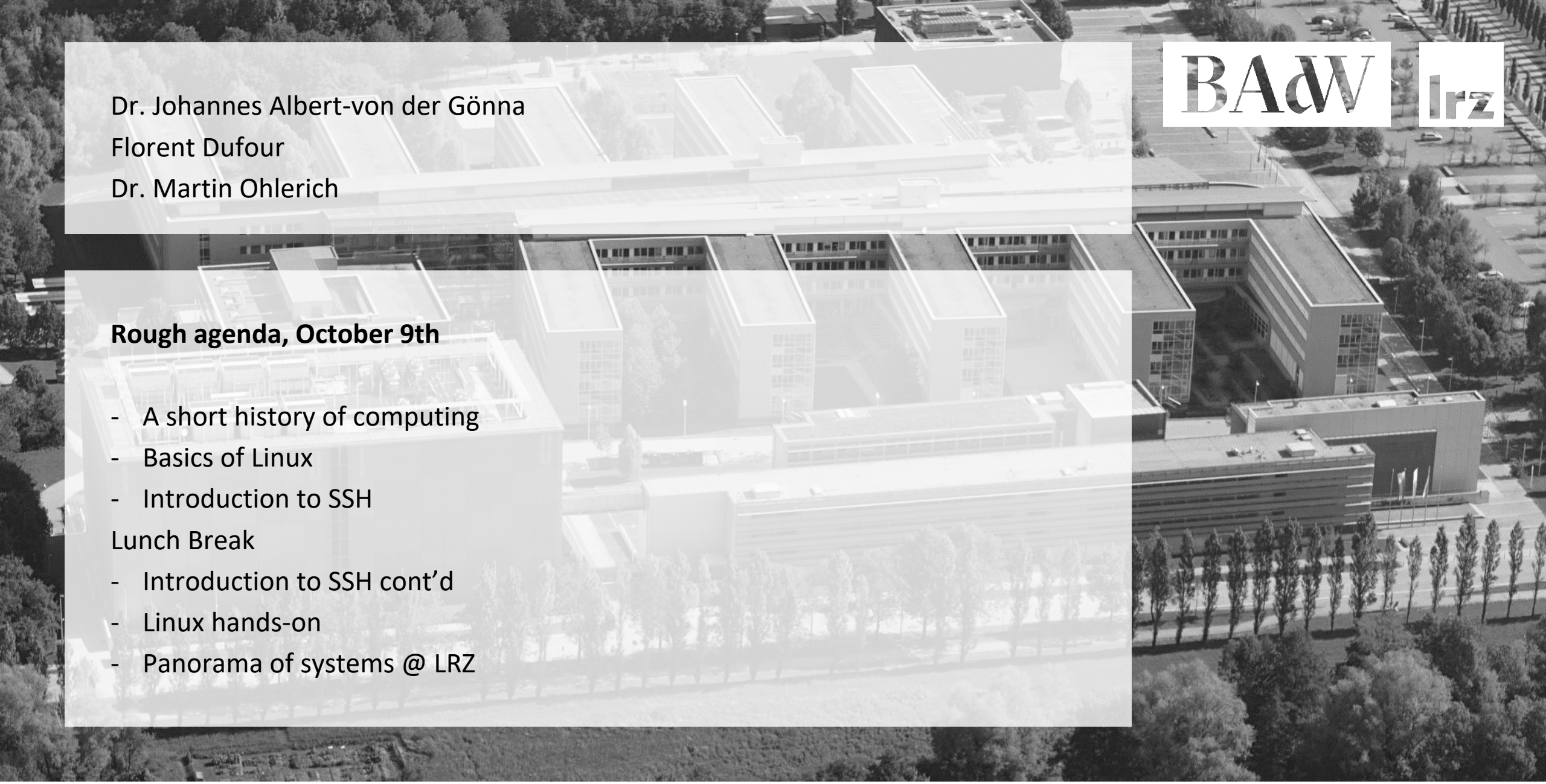

Leibniz Supercomputing Centre

of the Bavarian Academy of Sciences and Humanities

# AI Training Series: Orientation Session

October, 9th/10th 2023 | J. Albert-von der Gönna, F. Dufour, M. Ohlerich



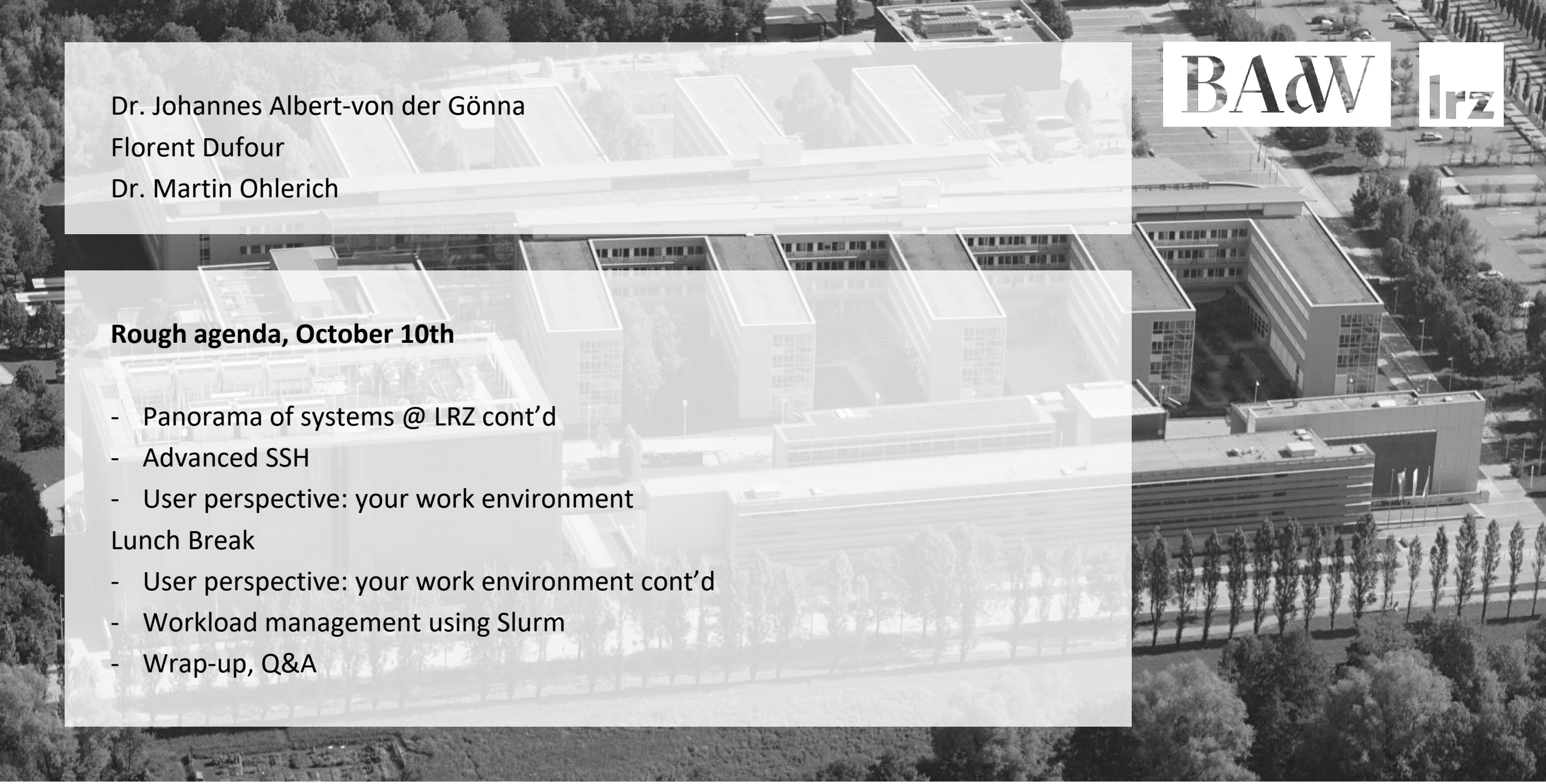
Dr. Johannes Albert-von der Gönna
Florent Dufour
Dr. Martin Ohlerich

**Rough agenda, October 9th**

- A short history of computing
- Basics of Linux
- Introduction to SSH

Lunch Break

- Introduction to SSH cont'd
- Linux hands-on
- Panorama of systems @ LRZ



Dr. Johannes Albert-von der Gönna
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**Rough agenda, October 10th**

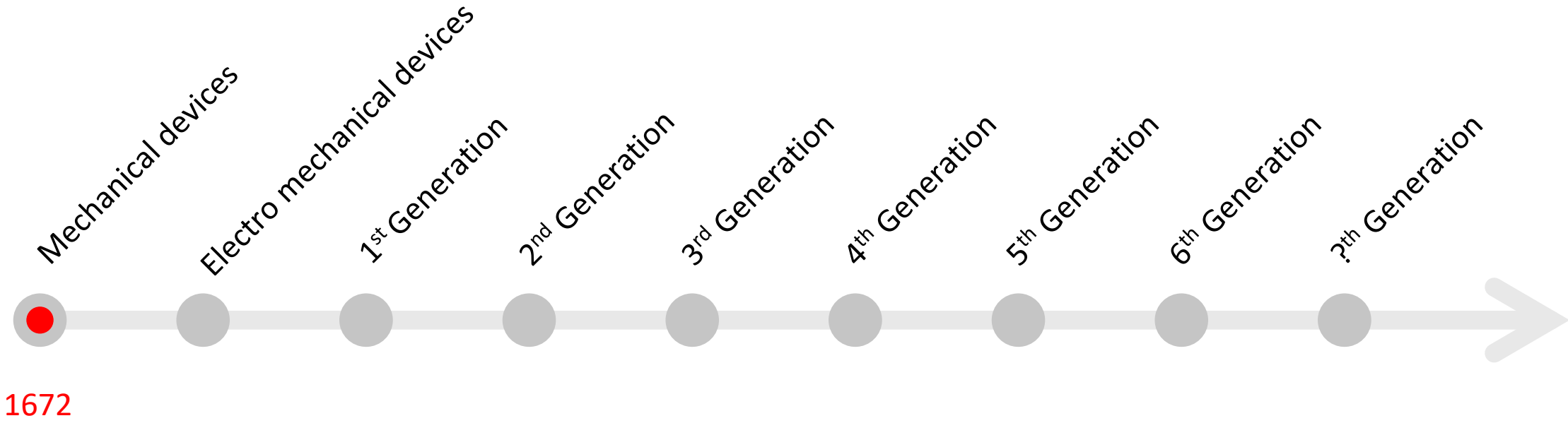
- Panorama of systems @ LRZ cont'd
- Advanced SSH
- User perspective: your work environment

Lunch Break

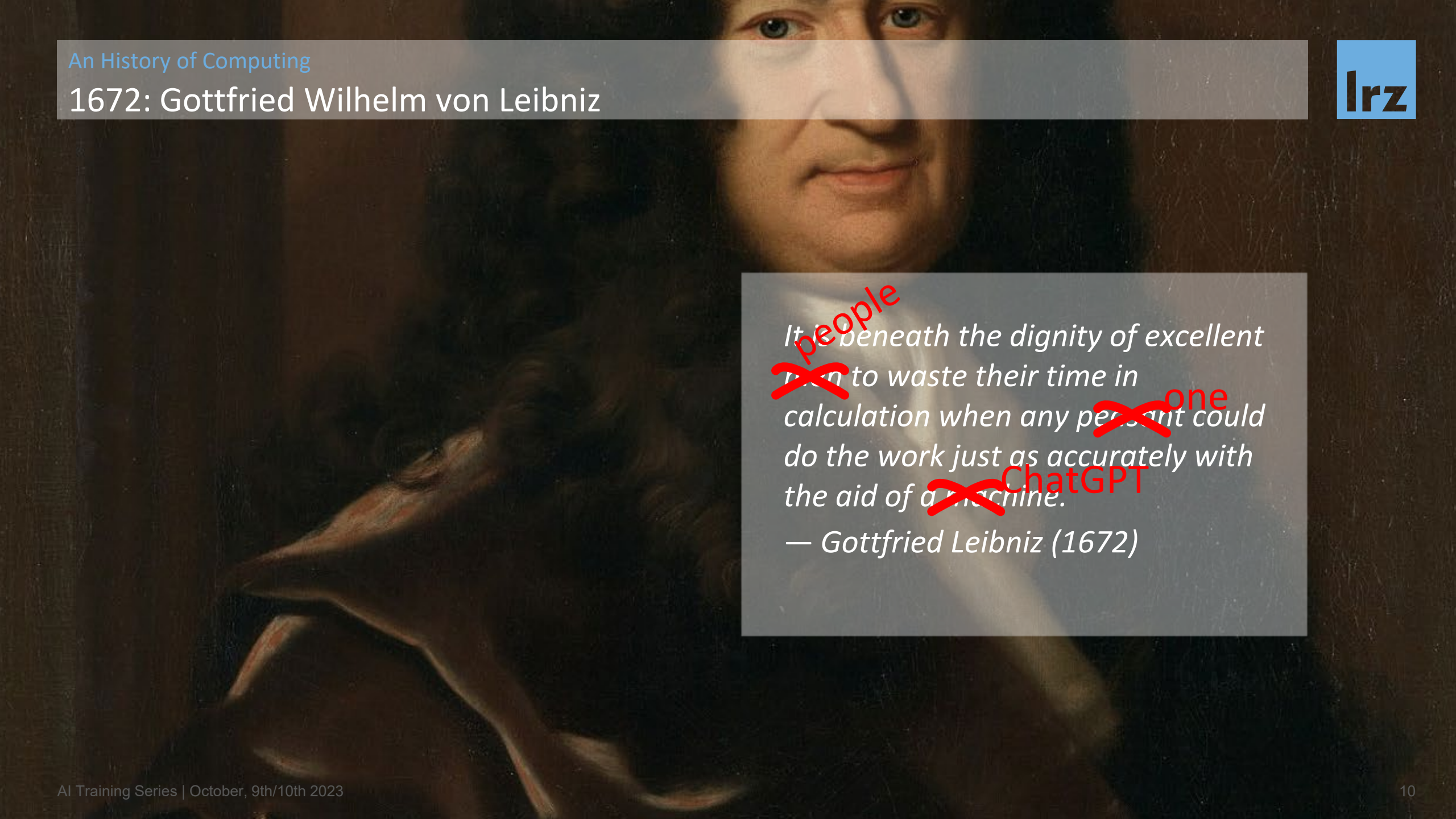
- User perspective: your work environment cont'd
- Workload management using Slurm
- Wrap-up, Q&A

# A Short History of Computing

# The Generations of Computing Devices



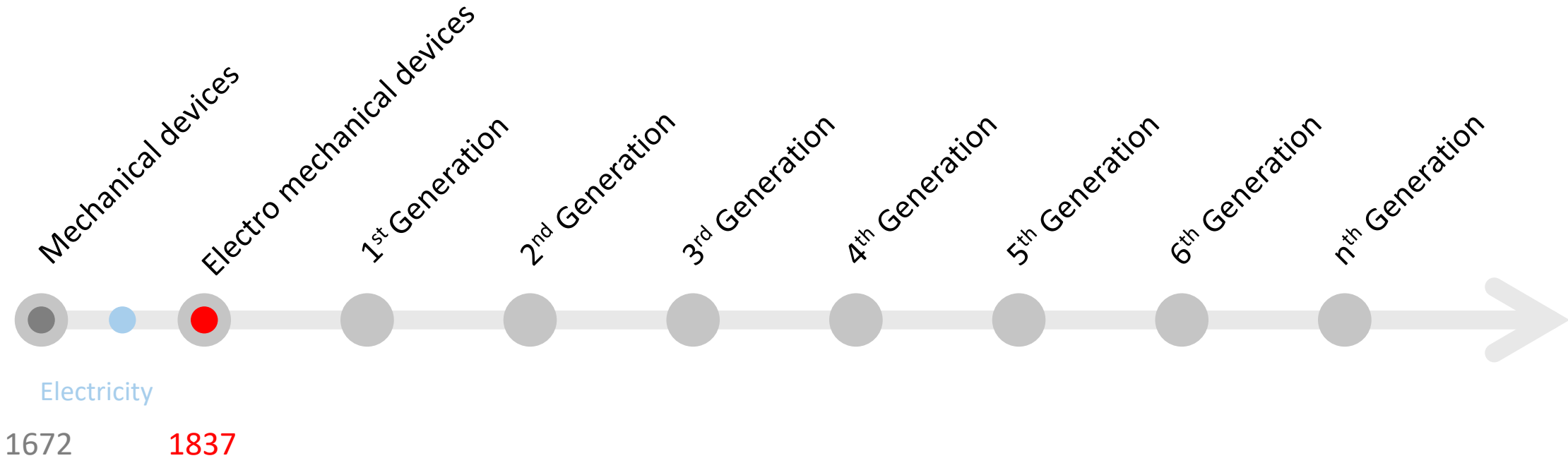
# 1672: Gottfried Wilhelm von Leibniz



*It is beneath the dignity of excellent ~~people~~ to waste their time in calculation when any ~~peasant~~ ~~one~~ could do the work just as accurately with the aid of a ~~machine~~ ChatGPT.*

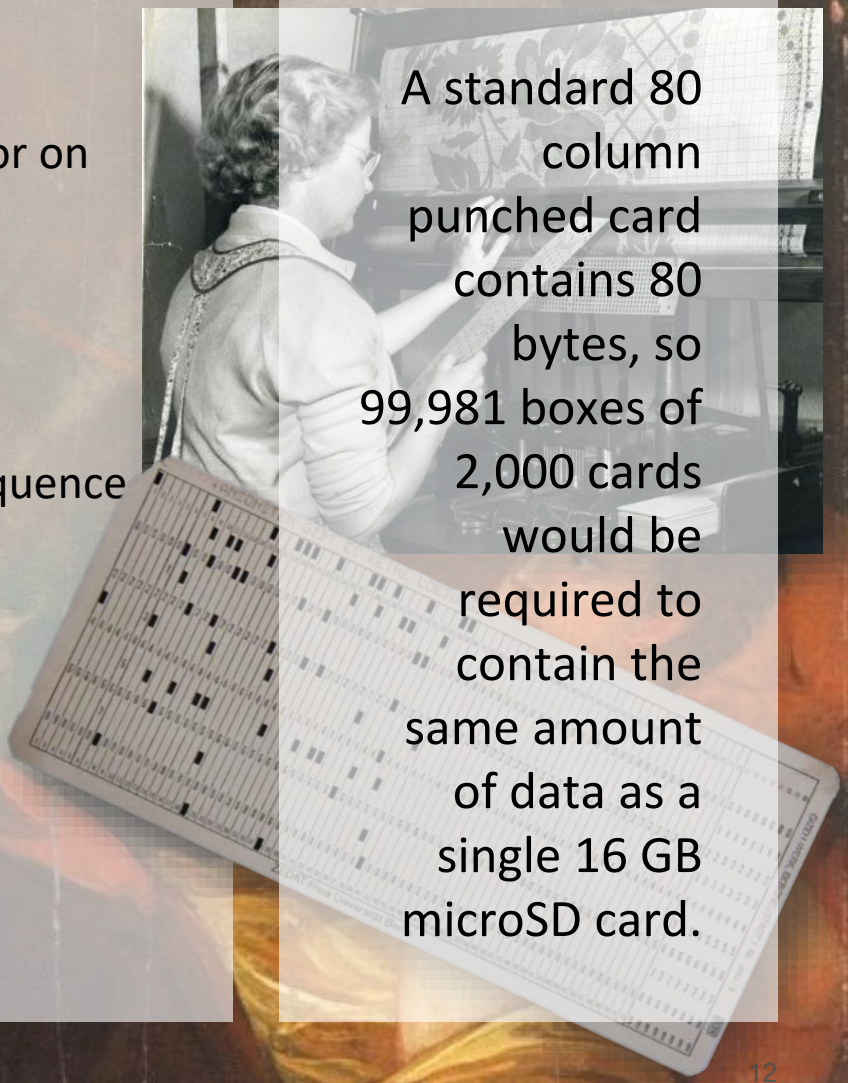
*— Gottfried Leibniz (1672)*

# The Generations of Computing Devices



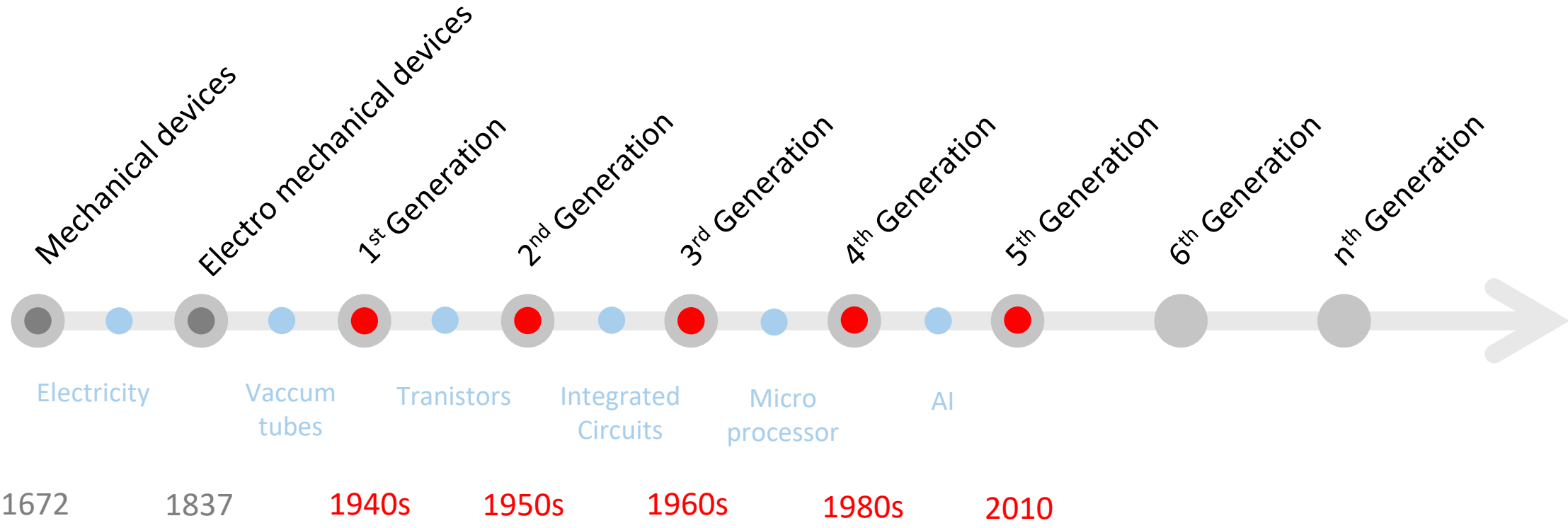
# From the Jacquard loom to Electro Mechanical Devices

- **1752: Benjamin Franklin and his kite “discover” electricity US**
  - Prove that lightnings are a electrical discharge that can charge a conductor on the ground
- **1804: The Jacquard Loom FR**
  - Was a mechanical loom for cloth weaving
  - First demonstrated by Joseph Marie Jacquard in 1801.
  - Any number of the cards could be chained together into a continuous sequence with each card corresponding to one row of the design
- **1837: Charles Babbage‘s Analytical Engine GB**
  - First general-purpose computing device
  - Electro mechanical Device
  - Ada Lovelace as the first programmer **GB**
- **Herman Hollerith: Punched card tabulating machine US**
  - Later became the “IBM Punchcards”

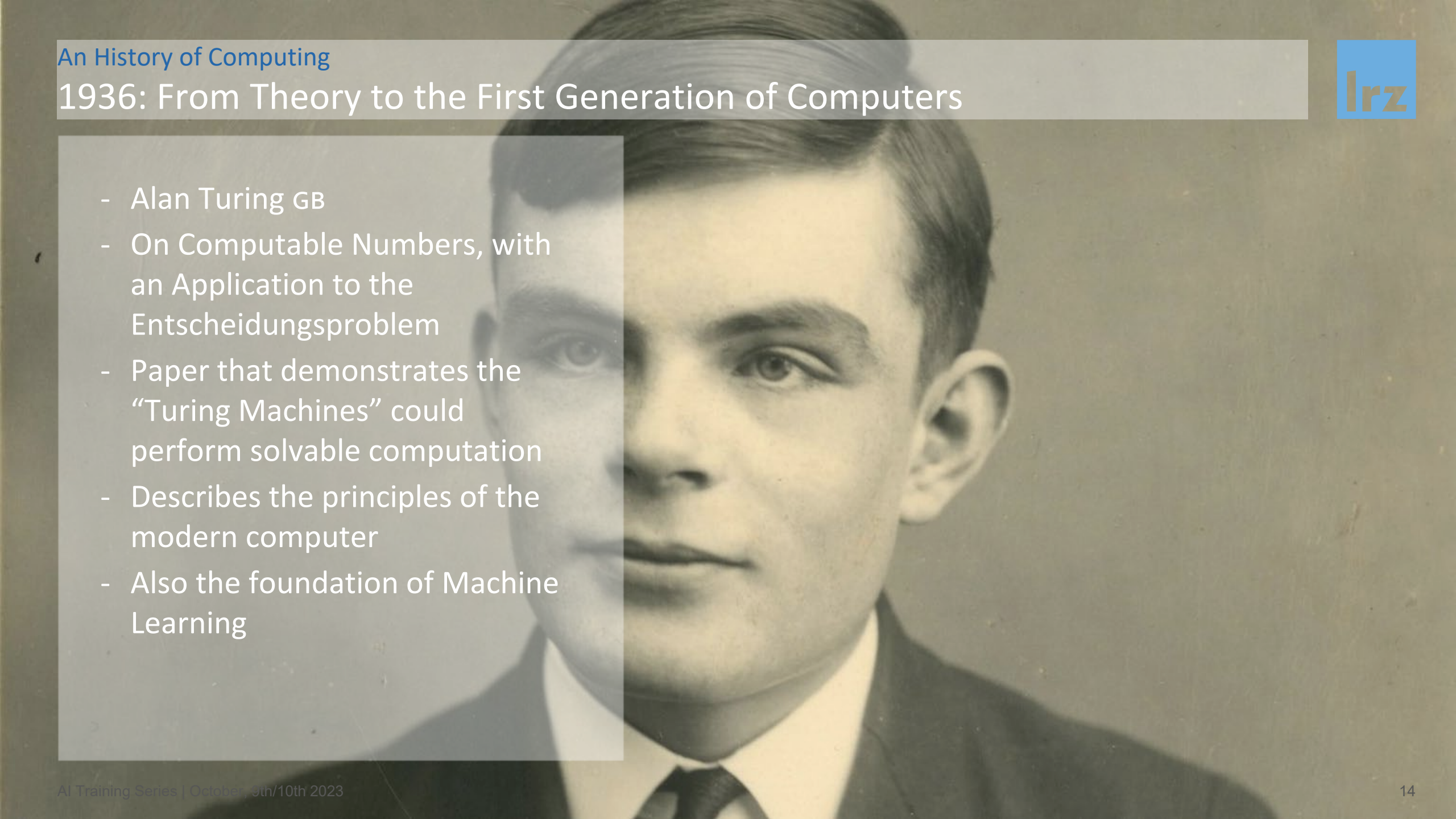


A standard 80 column punched card contains 80 bytes, so 99,981 boxes of 2,000 cards would be required to contain the same amount of data as a single 16 GB microSD card.

# The Generations of Computing Devices

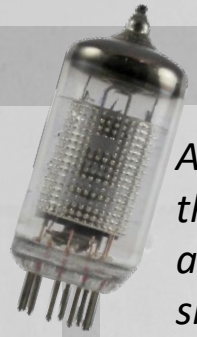


# 1936: From Theory to the First Generation of Computers



- Alan Turing GB
- On Computable Numbers, with an Application to the Entscheidungsproblem
- Paper that demonstrates the “Turing Machines” could perform solvable computation
- Describes the principles of the modern computer
- Also the foundation of Machine Learning

# 1940s-1950s: First Generation (Vaccum tubes)



- Used Vacuum tubes made of glass
  - Control flow of electricity between two electrodes: 0 || 1
  - Slow, unreliable, produced a lot of heat: Often would burn and would need to be replaced
- Heavy computers take up a full room
- Used for calculation, storage, and control purposes
- Main memory: Magnetic tapes and magnetic drums, IBM 650 would provide 4KB of storage
- No OS, no real programming language (machine code)
- Example of machines:  EDVAC, UNIVAC 1101, and IBM 650.

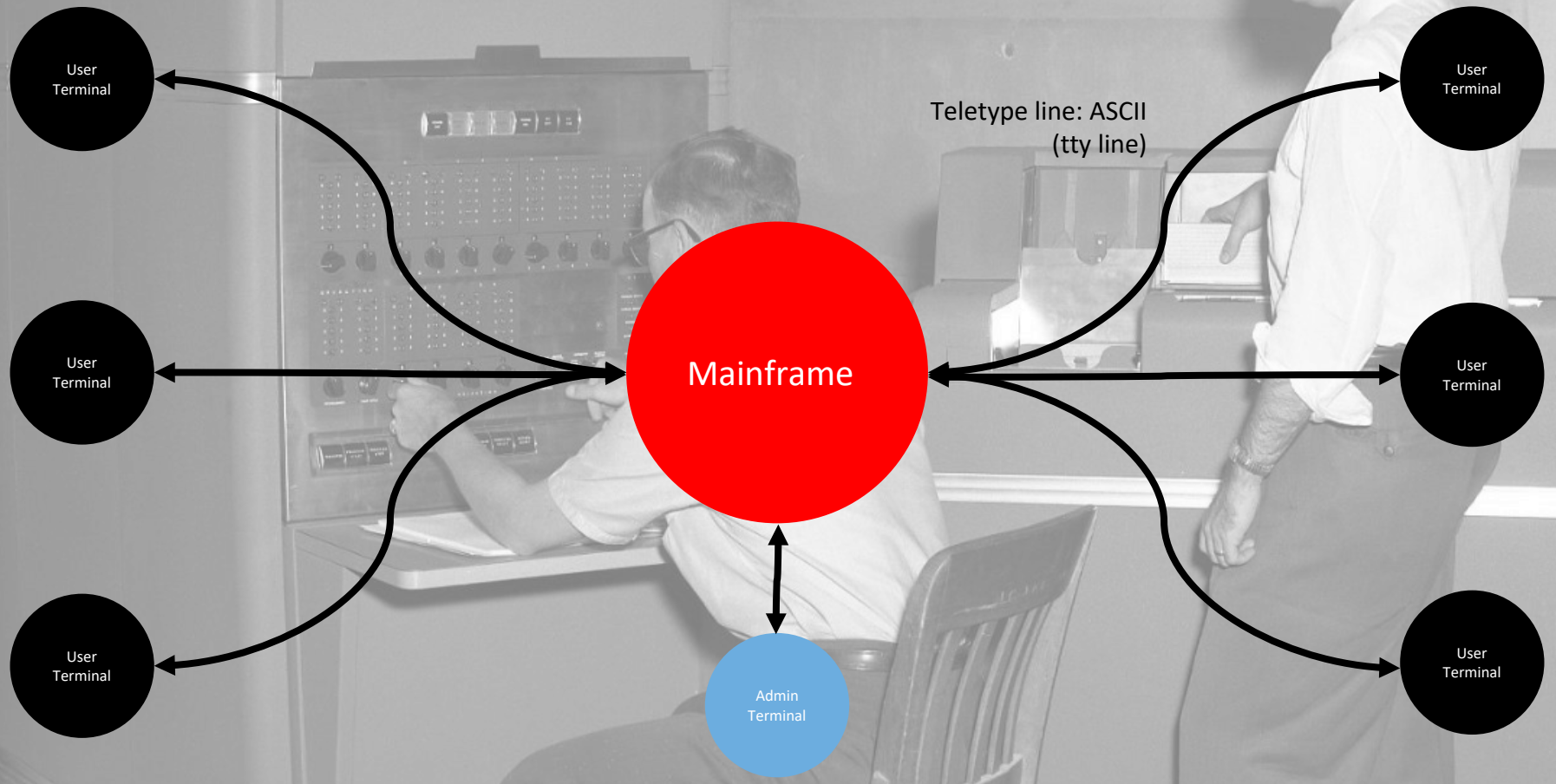
*A mainframe is a large computer system that is usually used for multi-user applications. It is so expensive it needs to be shared:*

- time sharing
- space sharing
- batch processing
- …

… all of which are still relevant.

*Until the mid-to-late 1950s, the word "computer" referred to people who performed computations, not to machines.*

# 1940s-1950s: First Generation, the centralized model



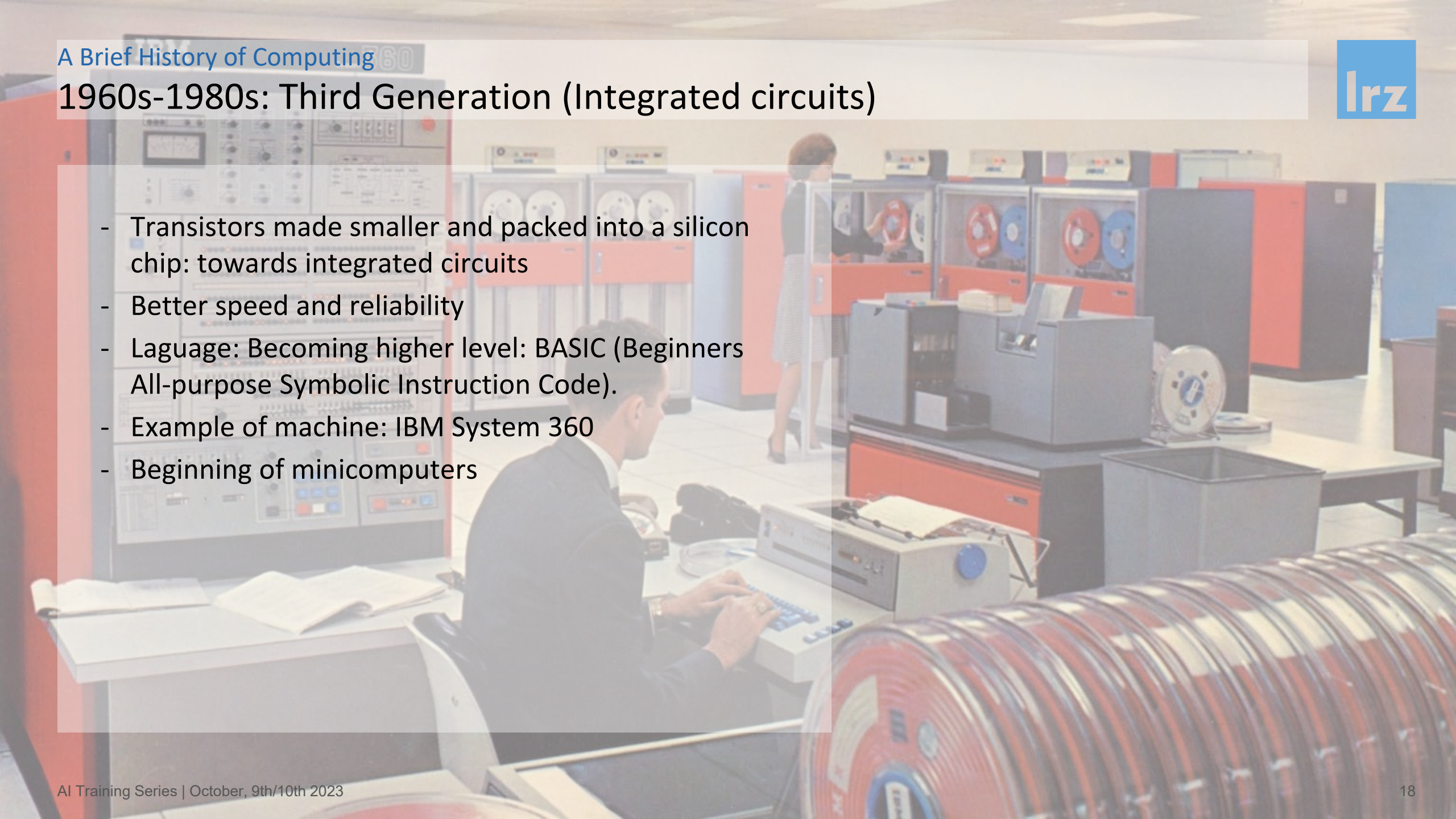
# 1950s-1960s: Second Generation (Tranistor)

- Use transistors instead of vacuum tubes
  - More reliable, smaller, and allow faster clock speeds
  - Transistors shaped the computer revolution and digital age: logical operations are performed by semi conductor devices
- Machine can store up to 2MB of data and run at 1 MHz
- Emergence of OS and multi-user support
- Basic networking capabilities
- Emergence of high-level programming language: FORTRAN (1956), ALGOL (1958), and COBOL (1959).
- Example of machine: IBM1400 series

*The very first transistor — the foundational building block which almost all of modern civilization was built from — was created at AT&T's Bell Labs on December 23, 1947.*

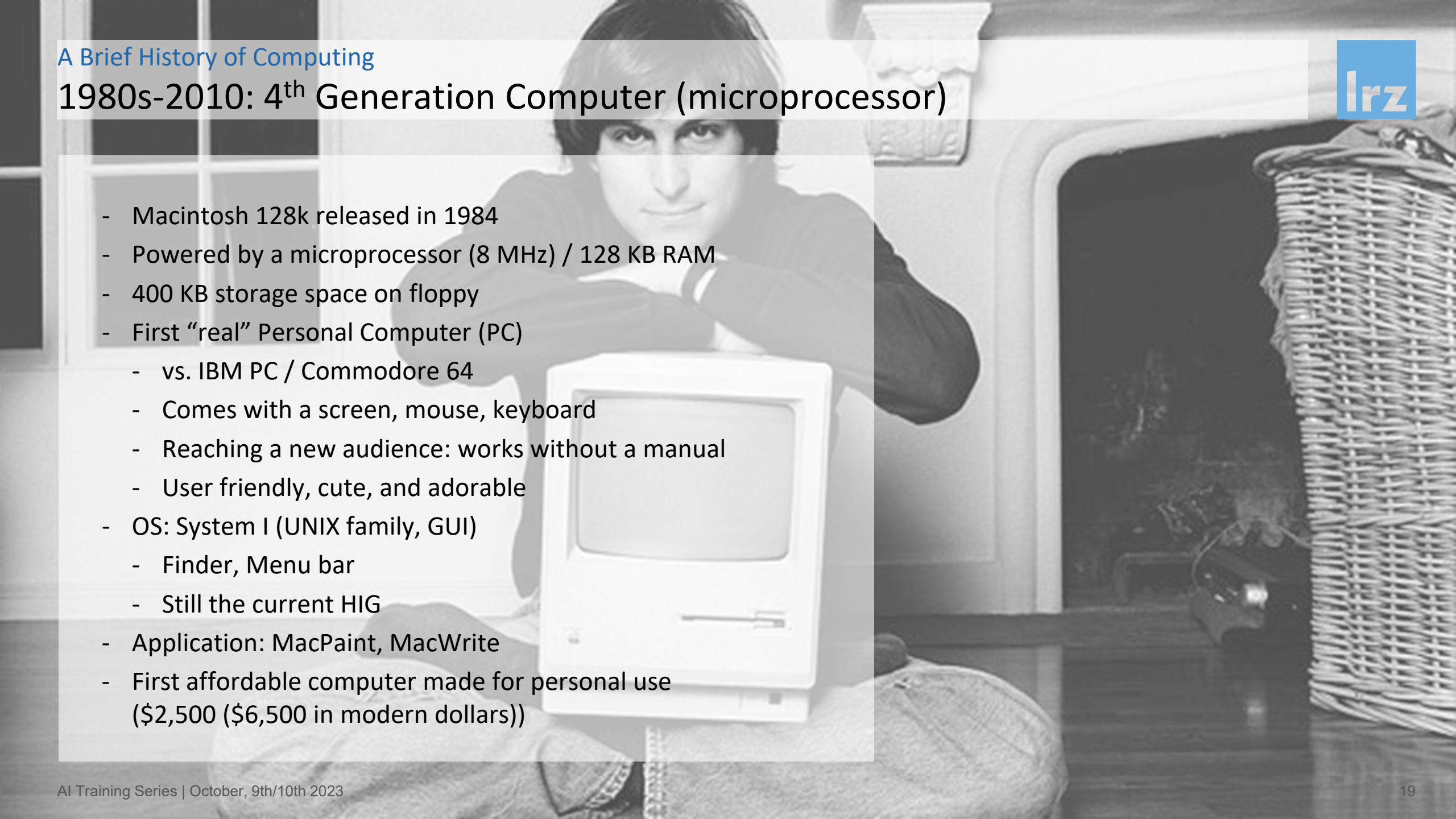
A transistor is a semi conductor that uses an electric current to control the flow of electrons. It amplifies or switches electrical signals by enabling or preventing the flow of current. Multiple transistors combined form logic gates, arithmetic circuits, memories etc.

# 1960s-1980s: Third Generation (Integrated circuits)



- Transistors made smaller and packed into a silicon chip: towards integrated circuits
- Better speed and reliability
- Laguage: Becoming higher level: BASIC (Beginners All-purpose Symbolic Instruction Code).
- Example of machine: IBM System 360
- Beginning of minicomputers

# 1980s-2010: 4th Generation Computer (microprocessor)

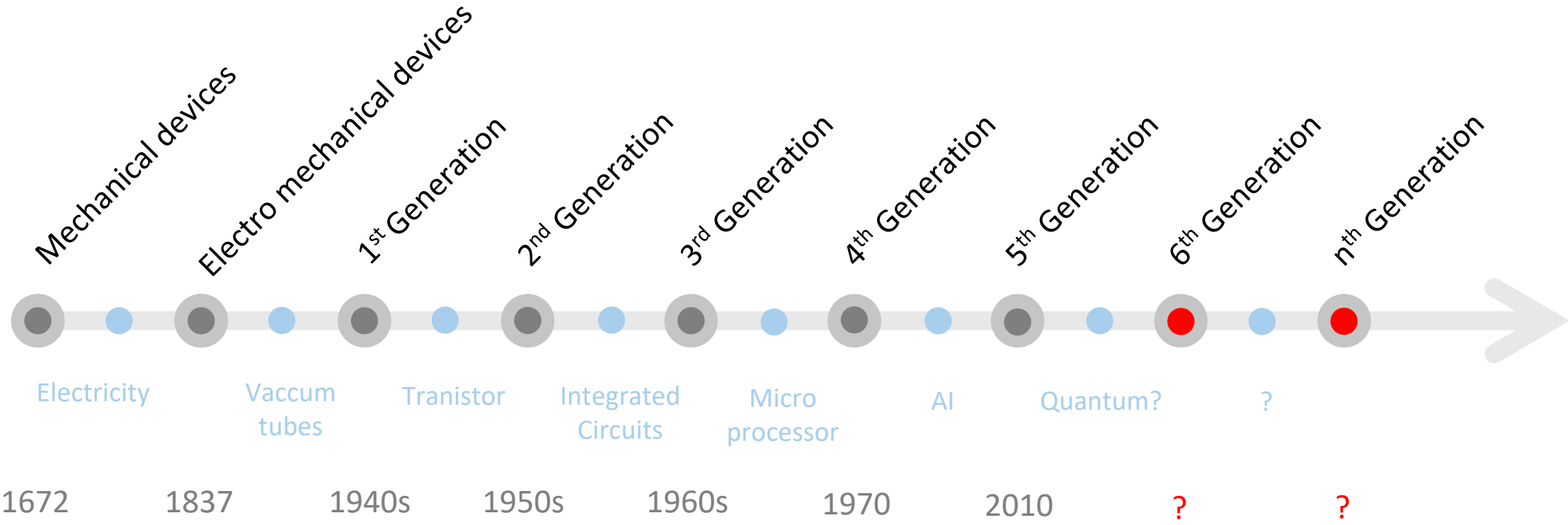


- Macintosh 128k released in 1984
- Powered by a microprocessor (8 MHz) / 128 KB RAM
- 400 KB storage space on floppy
- First “real” Personal Computer (PC)
  - vs. IBM PC / Commodore 64
  - Comes with a screen, mouse, keyboard
  - Reaching a new audience: works without a manual
  - User friendly, cute, and adorable
- OS: System I (UNIX family, GUI)
  - Finder, Menu bar
  - Still the current HIG
- Application: MacPaint, MacWrite
- First affordable computer made for personal use ($2,500 ($6,500 in modern dollars))

# 2010s – now: 5th Generation computer

- Key technologies include mobile devices (smartphones, tablets), cloud computing, social networks, high-speed wireless networks, IPv6 networking protocol, touchscreens, solid state storage, virtual/augmented reality, artificial intelligence
- Human like interaction and behaviour
  - Voice recognition
  - Computer vision
- Programming language: Very high level programming, natural language
- Come in pocket size / wearables / cloud only
- Digital twins, NVIDIA Omniverse, Metaverse

# The Generations of Computing Devices



# Multiuser clusters…

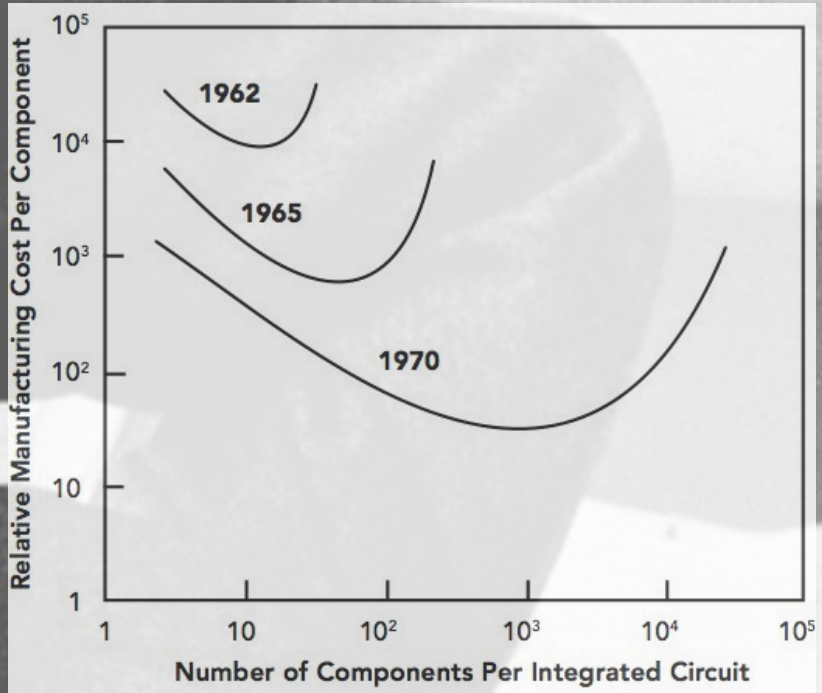
- … Haven’t always been multiuser
- … They are big and expensive: They need to be shared to cost-effectively serve a large number of concurrent users.
- … They are meant to be used remotely
- … System administrators take care of the system for the users
- … can achieve much higher performance than individual systems by aggregating resources
- … They provide fault tolerance through redundancy. If parts of the cluster fail, the rest of the cluster can typically continue operating
- … Common architectures include…
  - … Server clusters: Multiple interconnected servers with shared storage and networking. Used for high availability and scalability.
  - … High-performance computing clusters: Powerful servers with fast interconnects, used for running highly parallel workloads.
  - … Cloud computing clusters: Massive clusters that run cloud platforms and services, accessed by many users over wide-area networks.
  - … Edge clusters: Clusters deployed at the edge (near users/devices) to support localized computing, storage and networking needs.

# Moore’s Law

# Moore's Law

*The number of transistors on integrated circuits is doubling about every ~~18 months~~ 2 years.*

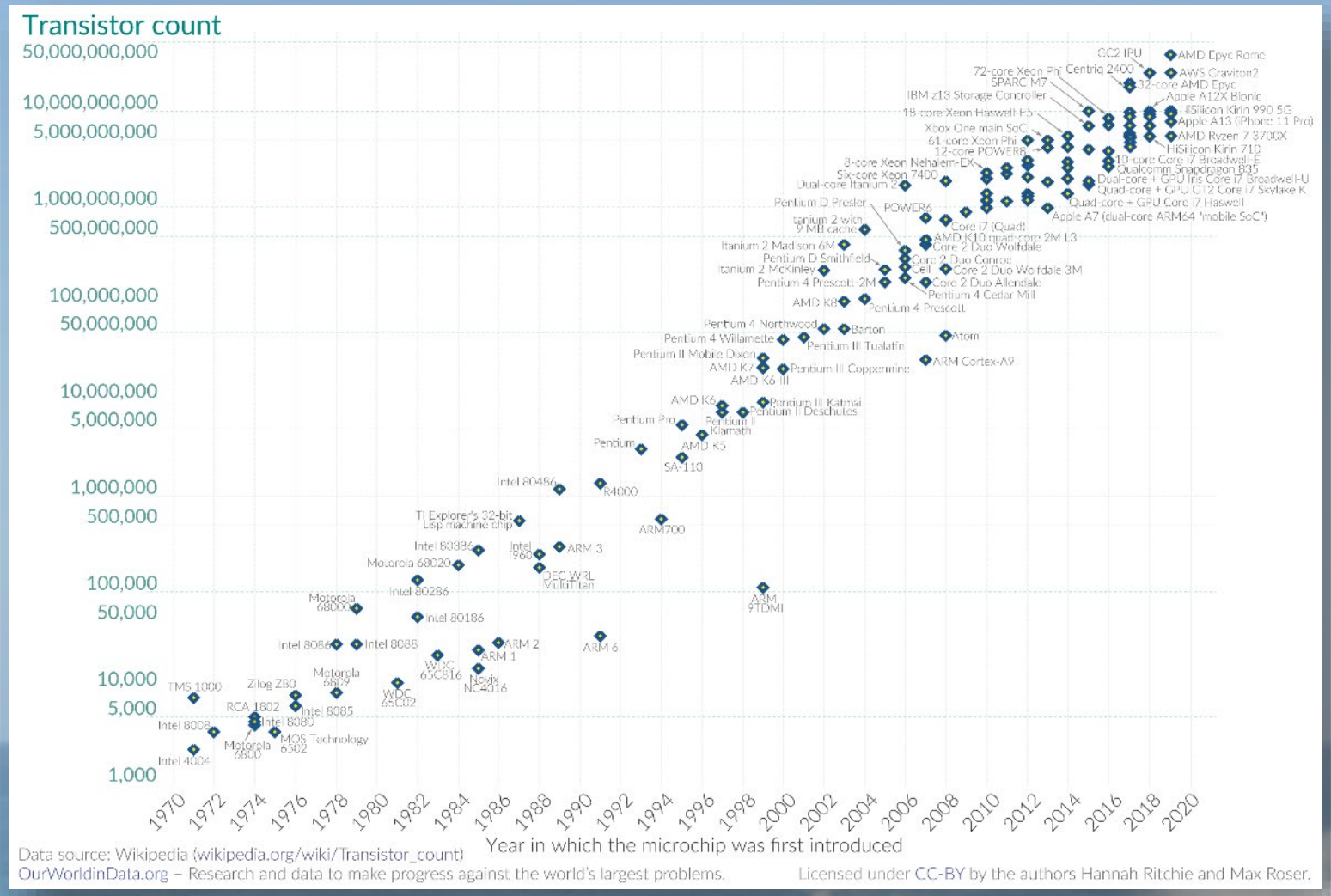
*— Gordon Moore, 1965*




Gordon Moore's curves on this plot show that development of the chemical printing technology makes more complex microchips the cheapest form of electronics.

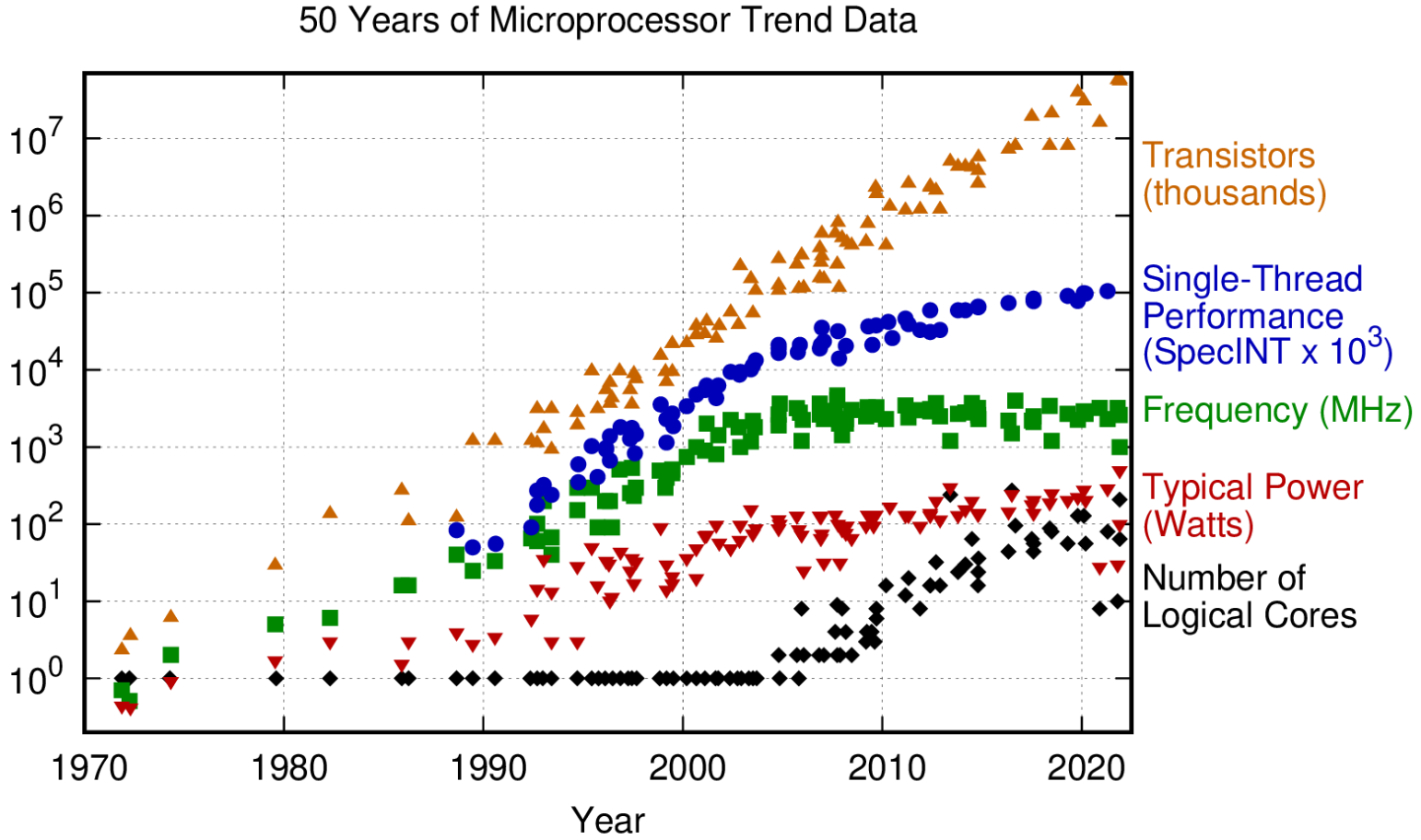
*Source:* Gordon Moore.

# Is Moore's Law dead?



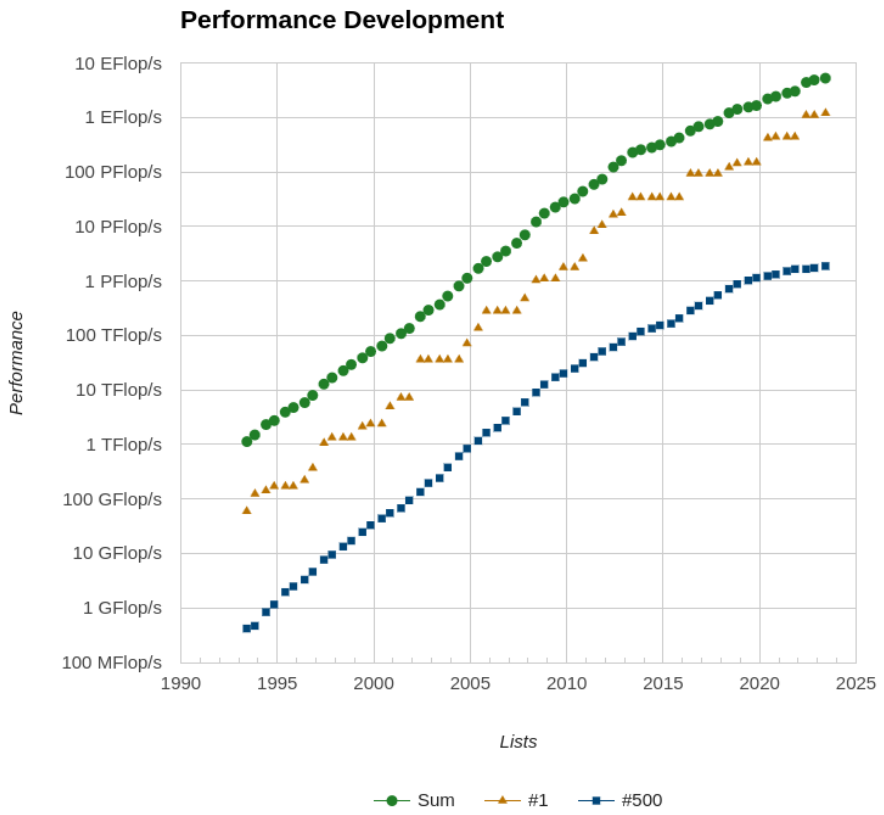

Data source: Wikipedia (wikipedia.org/wiki/Transistor_count)
OurWorldinData.org – Research and data to make progress against the world's largest problems.

# Is Moore's Law dead?

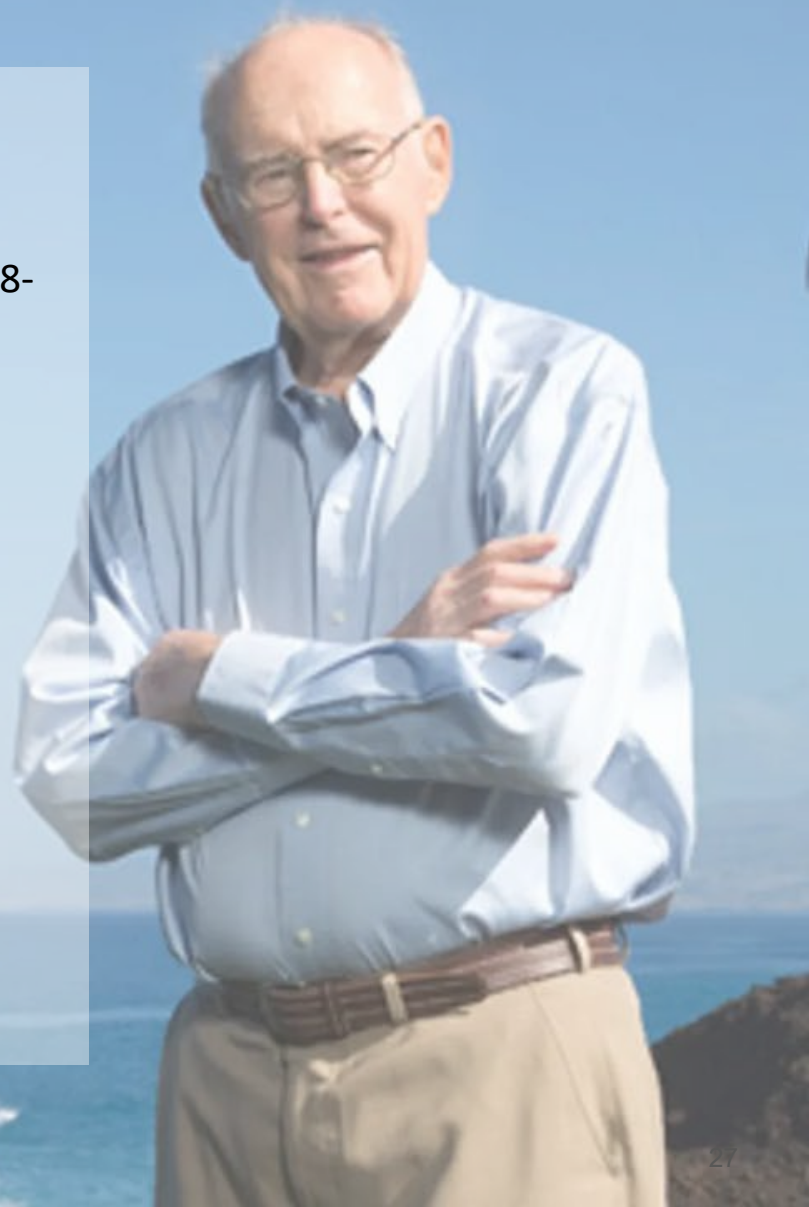



- **Mid 2000s: "heat death"**
- **No more faster processors, only more of them.**
- **But: 2x3 GHz != 6 GHz**

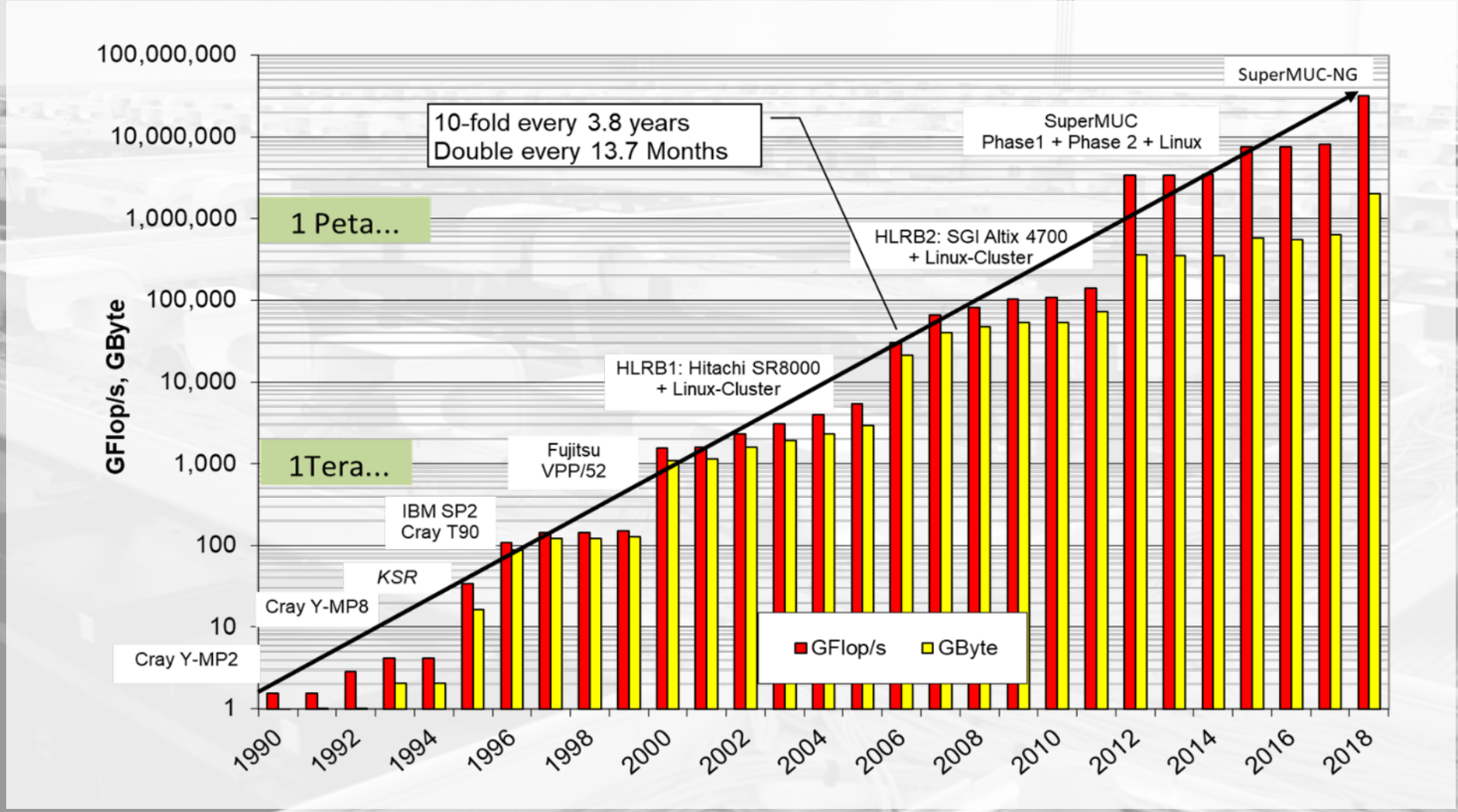
# Is Moore's Law dead?




- **From #1 to #500:** 6-8 years
- **From #500 to Notebook:** 8-10 years



# Evolution of Peak Performance and Memory



# What is a Supercomputer or High-Performance Cluster… (Not)?

| | |
|---|---|
| It runs Microsoft Windows? | 😌 No, no worries |
| It will run my Excel spreadsheet? | 😉 No! |
| It has overclocked high-speed processors? | 😯 No |
| The CPU runs faster than a desktop PC? | 😮‍💨 Not even |
| It has a large internal memory (RAM)? | 😱 Usually not (except exceptions) |
| It will run my old tried and tested executable? | 😔 Probably not |
| It will run my software without changes? | 😵 Probably not |
| It will run my program with millions of threads? | 😢 Probably not |
| It can be used interactively? | 😬 Probably not |
| It has shiny RGB lights? | ✨ |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