Analog to digital

Q: Describe the process of converting analog to digital signals, including the steps that are involved in this process.

1. *Sampling: Continuous to discrete time (frequency is important)*
2. *Quantization: Continuous amplitude to discrete signal*

Debugging

Q: Describe the most important reasons why debugging embedded devices might be complex

- *Reproducing the environment might be hard*
- *Monitoring in real-time is also difficult*

Network protocols

Q: Let us consider the electronic system of an electric car, where multiple subsystems need to communicate: considering the network protocols that you know, would you rather use a wired or a wireless protocol? Explain the reasons.

Wired, for higher security and higher bandwidth

Sampling frequency

Q: Consider a system, used to control the temperature of a fluid, that includes a temperature sensor and an electric heater. The fluid can have variations of up to 2°C/hour and the required accuracy of its temperature is of +-1°C. The control system runs on batteries (the heater is powered separately). Estimate the optimal sampling frequency for the temperature sensor and explain the reasons.

Scheduling

Q: Suppose there are three processes with the following execution times and periods:

- *P1 – exec. Time 2 – period 4*
- *P2 – exec. Time 1 – period 4*
- *P3 – exec. Time 1 – period 6*

Can they be scheduled (scheduling feasible) by using Rate Monotonic Scheduling? Can they be scheduled by Earliest Deadline First scheduling? Motivate your answers.

2/4 + ¼ + 1/6 = 11/12 -> RMS not feasible as not close to 70 %

EDF -> Feasible as <= 1.

Scheduling

Q: Consider three processes, P1, P2, and P3. Their arrival times are 4, 1, 0, respectively; their burst time are 1, 2, 5, respectively.

Draw the schedule for the first 15 cycles, when a FCFS scheduler is considered.

Watchdog

*Q: Discuss whether or not a **watchdog timer** would be useful in each of the following systems and explain the reasons:*

1. *A sensor node that is going to be deployed in the Alps in remote locations Yes*
2. *A digital hand-held thermometer (e.g., an infrared one) No*
3. *A surveillance camera Yes, and No*

Asyncronous I/O

Q: When the considered task includes some asynchronous I/O operations

- *the use of concurrent processes is recommended*
- *all the operations must be executed in a single task*
- *concurrent tasks can be used, but a single task is recommended*
- *the operations must be made synchronous*

Consider a signal with a maximum frequency of 16Hz. The minimum sampling rate that guarantees a faithful reproduction of the signal is:

Q: Consider a signal with a maximum frequency of 16Hz. The minimum sampling rate that guarantees a faithful reproduction of the signal is:

- *16Hz*
- *32MHz*
- *32Hz*
- *The maximum frequency allowed by the considered equipment*

Cross compilers

Q: Cross compilers

- *are used in the design flow of embedded systems*
- *are required when there is no operating system on the target device*
- *are used for debugging embedded software*
- *are compilers that produce machine code for a different architecture than the one of the host computer*

Cross-compilers

Q: Cross-compilers

- *Are compilers designed to run on embedded devices*
- *Are compilers that are designed to optimize the execution of software applications on embedded devices*
- *Are compilers that run on a host system, but produce executables for a different architecture*
- *Were used in the past but they are not required anymore as embedded devices got more powerful*

Cyber-physical systems

Q: A Cyber-physical system is:

- *A system exhibiting synergy of computational and physical components; there is no communication among computational elements*
- *A set of sensors and actuators placed in a specific environment*
- *A system exhibiting synergy of computational and physical components; computing elements coordinate and communicate*
- *A system composed of computing elements and physical components that are not interacting*

Discrete dynamics

Q: Discrete dynamics systems

- *Are naturally represented by finite state machines*
- *Cannot be represented by finite state machines*
- *Use discrete values but they are continuous in time*
- *Can be represented by Mealy machines, but not by Moore ones*

Edge computing

Q: Edge computing

- *is a technique used to optimize routing of messages in edge networks*
- *is applied in systems where the computation is local to IoT nodes*
- *is applied in a system where the computation is performed in the cloud*
- *is a technique used for computing the computational resources required by IoT nodes for executing predetermined tasks*

In embedded systems, maximum power is often considered as an important requirement because

Q: In embedded systems, maximum power is often considered as an important requirement because

- *They often run on batteries*

- *If the power is too low, the system may not work correctly in cold environments*
- *There are often limitations on the heat that can be dissipated, due to their placement and the absence of fans*
- *It is used to evaluate the speed of the system*

In fog computing

Q: In fog computing

- *The processing of some application components can take place at the edge of the network*
- *IoT devices are not connected to the cloud, but only use local information and computation*
- *The processing of all application components always take place in the edge devices*
- *The processing of all application components always take place in the cloud*

mBed

Q: mBed is

- *an operating system for IoT devices based on ARM processors*
- *a set of tools used for debugging embedded code*
- *a method for providing hardware support to process separation*
- *a library that adds real-time capabilities to Arduino devices*

PID controller

Q: The PID controller is

- *used as a controller in some open-loop continuous dynamics systems*
- *used as a controller in some closed-loop continuous dynamics systems*
- *used as a controller in discrete dynamics systems*
- *a device that can be used to debug embedded systems*

Polling and interrupts

Q: Let us suppose that a digital sensor produces values with variable frequencies ranging from 10Hz to 100Hz. Which one of the following techniques is the most suitable for handling this sensor, supposing that all the values produced are of interest?

- *Use polling and query the sensor as fast as possible*
- *Set up an interrupt that is triggered every time the device generates a new value*

- *Use a timer to poll the device every 10ms*
- *Use a watchdog timer set at 100ms*

Precision of a sensor

Q: Precision of a sensor

- *is the smallest absolute difference between two values of a physical quantity whose sensor readings are distinguishable*
- *evaluates repeatability of measures*
- *corresponds to the lower end of the values provided by the sensor*
- *is unrelated with the dynamic range*

Predictive maintenance of industrial plants is about

Q: Predictive maintenance of industrial plants is about

- *Performing maintenance on regular bases (e.g., every 1,000 hours)*
- *Performing maintenance in advance, but only when required, based on parameters that are monitored on the system*
- *Performing maintenance when something breaks*
- *Performing maintenance only when sensors in the plant detect that it is not operating within specification*

Priority inversion

Q: Priority inversion

- *Is a technique used in some operating systems to allow low-priority tasks to execute even in presence of high-priority tasks*
- *Is supported by most modern operating systems*
- *Is a problem caused by a low priority process that blocks the execution of a higher-priority process by keeping hold of a shared resource*
- *Cannot happen in real time operating systems*

PWM

Q: PWM

- *is a technique used to control analog devices by means of a digital signal*
- *is a technique for computing the optimal sampling rate of a sensor*
- *is a technique that switches on and off actuators and sensors to save energy*
- *is a scheduling algotithm used in real time operating systems*

Quantization

Q: Quantization

- *is an operation that converts continuous amplitude signals into discrete (digital) values*
- *is an operation that converts discrete (digital) values into continuous amplitude signals*
- *is an operation that samples signals that are continuous in time*
- *is an operation used to change the amplitude of signals*

Real time requirements are about

Real time requirements are about

- *Latency*
- *Latency or throughput, depending on the considered application*
- *Throughput*
- *Latency when hard real time is considered, throughput when soft real time is considered*

Security of IoT

Q: Security of IoT

- *Is always granted as long as data are encrypted*
- *IoT devices cannot be secured due to their limited resources*
- *Need to be evaluated depending on the type of system and on the known attacks*
- *As long as the IoT devices are secure, the whole system is secure*

Software on bare metal

Q: Software on bare metal refers to

- *Application software that is run on devices without any operating system*
- *An operating system that was designed for devices with limited resources*
- *Software for embedded devices*
- *Software that uses specific libraries for sensors and actuators*

The CANBus

Q: The CANBus

- *Uses point-to-point serial connections among the devices to guarantee quality of service*
- *Is based on a linear bus structure and recipient device identifiers are used to provide quality of service*

- *Is based on a linear bus structure and sender device identifiers are used to provide quality of service*
- *Is based on a parallel bus structure and provides no quality of service*

The main difference between open-loop and closed-loop systems is:

Q: The main difference between open-loop and closed-loop systems is:

- *In open-loop systems the actions of the controlleralso depend on the feeedback from the process; it does not in closed-loop systems*
- *Closed-loop systems tend to be faster*
- *In closed-loop systems the actions of the controller also depend on the feeedback from the process; it does not in open-loop systems*
- *Open-loop systems are not subject to accumulated errors*

Time redundancy is

Q: Time redundancy is

- *A technique used in some real-time operating systems to provide tolerance to delays in executing tasks*
- *A type of non functional requirement*
- *A category of techniques used to provide fault tolerance*
- *A feature of the MQTT protocol*

TrustZone

Q: TrustZone is

- *A software solution for relaibility*
- *A security solution that provides hardware support for process isolation*
- *A software security solution that provides process isolation in embedded operating systems*
- *A piece of software that can be used to evaluate security of some embedded operating systems*

Which are the steps in a typical (top down) embedded system design process?

Q: Which are the steps in a typical (top down) embedded system design process?

- *Requirements, specification, design of components, design of architecture, system integration*
- *Requirements, specification, design of architecture, design of components, system integration*

- *Design of architecture, design of components, specification, system integration*
- *Requirements, implementation of components, design of architecture, test*