Lesson 7: SYSTEM-ON-CHIP (SoC) AND USE OF VLSI CIRCUIT DESIGN TECHNOLOGY

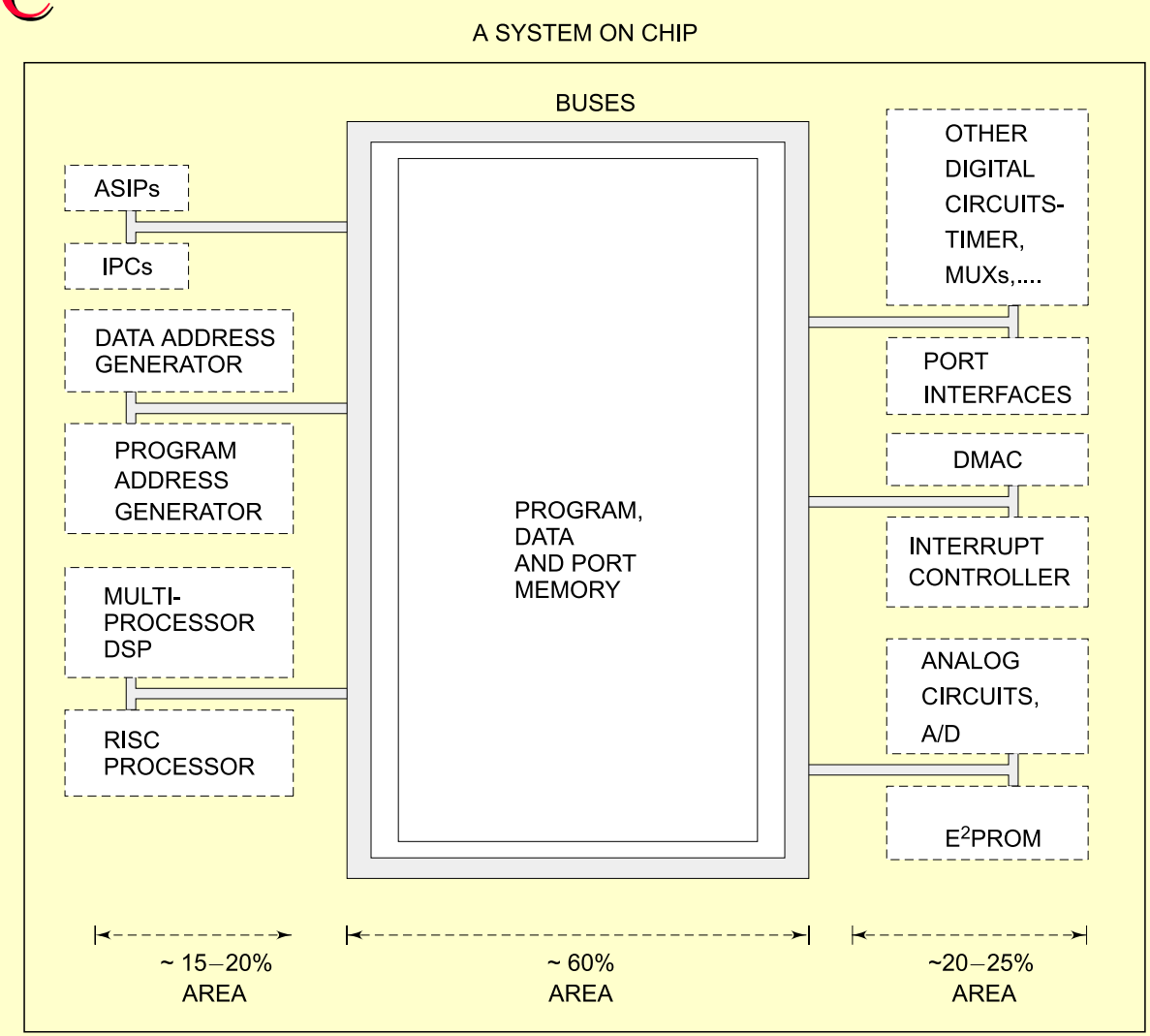
VLSI chip

- Integration of high-level components
- Possess gate-level sophistication in circuits above that of the counter, register, multiplier, floating point operation unit and ALU.

System on chip (SoC) a new design innovation

- 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

New Innovation Example – Mobile Phone on a SoC



SYSTEM-ON-CHIP

Embeds:

- Multiple processors,
- memories,
- multiple standard source solutions (IP Cores),
- Logic and analog units

Embedding a Microprocessor

- General Purpose Processor (GPP) microprocessor can be embedded on a VSLI chip.

Embedding an ASIP

- Processor with instruction set designed for specific application on a VLSI chip for example, microcontroller, DSP, IO, media, network or other domain specific processor

Embedding a Microcontroller core

- 68HC11xx,
- HC12xx,
- HC16xx8051,
- 80251 PIC 16F84 or
- 16C76, 16F876 and PIC18Microcontroller
- Enhancements of ARM9/ARM7 ARM Cortex M3 from Philips, Samsung and ST Microelectronics

Embedding a DSP Core

- TMS320Cxx, OMAP1Tiger SHARC 5600xx PNX 1300, 15002
- DSP for mobile phones, for example, OMAP of Texas Instruments use the effective power dissipation methods of dynamic switching both of power supply voltage and operating frequency of the CPU core.
- Filtering, noise cancellation, echo elimination, compression and encryption

Embedding a Multi-processor or Dual Core using General Purpose Processors (GPP)

- Speech signal-compression and coding.
- Signal decoding and decompression.

Embedding an Accelerator

- Accelerate the execution of codes, for example, a floating point coprocessor accelerates the mathematical operations and Java accelerator accelerates the Java code execution.

Embedding Single purpose processors

- For Dialing, Modulating, Transmitting. Demodulating and Receiving.
- Keypad interface and display interface handling.
- Touch screen
- Message display and creation, SMS (Short Message Service) and MMS
- Protocol- stack generation.
- Pixel coprocessor and CODEC in a digital camera

SoC

- Embedded processor GPP or ASIP core,
- Single purpose processing cores or multiple processor cores,
- A network bus protocol core,
- An encryption and decryption functions cores,
- Cores for FFT and Discrete cosine transforms for signal processing applications,
- Memories

SoC (Contd.)

- Multiple standard source solutions, called IP (Intellectual Property) cores,
- Programmable logic device and FPGA (Field Programmable Gate Array) cores.
- Other logic and analog units.

IPs in SoC

- IP –a standard source solution for synthesizing a higher-level component by configuring a core of VLSI circuit or FPGA core available as an Intellectual Property, called (IP).
- High Level Components with gate level sophistication circuit much above level of counters and registers.

IPs

- Designer or designing company holds the copyright for the synthesized design of a higher-level component for gate-level implementation of an IP.
- One might have to pay royalty for every chip shipped. An embedded system may incorporate several IPs.

IP

An IP may provide a

- design for adaptive filtering of a signal.
- full design for implementing Hypertext Transfer Protocol (HTTP) or File Transfer Protocol (FTP) to transmit a web page or file on Internet.
- USB port controller, Bluetooth, GPS interface, Wireless 802.11or 802.16 interfaces

FPGA Core

- An FPGA consists of a large number of programmable gates on a VLSI chip. There is a set of gates in each FPGA cell, called 'macro cell'.
- Embedded system designed with a view of offering enhancing functionalities in future, then FPGA core can be used in the circuits.

FPGA Core

- Each cell has several inputs and outputs. All cells interconnect like an array (matrix).
- Each interconnection is programmable through the associated memory RAM in a FPGA programming tool.
- A concept is using FPGA (Field Programmable Gate Arrays) core along with single or multiple processors.

Use of Xilinx Spartan-3

90 nm based FPGAs with Power PCs (2003)

Use of FPGAs cum Processor Cores

- FPGA 125136 Logic Cells along with the Four IBM PowerPC processors [Exemplary Application: System with a Data Encryption Engine at 1.5 Gbps]

FPGA

- An SIMD instruction, Fourier transform and its inverse, DFT or Laplace transform and its inverse, compression or decompression, encrypting or deciphering, a specific pattern-recognition (for recognizing a signature or finger print or DNA sequence).
- Configure an algorithm into the logic gates of the FPGA.

Summary

We learnt

- Subunits in SoC ,
- IPs into VLSI Chip
- Embedded FPGA Cores

End of Lesson 7