Introduction to the module

KF6010 – Distributed Real Time Systems

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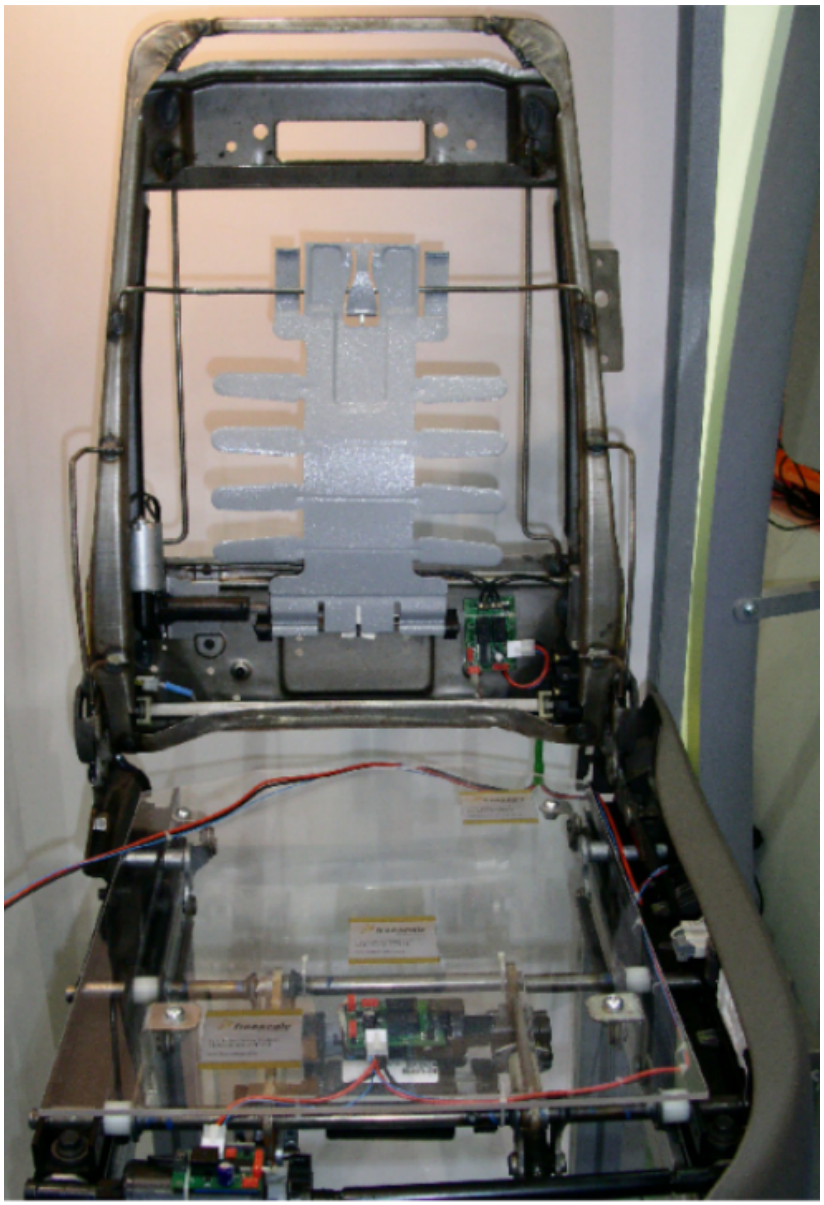
Lecture 1

Part I

Some definitions

Embedded systems are everywhere

How many CPUs in a car seat?



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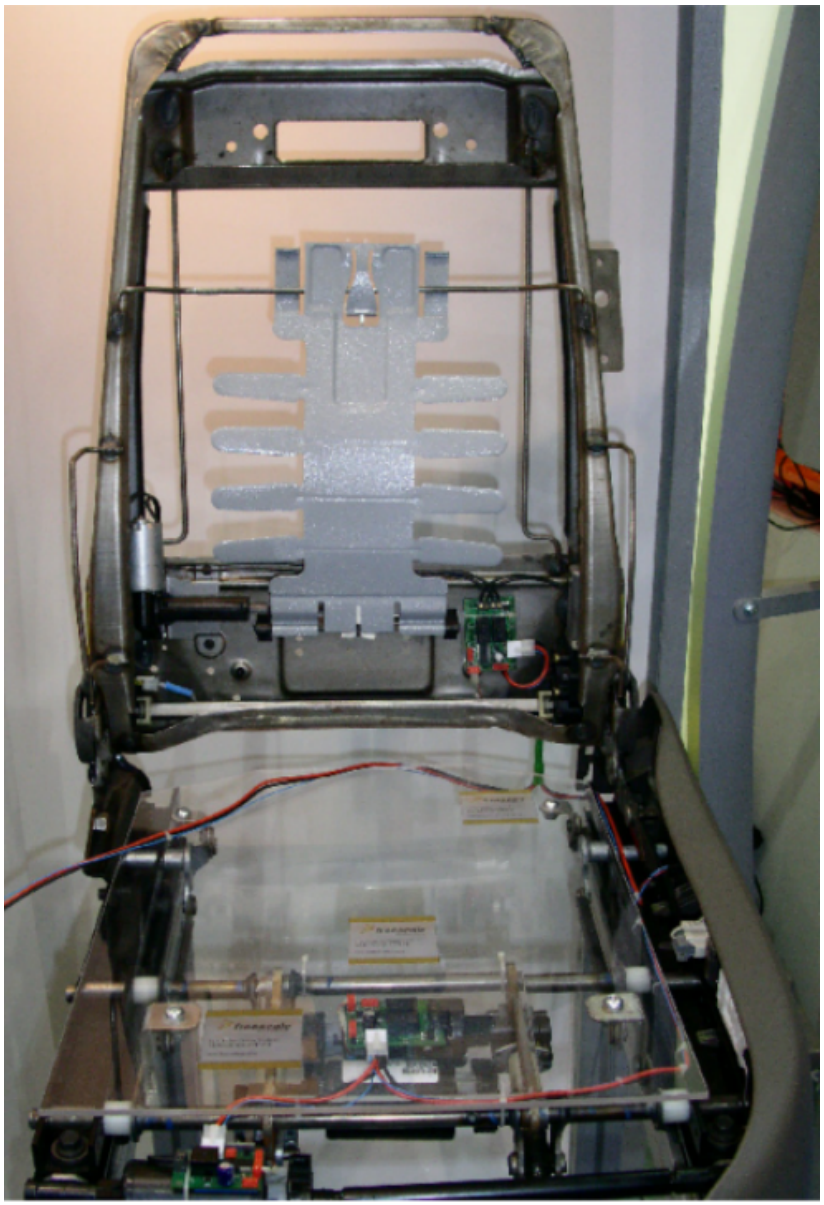

- Low speed LIN network to connect seat motion control nodes
- This is a distributed embedded system
- CPUs
  - Front-back motion
  - Seat tilt motion
  - Lumbar support
  - Control button interface

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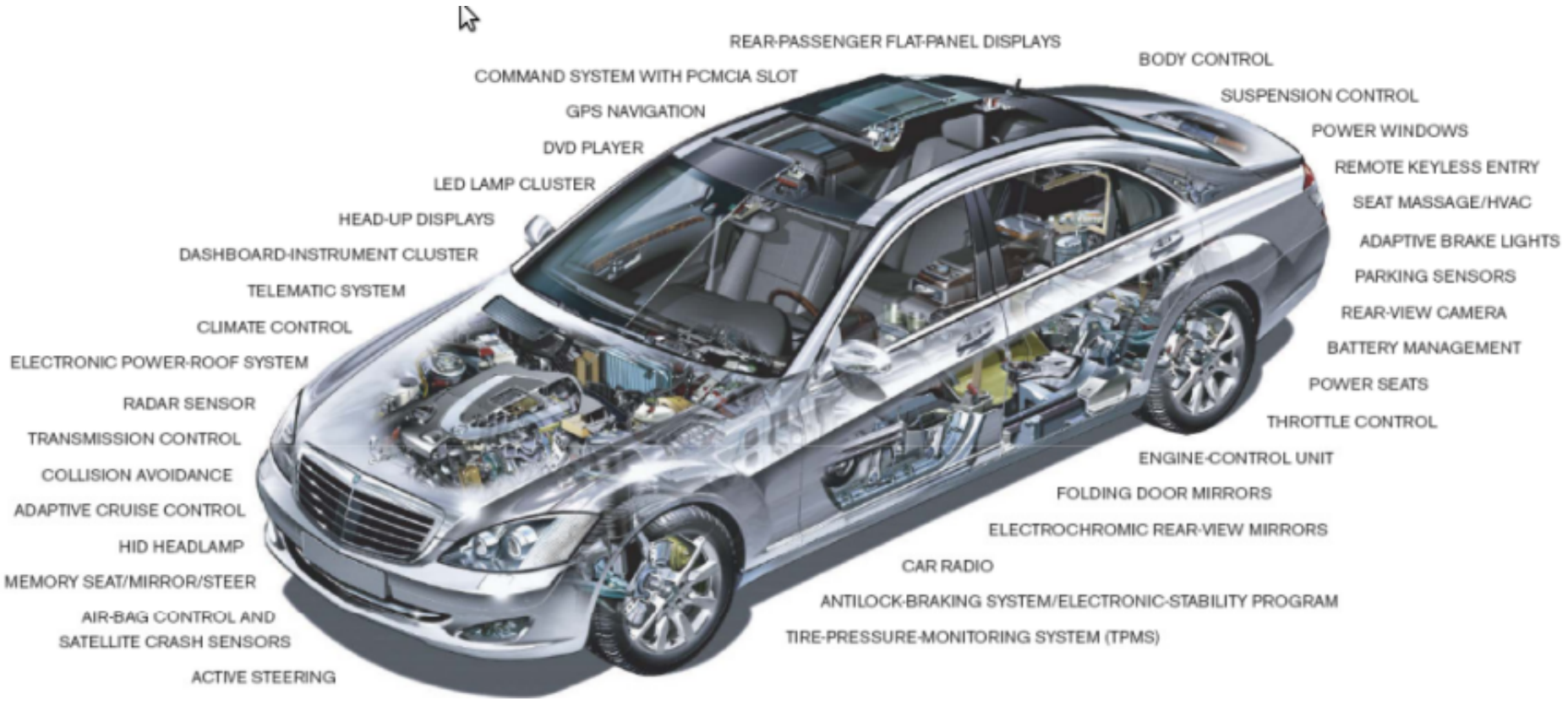

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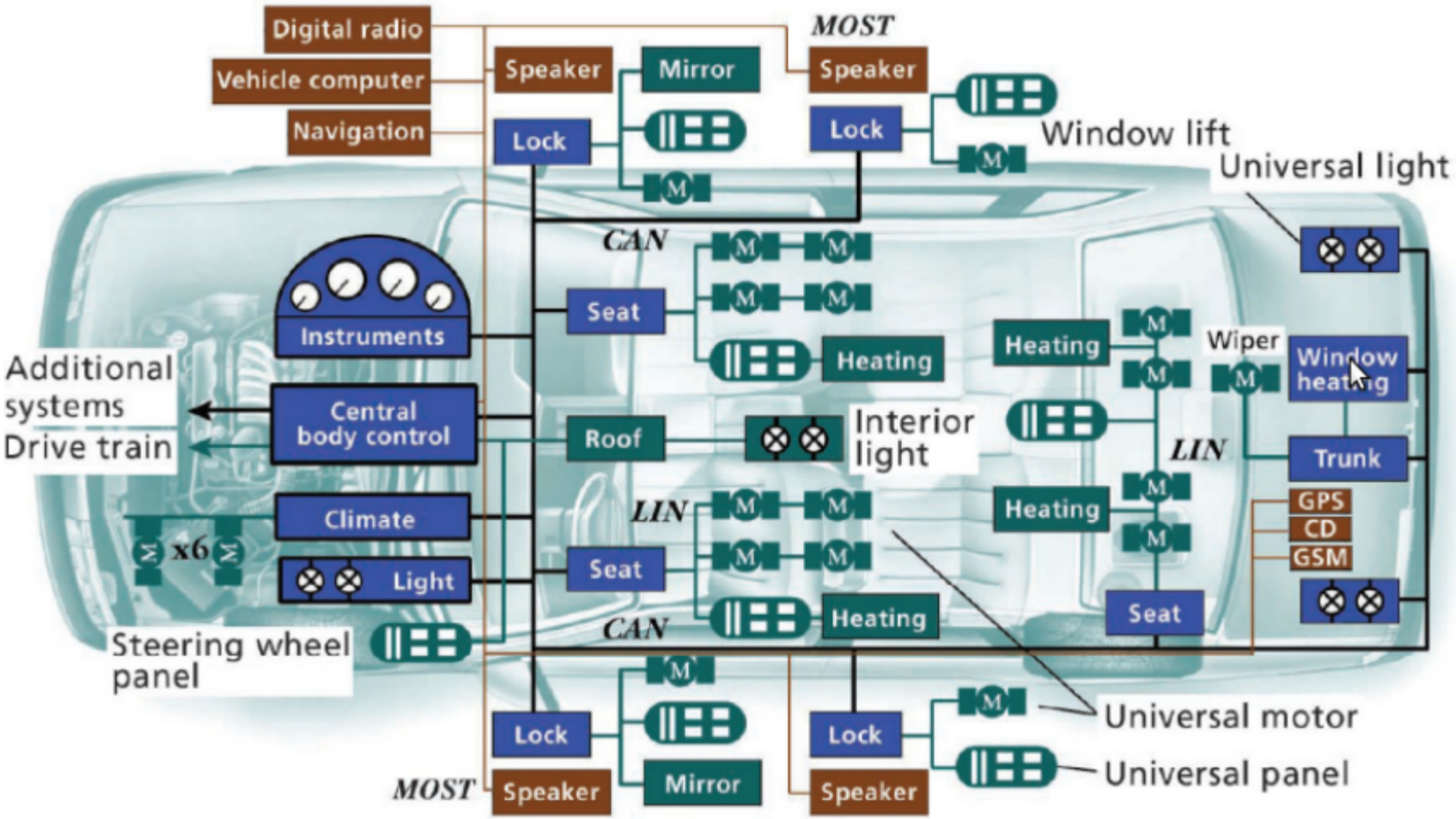

CAN	Controller area network
GPS	Global Positioning System
GSM	Global System for Mobile Communications
LIN	Local interconnect network
MOST	Media-oriented systems transport

What is an embedded system?

A working definition

Embedded system a computer built-into other systems

Embedded systems monitor and control their environment

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Applications

- Aerospace
  - Avionics – flight control systems
  - Engine management
- Buildings
  - Lift control
  - HVAC (Heating Ventilation Air-Conditioning)
  - Lighting
- Transport (see above)
- Consumer devices
  - remote controls
  - fridges

Part II

Some Engineering Detail

The creative application of scientific principles to design or develop structures, machines, apparatus, or manufacturing processes, or works utilizing them singly or in combination; or to construct or operate the same with full cognizance of their design; or to forecast their behaviour under specific operating conditions; all as respects an intended function, economics of operation and safety to life and property.

— The American Engineers' Council for Professional Development

For a successful technology, reality must take precedence over public relations, for nature cannot be fooled.

— Richard Feynman

Embedded Systems Characteristics

Concurrent – composed of multi-tasking and/or distributed processes

Communicating – specialised processes communicate in order to achieve some overall system function

Real-Time – timing requirements are established by the environment

Resource-constrained – limited resources: processing, memory, peripherals, power,. . .

Concurrency

- Arises when multiple processes (tasks) share a single processor
- allocation of the processor to a different task can be:

  event-triggered A response to any of many possible interrupts: periodic-timer overflow, arrival of message on CAN bus, the pressing of a switch, the completion of an A/D conversion,...

  time-triggered Response to one source of interrupt only: usually a periodic timer
- Managing and reasoning about concurrency is a major challenge for the Embedded Systems Engineer

Communication

- Computing nodes that communicate with each other, form a distributed system
- Economic and safe allocation of resources in a distributed system requires a predictable communication network
- Predictable communications networks include
  - CAN, TTCAN
  - TTEthernet

Real-Time

- A real-time system is a system where the total correctness of an operation depends not just on the logical correctness of the result, but also it's temporal correctness. *i.e.* the time at which it is produced.
- A deadline specifies the time by which an operation must complete and deliver it's result.
- A hard real-time system is a system that is considered useless if an operation misses a single deadline
- A soft real-time system tries to meet it's deadlines, but can tolerate an occasional missed deadline, perhaps giving reduced service quality

Embedded Systems Engineering

Application of scientific principles to:

- the design of embedded systems
- the construction of embedded systems with *full cognisance* of their design
- the forecasting of the behaviour of embedded systems under specific operating conditions

with respect to intended function, economics of operation, and safety to life and property

Part III

Module content

Module content

summary of key parts

- Uni-processor systems
  - Event-triggered
  - Time-triggered
- Distributed solutions
  - Networks for embedded systems
    - CAN bus
    - MQTT
  - Analysing networked embedded systems
    - Distributed Response Time Analysis
- Other topics
  - C programming for embedded systems
  - Methods, tools
  - Standards