Linux For Embedded Systems

For Arabs

Cairo University
Computer Eng. Dept.
CMP445-Embedded Systems

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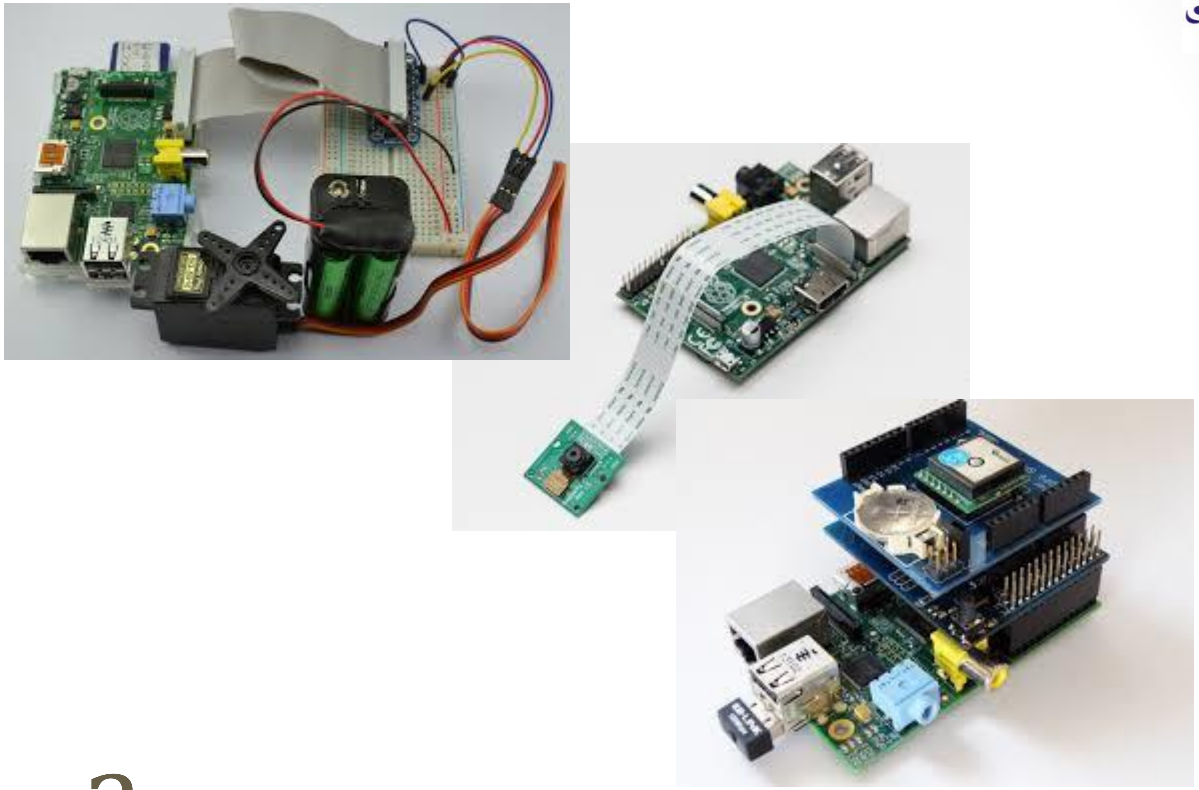


Lecture 2:
Introduction to Embedded Systems

What is an Embedded System ?

- An embedded system is a computer system embedded in a device with a dedicated function
- This is different from the traditional, general purpose computer systems

EXAMPLES OF EMBEDDED SYSTEMS

Phones and Tablets

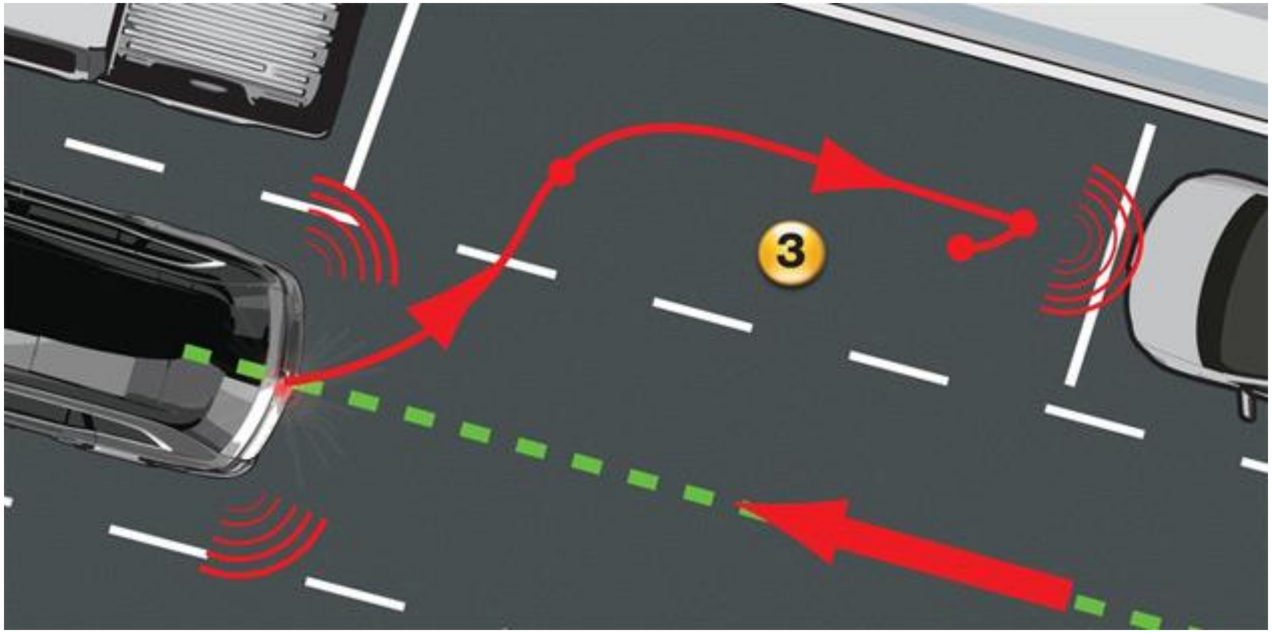
- Communication Processor (s)
  - Wifi
  - GSM/3G/LTE
  - Bluetooth/NFC
- Graphics Processor (s)
  - Graphics and Video Processing
- Application Processor
  - Android / Windows / iOS

Robotics

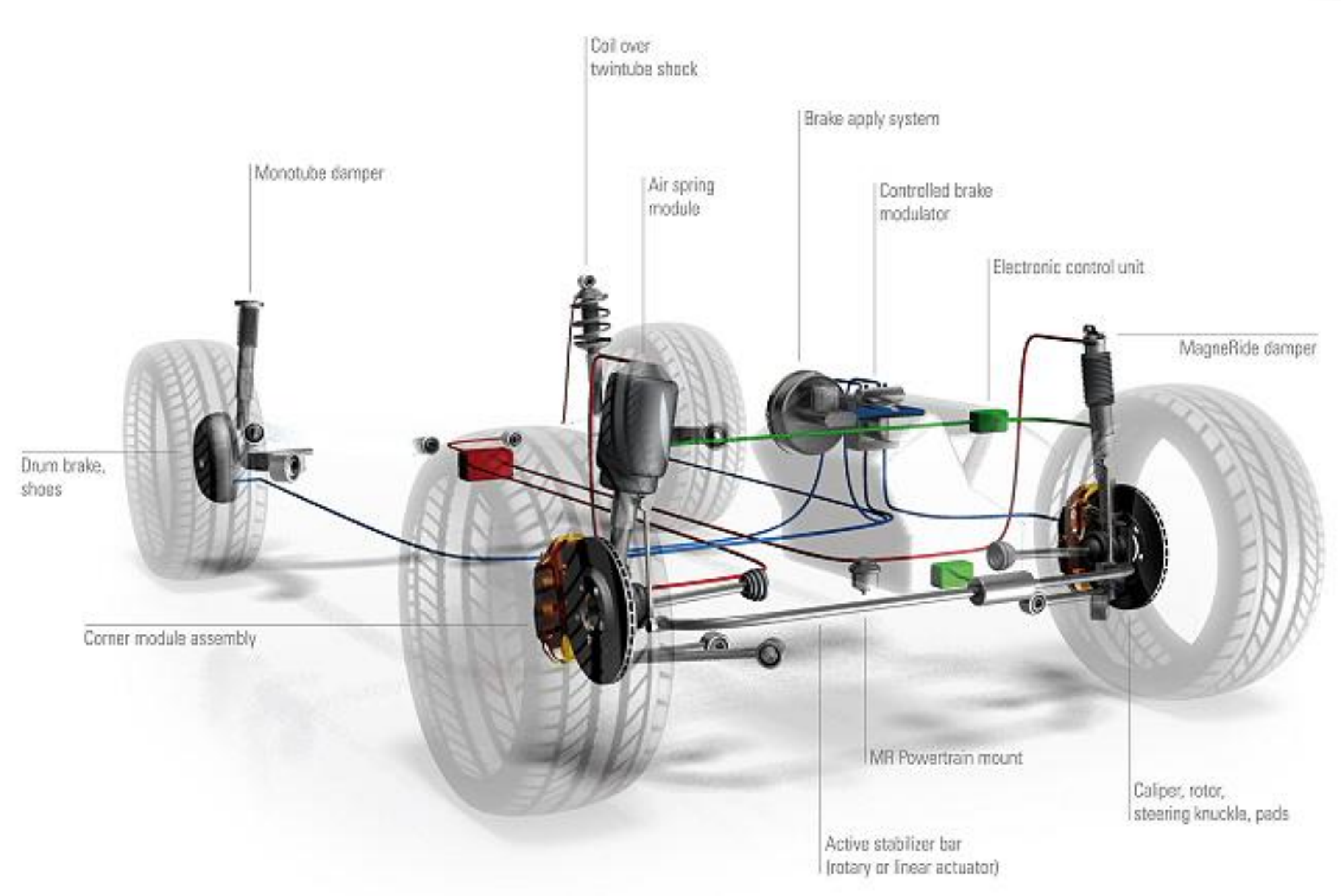
AUTOMOTIVE

Cars Are Getting Smarter…

- Electronics represents 40% of total cost of a car
- 90% of new car features require software



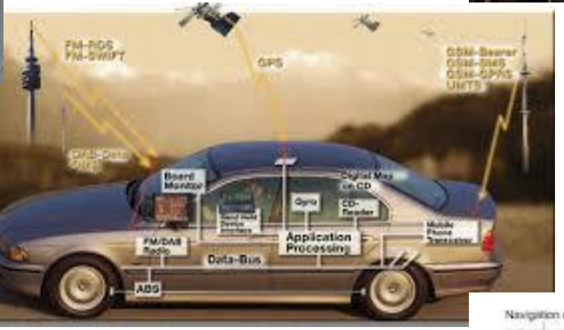
Embedded Systems in the Powertrain

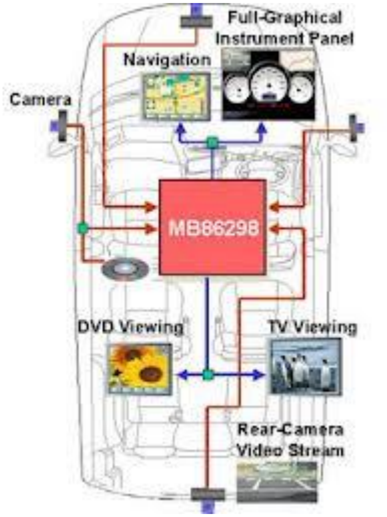


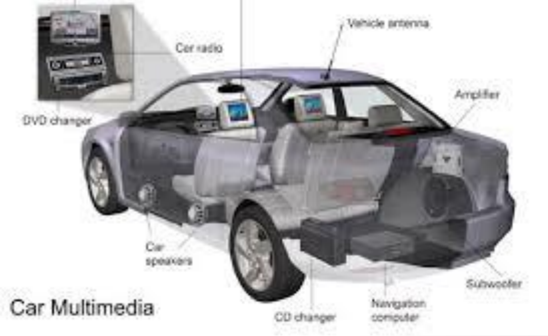
Automotive

APIX2

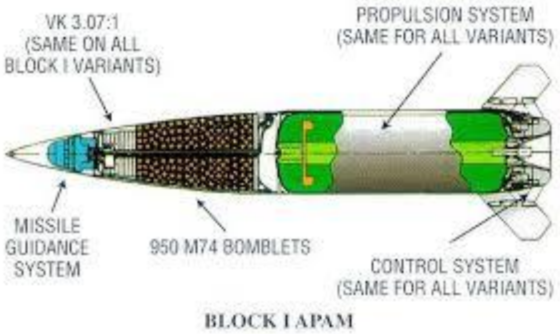
THE VERGE


FM-RDS
FM-SWIFT
GPS
GSM-Bearer
GSM-SMS
GSM-GPRS
UMTS
DAB-Data
DVB
Board Monitor
Digital Map on CD
Gyro
CD-Reader
Mobile Phone Transceiver
Application Processing
FM/DAB Radio
Data-Bus
ABS

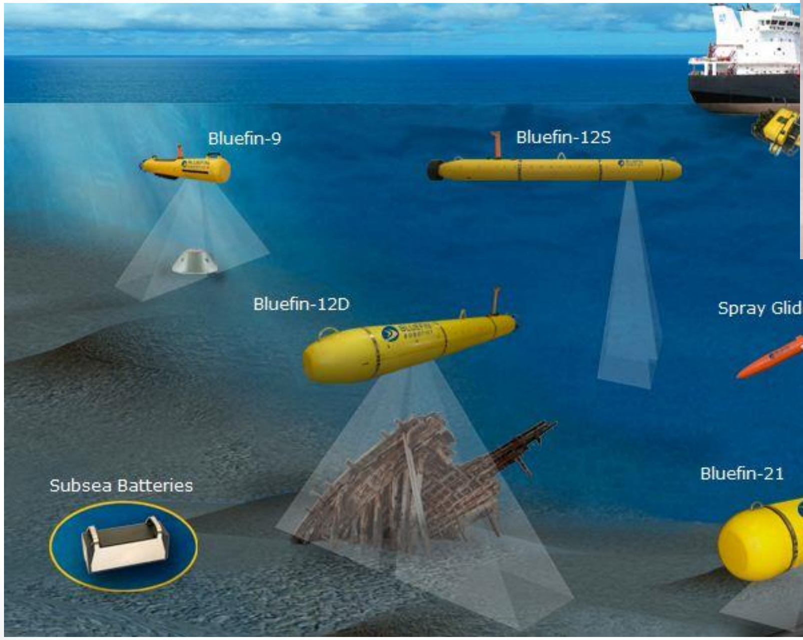

Full-Graphical Instrument Panel
Navigation
Camera
MB86298
DVD Viewing
TV Viewing
Rear-Camera Video Stream


Navigation display
Headrest monitor
Vehicle antenna
Car radio
Amplifier
DVD changer
Car speakers
Subwoofer
CD changer
Navigation computer
Car Multimedia

Military


VK 3.07:1
(SAME ON ALL
BLOCK I VARIANTS)
PROPULSION SYSTEM
(SAME FOR ALL VARIANTS)
MISSILE
GUIDANCE
SYSTEM
950 M74 BOMBLETS
CONTROL SYSTEM
(SAME FOR ALL VARIANTS)
BLOCK I APAM

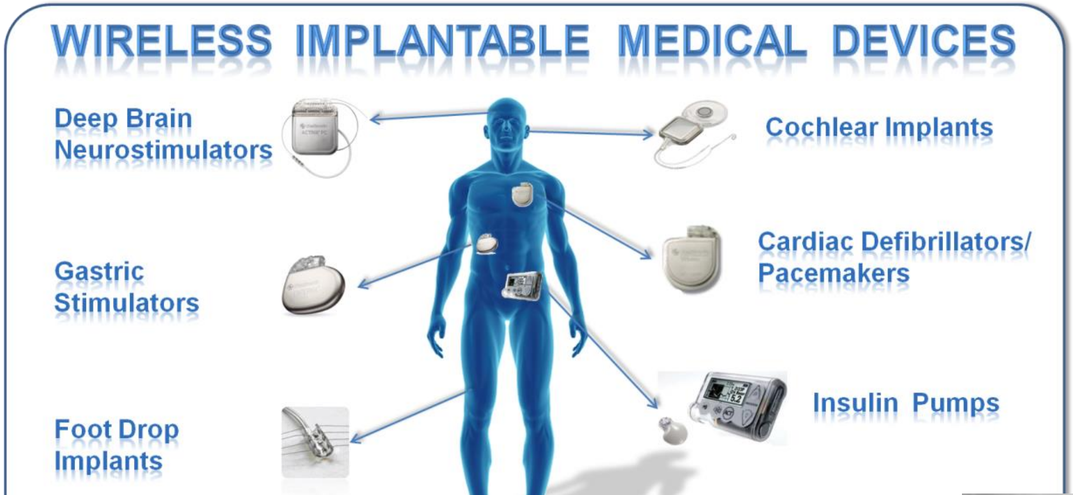
NY
566

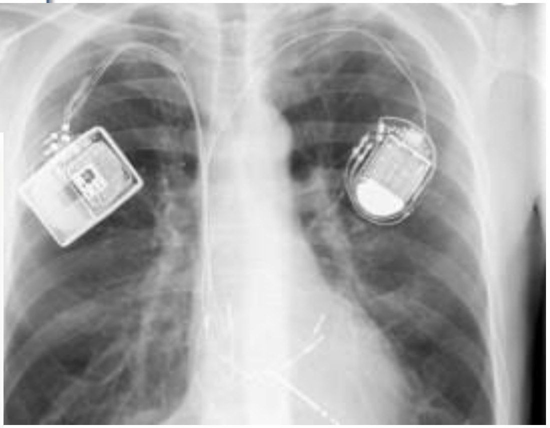

Bluefin-9
Bluefin-12S
Bluefin-12D
Spray Glider
1500M
Subsea Batteries
Bluefin-21
4500M

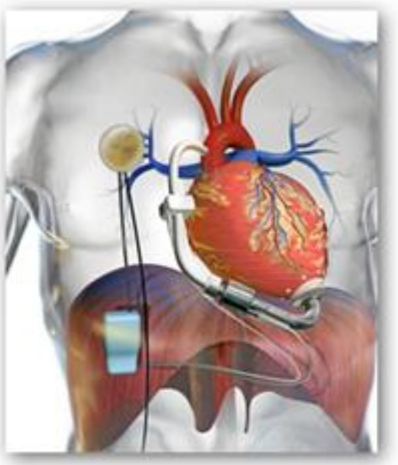
Networking Devices

Medical Devices

Implantable Medical Devices


WIRELESS IMPLANTABLE MEDICAL DEVICES
Deep Brain Neurostimulators
Cochlear Implants
Gastric Stimulators
Cardiac Defibrillators/ Pacemakers
Insulin Pumps
Foot Drop Implants





And Other Gadgets

So Why is it different from Desktop Development

- Embedded Systems normally come with constraints in hardware resources
  - Processing
  - Memory
  - Storage
  - Power
  - Display
  - Input/Output devices
- Also, embedded system applications often comes with real time system constraints
  - Latency
  - Throughput
- The system has a strong association between the HW and SW

OK ….. So What ??

- The developer has to deal with all of these constraints
  - Development should take into consideration, code efficiency, and code foot print
  - Debugging tools are “closer to the metal”
  - Special attention to power consumption in some cases

Develop

Compile

Unit Test

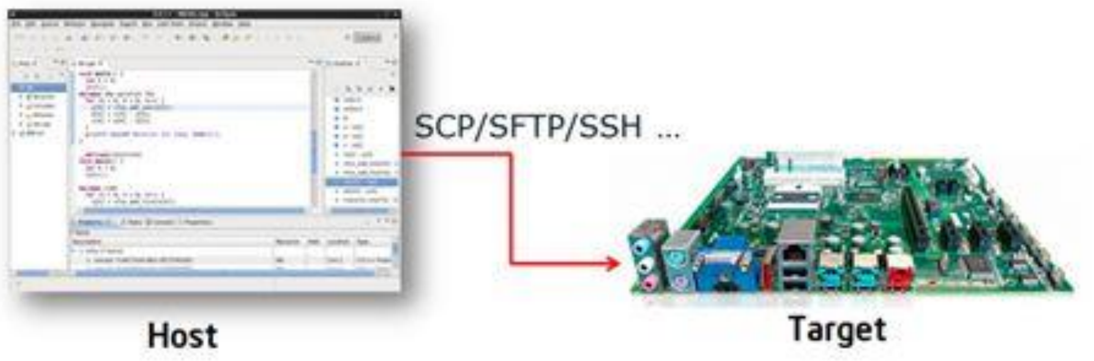
Debug

Run

Improve

Deploy

Cross-Platform Development



- Development Environment is different from target environment
- Need for cross platform development and debugging tools

Embedded Systems Classification

- There are two main families of embedded system platforms:
  - Microcontroller Family
  - Microprocessor Family

Embedded Systems Classification Microcontrollers

- Examples: PIC (MicroChip), AVR (Atmel), …
- Used for example in Arduino Boards
- Originally 8/16 bit but recently there are 32 bit chips
- Simple instruction set
- No or simple OS Support
- Limited performance (clock speed up to 10s MHz)
- Programming in assembly, or C
- Useful in small systems with lower Cost
- Typical usage:
    - Interfacing to sensors
    - Control of motors in simple robotics systems
    - Simple home automation
    - etc…

Embedded Systems Classification Microprocessors

- Examples: ARM, Intel ATOM, MIPS
- Used for example in Raspberry Pi, BeagleBone Black, …
- 32 bit (and sometimes 64 bits)
- Support Linux and other RTOSs
- Higher performance (clock speed in 100s MHz to few GHz)
- Programming in C/C++ (sometimes with little assembly), Java, Python, …
- Strong library support (act as a small computer)
- Useful in more complicated systems but with higher cost
- Typical Usage:
  - All what the microcontroller can do
  - Sophisticated control systems
  - Audio Processing
  - Image Processing
  - Video Processing
  - Communication Systems
  - Advanced guidance and navigation systems

In this course

- We will address microprocessor based systems
- We will be working with the Raspberry Pi board which uses an ARM
- Why,
  - Because we will be able to do everything the microcontroller can do
  - On top of that, we will be able to do more advanced projects
  - We will be able to build projects beyond reading sensors and simple control
  - We will be able to run with Linux, and make use of all of its available tools and libraries
  - We will be prepared to understand sophisticated products in the industry

جامعة القاهرة

Linux4

Embedded Systems

http://Linux4EmbeddedSystems.com