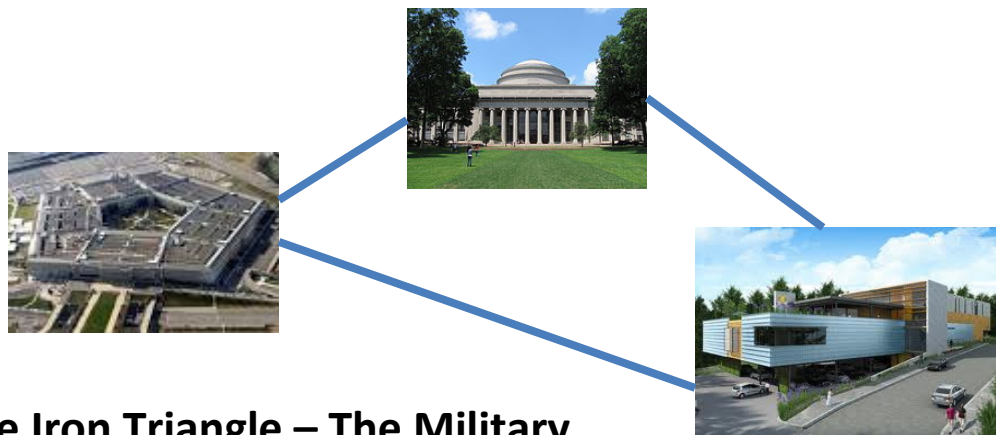


Session 4

- Video Games
- The Internet



Nolan Bushnell at the Game Developers Conference in 2011



The Iron Triangle – The Military, Industrial & Academic Complex

There Are **Three Demarcations** in Video Games

- Chicago based Pinball game industry. Conventional manufacturing. Electro-mechanical. Bally Co. till the 1970s. Not out of business but absorbing electronics.
 - **California based video games**. Electronic but **not chip based**. A laissez faire non-conforming work culture. The games of the 1970s, often tied into the home TV.
-
- The jump to **chip based games** following Moore's law that more and more electronics can be placed in smaller and cheaper devices. TV connected but now mostly stand alone. **The Wii generation**.


One of the Hackers' Driving Forces

- **There has to be to more to computers than number crunching— there has to be fun there.**

MIT Model Train Club circa 1960

- The Signal and Power subcommittee.
- The DEC PDP-1 prototype
- Early Hackers, not yet illegal, but tinkers
- An early dictum of Computer or video games was that they had to be cheap enough to make money. The first non commercial “Hackers” games on DEC PDP-1/11 or Data General Novas were good, but no one could afford to play them. **A \$1M computer @ 25¢/game is how many games?**

The DEC PDP-1

- The PDP-1 prototype was about the size of three refrigerators.
- It was the first computer to be designed for **direct interaction with the user.** 
- It could connect to a keyboard and monitor that displayed graphics and it could be **operated by a single person.**

Steve Russell and Spacewar!



- A number of MIT students, led by Russell, in **the Artificial Intelligence Lab**, began to assemble a Science Fiction oriented game [an alien invasion with spaceships]. **There were not elevating the state of AI; they just wanted to do something clever.**
- They reached a design plateau and needed DEC engineering assistance, so simply drove out to DEC in Maynard MA contacted the right engineers and were given code — that they installed.
- They were all believers in open source software.
- **The program was so good, and demonstrated so many capabilities, that DEC delivered a copy with each new computer they sold.**
- Still there was no market for a game that sat on a computer that cost >\$100,00s.

Spacewar Illustrated Three Aspects of the Evolving Hacker Culture

- **It was created collaboratively**
- **It was free and open source software**
- **It was based on the belief that computers should be personal and interactive.**

Isaacson Places the Start of Commercial Video Games with Nolan Bushnell

- Atari, a Japanese god, a Flying Horse, a US company
- Bushnell went to the University of Utah which had in the late 1960s one of the strongest computer graphics departments in the Nation. There he was with Jim Clark who founded Netscape, John Warnock who co-founded Adobe, Ed Catmull who co-founded PIXAR, and Alan Kay who produced the first personal computer at PARC [to be covered later].
- U of Utah was one of the first 4 ARPANET sites.

Atari and Pong



- This is prior to the venture capitalists.
- 1972 —The operations start on a shoe string and they funded themselves with continuing sales.
- Bushnell runs the company on a hippie philosophy
 - Authority should be questioned
 - Hierarchies should be circumvented
 - Nonconformity should be admired,
 - Creativity should be nurtured
 - There were no fixed working hours, no dress standards,
 - “At Atari, the work people did counted more than how they looked.”
 - A young Steve Jobs starts at Atari, more later...

Bushnell

- **Bushnell believed that Innovation requires three things**
 - **A great idea**
 - **Engineering talent to execute it**
 - **Business sense (plus deal making moxie) to turn it into a successful product**
- **Bushnell had viewed an early Magnavox Odyssey and went on to build the far more advanced Pong.**
- **Magnavox sued, they settled for \$700,000 with cross licensing and Magnavox picking up the cost of suing everyone else.**
- **Isaacson believes that Bushnell was the “founder “ of video games, but**

Video Games “Founder”

- Ralph Baer is credited with inventing the first home video games. He fled his native Germany with his family in 1938 ahead of the Second World War. He spent much of his career working on advanced radar systems for Sanders Associates before turning his attention to interactive video games in the late 1960s.
- Baer’s first video game console, dubbed The Brown Box, made its debut in 1972, and was later licensed by Magnavox as the Odyssey game system. It included the game Table Tennis, a forerunner to Pong, which was one of the first video games to achieve mainstream popularity.
- Baer also invented the iconic memory game **Simon**, a circular toy with four colored tiles that flashed in a pattern.
- Baer continued working from his home workshop through the 2000s and was awarded a **National Medal of Technology in 2006** by president George W. Bush.

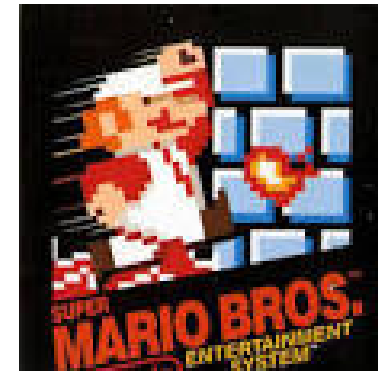


- Baer told PBS in a 2013 interview that **inventing was what kept him going into old age**. “All of my friends have died. What am I going to do? I need a challenge,” he said. “I’m basically an artist. I’m no different than a painter who sits there and loves what he does.”
- Baer joined the U.S. Army shortly after settling in New York City, serving from 1943 to 1946, much of the time as an intelligence officer in Europe, according to Baer’s website.
- **In 2005 Baer published a book “Videogames: In the Beginning” in which he staked his claim as the “inventor of home video games.”**
- Apple co-founder Steve Wozniak said in a review of the book “... that he could never thank Ralph enough for what he gave to me and everyone else.”
- The **Brown Box is now on display at the Smithsonian** in Washington, D.C., which houses a full collection of Baer’s documents. The museum plans to make Baer’s workshop part of a special exhibit on innovation in 2016.



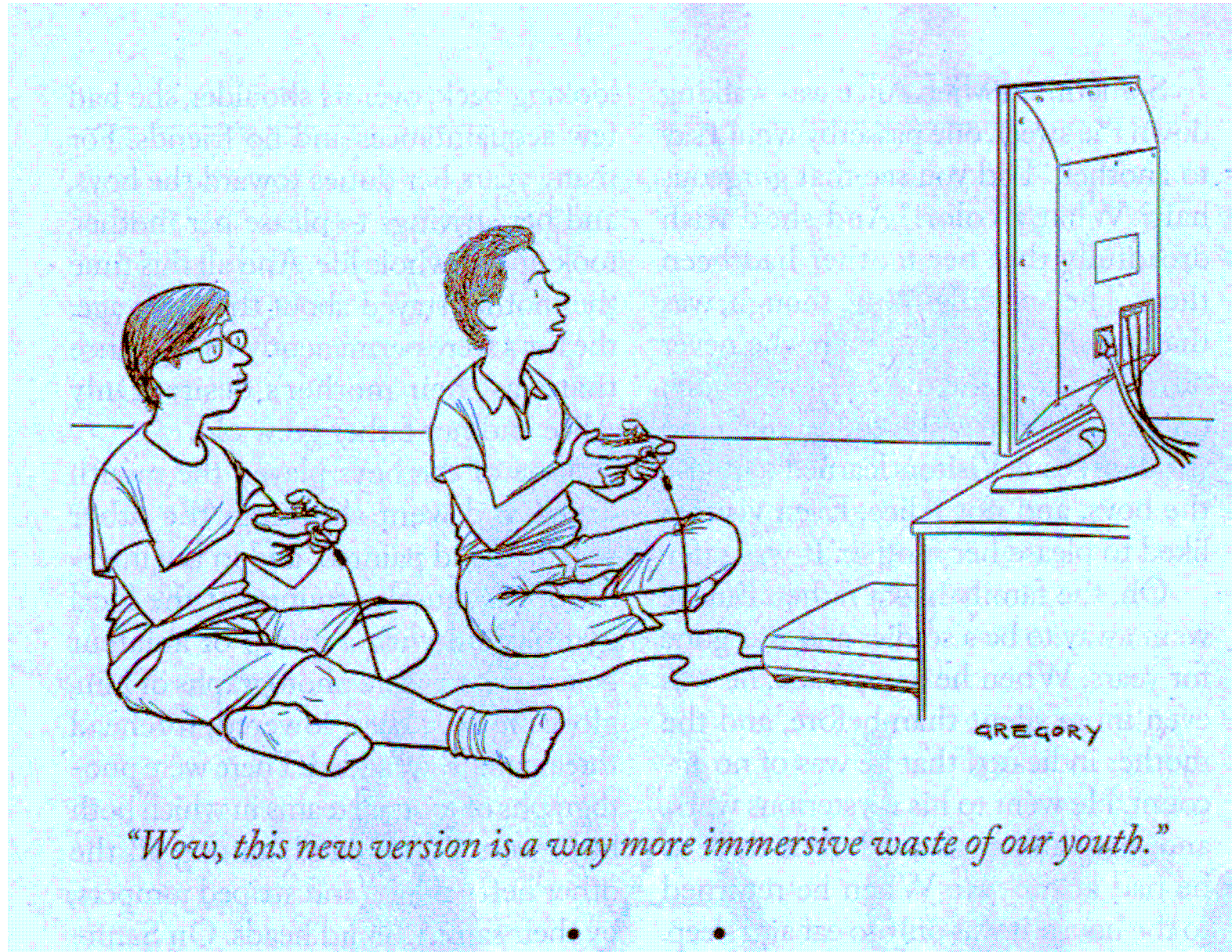
Isaacson Ends Here.
But — Did Time Improve the Product?
Implementers vs Innovators

Google Video Games and These Are the First Nine That Come Up.



Destiny





"Wow, this new version is a way more immersive waste of our youth."

Little By Little, **Violent Video Games** Make Us More Aggressive. Clash of Rugged Free Enterprise vs a Predominantly Violent Male Subculture.

* New research suggests that **hours of exposure** to violent media like video games can make kids react in more hostile ways compared to ones who don't spend lots of time controller-in-hand, reigniting the debate about children and gaming.



Ever since **Columbine**, where two students went on a deadly rampage at their high school; television, movies, and video games have been a popular target for senseless acts of violence.

After the shooting, the media pushed the narrative that [**Eric Harris and Dylan Klebold's**] inclinations for violent video games, not to mention metal music and goth subculture, were partly to blame for the horrific incident.

Nearly 15 years later, that hasn't discouraged teens from playing video games, especially of the violent ilk. Approximately **90% of children in the U.S. play video games, and more than 90% of those games involve mature content that often includes violence [> 81%]**. The connection between violent media and aggression has also spawned a body of research that has gone back and forth on the issue.

* [Alice Park @aliceparkny](#) , Time Magazine, March 24, 2014

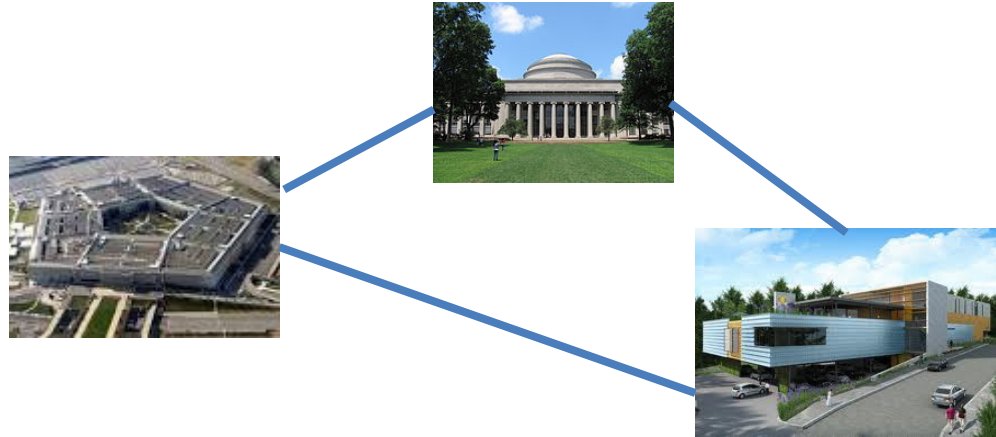
Future Employment Opportunity For Video Game Players



Worldwide Drone Operations Center, Creech AFB, NV

Session 4

- The Internet



**The Iron Triangle – The Military,
Industrial & Academic Complex**

Drivers

- The computer was driven by the need to do a vast number of **tedious complex calculations**.
- The Internet and later the Web were driven by the need to **locate and retrieve data** distributed all over the world in a vast number of electronic depositories.

Players, Organizations and Projects

- Vannevar Bush
- Norbert Wiener
- Jack C.R. Licklider
- Bob Taylor
- Larry Roberts
- Leonard Kleinrock
- Vint Cerf
- Office of Scientific Research and Development
- National Science Foundation
- MIT Lincoln Laboratory
- Bolt, Beranek and Newman
- RAND Corporation
- Stanford Research Institute
- Aerospace Corporation
- Mitre Corporation
- Xerox PARC
- Defense Applied Research Projects Agency
 - SAGE
 - ARPANET

Dr. Vannevar Bush

50 Years — Engineer, Inventor and
Science Administrator



- Most significant contribution: Head of the U.S. [Office of Scientific Research and Development](#) (OSRD) during World War II, through which almost all wartime military R&D was carried out, including initiation and early administration of the [Manhattan Project](#).
- He is also known in engineering for his work on [analog computers](#), for founding [Raytheon](#), and for the **Memex**, a concept with a PC like device connected to a structure analogous to that of the [World Wide Web](#).
- At MIT in 1927, Bush constructed a [differential analyzer](#), an analog computer with some digital components that could solve [differential equations](#) with as many as 18 independent variables. An offshoot of the work at MIT by Bush and others was the beginning of [digital circuit](#) design theory.
- Bush became MIT Vice President and Dean of Engineering in 1932, and president of the Carnegie Institution of Washington in 1938. Bush appointed Chairman of the [National Advisory Committee for Aeronautics](#) in 1938.

Early Computers, Digital logic, The Web, Organized Research

- Bush in 1940 as Chairman of the revised National Defense Research Committee (NDRC), and later Director of OSRD, he coordinated the activities of some 6,000 leading American scientists in the application of science to warfare.
- Bush was a well-known policymaker and public intellectual during World War II, where he was in effect the first presidential science advisor.

Bush's Vision

- In **1945**, Bush published "*As We May Think*" where he predicted that "wholly new forms of encyclopedias" will appear, ready made with a mesh of associative trails running through them, ready to be dropped into the Memex and there amplified."
- Fore saw Wikipedia and its internet links
- The Memex influenced generations of computer scientists, who drew inspiration from its **vision of the future.**

Bush's Practical Actions

- ***“Science, The Endless Frontier,”* his 1945 report to the President — Bush called for an expansion of government support for basic science, and he pressed for the creation of the National Science Foundation.**
- **He also established an office in the DoD to underwrite basic research: Advanced Research Projects Agency.**

30 Second In-Place Stretch

JPG Preview

service@clipartof.com



www.clipartof.com/1075303

No Free Use Allowed

J.C.R. Licklider [Lick to his friends]: A Founding Father of the Internet



- At MIT's Artificial Intelligence lab* and Lincoln laboratory in the early 1950s, Lick worked on the cooperative symbiosis of a human working with a machine.
- He came up with **inter-active computing** using time sharing, which made complete use of computing capabilities.
- Most significantly he went to DARPA and established the Information Processing Techniques office [IPTO] from where he managed the ARPANet program.

* Where many of the Model Train Club members studied.

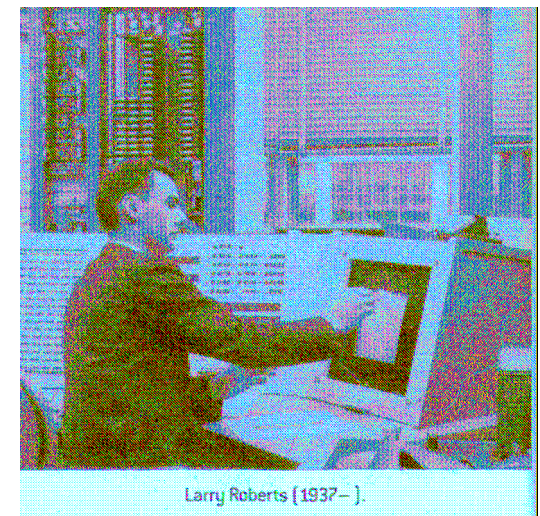
The ARPANET → Internet

- One significant ARPA project becomes the ARPANET
- The ARPANET was the precursor to the Internet.
- It began as a means of timesharing expensive hardware at various academic locations to serve the needs of other institutions w/o duplicating computers.
 - Ex. If a researcher at University of Texas needed some detailed computer graphics support, he/she would connect to the Graphics Center at the U of Utah and use some of their time vs. buying another expensive computer.
- The Universities complained — But, since most of their funding was coming from ARPA, there would be no more Computer \$\$s until they were linked!


**Here Lick works on the
operator machine
Interface in the Air Force
SAGE system**



**Bob Taylor and Larry Roberts
followed Lick to ARPA and
were the implementing
managers of the ARPANet.**



Again a problem and a Solution

- Issue: If the University computers had to be part of a comm network, then they would have to give up valuable computer time for “**housekeeping**” tasks.
-  A Lincoln Labs engineer, **Wes Clark**, at an ARPA meeting, bored with the speakers, but listening to the complaints thought — that if an individual personal computer, that he was dreaming up, was placed in front of each large computer it would:
 1. Relieve all the large computers of admin work
 2. ARPA could standardize the network
 3. The routing of the data would be **distributed**.
- The device was an Interface Network Processor, an IMP, now called a **router**.

Distributed Communication [DC] Did not Come Easily; It was Disruptive

- Seminal Work By **Paul Baran** of RAND Corp and **Donald Davies**, UK National Physics Laboratory.
- While ARPA initiated DC development, many in DoD wanted the Defense Communications Agency to engineer it and roll it out. But, ARPA managers considered DCA too bureaucratic and burdened with entrenched ideas.
- ARPA kept the effort and contracted with BBN.
- AT&T, as the major US Telecom provider, did not want it, as it flew in the face of how their network was engineered and managed.
- **Vested Interests:** Eventually, AT&T, IBM, DEC and all other computer manufacturers who had their own schemes and investments, adopt the APRANET model in its later incarnations.

Distributed Communication Came From the Need of Nuclear Survivable Comm

- **Packet Switching**, think of a letter with 10 (¶)s.
- Divide the letter into 10 packets, numbered 1...10. Make each the same length. Set aside a few bits for address, Packet number and over all message ID.
- Each node is connected to a number of adjacent nodes.
- Let each node handle the packets sent to it, if too many, send to an adjacent node and pass on.

Leonard Kleinrock



- He made several important contributions to the field of [computer networking](#), in particular to the theoretical side of computer networking. He also played an important role in the development of the [ARPANET](#), the precursor to the [Internet](#), at UCLA.
- His most well-known and significant work is his early work on [queueing theory](#), which has applications in many fields, among them as a key mathematical background to [packet switching](#), one of the basic technologies behind the Internet.
- His initial contribution to this field was his doctoral thesis at MIT in 1962, republished in book form in 1964, is one of the standard works on the subject.

Leonard Kleinrock

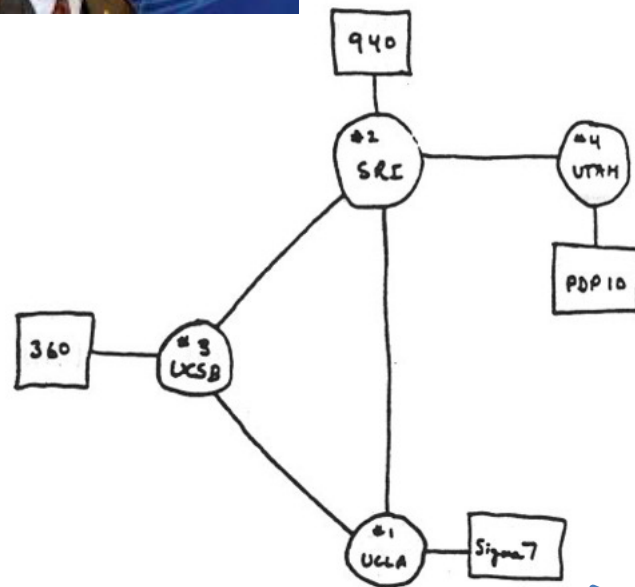
- He described this work as: "Basically, what I did for my PhD research in 1961–1962, was to establish a mathematical theory of packet networks..." **But he did not call it a packet and he has been challenged as taking too much credit.**
- His theoretical work on hierarchical routing, in the late 1970s with his then-student Farouk Kamoun, is now critical to the operation of today's worldwide Internet.
- He shows up later with Sen. Al Gore

The Internet Ethos

- The Kleinrock controversy “Too much credit claimed” shows that most of its creators preferred to use the metaphor of the internet itself — a system of fully distributed credit.
- They routed around controversy.
- The Internet was born of an ethos of creative collaboration and distributed decision making.

In the Beginning ... at 10:30 PM, October 29, 1969

- The first message on the [ARPANET](#) was sent by UCLA student programmer [Charley Kline](#) from Boelter Hall room 3420, the school's main building.
- Supervised by Kleinrock, Kline transmitted from the university's [SDS Sigma 7](#) host computer to the Stanford Research Institute's [SDS 940](#) host computer.
- The message text was the word "login"; the letters "l" and the "o" were transmitted, but the system then **crashed**. Hence, the literal first message over the ARPANET was "lo."
- About an hour later, having recovered from the crash, the SDS Sigma 7 computer effected a full "login."
- The first permanent ARPANET link was established on November 21, 1969, between the IMP at UCLA and the IMP at the Stanford Research Institute.
- **By December 5, 1969, the entire four-node network was established.**



THE ARPA NETWORK

DEC 1969

4 NODES

From Vint Cerf's Engineering Notebook

December 5, 1969—the DoD's Advanced Research Projects Agency (ARPA) connected **four computer network nodes**:

1. University of California, Los Angeles, (UCLA),
2. Stanford Research Institute (SRI) in Menlo Park, Calif.,
3. U.C. Santa Barbara (UCSB), and
4. University of Utah.

The "Sigma 7" note next to the circle depicting the UCLA node refers to the Sigma 7 computer at UCLA's Network Measurement Center that Vint Cerf connected to ARPANET.

Was the ARPANET Academic or Defense?

- Many of its founders and implementers claim that it was established only to aid academia in research.
- Its \$\$s came from ARPA and many were provided during Vietnam era and the height of the Cold War, when there was tremendous pressure on the DoD budget.
- Senator Mike Mansfield in hearings pointedly asked:
 - Q. If it was a means of providing a survivable national communication system in the event of a Soviet nuclear attack.
A. Yes!
 - Q. Was it integrated into the existing DoD comm system?
A. No, not yet.
- The implementers claim that it wasn't for defense. The ARPA higher managers claim that it was sold ultimately as a means of defense and that is how it the got funding!
- **In March 1982, DoD declared TCP/IP as the standard for all military computer networking.**

From ARPANet to The Internet

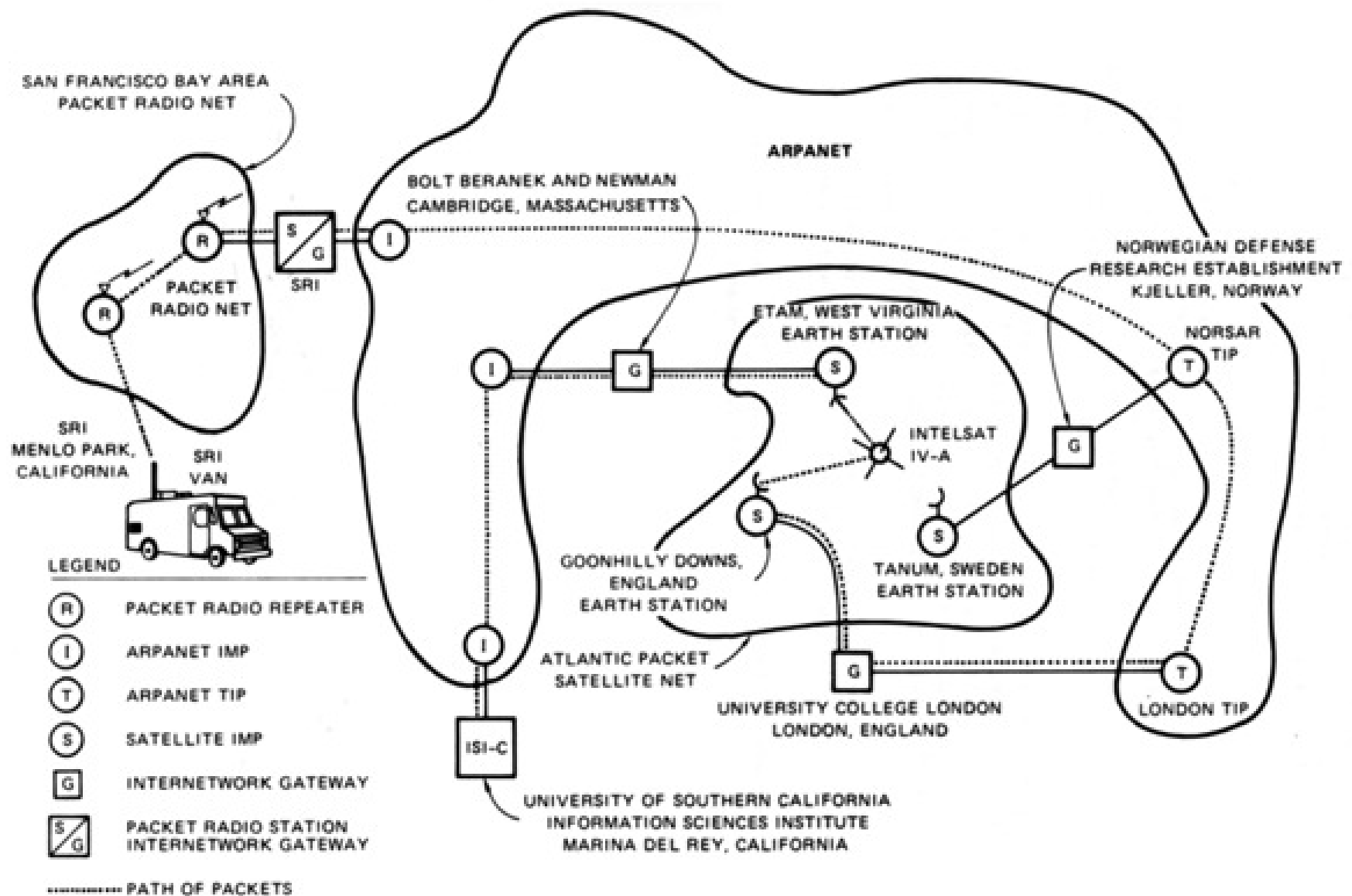
- First there was the ARPANet, then many more packet nets came into being.
- In 1973 Kahn and Cerf worked their way through the issue of connecting all these different computers over a ubiquitous network.
- The consensus solution: If you connect to the internet then:
 - All packets would move around the same following the Standard Transport Communication Protocol [TCP] and
 - All packets would be addressed that same [IP]
- **The Transport Communication Protocol/Internet Protocol (TCP/IP)**

What Is the Internet and Its Scheme?

- To expand the ARPANet, Robert Kahn and Vint Cerf, who were involved with early ARPANet development collaborated in 1973 on a scheme to allow all computers to communicate in a common way. They collaborated with many others to define the scheme:

→ TCP/IP

- The Internet now is a global system of interconnected computer networks that use the **standard** Transmission Control Protocol /Internet protocol (TCP/IP) suite to link several billion devices worldwide.
- It is a ***network of networks*** that consists of millions of private, public, academic, business, and government networks, of local to global scope, that are linked by a broad array of electronic, wireless, and optical networking technologies.
- The Internet carries an extensive range of information resources and services, such as the inter-linked hypertext documents and applications of the World Wide Web (WWW), the infrastructure to support email, and peer-to-peer networks for file sharing and telephony.



1975 The First Internetworked Connection

Key Layers and Key Innovators

early milestones	Key Layers of the Internet		milestones
email@-1971 Ray Tomlinson	CONTENT		1991-.html Berners-Lee & Cailliau
Archie-1990 Emtage & Deutsch	SEARCH ENGINE		1998-Google Brin & Page
DOS Houdini-1986 Neil Larson	BROWSERS		1993-Mosaic Marc Andreessen
(Vannevar Bush, Ted Nelson, Douglas Engelbart)	WORLD WIDE WEB		1990-http:// Tim Berners-Lee
ARPANET-1969 J.C.R. Licklider	INTERNET		1975-TCP/IP Cerf & Kahn
SAGE-1956 George Valley	NETWORKS		1973-Ethernet Robert Metcalfe
Z3-1941 Konrad Zuse	COMPUTERS		1976-Apple Jobs & Wozniak

The Internet is a 'network of networks' upon which the World Wide Web is enabled.

What Was The Leap From ARPANet To Internet?

- ARPANet is Working.
- DOD makes it a standard in 1982.
- Federal legislation in early 1990s opens the way for **commercialization**.
- Driven by economic force of the market place!
- Actions by Senator and Vice President Al Gore.

- Hold the laughs:



Did Al Gore Invent the Internet?—

No, His Comments Were Taken Out Of Context

- During the 1990 Presidential campaign, CNN's Wolf Blitzer asked Gore to list his qualifications to be President.
- Gore listed amongst other things “During my service in the United States Congress, I took the initiative in creating the Internet.” Perhaps an inelegantly stated sound bite but...
- In 1988 he initiated Congressional studies on the Internet. They were led by Len Kleinrock. This was followed by Senate hearings chaired by Gore and these led to 3 non-partisan Bills:
 - The High Performance Computing Act of 1991, known as the Gore Act
 - The Scientific and Advanced Technology Act of 1992
 - The National Information Infrastructure Act of 1993
- These **removed regulatory roadblocks** and paved the way for commercial companies such as AOL to connect to the ARPANET and provide commercial internet service to the general public.



Impact and Partnership



- “It’s something that Gore had worked on for a long time...Gore is not the father of the internet, but in all fairness, Gore is the person who in Congress, most systematically worked to make sure that we got an Internet.”
- **Partnership:** For over more than 3 decades, the Federal Government, working with private industry and research universities had designed and built a massive infrastructure, like the interstate highway system, but far more complex and then threw it open to ordinary citizens and commercial enterprises.
- **Impact:** It was funded primarily with public dollars, but paid off 1000s of times over by seeding a new economy and an era of economic growth.



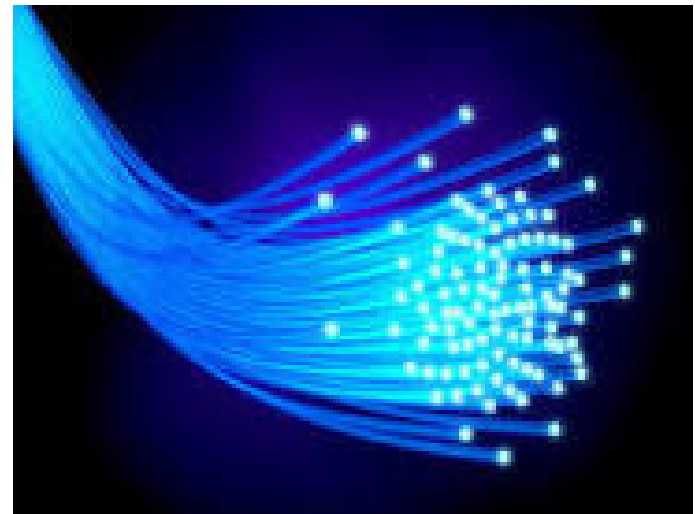
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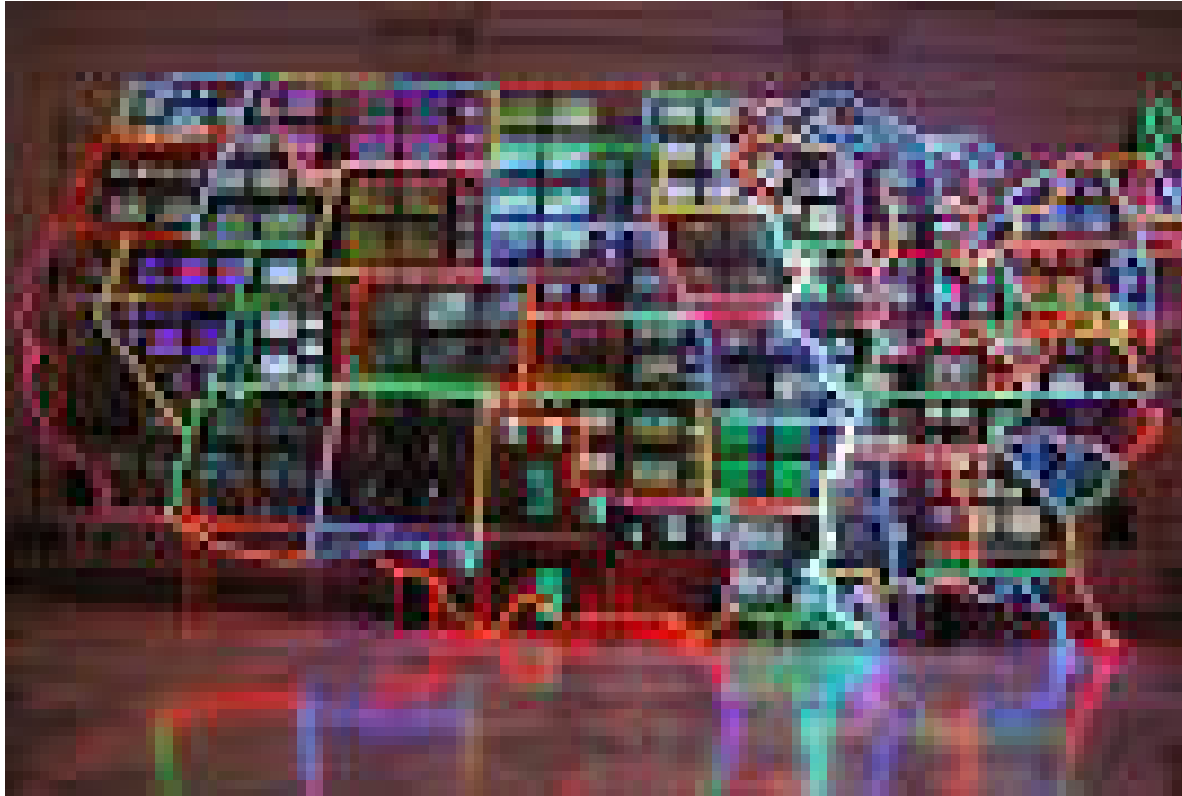
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Newt Gingrich
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- **Impact:** It was funded primarily with public dollars, but paid off 1000s of times over by seeding a new economy and an era of economic growth.

Independent Development That Made the Internet Work: Fiber Optics

- A technology using glass (or plastic) threads (fibers) to transmit data.
- A fiber optic cable consists of a bundle of glass threads, each of which is capable of transmitting messages modulated onto light waves.
- Fiber optics has several advantages over traditional metal communications lines, ultimately cost, as it has significantly greater capacity



Smithsonian's Nam June Paik's *Electronic Super Highway/Internet*



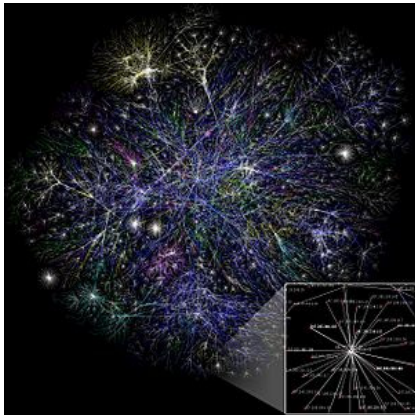
**World internet village driven by
Corning glass fibers**

**A modern artwork
reflects the high
speed electronically
connected new age.**

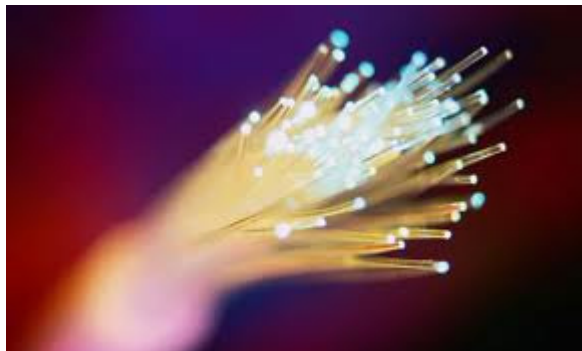
**It evolved from the
first copper telegraph
land and under sea
cables, then telephone
cables, then microwave,
then satellite, fiber optic
cables and now
cellphone radios.**

Internet

The infrastructure of the Digital Age



Visualization from the Opte Project of the various routes through a portion of the Internet

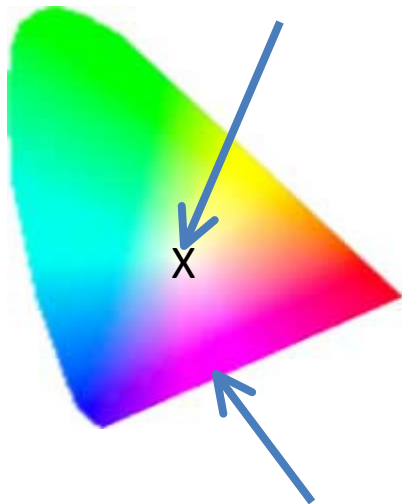


Backbone of the Cell Phone System



The Use of Color to expand Fiber Optics

1 channel - pure
White light

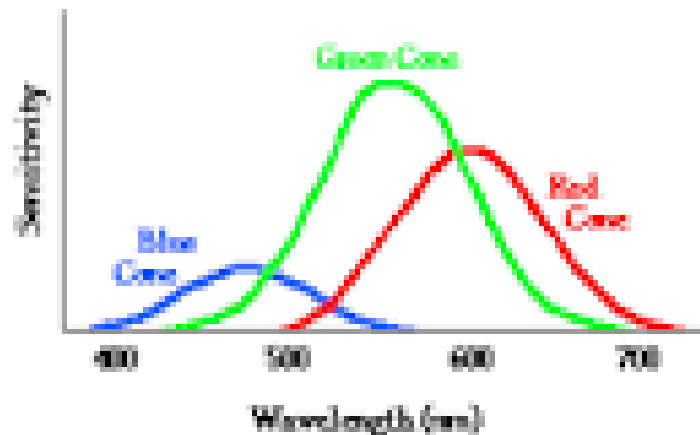


6800 channels



Wavelengths in the visible spectrum in nanometers [10^{-9} m]

<u>color</u>	1	2	3	4
red	647-700	647-760	630-700	620-800
orange	585-647	585-647	590-630	590-620
yellow	575-585	575-585	570-590	560-590
green	491-575	491-575	500-570	480-560
blue	424-491	424-491	450-500	450-480
violet	400-424	380-424	400-450	400-450





The Second Half of 1969

“Amid national turmoil, three historic enterprises each in the making for over decade occurred:

- NASA sent men to the moon.**
- Engineers in Silicon Valley were able to devise a way to place a programmable computer on a chip. A microprocessor.**
- ARPA created a network that connected distant computers.**

Only the first, perhaps the least historically significant, made headlines.”

Consequences [+ and -]

- Both the Mac and the PC **revolutionized the American workplace**. Through them now almost everyone is doing clerical tasks. The written or typed letter disappeared. The first hit were secretaries, those who once supported 10 staff were now supporting 25-40 staff as Admin Assistants.
- Email and Instant messages (IMs).
- The **demise of**   **script and letters stored away in a trunk**. Is the Cloud better?
- Are we better off now that we were swamped with email and their tails.
- Once technical staffs obtained the useful PowerPoint tool, presentations were whelmed with fancy graphics, colors, shadings, audio and automation to the point that actual productive hours dropped.
- **Texting — the loss of spelling, grammar, good taste (?)**
- **Speed, utility and communication.**

Net Neutrality



- Net neutrality is the principle that Internet service providers and governments should **treat all data on the Internet equally**, not discriminating or charging differentially by user, content, site, platform, application, type of attached equipment, or mode of communication.
- The term was **coined** by Columbia University **media law professor Tim Wu** in 2003 as an extension of the longstanding concept of a common carrier.
- Advocates of net neutrality such as **Lawrence Lessig*** have raised concerns about the ability of broadband providers to use their last mile infrastructure to block Internet applications and content (e.g. websites, services, and protocols), and even to block out competitors.
- There has been extensive debate about whether net neutrality should be required by law, particularly in the United States.
- Debate over the issue of net neutrality predates the coining of the term.
- **FCC ruled on Feb 22, 2015 that the Internet should be treated as a common carrier under the FCC Laws of 1932. No fast lane for the well-heeled.**

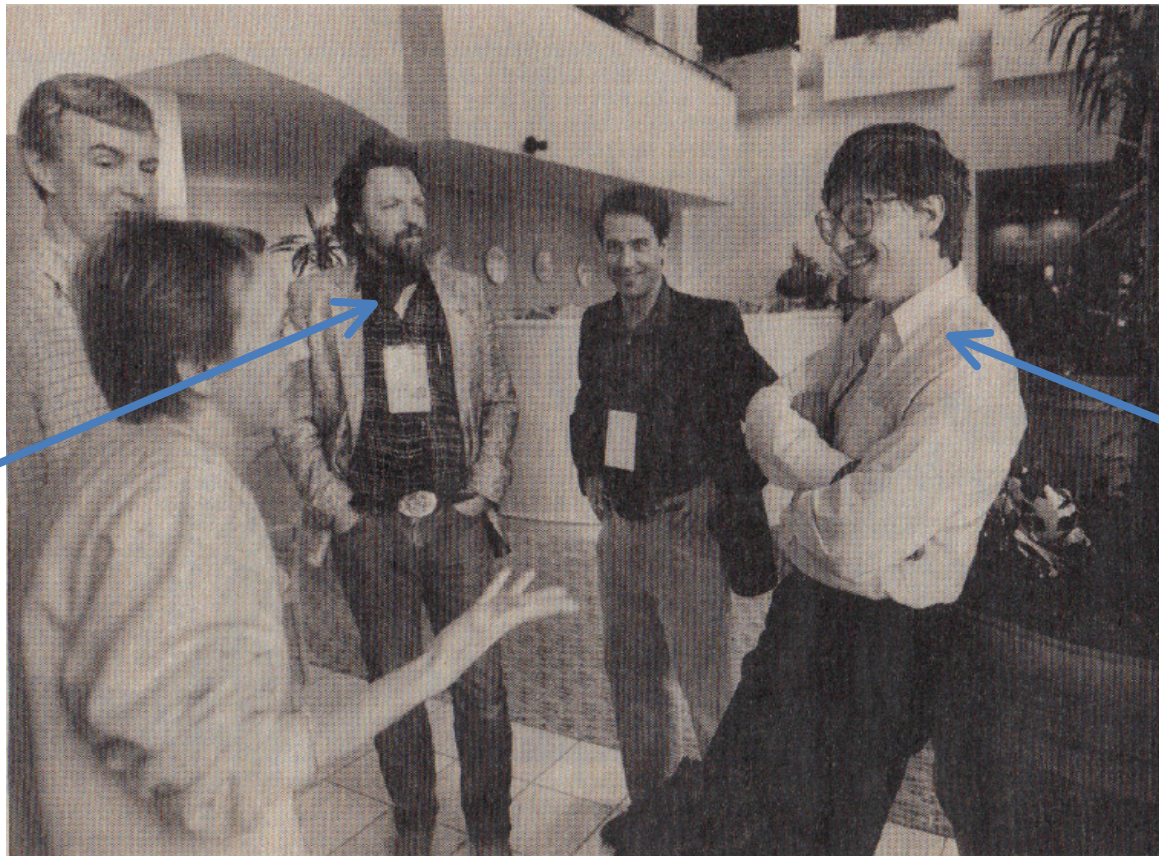
* Lessig was a professor at Stanford Law School, where he founded the school's Center for Internet and Society

Washington Post, *Outlook*, The Tech Issue, March 22, 2015

On a Different Note: The Internet's First Anarchist — John Perry Barlow

“Governments of the Industrial World, you weary giants of flesh and steel, I come from Cyberspace- the new home of Mind. On behalf of the future, I ask you of past to leave us alone. You are not welcome among us. You have no sovereignty where we gather.”

“A Declaration of the Independence of Cyberspace” February 8, 1996



Barlow

**Skinny kid
from Seattle**

John Perry Barlow, center, chats with Bill Gates, right, and others during the annual PC Forum in Tuscon in 1991. Barlow's cyberspace manifesto five years later deeply influenced a generation of thinkers.

ANN E. YOW-DYSON/GETTY IMAGES