Pengantar Sistem Dijital

CSCM601150, 2022/2023 - 1

Dosen: Erdefi Rakun dan Tim Dosen PSD

Fasilkom UI

- These slides are adapted from
  - CSE260: Introduction to Digital Logic and Computer Design, by: Viktor Gruev
 - http://www.cse.wustl.edu/~vgruev/cse/260/index.htm

Course Description

- This course provides a modern introduction to logic design and the **basic building blocks** used in digital systems, in particular **digital computers.**

- It starts with **number systems** and continues with **combinational logic**: logic gates, minimization techniques, arithmetic circuits, and modern logic devices such as field programmable logic gates.

- The second part of the course deals with **sequential circuits**: flip-flops, synthesis of sequential circuits, and case studies, including counters, registers, and random access memories.

- **State machines** will then be discussed and illustrated through case studies of more complex systems using programmable logic devices. Different representations including truth table, logic gate, timing diagram, switch representation, and state diagram will be discussed.

Course Description: Lab

- The course has an accompanying lab component that integrates hands-on experience with logic simulation (Logisim)

- Logisim will be used to build the components needed for a computer processor gradually: ALU, Decoder, Multiplexer, Register Files, and Memory.

- The labs will give you direct feedback on how your design performs and will be a great learning tool.

Text Book
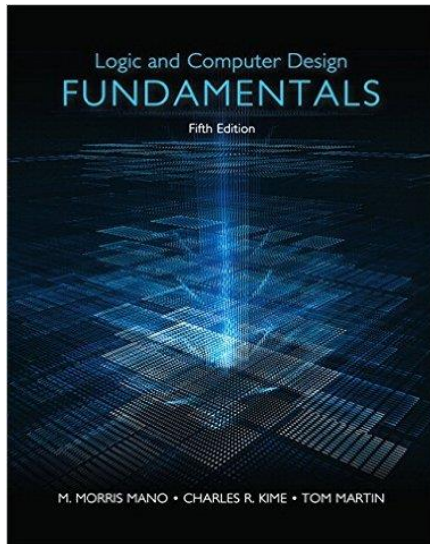
Title: **Logic and Computer Design Fundamentals**
Authors: M. Morris Mano, Charles R. Kime, Tom Martin
Edition: 5th edition, 2015
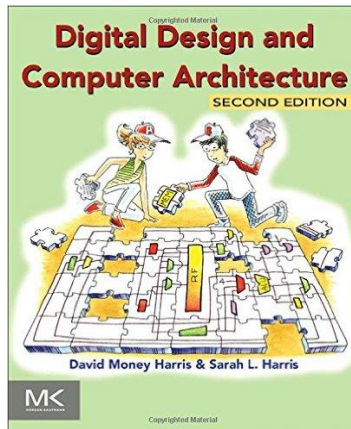Publisher: Pearson Education
ISBN-13: 978-0133760637
ISBN-10: 0133760634

Supplement Books

Title: **Digital Logic Design**
Author: Tan Tuck Choy, Aaron
Edition: 2004
ISBN: 007-124718-1
Publisher: McGraw-Hill

Title: Digital Design and Computer Architecture
Authors: David M. Harris and Sarah L. Harris
Edition: Second, 2013
ISBN-13: 978-0123944245
ISBN-10: 0123944244
Publisher: Elsevier

Grading System

- Homeworks(8)   : 20%
- Labs (6)   : 20%
- Mid Test   : 25%
- Final Test   : 35%
- Quiz (Bonus)   : 5%

Cheating means E in your grade.

Code of conduct for the class

- Be punctual, max 10 min late
- You are responsible for your class attendance; this class follows university rules about attendance (>75%)
- Definitely no cheating for class quizzes/tests
- Your cellular phone must be SWITCHED OFF during the class – no exception
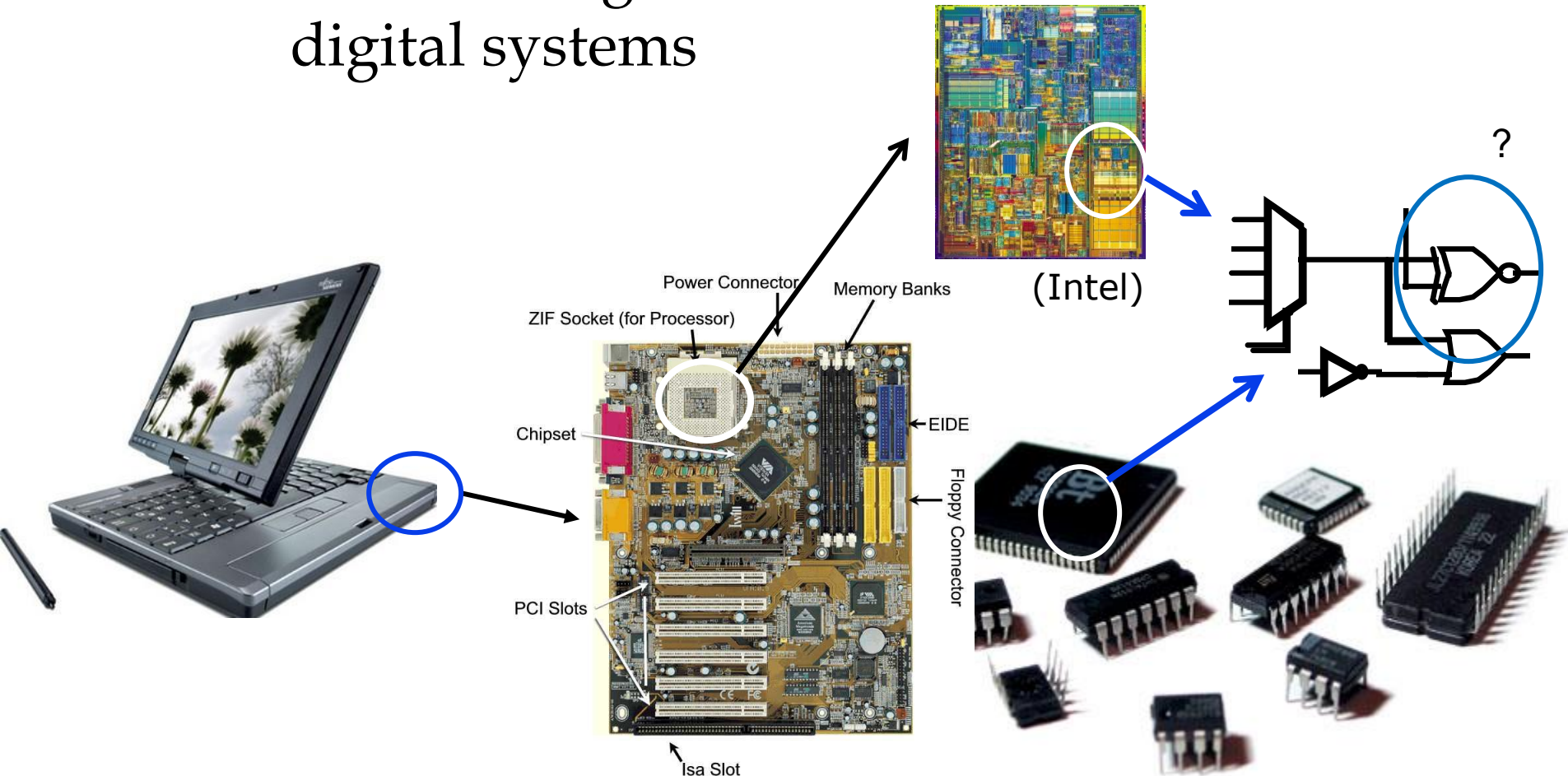
Digital Circuits are Everywhere

(Source: R. Tummala, IEEE Spectrum, June 2006)
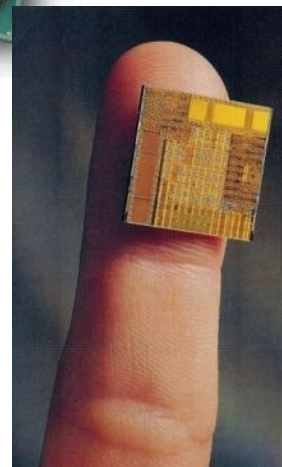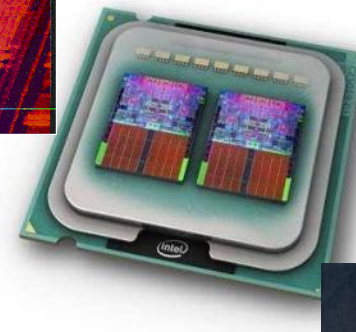
Communications
Multi-media
Manufacturing
Consumer electronics
Health care
Defense and security
Software
Automotive, etc
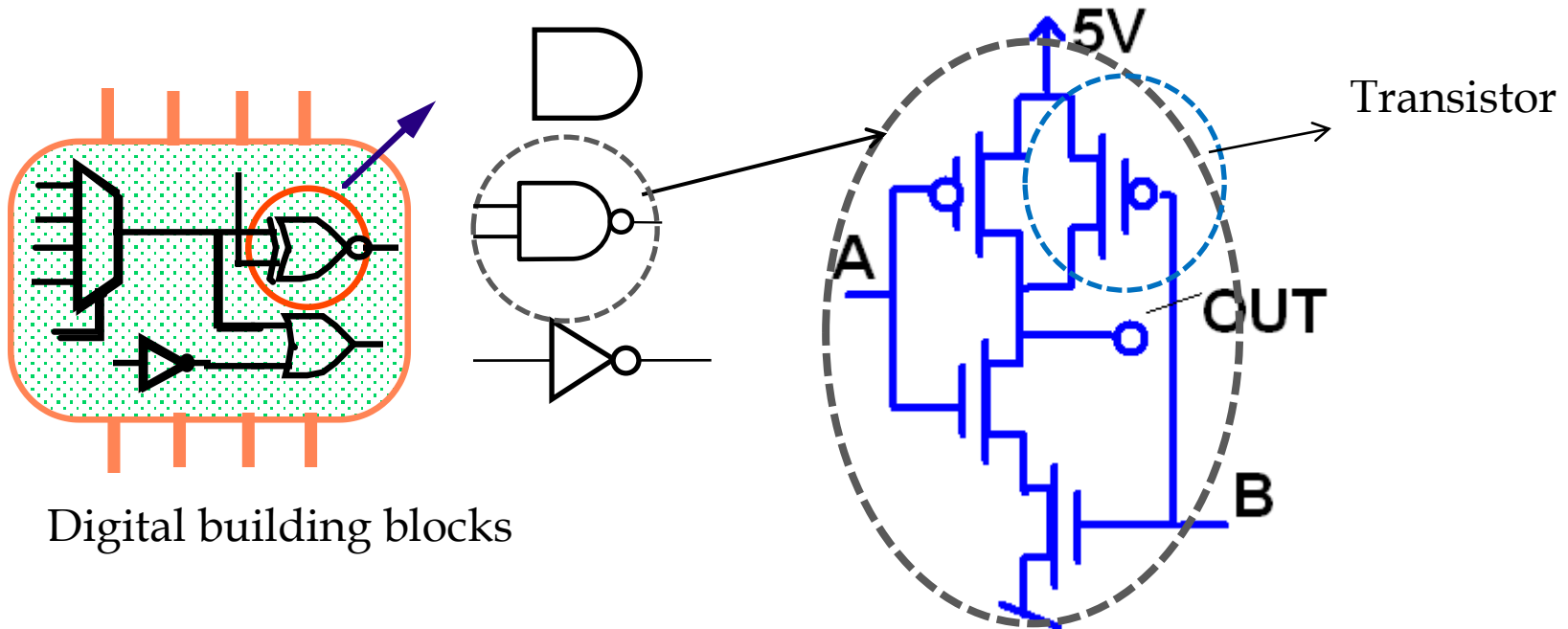
Introduction to Digital Systems

Deals with building blocks of digital systems

(Intel)

?

Power Connector
Memory Banks
ZIF Socket (for Processor)
Chipset
EIDE
Floppy Connector
PCI Slots
Isa Slot

What are Logic Gates built from?

Transistors:

- The transistor is the workhorse of every electronic device.
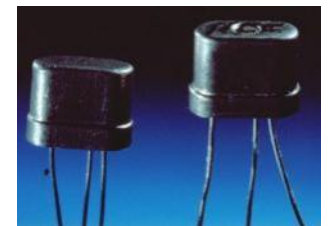
Digital building blocks

Transistor

5V

A

OUT

B

What is a Transistor?

- Electronic, solid-state device that can amplify an electric signal:
  - $V_{out} > V_{in}$
  - $Power_{out} > Power_{in}$

in

out

S

B

transistor
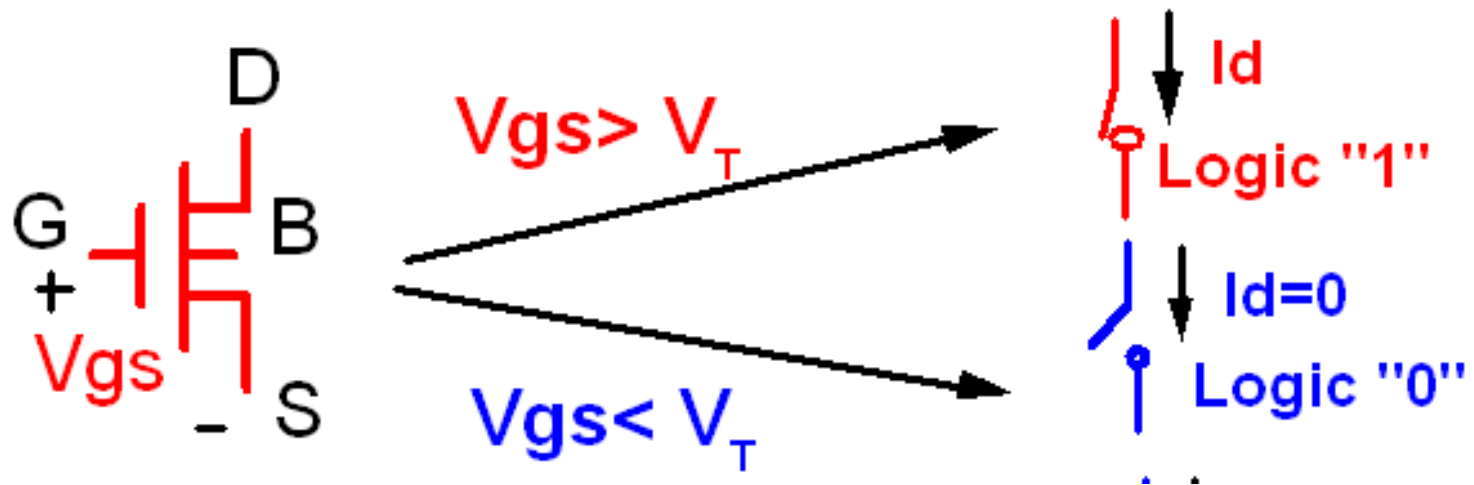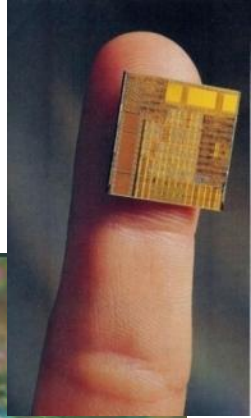
Id

input

Mike

output
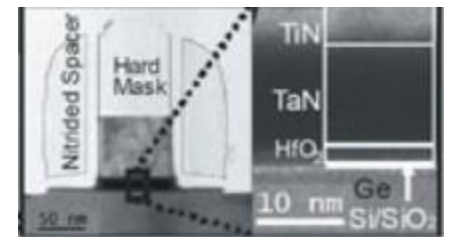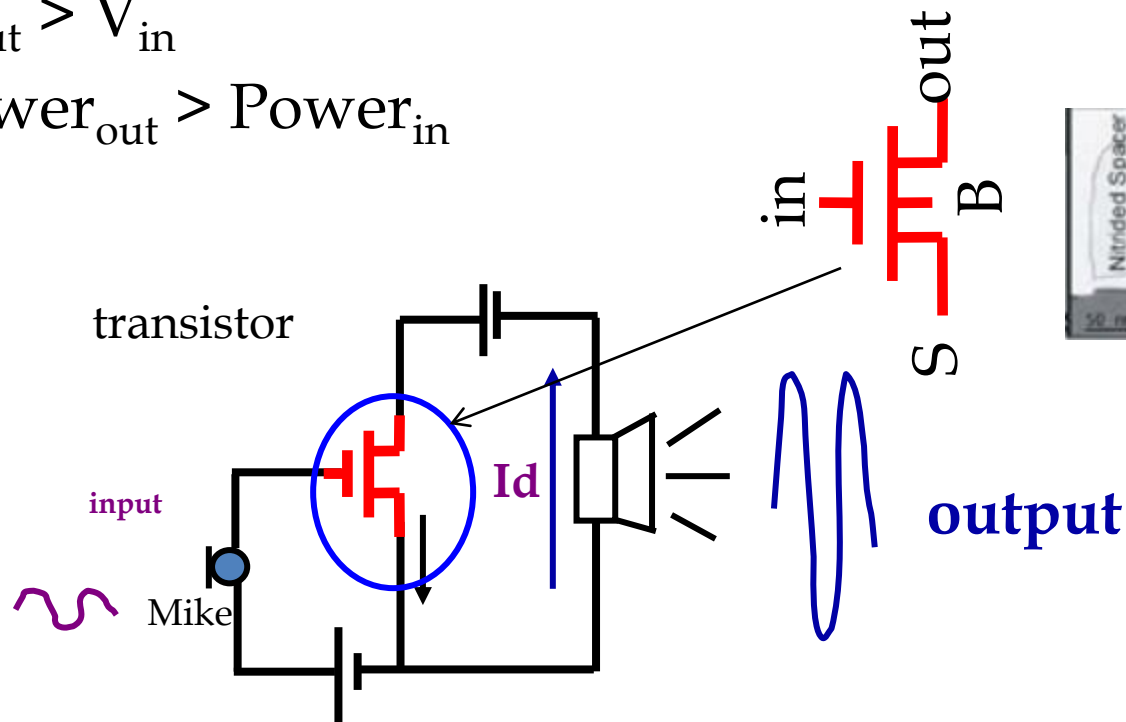
(Source: IMEC)

Digital Model of a Transistor

- We make abstraction of the signals: 0 or 1
- As a result a transistors can be considered a switch (on or off; 1 or 0;):
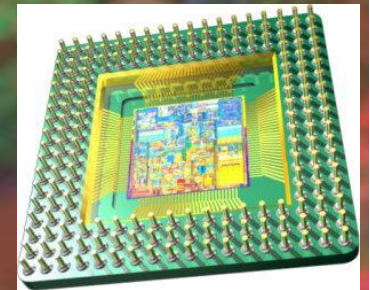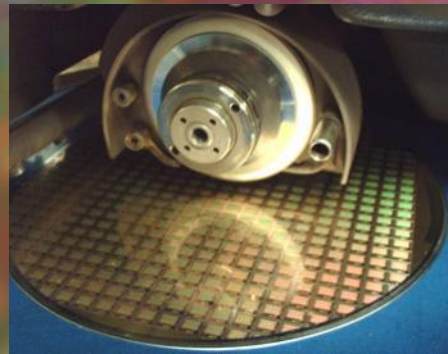
What is an IC?

An Integrated Circuit is a miniaturized electronic circuits whose components (transistors, resistors, capacitors) are build on the surface of a semiconductor wafer, using the same planar fabrication technology.
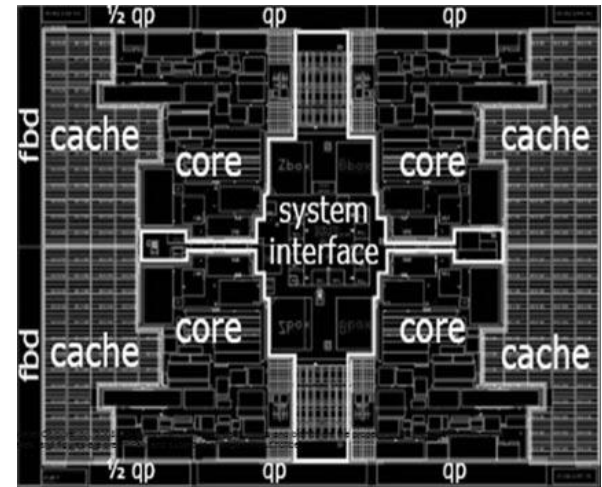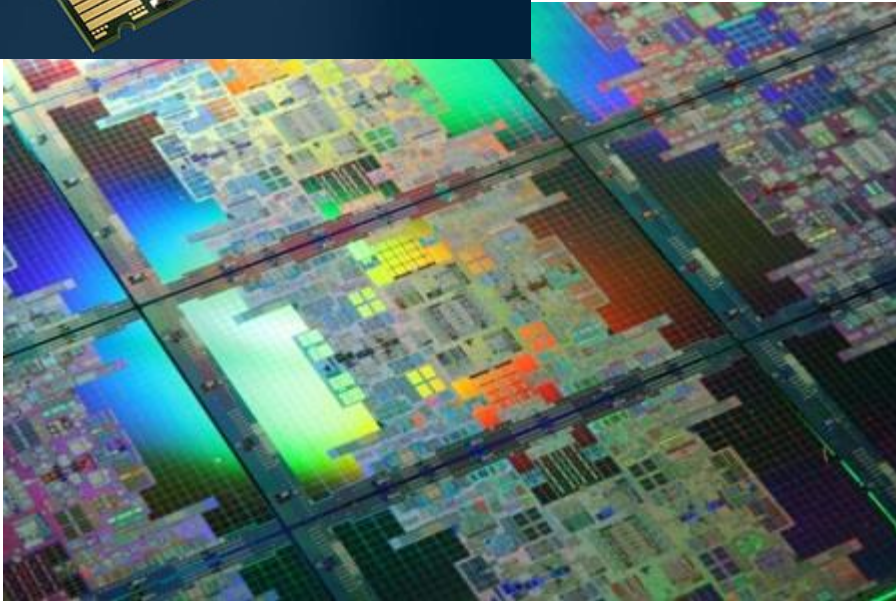
(Source: http://www.majelac.com/images/wafer_dicing.jpg)

(Source: Wikipedia)

(Picture: Scientific American, Jan. 2010)
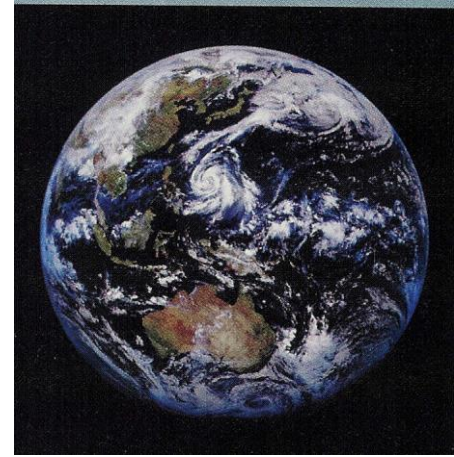
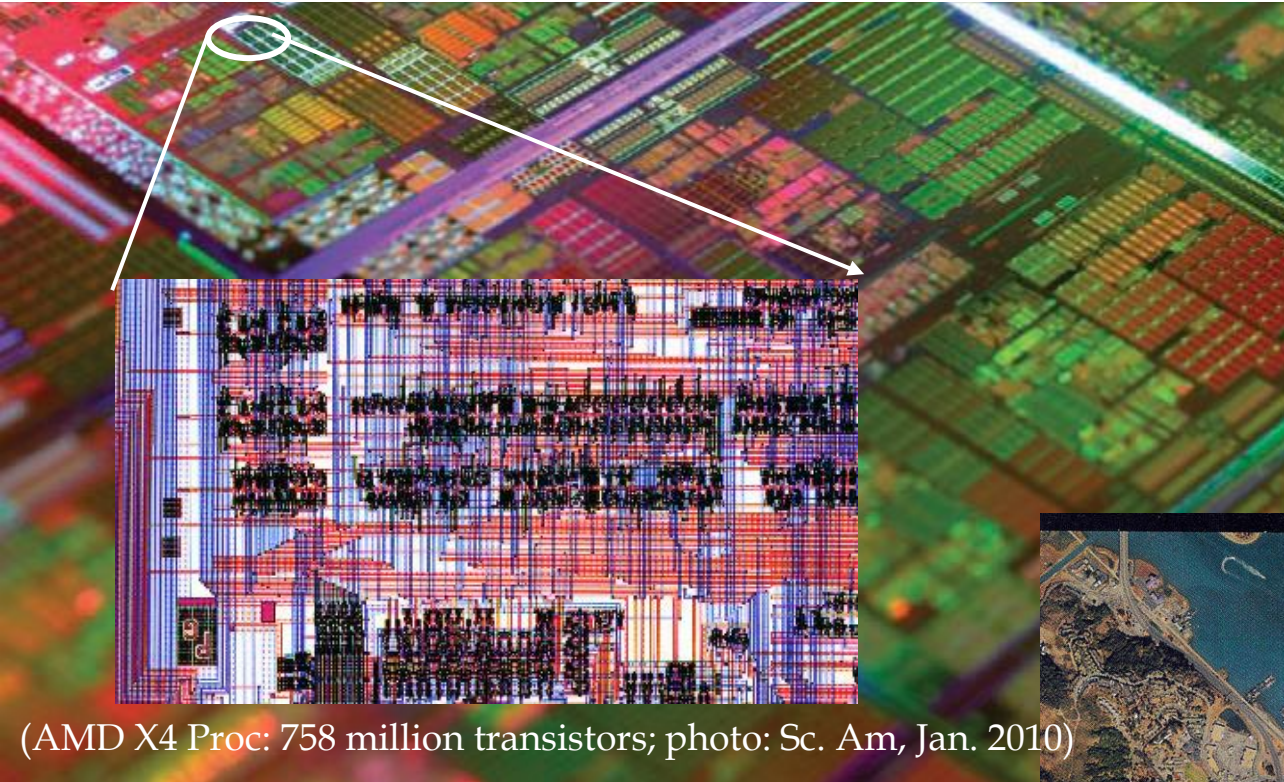# Intel Itanium 9300 Tukwila Processor

(source: www.tgdaily.com)

Four cores
Over 2 billion transistors!

Chip complexity

(AMD X4 Proc: 758 million transistors; photo: Sc. Am, Jan. 2010)

Submicron and nanoscale dimensions

Compare to a street map

Moore's Law

Chip complexity doubles every two years
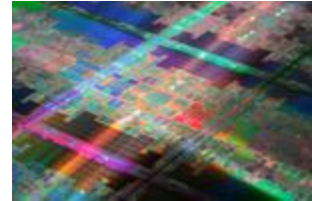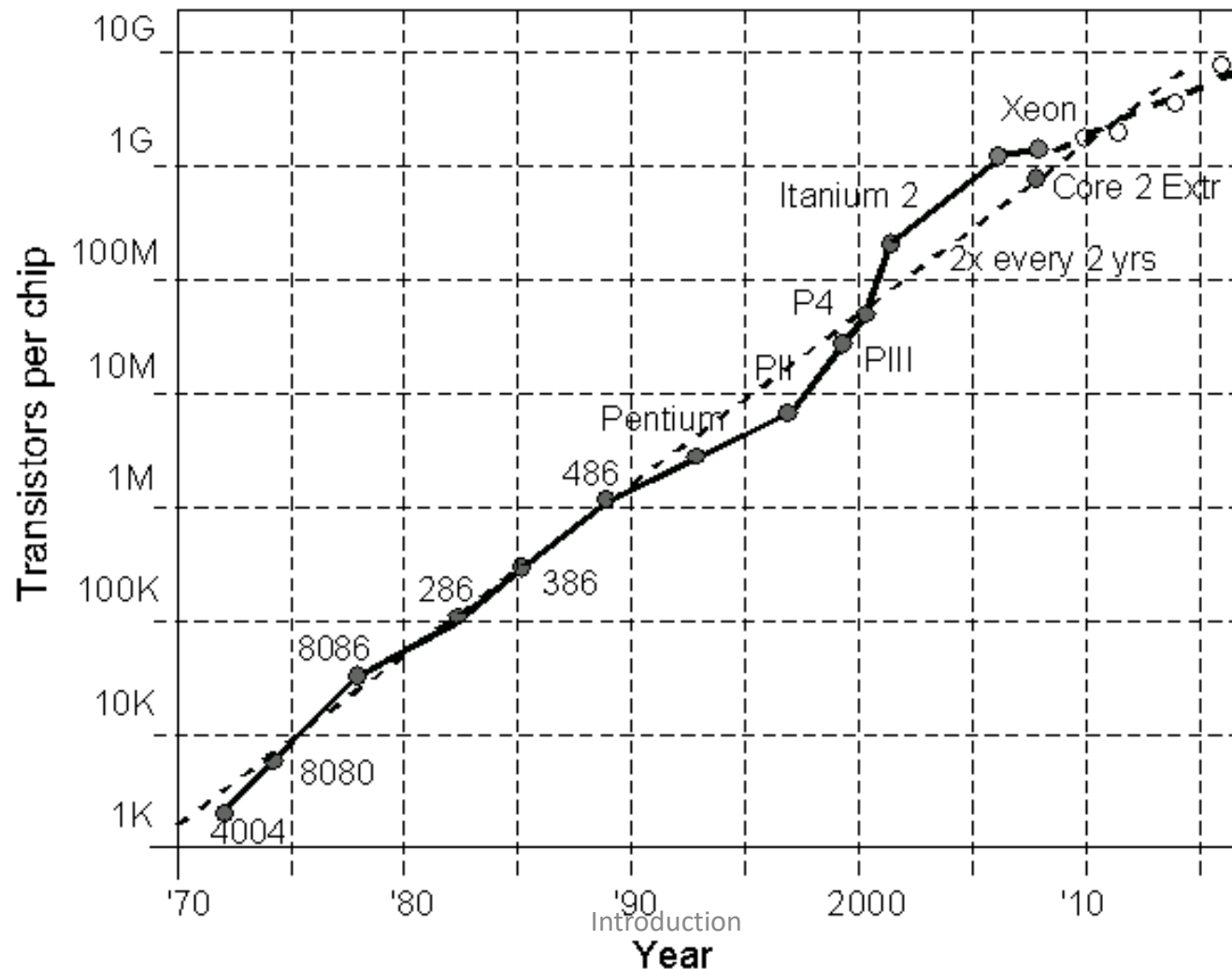
First 2-Billion
Trans. Processor
([Tukwila:
Itanium
processor]);
Production Q1,
2010

How to Design such complex systems?

- Make Abstractions
- Divide and Conquer
- Reuse previous designs

Importance of Abstraction

- Real world is very messy – can be described by the laws of Physics

- For EE, CS, these laws are Maxwell's equations (Electromagnetics)

- Simplifications (abstractions):

Levels of Abstraction

Software

Application (IE, Excel, etc.)

Operating System (Windows XP)

Compiler

Assembler

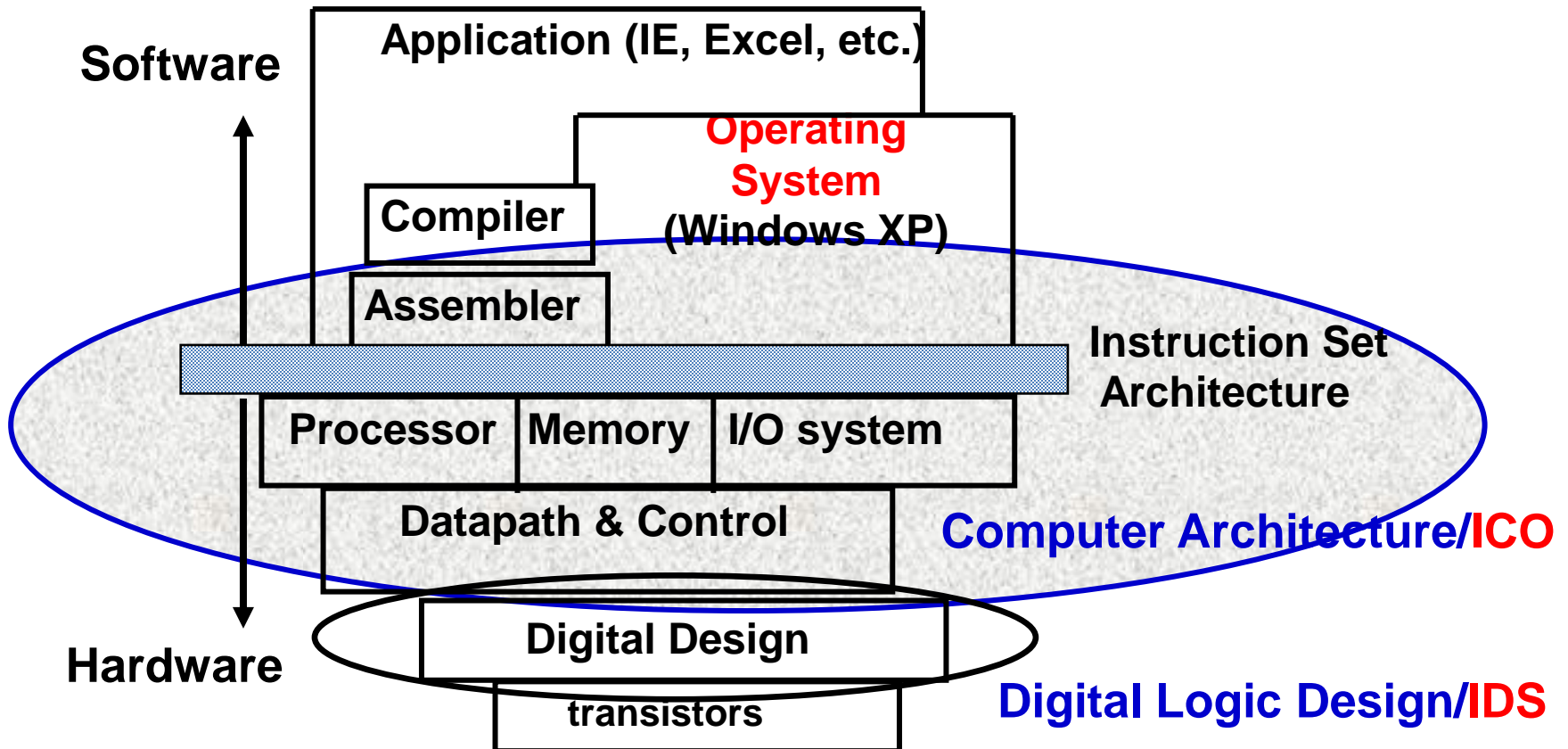**Instruction Set Architecture**

Processor | **Memory** | **I/O system**

Datapath & Control

Computer Architecture/ICO

Digital Design

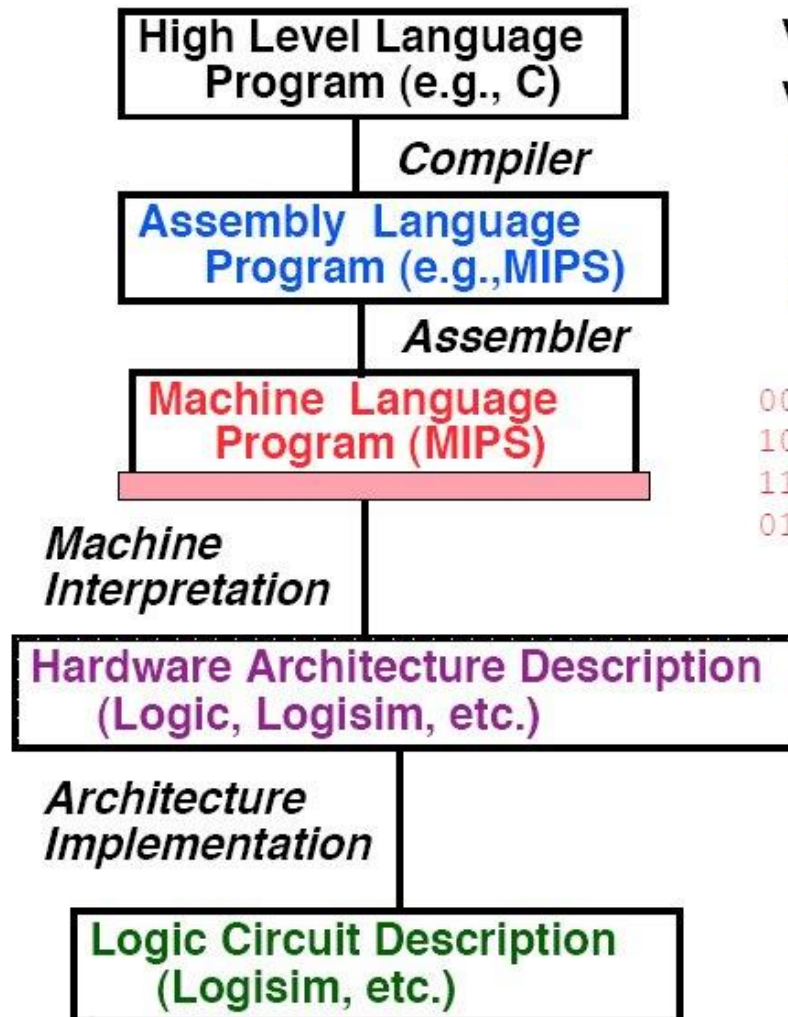**transistors**

Hardware

Digital Logic Design/IDS

Note: Portion of this material are taken from Aaron Tan's slide and other portions of this material © 2008 by Pearson Education,Inc

Levels of Abstraction

S/W and H/W consists of hierarchical layers of abstraction, each hides details of lower layers from the above layer

The instruction set arch. abstracts the H/W and S/W interface and allows many implementation of varying cost and performance to run the same S/W

LEVELS OF REPRESENTATION

High Level Language
Program (e.g., C)

Compiler

Assembly Language
Program (e.g.,MIPS)

Assembler

Machine Language
Program (MIPS)

Machine Interpretation

Hardware Architecture Description
(Logic, Logisim, etc.)

Architecture Implementation

Logic Circuit Description
(Logisim, etc.)

```
temp = v[k];
v[k] = v[k+1];
v[k+1] = temp;
```

```
lw    $t0, 0($2)
lw    $t1, 4($2)
sw    $t1, 0($2)
sw    $t0, 4($2)
```

```
0000 1001 1100 0110 1010 1111 0101 1000
1010 1111 0101 1000 0000 1001 1100 0110
1100 0110 1010 1111 0101 1000 0000 1001
0101 1000 0000 1001 1100 0110 1010 1111
```
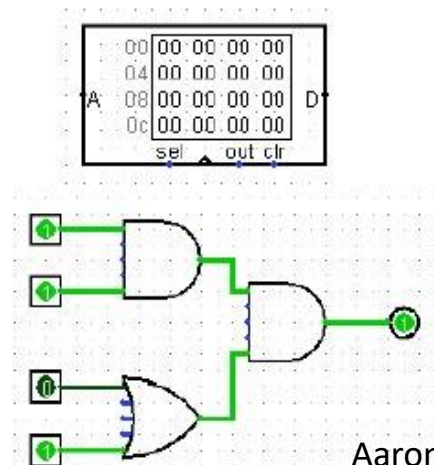
Aaron Tan's slide

CSCM601150 : PSD

- Introduction to modern logic design and digital building blocks:
  - Digital circuits, Logic design and Micro-operations

- Focus on how to design and build Digital Systems:
  - From simple gates to more complex building blocks.

- Learn modern tools to design digital circuits.