

Risk and Reward in the Information Society

Part 1: History

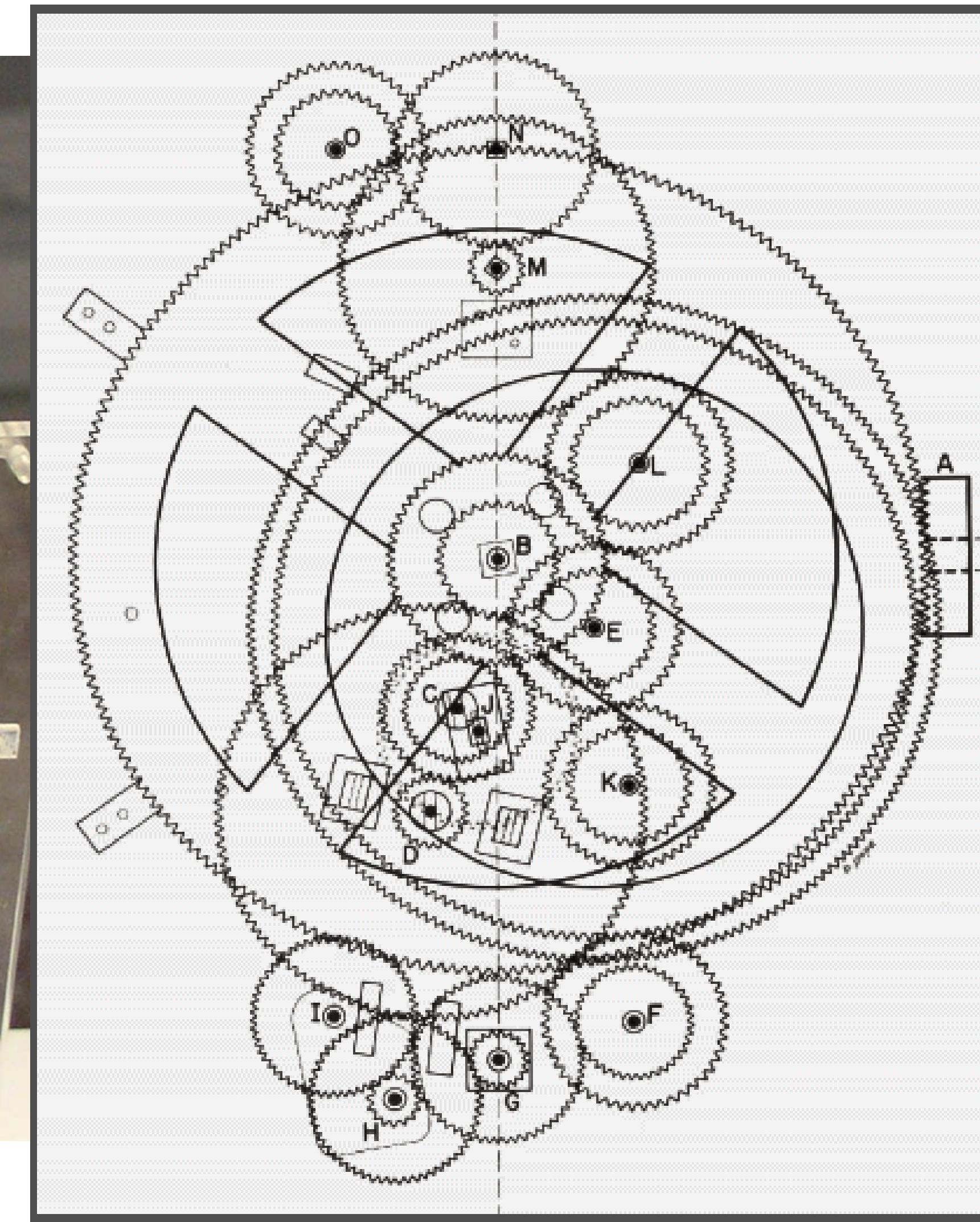
Goals for Part 1

- List the contributions of several pioneers in the computing field.
- Compare daily life before and after the advent of personal computers and the Internet.
- Identify significant continuing trends in the history of the computing field.
- Appreciate the rate of change and the awesomeness of today

Parameters: computing history

- Huge, complex, scandalous, recent
- we'll skip most of history of math, logic, counting tools
- Focus:
 - ▶ People and events
 - ▶ Life before and after
 - ▶ Serve as an introduction to other topics
- *Brief* treatment
 - ▶ Lots more, available online

The Antikythera Mechanism (80BC)



Early Analog computing

- Geared mechanisms approximating physical processes
 - ▶ Clocks for timekeeping
 - ▶ Machines for predicting tides
 - ▶ Machines for predicting the location of planets
- Tally mechanisms for aiding in calculation
 - ▶ Tally sticks, Abacus, etc
 - ▶ No actual computation, just a placekeeping aid.
- Conversion devices (e.g. Slide rule, tables, Torquetum)
 - ▶ Accurate markings allow computation

Pre-computer people

- Charles Babbage
(1791 - 1871)
 - ▶ Analytical Engine
 - ▶ First design of a *programmable, general purpose* machine
 - ▶ Punch cards, CPU, steam powered
 - ▶ Turing-complete (before Turing)
 - ▶ never built



Pre-computer people

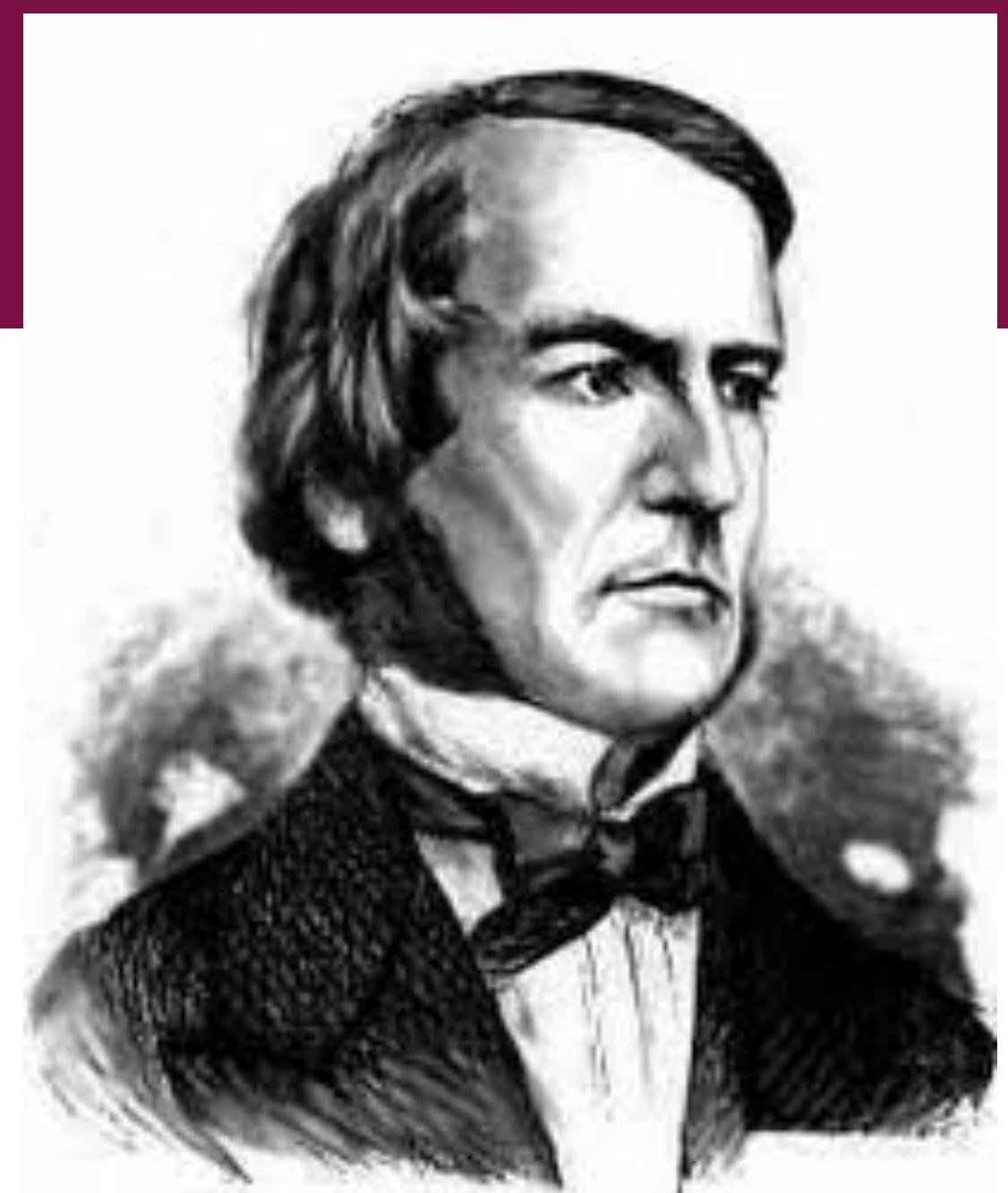
- Ada Lovelace (1815 - 1852)
 - ▶ Augusta Ada King, Countess of Lovelace
 - ▶ Developed programs for Babbage's then-still-theoretical analytical engine
 - ▶ First computer programmer
 - probably besides Babbage himself
 - ▶ “ada” language is named after her



Library of Congress

Pre-computer people

- George Boole (1815 - 1864)
 - ▶ Boolean Logic
- Claude Shannon (1916 - 2001)
 - ▶ Expanded Boolean Logic, developed information theory, digital switching, early chess program, game theory



Pre-computer people

- Vannevar Bush (1890 - 1974)
 - ▶ Graduate supervisor to Claude Shannon
 - ▶ Also worked on the Nuclear Bomb
 - ▶ *"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."*
- memex = theoretical hyperlinked microfilm



Pre-computer people

- Alan Turing (1912 - 1954)
 - ▶ Cryptography, Algorithms, broke enigma code, single-handedly won the war
- Convicted of indecency in 1952 for a homosexual relationship
- Turing test:
 - ▶ impersonating intelligence *is* intelligence
 - refuted by, e.g., the Chinese room



Turing: 9 objections to AI (1950)

- 9 common objections, which Turing refutes (and we will too)
- Religious: Computers will never have a soul
- Head in the sand: It's too terrible to think about
- Mathematical: Gödel's incompleteness theorem
- Consciousness: "not until a machine can write a sonnet or compose a concerto because of thoughts and emotions felt..."
- Disabilities: there will never be a computer that can _____

Strawberries and cream (Turing's examples)

- “Computers will never be intelligent because they never will be able to be kind, resourceful, beautiful, friendly, have initiative, have a sense of humor, tell right from wrong, make mistakes, fall in love, enjoy strawberries and cream, make someone fall in love with it, learn from experience, use words properly, be the subject of its own thought, have as much diversity of behaviour as a man, do something really new.”

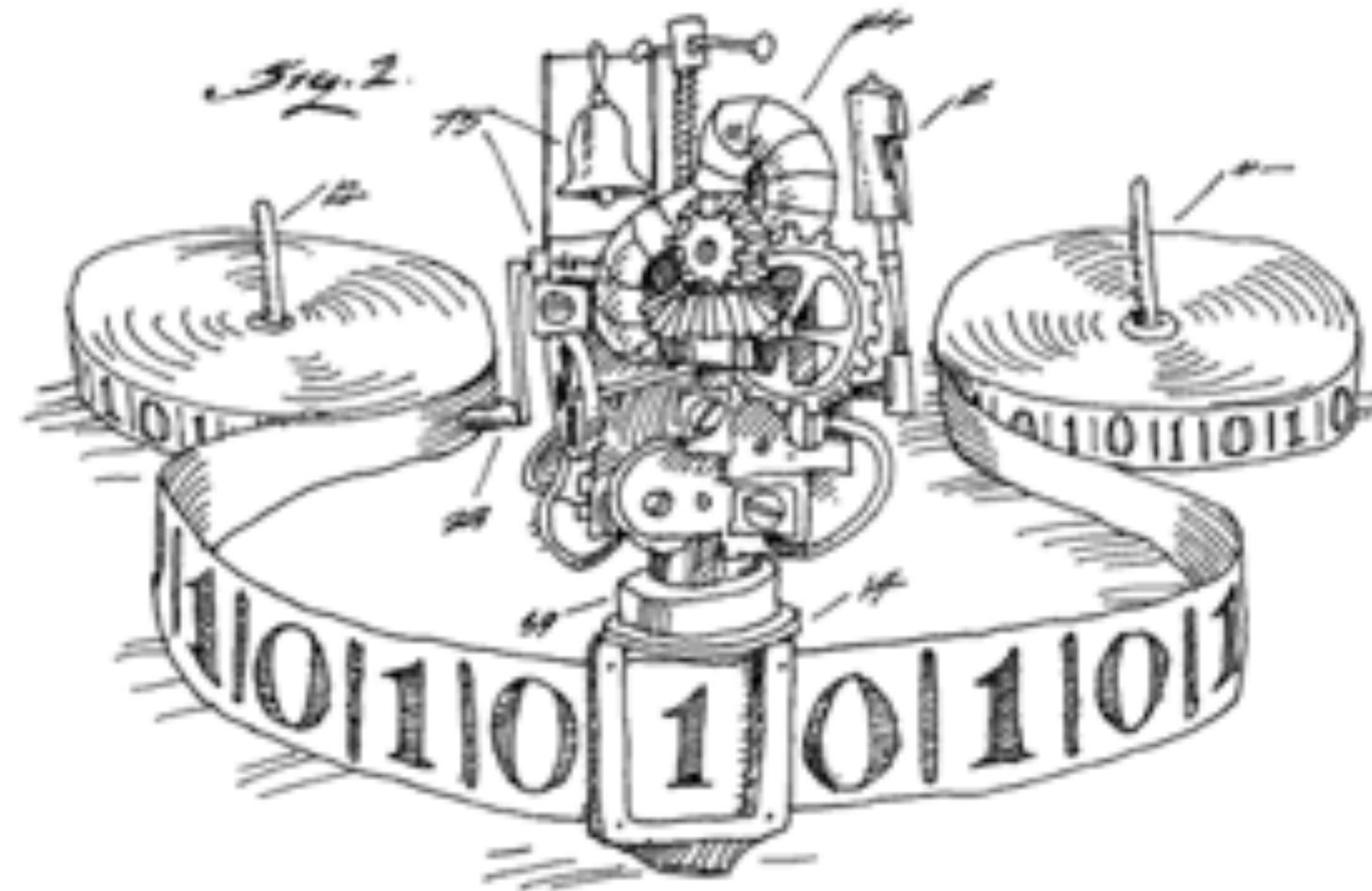
Turing: 9 objections to AI (continued)

- Originality: a computer can only do what we program it to do (aka Lady Lovelace's Objection)
- Continuity: computers are digital but brains are analog
- Informality of behaviour: any system governed by laws is predictable
- ESP: People can read minds, but computers cannot
 - ▶ (it was the 1950s after all)

**More on risks and rewards of AI
later in the course**

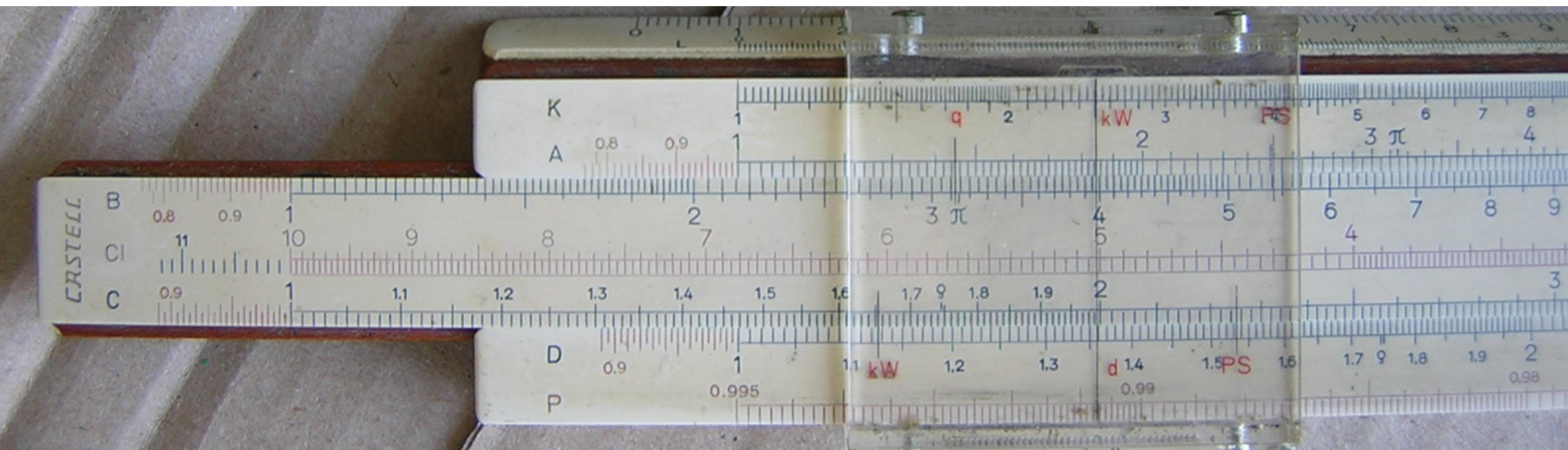
Church-Turing Thesis

- *Everything computable is computable by a Turing machine.*
- Turing Machine:
 - ▶ State machine with an "infinite tape"
 - ▶ CPU with access to memory
 - all modern computers are (more or less) turning machines



Pre-computer people

- Computers (as a job description)
 - ▶ People (usually women) who did math
 - ▶ Calculated trajectory tables for the military, astronomical data, tedious tasks
 - ▶ Used tables, pencil-and-paper, Slide rules



Life before computers: Consider these tasks

- Cross-referencing birth records to death records
- Calculating amount of interest in mortgage payments
- Preparing slides for a lecture
- Layout and formatting a magazine or newspaper
- Typesetting mathematical formula
- Editing a paginated manuscript
- Calculating logarithms
- Copying material from a reference document
- ▶ Others? Tedious, repetitive, boring or dangerous?

Life before the internet: consider these tasks

- Looking up song lyrics, listening to music
- Finding all references to a given research paper
- Publishing and distributing a work of art
- Taking, storing, and indexing photographs by location or subject
- Finding the user manual to an obscure machine
- Keeping a file synchronized between multiple people
- Finding easter eggs or walkthroughs for a video game
- Advertising
- Spreading misinformation

Early computers in the 1940's

- independent and secret
- war applications, shell trajectories
- Manually programmed (instruction by instruction, relay by relay)
- Ballistics calculation: 30 sec on ENIAC
 - ▶ 12 hours by a human “calculator”
 - Electronic Numerical Integrator and Computer

Defining characteristics of some early digital computers of the 1940s

Name	Date	Turing complete
Zuse Z3 (Germany)	1941	Yes
Atanasoff–Berry Computer (US)	1942	No
Colossus Mark I (UK)	1944	No
Harvard Mark I – IBM ASCC (US)	1944	No
Colossus Mark 2 (UK)	1944	No
Zuse Z4 (Germany)	1945	Yes
ENIAC (US)	1946	Yes
Manchester Small-Scale Exp. Machine (UK)	1948	Yes
Modified ENIAC (US)	1948	Yes
EDSAC (UK)	1949	Yes
Manchester Mark I (UK)	1949	Yes
CSIRAC (Australia)	1949	Yes

generations of computing (generalization)

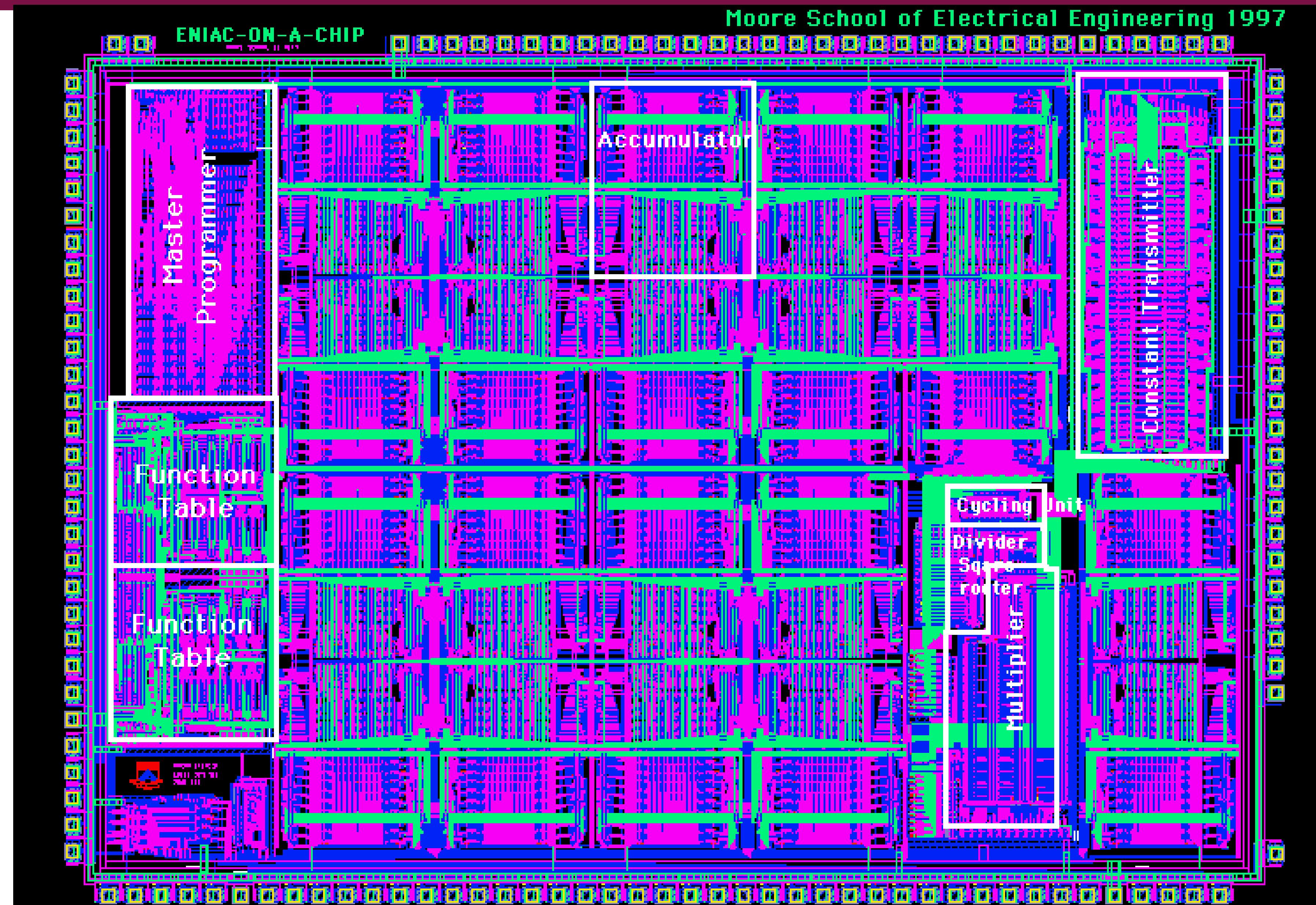
Gen.	Processor	Memory	I/O devices	Size
0 (1940s)	Mechanical	Wheel, card	Lever, dial, punched card	Factory
1 (1950s)	Vacuum tube	Mag drum	Paper tape, magnetic tape	Hall
2 (1960s)	Transistor	Mag core	Drum, printer, text terminal	Room
3 (1970s)	SSI/MSI	RAM chip	Disk, keyboard, monitor	Desk
4 (1980s)	LSI/VLSI	DRAM	Network, CD, mouse, sound	Desk
5 (1990s)	SOC	Flash	Sensor/actuator, point/click	Lap
6 (2000s)	Multi-core	SSD	Blue Ray, GPS, Accelerometer	Phone
7 (2010s)	GPU	Cloud	VR, RFID, Qi	IOT

ENIAC (1946)

- 27 tonnes
- 8' x 3' x 100'
- 150 kW
- \$500,000.
- 5kHz
- 385 integer multiplications per second



ENIAC-on-a-chip (1997)



More people: Grace Hopper (1906 - 1992)

- ▶ Human-readable programming languages
- ▶ Compilers
- ▶ “first computer bug”
 - But “bug” was already a term for problems in electronics...



9/9

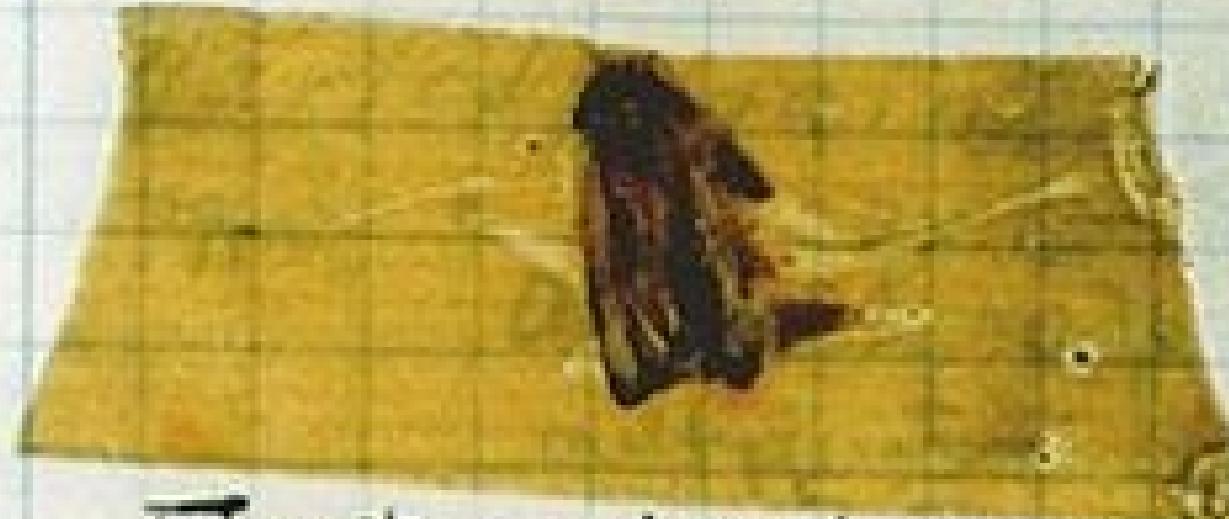
0800 Auton started
1000 . stopped - auton ✓ { 1. 2700 9. 037 847 025
1300 (032) MP-MC ~~1.982642000~~ 9. 037 846 795 const
 ~~2.130476415~~ 4. 615 925 059 (-2)
(033) PRO 2 2. 130476415
 const 2. 130676415

Relays 6-2 in 033 failed special speed test
In relay .. 11.000 test.

Relay
2145
Relay 3370

1100 Started Cosine Tape (Sine check)
1525 Started Multi Adder Test.

1545



Relay #70 Panel F
(moth) in relay.

1600 Auton started.

1700 closed down.

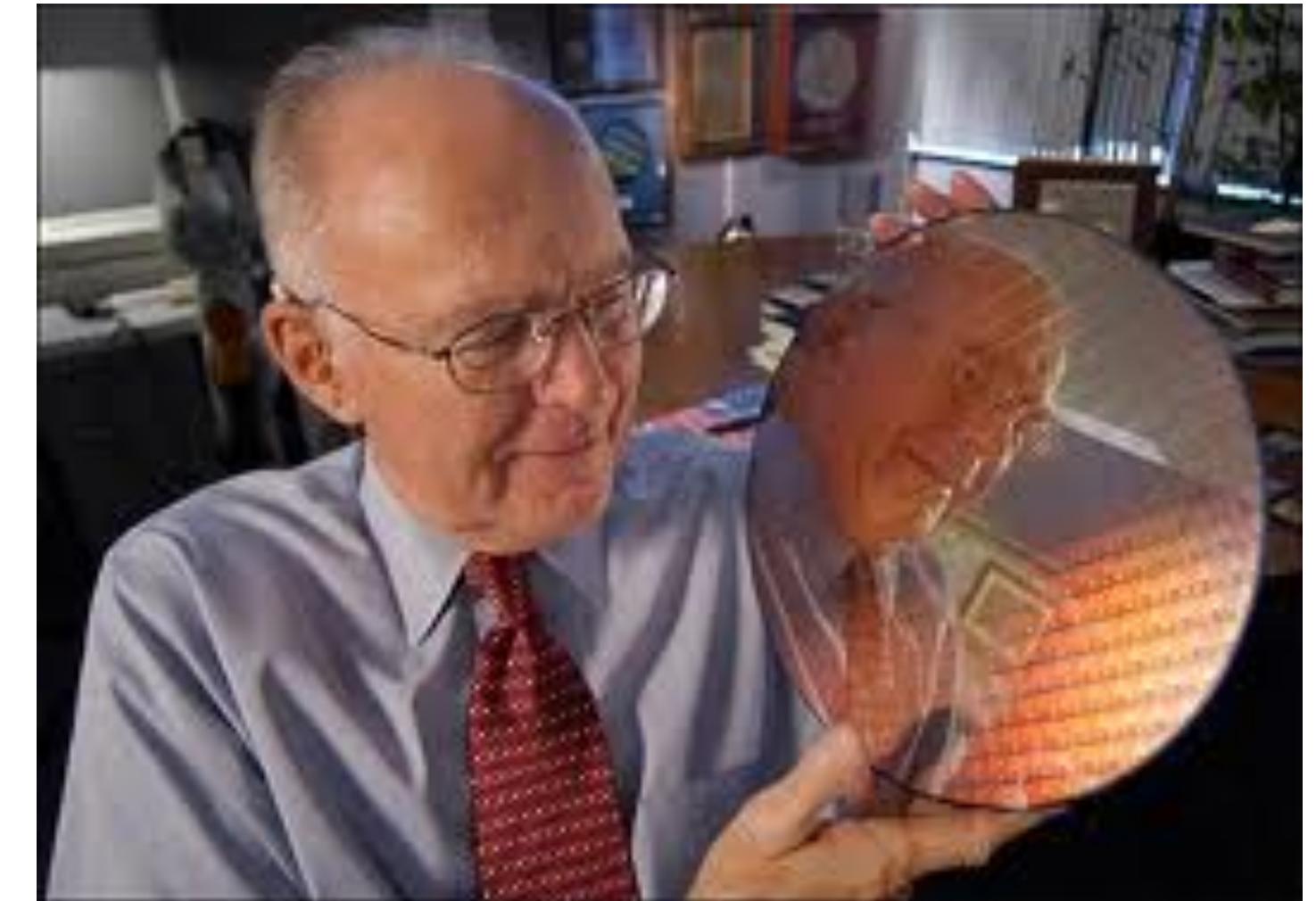
John von Neumann (1903-1957)

- von Neumann architecture
 - ▶ single storage area for programs and data
- compared to “Harvard” architecture
 - ▶ separate storage areas for programs and data



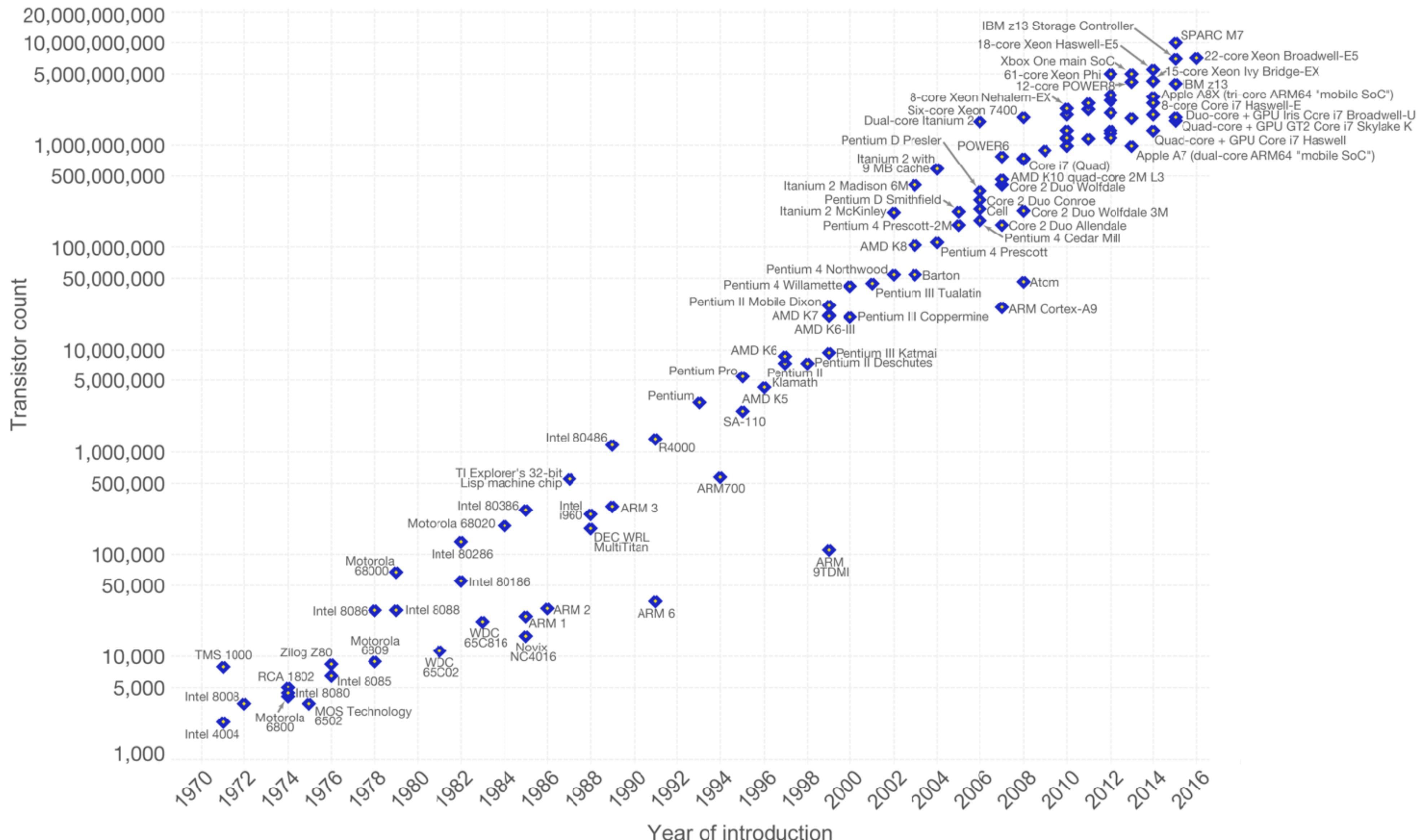
Gordon Moore (b 1929)

- ▶ Co-founder of Intel
- ▶ Moore's law:
 - number of transistors on an integrated circuit for minimum component cost doubles every 24 months
 - Hard drive capacity, RAM storage, follows (followed?) a similar law of accelerating change



Moore's Law – The number of transistors on integrated circuit chips (1971-2016)

Moore's law describes the empirical regularity that the number of transistors on integrated circuits doubles approximately every two years. This advancement is important as other aspects of technological progress – such as processing speed or the price of electronic products – are strongly linked to Moore's law.

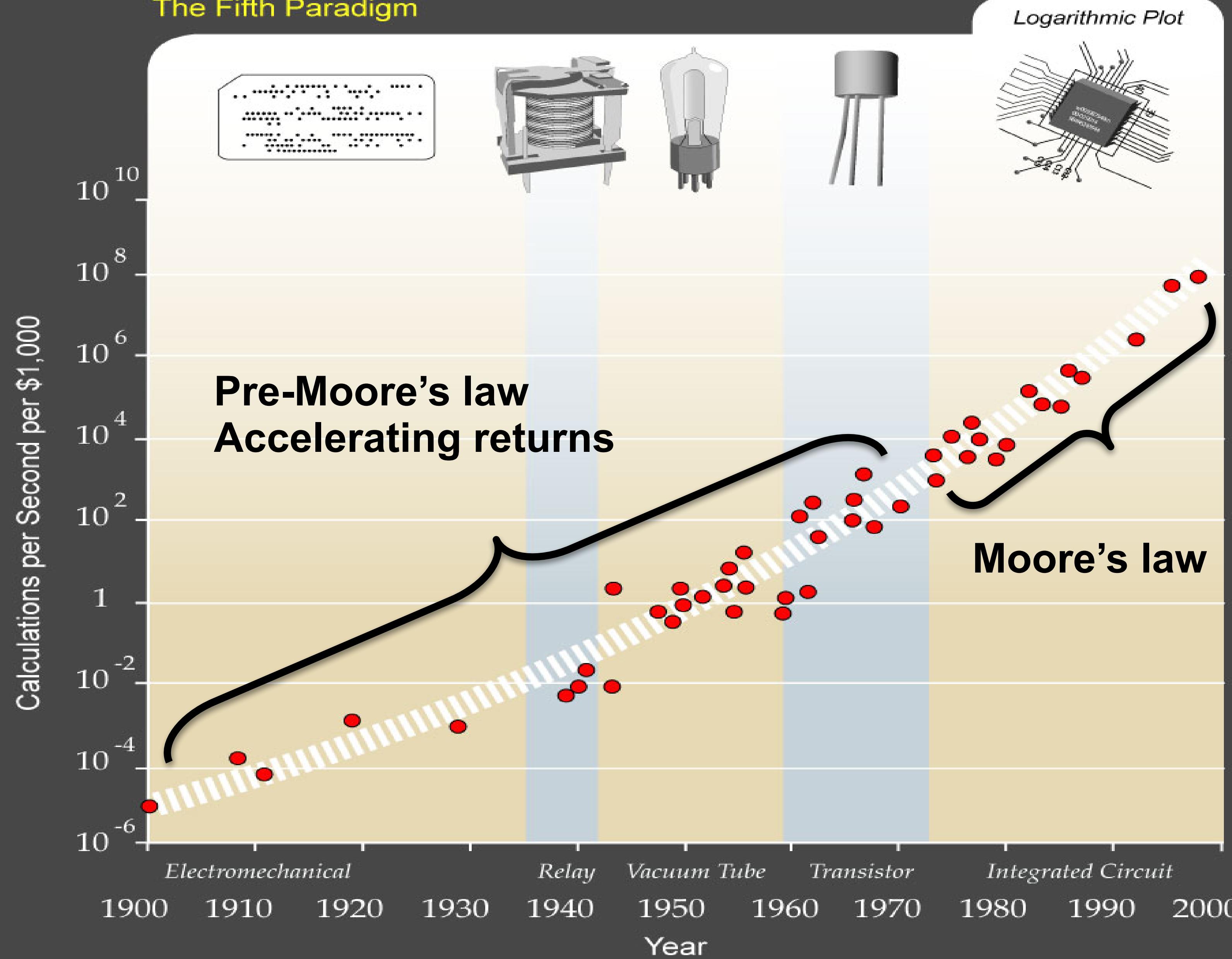


Raymond Kurzweil (b 1948)

- OCR, Speech recognition and synthesis
- Accelerating Returns
(Moore's law, extended)
 - ▶ predicts a “technological singularity” when artificial intelligence supersedes human intelligence

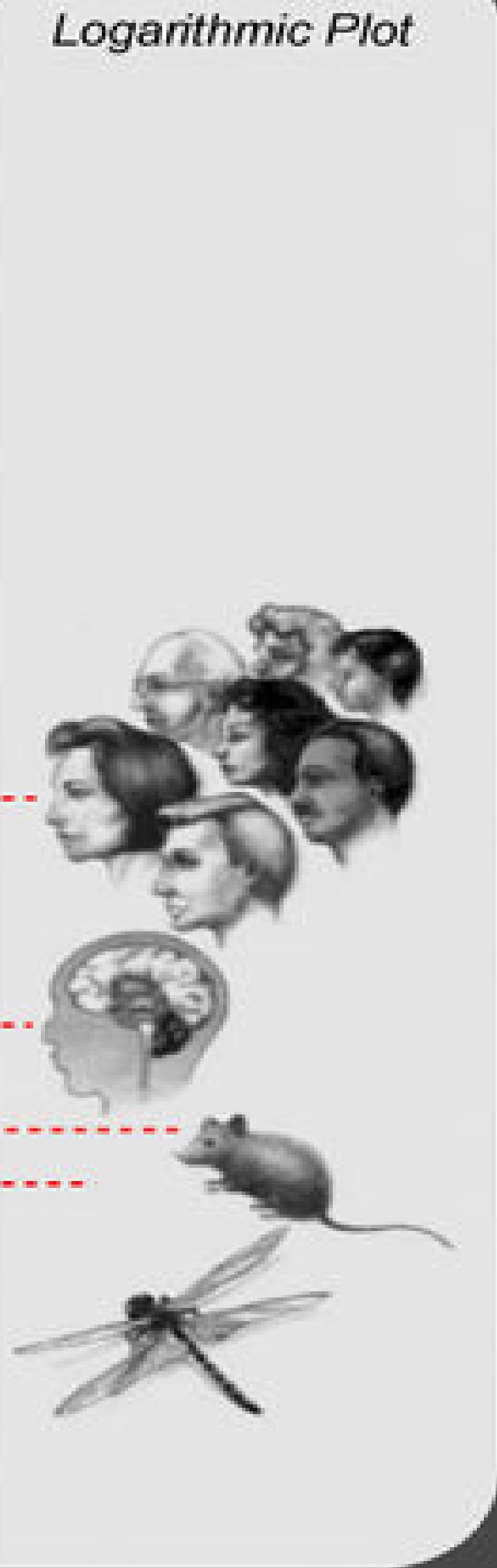
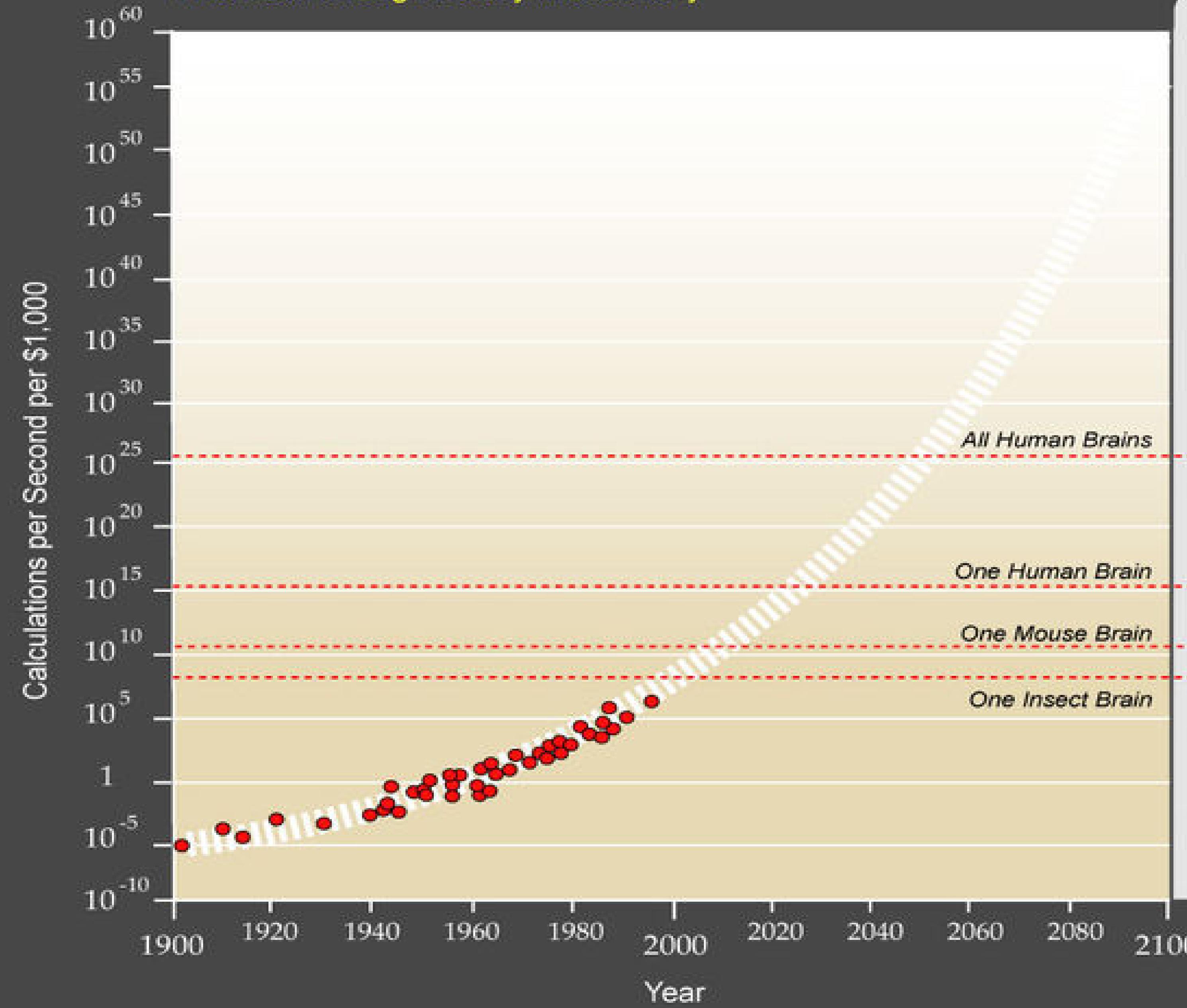


Moore's Law The Fifth Paradigm



Exponential Growth of Computing

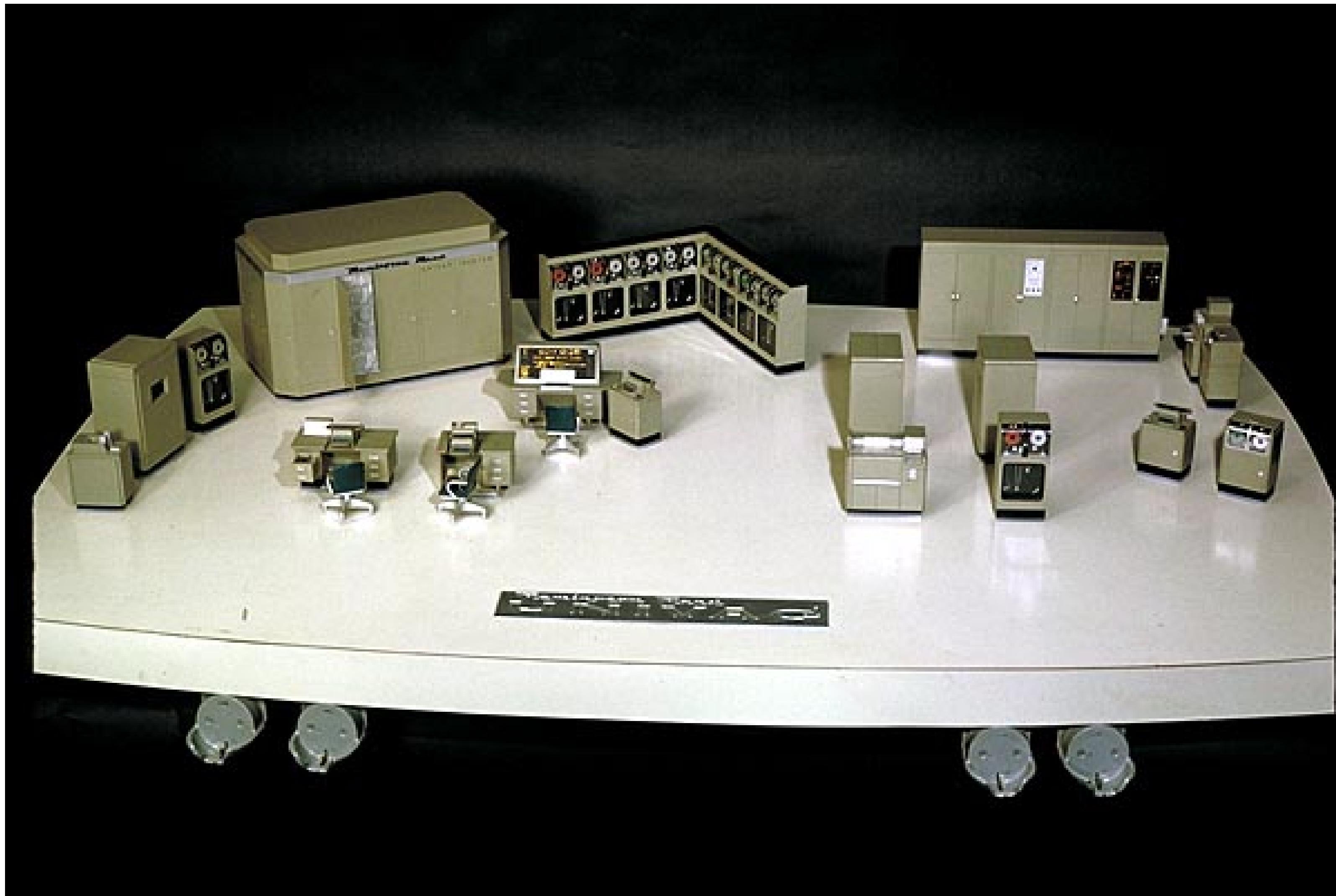
Twentieth through twenty first century



Commercial computing

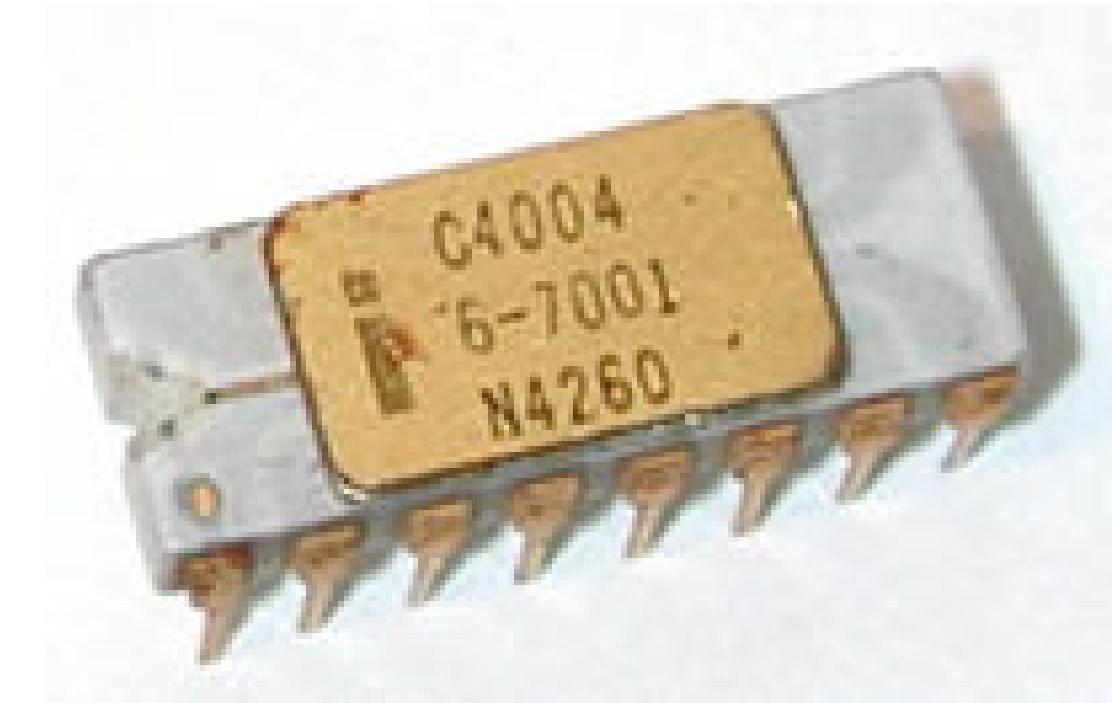
- UNIVAC (1951)
 - ▶ UNIVersal Automatic Computer
 - ▶ First US commercial computer
 - ▶ Sold to Census bureau, insurance companies, air force *etc.* (46 were built and delivered)
 - ▶ originally \$159,000 (1951 dollars), rose to \$1,500,000
 - ▶ predicted 1952 election
 - ▶ competed against punch-card data processors
 - ▶ IBM's first computer was in 1952

UNIVAC



Microprocessors and Personal Computing

- intel 4004: 1971
 - ▶ first commercial microprocessor
 - ▶ popular with hobbyists
- Altair 8800: 1975
 - ▶ First “complete” computer kit
 - ▶ based on Intel 8080A
 - ▶ instruction-by-instruction programming



HOW TO "READ" FM TUNER SPECIFICATIONS

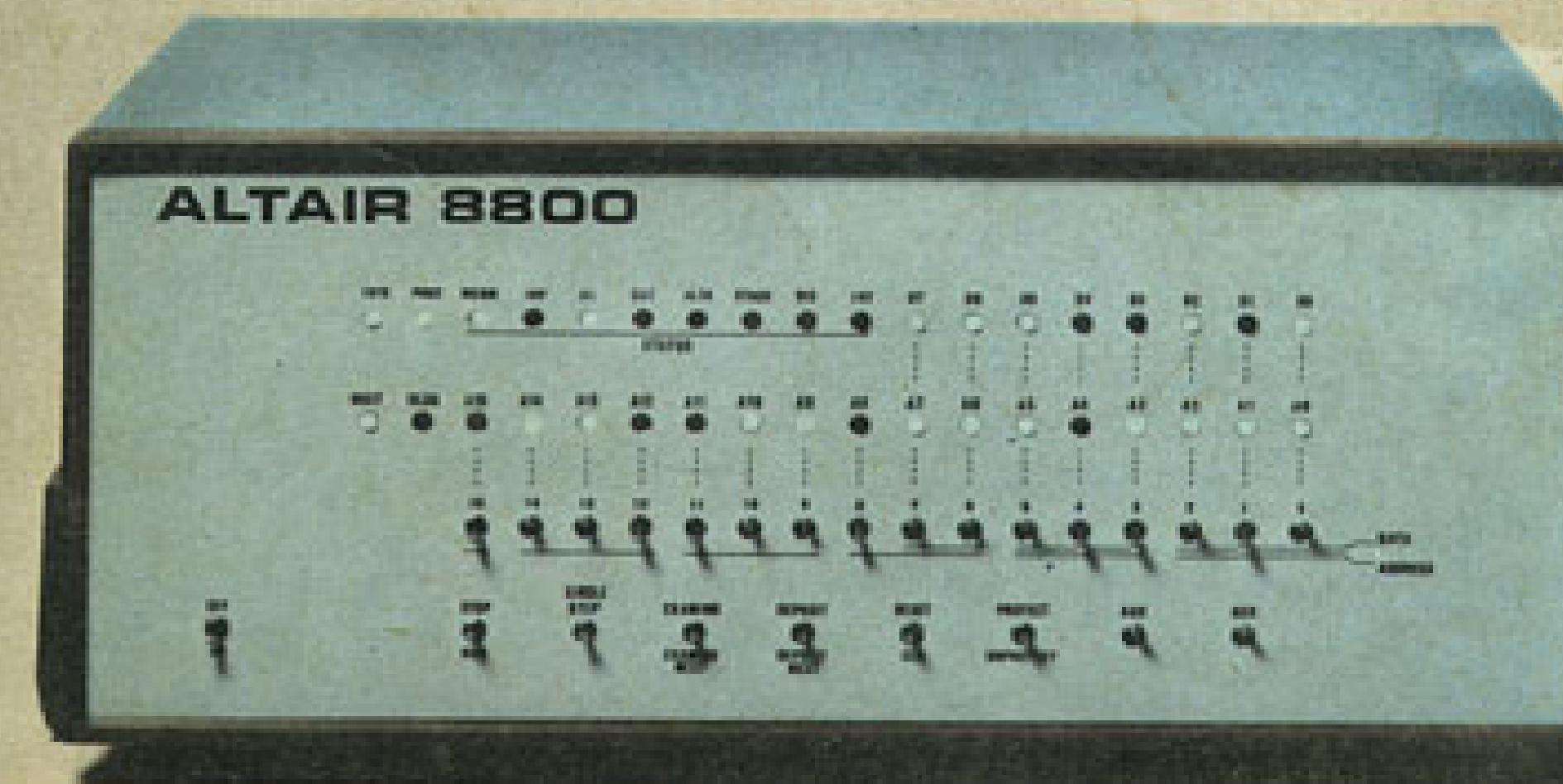
Popular Electronics

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE JANUARY 1975 / 75¢

PROJECT BREAKTHROUGH!

**World's First Minicomputer Kit
to Rival Commercial Models...**

"ALTAIR 8800" **SAVE OVER \$1000**



Wow!

ALSO IN THIS ISSUE:

- An Under-\$90 Scientific Calculator Project

Aside: graphing calculators

- TI83 (1996) - \$125
 - ▶ 6Mhz CPU, 32k ram
- TI84+ (2004) - \$125
 - ▶ 15Mhz Zilog CPU, 160k ram
- Free / cheap software on a phone can do everything this can do
- Millions still sold today, primarily to students.

Microsoft

- Paul Allen and Bill Gates wrote “Basic” for the altair
 - ▶ read in using a paper tape
 - ▶ sold to MITS, manufacturers of the altair
 - (just in time to ship with the 8800)
 - ▶ Most other software was freely shared around at the time
- formed “Micro-soft”

Apple

- Steve Jobs, Steve Wozniak
 - ▶ Apple 1: \$666.66
 - ▶ Apple][
 - first packaged micro-computer, June 1977
 - Visicalc - first spreadsheet
 - versions for sale till October 1993.
 - ▶ Apple][dominated the market till IBM



Apple][contemporaries

- Commodore PET
 - ▶ calculator manufacturer
 - ▶ BASIC licensed from Microsoft
- Radio Shack TRS-80
 - ▶ Modular (display and tape drive separate)
 - ▶ Distributed through radio shack stores



Xerox PARC (Palo Alto Research Center)

- Xerox Alto (1973)
 - ▶ developed first GUI, mouse, laser printer, WYSIWYG, network, object oriented computing, email...
 - Many were developed from others, e.g. Doug Engelbert invented the mouse
- Only a few thousand made, would have cost \$40,000 if commercially available



IBM PC: 1980

- Off-the-shelf parts
- IBM's name led credibility to corporate customers
 - ▶ Huge sales volume, dominant market share
- Microsoft licensed DOS and BASIC to IBM
 - ▶ Gates bought DOS from Jim Patterson, who had “adapted” it from Gary Killdall’s CPM

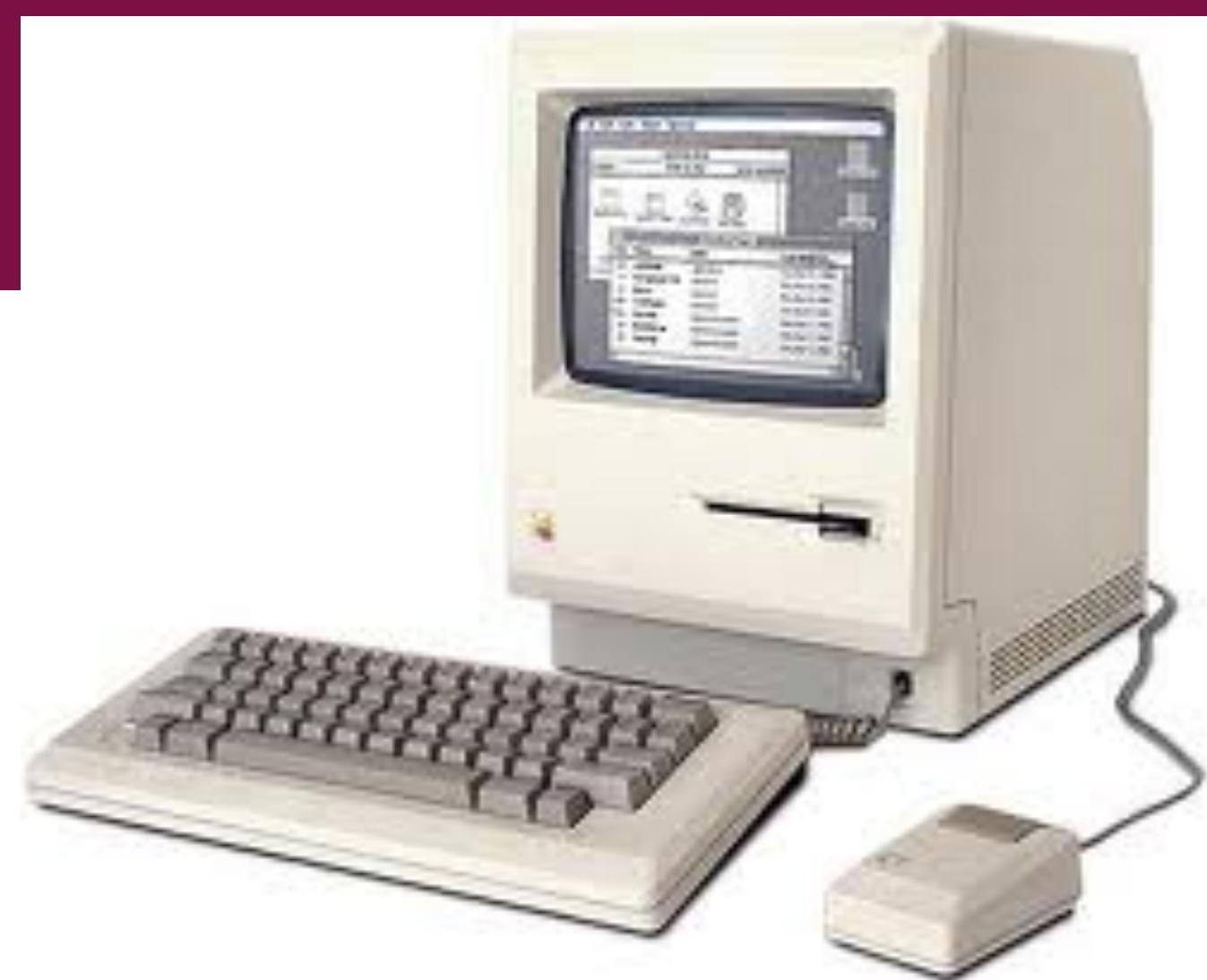


Commodore 64 (1982)

- Similar configuration but much cheaper, better advertised
 - ▶ \$100 rebate for any game console
 - contributed to video game crash of 1983
- Successor: Amiga (1992)
 - ▶ “video toaster” plug-in allowed at-home TV production.



Macintosh (1984)



- ▶ Xerox Parc invited Apple to a demo of the work, Apple compensated Xerox for the IP
 - Apple significantly refined hardware and software, added desktop metaphor, built HCI guidelines for consistency across applications.
- Mac was the first large-market GUI PC
- Enormous marketing campaign
- Targeted IBM as main competition.

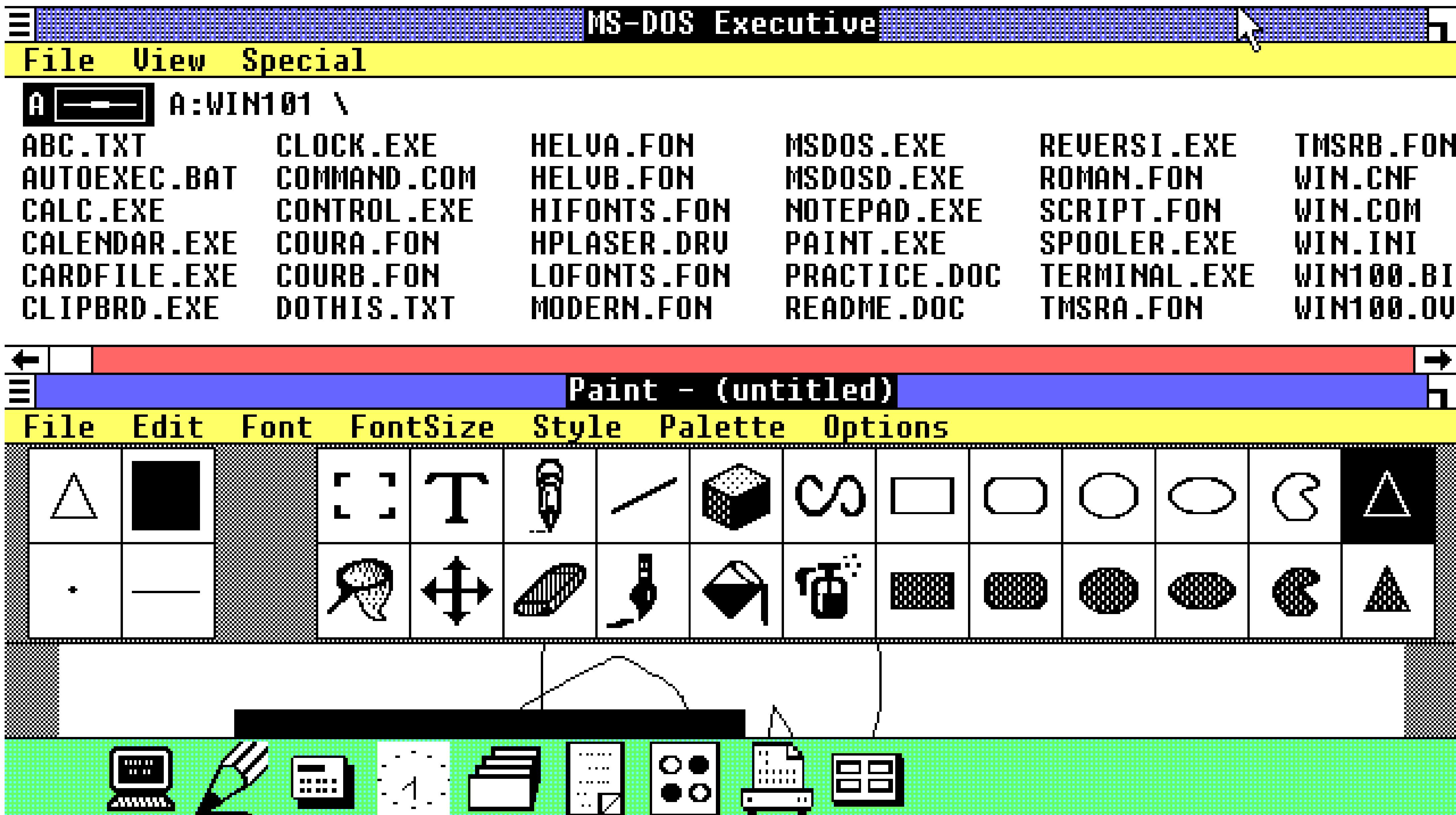
Theme: “democratization of innovation”

- Before PCs, only professional industry could produce books, TV, music, etc.
 - ▶ High cost of entry, training, maintenance,
 - ▶ Not economical without high sales volume
- PCs allowed this to be done by anyone, anywhere
- Good: tools of innovation are in the hands of the people
- Bad: no editing, no curation, a vast sea of terrible content, copyright violation, fake news, and mediocrity

IBM Compatible

- runs software just like an IBM
- reverse-engineered the BIOS, bough everything else off-shelf
- Compaq: first “portable” computer
- Clones
 - ▶ Licensed software from microsoft
 - ▶ Bought chips from intel
 - ▶ both companies made millions

Windows 1.0 (1985)



Windows 2.11 (1988)

- overlapping windows, “very” similar to Mac, Alto
- Apple sued Microsoft for copyright infringement
 - ▶ Apple lost
 - ▶ from the Appeal:
 - ▶ “It is not easy to distinguish expression from ideas, particularly in a new medium. However, it must be done, as the district court did in this case”
 - ▶ We’ll talk about IP protection, copyright etc later

Linux and GNU

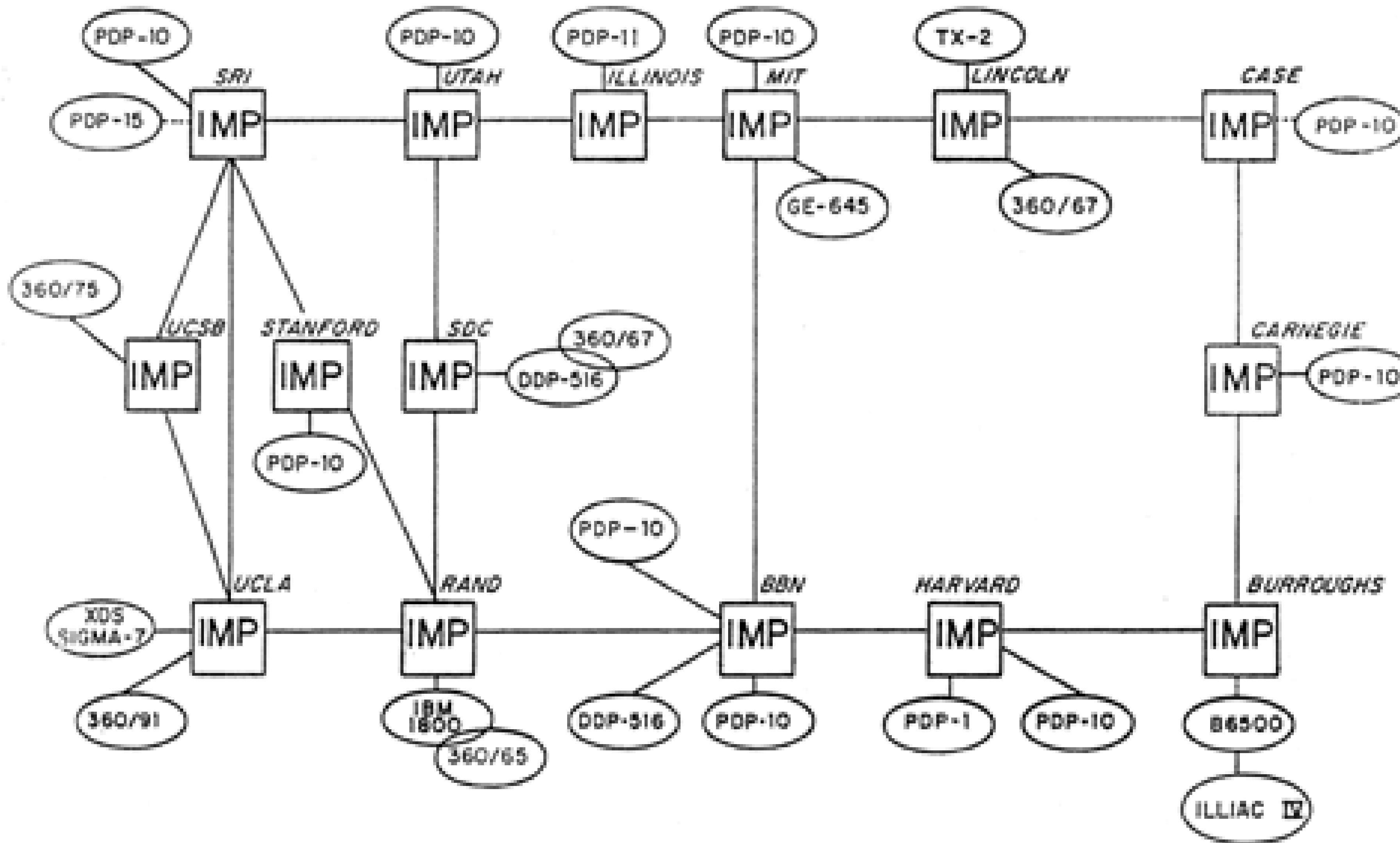
- 1983: Richard Stallman founds the GNU project
 - ▶ “free” alternative to proprietary unix
- 1991: Linus Torvalds builds Freax
 - ▶ later renamed to Linux
- Gnu/Linux uses Linux kernel and GNU software.
 - ▶ We'll talk about about “free” software and open source later



ARPANET: Advanced Research Projects Agency

- 1969: 4 “Interface Message Processors” connected to 4 university computer labs
- Funded by government, universities
- Strictly non-commercial, academic applications
 - ▶ Email, data-sharing

ARPANET, 1971



IMP =
internet
message
processor

SITE

IMP

Onsite
Computer

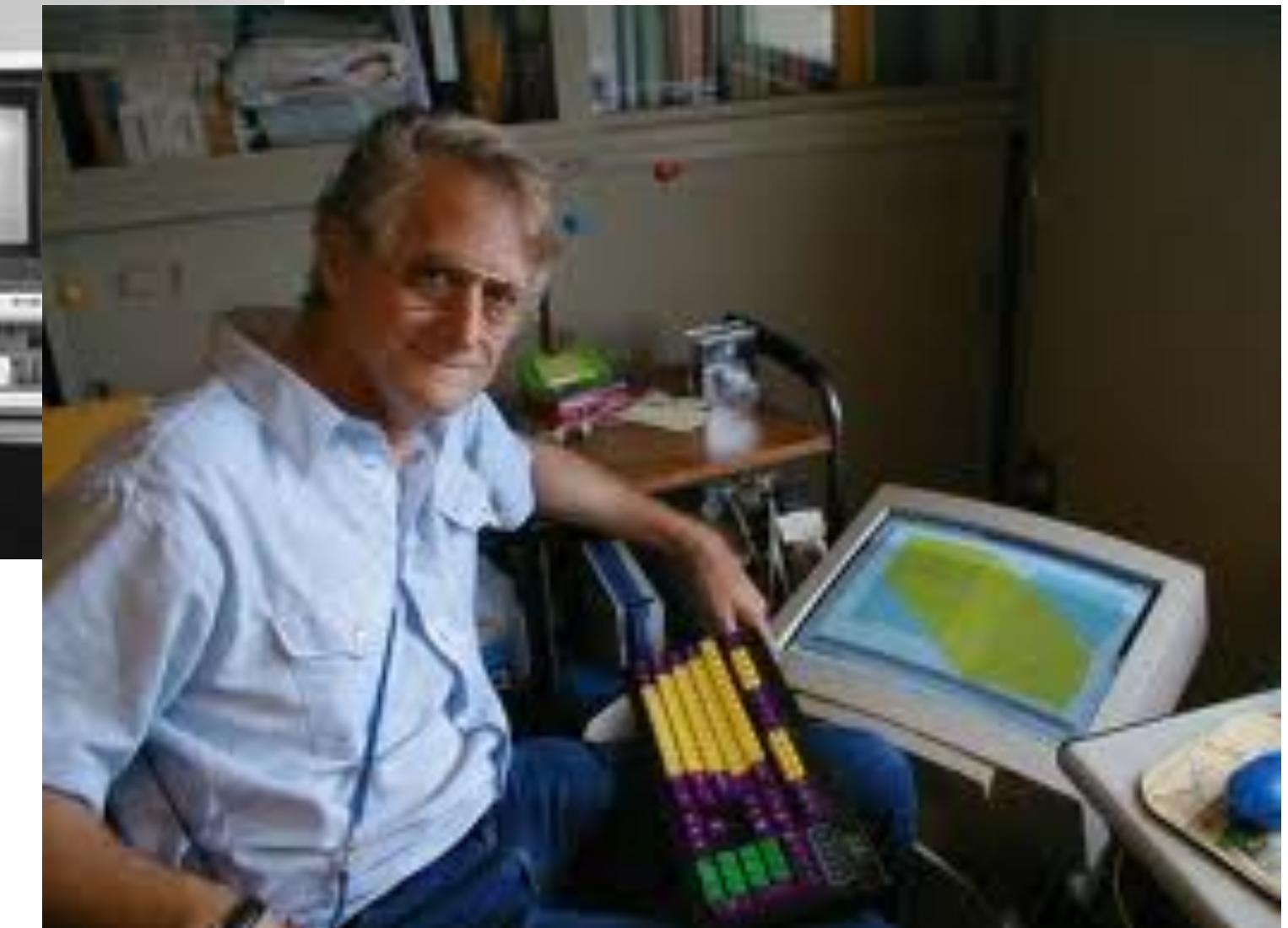
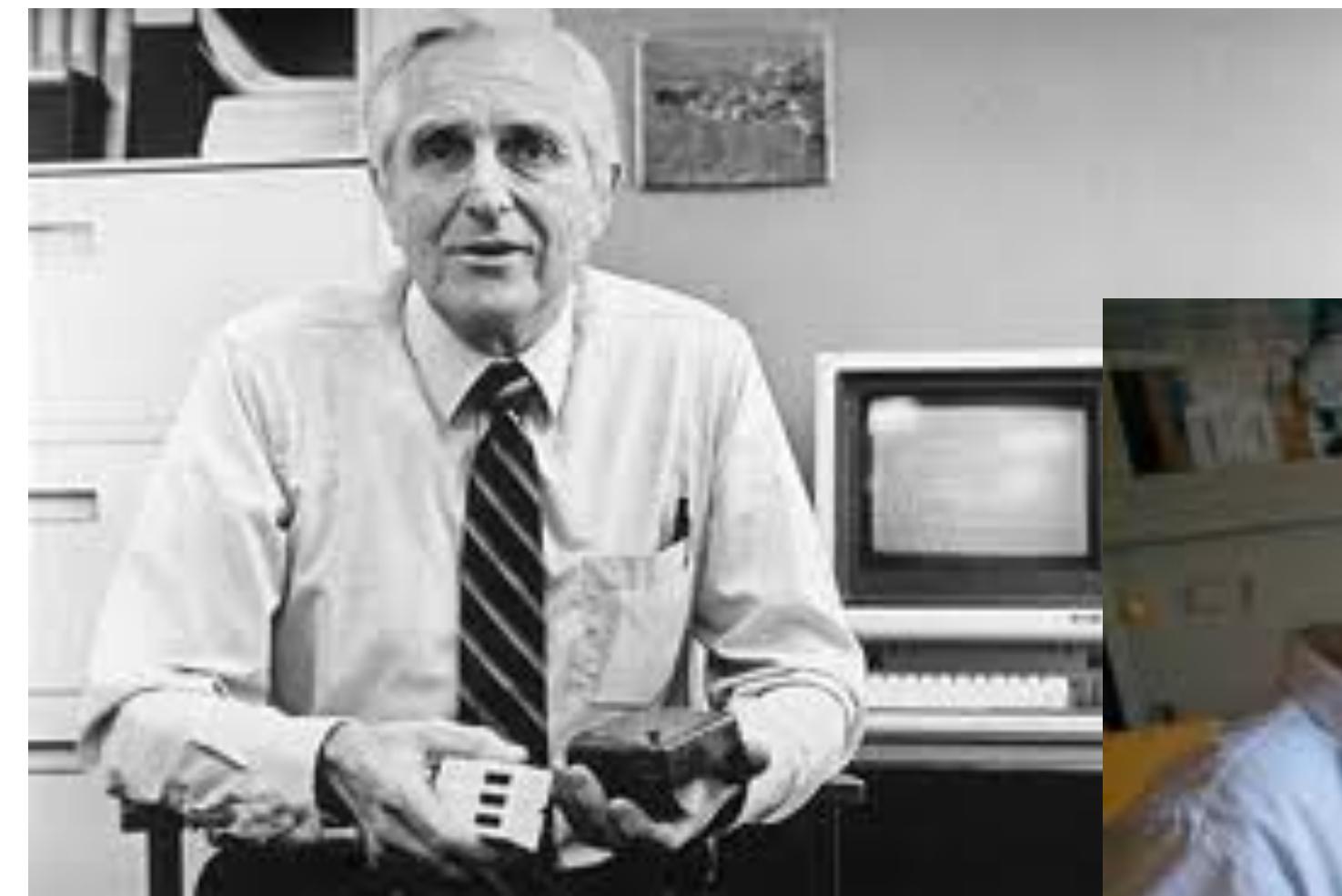
ARPA NET, APRIL 1971

Usenet (1979)

- “User Network”
 - ▶ Users post messages to local server, servers exchanges messages, users can read messages
 - ▶ First large distributed bulletin board system
 - ▶ First social network
 - ▶ still in use today

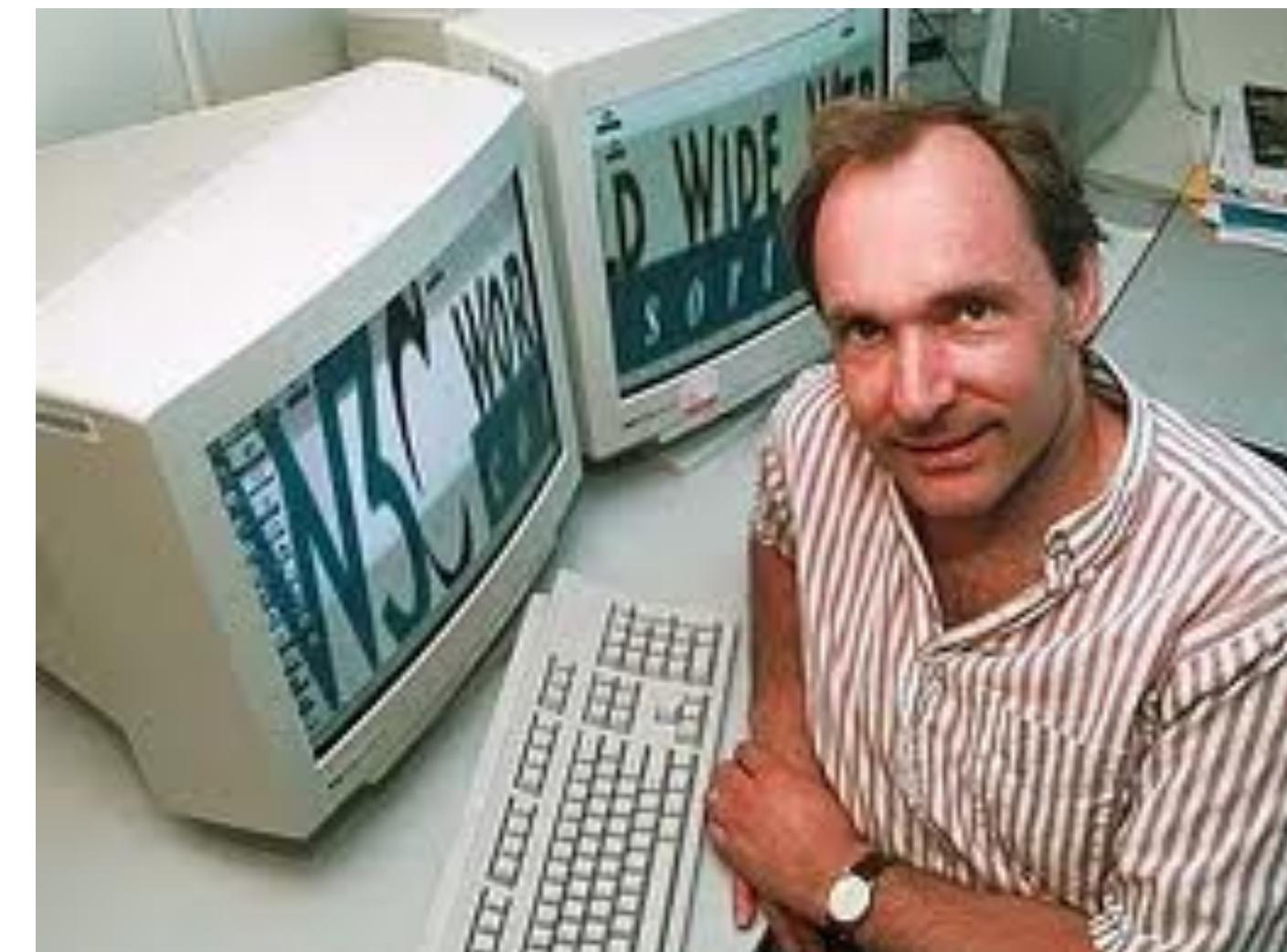
Engelbart and Nelson

- Douglas Engelbart (1925-2013)
 - ▶ Mouse, Hypertext
- Ted Nelson (b. 1937)
 - ▶ Usability, hypertext
 - ▶ “A user interface should be so simple that a beginner in an emergency can understand it within ten seconds.”



Sir Tim Berners-Lee (b 1955)

- Invented the world wide web (1989, 1990)
 - ▶ "I just had to take the hypertext idea and connect it to the Transmission Control Protocol and domain name system ideas and—ta-da! – the World Wide Web"
- Founded the world wide web consortium (w3c) in 1994



Dot-com bubble

- Old-style companies scrambled to produce new business models for “the internet”
- Venture capitalists invested in anything
- e.g. Pets.com
 - ▶ \$82.5 million IPO
 - ▶ folded 9 months later
- Other examples
 - ▶ WebVan.com (groceries)
 - ▶ Garden.com (gardening supplies)



7,136.56 +58.64 (0.83%) ↑

Jan. 5, 4:14 p.m. EST · Disclaimer

NASDAQ composite

1 day

5 days

1 month

1 year

5 years

Max



Y2K

- Computers used 2 digits for the date
 - ▶ Historically, from Punch-card days where every character counted
- Fears that $2000 = 00 = 1900$
 - ▶ Mortgages, financial would be upset
 - ▶ error checking would cause many systems to fail
- \$300 billion to fix
 - ▶ good time to be a programmer
- ▶ More about risk and ethics of code decisions later

Y2K related

- 2038: 32-bit POSIX will roll over
 - ▶ Standard time format for UNIX, C programming
 - ▶ 32b integer for seconds since Jan 1 1970
 - ▶ some problems already occurring
 - AOL used a billion seconds in the future for “never”
 - rolled over in 2006, causing crashes
 - ▶ 32-bit embedded devices will likely still be around
- y10k: need to express year as 5 digits
 - ▶ probably not need to worry?

United States v. Microsoft Corporation

- 1998-2001, about things that happened 1990s
- Microsoft bundled their browser (IE) with their operating system to compete with Netscape, Opera, others
- Judgement: Microsoft abused their monopoly, browser was to be made separate
- At trial, Bill Gates was "evasive and nonresponsive"
- Microsoft said they were being prevented from innovating
 - ▶ Sound familiar?
- Microsoft forced to publish APIs

Relaxing Restrictions

- US government attempted to classify encryption as a military technology
 - ▶ 2000: Government relaxes restrictions
- US government “dithered” GPS adding random errors of up to 100m
 - ▶ Attempt to limit the use by enemies
 - ▶ Called “selective availability”, could be removed by authorized receivers
- 2000: Government removed dithering

Notable Firsts 2001-2010

- Operating Systems
 - ▶ Windows XP (2001)
 - ▶ Mac OS X (2001)
- Web / Social
 - ▶ Facebook (2004)
 - ▶ Gmail (2004)
 - ▶ Youtube (2005)
 - ▶ Twitter (2006)
- Phones
 - ▶ Blackberry (2002)
 - ▶ iPhone (2007)
 - ▶ Android (2008)
 - ▶ Windows Phone (2010)

Notable Computer Rivalries

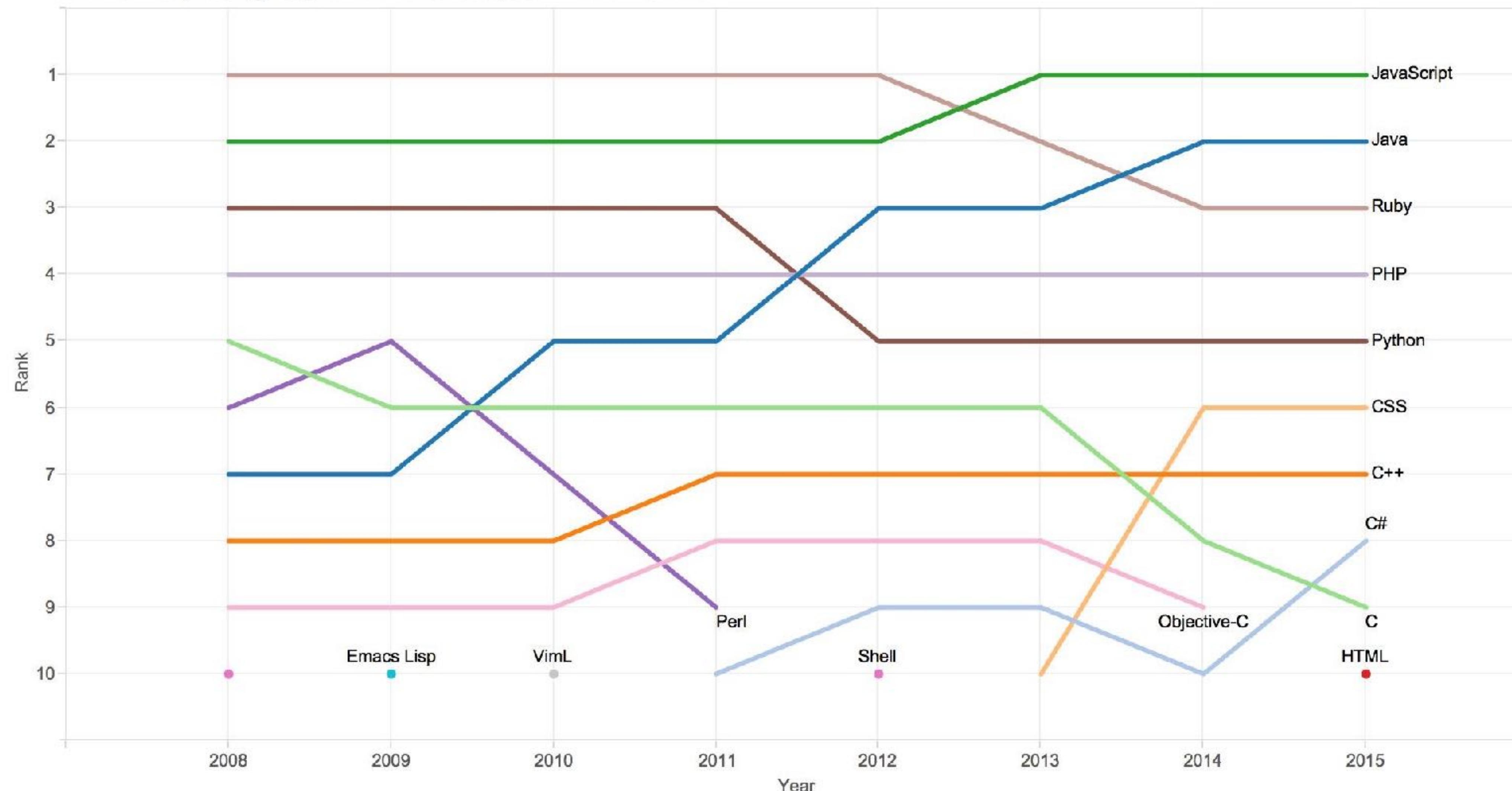
- IBM PC vs Commodore 64
- Mac vs Windows
- Internet Explorer vs Netscape Navigator
- Blackberry vs Palm vs Handspring (HTC)
- AMD vs Intel
- Xbox vs Playstation (and Nintendo vs Sega)
- Nvidia vs AMD
- Apple vs Samsung

Google's graveyard

- Google has a history of closing or modifying popular projects, either internal or acquired
 - ▶ If it can't make ad revenue
 - Reader; Picassa; Wave; Songza, Waze
- See Also
 - ▶ Google Glass, Google Plus

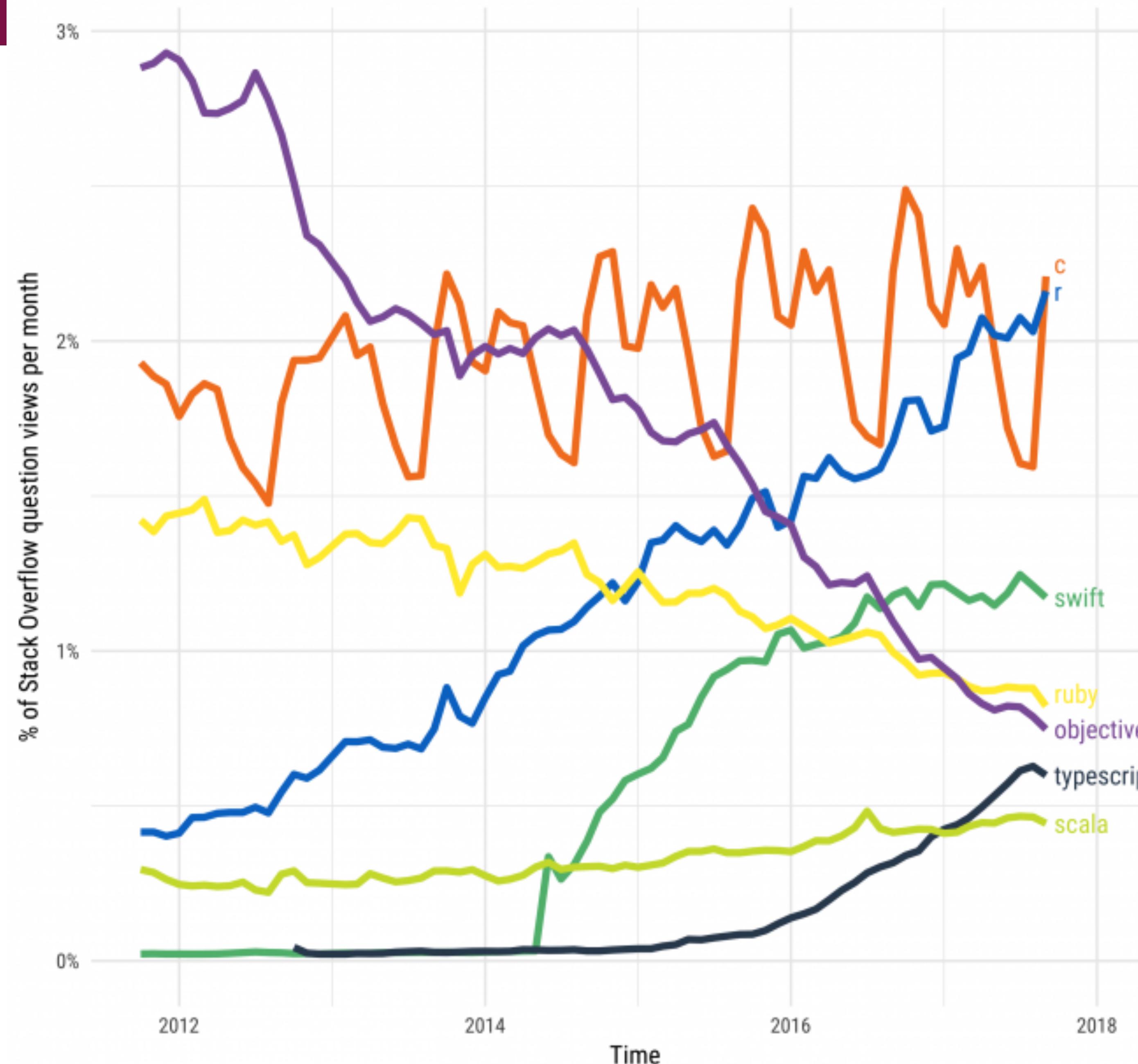
Programming Language Trends

Rank of top languages on GitHub.com over time



Stack Overflow Traffic to Programming Languages

Based on visits to Stack Overflow questions from World Bank high-income countries.
The more-visited languages of Python, JavaScript, Java, C#, and PHP were omitted.



Programming Language Trends

- C is used for school (so lots of people asking questions)
- Swift, R users don't use github
- What would be more useful measures? How could we find them?

Other histories

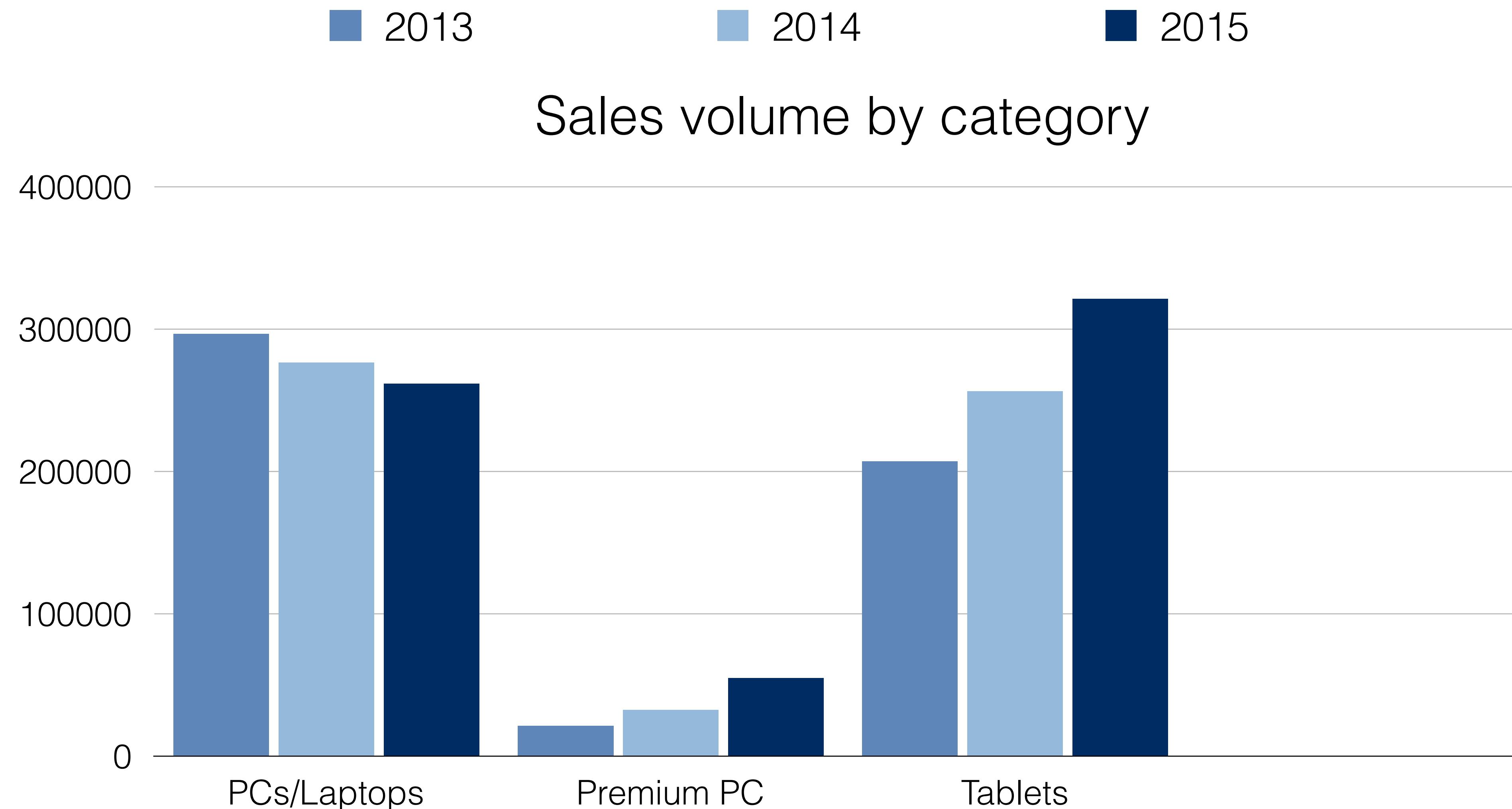
- ▶ Bonus marks to anyone wanting to research and prepare a presentation.
- Video games
- Web 2.0, social media, cloud computing
- Open Source
- Servers, portables, embedded, tablets
- Smartphones, iOS, android
- Browsers, office suites, SaaS
- Big data, AI, IoT, VR/AR,

Predicting the future

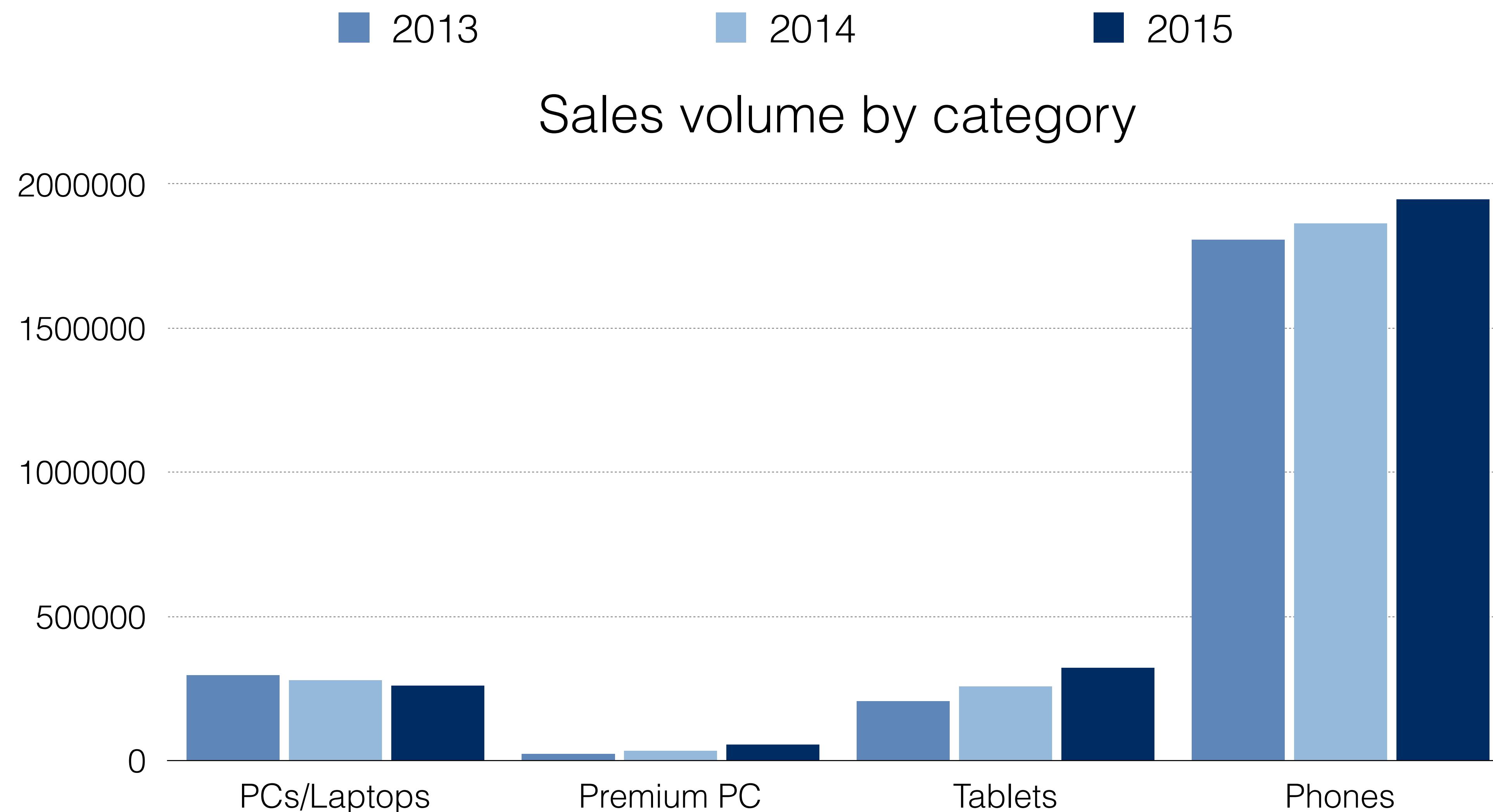
- Arthur C Clarke
 - ▶ Computer terminal, video chat, email, internet, telecommuting,
- Ray Kurzweil
 - ▶ Chess program will beat human; search engines; voice input; language translation
- Prediction is more often wrong than right
- Prediction is sometimes self-fulfilling.

The Future

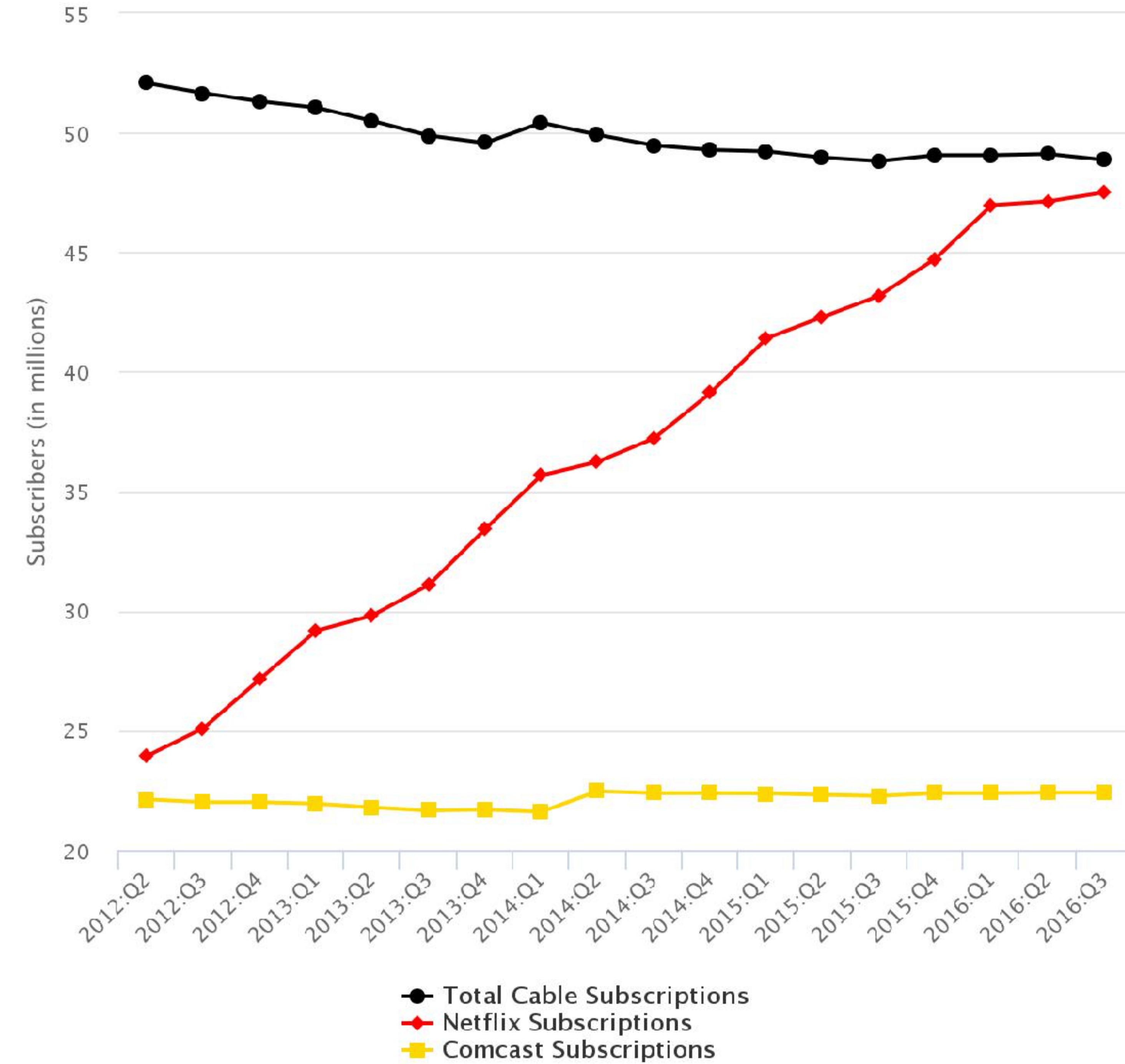
The Platform Shift is over



The Platform Shift is over

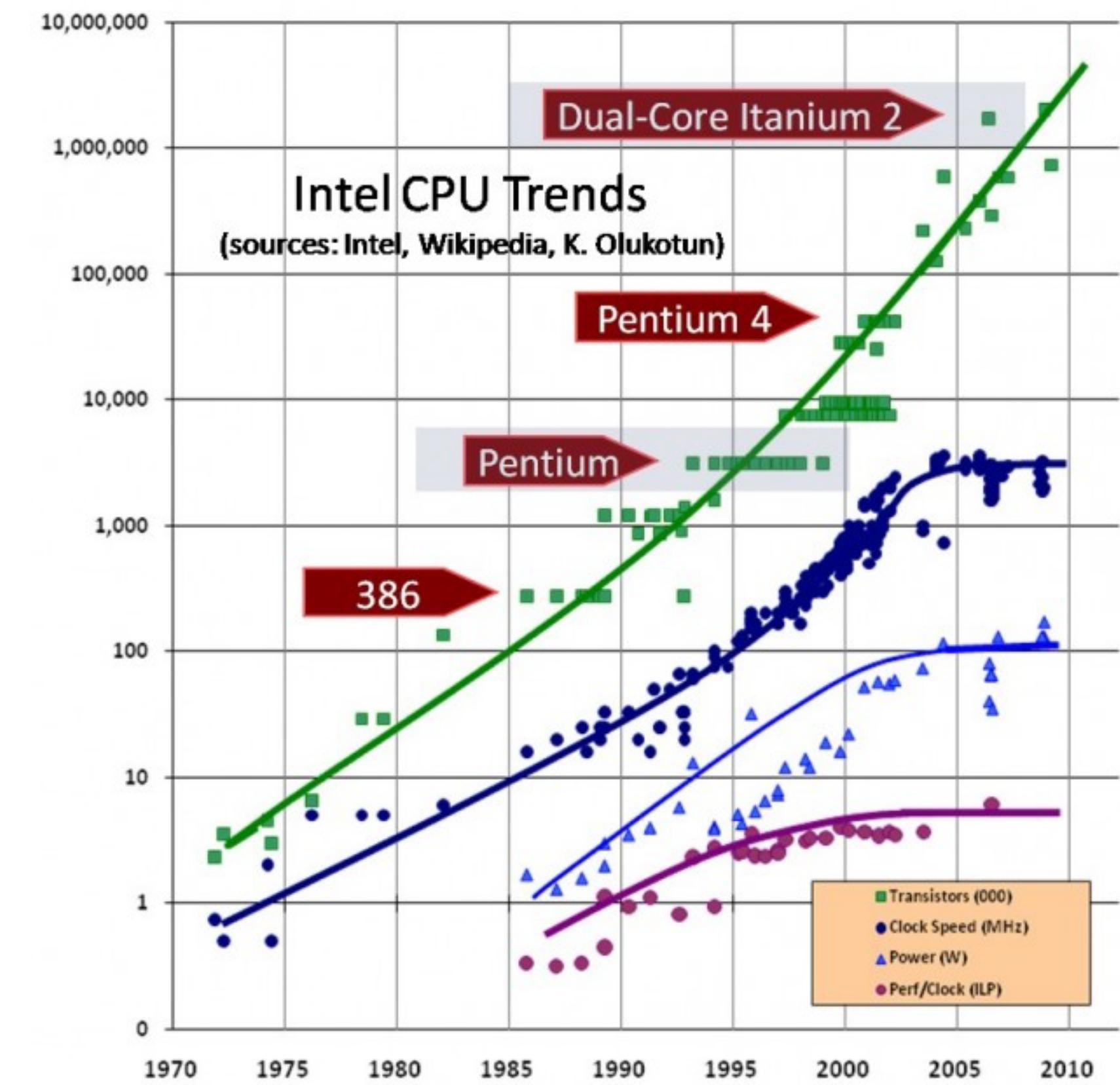


TV is Over



~~Moore's Law~~ Performance is Over

- RAM speed topped out int 1965, Disk speed is making a jump to SSD, but it's also flat.
- Clock speed topped out in 2003
- More processors is only useful if programmers write well-threaded code (which we don't)
- Latest chip processes are close to heat limits
- ***improvements will come from software, not hardware***



Work is Over

- As robots and AI displace more jobs, unemployment may surpass depression-era rates
- Computing jobs will thrive, until they too will be replaced
- What does the world look like when most of us don't work to make money?

Advertising is ~~Over~~ Shifting

- Advertising pays for all the free stuff, BUT
 - Targeted ads require tracking of private info
 - Many people use ad-blocking
 - Many content creators are transitioning to integrated advertising or patreon,
 - If you're not paying for the service, you aren't the customer

Privacy is Over

- High profile user data hacks
 - eg Uber data breach Dec 12 2017
- Mobile / web usage and demographics for sale
- Millennials are comfortable with limited (or no) privacy, as long as ***tradeoffs are valuable***
 - eg rewards for brand loyalty



Community is Over

- Social Media Fragmentation = end of shared experience
- Trending topics can be suspect (logan paul?)
- More smaller sub-groups with specialized content, intent, policy, and agenda
- More ***confirmation bias*** and more ***insulation*** from the rest of the world
- More polarization of opinions and ideas





I won't fail you, I'm not afraid.

REYISBAEOK

You will be.... you will be.