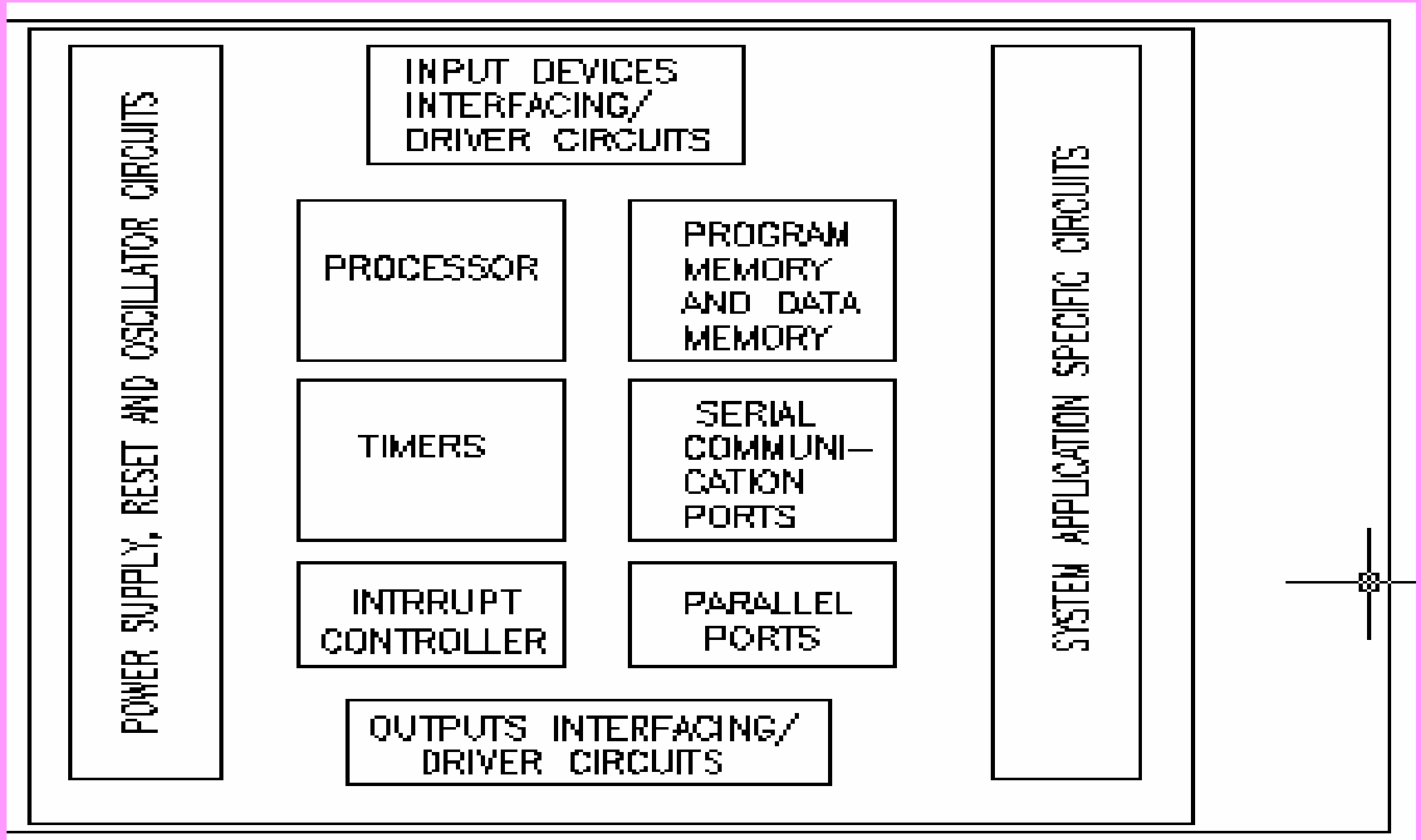
Chapter 1 Lesson 3

Hardware Elements in the Embedded Systems

Typical Embedded System Hardware units



Basic Circuit Elements at the System

(i) Power Source

1. System own supply with separate supply rails for IOs, clock, basic processor and memory and analog units, *or*
2. Supply from a system to which the embedded system interfaces, for example in a network card, *or*

(i) Power Source (*contd.*)

3. Charge pump concept used in a system of little power needs, for examples, in the mouse or contact-less smart card.

Power Dissipation Management

1. Clever real-time programming by Wait and Stop instructions
2. Clever reduction of the clock rate during specific set of instructions
3. Optimizing the codes and
4. Clever enabling and disabling of use of caches or cache blocks

(ii) Clock Oscillator Circuit and Clocking Units

1. Appropriate clock oscillator circuit
2. Real Time Clock*(System Clock) and Timers driving hardware and software

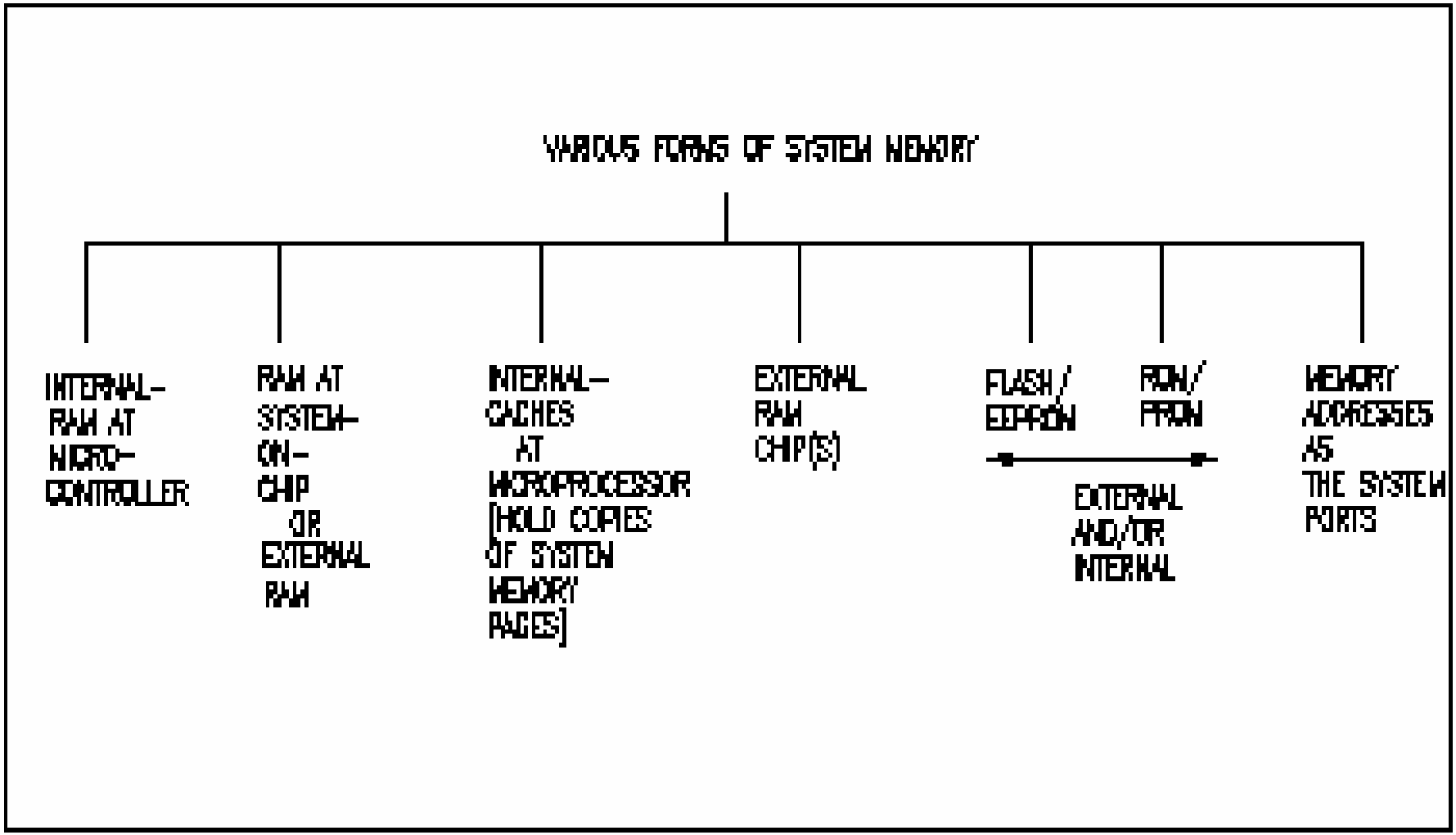
* RTC

(iii) Reset Circuit

1. Reset on Power-up
2. External and Internal Reset circuit
3. Reset on Timeout of Watchdog timer

(Ref: Section 1.3.4 for details)

(iv) Memory


VARIOUS FORMS OF SYSTEM MEMORY
INTERNAL-RAM AT MICRO-CONTROLLER
RAM AT SYSTEM-ON-CHIP OR EXTERNAL RAM
INTERNAL-CACHES AT MICROPROCESSOR [HOLD COPIES OF SYSTEM MEMORY PAGES]
EXTERNAL RAM CHIP(S)
FLASH/EEPROM
ROM/PROM
EXTERNAL AND/OR INTERNAL
MEMORY ADDRESSES AS THE SYSTEM PORTS

a. Functions Assigned to the ROM or EPROM or Flash

1. Storing 'Application' program from where the processor fetches the instruction codes
2. Storing codes for system booting, initializing, Initial input data and Strings.
3. Storing Codes for RTOS.
4. Storing Pointers (addresses) of various service routines.

b. Functions Assigned to the Internal, External and Buffer RAM

1. Storing the variables during program run,
2. Storing the stacks,
3. Storing input or output buffers for example, for speech or image .

c. Functions Assigned to the EEPROM or Flash

- Storing non-volatile results of processing

d. Functions Assigned to the Caches

1. Storing copies of the instructions, data and branch-transfer instructions in advance from external memories and
2. Storing temporarily the results in write back caches during fast processing

(v) Interrupts Handler

Interrupt Handling element for the external port interrupts, IO interrupts, timer and RTC interrupts, software interrupts and exceptions

(Ref: Section 1.3.11 for details)

(vi) Linking Embedded System Hardware

- Linking and interfacing circuit* for the Buses by using the appropriate multiplexers, and decoders, demultiplexers Interface the various system units

**(Also called glue circuit, Ref: Section 2.2 for details)*

3. IO Communication Unit

a. Communication Driver(s) *: Network Ethernet or serial driver to communicate with host embedded system Expansion Facility …

**(Ref: Sections 3.9 to 3.13 for details)*

- Serial Bus(es): For example, UART (512 kbaud/s), 1-wire CAN (33 kbps), Industrial I^2C (100kbps), SM I^2C Bus (100 kbps), SPI (100 kbps), Fault tolerant CAN (110 kbps), Serial Port (230 kbps), MicroWire (300 kbps), …

- SCSI parallel (40 Mbps), Fast SCSI (8M to 80 Mbps) , Ultra SCSI-3 (8M to 160 Mbps), FireWire/IEEE 1394 (400 Mbps, 72 meter), High Speed USB 2.0 (480 Mbps, 25 meter)

Parallel Bus(es): PCI, PCI-X

b. Media IO Control Element

c. Keypad or Keyboard IO Interface

d. LCD Display System Interface

e. ADC – Single or Multi channel

f. DAC

g. GPIB Interface Element

h. Pulse Dialing Element

i. Modem

j. Bluetooth, 802.11, IrDA, ..

Summary

We learnt that the hardware elements :

(i) processor(s) and

(ii) basic circuit elements: power source, clock, reset, timers, memory, glue circuit for the elements linking and interfaces

(iii) keypad, LCD display matrix or touch screen

(iv) IO communication elements: buses (serial and parallel), interfaces for network interface, ADC, DAC, pulse dialer, modem, Bluetooth, 802.11, … as per the application

(v) interrupt handler

End of the Lesson - 3