

Information Technology and Society

Waseda University, SILS,
Science, Technology and Society (LE202)

The communication revolution

- In the first period of the history of computers, we see that almost all development is driven by the needs and the financial backing of large organizations: government, military, space R&D, large corporations.
- In the second period, we will notice that the focus is now shifting to small companies, individual programmers, hobbyists and mass consumers.
- The focus in the first period was on computation and control. In the second period, it is on usability and communication.
- A **mass market** for computers (desktop, laptop, handheld) was created, through the development of a user-friendly personal computer.

Generations of electronic computers

	1 st	2 nd	3 rd	4 th	5 th
Period	1940s–1955	1956–1963	1964–1967	1971–2005	2007–?
Tech- nology	vacuum tubes	transistors	integrated circuits	micro- processors	RIS chips
Size	full room (huge)	large machine	desk sized	desk-top,	hand-held
Software	machine language	assembly language	operating systems	GUI interface	fully networked

Languages, systems, and software

- The first programs were written by rearranging switches and wires on the computer: direct machine language.
 - The early computer programmers were often women. (Hopper.)
 - By the late-1950s, the salaries of the operators was the largest cost of running computers, and the operators were mostly men.
- The first languages, were assembly languages, which translated the commands of the programmers into machine language. Often each model of computer had its own assembly and machine languages.
- The second generation of languages, such as FORTRAN and COBOL, were procedural, imperative languages, designed so that programmers could write in these languages and then an assembly level compiler could interpret the programs.
- During the 1950s–1960s, new software firms began to develop software by commission for individual projects.



Grace Hopper (1906–1992),
holding a COBOL manual

BASIC and structured programming

- Working with the earliest languages was basically restricted to mathematicians.
- At Dartmouth College, Kemeny and Kurts, along with their students, designed the Beginner's All-purpose Symbolic Instruction Code (BASIC), in 1964.
 - BASIC used simple English keywords like PRINT, NEXT, GOTO, IF THEN, etc., to allow users to structure their programs in a more "natural" or obvious way.
- BASIC could be taught to children and it became a widely used language because it was so easy. It was adopted on personal computers in the 1970s.
- These early languages were unstructured, running from beginning to end and jumping around with some use of the "go to" command.

Structural programming

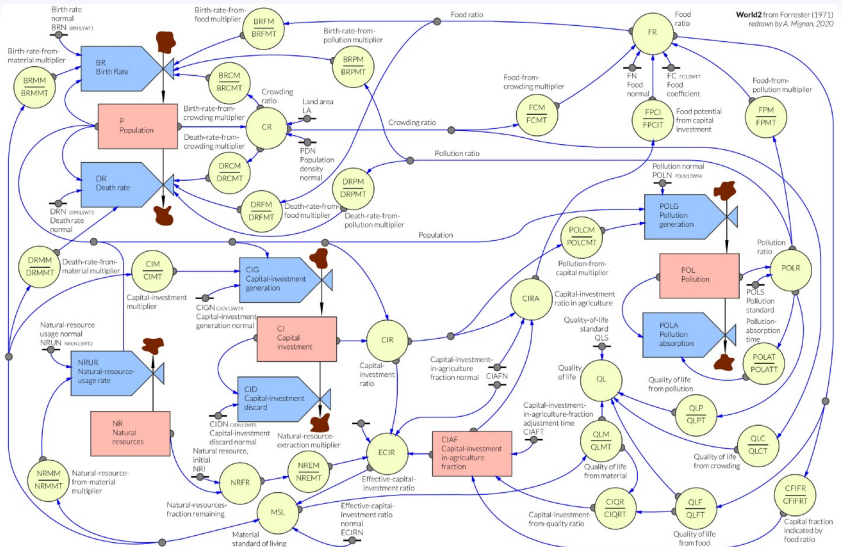
- The “spaghetti code” of FORTRAN and BASIC lead to Dijkstra’s paper “A case against the GOTO command” and to structural programming, with new languages such as Pascal and C. FORTRAN was the most popular language from the early 60s to the 80s.
- There have been numerous programming languages that use the basic concept of modularity and structure. Pascal was the most popular language in the early 80s. C took over from 85–2000.
- As new languages were developed they used more and more high-level concepts that had been developed by computer scientists. Java was the most popular language in the early part of the 21st century, and Python became the most popular language in 2018.
- Starting from about the 1970s, the relationship between computer science and mathematics began to run in both directions and mathematicians and logicians began to use concepts from computer science to do mathematical and logical theory.

Cybernetics and the limits of growth

In 1968 a group of scientists, engineers, and business experts convened a group to study the world system from a global, long-term perspective, which called itself the Club of Rome.

They enlisted the collaboration of the MIT cyberneticist Jay Forrester, who designed a cybernetic model of the whole world that could be implemented on mainframe computers to compute the long-term development of various systems such as human population, resources, food, industrial output, pollution, and so on. They were shocked to learn that all the models that they ran predicted societal collapse in the mid-21st century. Published in *Limits of Growth* (1972).

In 1973 the first international conference on environmental problems was convened to announce these results. The conference was protested by environmentalists and the left, because the Club of Rome proposed making a sustainable world, not changing the industrial basis of society.



A flowchart of Forrester's World2 model of the "world system."

Computerized war, computerized policing

In the late 60s and early 70s, military and security establishments began to use mainframe computers to plan wars and security operations. There were some successes, as well as huge failures.

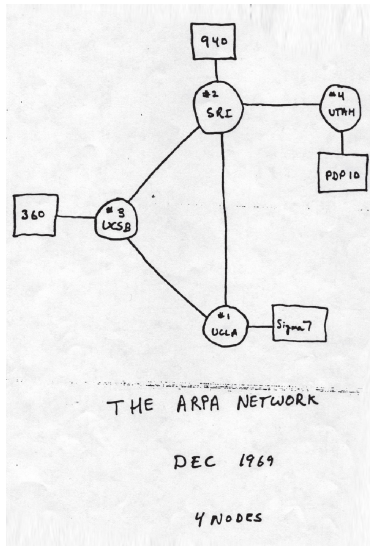
Robert McNamara, who served as US Secretary of Defense under President Kennedy, used computers to strategize on how to fight the American war in Vietnam. There are many legendary stories of the computers wildly missing the actual picture of what was happening on the ground. The Americans eventually lost the war. [*Fog of War* (2003)]

In the early 1970s, Horst Herold the head of the German federal police (Bundeskriminalamt, BKA), used data gathered from surveying the whole citizenry entered into main frame computers to quickly capture the heads of the militant left-wing group the Red Army Faction, after the RAF bombed a number of buildings and governmental facilities.

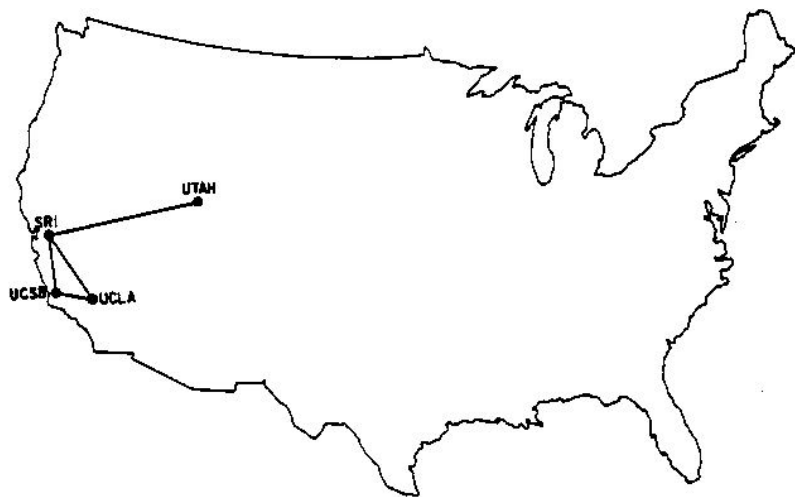
ARPAnet

- The Advanced Research Projects Agency (ARPA), was started in the US, in 1958, in response to the launch of Sputnik 1, by the Soviet Union (USSR).
- The ARPAnet was designed to solve the technical issues — like packet switching, timesharing, terminal usage, etc. — involved in getting one computer to talk to another computer, or multiple computers.
- It was meant to be a **research tool**, allowing multiple users to share computer time and facilitating collaborative work.
- Faculty and graduate students at host universities wrote the protocols and software to enable the different computers to understand each other — including email.
- The network was originally set up between 4 computers. Over the next decade, it rapidly expanded.
- There were similar networks developing in other countries.

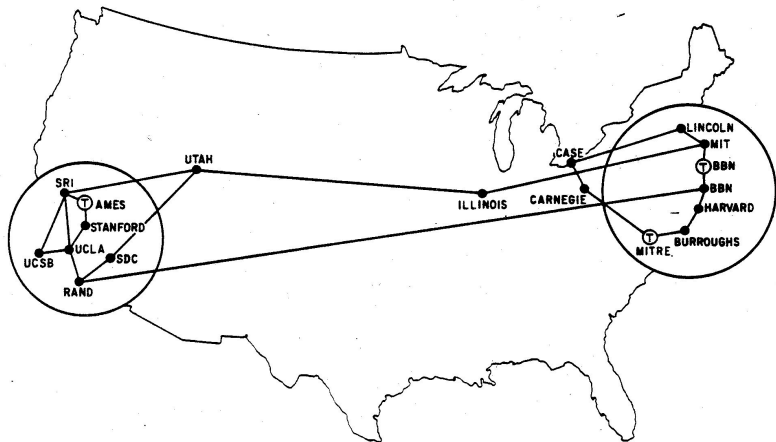
ARPAnet, 1969, diagram



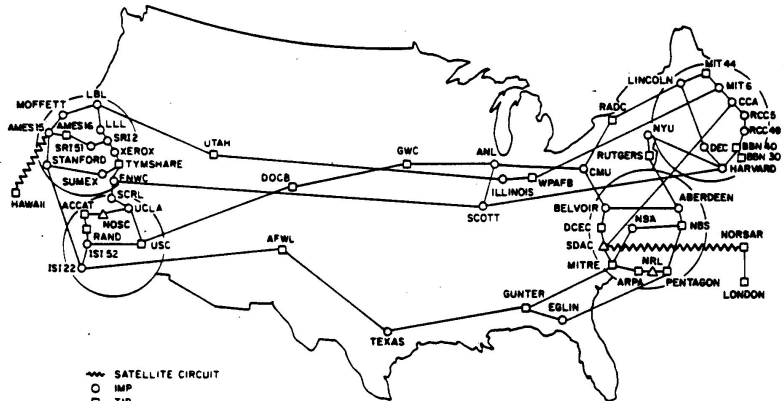
ARPAnet, 1969



ARPAnet, 1971



ARPAnet, 1977



~ SATELLITE CIRCUIT

○ IMP

□ TIP

△ PLURIBUS IMP

(NOTE THIS MAP DOES NOT SHOW ARPA'S EXPERIMENTAL
SATELLITE CONNECTIONS)

NAMES SHOWN ARE IMP NAMES, NOT (NECESSARILY) HOST NAMES

The Internet

- In the 1970s, there were a number of large networks all over the world, but they could not be linked together. In 1974, Kahn and Cerf proposed the Transport Control Protocol and Internet Protocol (TCP/IP) as a way to link these various networks together.
- TCP/IP was an open protocol, available to anyone, and anyone could contribute through “requests for comments” (RFCs).
- In the late 1970s, ARPAnet switched over to TCP/IP. In 1981, the National Science Foundation (NSF) created a network for US universities that were not on ARPAnet using TCP/IP.
- The TCP/IP functions using unique addresses for each machine, such as 192.168.34.2. In 1983, a domain name system (DNS) was established.
- The networks were linked internationally, using TCP/IP. In 1990, and 1995, the APRAnet and NSF net were dismantled. The Internet was now maintained by thousand of nodes.

Télétel and Minitels

Probably the first country to have a commercial internet used by large numbers of people was France.

Télétel was a service that could be accessed through the phone lines, using a Minitel terminal that was provided by the telecommunication company. From 1982 it could be used to do some online banking, pay bills, look up information, and so on.

In 1986, university students used Minitel to coordinate a national strike, making this an early use of an internet technology to foment political action.

There is debate about whether or not the presence of Télétel may have delayed the roll-out of TCP/IP internet in France.

The standard Minitel terminal used text-only monochrome screens.

Later, more advanced terminals could display a number of different character sets: Latin, Cyrillic, Chinese, Arabic, and Japanese, but these were rarely purchased.



JUNET (Japan University Network)

In 1984, researchers at University of Tokyo, Tokyo Institute of Technology, and Keio University used modems brought back from the US to connect computers at these universities before it was officially allowed to use modems over the telephone lines in Japan.

In 1988, the WIDE Project (Widely Integrated Distributed Environment) was established joining companies, universities, and public institutions, with the goal of switching the networks of all of these to TCP/IP protocol.

The 1995 Great Hanshin-Awaji Earthquake (兵庫県南部地震) spread awareness of the internet, because while many means of communication were cut off, email could be used by volunteers to coordinate their efforts within Japan and also to organize overseas support. This showed many people how networks and email could be used to build communities and communicate.

The World Wide Web (WWW), “Web 1.0”

- The early Internet organized information through electronic bulletin board systems (BBSs), listserves, and Usenet. (All text based.)
- The WWW was developed by Tim Berners-Lee (1955–) and Robert Cailliau (1947–) at Conseil Européen pour la Recherche Nucléaire (CERN).
 - Created hypertext transfer protocol (HTTP), so that documents could be delivered over a network.
 - A human-readable display language, called HyperText Markup Language (HTML).
 - A protocol for identifying documents, universal resource location (URL).
- In 1991, Berners-Lee gave copies of these WWW programs to his colleagues, who passed them on. The tools spread through academia.
- The first graphical web browser, Mosaic, was developed at University of Illinois at Urbana-Champaign, 1993.

The first webpage, 1991

The World Wide Web (W3)

Welcome to this [demonstration](#) for Hypertext '91. As we do not have a network connection, we will show you hypertext which we brought on an optical disk, but not the large range of information on the "web" across the world.

How to proceed

References to other information are represented like [this](#). Double-click on it to jump to related information.

On this optical disk

Information about [hypertext](#) in general and about the [WorldWideWeb](#) project.

Network sources

Now choose an area in which you would like to start browsing. The system currently has access to three sources of information. With the indexes, you should use the keyword search option on your browser.

[CERN Information](#)

A general keyword index of information made available by the computer centre, including CERN, Cray and IBM help files, "Writeups", and the Computer Newsletter (CNL). (This is the same data on CERNVM which is also available on CERNVM with the VM [FIND command](#)).

[CERN home](#)

stuff at CERN

At UNC

[Eric-digests](#),

[Yellow Pages](#)

A keyword index to the CERN telephone book by function.

[Internet News](#)

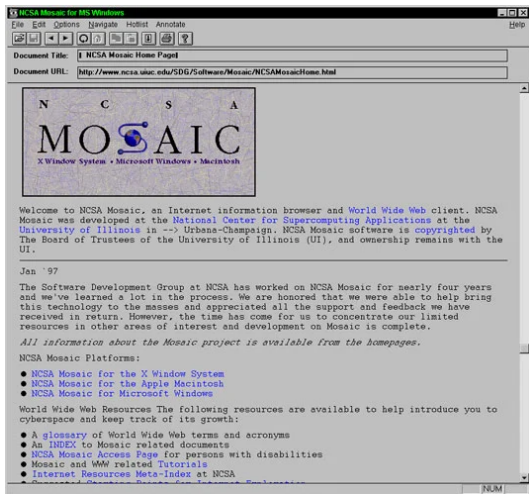
You can access the internet news scheme (See [information for new users](#)). News articles are distributed typically CERN-wide or worldwide, and have a finite lifetime.

Newsgroups which may be of general interest at CERN include

- [CERN/ICP news](#)
- [STING \(Software Technology Interest Group\) news](#).

A copy of the page found on a NeXT machine. The first link is scrambled because Berners-Lee showed the live editing feature during his presentation.

The Mosaic web browser, allowed one to display webpages in a window environment, reading and displaying the HTML commands.



Search engines

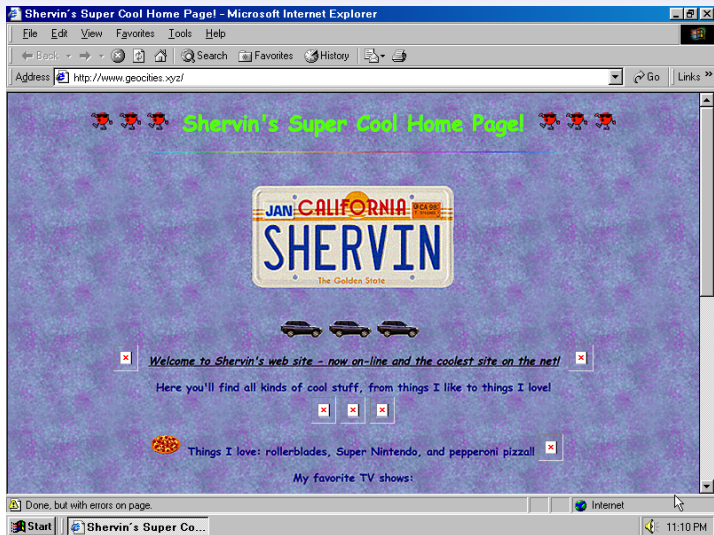
- The WWW became useful to the average user with the development of search engines.
- The first were automated web-crawling programs — such as Webcrawler & Altavista — that prowled the internet trying to figure out the purpose of a webpage by analyzing the content. They often returned strange results.
- Another type of search engine used human readers categorize pages. Yahoo!, started by two Stanford graduates, used a combination of both approaches.
- Larry Page (1971–) and Sergey Brin (1973–) developed an algorithm for ranking webpages based on how many other pages linked to them. This became the core of Google, which is most popular worldwide, but not in every country (Baidu in China, YANDEX in Russia).
- Unfortunately, most search engines are again becoming useless.

Homepages and online payments

In the 90s, although some portals and service providers (ISPs) provided tools for making personal webpages, many people in the 90s and 00s created their own. Many internet users had their own homepages, but these were static and required the authors to use some sort of markup language (straight HTML, later some cascading style sheets, CSS).

Most internet users were reluctant to do online shopping and banking. This began to change with the introduction of credit card payment methods, and online payment services. One of the most important of these was PayPal, which was initially fairly small scale until it was bought by Ebay in 2002. After this, many of the founders and founding employees of PayPal went on to found and work at many of the biggest tech companies around today – the PayPal Mafia.

There was an incredible *techno-optimism* about the internet, which was disappointed by the market crash of 1998, and the realization that the promised freedoms were illusory.



A 1990s Geocities "homepage"

The users are the product

humdog, "pandora's vox: on community in cyberspace," 1994

"i have seen many people spill their guts on-line, and i did so myself until, at last, i began to see that i had commodified myself. commodification means that you turn something into a product which has a money-value. in the nineteenth century, commodities were made in factories, which karl marx called 'the means of production.' capitalists were people who owned the means of production, and the commodities were made by workers who were mostly exploited. i created my interior thoughts as a means of production for the corporation that owned the board i was posting to, and that commodity was being sold to other commodity/consumer entities as entertainment. that means that i sold my soul like a tennis shoe and i derived no profit from the sale of my soul. people who post frequently on boards appear to know that they are factory equipment and tennis shoes, and sometimes trade sends and email about how their contributions are not appreciated by management." (Carmen Hermosillo)

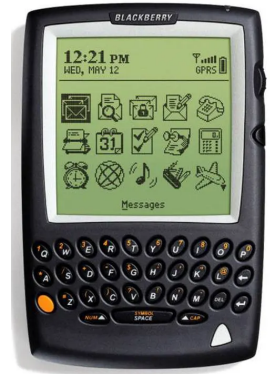
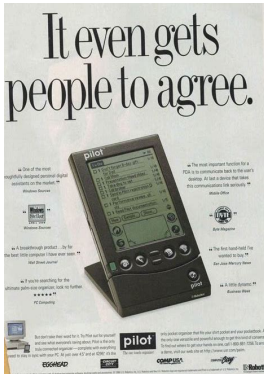
Handheld computers and smart phones

There were many early handheld computers and tablets in the 90s, but these did not have full internet access, and they served niche markets.

Japan was the first country to develop a full internet for mobile phones, by NTT DoCoMo in 1999. For the next 8–9 years, in most other countries mobile phones were mostly for talking and texting, and smartphones, such as Blackberry, were for the business market.

With the mass marketing of flip phones in Japan, and then smart phones such as the iPhone, in 2007, and Android handsets, 2008, handheld computers and internet access began to have a profound influence on interpersonal relations, and society at large. From this period on, more and more people were carrying a smartphone with them everywhere and it was changing the nature of their education, working life, and interpersonal relationships.

Handhelds around the turn of the century



“Web 2.0”

- Web 2.0 became a buzzword around 2004 to indicate websites that emphasized ways in which users could create their own posts and interact online. These sites promoted interactions among friends and family, as well as strangers: Mixi (1999), MySpace (2003), Facebook (2004), YouTube (2005), Twitter (2006), VKontakte (2007), Weibo (2007), Netflix (streaming, 2007), Instagram (2010), Tinder (2012), etc.
- Many of these platforms were “walled gardens” that attempted to keep users on their services for as long as possible, and attempted to interrupt the previous flow of hyperlinking.
- This enclosed effect was made more pronounced with the use of apps on smartphones, tables and smart TVs, which increased the feeling of being within a curated environment.
- Walled gardens control their users experiences through algorithms that categorize users into arbitrary personality types.

“Engagement” and disappointment

- These sites emphasized using the platform as a place for interacting with others, in which the interactions were part of the “contents” of the sites.
 - Many platforms developed ways for “content creators” to get paid for their contributions to the site.
- The business model for many of these platforms was to give away the product and to collect and sell the users’ data to other companies. The companies use psychological tricks to keep users “engaged.”
 - Algorithmic recommendations, viral dynamics, endless scroll, etc.
- Just as with Web 1.0 there was an initial *techno-optimisim* about how these platforms were going to “make the world better,” by bringing everyone together and creating more freedom (Arab Spring, etc.), but there was again a disappointment in realizing that they were being used for political control and data mining. The companies that provide these services have no incentive to improve the world.

Hacking and information security

- In the 1960s a hacker was someone who could write code or modify hardware. (Phreakers could manipulate the phone system.) The word was used as a term of praise.
- The term hacker came to mean someone who breaks into computer systems, and was made popular by *WarGames* (1983) and *Neuromancer* (1984). Hackers are motivated by a desire for knowledge, notoriety, wealth, thrill-seeking, revenge, political expression, etc.
- Most large systems are “attacked” at least a couple times a week.
 - In 1996, the US National Security Agency authorized a team of hackers to try to break into military systems. They were successful.
 - In 2000, a disgruntled employee broke into the sewage system in Moroochy Shire, Australia and dumped 1,000,000 liters of sewage into local streams.
 - In 2010, a huge number of US military and diplomatic files were leaked on Wikileaks.

Cyberwar

- Cyberwar is a broad term that includes any kind of use of computers in offensive or defensive warfare.
- The US National Security Agency (NSA) is a cryptological intelligence agency responsible for the collection and analysis of foreign communications. They are said to have more supercomputers than any other organization.
 - They established a secret system, the Echelon, to intercept and decrypt email, fax, telex and telephone communications from all over the world. In 2013, details about the successor to this program, PRISM, were leaked by Edward Snowden.
- The Five Eyes – US, Britain, Canada, Australia, New Zealand – have eavesdropping tools installed at nodes all over the internet. Although they are usually not allowed to spy on their own citizens, they collect information on all other users, and often share information on each others' citizens.

Cyber weapons: Struxnet

The first large-scale cyber weapon was designed by the US and Israel for use against Iran. Started under the Bush administration and implemented under Obama, Struxnet was a worm that was designed to target the Iranian nuclear facility by causing the centrifuge to behave weirdly and overheat. It was meant to make the Iranian engineers think that they were incompetent. It was discovered in 2010, acting up on a Window's computer. It took security experts some time to figure out what it was.

In 2012, Flame was discovered spying on hundreds of computers in Iran and Israel. In the same year, Wiper shut down many Windows computers in the Iranian oil industry. It erased files, damaged the OS, and then destroyed and overwrote itself.

Internet espionage: Stealing secrets

Many different nations are using hacking capabilities to spy on each other.

- As well as the wide-scale NSA eavesdropping on everyone, in the 00–10s and the Chinese directed hacking operations, such as Operation Aurora, against US tech firms like Google.
- In 2013, the security firm Mandiant reported on the activities of Unit 61398 of the Chinese army in collecting data from US government and business computers on everything from product and weapons design, manuals, manufacturing processes, personal information, etc.
- The US hacked the Chinese back.
- Often multiple intelligence agencies would infiltrate the same machines and steal each others secrets.
- Many states also hack the secrets of their allies.

Internet disruption

A number of states have used various types of disruption to try to effect their policy aims.

- In 2012, Iranian hackers implemented Shamoon in an attack on the Saudi Arabian national oil company Aramco. Shamoon was a worm that infiltrated Aramco computers, erased files with overwriting and sent reports to its operators. It made more than 35,000 Windows machines inoperable. It took 5 months to get back to operational stability.
- In 2014, N. Korean hackers infiltrated the Sony US system and tried to force them to suppress *The Interview*. They took a huge number of sensitive emails and documents and released them in timed dumps while they tried to coerce the company not to release the movie. At first it seemed to work, but eventually it was released online and became the best selling online release up to that time.

Internet destabilization: TheShadowBrokers

In 2026, an obscure hacking group that called itself TheShadowBrokers began offering various hacking tools for sale that it claimed to have stolen from the NSA — “the Equation Group.” It was not able to find many buyers, and eventually gave the tools away for free. Security experts were able to confirm that there were many sophisticated attack tools designed by the NSA, such as DoublePulsar (a Windows remote control app) and EternalBlue (a Windows worm).

- In 2016, these were used by N. Korea in the WannaCry ransomware attack that shut down the British NHS, and many other institutions.
- In 2017, they were used by Russian hackers in the NotPetya worm, which shut down computers across the Ukraine, as well as at Maersk (shipping), FedEx (shipping), Merck (pharmaceuticals), and many other international corporations.

Cryptocurrencies

Cryptocurrency is a form of electronic funds (in fact a transaction record), that arose out of the cypherpunk movement of the late 80s and 90s. Cypherpunks were programmers who produced strong cryptography, which was then often illegal, and who engaged in political activism to protect the rights of individuals to write and use cryptography.

In 90s and early 00s, the cypherpunks put out a number of systems for electronic money using cryptographic methods such as HashCash, b-money, bit gold, and so on. None of these cryptocurrencies caught on, nor are they in use today.

In the wake of the 2007 financial crisis, "Satoshi Nakamoto" (probably Adam Back) released Bitcoin. Starting from 2010, this went on to become the most prominent cryptocurrency, along with Ethereum, and many others. Although there have been many promises made for cryptocurrencies, they play a fairly niche role in the overall economy and have not yet gone mainstream for payment transfers.

Ransomware

One type of hacking that has grown massively due to the presence of viable cryptocurrencies is *ransomware*. This is a type of attack in which a hacker takes over a computer system and disables some part of it, demanding payment to free it up.

In fact, ransomware attacks were carried out before the rise of cryptocurrencies – such as a 1986 attack on PCs at an AIDS research conference and a 2006 Windows attack on the MyDocuments folder. These attacks demanded payment by money order, or Western Union transfer, and are not believed to have made much money.

The first Bitcoin ransomware attack was CryptoLocker in 2013. In 2017 the WannaCry and NotPetya attacks are believed to have caused \$10s of billions USD in damages. In 2021, the US Colonial Pipeline corporation was attacked, causing a 6-day shutdown of the petrol lines, and a \$4.4 million USD payout in Bitcoin (much of which was blocked).

Artificial intelligence (AI) and robots

- The first attempts at AI – by Turing, von Neumann, and others – were not very successful. They used an approach called **expert systems**, which are based on a series of rules and an inference engine.
- In the 1990s, AI research, cognitive science and neuroscience began to develop and become interlinked. This led to the “neural networks” approach. (Fuzzy logic, machine learning, etc.)
 - Deep Blue defeated Kasparov at chess, 1996; Watson defeated Rutter and Jennings at Jeopardy!; 2011, Eugene Goostman beat the Turing Test, 2014; Google’s AlphaGo beats Lee Sedol, 2016; Google’s AlphaFold solved the problem of protein structure, 2020.
- There are now many AI systems, some of which are very powerful, but **still no general AI, AGI** – an AI that determines its own goals.
- We have many special purpose robots: manufacturing, space exploration, military, etc. There are some robots used in research projects.

Final Remarks

- We have looked at the development of various aspects of computer networks in combination with handheld computing devices.
- We have seen how personal computing can turn the computer into a tool for self-expression and personal freedom, but it can also be used by corporations and governments to commodify and control people.
- We have looked at the rise of large computing networks, such as the internet and WWW, which allow people all over the world to communicate instantly, with both positive and negative outcomes.
- We have seen, again, how the spread and use of computer technology is both social and political.