Introduction to Embedded Systems

Chapter 1

Renesas Electronics America Inc.
Embedded Systems using the RX63N

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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

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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

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Embedded Networks

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

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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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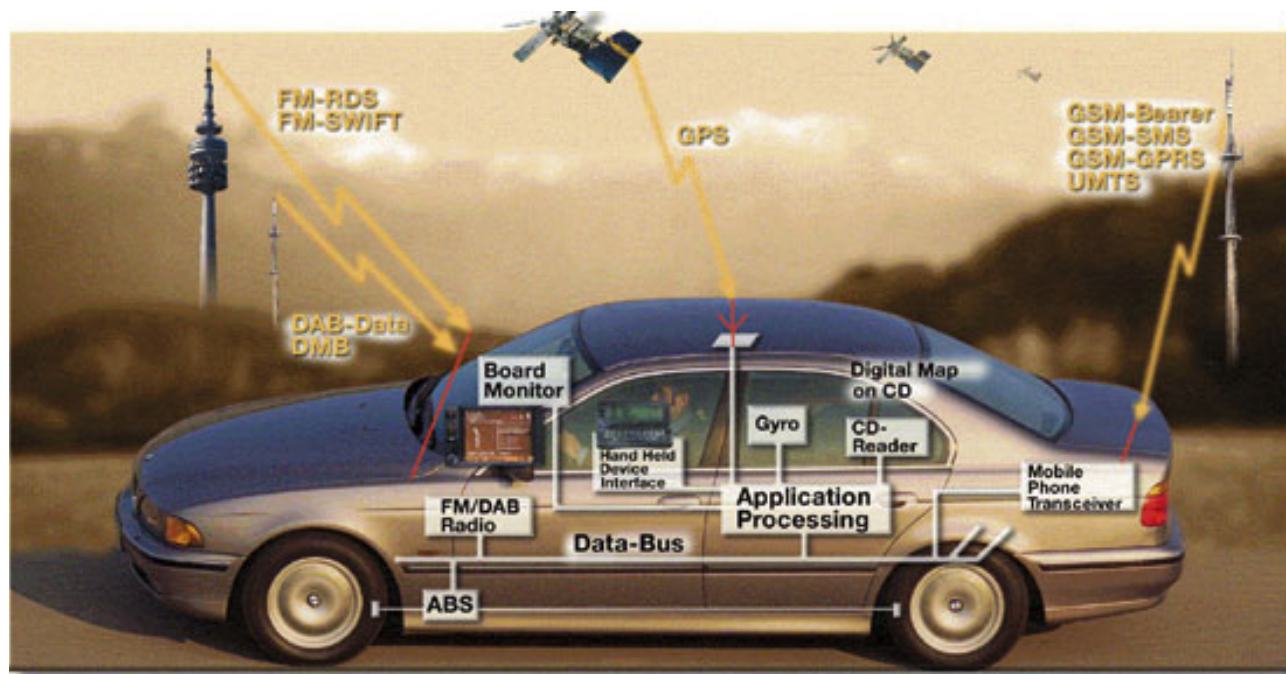
Using an Automobile as an Example

- 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

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Using an Automobile as an Example (cont.)

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

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- **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; e.g., check engine light
  - Diagnostic information can be provided to the driver or service personnel

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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
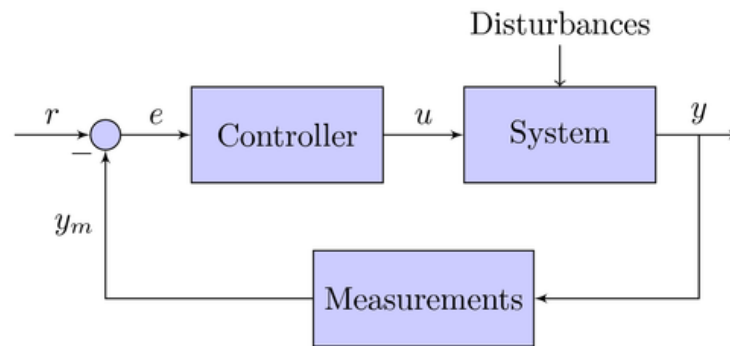

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Attributes of Embedded Systems

- Embedded systems respond to events which occur 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 can be both difficult and expensive

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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

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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

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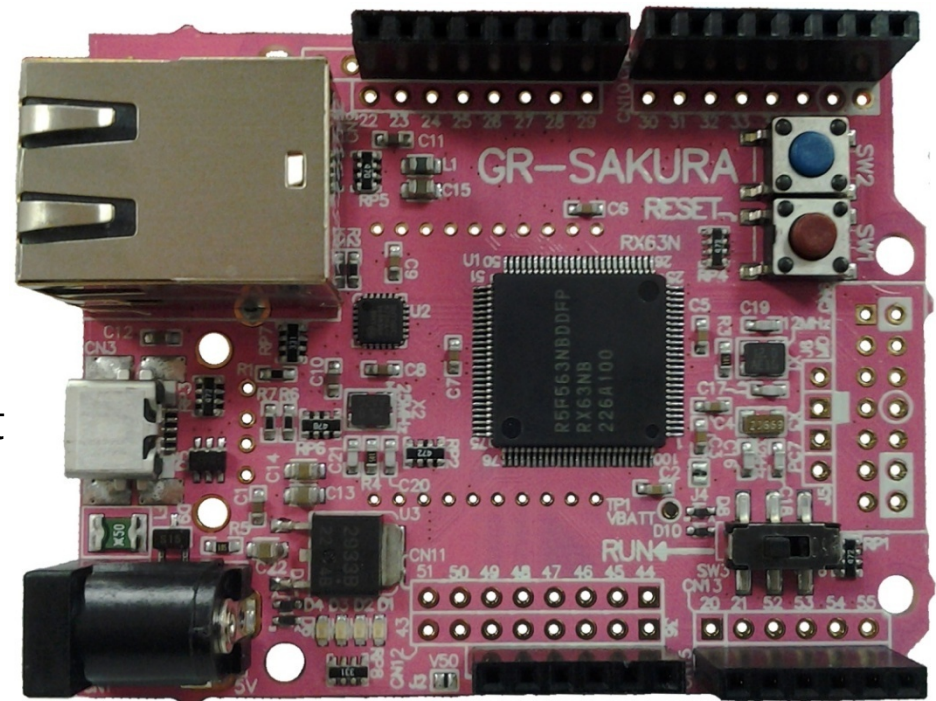
What we have covered

- Embedded system: application-specific computer built into a larger system or device
- Embedded systems improve upon the performance, functions, 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

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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

[5] Embedded Systems, An Introduction Using the Renesas RX63N Microcontroller

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