Chapter 1 Lesson 2: PROCESSOR IN EMBEDDED SYSTEM
Hardware units in the Embedded Systems
Typical Embedded System Hardware units

- Input Devices Interfacing/Driver Circuits
  - Processor
  - Timers
  - Interrupt Controller
- Outputs Interfacing/Driver Circuits
- Program Memory and Data Memory
  - System Application Specific Circuits
  - Serial Communication Ports
  - Parallel Ports
Processor

- Program Flow and data path Control Unit (CU) —includes a fetch unit for fetching instructions from the memory
**Processor**

- Execution Unit (EU) — includes circuits for arithmetic and logical unit (ALU), and for instructions for a program control task, say, data transfer instructions, halt, interrupt, or jump to another set of instructions or call to another routine or sleep or reset.
System designer considerations

- Processor Instructions in the Instruction set
- Processor ability to solve the complex algorithms used in meeting the deadlines for their processing.
- Maximum bits in operand (8 or 16 or 32) in a single arithmetic or logical operation.
- Internal and External bus-widths in the data-path
System designer considerations

Clock frequency in MHz and processing speed –

- Million Instructions Per Second (MIPS) or
- Million Floating Point Instructions Per Second (MFLOPS) or
- Dhrystone – an alternate metric for measuring processing performance. Refer Section 2.6
1a. General purpose microprocessor

For example, Intel 80x86, Sparc, or Motorola 68HCxxx
1b. **Embedded general purpose processor**

- Fast context switching features, use of on-chip Compilers, for example, Intel® XScale™

Applications Personal Internet Client
Architecture-based PDAs, cell phones and other wireless devices,
2. Application Specific Instruction-Set Processor (ASIP)

(a) Microcontroller — Intel, Motorola, Hitachi, TI, Philips and ARM, …
For example, an Intel® — MCS51, Philips® 51XA, 51MX, or Motorola — 68HC11, 68HC12, 68HC16
Commonly used exemplary microcontrollers in small scale embedded systems

Small Scale Embedded System 8/16-bit Microcontroller

- 8051 family
- PIC16F8X family
- Hitachi H8
- 68HC11xx
Commonly used exemplary microcontrollers in medium scale embedded systems

Medium Scale Embedded System
16-bit Microcontroller

- 8051MX
- PIC 16F876, PIC18
- Hitachi D64F2623FA
- 68HC12xx, 68HC16xx
Commonly used exemplary microcontrollers in large-scale embedded systems

Large Scale Embedded System 32-bit Microcontroller

ARM family Cortex-M3, Atmel AT91 series, ST10 series, Philips LPC 2000 series, Texas Instrument C16x and TMS470R1B1M, Samsung S3C44B0X

Hitachi SH7045F
Subunits in a Microcontroller

- Functional Circuits in a Chip of Microcontroller (Microcomputer)
  - Processor
  - RAM and ROM in Internal Pay
  - EEPROM/PROM
  - External Memories Interface
  - Timer and Watchdog Timer
  - Interrupt Controller

Application Specific Circuits in Specific Versions
- UART Controller
- A/D Converter
- LAN Controller
- Parallel Circuit for EMU
- USB
- Other ISA
Application Specific Instruction-Set Processor (ASIP)

(b) DSP or
(c) Media processor or
(d) IO processor or
(e) Network processor or
(f) A domain specific processor
(b) DSP

Typically a

- Texas Instruments- C28x Series, C54xx or C64xx or
- Analog Devices SHARC or TigerSHARC,
- Motorola 5600xx
(d) Media processor

TI DSP TMS320DM310 or Trimedia Philips Media Processor 1x00 series for Processing Streaming and Data Networks and Image, Video and Speech: PNX 1300, PNX 1500 (2002)
A Media Processor PNX 1x00
3. **GPP or ASIP core (s)**

- GPP or ASIP Integrated into either an Application Specific Integrated Circuit (ASIC), or a *Very Large Scale Integrated Circuit (VLSI)* circuit or a FPGA core integrated with processor unit(s) in a VLSI (ASIC) chip
4. Application Specific System Processor (ASSP)

Typically a set top box processor or mpeg video-processor or network application processor or mobile application processor
5. Single purpose processor or Application Specific Instruction processor

- Floating point Coprocessor
- CCD Pixel coprocessor and image codec in digital camera
- Graphic processor
- Speech processor
- Adaptive filtering processor
- Encryption engine
- Decryption engine
- Communication protocol stack processor
- Java accelerator
Use of Accelerator Cores:

**Examples**

- Java Accelerator *Nazonin Communications* Java codes run 15 to 60 Times fast,
- Video Accelerator for fast Video processing
6. Multi core processors or multiprocessor system using GPPs

Examples

- Multiprocessor system for Real time performance in a video-conference system,
- Embedded firewall cum router,
- High-end cell phone, …
Summary

We learnt

- (i) overview of hardware units,
- (ii) Processor (s) used in the systems: general purpose processor, ASIPs (microcontroller, DSP, Media processor, ..), single purpose processor and multi-processor, ...
End of Lesson 2