

Lesson 10:DESIGN PROCESS  
EXAMPLES –Automatic Chocolate  
vending machine, smart card and digital  
camera

# Automatic Chocolate Vending Machine (ACVVM)

# Diagrammatic representation of ACVM

Keypad for user  
Interface

LCD Display or Touch Screen for  
user

Mechanical  
Coin Sorter

Microcontroller based  
hardware

USB\_Wireless  
\_Modem

RTOS

Software

**Chocolate and refunded coins  
collector**

# ACVM

- Coin insertion slot
- Keypad on the top of the machine.
- LCD display unit on the top of the machine. It displays menus, text entered into the ACVM and pictograms, welcome, thank and other messages.
- Graphic interactions with the machine.
- Displays time and date.

# ACVM

- Delivery slot so that child can collect the chocolate and coins, if refunded.
- Internet connection port so that owner can know status of the ACVM sales from remote.

# ACVM Hardware units

- Microcontroller or ASIP (Application Specific Instruction Set Processor)
- RAM for storing temporary variables and stack
- ROM for application codes and RTOS codes for scheduling the tasks
- Flash memory for storing user preferences, contact data, user address, user date of birth, user identification code, answers of FAQs

## ACVM Hardware units (contd.)

- Timer and Interrupt controller
- A TCP/IP port (Internet broadband connection) to the ACVM for remote control and for getting ACVM status reports by owner.
- ACVM specific hardware
- Power supply .

# ACVM Software components

- Keypad input read
- Display
- Read coins
- Deliver chocolate
- TCP/IP stack processing
- TCP/IP stack communication

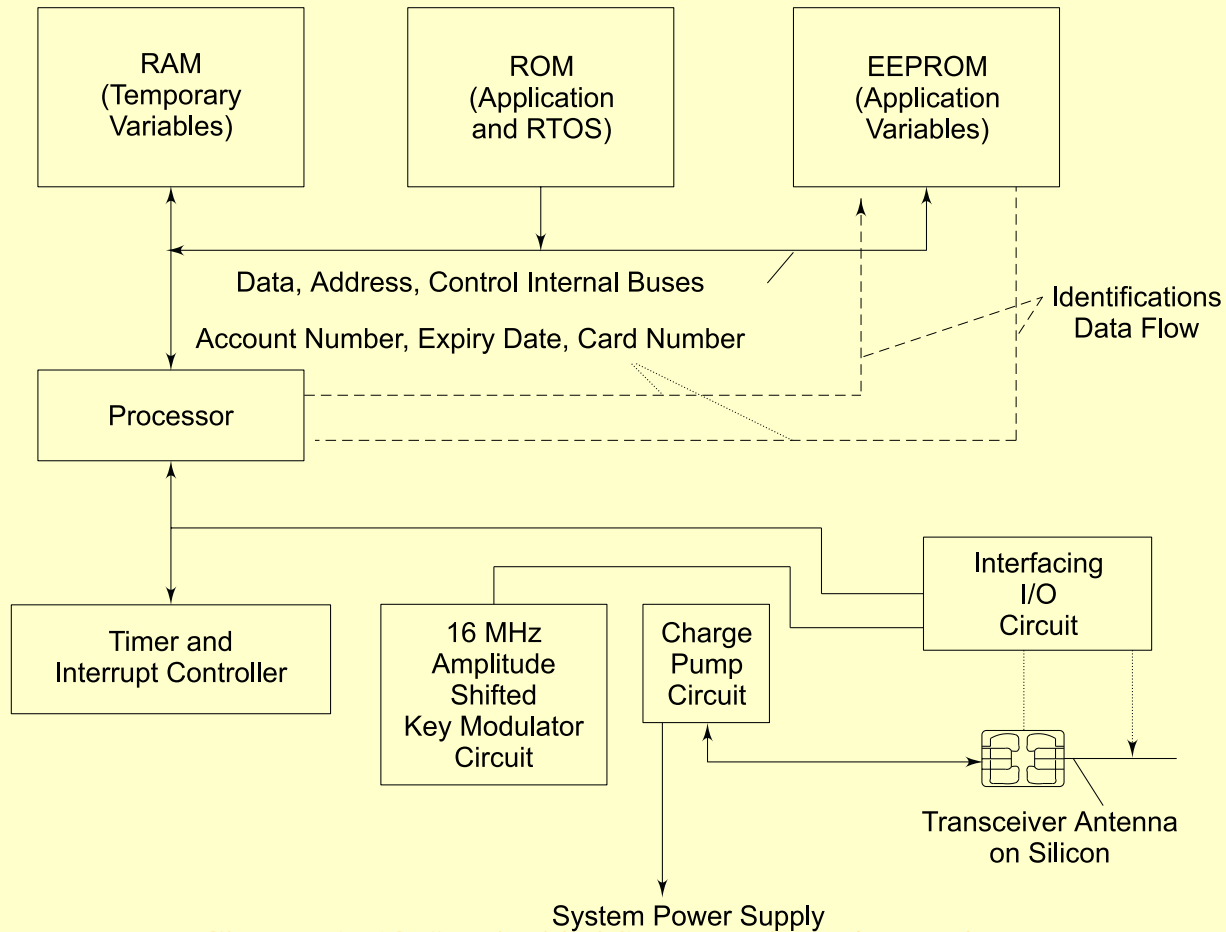
# Smart Card

## Smart Card

- Smart card– a plastic card in ISO standard dimensions, 85.60 mm x 53.98 x 0.80 mm.
- Embedded system on a card.
- SoC (System-On-Chip).
- ISO recommended standards are ISO7816 (1 to 4) for host-machine contact based cards and ISO14443 (Part A or B) for the contact-less cards.
- Silicon chip is just a few mm in size and is concealed in-between the layers. Its very small size protects the card from bending

# Embedded hardware components in a contact less smart card

An Embedded System  
Contact-less Smart Card Components



# Embedded hardware components

- Microcontroller or ASIP (Application Specific Instruction Set Processor)
- RAM for temporary variables and stack
- ROM for application codes and RTOS codes for scheduling the tasks
- EEPROM for storing user data, user address, user identification codes, card number and expiry date
- Timer and Interrupt controller
- A carrier frequency ~16 MHz generating circuit and Amplitude Shifted Key (ASK)
- Interfacing circuit for the I/Os
- Charge pump

# ROM

- Fabrication key, Personalization key An utilisation lock
- RTOS and application using only the logical addresses.

# Embedded Software

- Boot-up, Initialisation and OS programs
- Smart card secure file system
- Connection establishment and termination
- Communication with host
- Cryptography
- Host authentication
- Card authentication
- Addition parameters or recent new data sent by the host (for example, present balance left)

# Smart Card OS Special features

- Protected environment.
- Every method, class and run time library should be scalable.
- Code-size generated be optimum.
- Memory should not exceed 64 kB memory.
- Limiting uses of specific data types; multidimensional arrays, long 64-bit integer and floating points

# Smart Card OS Limiting features

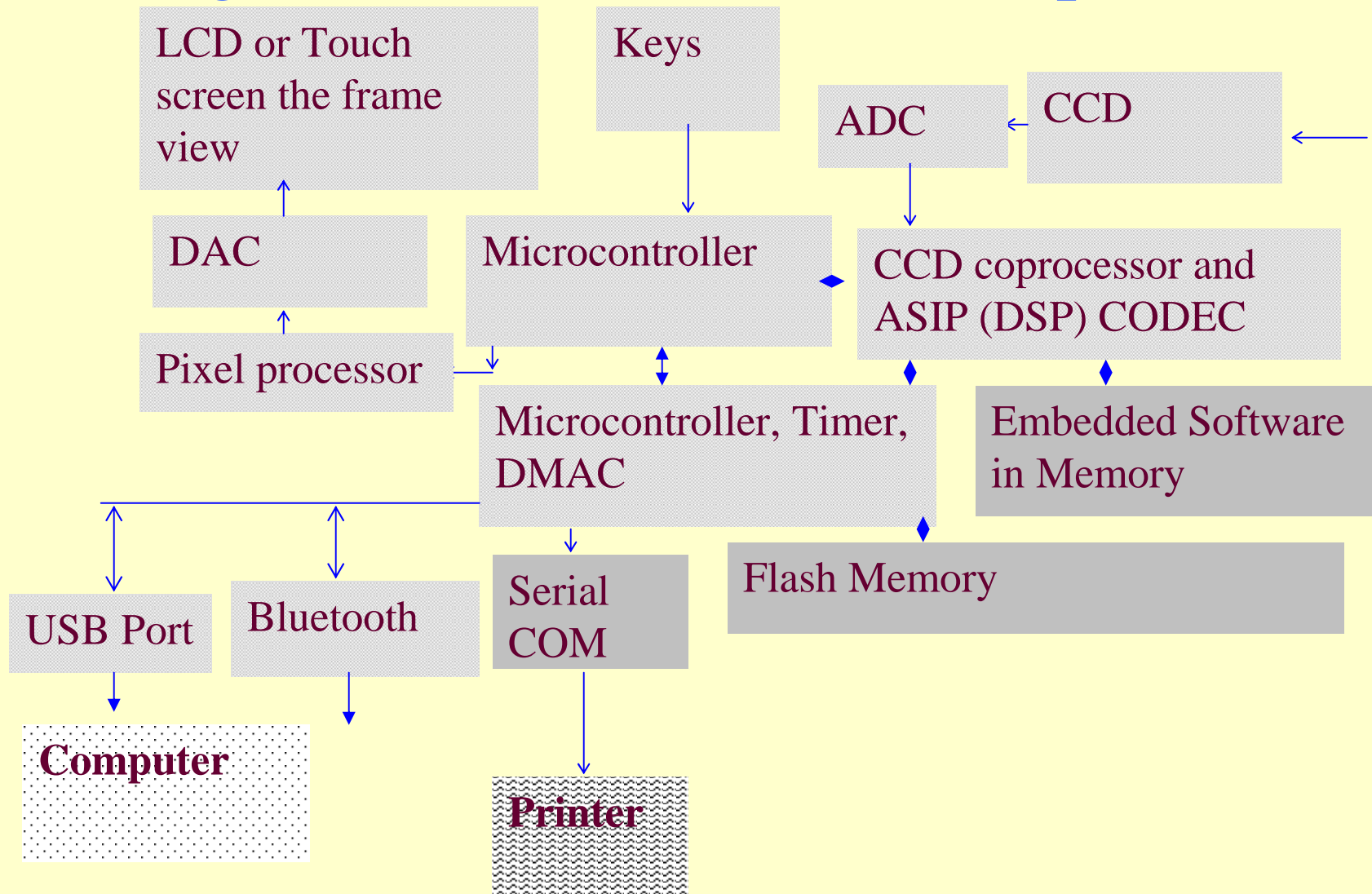
- Limiting uses of the error handlers, exceptions, signals, serialization, debugging and profiling. [Serialization means process of converting an object is converted into a data stream for transferring it to network or from one process to another. At receiver end there is de-serialization.]

# Smart Card OS File System and Classes

- Three-layered file system for the data.
- **Master file** to store all file headers.
- **Dedicated file** to hold a file grouping and headers of the immediate successor elementary files of the group.
- **Elementary file** to hold the file header and its file data.
- Fixed-length or **variable-file length management**
- **Classes** for the network, sockets, connections, data grams, character-input output and streams, security management, digital-certification, symmetric and asymmetric keys-based cryptography and digital signatures.

# Digital Camera

# Digital camera hardware components



# A typical Camera

- 4 M pixel/6 M pixel still images, clear visual display (ClearVid) CMOS sensor, 7 cm wide LCD photo display screen, enhanced imaging processor, double anti blur solution and high-speed processing engine, 10X optical and 20X digital zooms
- Record high definition video-clips. It therefore has speaker microphone(s) for high quality recorded sound.
- Audio/video Out Port for connecting to a TV/DVD player.

# Arrangements

- Keys on the camera.
- Shutter, lens and charge coupled device (CCD) array sensors
- Good resolution photo quality LCD display unit
- Displays text such as image-title, shooting data and time and serial number. It displays messages. It displays the GUI menu when user interacts with the camera.
- Self-timer lamp for flash.

## Internal units

- Internal memory flash to store OS and embedded software and limited number of image files
- Flash memory stick of 2 GB or more for large storage.
- Universal Serial Bus (USB), Bluetooth and serial COM port for connecting it to computer, mobile and printer.

## Internal units

- LCD screen to display frame view.
- Saved images display using the navigation keys.
- Frame light falls on the CCD array, which through an ADC transmits the bits for each pixel in each row in the frame and for the dark area pixels in each row for offset correction in CCD signaled light intensities for each row.
- The CCD bits of each pixel in each row and column are offset corrected by CCD signal processor (CCDSP).

# ASIP and Single purpose processors

- For Signals compression using a JPEG CODEC and saved in one jpg file for each frame.
- For DSP for compression using the discrete cosine transformations (DCTs) and decompression.
- For DCT Huffman coding for the JPEG compression.
- For decompression by inverse DCT before the DAC sends input for display unit through pixel processor.
- Pixel processor (for example, image contrast, brightness, rotation, translation, color adjustment)

# Digital Camera Hardware units

- Microcontroller or ASIP (Application Specific Instruction Set Processor)
- Multiple processors (CCDSP, DSP, Pixel Processor and others)
- RAM for storing temporary variables and stack
- ROM for application codes and RTOS codes for scheduling the tasks

# Digital Camera Hardware units

- Timer, Flash memory for storing user preferences, contact data, user address, user date of birth, user identification code, ADC, DAC and Interrupt controller
- The DAC gets the input from pixel processor, which gets the inputs from JPEG file for the saved images and also gets input directly from the CCDSP through pixel processor or the frame in present view
- USB controller Direct Memory Access controller
- LCD controller
- Battery and external charging circuit

# Digital Camera Software components

- CCD signal processing for off-set correction
- JPEG coding
- JPEG decoding
- Pixel processing before display
- Memory and file systems
- Light, flash and display device drivers
- LCD, USB and Bluetooth Port device- drivers for port operations for display, printer and computer communication control

# Digital camera software components

Light, flash and display device drivers

CCD signal processing

JPEG coding

JPEG decoding

Pixel co-processing  
LCD and USB Port device drivers

LCD, Bluetooth COM and USB Port device drivers

# Summary

We learnt functions, hardware and software components for

- Automatic Chocolate vending machine,
- smart card and
- digital camera

# End of Lesson 10