ECE 101, Lecture 2:
History, Map, and Keywords in Computing

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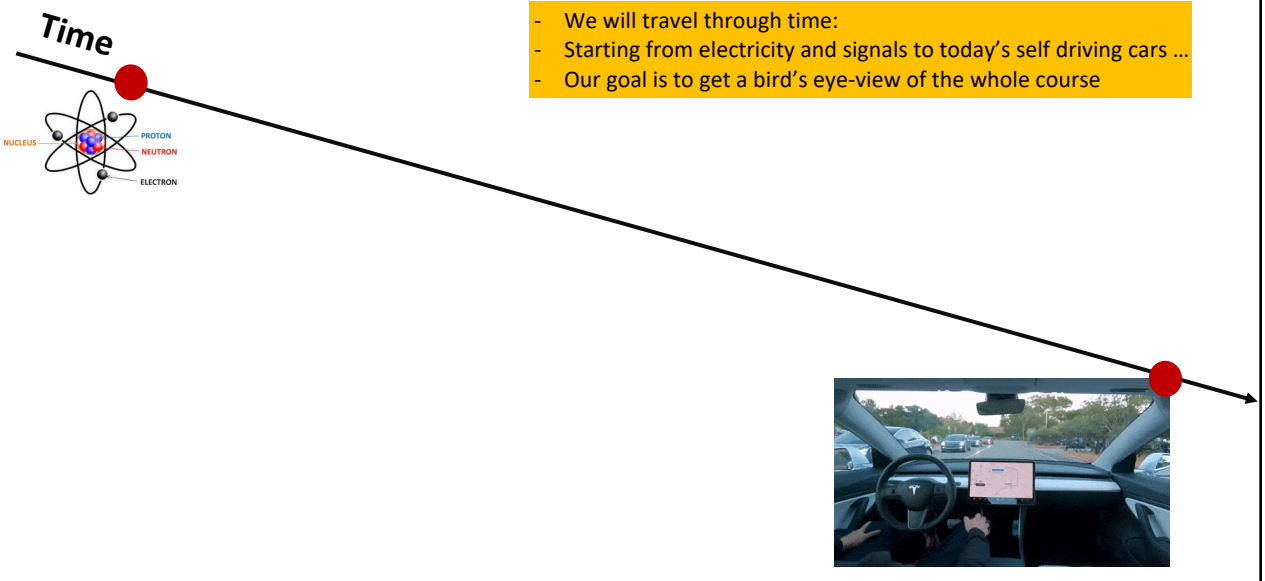
1

History, Map, and Keywords in Computing



- We will travel through time:
- Starting from electricity and signals to today's self driving cars …
- Our goal is to get a bird's eye-view of the whole course

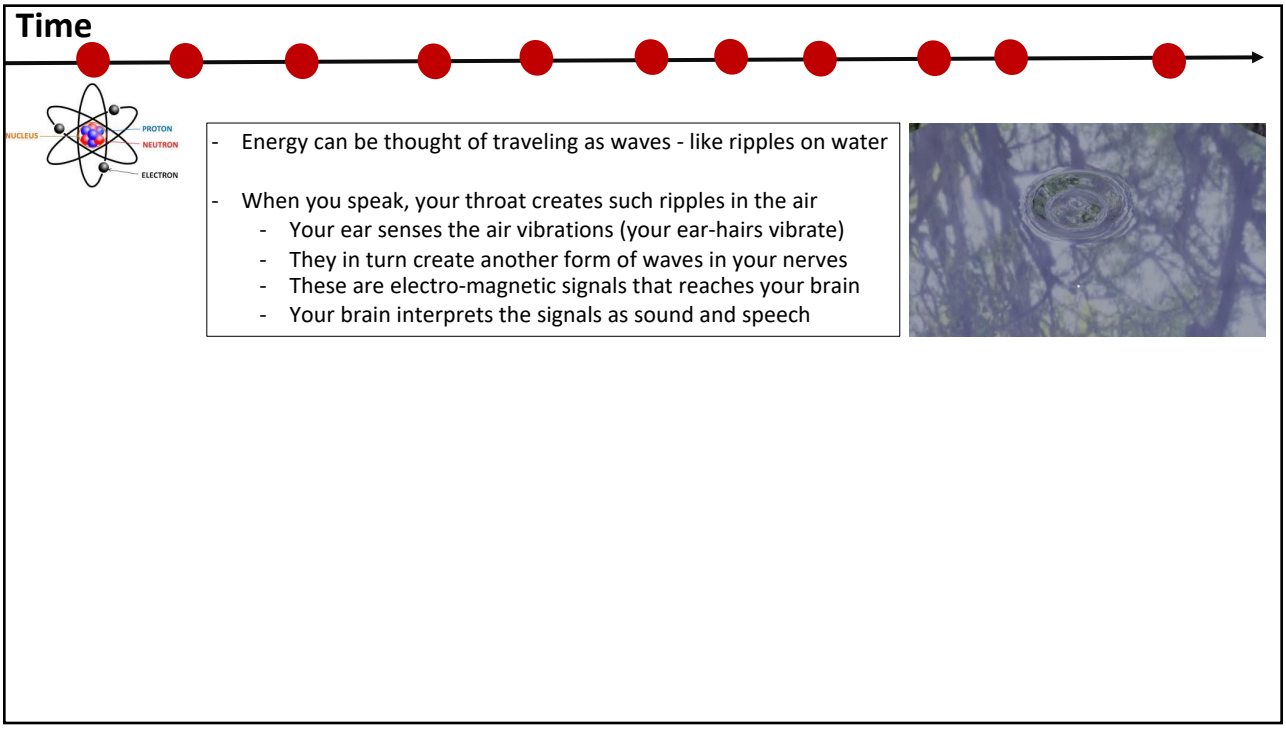
2

History, Map, and Keywords in Computing

- We will travel through time:
- Starting from electricity and signals to today's self driving cars …
- Our goal is to get a bird's eye-view of the whole course

- We will meet the computer and the Internet …
- And many other important milestones in the path
- So, let's get started.

3

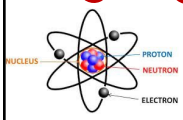


- Energy can be thought of traveling as waves - like ripples on water

- When you speak, your throat creates such ripples in the air
  - Your ear senses the air vibrations (your ear-hairs vibrate)
  - They in turn create another form of waves in your nerves
  - These are electro-magnetic signals that reaches your brain
  - Your brain interprets the signals as sound and speech

4

Time



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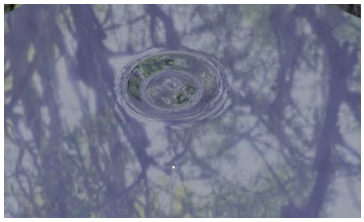
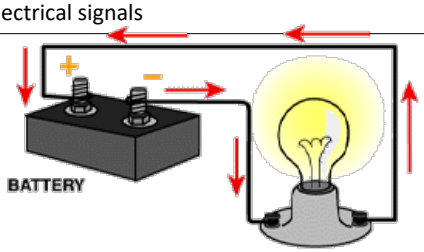
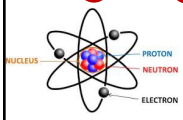


- You know about electricity flowing through wires …
- Turns on light bulbs or charge your phones
- Electricity flowing through electronic devices is called electrical signals



5

Time



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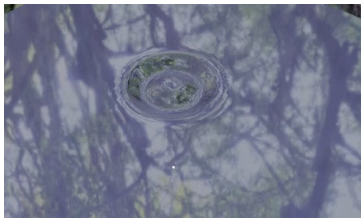

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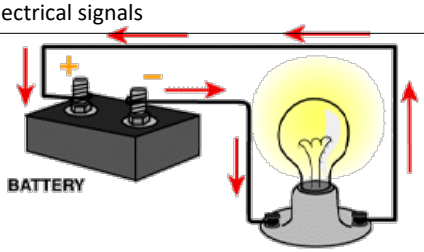
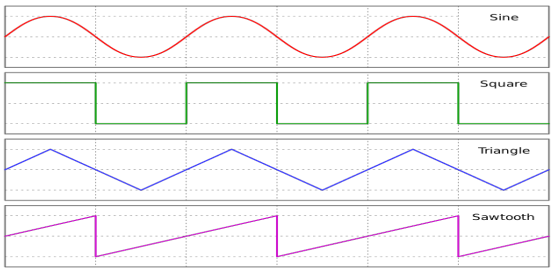


- Henceforth, when we think of signals, let's picture this:



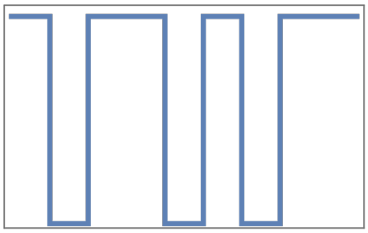
6

- From lecture #1, we spoke about expressing information as bits
- We understand the concept of bits … but how do we physically represent them?
- One way could be **presence** or **absence** of a signal.

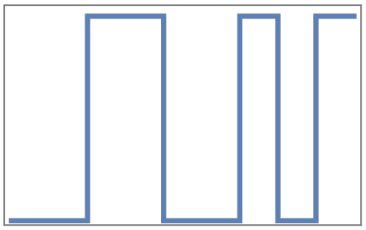
- Let's express bits through signals

- Specifically:
  To represent bit = 1 … let signal be HIGH
  To represent bit = 0 … let signal be LOW

- So, to transmit the bit sequence: **1 0 1 1 0 1 0 1 1 1**



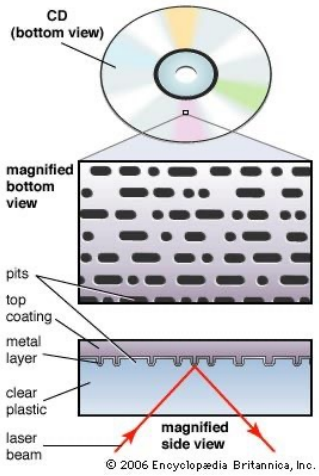
- Someone sends you this signal.
- What bit sequence are they communicating to you?



Communicated bit sequence = 0 0 1 1 0 0 1 0 1

7

- I know how to send bits … but where do I store them?
- How about find some natural persisting shape that can be modified
  - Pretend some shape is Bit=0 and the modified shape is Bit=1
- Now we can store the full bit sequence by modifying the natural shape
- That means you have "bit memory"



8

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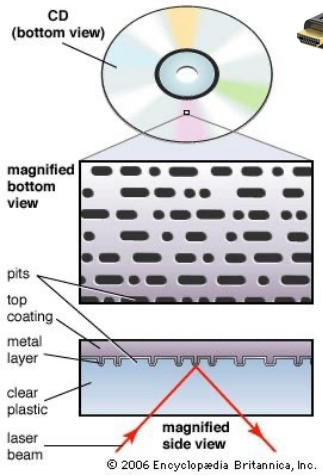
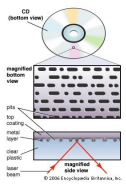


Communicated bit sequence = 0011010011

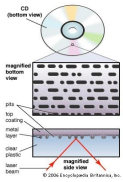
9



Communicated bit sequence = 0011010011

- But how does the TV know what to do with the received bits?
- That is, where are the instructions (like, when this happens, do this, else that)

10



Communicated bit sequence = 0011010011

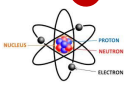
- But how does the TV know what to do with the received bits?
- That is, where are the instructions (like, when this happens, do this, else that)

Instructions (aka code) can also be expressed in bits … and stored in TVs … and this code can receive bits of data and display on screen

Digital Revolution

11

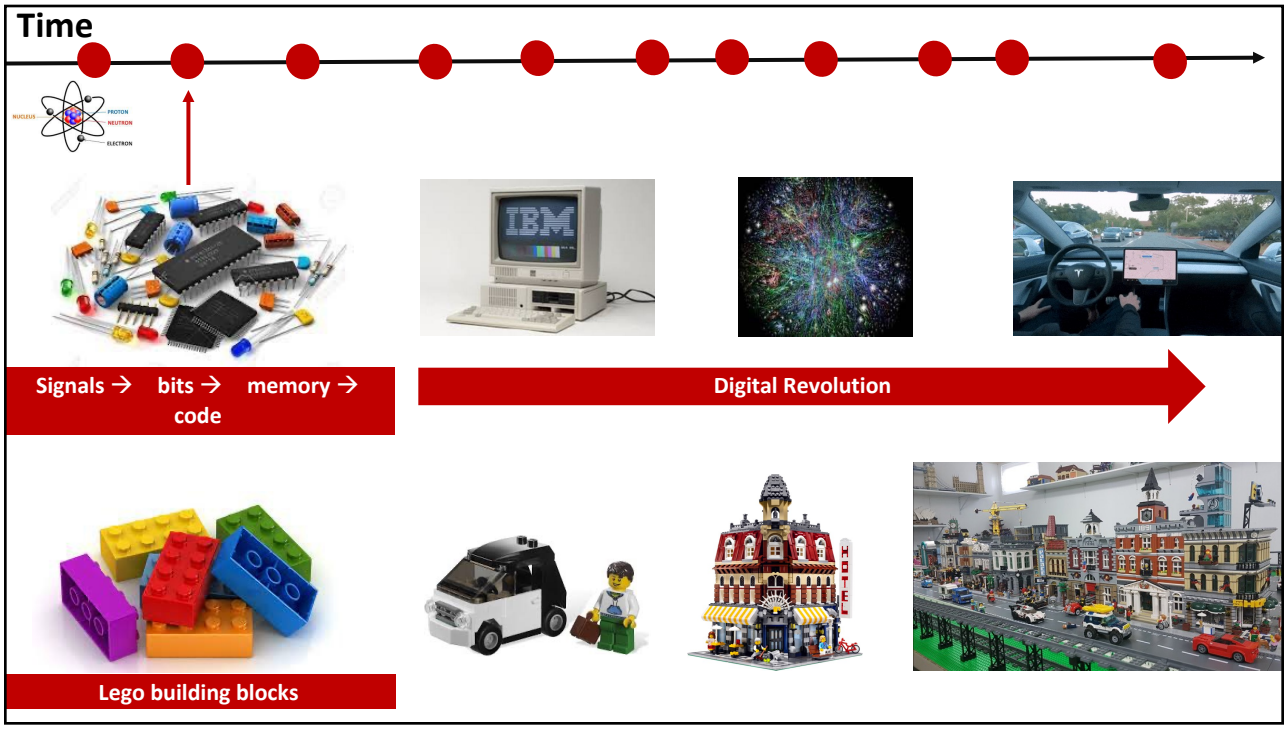
Time



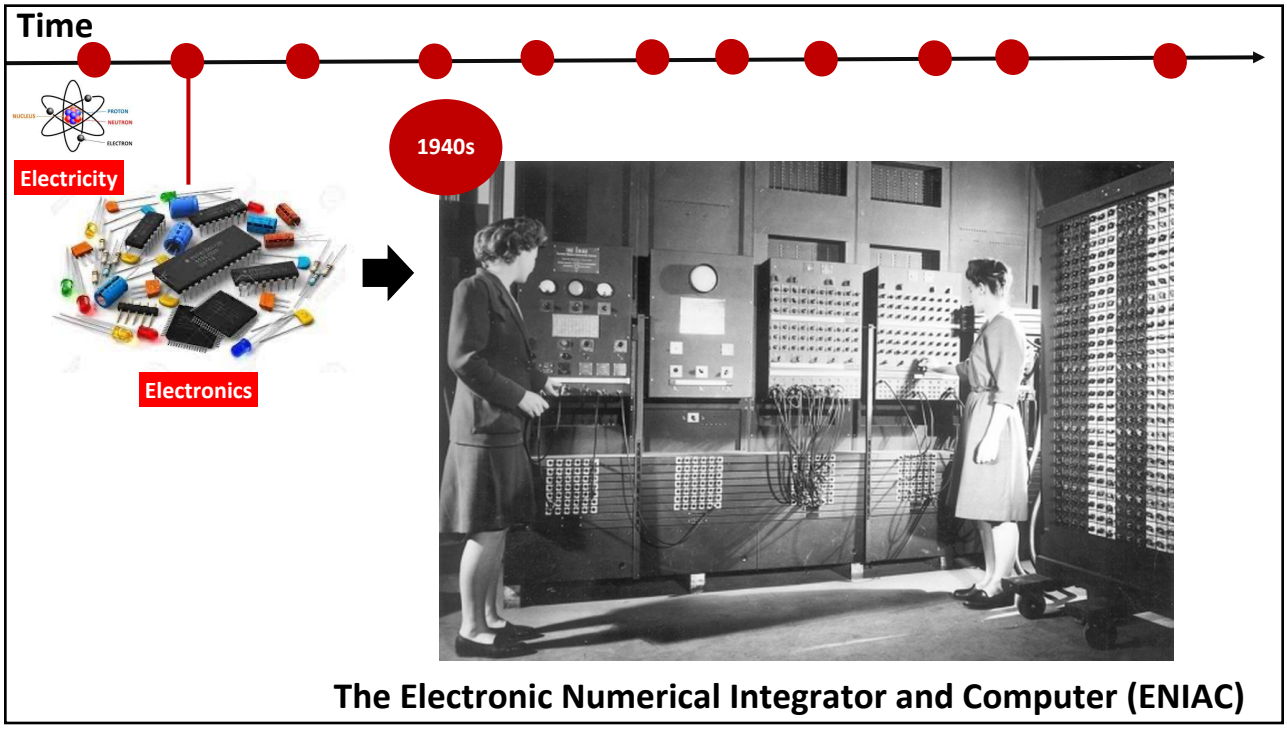
Signals → bits → memory → code

Digital Revolution

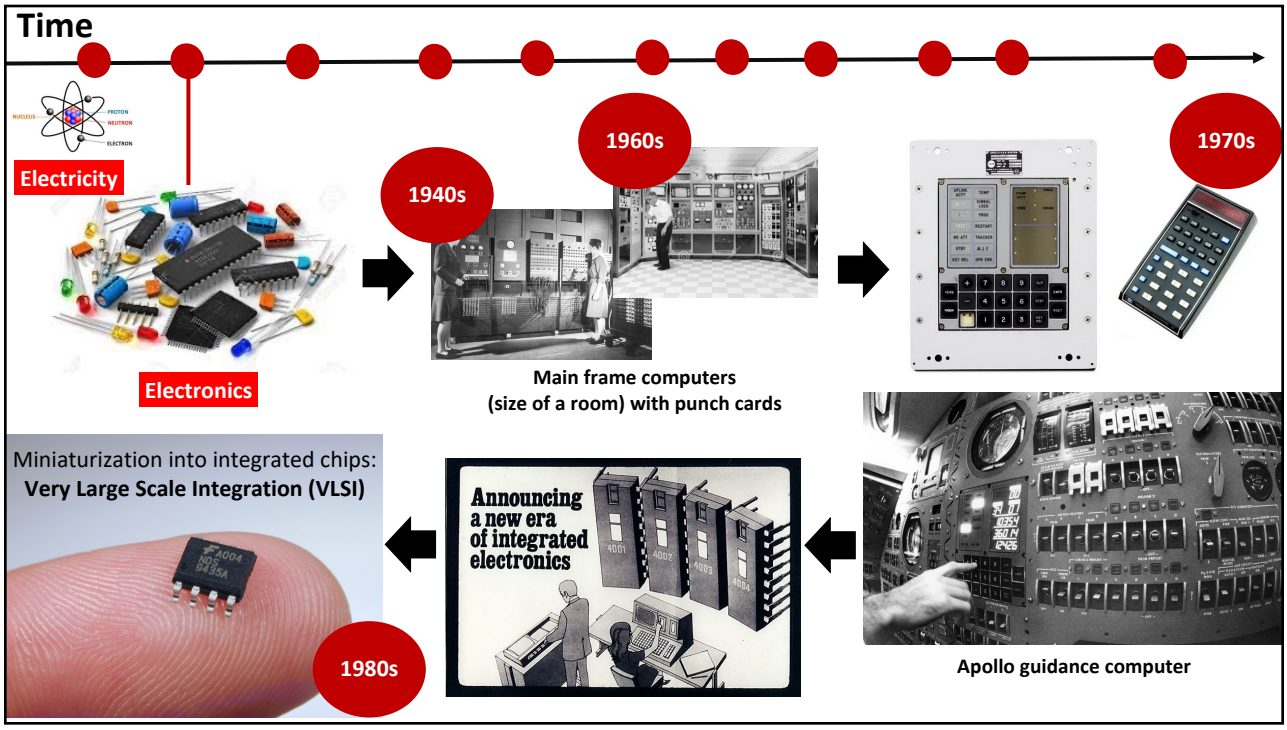
12


Time
Signals → bits → memory → code
Digital Revolution
Lego building blocks

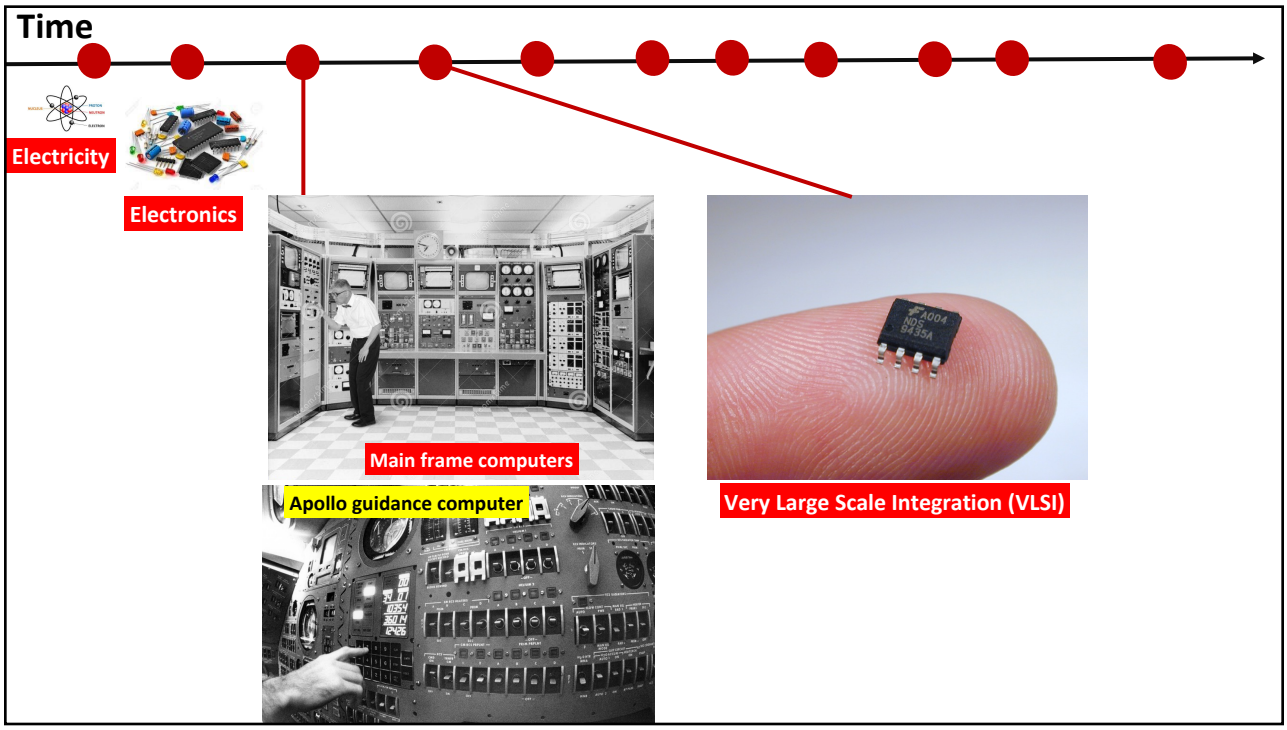
13


Time
Electricity
Electronics
1940s
The Electronic Numerical Integrator and Computer (ENIAC)

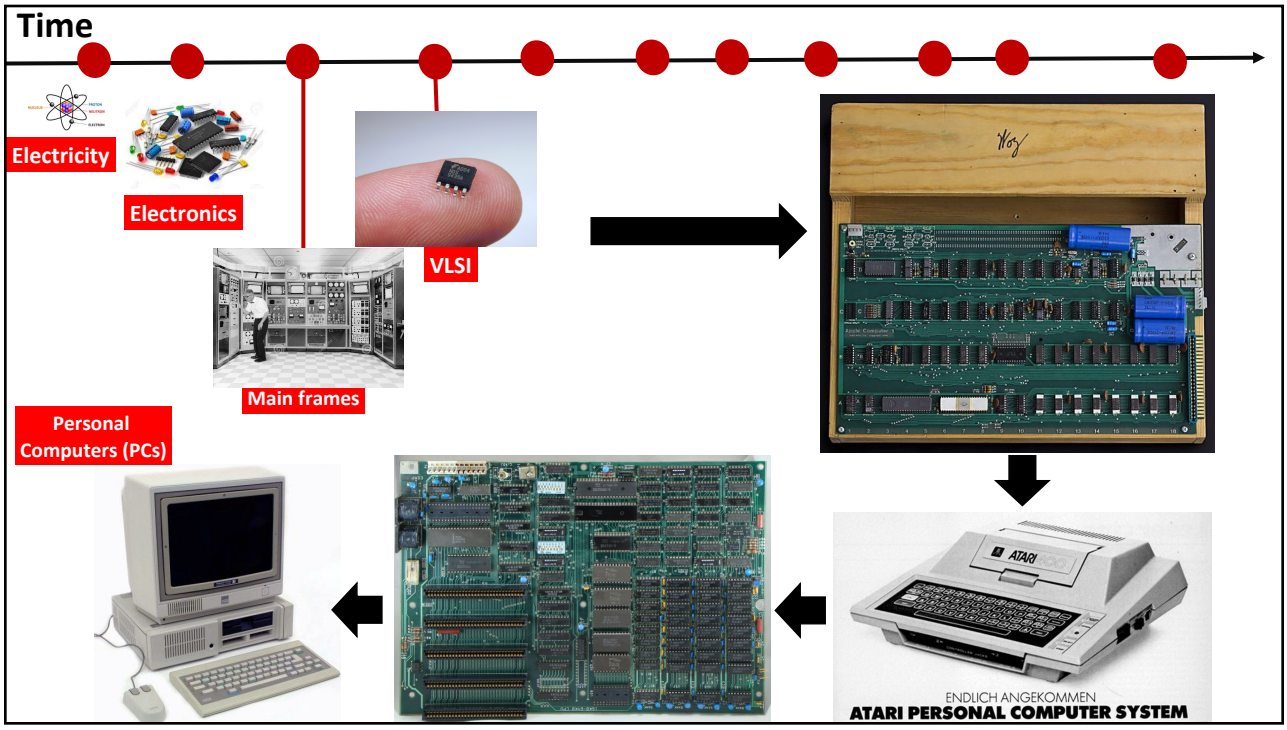
14


Time
Electricity
Electronics
1940s
1960s
1970s
Main frame computers
(size of a room) with punch cards
Apollo guidance computer
Announcing a new era of integrated electronics
Miniaturization into integrated chips:
Very Large Scale Integration (VLSI)
1980s

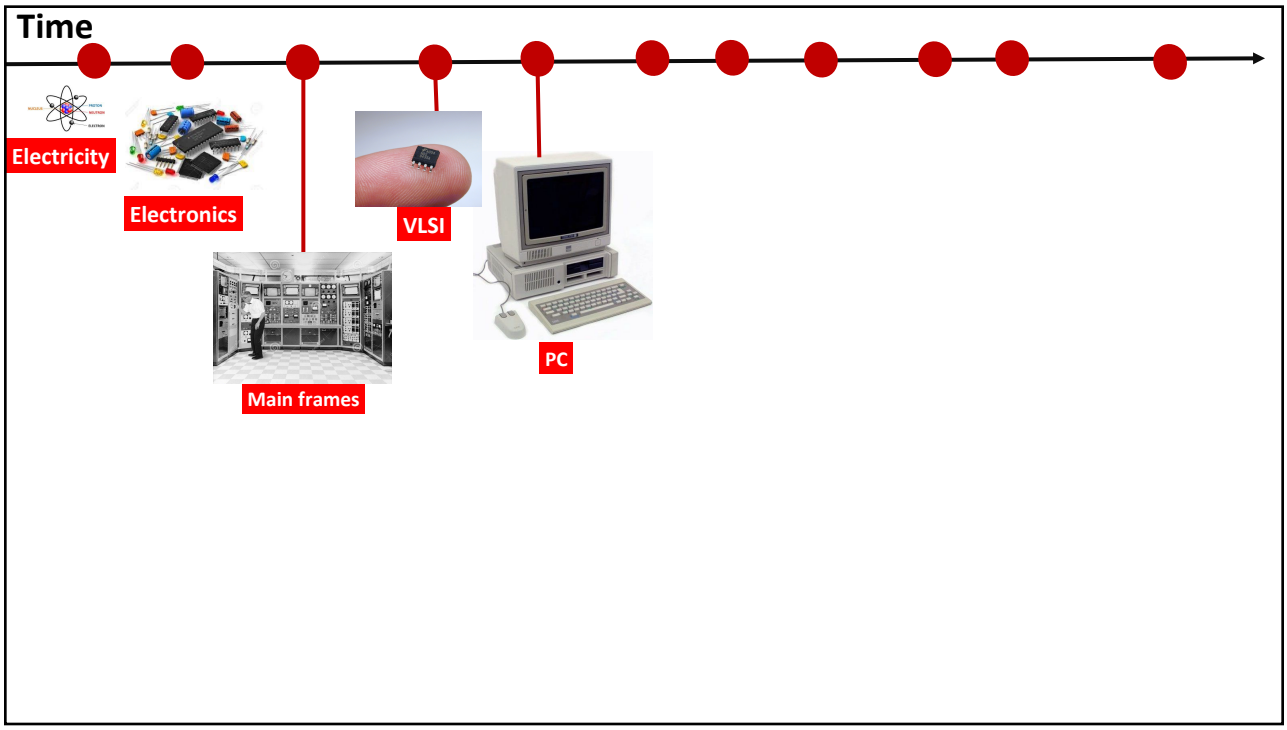
15


Time
Electricity
Electronics
Main frame computers
Apollo guidance computer
Very Large Scale Integration (VLSI)

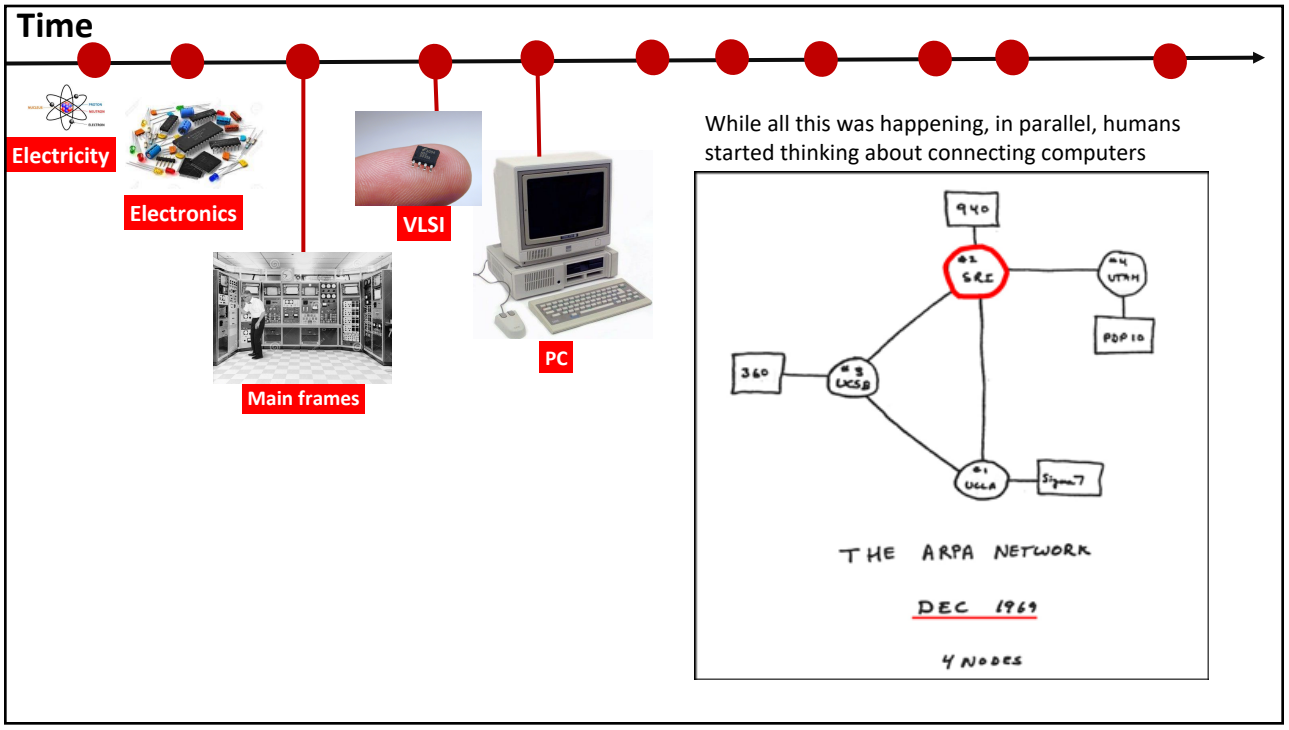
16


Time
Electricity
Electronics
VLSI
Main frames
Personal Computers (PCs)
ENDLICH ANGEKOMMEN
ATARI PERSONAL COMPUTER SYSTEM

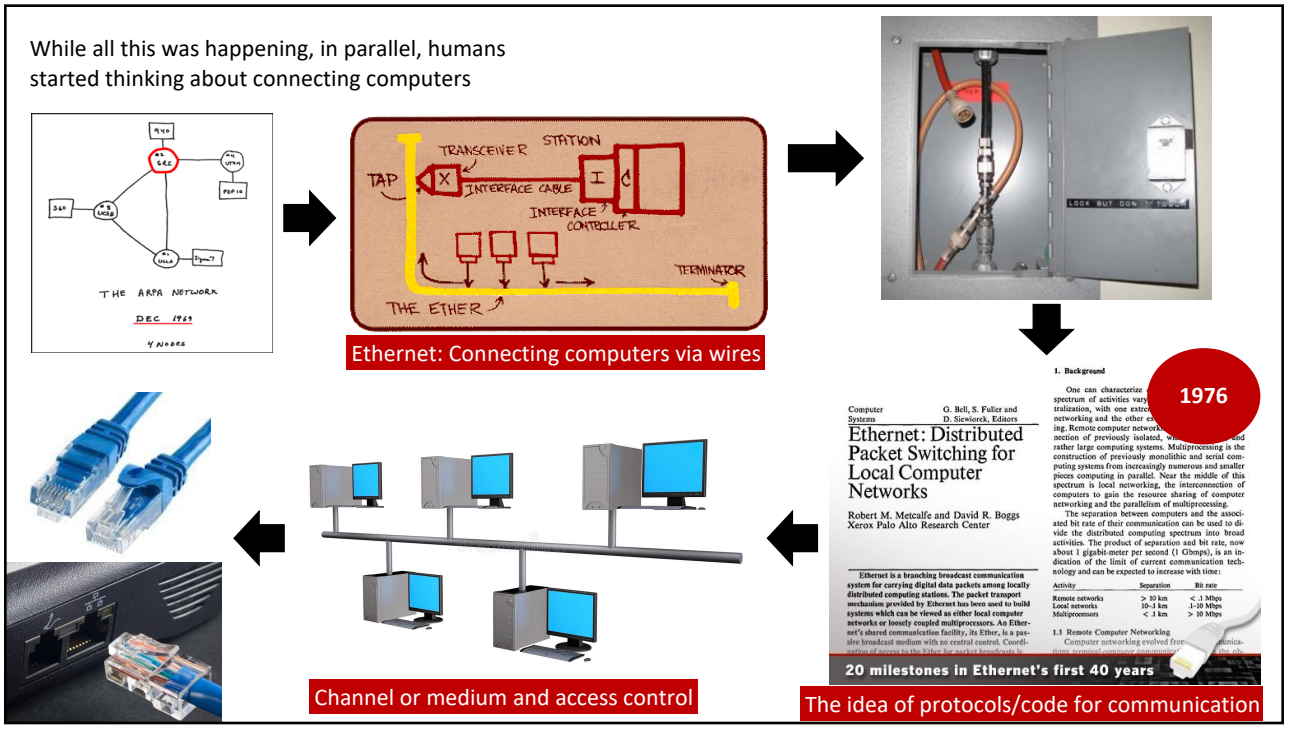
17


Time
Electricity
Electronics
VLSI
PC
Main frames

18


Time
Electricity
Electronics
VLSI
PC
Main frames
While all this was happening, in parallel, humans started thinking about connecting computers
940
SRI
UTAH
PDP 10
360
UCSB
UCLA
Sigma 7
THE ARPA NETWORK
DEC 1969
4 NODES

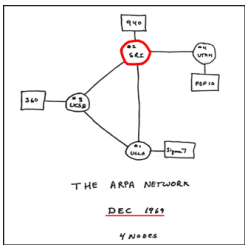
19

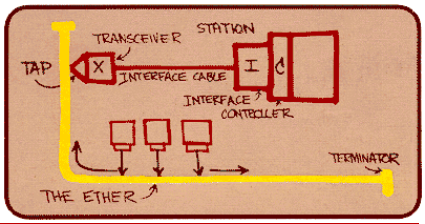

While all this was happening, in parallel, humans started thinking about connecting computers
THE ARPA NETWORK
DEC 1969
4 NODES
TRANSCEIVER
STATION
TAP
INTERFACE CABLE
INTERFACE CONTROLLER
TERMINATOR
THE ETHER
Ethernet: Connecting computers via wires
1976
Computer Systems
G. Bell, S. Fuller and D. Siewiorek, Editors
Ethernet: Distributed Packet Switching for Local Computer Networks
Robert M. Metcalfe and David R. Boggs
Xerox Palo Alto Research Center
20 milestones in Ethernet's first 40 years
The idea of protocols/code for communication
Channel or medium and access control

20

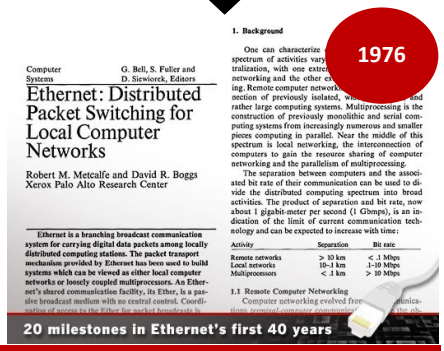
But why stop at connecting few computers in a lab?

started thinking about connecting computers





Ethernet: Connecting computers via wires

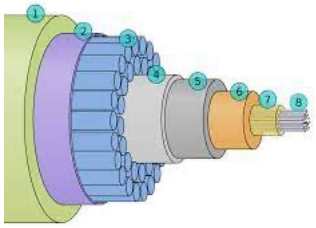


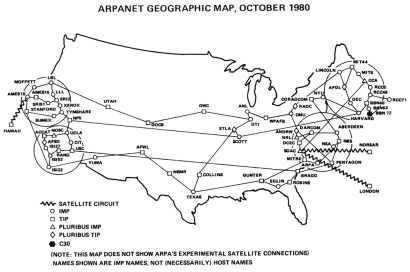
The idea of protocols/code for communication

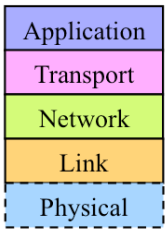
Channel or medium and access control

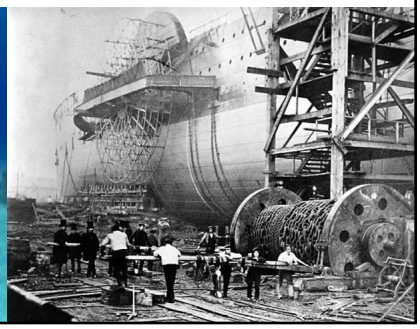
21

But why stop at connecting few computers in a lab?

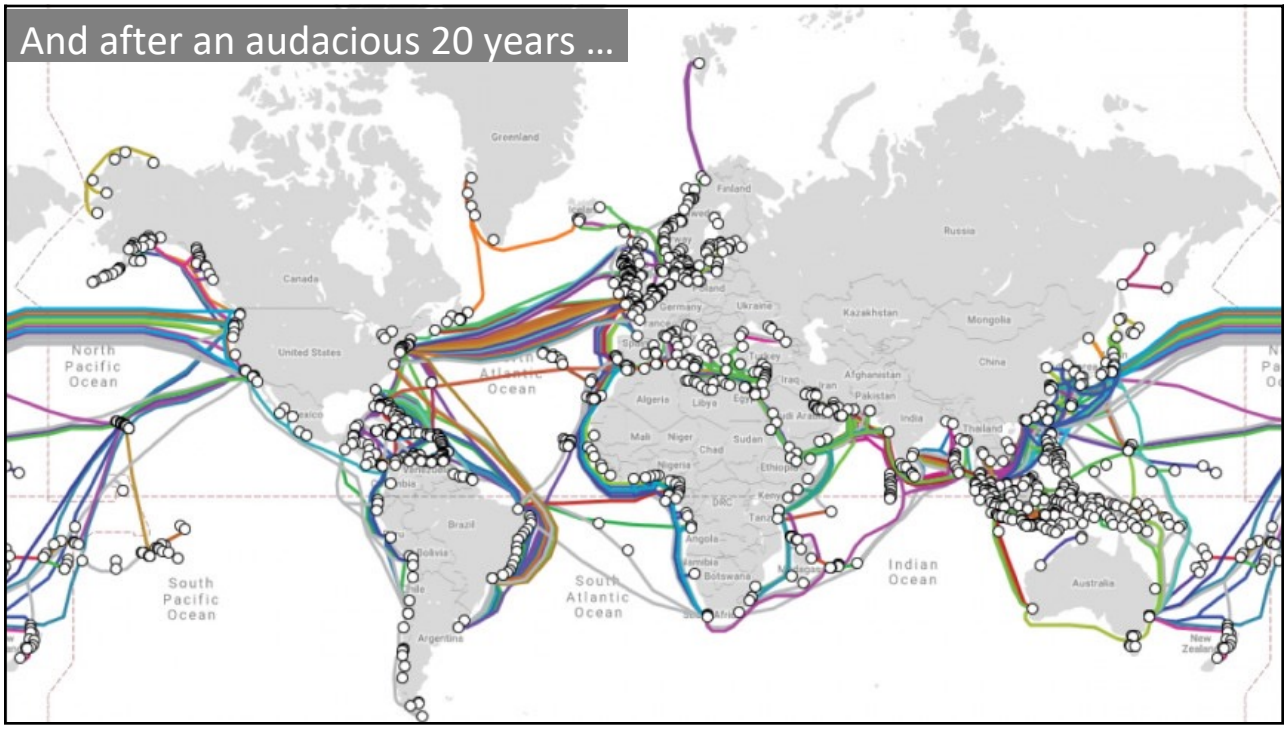




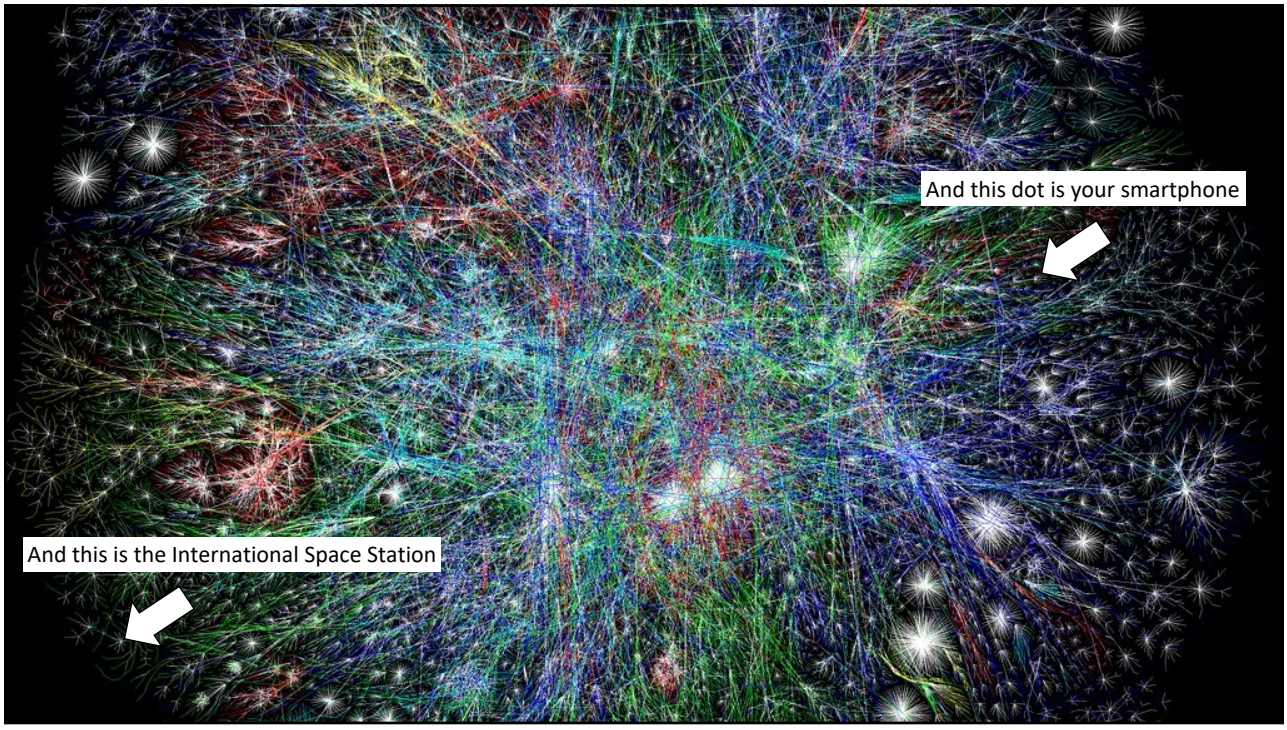




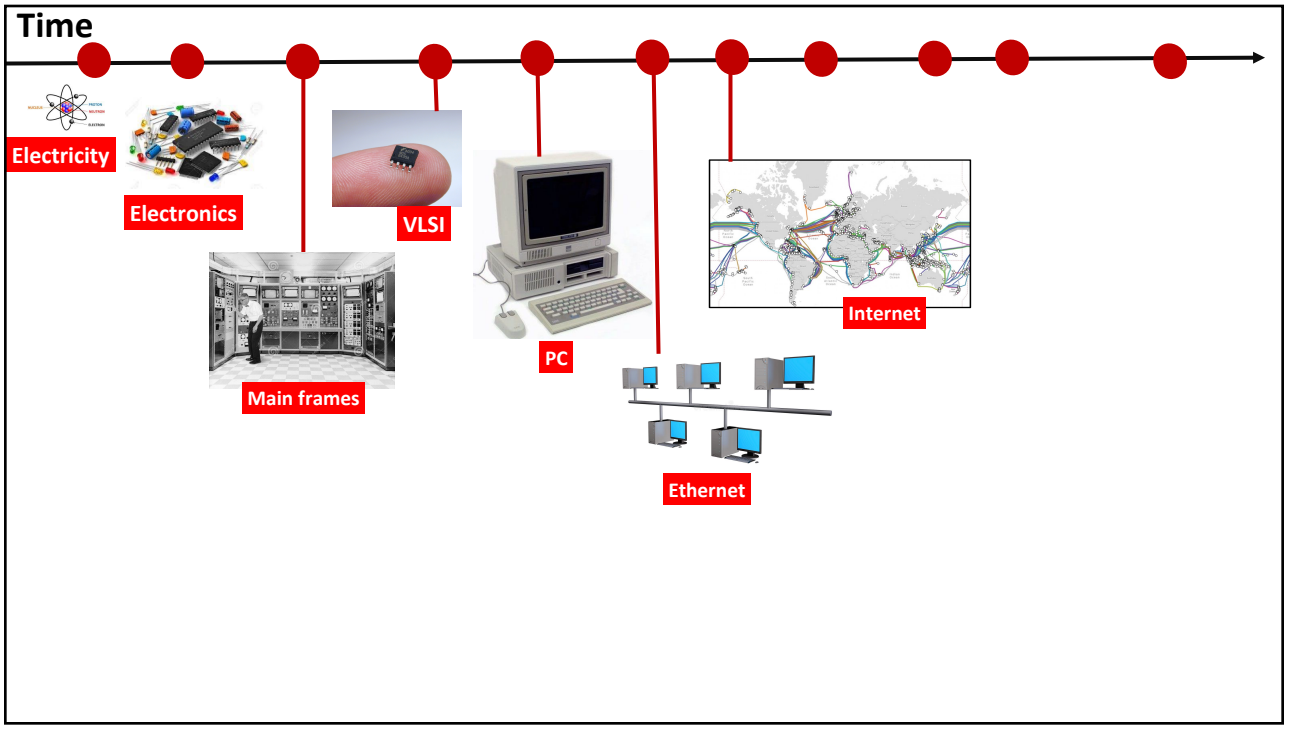
22


And after an audacious 20 years …
Greenland
Canada
United States
North Pacific Ocean
South Pacific Ocean
North Atlantic Ocean
South Atlantic Ocean
Indian Ocean
Russia
Finland
Ukraine
Kazakhstan
Mongolia
China
Afghanistan
Pakistan
India
Thailand
Australia
Algeria
Libya
Mali
Niger
Chad
Sudan
Nigeria
DRC
Angola
Namibia
Botswana
Brazil
Argentina

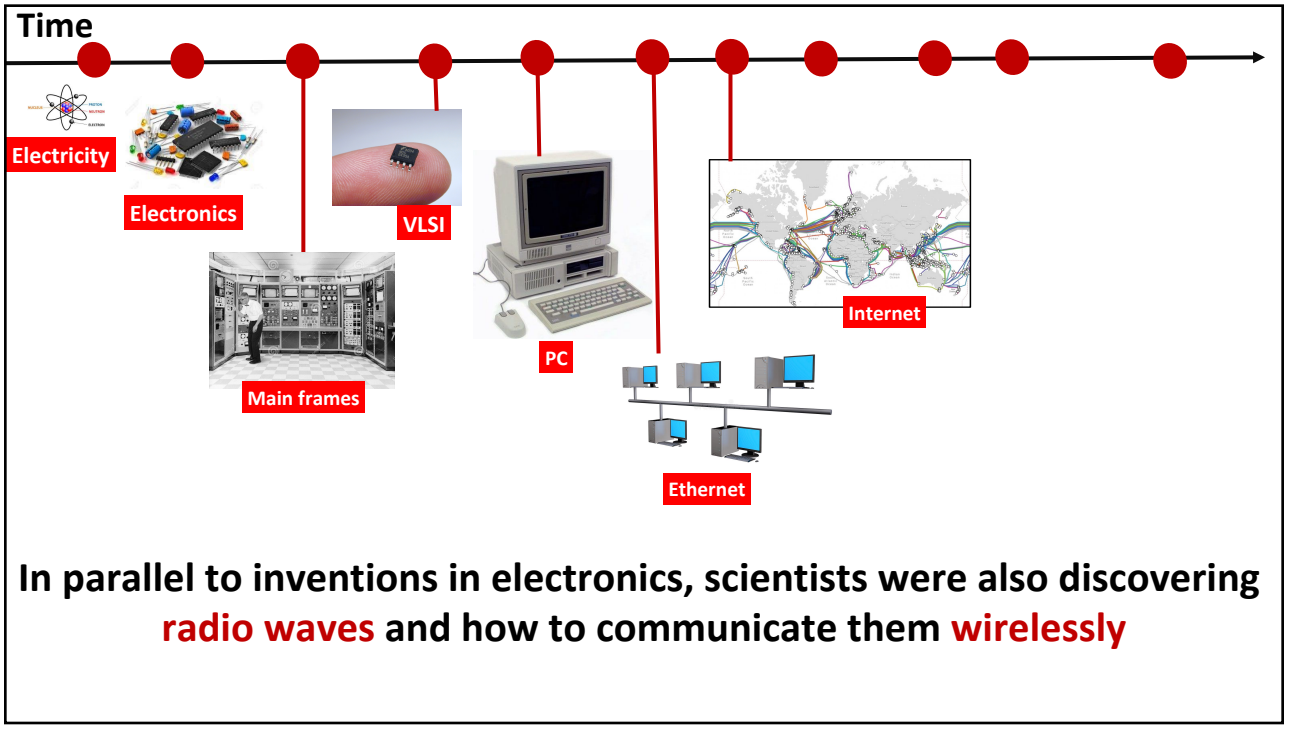
23


And this dot is your smartphone
And this is the International Space Station

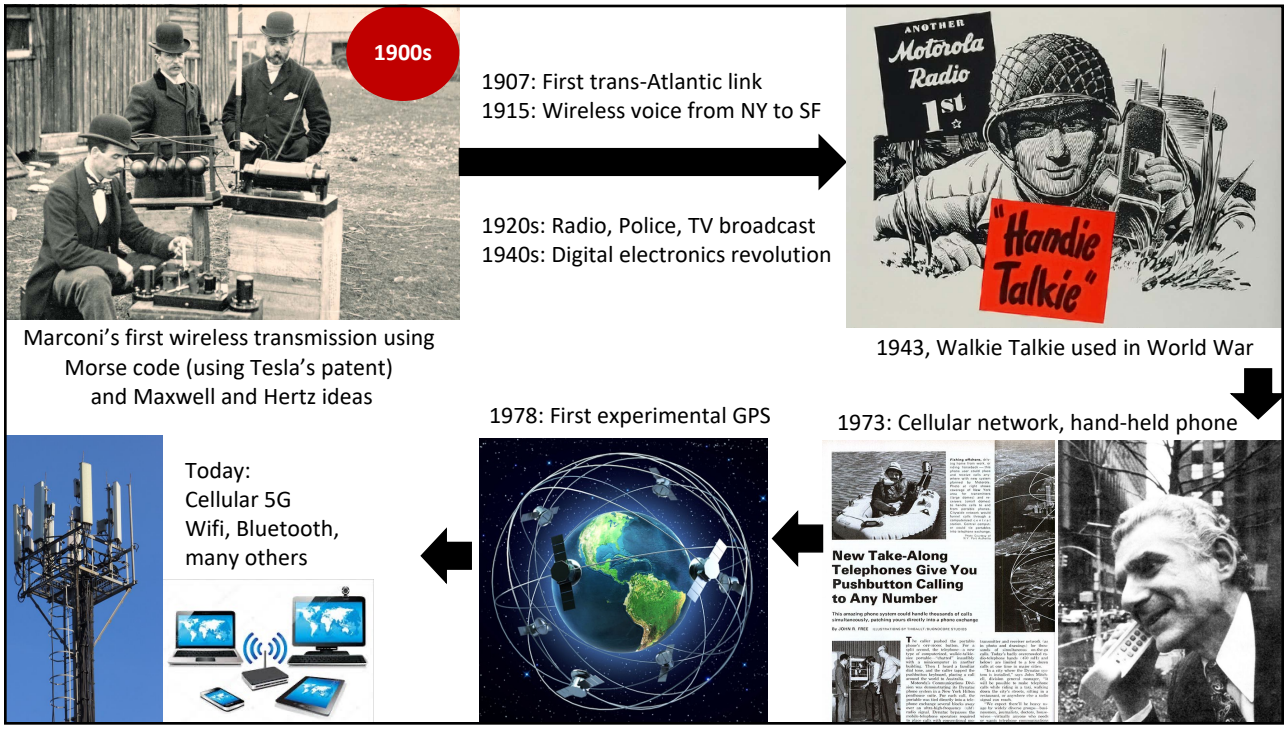
24


Time
Electricity
Electronics
VLSI
Main frames
PC
Internet
Ethernet

25

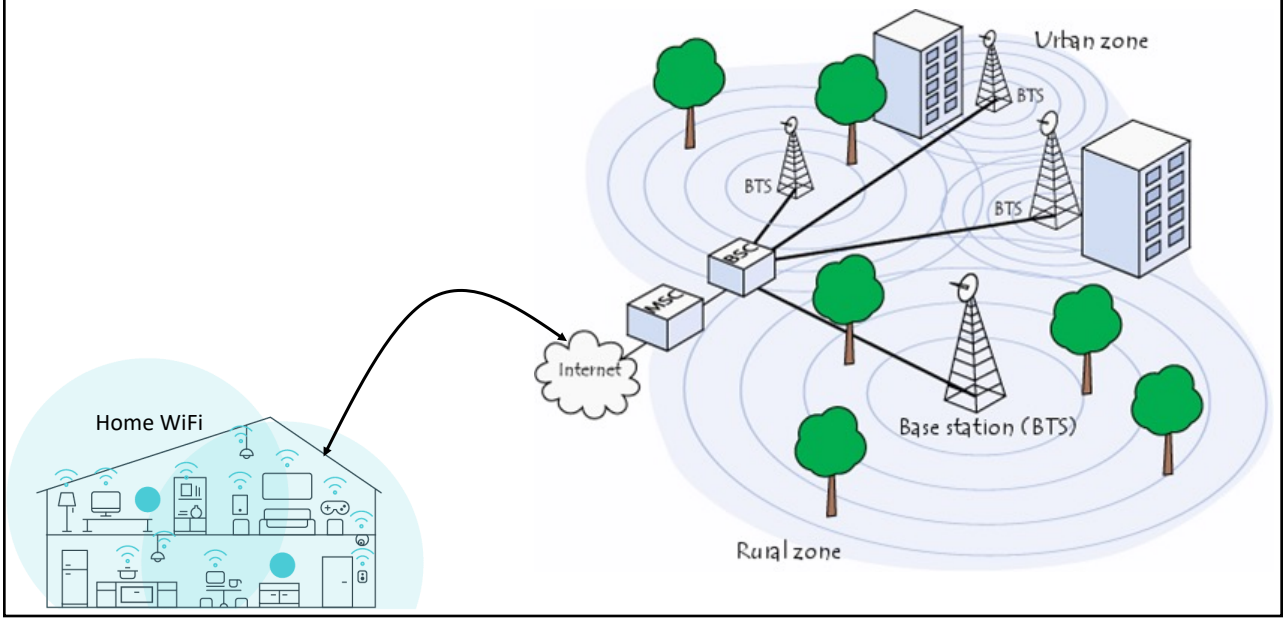

Time
Electricity
Electronics
VLSI
Main frames
PC
Internet
Ethernet
In parallel to inventions in electronics, scientists were also discovering radio waves and how to communicate them wirelessly

26



27

Electronic devices → Wired networks → Internet
Electronic devices → Wireless networks → Internet



28

Electronic devices → Wired networks → Internet
Electronic devices → Wireless networks → Internet
Which means everything is connected via the Internet: Internet of Things (IoT)

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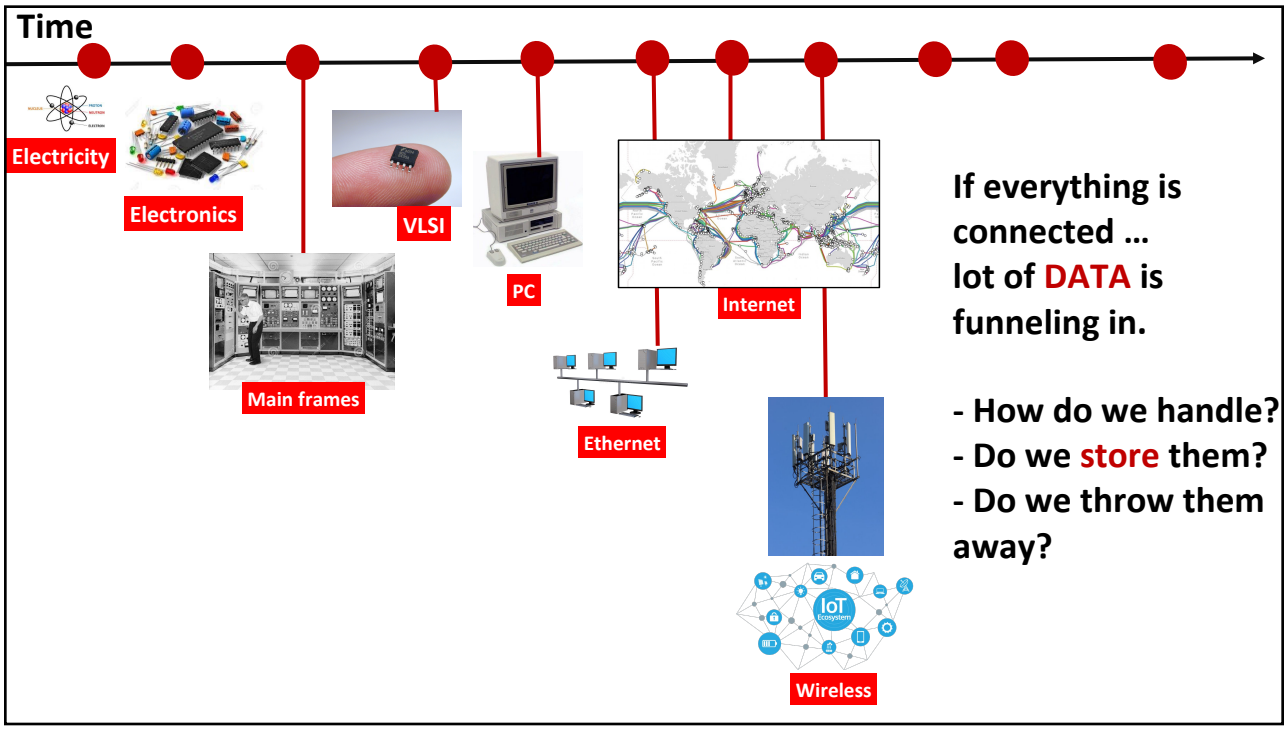
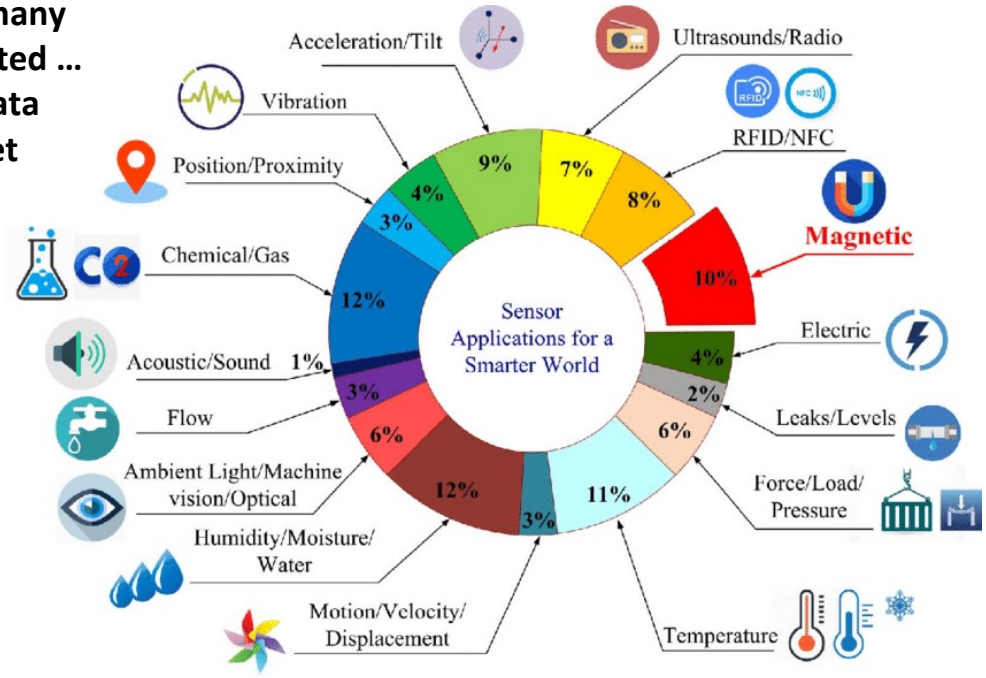


30

IOT has many many sensors connected … all streaming data into the Internet



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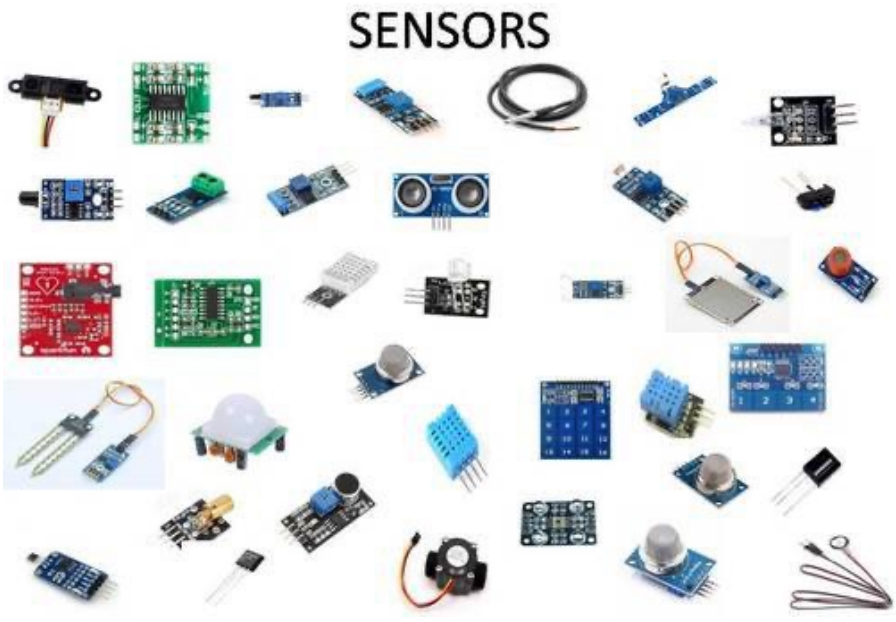
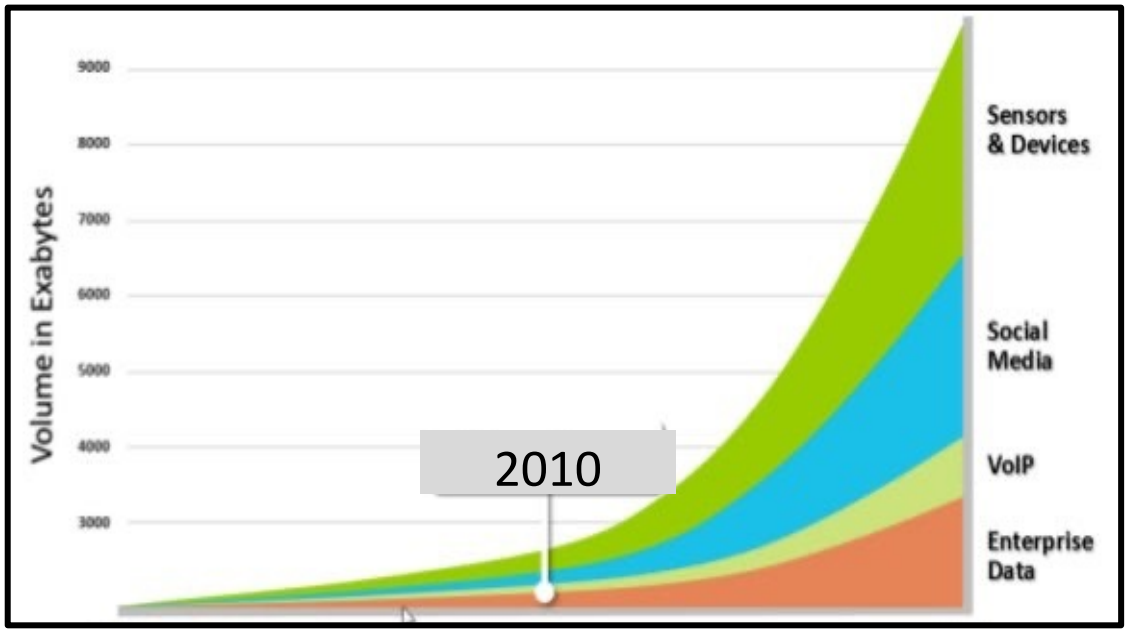
IOT has many many sensors connected … all streaming data into the Internet

Again, VLSI and advance battery technology helping.

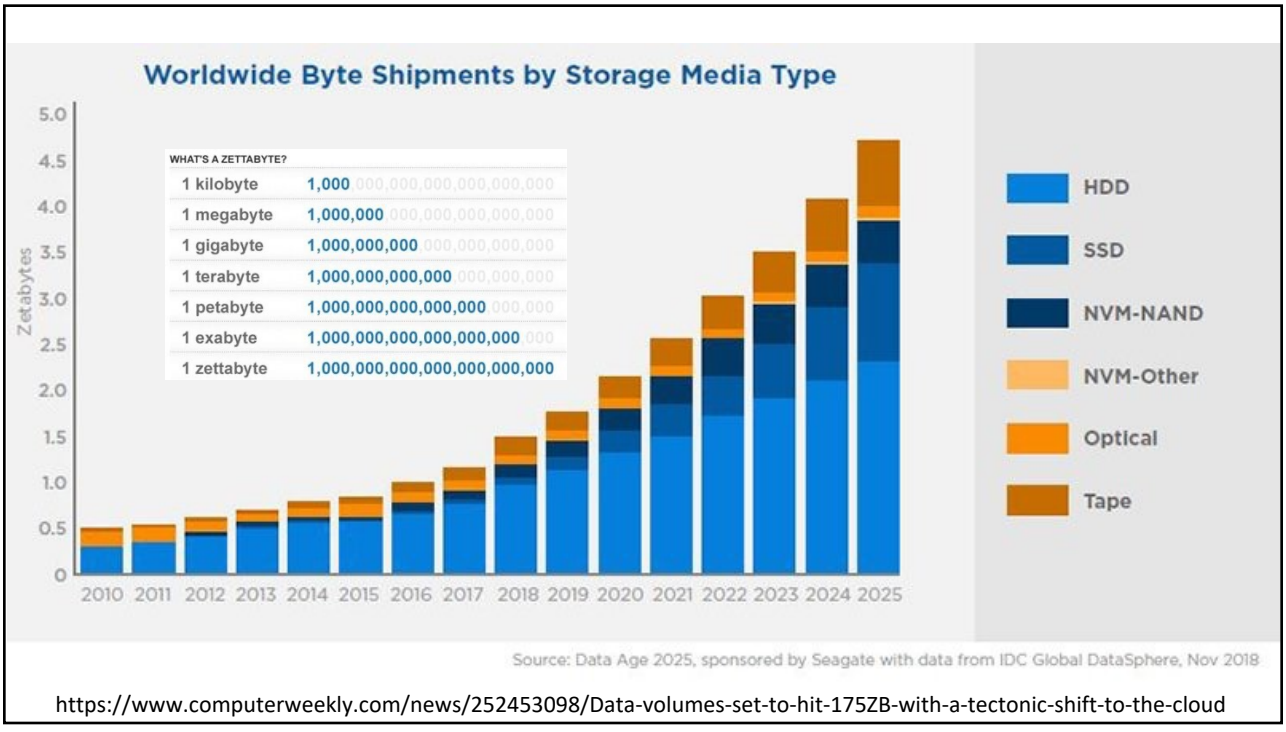
Wireless allowing sensed data to be sent to Internet



32

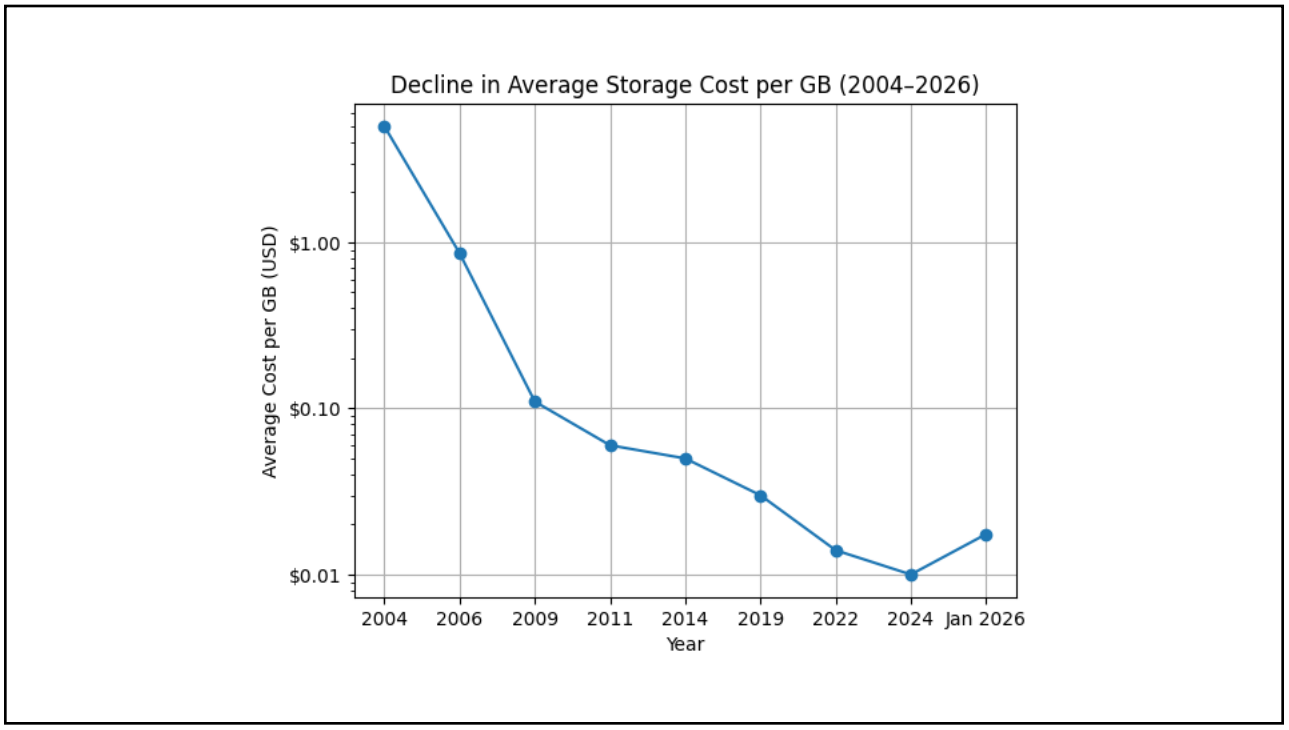


33

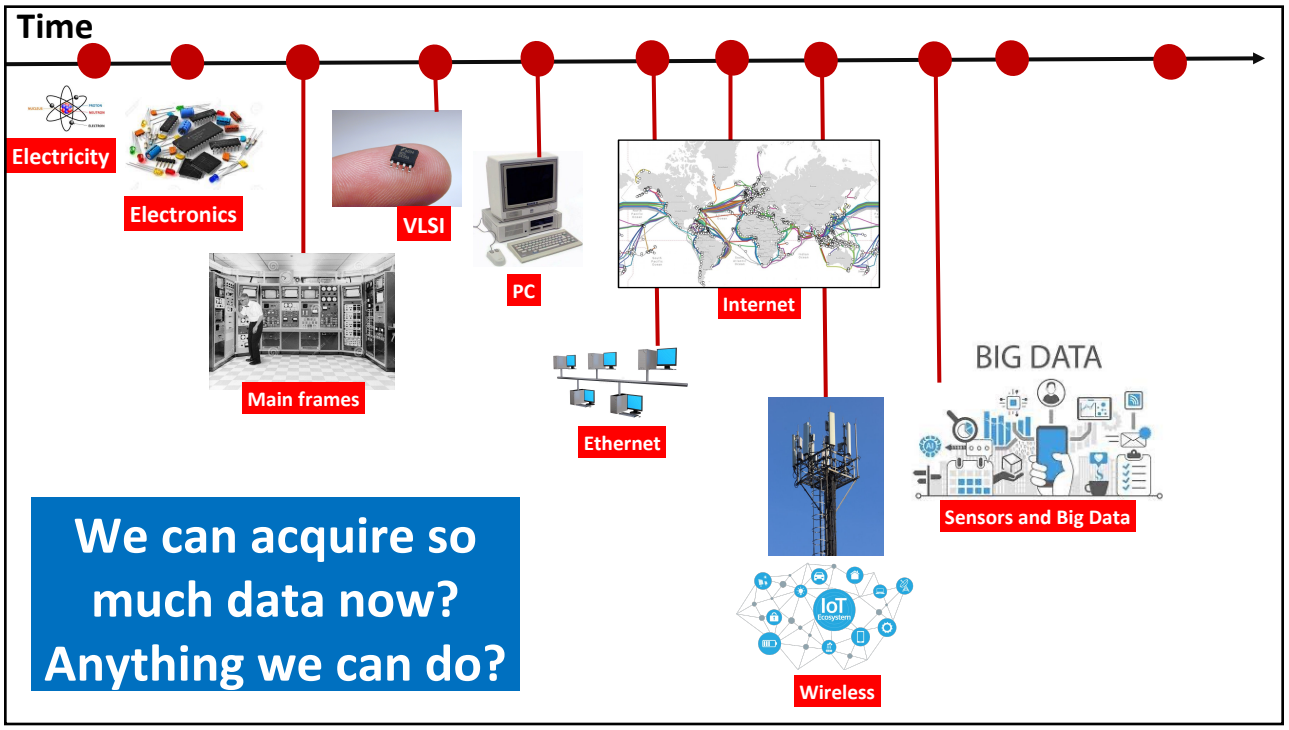


https://www.computerweekly.com/news/252453098/Data-volumes-set-to-hit-175ZB-with-a-tectonic-shift-to-the-cloud

34


Decline in Average Storage Cost per GB (2004–2026)
Average Cost per GB (USD)
$1.00
$0.10
$0.01
2004
2006
2009
2011
2014
2019
2022
2024
Jan 2026
Year

36


Time
Electricity
Electronics
Main frames
VLSI
PC
Ethernet
Internet
Wireless
BIG DATA
Sensors and Big Data
We can acquire so much data now? Anything we can do?

37

One idea: Can data help computers get smarter?
Consider the task of a computer recognizing a face in a picture

How would you make the computer recognize a face?

Past approaches:
Specify the rules to identify a face
Make the computer look for these rules (or "Features")

Rules could be:
1. two symmetric black curves (eyebrows)
2. two black dots below the curves (iris)
3. two small dots close to the middle (nostrils)

…
1000. slight darkness below the chin (shadow)

Does this work?

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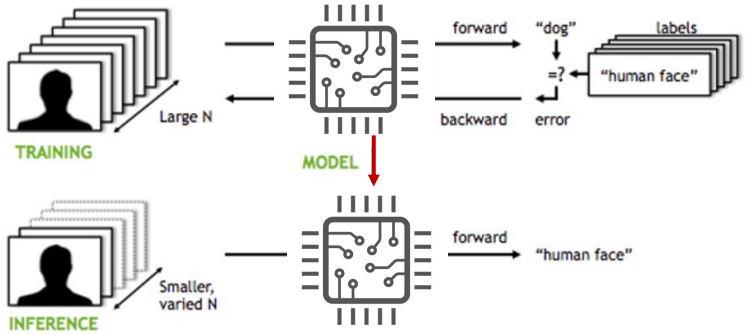
One idea: Can data help computers get smarter?
Consider the task of a computer recognizing a face in a picture

But say you have lots of pictures of faces

1. Let the computer figure out which patterns are common across thousands or millions of faces (training data)
2. Remember those patterns (model)
3. When a new face picture (test data) comes, apply those patterns to check if it is a face. Output yes or no.



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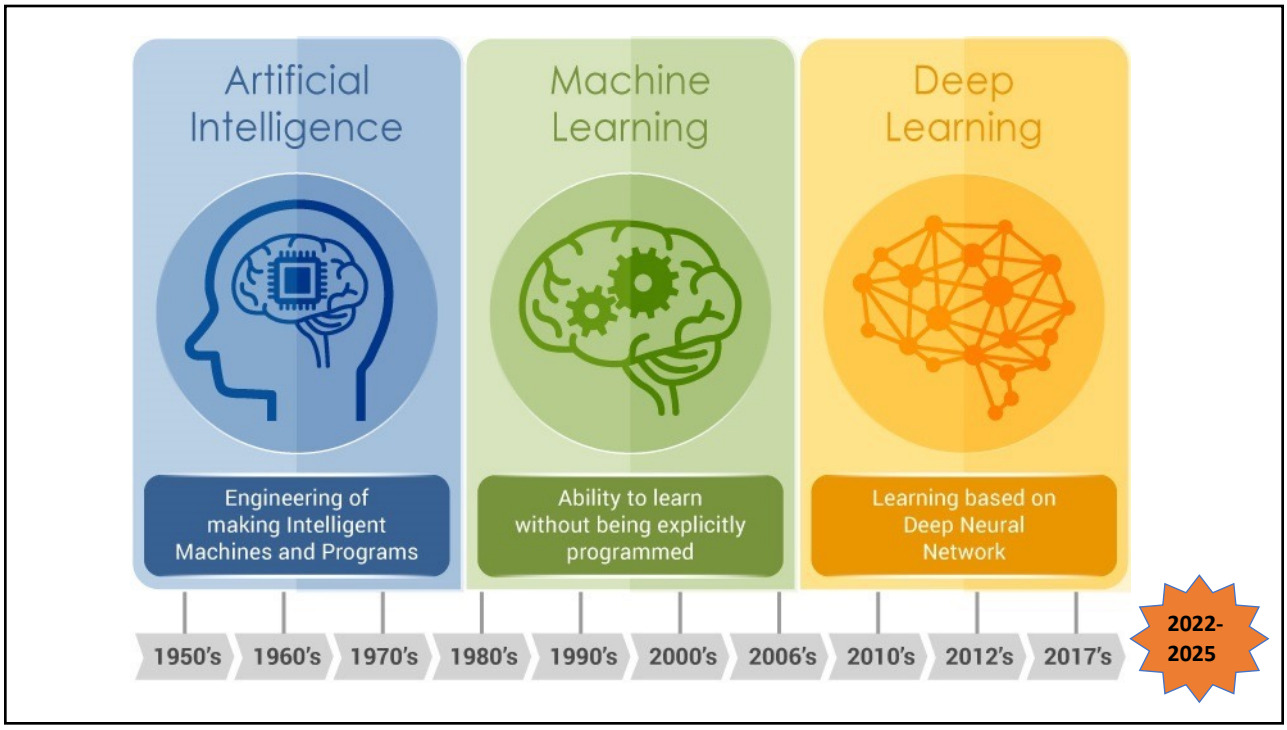
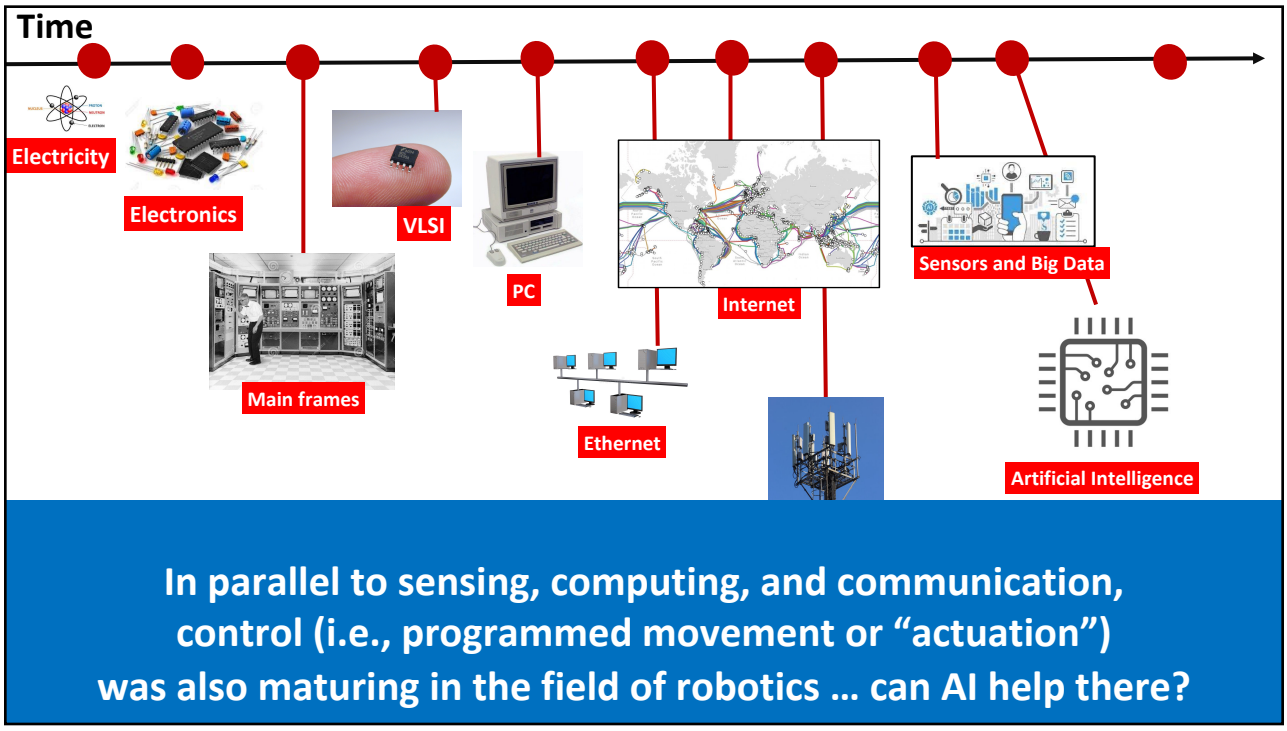

Artificial Intelligence
Machine Learning
Deep Learning
Engineering of making Intelligent Machines and Programs
Ability to learn without being explicitly programmed
Learning based on Deep Neural Network
1950's
1960's
1970's
1980's
1990's
2000's
2006's
2010's
2012's
2017's
2022-2025

40


Time
Electricity
Electronics
Main frames
VLSI
PC
Ethernet
Internet
Sensors and Big Data
Artificial Intelligence
In parallel to sensing, computing, and communication, control (i.e., programmed movement or "actuation") was also maturing in the field of robotics … can AI help there?

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Yes, AI particularly effective when humans don't know why they do what they do (so its hard to teach a computer) …

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Yes, AI particularly effective when humans don't know why they do what they do (so its hard to teach a computer) …

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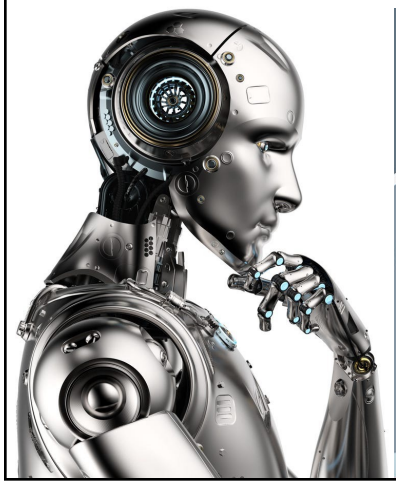
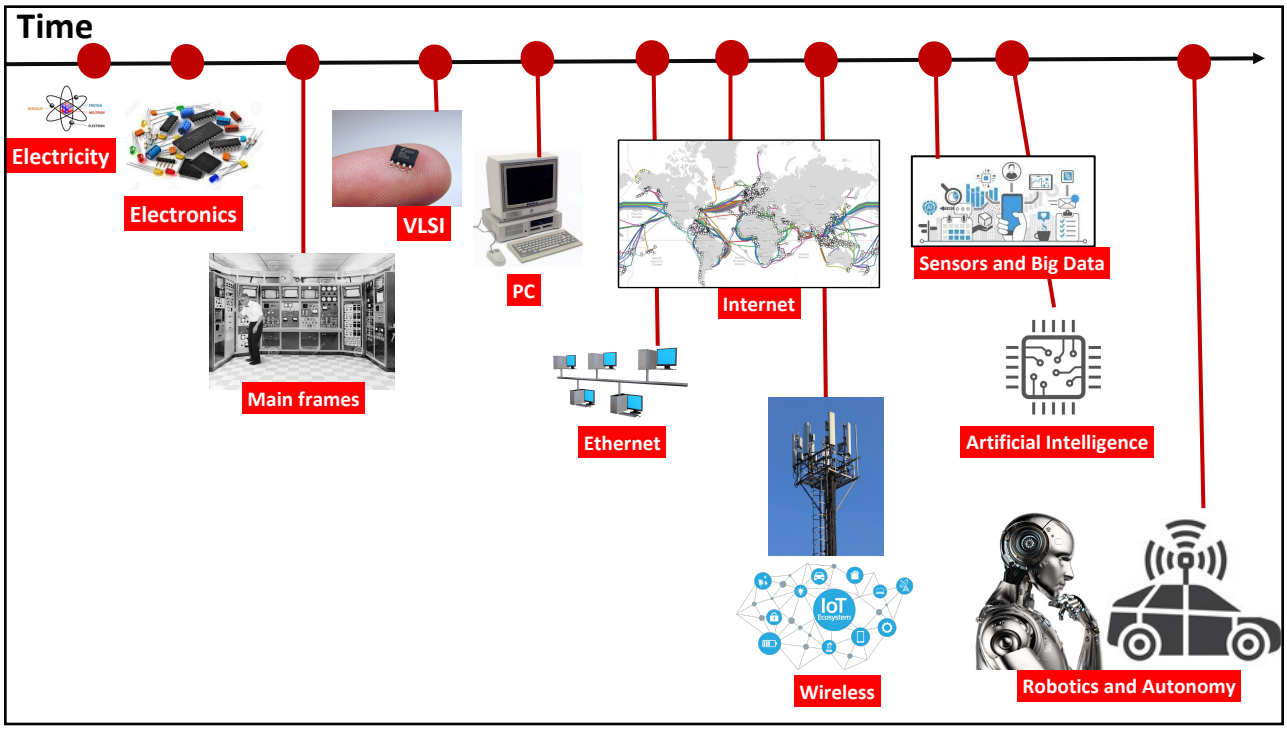
And this is where we are today … convergence of
Sense + Compute (AI) + Communicate + Control
using machines that can do things that we cannot explain.
This is the new age of "autonomous systems".



44



45

Of course, you are NOT supposed to remember all this …

The goal was to show you the landscape for this ECE 101 course …
and why this could be exciting and relevant to students
of all departments in the campus.

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Questions? Comments?

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