SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECT312 – EMBEDDED SYSTEM DESIGN

III YEAR/ VI SEMESTER

UNIT 1 – **INTRODUCTION TO EMBEDDED SYSTEMS**

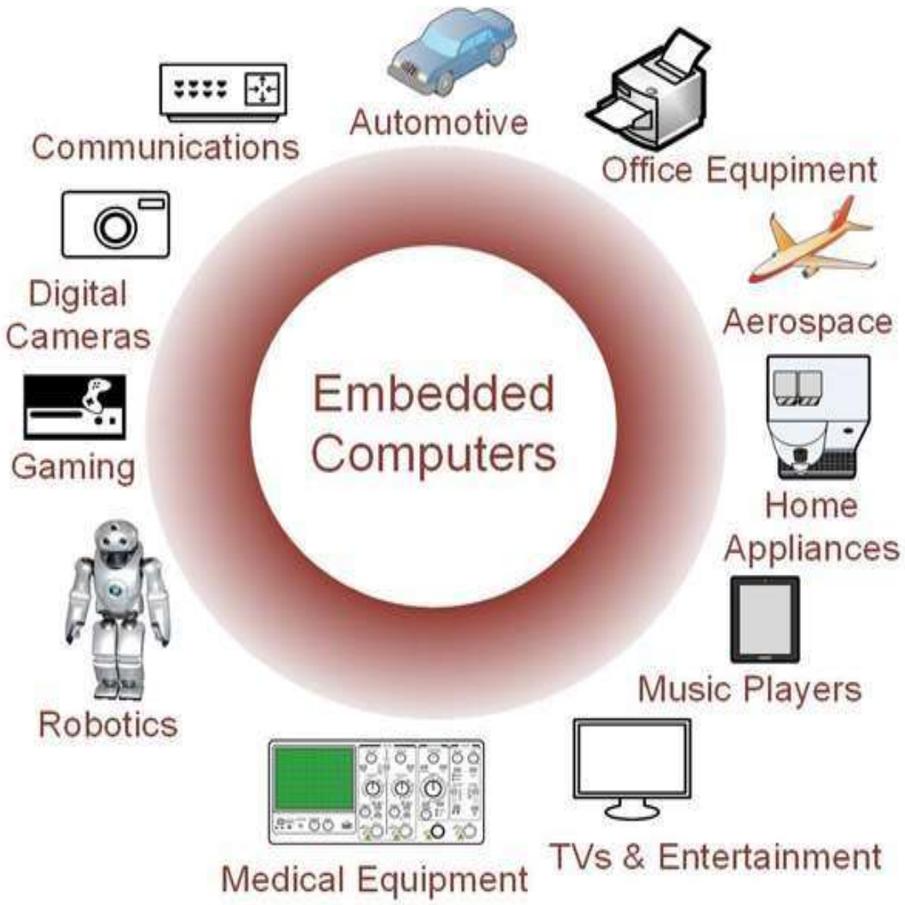
TOPIC 2 –1.3 – Introduction to Embedded Systems

Introduction to Embedded Systems

- Electronic or Electro-mechanical system, which is a combination of hardware and software designed to perform a specific function
- computer system mounted inside any product.
- similar to a general-purpose computer, which performs different applications like
  - printing
  - scanning
  - playing games
  - reading and writing documents
  - hearing songs and videos

How it differs from computer system?

- computer system is a general purpose computing system which is designed to perform general purpose applications like
  - playing games
  - watching movies
  - document works
  - printing and scanning
  - saving the content in the memory, etc.



How it differs from computer system?

Sl.no	Computer System	Embedded System
1	General purpose computing system.	Specific purpose computing system.
2	Needs human interaction to perform a task.	Does not need any human interaction to perform a task.
3	Requires more user interface to work with.	It requires only less user interface to with an embedded system.
4	Computers can be reprogrammed by the end-user.	Embedded systems cannot be reprogrammed by the user.
5	It is not a time-critical system.	It is a time-bounded system. The task must be completed within a specified time.
6	The size of the computers is large in size when compared with embedded systems.	Most modern embedded systems are small in size.
7	Computers require more memory to store lots of data.	It requires less memory to store the system program.

Applications

- In our day-to-day life, embedded systems play a vital role starting from our home to large industries
- We live in a world surrounded by an embedded system

Applications

Automotive Industry – Cruise control system, Airbag control system, in-vehicle Entertainment system, navigation systems, climate control, anti-lock breaking system (ABS), parking system, etc.

Telecommunications – telephone switches, mobile phones, broadband networks, robotics in the transmission line, etc.

In Peripherals & Computer Networking – Displays and Monitors, Networking Systems, Image Processing, Network cards, routers and printers.

Household applications – Television, Washing machine, refrigerators, Microwave Owen, induction stove, etc.

Measurement & instrumentation – Digital multimeters, Digital CROs, Logic analyzers, Control units, etc.

Applications

Consumer Electronics – Digital Cameras, Set-top Boxes, mobile phones, GPS receivers, game consoles, High Definition TVs, DVDs, etc.

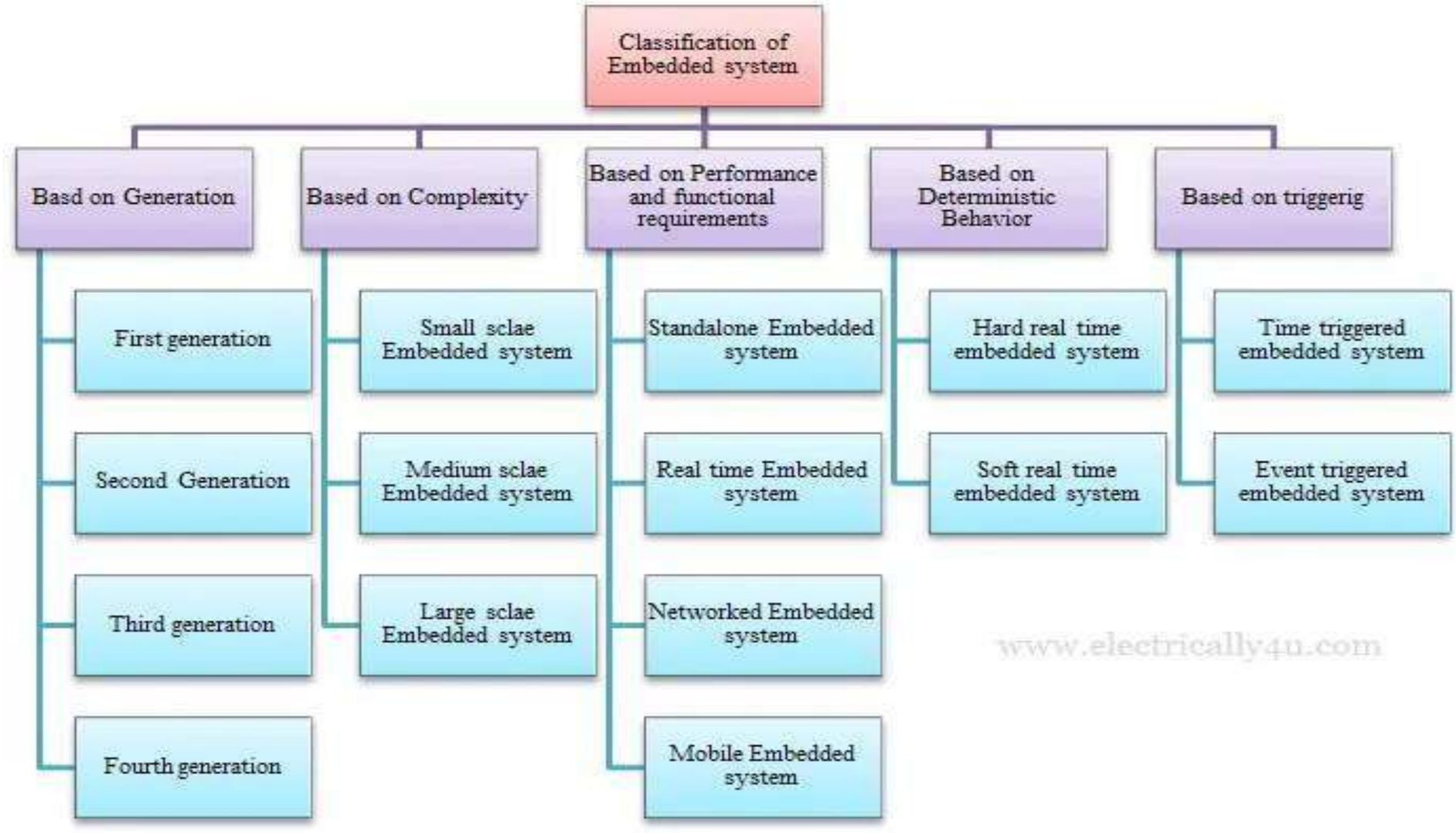
Military applications – surveillance systems, cybersecurity systems, Defense and aerospace, Communication, etc.

Home Automation and Security Systems – Air conditioners, Sprinklers, Detection alarms, Fire alarms, CCTVs, Television cameras, etc.

Health care – Different scanners, EEG, ECG machines, CT scans, MRI scans, glucose monitors, pacemakers, etc.

Banking Industry – Automatic Teller Machines (ATM), currency counters, Cash Dispersing Machine (CDM), passbook printing machine, card swipe machine, etc.

Classifications of Embedded Systems



Classifications of Embedded Systems

Based on Generation- evolved from its initial version to the latest version.

First Generation

- 8-bit microprocessors and 4-bit microcontrollers.
- Such embedded system possess simple hardware and firmware developed using assembly code.
  eg. Digital telephone keypads, stepper motor control units etc..

Second Generation

- 8-bit processor and 4-bit controllers are replaced by 16-bit microprocessors and 8-bit microcontrollers.
- more powerful and complex compared to previous generation processors
  eg. Data acquisition systems, SCADA systems

Classifications of Embedded Systems

Third Generation

- domain-specific processors/controllers like Digital Signal Processors (DSP), Application-Specific Integrated Circuits (ASICs) and the concept of instruction pipelining, embedded real-time operating system evolved into the embedded system industry
- powerful 32-bit microprocessors and 16-bit microcontrollers
- operation has become much more powerful and complex than the second generation eg. Robotics, industrial process control, embedded networking

Fourth Generation

- recent development of microprocessors and microcontrollers has evolved during these modern days.
- New concepts like System-on-Chip(SOC), reconfigurable processors, multicore processors, coprocessors also emerged into the embedded market to add more powerful performance in the embedded system.
- These systems also make use of the high-performance real-time operating system for their operation.

  eg. Smart devices, digital cameras, etc

Classifications of Embedded Systems

Based on complexity

1. Small Scale Embedded Systems
2. Medium Scale Embedded Systems
3. Large scale Embedded Systems

Small Scale Embedded Systems

- single 8 or 16-bit microprocessor or controller.
- main programming tools used are an editor, assembler, cross assembler and Integrated Development Environment (IDE).
- The hardware and software complexities in small-scale embedded system are very low.
- It may or may not contain an operating system for its functioning.
  eg. An electronic toy

Classifications of Embedded Systems

Medium Scale Embedded Systems

- 16-bit or 32-bit microprocessor or controller, ASICs or DSPs.
- They have both hardware and software complexities.
- The main programming tools used are C, C++, JAVA, Visual C++, RTOS, debugger, source code engineering tool, simulator and IDE.

Large scale Embedded Systems

- highly complex hardware and software, built around 32-bit or 64-bit processors/controllers, RISC processors, SoC, scalable and configurable processors
- sophisticated embedded systems
- They are used for cutting-edge applications that need hardware and software Co-design, where components have to be assembled into the final system
- contain a high-performance real-time operating system for task scheduling, prioritization and management

Based on performance and functional requirements

1. Standalone Embedded Systems
2. Real Time Embedded Systems
3. Networked Embedded Systems
4. Mobile Embedded Systems

Based on performance and functional requirements

Standalone Embedded Systems

- independent systems that do not depend on other systems.
- It takes the input either in analog or digital form, processes and produces the output.
- It may either control or drive the connected devices.

  eg. mp3 players, digital cameras, video game consoles, microwave ovens and temperature measurement systems etc

Real Time Embedded Systems

- gives a required output within a specified time.
- These systems follow the time deadlines for the completion of a task.
- two types - soft real-time and hard real-time embedded systems.

  eg. Automotive airbag control systems, flight control systems

Based on performance and functional requirements

Networked Embedded Systems

- related to a network to access the resources from one place.
- connected network can be LAN, WAN or the internet.
- connection can be either wired or wireless.
- fastest growing area in embedded system applications.

Eg. the embedded web server is a type of system wherein all embedded devices are connected to a web server, accessed and controlled by a web browser.
Home security system, ATM machines, card swipe machines

Mobile Embedded Systems

- compact, easy to use and require fewer resources.
- eg. portable embedded devices like mobile phones, digital cameras, mp3 players and personal digital assistants, etc.

Based on deterministic behavior

Hard Real time system

- A real-time operating system should strictly adhere to the timing constraints for a task.
- A hard real-time system must meet the timing deadlines without any delay.
- Missing the deadline would cause serious failure to the system or user

eg. airbag control system and antilock braking system of vehicles are typical examples for hard real-time systems

(When a vehicle is met with an accident, the airbag control system should operate immediately without any delay to safeguard the passenger. If there is any delay in the deployment of airbags, it will lead to the death of passengers in the vehicle.

So for a hard real-time system, "*A late answer is always a wrong answer*".

Soft Real time system

- deadline is not strictly followed
- Missing deadlines for tasks are acceptable for soft real-time systems, but the frequency of deadlines missing should be within the compliance limit.

eg. ATM - if it takes a few seconds more than the normal operating time, it may not cause any serious problem.

In this case, "a late answer is an acceptable answer", but it could have been done a bit faster

Based on triggering

- time-triggered - activated or triggered based on the pre-defined task or preset time, then such a system is said to be the time-triggered embedded system

- event-triggered- if the system is triggered based on some activity like change in temperature or change in pressure, such system is said to be an event triggered embedded system

THANK YOU