INTRODUCTION TO INFORMATICS

LECTURE 2

Ferenc Peták

Department of Medical Physics and Informatics

2018/19

Semester I.

1

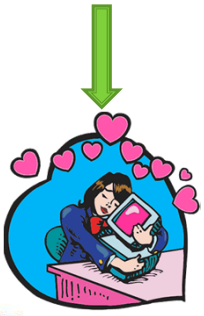
Informatics in medicine? Why we learn?

Because today's health care environment:

- expanding role of technology and information management

Because computer literacy is an important skill to possess in the 21st century

- ability to utilize information technology efficiently, with skills covering from elementary levels to advanced problem solving



Association of American Medical Colleges (AAMC) has recommended that medical students also receive a strong foundation in informatics

AAMC

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Introduction to informatics – lecture topics

- **Sept 3** - Informatics revolutionized medicine and medical research (Prof. Ferenc Bari)
- **Sept 10** - The development of computers (Prof. Ferenc Peták)
- **Sept 17** - Medical digital imaging (part 1) (Dr. László Almási)
- **Sept 24** - Medical digital imaging (part 2) (Dr. László Almási)
- **Oct 1** - Data processing in life sciences (part 1) (Prof. Ferenc Peták)
- **Oct 8** - Data processing in life sciences (part 2) (Prof. Ferenc Peták)
- **Oct 15** - Computer software, Operating Systems (Prof. Ferenc Peták)
- **Oct 22 -** AUTUMN BREAK
- **Oct 29** - Data presentation (Dr. László Almási)
- **Nov 5** - Document processing, cloud computing (Dr. József Tolnai)
- **Nov 12** - Telemedicine (part 1) (Ernő Duda)
- **Nov 19** - Computer networks, data security (part 1) (Prof. Ferenc Peták)
- **Nov 26** - Computer networks, data security (part 2) (Prof. Ferenc Peták)
- **Dec 3** - Telemedicine (part 2) (Dr. József Tolnai)

Lecture bonus with Mentimeter

Bonus system

Two bonus points (1%) can be awarded in each lecture if:

1. Providing a valid **full name** at the Mentimeter test
2. At least **3 correct answers** out of the 4 online test questions

Participation:

- Mobile devices with installed Mentimeter application
- Online device with internet access ***http://www.menti.com***

Introduction to computer architerture
The development of computers

Ferenc Peták
Department of Medical Physics and Informatics
2018

„If you want to understand today, you have to search yesterday" Pearl Buck

Hardware and software

Hardware

Software

MacOS™ Windows

Linux

Office

Biopac Student Lab

The history of computers

Three major steps of development:

1. Mechanical calculators
2. Electro-mechanical calculators
3. Electronic computers:

Generation	Year	Design	FLOPS*
First	1945-55	Vacuum tubes	100
Second	1955-65	Transistors	10K
Third	1965-80	Integrated circuits IC	1 MF
Fourth	1980-91	Personal computers, LSI, VLSI	10 MF
Fifth	1991-	Paralel and associate processors	1 GF-

Flops: floating point operation/second

Floating-point format is a computer number format, usually occupying 32 bits in computer memory

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1. Mechanical calculators

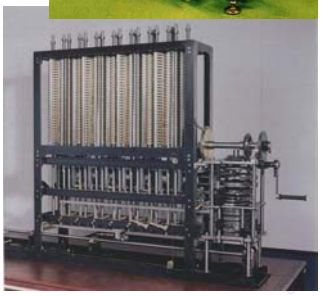
Numerous legends about ancient Chinese, Greek and Arabic inventors developing automatic calculators

Blaise Pascal (1642):

additon/subtraction in 6 digits

Gottfried Wilhelm Leibniz (1694): mechanical calculator to multiply/divide

Charles Babbage (1792-1871): the first general-purpose computer

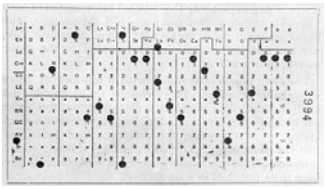


2. Electro-mechanical calculators

Hermann Hollerith

punch-card

1890 census in the US for data processing.
Company in 1896 (International Business Machines)

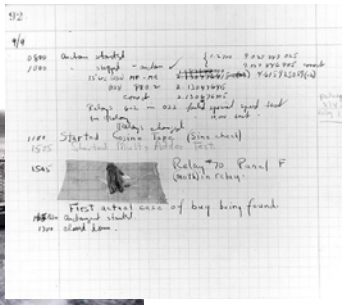


1936, Konrad Zuse

program-controlled electromechanical computer (Z1)
Programming language „Plankalkül"

Z4: first commercially available computer

The first **binary** computer.



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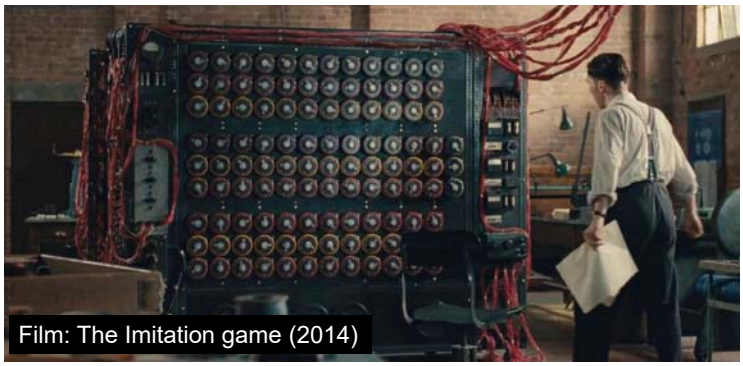
3. First-generation electronic computers

Digital electronic computers used vacuum tubes (1945 – 1955)

ABC (Atanasoff – Berry Computer): the prototype of a fully electronic computer, 1939 (USA) - The alternating current power line frequency of **60 Hz** was the primary **clock rate**

Colossus I: Alan Turing, breaking the German Lorenz code, 1943 (England)



IBM refused to buy Atanasoff's computer …He considered using mechanical calculators and even started to modify an IBM calculator but IBM complained about the damage to their leased machine!

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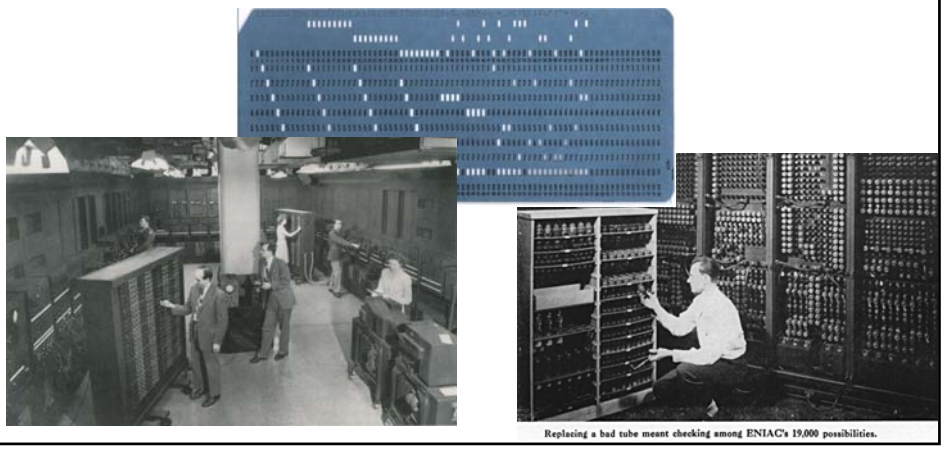
3. First-generation electronic computers

ENIAC – (Electronic Numerical Integrator And Computer) 1946
Pennsylvaniai University, sponsor: Ballistic Research Laboratory
First test run: computations for the hydrogen bomb (1 million puch cards)
Performed 5,000 additions, 357 multiplications, or 38 divisions in one second.



Replacing a bad tube meant checking among ENIAC's 19,000 possibilities.

3. First-generation electronic computers

(continued.)

EDVAC 1949: (Electronic Discrete Variable Automatic Computer)

The first universal computer built on the theory of **John von Neumann** (1903 Budapest – 1957 Washington)

MESM, BESM, 1952: Moscow followed by **Strella** in 1953

M-3, 1953: the first Hungarian electronic computer

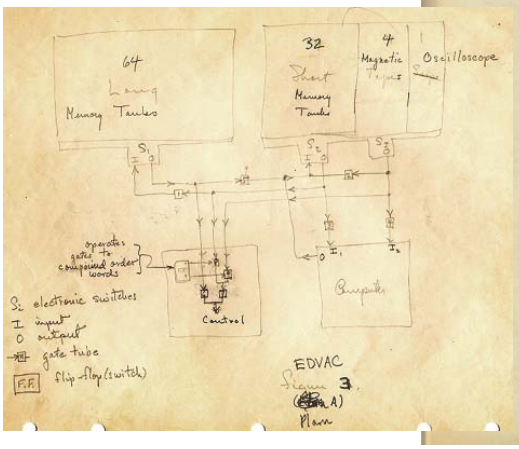
The first computer center in Szeged in 1963
László Kalmár

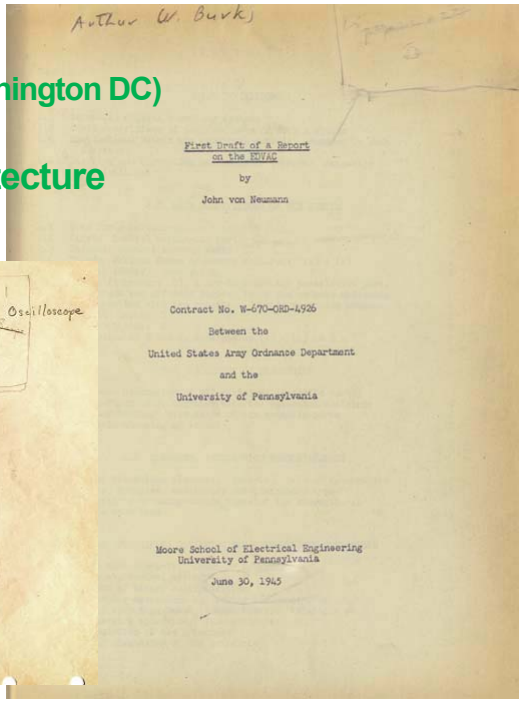
BESM6

"Computers in the future may weigh no more than 1.5 tons (Popular mechanics, forecasting the relentless march of science, 1949)

John von Neumann
1903 (Budapest) – 1957 (Washington DC)

Modern Computer Architecture
1945





von Neumann architecture

Summarized in three main points:

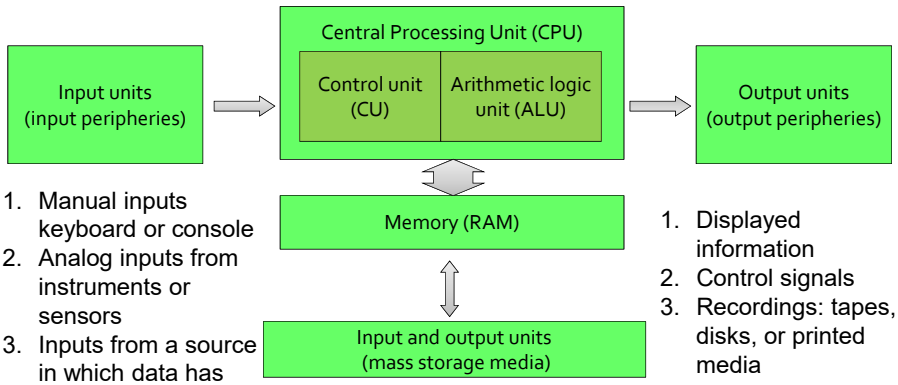
I. The main components of the computer:
- **control unit** (CU)
- **arithmetic logic unit** (ALU), for basic logical and arithmetical operations
- **storage unit** (operational memory), indexible, rewritable (RAM),
- input/output units

All these components are fully electronic and use binary coding.

II. The stored-program concept:
- The program and the data are stored **in the same storage unit**

III. Theory for automatic execution:
- The Control unit **executes** the operations **automatically** based on the commands read from the storage unit (no external intervention)

Modern computer architecture



1. Manual inputs keyboard or console
2. Analog inputs from instruments or sensors
3. Inputs from a source in which data has previously been stored

1. Displayed information
2. Control signals
3. Recordings: tapes, disks, or printed media

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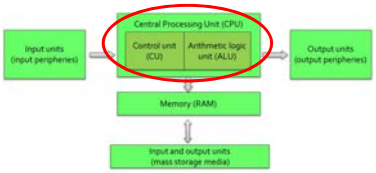
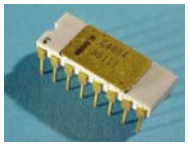
Processors



- **The processor** (**CPU** - Central Processing Unit) executes the commands and controls the data processing and transfer
- Two competing manufacturesers for PCs, **Intel** and **AMD**
- The history of CPUs started in 1971, when a small unknown company **Intel** built multiple transistors together to form a central processing unit (Intel: „Integrated Electronics„
  The first microprocessor: i4004 (1971)



- Intel processors today:
  - **Intel® Core™ i3**
  - **Intel® Core™ i5**
  - **Intel® Core™ i7** (i7-8700K)
    - 4.7 GHz, 14 nm, 6 processor cores, 12 threads Intel® HT (Hyper-Threading), 12 MB Cache ($400)
  - **Intel® Core™ i9** (i9-7980XE)
    - 2.6GHz (max. 4.4GHz), 14 nm, 18 processor cores, 2 threads Intel® HT (Hyper-Threading), 25MB cache ($2000)

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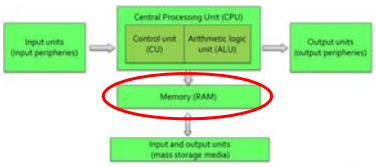
The memory (RAM)



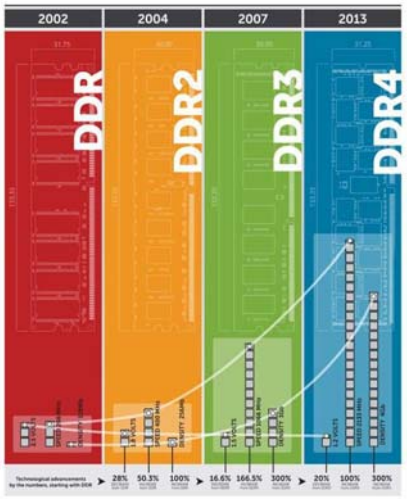
The **Random Access Memory (RAM)** stores temporarily the output of the work of the CPU

Typical RAM sizes:

ZX-81	1KB
PC (8088)	16KB
XT (8086)	640KB
AT (286)	2MB
386	2-8MB
486	8-32MB
Pentium (586)	32-64MB

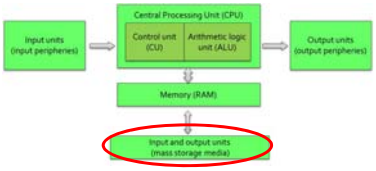
PC today: 4-16 GB DDR3-DDR4

DDR: Double Data Rate

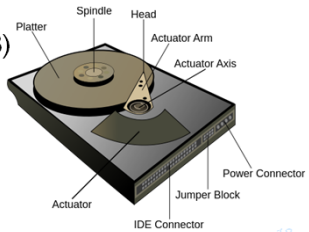


www.maketecheasier.com

The mass storage media



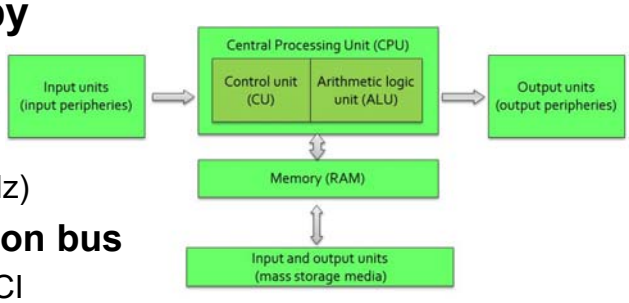
- **Hard disk drives (HDD)**
  - electromechanical data storage
  - rapidly rotating magnetic disk(s)
- **Flash memory, solid-state drives (SSD)**
  - Portable/fixed
  - Portable: USB flash drive (8 Mbytes, IBM 2000 December)
  - No moving components
  - Less energy consumption
  - Faster data access (startup time and transfer rate)
  - Capacity: 64-1024 Gbytes
  - Cost: US$0.65 per GB (vs. HDD 0.1 per GB)



The speed of a computer

Determined by

- **CPU**
  - Type (i3, i5, i7)
  - Cores
  - Clock rate (GHz)
- **Communication bus**
  - MCA, EISA, PCI
- **Amount and type of RAM**
  - Typically for a PC: 2-16 Gbytes
  - Double Data Rate (DDR vs. DDR2 vs. DDR3 vs. DDR4)
- **Type of mass storage media**
  - HDD spin 5,400 or 7,200 rpm
  - Solid-state disk (SSD)



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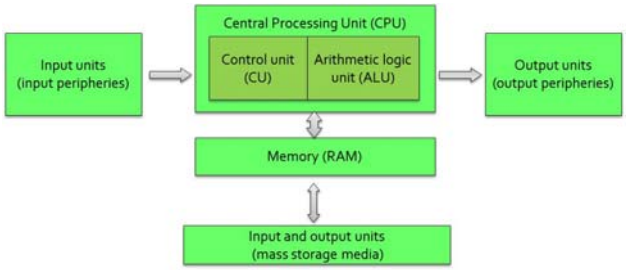
Which is faster?



	Computer 1	Computer 2
CPU type	Intel® Core™ i3-7020U	Intel® Core™ i5-8250U
CPU clock rate	2,3 GHz	3,4 GHz
Memory	4 GB DDR4	8 GB DDR4
Mass Storage Capacity	500 GB	256 GB SSD

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Personal computers
(contd.)

Apple 1 (1977)
The IBM-compatible
IBM-PC (1981)
IBM-PC/XT (1983) : eXtended Technology
IBM-PC/AT (1984) : Advanced Technology: 286, 386, …

IBM-PC/XT

Commodore 64

„640K ought to be enough for anybody" Bill Gates 1981

Personal computers
(contd.)

The first portable … 1981 - Osborne

Amiga 1000

"There is no reason anyone would want a computer in their home." --Ken Olson, president, chairman and founder of Digital Equipment Corp., 1977

Personal computers
(contd.)

Apple: Lisa 2

Apple: Macintosh

Videoton TV Computer (1983)

"I think there is a world market for maybe five computers." --Thomas Watson, Chairman of IBM, 1943

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Personal computers
(contd.)

Today PCs, laptops

Raidmax Ninja

Raidmax Samurai

Apple Mac Pro

„Apple" laptop

Antique laptop

Apple MacBook Pro

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Tablet computers

One-piece mobile computer that typically offer a touchscreen as the primary means of control

- Virtual keyboard
- Wi-Fi, bluetooth, GPS access
- Built-in camera
- The first tablet was released by Microsoft in (2001)
- Later Apple iPad (2010), Samsung Galaxy Tab, Google Nexus, Huawei mediapad
- Operating system: Android, iOS, Windows

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Tablet computers

1969: Did Stanley Kubrick Invent the iPad in „*2001: A Space Odyssey*"?

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Smartphones

„Small tablet”: mobile phone built on a mobile operating system, with more advanced computing capability connectivity than a feature phone

Operating systems:

Google's Android

Apple iOS

Nokia Symbian

RIM BlackBerry OS

Samsung Bada

Microsoft Windows Phone

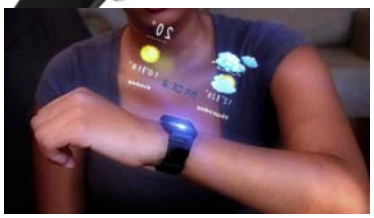
Hewlett-Packard webOS

Linux distributions
such as Maemo, MeeGo

The computer in your cell phone has more processing power than all the computers in the Apollo 11 Lunar Lander that put 2 men on the moon.
(www.popsci.com)

Smart Watches

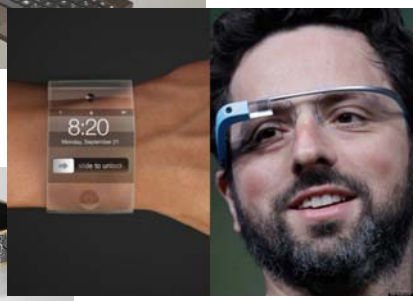
- The first (1984): Seiko RC-1000
- Today:
  - Bluetooth connection with smartphones
  - Displays phone functions
  - Monitors vital signs
    - Heart rate, skin conductance, step (floor) count, giroscope (activity and sleep monitoring)
- Future

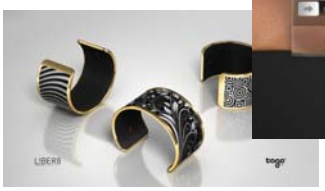


Present and future …

- Hybrid computers
- PadPhones
- „Smart” glass
- „Smart” shoes
- „Smart” Heart Strap
- „Smart” jewelry
- „Smart” clothing





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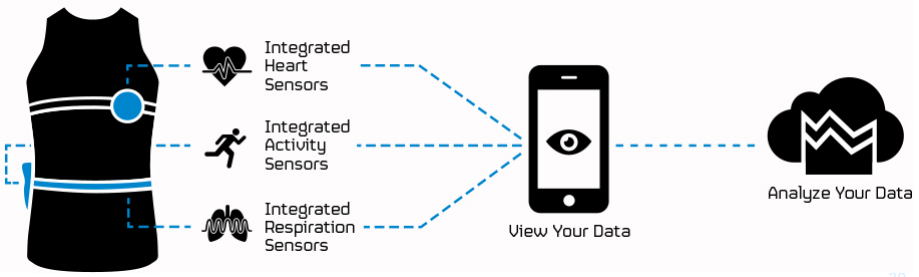
„Smart” shirt

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Mainframe and supercomputers

- **Workstation:** specially optimized for a particular purpose
  - Perform large-scale transaction processing
  - Support thousands of users and application programs
  - Manage terabytes of information in databases
  - Handle large-bandwidth communication
- **Mainframe computers**: ("big iron") powerful computers
- Typically Unix-based operating systems (e.g. **IBM AIX, Linux**)
- Accessed via terminals

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Supercomputers - Top500

(http://www.top500.org)

Rank	Site	System	Cores	Rmax (TFlop/s)	Rpeak (TFlop/s)	Power (kW)
1	DOE/SC/Oak Ridge National Laboratory United States	**Summit** - IBM Power System AC922, IBM POWER9 22C 3.07GHz, NVIDIA Volta GV100, Dual-rail Mellanox EDR Infiniband IBM	2,282,544	122,300.0	187,659.3	8,806
2	National Supercomputing Center in Wuxi China	**Sunway TaihuLight** - Sunway MPP, Sunway SW26010 260C 1.45GHz, Sunway NRCPC	10,649,600	93,014.6	125,435.9	15,371
3	DOE/NNSA/LLNL United States	**Sierra** - IBM Power System S922LC, IBM POWER9 22C 3.1GHz, NVIDIA Volta GV100, Dual-rail Mellanox EDR Infiniband IBM	1,572,480	71,610.0	119,193.6	
4	National Super Computer Center in Guangzhou China	**Tianhe-2A** - TH-IVB-FEP Cluster, Intel Xeon E5-2692v2 12C 2.2GHz, TH Express-2, Matrix-2000 NUDT	4,981,760	61,444.5	100,678.7	18,482
5	National Institute of Advanced Industrial Science and Technology (AIST) Japan	**AI Bridging Cloud Infrastructure (ABCI)** - PRIMERGY CX2550 M4, Xeon Gold 6148 20C 2.4GHz, NVIDIA Tesla V100 SXM2, Infiniband EDR Fujitsu	391,680	19,880.0	32,576.6	1,649

Rmax: theoretical capacity in TFLOPS
TFLOPS: Tera Floating-point Operations Per Second = 1000 GFLOPS

Modern desktop computer: 3GHz P4 ~ 0.5 to 1.0 Gflop

Top supercomputer: ~100 000 000 times faster than our desktop

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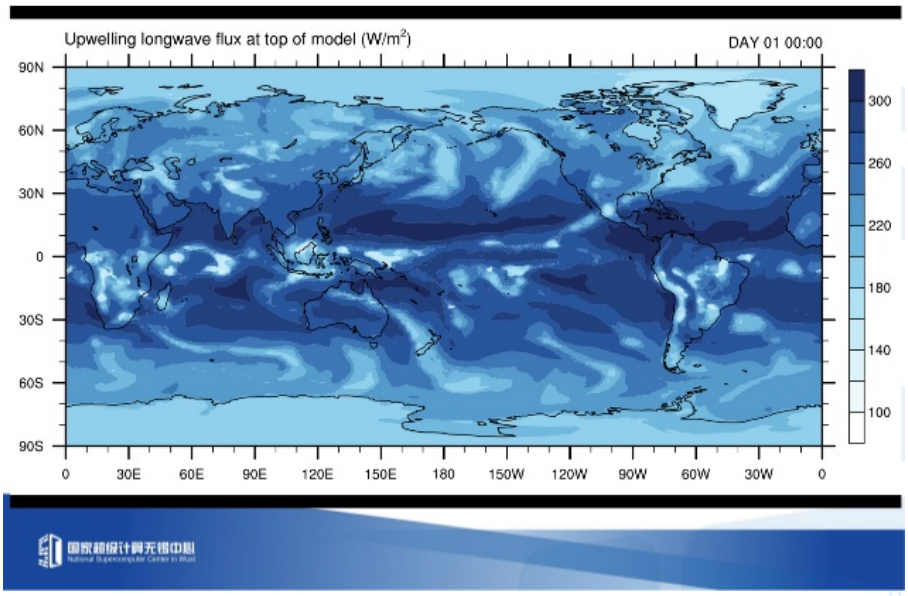
CAM results on Sunway TaihuLight



Past and future trends …

Moore's law: the number of transistors in a dense integrated circuit doubles about every two years.