

# Projects Assignments

Sistemi embedded e real-time

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**UNIMORE**  
UNIVERSITÀ DEGLI STUDI DI  
MODENA E REGGIO EMILIA

**Hipert/Lab**  
High Performance Real Time  
Lab

# Standard Assignment

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# General information and requirements

1. Hardware: B-L475E-IOT1A or Qemu platform
2. RTOS: FreeRTOS
3. Delivery
  - 3.1 Code and short report (max 2 pages)
  - 3.2 Presentation with demo and discussion
    - On the same date of the written exam
    - Other appointments to be aggregated and scheduled on demand

# Application requirements

Channels: sensors, buttons, UART / LED, GPIO, UART...

1. use 1 task per input/output channel
2. use  $\geq 3$  input channels
3. use  $\geq 2$  sensor devices or 1 sensor device + 1 network device
4. use  $\geq 2$  output channels
5. use  $\geq 1$  many-to-one task communication

- Inter-team collaboration is allowed and encouraged only if on the forum and about the following topics
    - Project definition (ideas about what to do)
    - Publicly available resources (e.g. drivers)
    - Implementation of specific algorithms (e.g. Kalman filter)
  - Synergies with other classes' projects is allowed and mildly encouraged
- Out-of-scope contributions will increase the project evaluation

## Additional requirements

### Easy

- Git versioning
- Periodic execution (timer-based tasks)
- Task WCET analysis measurement-based (under isolation assumption)
- Tuning
  - Footprint minimisation
  - Task's constraints optimisation (e.g. sensor refresh rate)

### Challenging

- MISRA C compliance
- Response time analysis, e.g. w/ Mast
- Task WCET analysis w/ Ottawa (implies Arm Cortex M4 modelisation)

See also the challenging Project Assignment

- Weather station with remote signalling and real-time actuation
- Microphone-captured voice distortion w/ FFT and bluetooth audio
- Vocal command to operate LEDs blinking
- NFC card authentication

## Challenging Assignment

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- Effort is comparable with the standard assignment
- Tasks are research-level, original, challenging (and fun!)
- Access restricted to motivated and independent students
- Collaboration with the RTES research team
- Possible collaboration with industrial companies: Arm, Xilinx, Nvidia; Lynx; Ferrari (also GES), Maserati; Tetra Pak, IMA, SACMI

## Technical requirements

- High-performance platforms: Nvidia, Xilinx, NXP, Huawei
- Rich multi-OS layer
  - Jailhouse/Xen hypervisor
  - Erika/FreeRTOS RTOS
  - Linux
- Possible applications: car ECU/gateway, drone flight computer, industrial automation control

1. Safety system monitor
  - 1.1 Virtual machine watchdog for Jailhouse: detect failures and take actions
  - 1.2 Hardware watchdog support for Jailhouse on i.MX 8QM
2. Automated testing on Linux and Jailhouse
  - 2.1 Automatic test execution routine on Nvidia Xavier AGX (e.g. CUDA tests, DRIVE demo)
  - 2.2 Initial Jailhouse support for Arm Workload Automation

- 3. Advanced memory management on Jailhouse hypervisor
  - 3.1 Human interface for memory bandwidth throttling: static configuration of VM
  - 3.2 Automatic VM configurator: translate JSON to C configurations
- 4. Jailhouse paravirtualisation support (VM drivers + hypervisor mediation)
  - 4.1 Engineering of UART support for console multiplexing
  - 4.2 Engineering of CAN support for virtual devices

**Questions on the Dolly forum, or privately at  
`mailto:marco.solieri@unimore.it`**