Chapter 1: Introduction to Embedded Systems

In this chapter we will learn:

- What an embedded system is
- Why to embed a computer
- What functions and attributes embedded systems need to provide
- What constraints embedded systems have

What is an Embedded System?

- Application-specific computer system which is built into a larger system or device
- Often runs dedicated software
- Often there to replace previously electromechanical components

[1]

Embedded Networks

- Consists of multiple embedded computers communicating with each other
- Benefits:
  - Lower parts cost
  - Lower labor costs
  - Greater reliability

What are the Benefits of Embedded Systems?

- Reduced cost
- Increased functionality
- Improved performance
- Increased overall dependability

The following slides will explore these aspects of embedded systems by using an automobile as an example
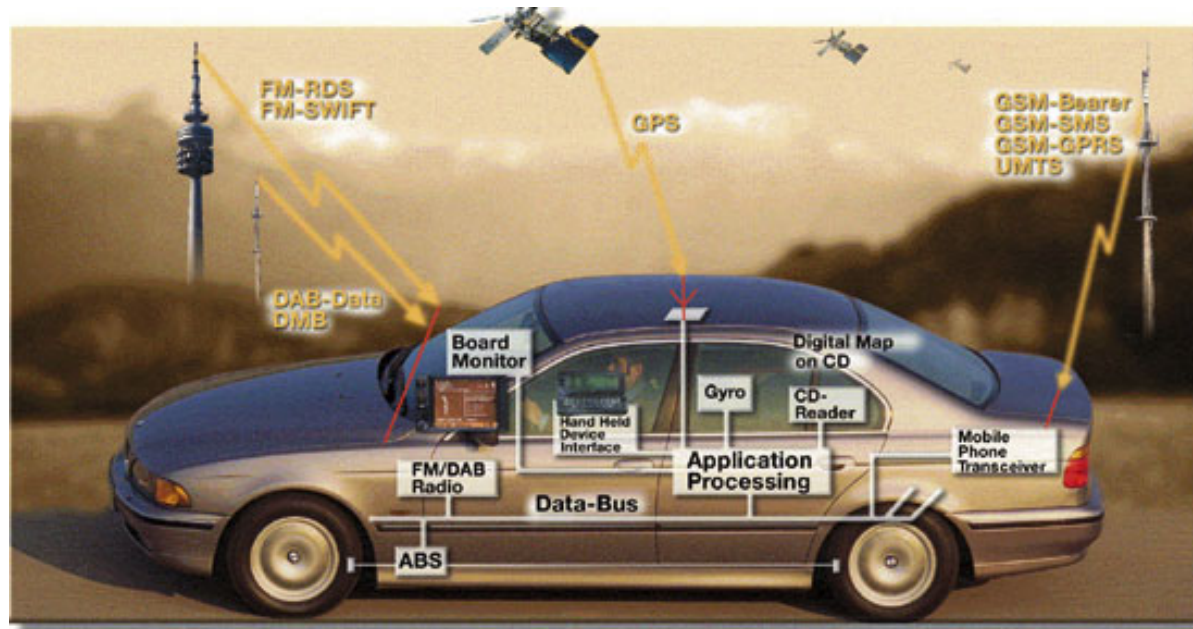
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Using an Automobile as an Example

- Lower costs
    - Components costs: Embedded software can compensate for poor signal quality
    - Manufacturing costs: Control Area Network in a car reduces assembly and parts costs due to the simpler wiring harness
    - Operating costs: Embedded systems allow automobile engines to operate more efficiently by constant monitoring
    - Maintenance costs: Notifying the user when an oil change is due will extend the engine life

Using an Automobile as an Example

[3]

- **More features**
    - Cruise control
    - Smart airbags
    - Power seats
    - Headlights and Interior Lights Automation

- **Better Dependability**
    - Engine controllers can provide limp-home modes to keep the car running even if one or many sensors fail
    - Warning of impending failure can be provided, eg: check engine light
    - Diagnostic information can be provided to the driver or service personnel

Embedded System Functions

- Control systems monitor a process and adjusts an output variable to keep the process running at the desired set point, for example a cruise control system in a car.

- Sequencing, for example the program that runs when a car is started cycling through Crank and Start, Warm-Up, and Idle modes.

- Signal processing modifies input signals to eliminate noise.

- Communications and networking enables different devices on the same network to communicate with one another and exchange information.
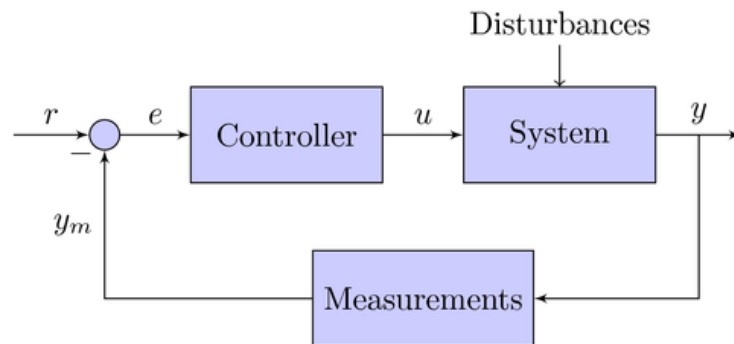

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Attributes of Embedded Systems

- Embedded systems respond to events which occurs in the environment. For example: a user pushing a button, or a motor overheating

- For real-time systems, certain applications require a response from the embedded system within a certain time frame. For example: igniting the fuel in a cylinder since bad timing may damage the engine

- Embedded systems require fault handling in order to ensure safe and reliable operation

- Embedded systems may be expected to operate independently for years without the need for adjustment or resetting. Developing perfect software is both difficult and can be expensive.

Constraints of Embedded Systems

- Costs, many systems are sold in very competitive markets forcing prices down

- Size and weight limits, many systems are required to fit small gadgets such as a remote keyless entry transmitter for a car

- Power and energy requirements, batteries have a limited amount of energy which limits the amount of power the embedded system may consume

- Harsh environments, many embedded systems are designed to be operated in a wide range of temperatures, being able to withstand vibrations, physical impacts and interference from other electronics

Example of an Embedded System

- Renesas Sakura Board

- Based around the RX63N microcontroller with:
  - 1024 K of flash memory
  - 128 Kbytes of RAM
  - 32 Kbytes of data flash
  - 55 i/o pins
  - Runs at 96 MHz

- Main components:
  - 100/10 Mbps ethernet port
  - Micro USB port
  - Two push buttons
  - Micro SD card slot
  - 5V DC power jack
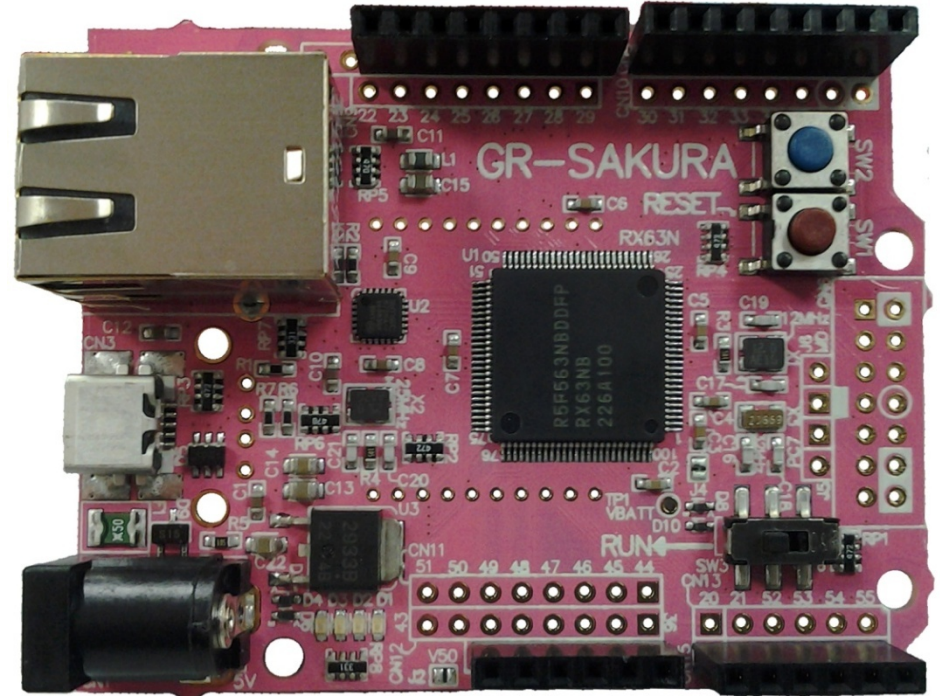
What we have covered

- Embedded system – application-specific computer built in to a larger system or device

- Embedded systems improve upon the performance, fuctions and features while lowering the cost and increasing the dependability of a system

- With embedded systems sophisticated controls can be added to systems by using low-cost microcontrollers running custom sofware

References

[1] http://www.embedded-vision.com/sites/default/files/technical-articles/Altera/Fig1_hires.jpg

[2] http://www.codeproject.com/KB/mobile/EMBEDDEDSYSTEMSP1/FIG_01.jpg

[3] http://pleasantonautorepair.net/wp-content/uploads/2009/11/check-engine-light1.jpg

[4] http://www.texample.net/media/tikz/examples/PNG/control-system-principles.png