# Investigation on Quality in Critical Embedded Systems

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## Summary

- Embedded Systems and Critical Embedded Systems
- Software Architecture
- Ph.D Project
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# Embedded Systems and Critical Embedded Systems

### Definitions

- "Embedded systems are information processing systems embedded into enclosing products" (Marwedel, 2003).
- "Embedded software is software integrated with physical processes..." (Lee, 2006).
- "Cyber-Physical Systems (CPS) are integrations of computation and physical processes" (Lee, 2007).

### Important characteristics

- Limitations in terms of software and/or hardware.
- Normally for a dedicated function.
- Time-to-market constraints versus strict requirements.

## **Critical Embedded Systems**

#### **Basic definition of CESs**

 A type of embedded systems that, in case of failure, may cause serious damage to the environment and/or to human lives.

## **Application domains**

Critical embedded systems may be found in:

- Automotive
- Avionics
- Railways
- Health care
- Robotics, etc.

## **Quality Attributes**

Some of the most important quality attributes for CESs:

- Dependability
- Safety
- Security
- Performance

### **Embedded Systems Design**

 One of the most used process models for developing ESs is the V-Model:



## Software Architecture

### Definitions

According to Pressman (2006), "The architecture is not the operational system, but it is a representation to aid the software engineer the following ways: 1) Analysing the effectiveness of the project; 2) Considering alternatives; and 3) Reducing the risks."

### Definitions

According to Bass et al. (2013), "the software architecture of a system is the set of structures needed to reason about the system, which comprise software elements, relations among them, and properties of both."

## **Quality Attributes**

- Quality attributes have a strong influence on the shape of an architecture.
- Divided into three classes:
  - System quality attributes
  - Business qualities
  - Architecture qualities

#### **A General Software Architecture Design Model**



## **Architectural Analysis**

- In this context, Architectural Analysis plays a central role for designing successful architectures.
- Challenges to be taken into account in this phase:
  - Multiple stakeholders in the project.
  - Imprecise and ill-defined needs.
  - Quality attributes versus functional requirements.

## Software Quality Models

# A quality model for Critical Embedded Systems

Ph.D Project

Objective

• To investigate how the architectural analysis for CESs has been conducted.

#### Motivation (1/2)

- A major concern w.r.t the development of CESs:
  - Risks associated to software failures.
- What is the crucial factor for such concern?
  - Software architecture.

#### Motivation (2/2)

- **How** must one conduct the architectural design?
  - ASRs provide a concrete basis.
- **Why** is quality of the ASRs important?
  - Most of failures in CESs have been traced to requirements problems.

#### Important findings (1/2)

- Use of natural language.
- Lack of method guidance.
- Need for clear separation between requirements and design.

#### Important findings (2/2)

- Lack of strategies to cover crucial quality attributes.
- Limited support for safety standards.

## **Project Proposal**

#### Objective

- To establish a process for architectural analysis of CESs.
  - A set of techniques and guidelines to systematically conduct the process.
  - A system of analysis patterns based on prescriptions in standards for the detailed workflow of the process.
  - A tool to provide automated support for the process application.

### Project Proposal Context



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