

Embedded and Real Time Systems

**Sistemas Embutidos
e de Tempo Real**



Lecturers

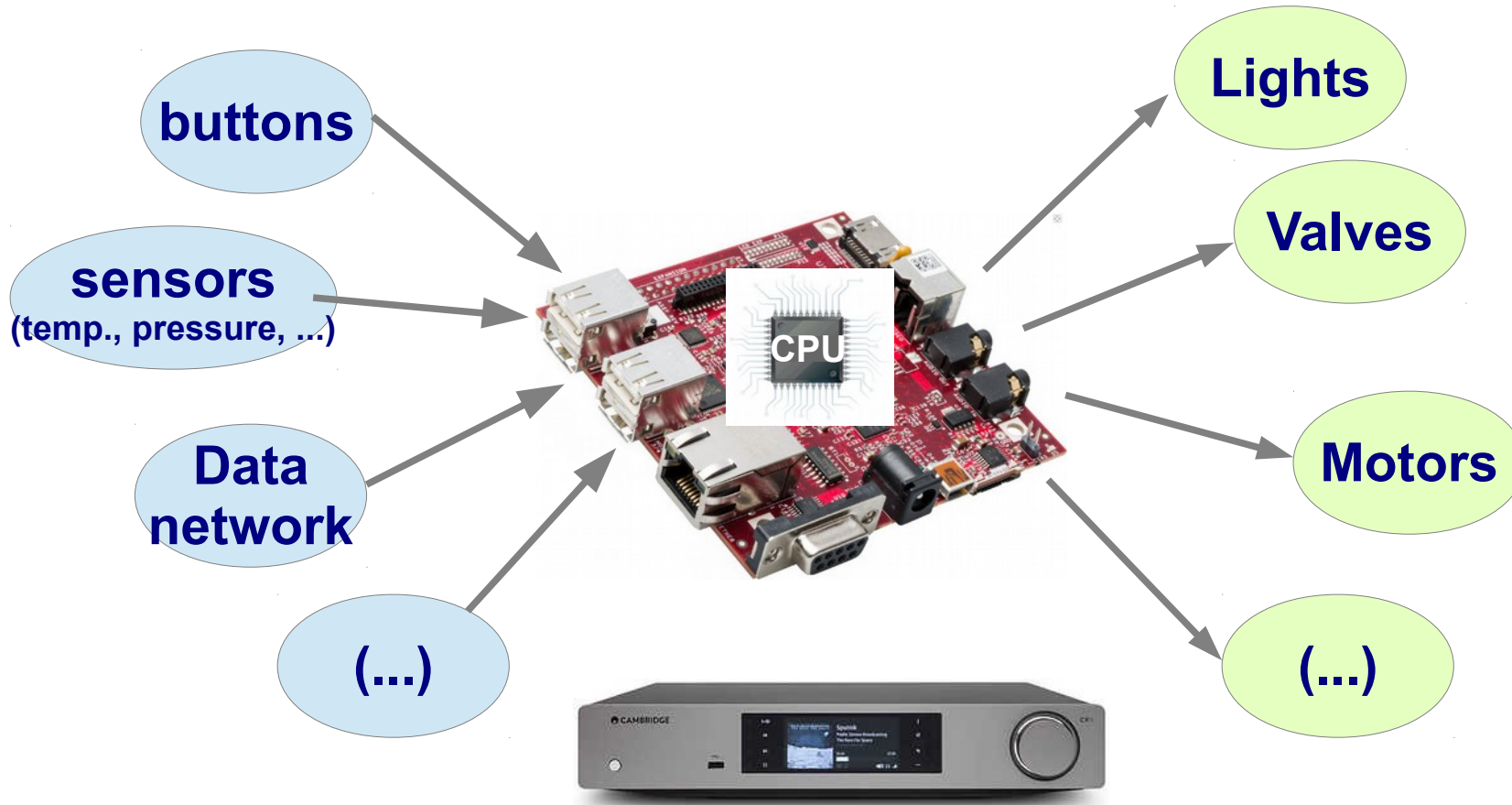


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Embedded System



Real-Time

Radar System

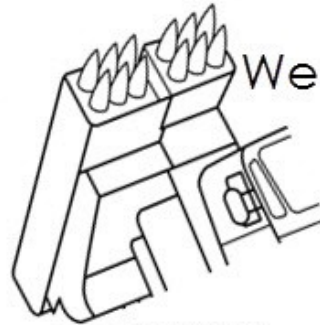


REAL-TIME SYSTEM

Incoming Missile



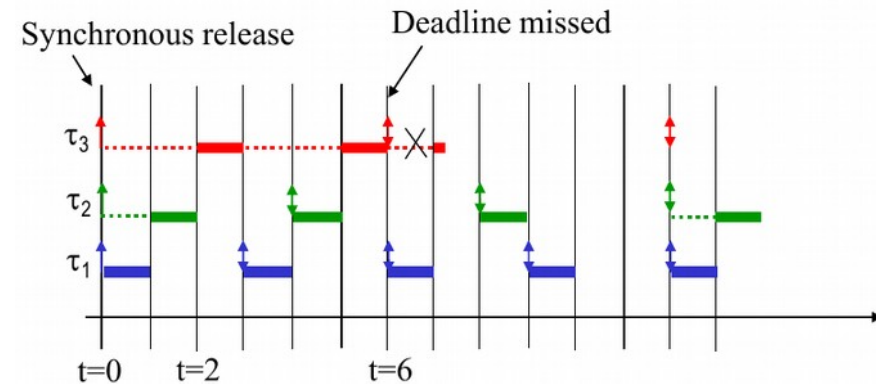
Command &
Decision System



Weapon Firing
System



electronicshub.org



Application Domains

- Automotive
 - Safety-Related
ABS, Cruise Control,
Stability Control,
Engine Control,
Digital Displays, ...
 - Non Safety-Related
HVAC, Infotainment,
Maps/Directions,
Intrusion Detection,
...



Application Domains

- Health Care
 - Life Support Systems
Ventilation,
Heart/Lung Machine,
Defibrillator,
...
 - Life Monitoring Equipment
Heart monitor,
Blood O₂ saturation monitor,
...



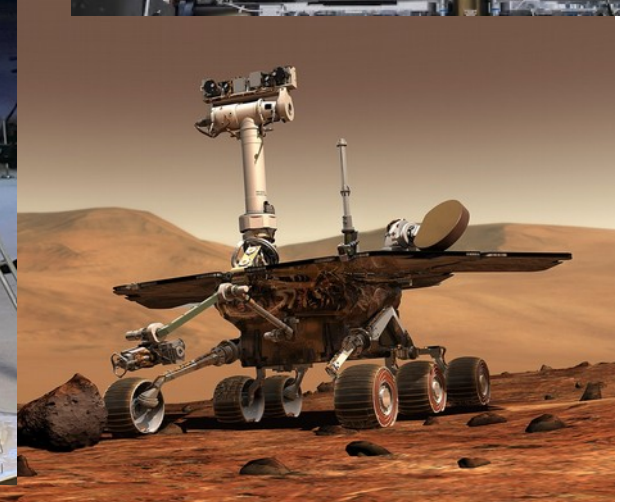
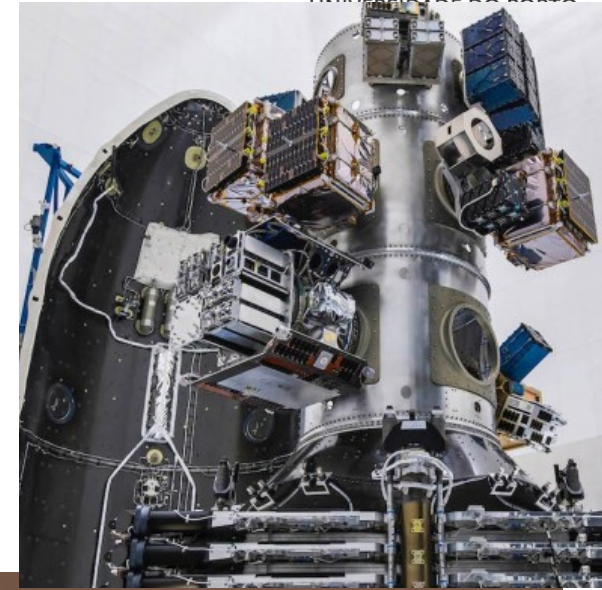
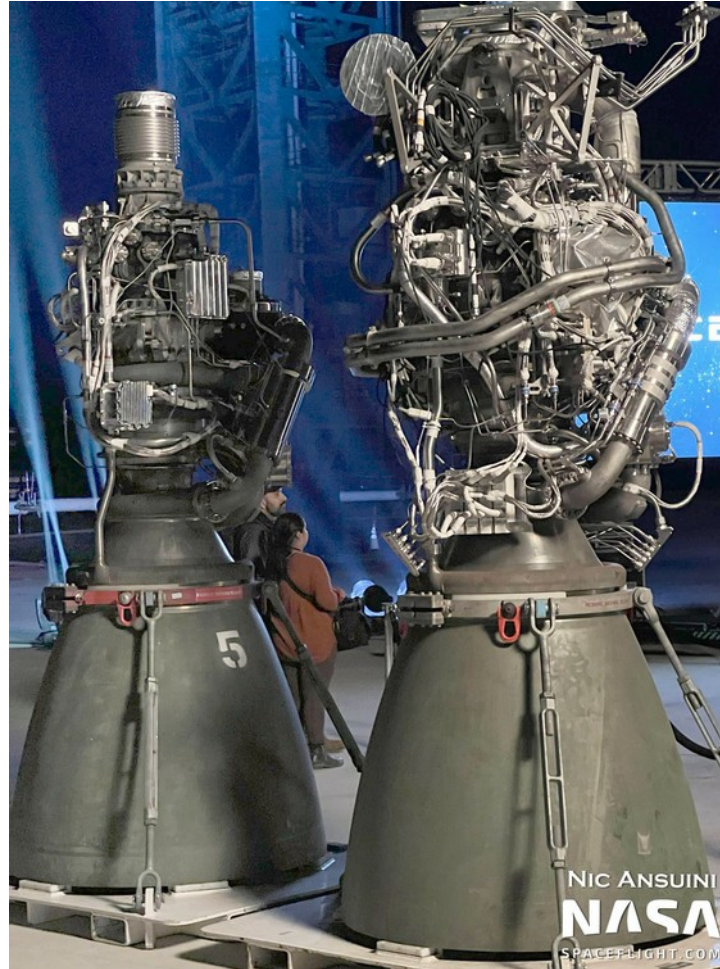
Application Domains

- **Railway**
 - **Rolling Stock**
Speed monitoring,
Automated speed control,
Passenger doors,
...
 - **Track Side Equipment**
Signalling,
Track switching gear,
...



Application Domains

- Aerospace
 - Aeroplanes
 - Satellites
 - Rockets
 - Space probes



Application Domains

- Financial

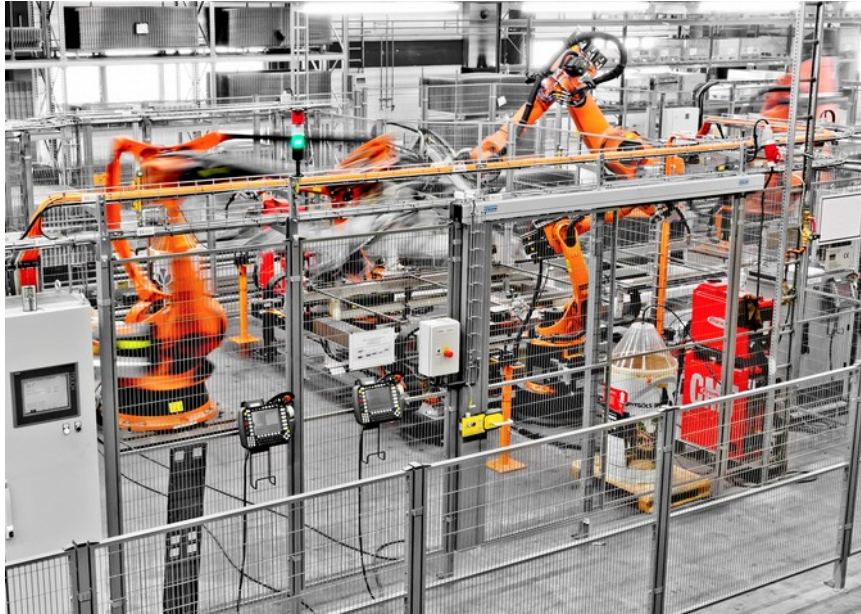


- Telecommunications



Application Domains

- Industrial Automation



Application Domains

- User Interfaces

- Home Automation



Professional Opportunities



Aerospace, Satellites, ...



Industrial Automation



Ovar → Fire Alarms
Aveiro → Hot Water Boilers
Braga → Automotive

Real-Time Operating Systems



Embedded Hardware Platforms

Arduino



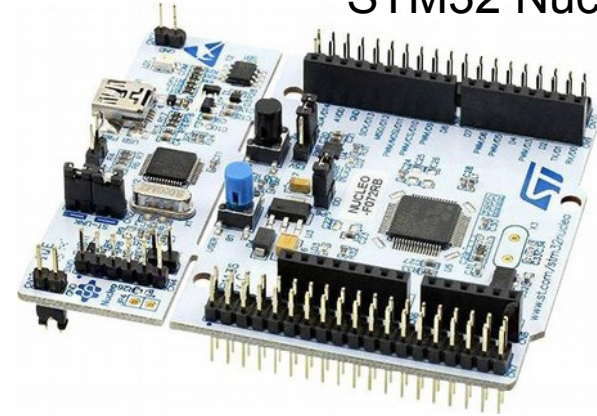
BeagleBoard



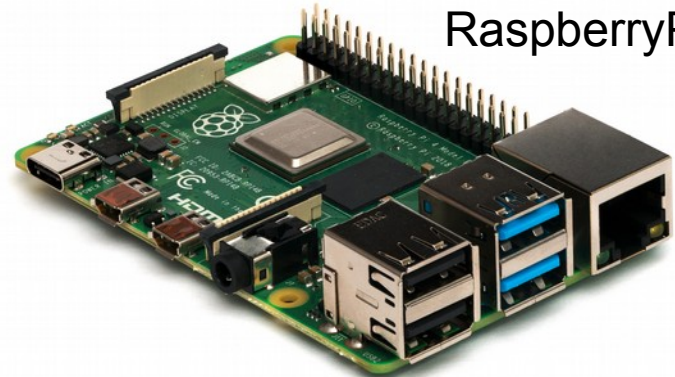
ESP8266



STM32 Nucleo



RaspberryPi



Syllabus

- 1) Introduction to real-time (embedded) systems and the role of time constraints;
- 2) Software development for real-time embedded systems
- 3) Temporal behaviour of program execution in isolation:
software (conditional and cycles) and hardware (pipelines and caches) structures;
- 4) Real-time scheduling for concurrent systems:
periodic tasks with cyclic tables and sporadic and aperiodic tasks, static and dynamic priorities,
synchronization and multiprocessors;
- 5) POSIX Real-Time Programming and use of Real-Time Operating Systems (RTOS).
- 6) Hands-on: building a Real-Time kernel for embedded systems

Grading & Course Organization

- Grading
 - 40% → Written Exam
 - 10% → Seminar Presentation
 - 50% → Course Project
 - 25% project presentation
 - 25% project report
- Course Organization
 - 1/3 rd semester
Theoretical Presentation classes
 - 1/3 rd semester
Theoretical Presentation classes
Guided Practical Session
 - 1/3 rd semester
Course Project

Sample Projects

- Maze in QVGA <https://www.youtube.com/watch?v=yIrrkUGHrhg>
- FreeRTOS SmartWatch <https://www.youtube.com/watch?v=l1-dpSXaCW0>
- 3D Tetris <https://www.youtube.com/watch?v=dmYZqJ7ktw0>
- SmartWatch <https://www.youtube.com/watch?v=GygRAsSxO6k>
- Ball on Plane (1) <https://www.youtube.com/watch?v=5CphbklyvwA>
- Ball on Plane (2) <https://www.youtube.com/watch?v=h3-r7ReBqNI>
- Vector Graphics Pong https://www.youtube.com/watch?v=wnK_w7XWLa0
- VGA + Music Synth. <https://www.youtube.com/watch?v=Q8o4x-9sz4o>
- Arduino+BT Snake Game <https://www.youtube.com/watch?v=ILk39jCIITs>
- AlphaBot2-Pi Line follower https://www.youtube.com/watch?v=1UamqnIj_-A
- Drone https://www.youtube.com/watch?v=c17_WOLJ_HQ