

Overview

- Why VLSI?
- Moore's Law.
- The VLSI design process.

Integrated Circuits (IC)

Name	Signification	Year	Transistors number	Logic gates number
SSI	small-scale integration	1964	1 to 10	1 to 12
MSI	medium-scale integration	1968	10 to 500	13 to 99
LSI	large-scale integration	1971	500 to 20,000	100 to 9,999
VLSI	very large-scale integration	1980	20,000 to 1,000,000	10,000 to 99,999
ULSI	ultra-large-scale integration	1984	1,000,000 and more	100,000 and more

VLSI

- Acronym of VLSI
 - Very-Large-Scale Integration
- A VLSI contains more than a million or so switching devices or logic gates
- Early in the first decade of the 21st century, the actual number of transistors has exceeded 100 million
- A piece of silicon (a chip) is typically about 1 centimeter on a side

Advantages of VLSI

- **Size:** Integrated circuits are much smaller. Small size leads to advantages in speed and power consumption, since smaller components have smaller parasitic resistances, capacitances, and inductances.
- **Speed:** Signals can be switched between logic 0 and logic 1 much quicker within a chip than they can between chips.
- **Power consumption:**
 - Logic operations within a chip take much less power.
 - Smaller parasitic capacitances and resistances require less power to drive them

VLSI and systems

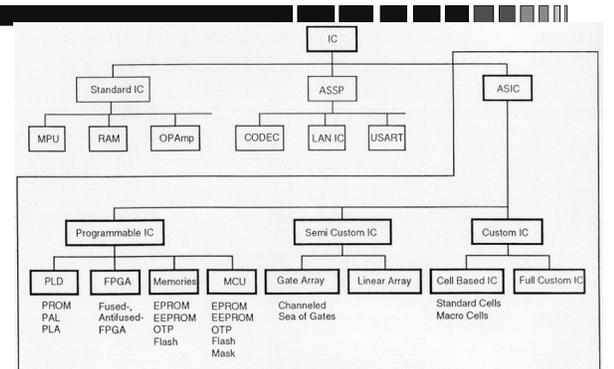
These advantages of integrated circuits translate into advantages at the system level:

- Smaller physical size
- Lower power consumption
- Reduced cost
- Integration improves the design:
- Integration reduces manufacturing cost-(almost) no manual assembly.

VLSI and you

- Microprocessors:
 - personal computers;
 - microcontrollers.
- DRAM/SRAM.
- Special-purpose processors.

VLSI Design Styles



VLSI Design Styles....

- Full Custom
- Application-Specific Integrated Circuit (ASIC)---
- Programmable Logic (PLD, FPGA)
- System-on-a-Chip

Full Custom Design

... a methodology for designing integrated circuits by specifying the layout of each individual transistor and the interconnections between them

- Each circuit element carefully “handcrafted”
- Huge design effort
- High Design & NRE Costs / Low Unit Cost
- High Performance
- Typically used for high-volume applications

ASIC

■ *Rather than build a system out of standard parts, designers can now create a single chip for their particular application*

- Constrained design using pre-designed (and sometimes pre-manufactured) components
- Also called semi-custom design
- CAD tools greatly reduce design effort
- Low Design Cost / High NRE Cost / Med. Unit Cost
- Medium Performance

Programmable Logic (FPGA)

It contains ten thousand to more than a million logic gates with programmable interconnection. Programmable interconnections are available for users or designers to perform given functions easily

- Pre-manufactured components with programmable interconnect
- CAD tools greatly reduce design effort
- Low Design Cost / Low NRE Cost / High Unit Cost
- Lower Performance

System-on-chip (SOC)

SoC is a system on a VLSI chip that has all needed analog as well as digital circuits, processors and software, for example, single-chip mobile phone

- Idea: combine several large blocks
 - » Predesigned custom cores (e.g., microcontroller) - “intellectual property” (IP)
 - » ASIC logic for special-purpose hardware
 - » Programmable Logic (PLD, FPGA)
 - » Analog
- Open issues
 - » Keeping design cost low
 - » Verifying correctness of design

Moore's Law

- Gordon Moore: co-founder of Intel.
- Predicted that number of transistors per chip would grow exponentially (double every 18 months).
- Exponential improvement in technology is a natural trend: steam engines, dynamos, automobiles.