EE-309: Microprocessors

Course Introduction

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WHAT IS THE DIFFERENCE BETWEEN THE COMPUTING INDUSTRY AND THE PAPER TOWEL INDUSTRY?

Industry of Replacement

1971 2015

?

Industry of new possibilities

CAN WE CONTINUE BEING AN INDUSTRY OF NEW POSSIBILITIES ???

Personalized healthcare	Virtual reality	Real-time translators

Where Are Interesting Applications?

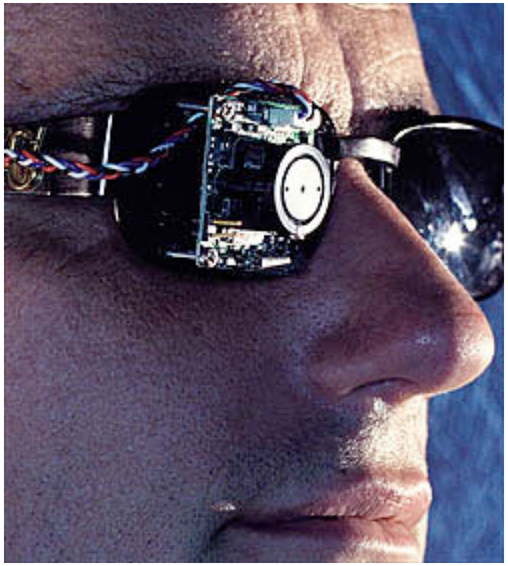
Why Study Microprocessor Design?

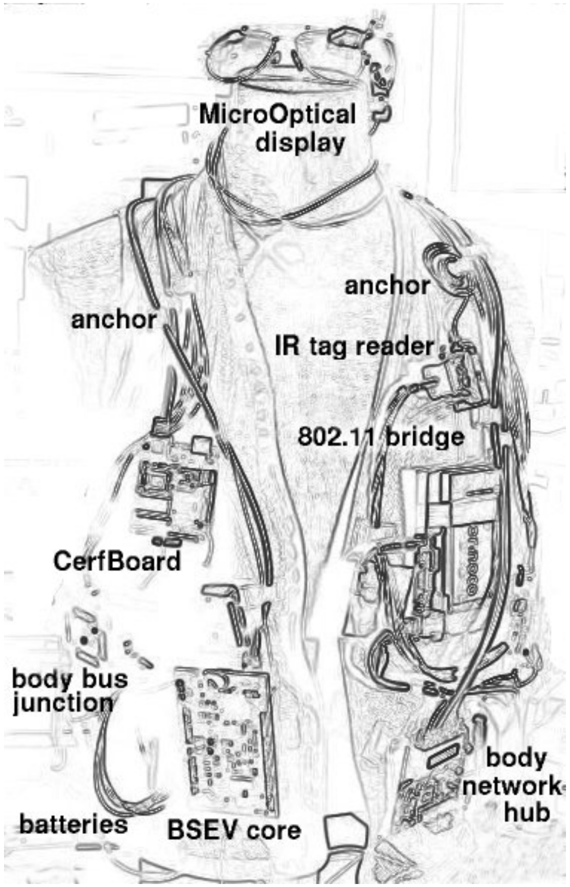
- It's exciting!; It has never been more exciting!
- It impacts every other aspect of electrical engineering and computer science

Bionics:
Sensors in latex fingers instantly register hot and cold, and an electronic interface in his artificial limb stimulates the nerve endings in his upper arm, which then pass the information to his brain. The $3,000 system allows his hand to feel pressure and weight, so for the first time since losing his arms in a 1986 accident, he can pick up a can of soda without crushing it or having it slip through his fingers. *One Digital Day*

Only Sociology graduates help real people?

Why Study Microprocessor Design?





Why Study Microprocessor Design?

Sony Playstation 2000

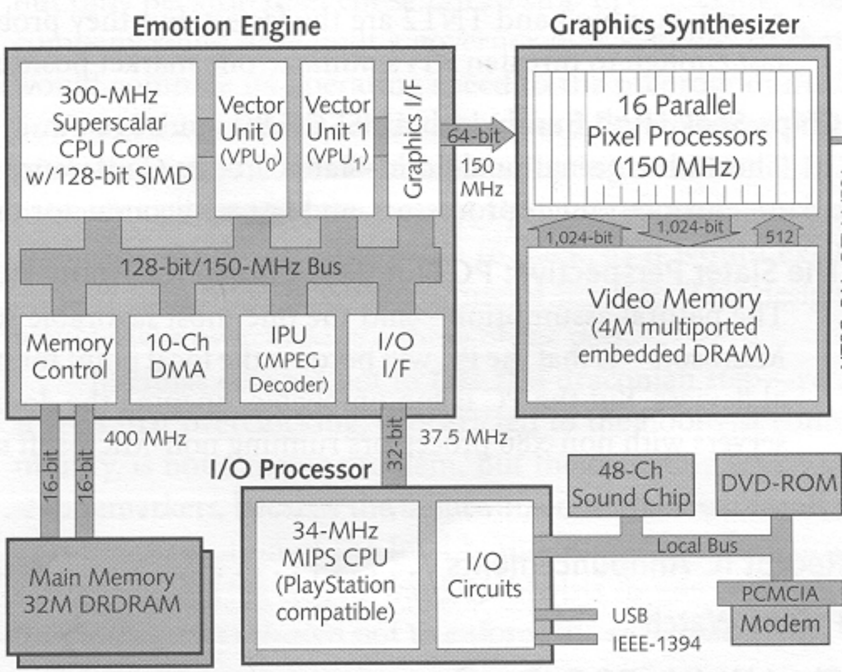


Figure 1. PlayStation 2000 employs an unprecedented level of parallelism to achieve workstation-class 3D performance.

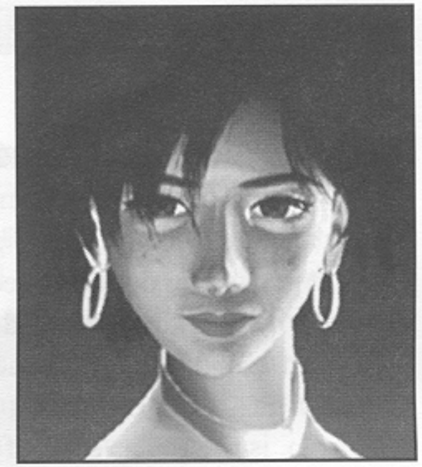


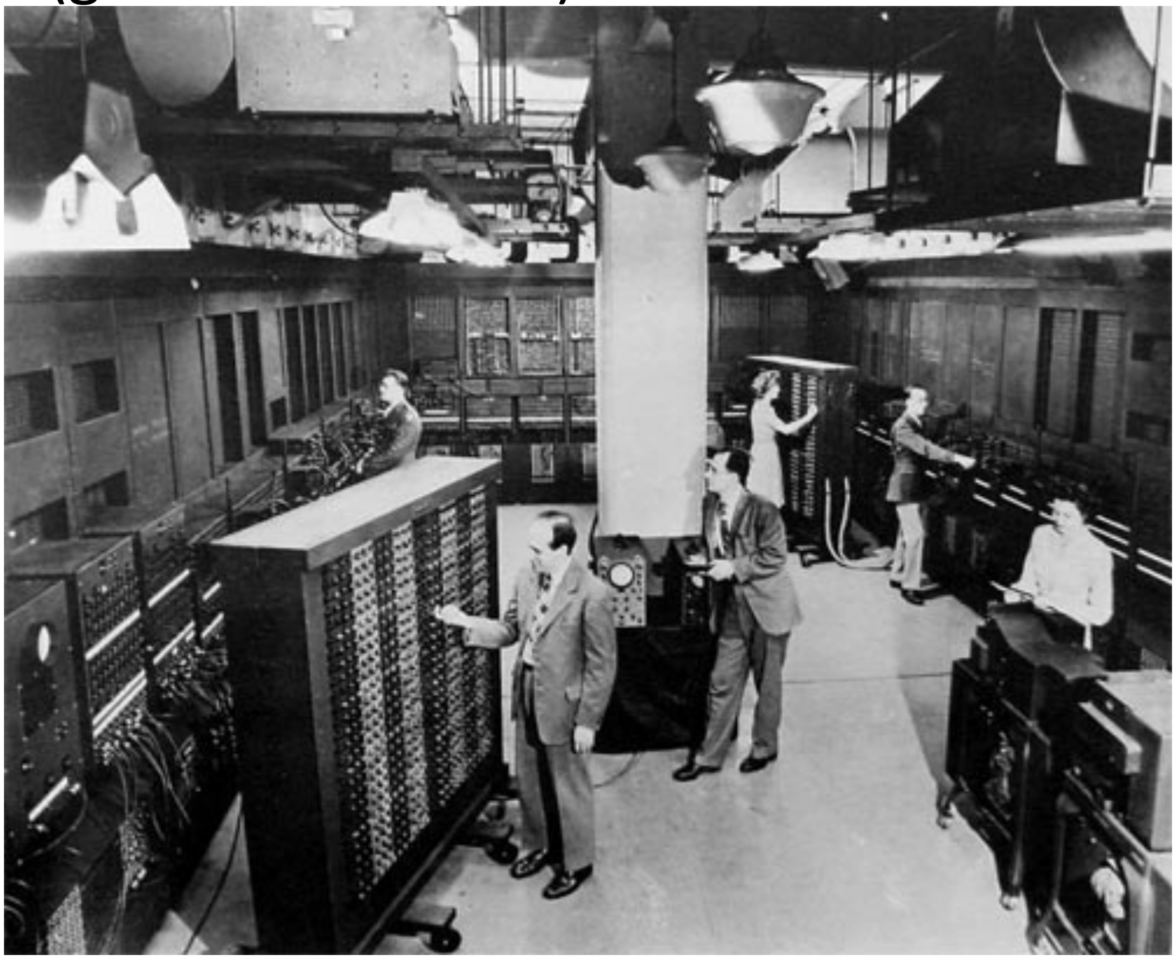
Figure 2. PlayStation 2000 screenshot. (Source: Namco)

- (as reported in Microprocessor Report, Vol 13, No. 5)
  - Emotion Engine: 6.2 GFLOPS, 75 million polygons per second
  - Graphics Synthesizer: 2.4 Billion pixels per second
  - Claim: *Toy Story* realism brought to games!

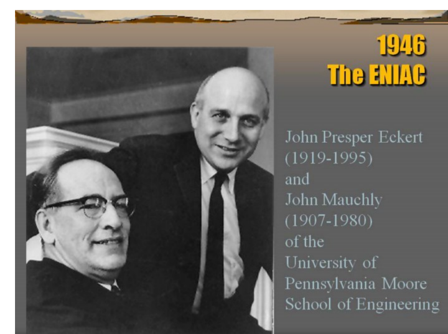
Why Study Microprocessor Design?

Electronic Computers

- 1943-44: John Mauchly (professor) and J. Presper Eckert (graduate student) built ENIAC at U. Pennsylvania.



- large number of vacuum tubes
- Big size,
- high power,
- short life time filament



First Draft of EDVAC

1945-52: John von Neumann proposed a "*stored program computer*" EDVAC (Electronic Discrete Variable Automatic Computer) – *Von Neumann Architecture* – use the same memory for program and data.

First Draft of a Report on the EDVAC

JOHN VON NEUMANN

Introduction

Normally first drafts are neither intended nor suitable for publication. This report is an exception. It is a first draft in the usual sense, but it contains a wealth of information, and it had a pervasive influence when it was first written. Most prominently, Alan Turing cites it, in his proposal for the Pilot ACE,* as the definitive source for understanding the nature and design of a general-purpose digital computer.

After having influenced the first generation of digital

taken great pains *not* to modify the intended expression, nor to editorialize on the original work. The report is still not easy reading, but to the best of my ability this version is a correct rendering of what von Neumann wrote and intended.

A careful reading of the report will be instructive to anyone with an interest in the past, present, or future of computing.

First Draft of a Report
on the EDVAC

by

John von Neumann

Contract No. W-670-ORD-4926

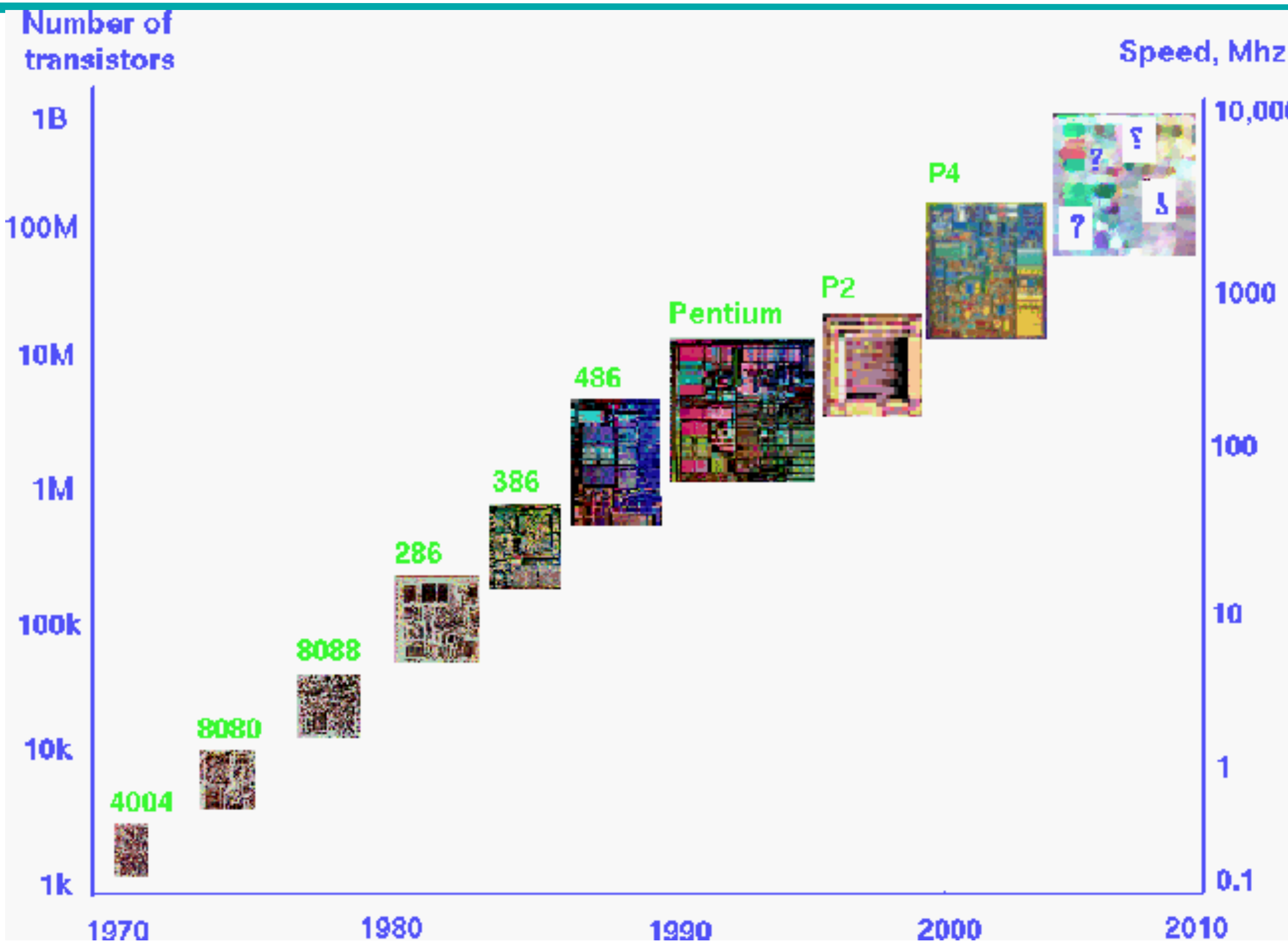
Between the

United States Army Ordnance Department

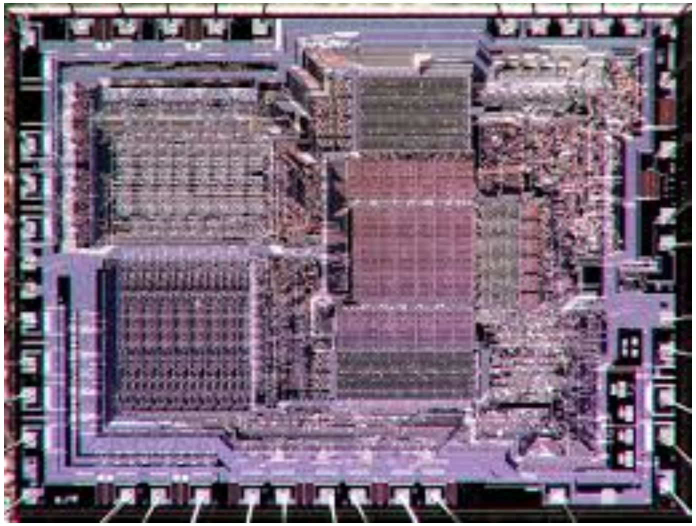
and the

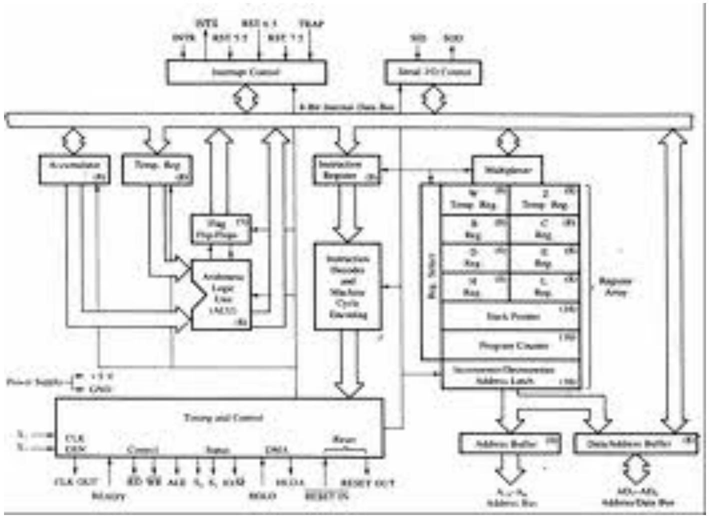
University of Pennsylvania

Microprocessor Designs

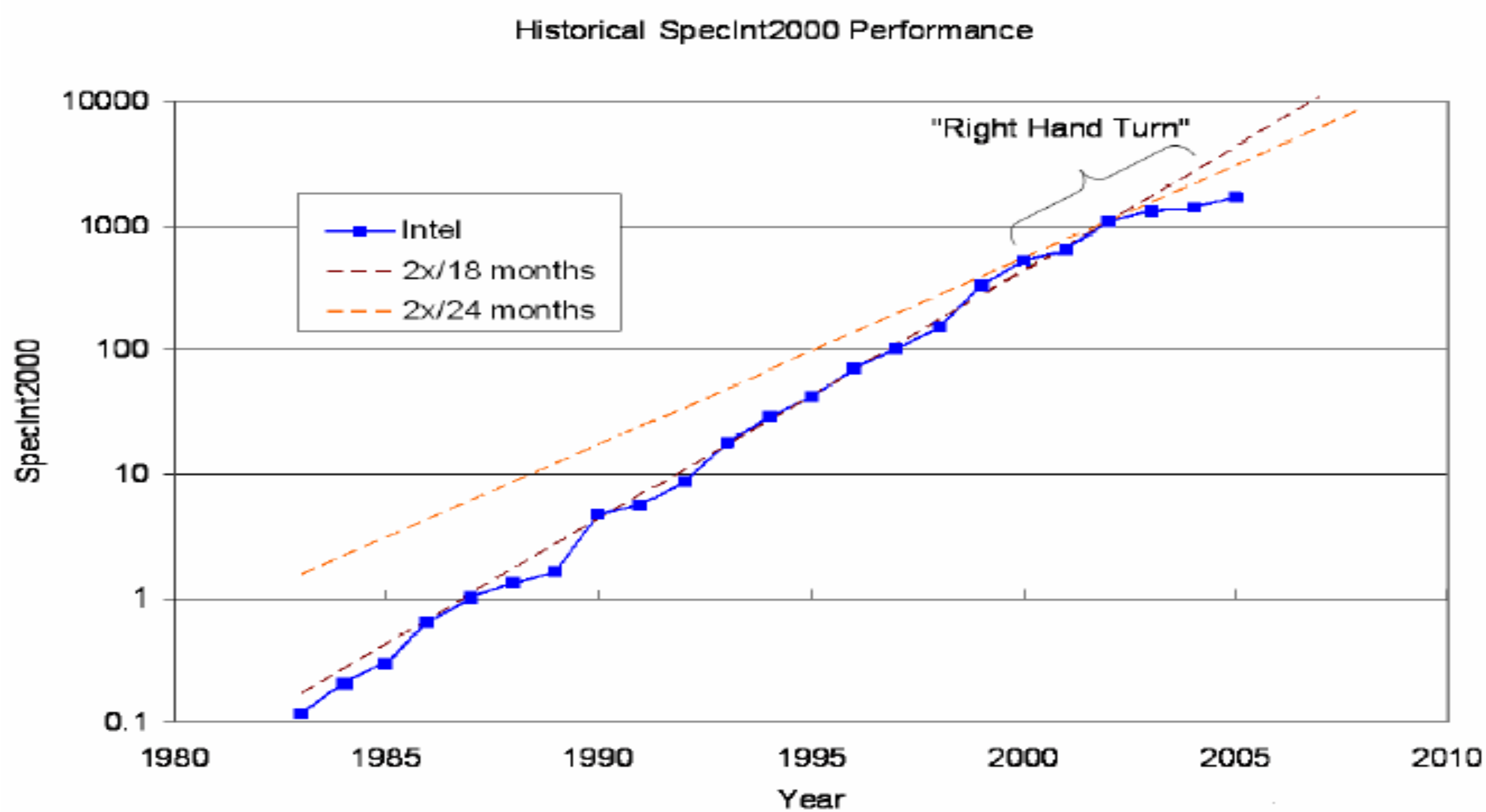


Microprocessor: 8085





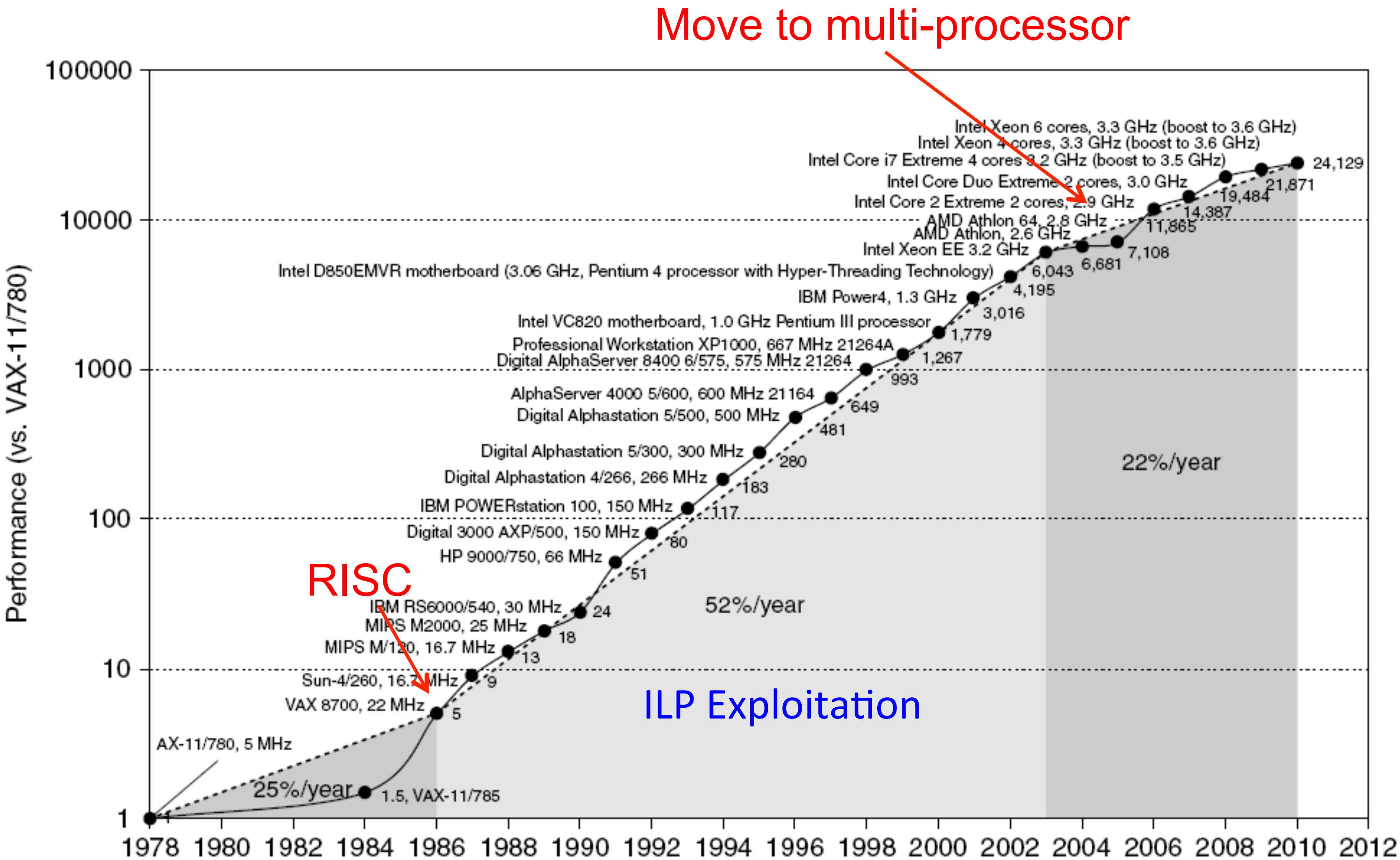
VLSI Trends



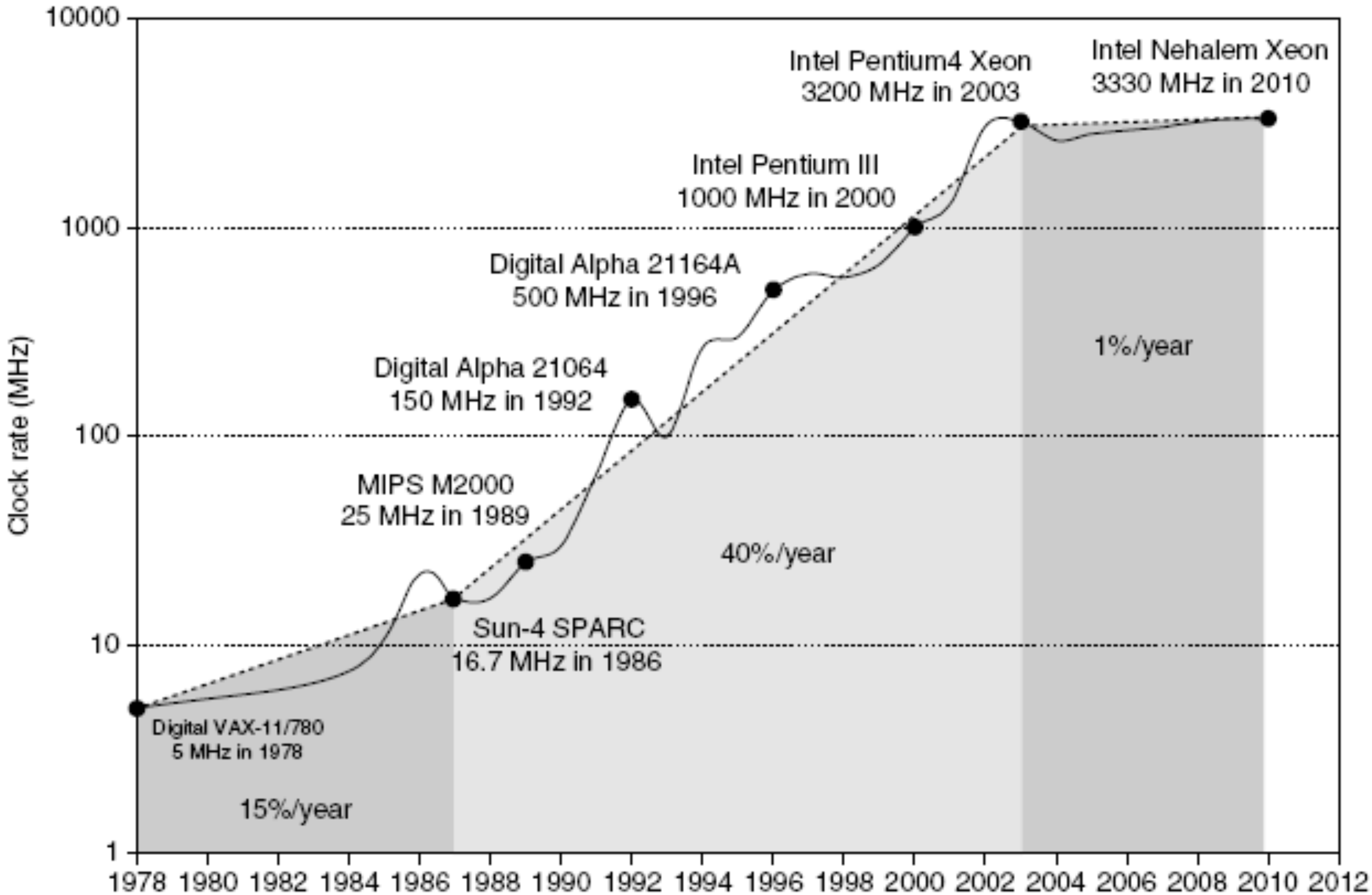
- Moore's Law for device integration
- Chip power consumption
- Single-thread performance trend

[source: Intel]

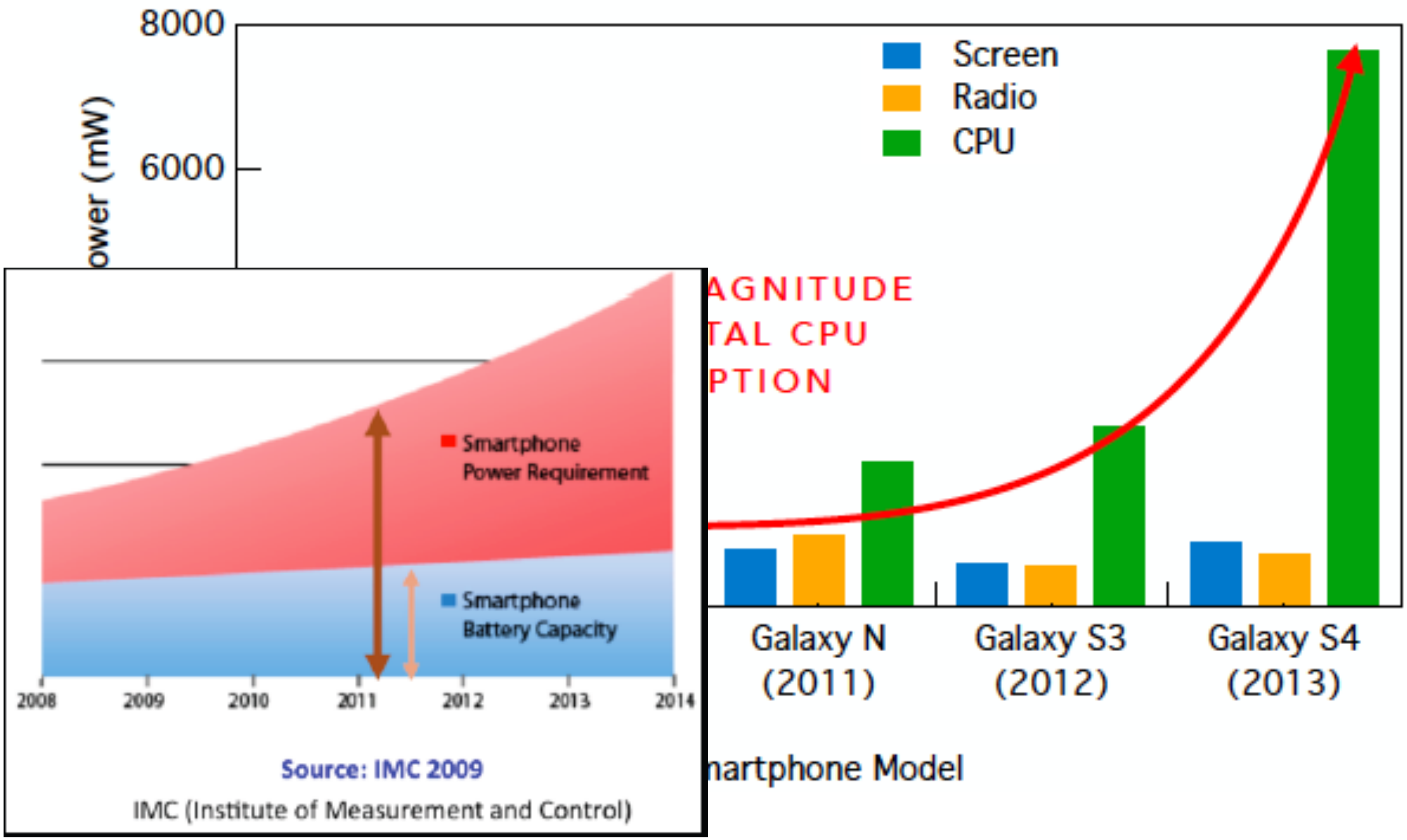
Single Processor Performance



Frequency Scaling



Mobile Devices Power Consumption



Computer Technology → Dramatic Change

- Processor
  - 2X in speed every 1.5 years;
    100X performance in last decade
- Memory
  - DRAM capacity: 2X / 2 years; 64X size in last decade
  - Cost per bit: improves about 25% per year
- Disk
  - capacity: > 2X in size every 1.0 years
  - Cost per bit: improves about 100% per year
  - 250X size in last decade

Putting it all in Perspective…

"If the automobile had followed the same development cycle as the computer, a Rolls-Royce would today cost $100, get a million miles per gallon, and explode once a year, killing everyone inside."

– *Robert X. Cringely*

Technical Writer, Broadcaster and Computer Guy

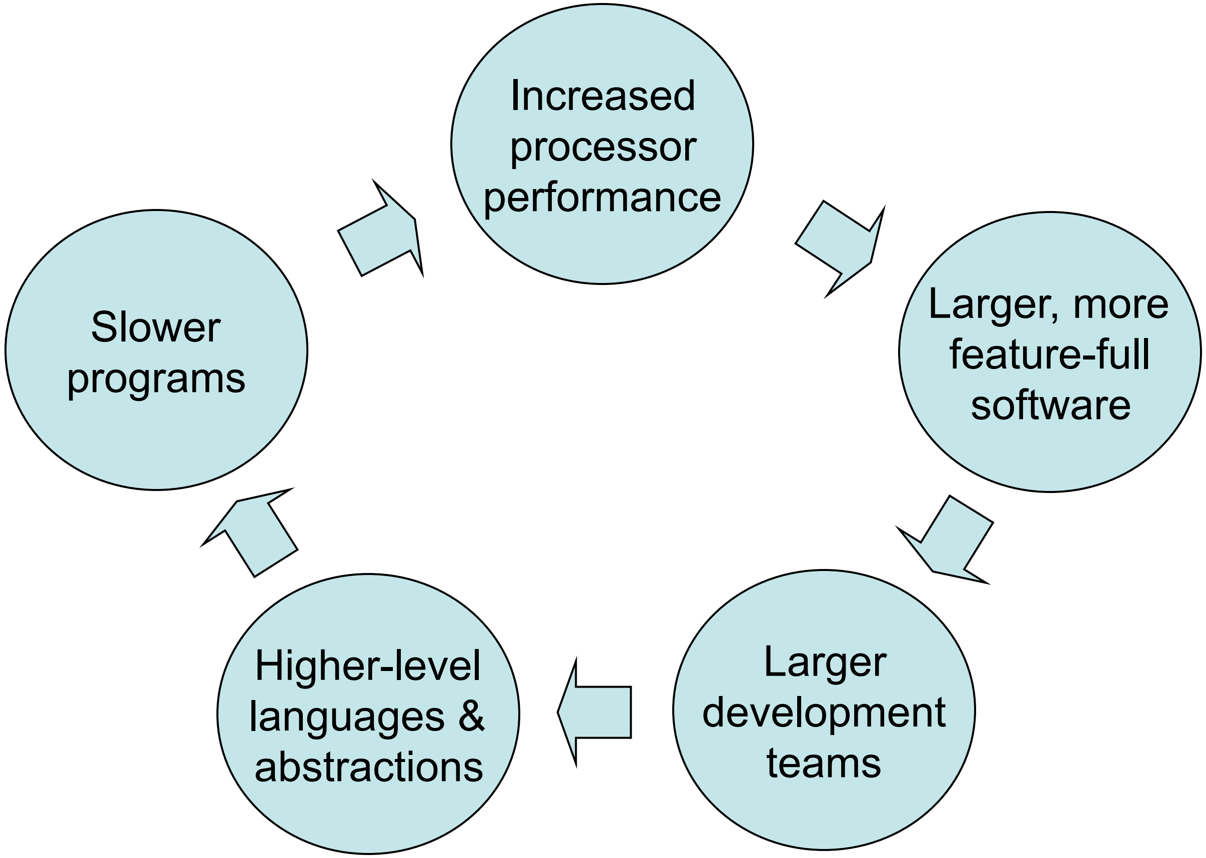
http://www.pbs.org/cringely/about/

Triumph of the Nerds

A history of the PC industry,

An ABC program a few years ago

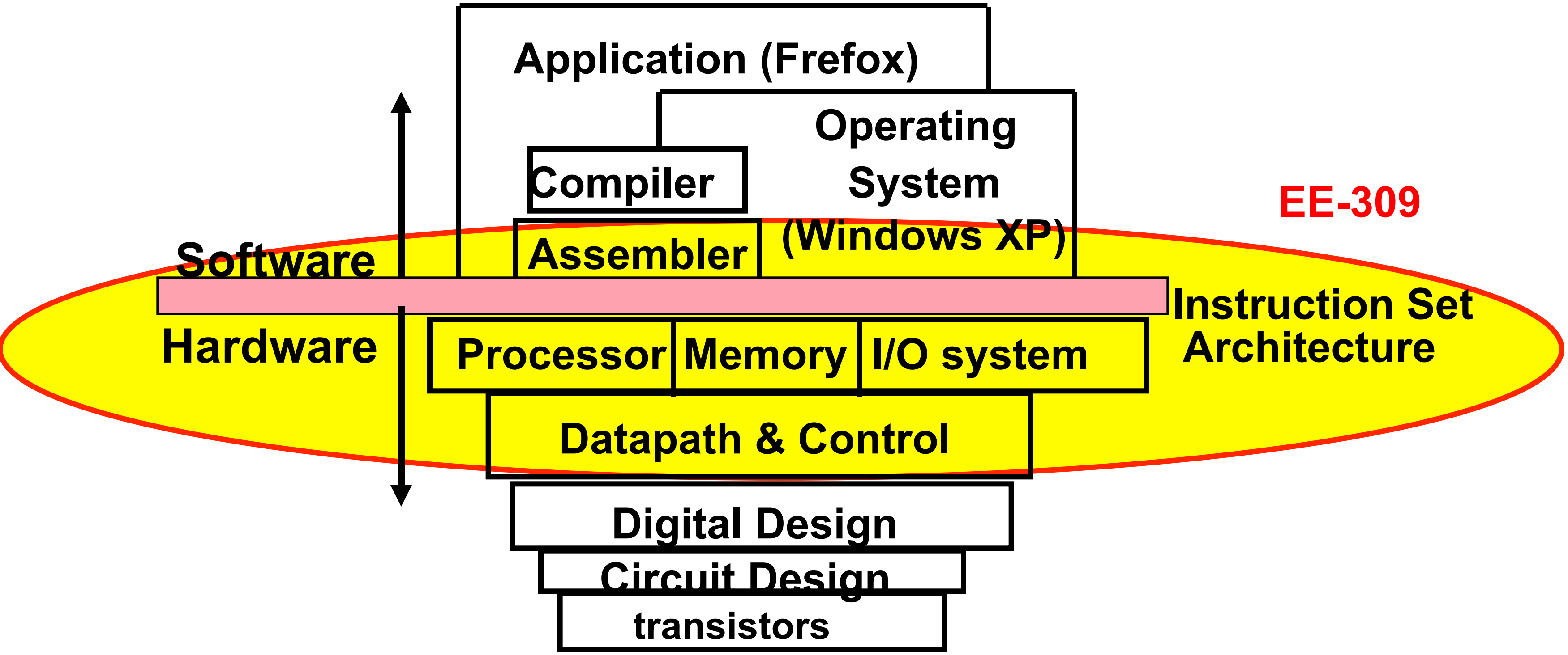
Virtuous Cycle, (1950 – 2005)



World-Wide Software Market (per IDC):

$212b (2005)

What is this course about?



- Coordination of many *levels of abstraction*

Running Program on Processor

$$\text{Processor Performance} = \frac{\text{Time}}{\text{Program}}$$

$$= \frac{\text{Instructions}}{\text{Program}} \times \frac{\text{Cycles}}{\text{Instruction}} \times \frac{\text{Time}}{\text{Cycle}}$$

(code size) (CPI) (cycle time)

Architecture --> Implementation --> Realization

Compiler Designer **Processor Designer** **Chip Designer**

Course Outline

- Introduction & 8085 Architectures [1 week]
- 8051 Architecture & Programming [2 Weeks]
- Device Interfacing [2 weeks]
- ISA and CISC Processor Design [3 Weeks]
- RISC Processor Design [3 Weeks]
- Pipelined Design [2 Weeks]
- Memory System Design [1 Week]

Course Schedule

Class Hours:

Slot 2

- Monday: 9:30 am to 10:30 am
- Tuesday: 10:30 am to 11:30 am
- Thursday: 11:30 am to 12:30 pm

Office Hours: Wednesday (8:00 pm to 9:00 pm)

Course Evaluation

- Mid Term Exam (10%)
  - Open Book/Notes Exam
- Final Exam (25%)
  - Open Book/Notes Exam
- Assignments (15%)
  - Set of assignments will be given periodically
- Course Project-I (10%) – Implementation of IITB-RISC on FPGA
  - Group (Max size 4) Common project with Lab. (EE-337)
- Course Project-II (15%) – Pipelined Implementation of IITB-RISC
  - Group (Max size 4)
- Continuous Evaluations (25%) – weekly quiz
  - Weekly Quiz – Open Book (80% best will be counted)
- [BONUS] Project - III (10%)
- Saturating counter sums to 100

Grades

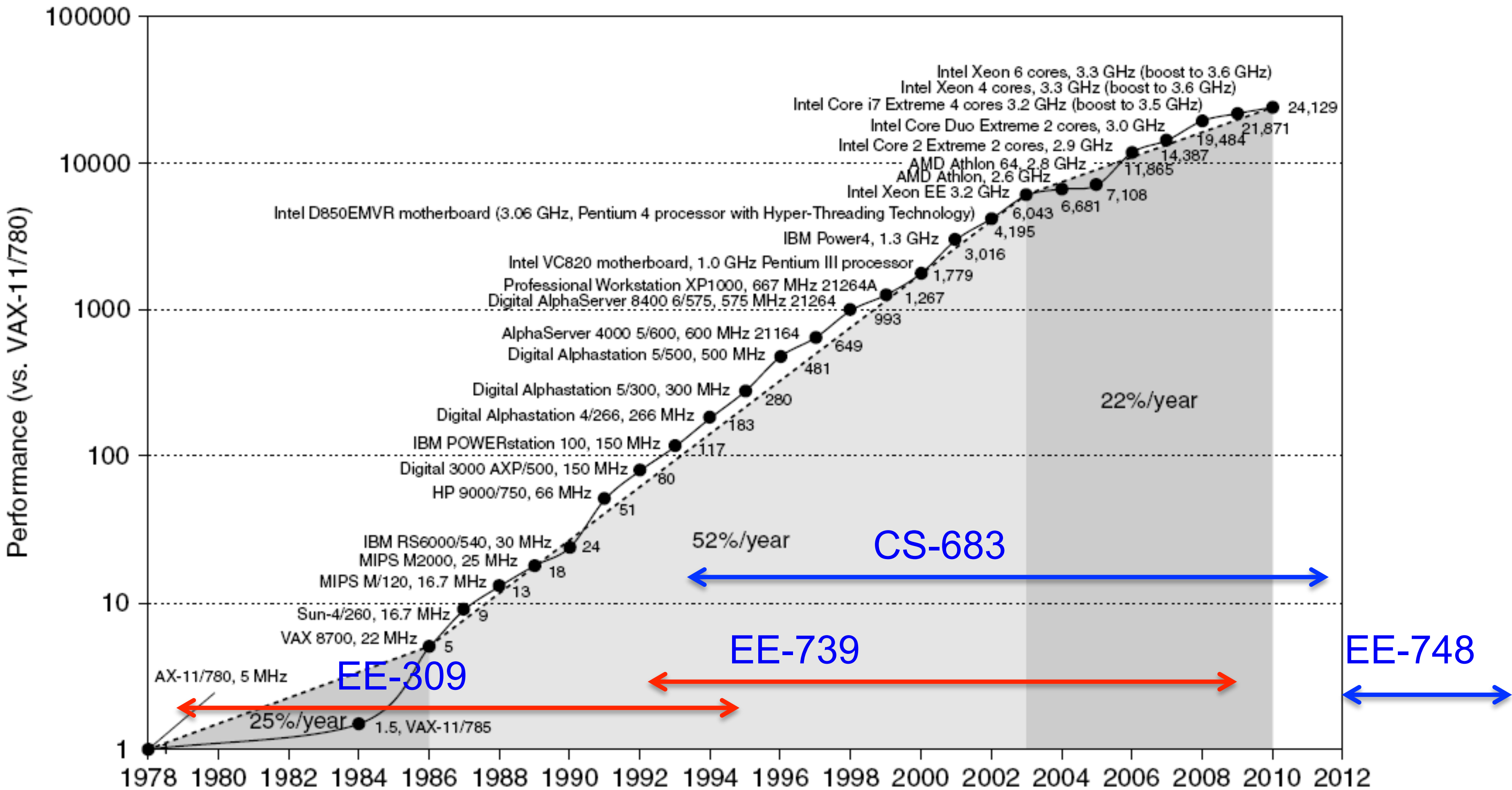
Absolute Grade

- > 90: AA
- 81 – 90: AB
- 71 – 80: BB
- 61 – 70: BC
- 51 – 60: CC
- 45 – 50: CD
- 40 – 44: DD
- < 40 :FR

Books

- Microprocessor architecture, programming, and applications with 8085
  - Ramesh Gaonkar
- The 8051 microcontroller
  - Kenneth Ayala
- Computer Organization and Design
  - Patterson and Hennessy
- Microprocessor Design
  - Nick Tradenick

Related Courses



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Thank You