ELCN100
Electronic Lab.
Instruments and Measurements
Spring 2020

Lecture 01: Introduction

Dr. Hassan Mostafa

د. حسن مصطفى

hmostafa@uwaterloo.ca

Course Outline

- Course objectives
  - To introduce to students the theory and applications of measurement and instrumentation systems for electrical, electronics and computer engineering.

Course contents

- 1. Oscilloscopes
- 2. Measurements Errors
- 3. Digital Multi-meter
- 4. Frequency Meter
- 5. Logic Analyzer
- 6. Spectrum Analyzer

Course Outline

- Instructor: Dr. Hassan Mostafa
  - hmostafa@uwaterloo.ca
- Course website:
  - http://scholar.cu.edu.eg/hmostafa/classes/elcn100
- Textbook:
  - *Lecture Notes and slides*
- References
  - [1] Larry D. Jones / A. Foster Chin, “Electronic Instruments and Measurements“, Second Edition, Prentice Hall.
  - [2] David A. Bell, "Electronic Instrumentation and Measurements", Prentice-Hall.

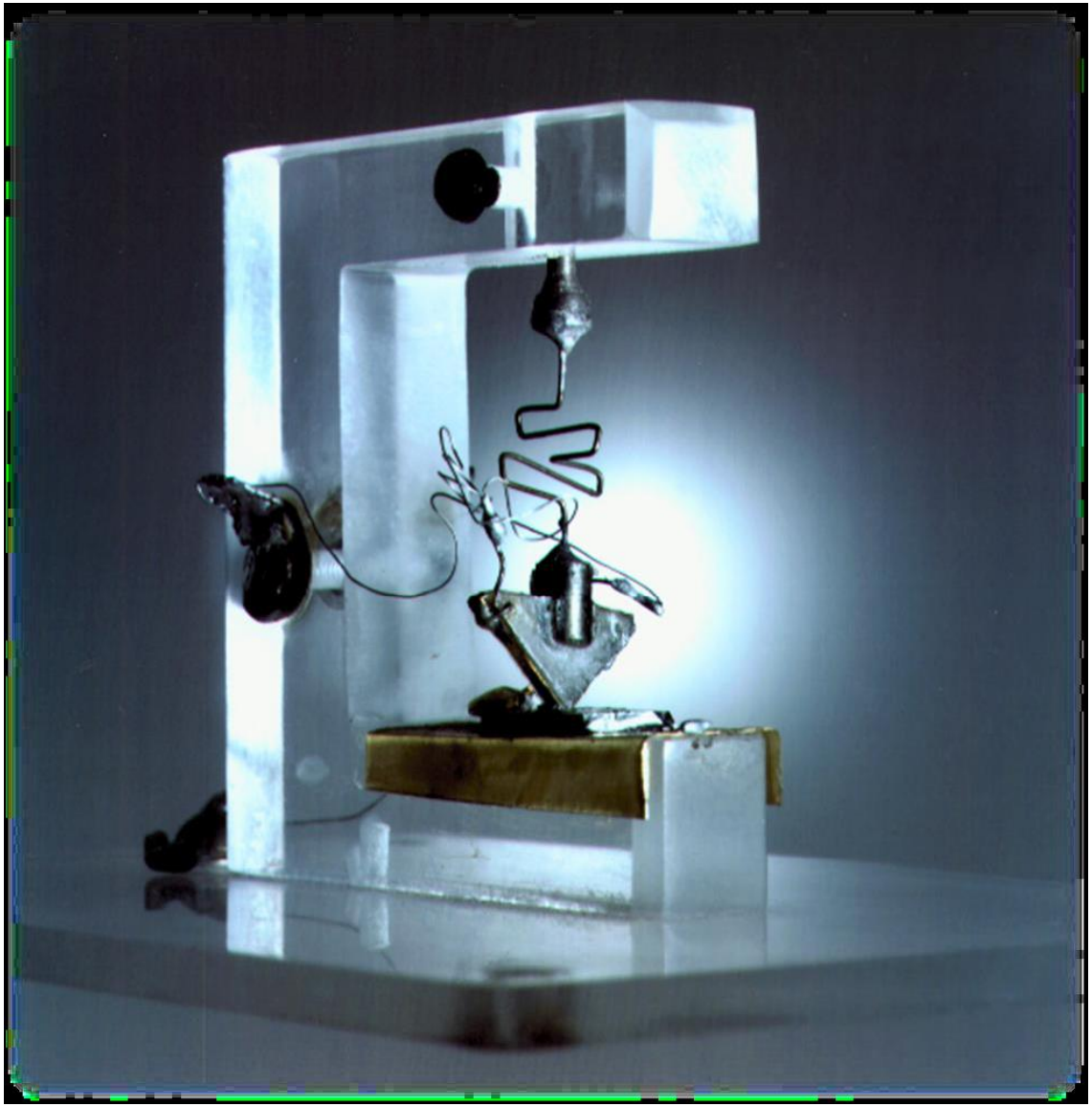
Course Outline

- Grading:
  - 10% Quizzes (pop-up and arranged)
  - 10% Course Project (Video)
  - 20% Lab with lab exam.
  - 20% Midterm Examination
    - (MCQ, T/F, Short answers, and Problems)
  - 40% Final Examination
    - (MCQ , T/F, Short answers, and Problems)

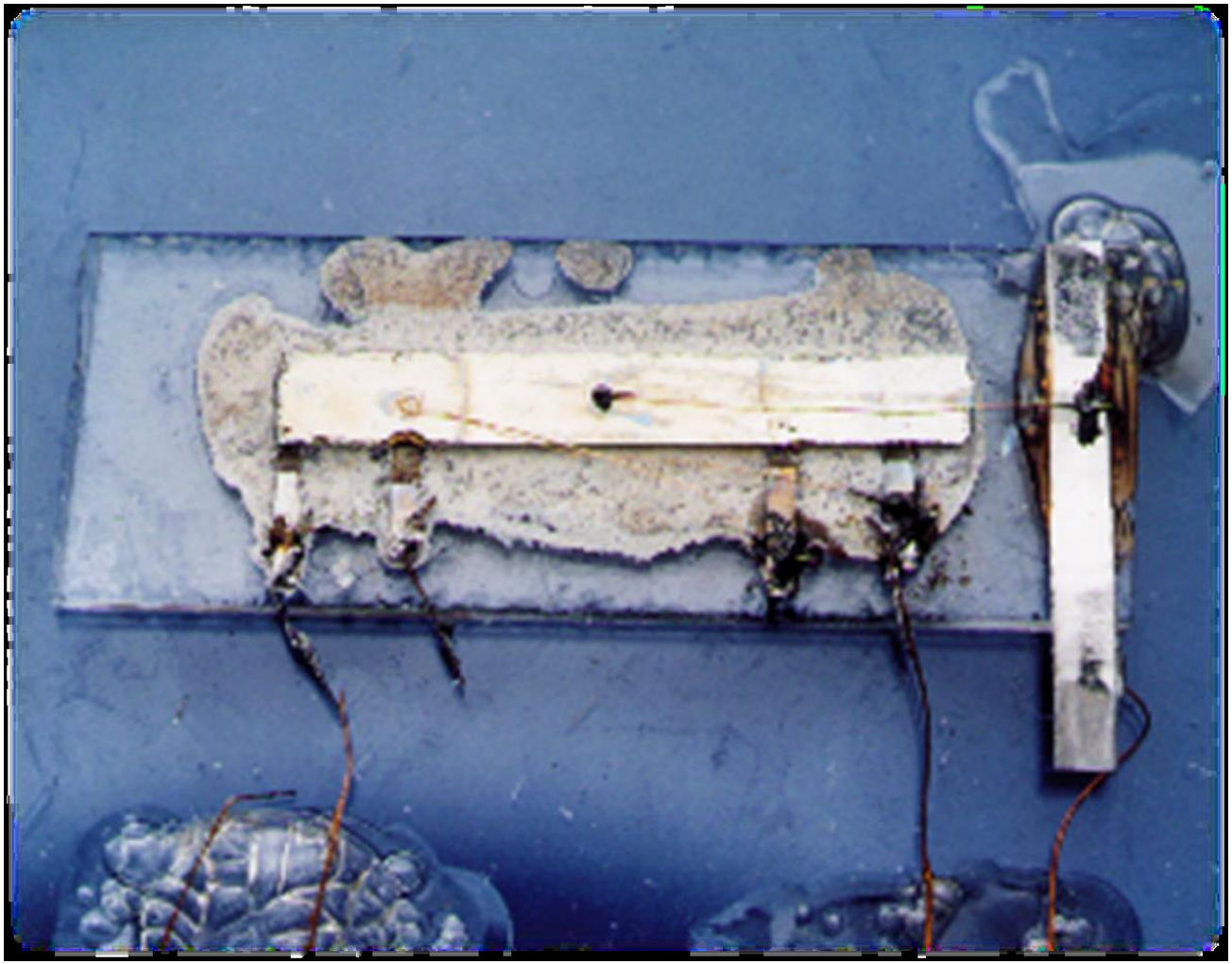
Information age

- The ability to fabricate billions of individual components (transistors, resistors, capacitors, etc.) on a silicon chip with an area of a few cm^2 has enabled the information age.
- Shrinking geometries permit more devices to be placed in a given are of silicon.
- It is widely expected that these historical trends will continue for at least another 5-10 years, resulting in Chips that contain tens of billions of components.

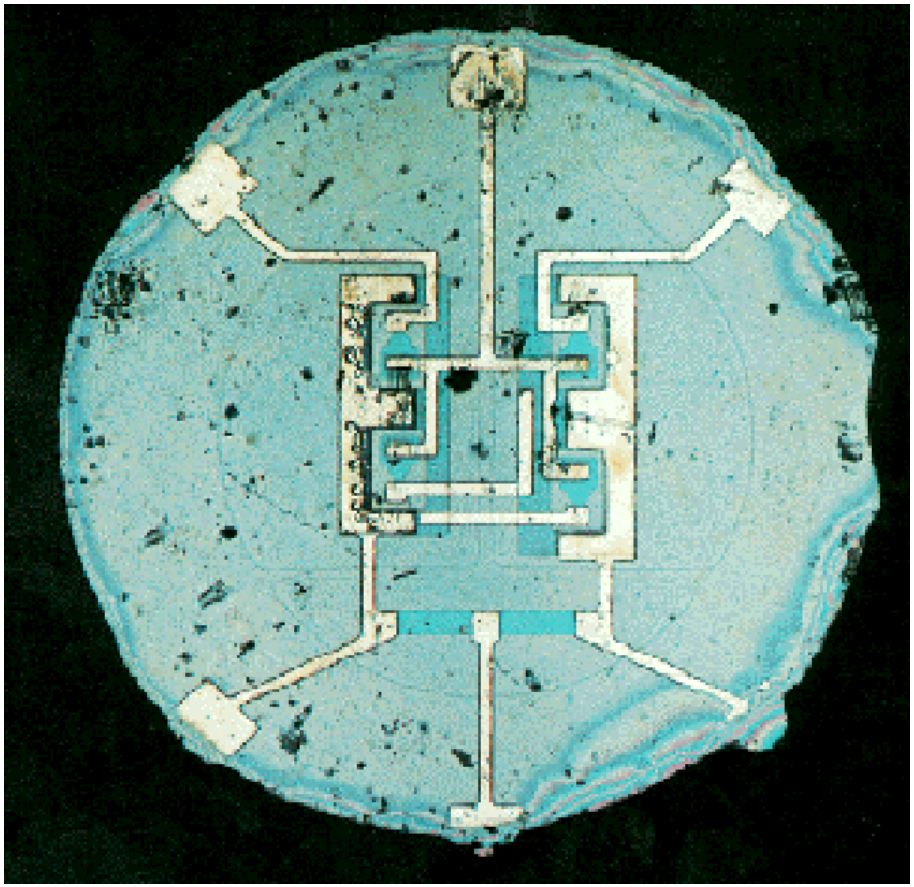
First Transistor from Bell Labs (1947)



Kilby first IC (1958)



First monolithic integrated circuit



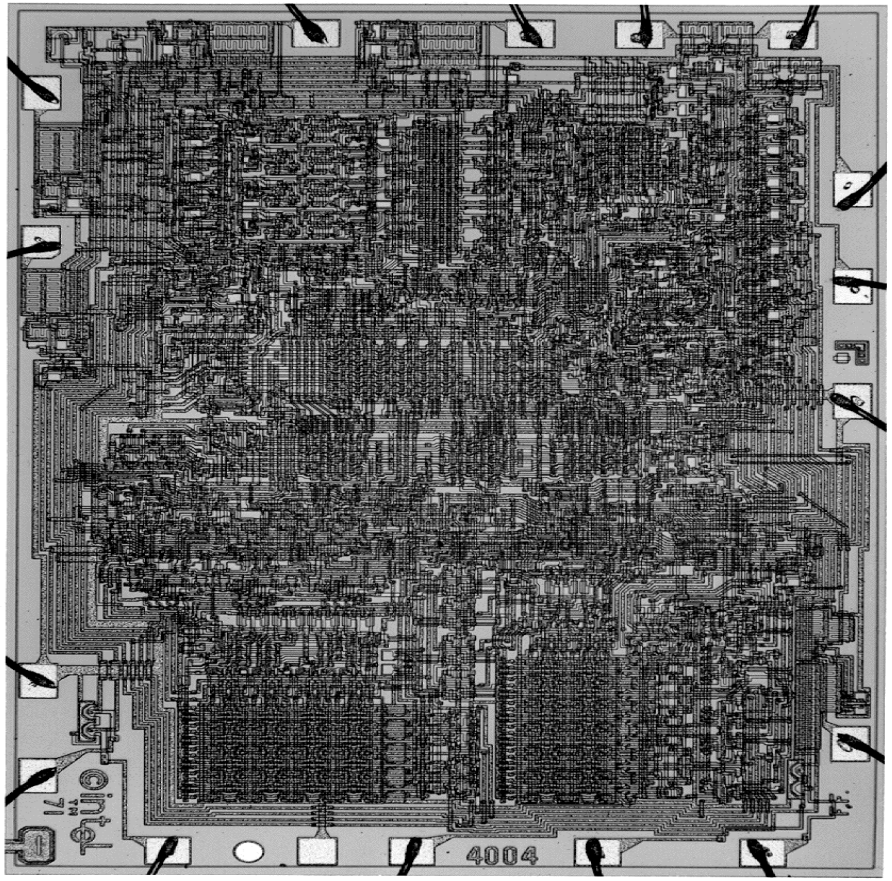
1961

Picture shows a flip-flop circuit containing 6 devices, produced in planar technology.

Source:

R. N. Neyce, “Semiconductor device-and-lead structure”, U.S.Patent 2,981,877

first microprocessor



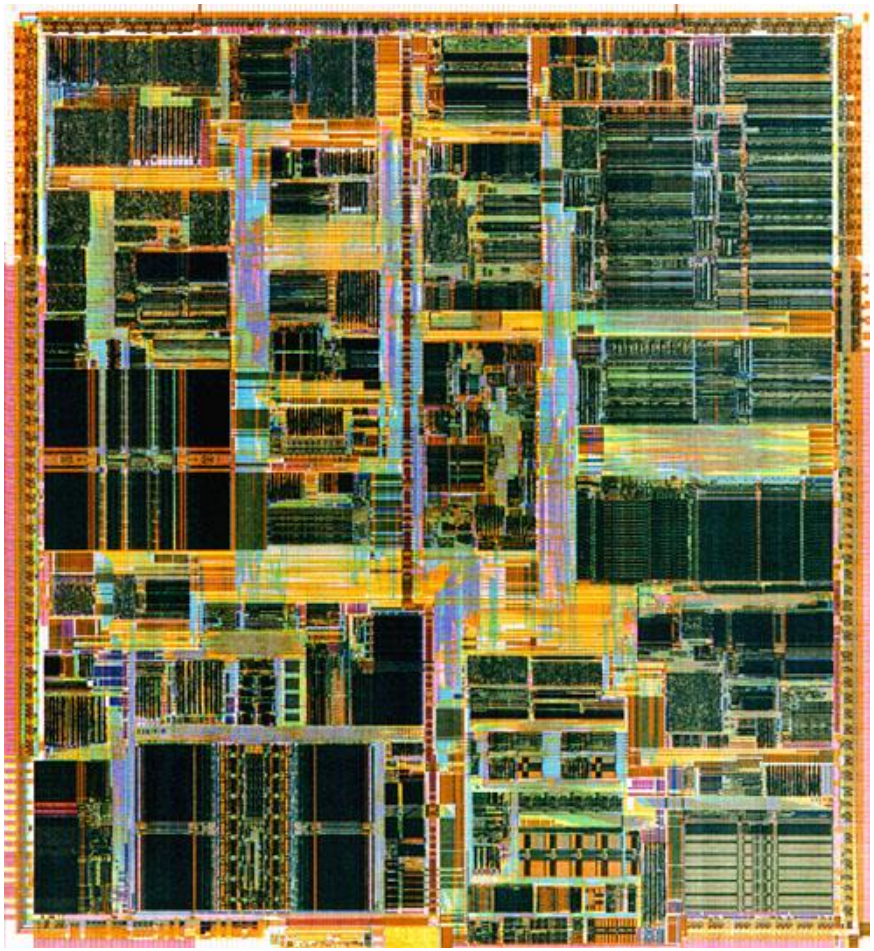
1971

Picture shows a four-bit microprocessor *Intel 4004*.

- 10 µm technology
- 3 mm × 4 mm
- 2300 MOS-FETs
- 108 kHz clock frequency

Source:
Intel Corporation

Pentium IV processor

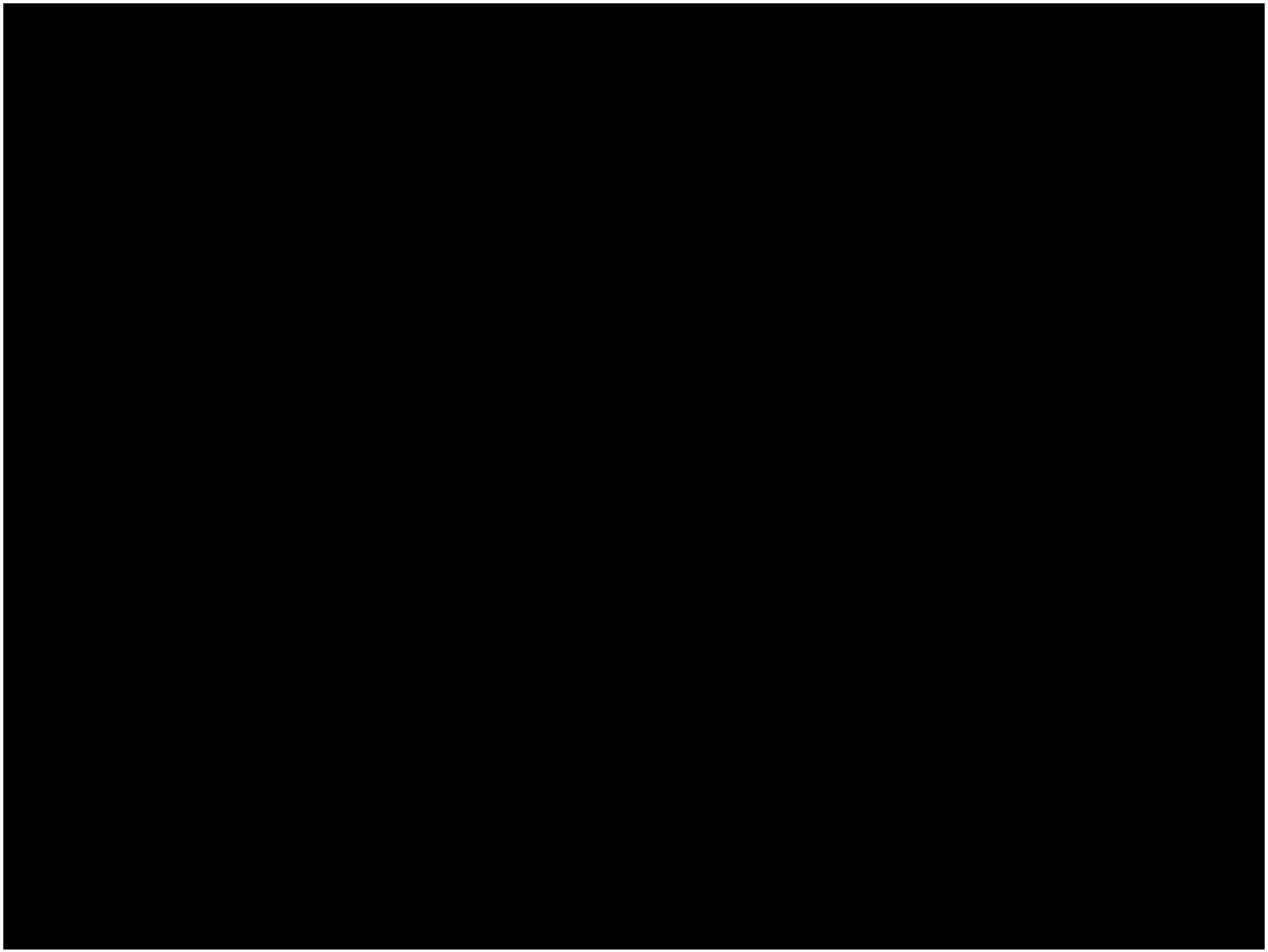


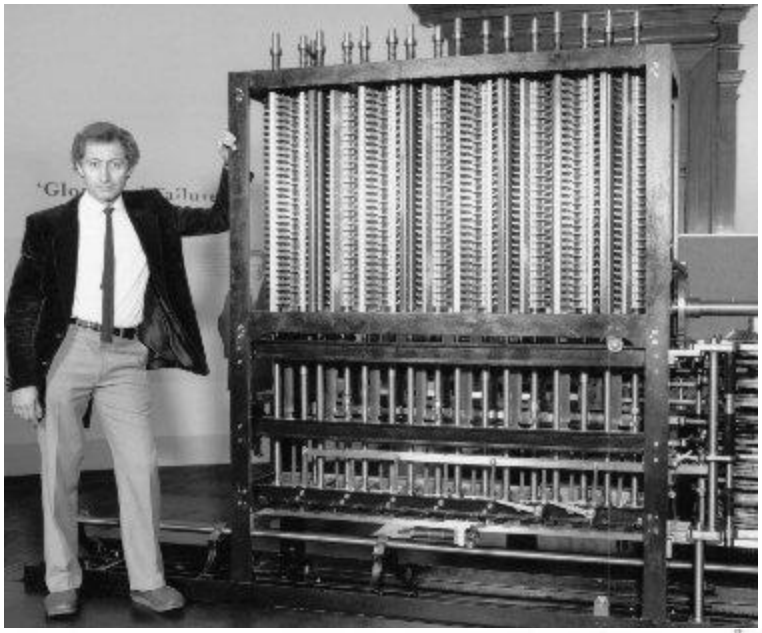
2001

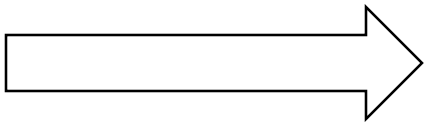
Picture shows a ULSI chip with 32-bit processor *Intel Pentium 4*.

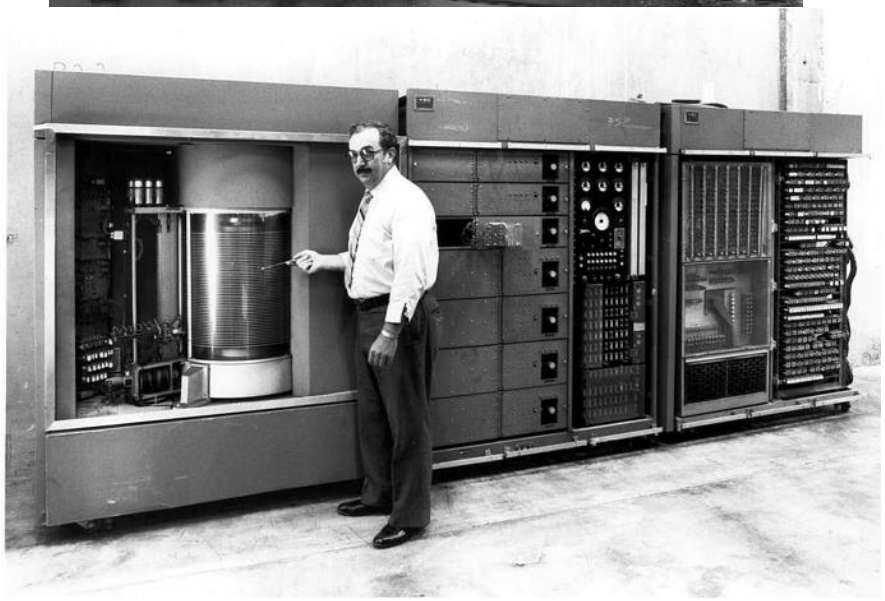
- 0.18μm CMOS technology
- 17.5 mm × 19 mm
- 42 000 000 components
- 1.6 GHz clock freuqncy

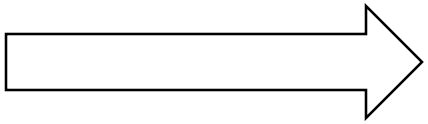
Source:
Intel Corporation

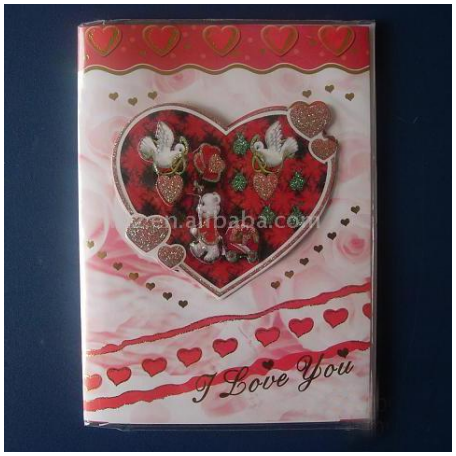






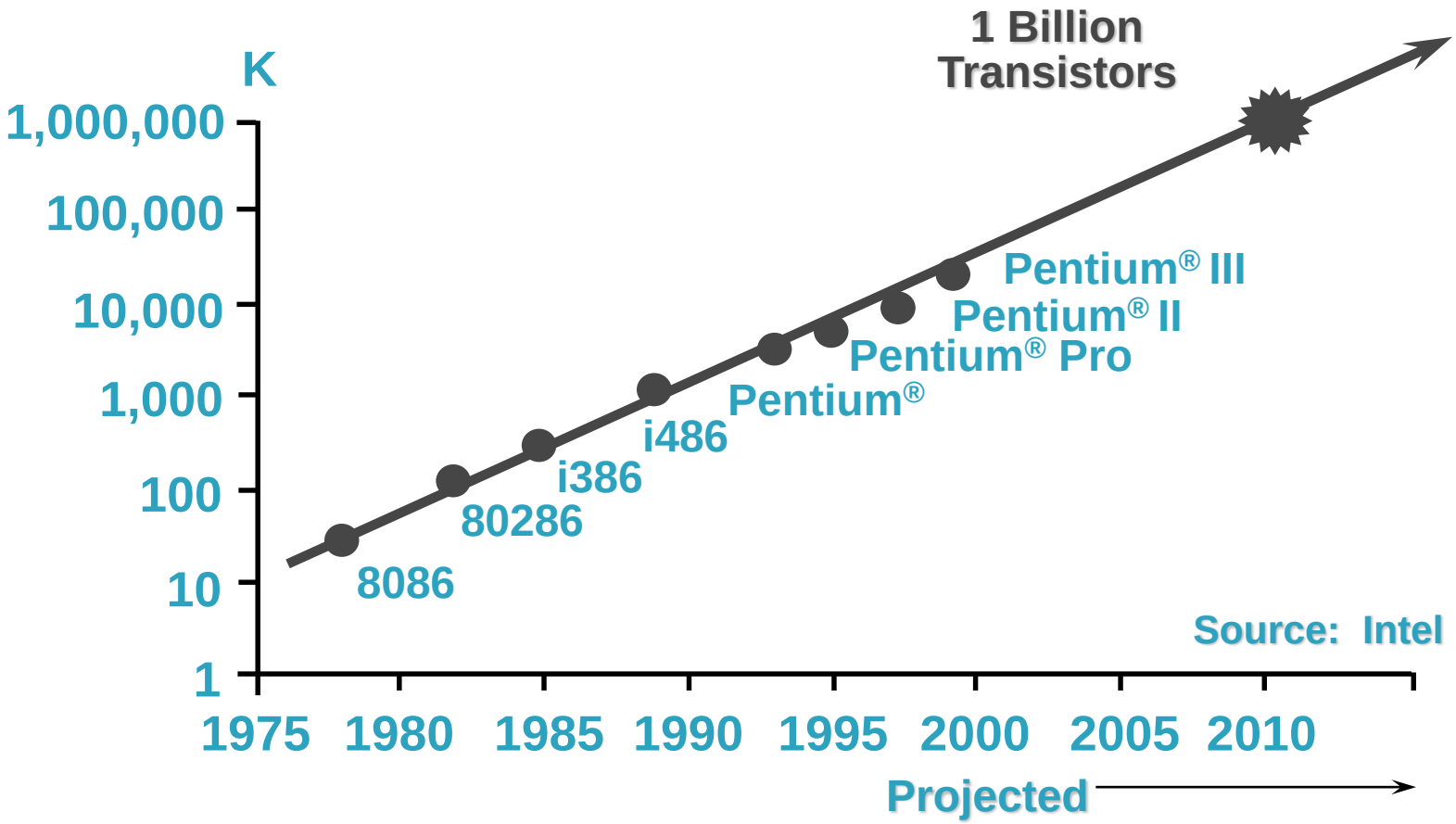





I Love You

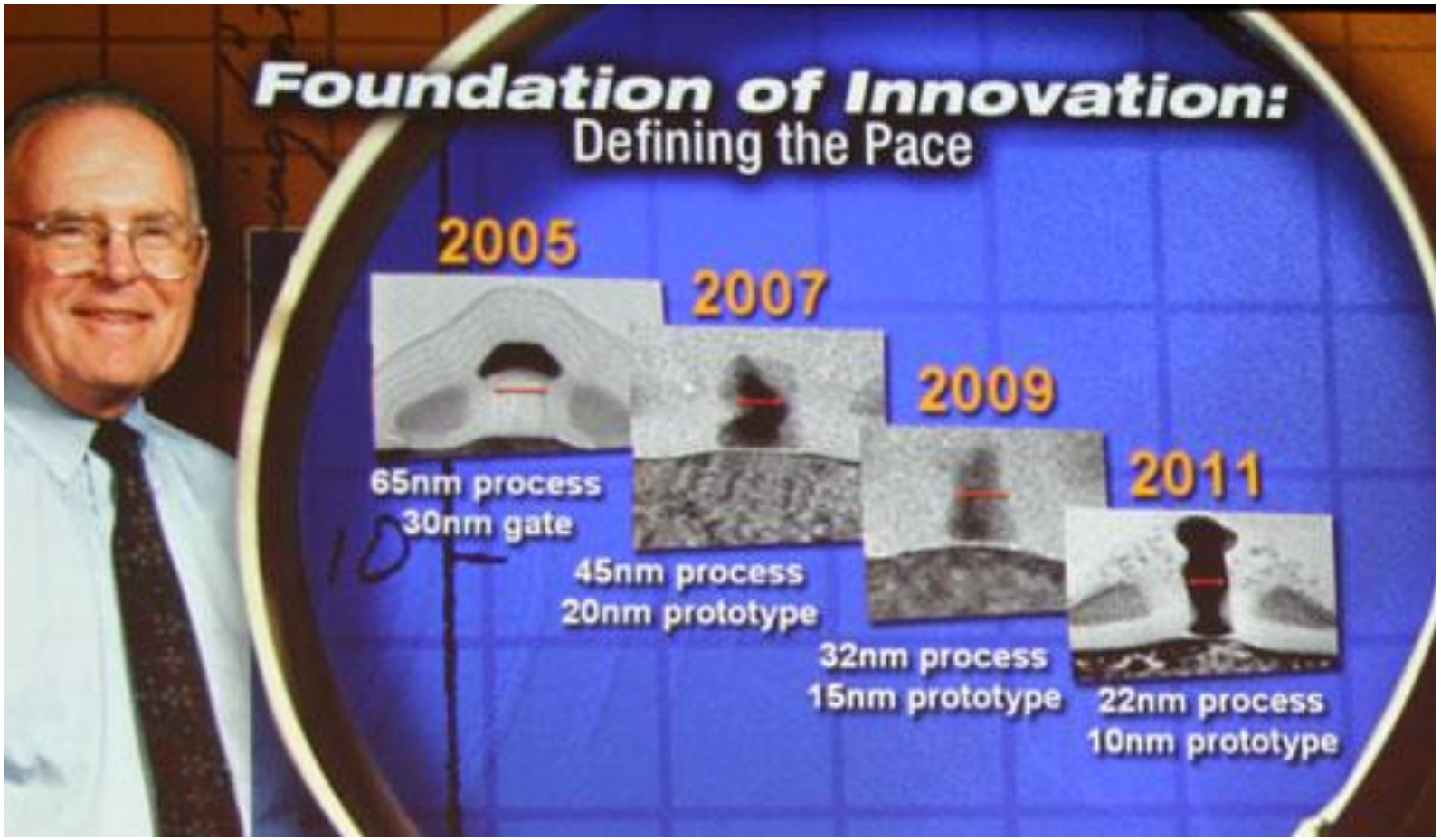
Moore's Law in Microprocessors

Transistors on microprocessors double every 2 years



Courtesy, Intel

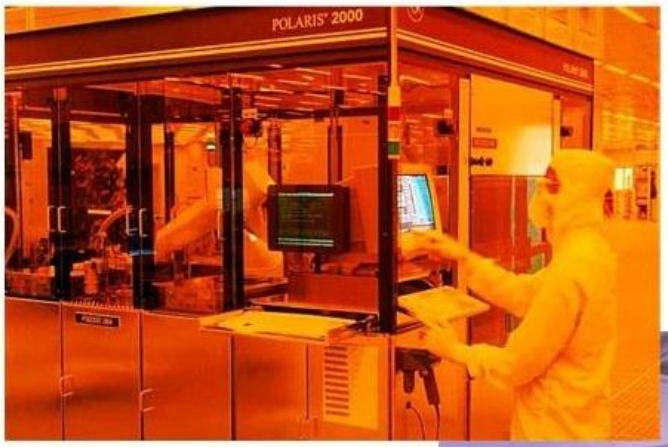
Moore and CMOS Scaling



“CMOS scaling will not stay forever, but, forever can be delayed”
Moore, 2003

Clean Rooms

- Clean room facility:
  - Particle free walls, furniture, and accessories must be used
  - Airflow through 0.3 microns filters



Clean Rooms

- Clean room facility:
  - Main function of clean rooms is control of particle contamination
  - Requires control of air flow, water and chemical filtrations, human protocol
  - Class N clean room means fewer than N particles (>0.5 μm) in 1 cubic foot of air

  - Classes types:
    - Class 10,000
    - Class 1,000
    - Class 100
    - Class 10

Why electronics measurements/instrumentation?

- Testing the chip after coming back from tape-out requires good knowledge of testing and measurements equipments such as:
  - Oscilloscope
  - Digital Multi-meter
  - Frequency meter
  - Logic Analyzer
  - Spectrum Analyzer
  - Frequency synthesizer
  - FPGA based testing
  - …..
- Not only you need to know how to use these equipments but you should understand briefly what is inside them….?

Other measurements/instrumentation types:

- Environmental measurements:
  - Pressure measurements
  - Temperature measurements
  - Humidity measurements
  - …
- These measurements systems are used currently in smart phones
  - MEMS-VISION (Canadian-Egyptian company) that designed the pressure measurement circuitry for SAMSUNG to implement it in smart phones starting from S3.

Other measurements/instrumentation types:

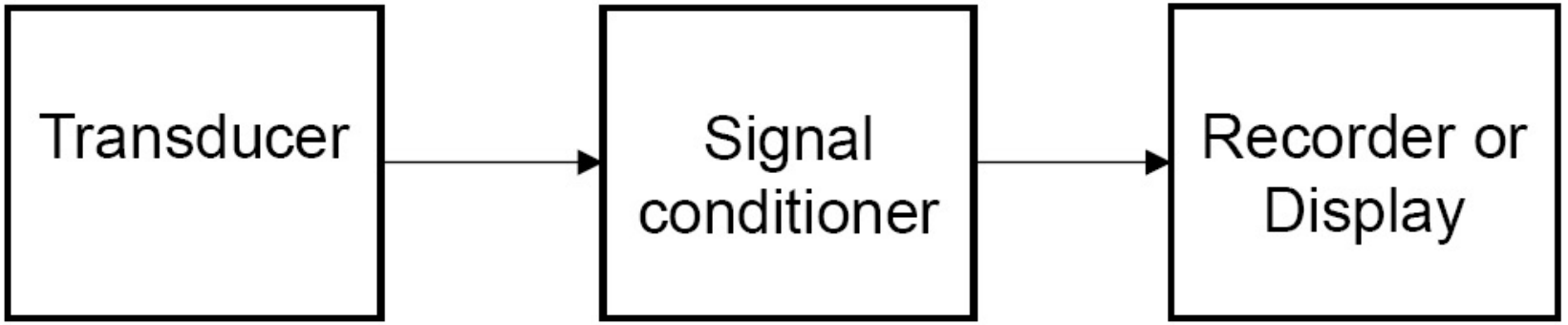
- Health measurements:
  - Blood pressure measurements
  - Blood sugar measurements
  - Heart beats measurements
  - …..
- These measurements are essential to provide the required health care on-time to save lives.


ONE
Lab
ONE Lab

Measurement/instrumentation system

A complete measurement system

All measuring systems include three basic elements:



Perform signal processing such as converting analog signal to digital

Convert the measured quantity into voltage

Display the measured value (typically: in digital format)

Instrumentation Programs and Companies Examples

Virtual Instrumentation With NI LabVIEW

NI LABVIEW

- LABVIEW builds virtual instruement that can be used to either:
  - Simulate a specific design and test its performance at the simulation level
  - Or interface with actual hardware and perform real testing and measurements
- NI Egypt/Lebanon are targeting job applicants with good knowledge in NI LABVIEW

NI ELVIS

NI RIO

NI MYDAQ

VALEO AUTOMOTIVE TESTING

- VALEO EGYPT:
  - Perform testing on all the automotive products
  - This testing includes FPGA based testing, oscilloscopes, logic analyzers.
  - Even with simple automotive products such as wipers, exhaustive measurements MUST be conducted

TESTING/MEASUREMENTS

- In general, the testbench for any new electronic product (which might include transducers or health sensors), should be designed by the testing engineer
- To design the testbench, you need to know the basics of measurements equipment as well as instrumentation programs such as **LABVIEW**
- Also, you should understand the measurements errors that might result in completely wrong measurements

- **Within this course, we will cover most of these requirements……Keep tuned**