



UNIVERSITÀ DEGLI STUDI DI NAPOLI  
FEDERICO II

itee<sup>PhD</sup>  
information technology  
electrical engineering



DIE  
TI

UNI  
NA

Marco De Luca

# Functional safety in managed NAND embedded systems

Tutor: prof. Anna Rita Fasolino

co-Tutor: Pasquale Cimmino

Cycle: XXXVII

Year: Second

# My background

- MSc degree: **Computer Engineering**
- Research group/laboratory: ***REvERSE* - REsEarch gRoup of Software Engineering**
- PhD start date: **1<sup>st</sup> November 2021**
- Scholarship type: **founded by Micron Semiconductor Italia S.R.L**

# Research field of interest

- **Software Development and Documentation process in safety critical domain in compliance with ISO 26262:**
  - Definition of a documentation template that aims to support the compliance process with the requirement of ISO 26262-6§7 about the software architecture design (SAD)
- **Software Testing:**
  - robustness of locators in Template-based Web Application testing

# Summary of study activities

- Ad hoc PhD courses:
  - **Using Deep Learning Properly**
- PhD Schools:
  - **ISSSE 2023** – *16<sup>th</sup> International Summer School on Software Engineering*, 12-15 June 2023, University of Salerno, Italy
- Conferences:
  - **ICSA 2023** – *20<sup>th</sup> International Conference on Software Architecture*, 13-17 March 2023 L'Aquila, Università degli Studi dell'Aquila

# Research activity: Software Documentation in compliance with ISO 26262

- **Context:**
  - Complexity of automotive system has increased in recent years. ISO 26262 is a standard that deals with the functional safety of the E/E (Electric and Electronic) components of road vehicles. The standard define a functional safety development process model that automotive manufacturing must follow and document to achieve compliance with the standard, otherwise the manufactured product will not be suitable to run in commercial vehicles.
- **Problem:**
  - Documenting Software Architecture Desing (SAD) is a challenging activity in industries for safety critical software.
  - This is amplified when the software development process must comply with the guidelines of safety standard like the ISO 26262
- **Objective:**
  - Define a documentation template that can help in the compliance process with the requirement of ISO 26262

# Research activity: Software Documentation in compliance with ISO 26262

- **Methodology:**

1. Focus group with industry safety expert from the automotive domain
2. Based on the result of the focus group we define a **Software Architectural Documentation Template** intended to overcome the emerged difficulties and challenges
3. Validation of the proposed template with a case study that involved the same experts enrolled in the survey

# Research activity: Software Documentation in compliance with ISO 26262

1. From the focus group we extracted which are the challenges and issues most frequently encountered when software development organizations need to comply with the safety standard guidelines regarding the software architecture design defined by ISO 26262§6.7

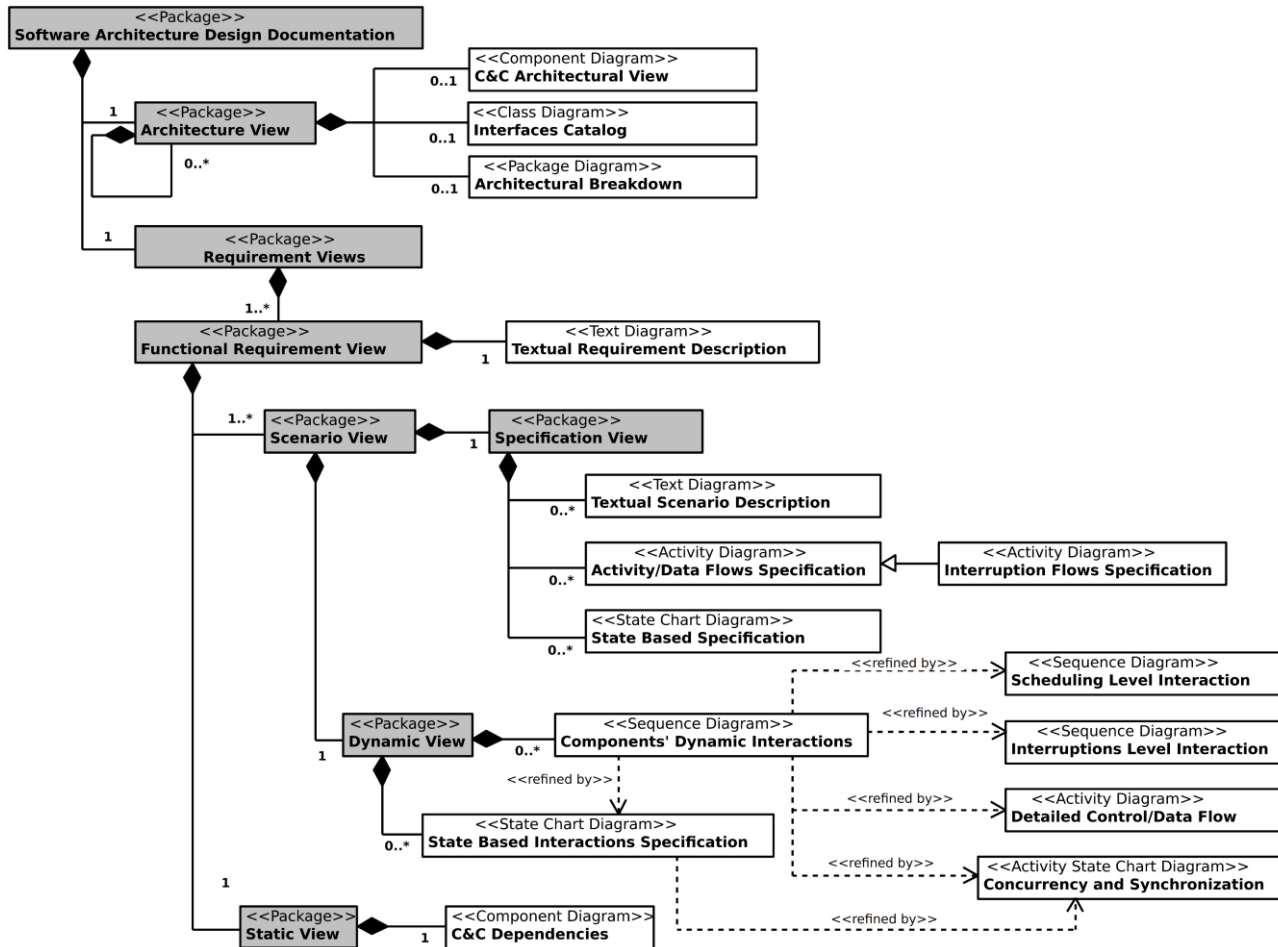
ID	ISO REFERENCE	CHALLENGE	DESCRIPTION
C1	Properties, 7.4.1.b: consistency	<b>Consistency management</b>	Difficulties in ensuring the consistency between the different artifact produced during the documentation process.
C2	Properties, 7.4.1.d: verifiability	<b>Verification of the design principles recommended by the ISO-26262</b>	Difficulty in finding methods for checking that the SAD adheres to the characteristics defined by the standard such as: modularity, maintainability and consistency
C3	Properties 7.4.1.f: abstraction	<b>Document the SAD with a hierarchical structure</b>	Abstraction can be supported by using hierarchical structures, grouping schemes or views to cover static, dynamic or deployment aspects of an architectural design
C4	Principle, 7.4.3-3: restricted size of interfaces	<b>Verifiability of the principle</b>	Difficulties in documenting software component interfaces to help the verification of the principle
C5	Requirement, 7.4.10.2: identify or confirm the safety related part of the software.	<b>Find mechanism to easily identify safety related part</b>	Difficulties in identification of Safety related component (unit) and parameters of interfaces

# Research activity: Software Development in compliance with ISO 26262

2. Thanks to the *Focus Group* we understood that most of the emerged *Challenges* are related to:

- **Scant documentation**
- **Improper use of design tools in support *traceability* and *consistency* management**

To overcome these problem, we propose a ***Documentation Template***

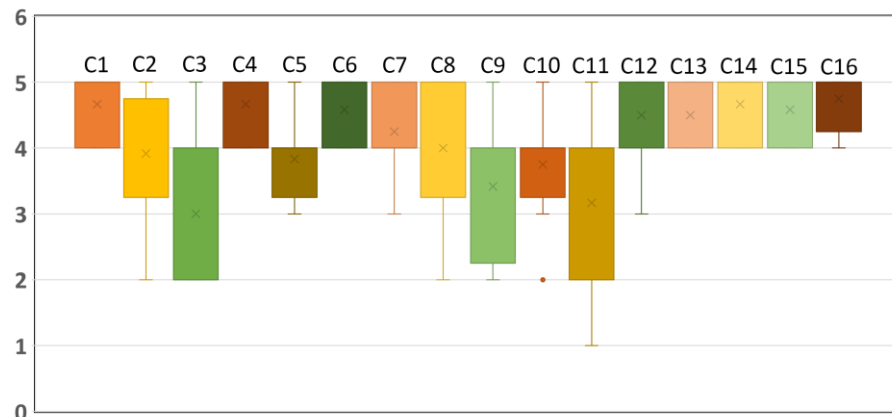




# Research activity: Software Documentation in compliance with ISO 26262

## 3. Results:

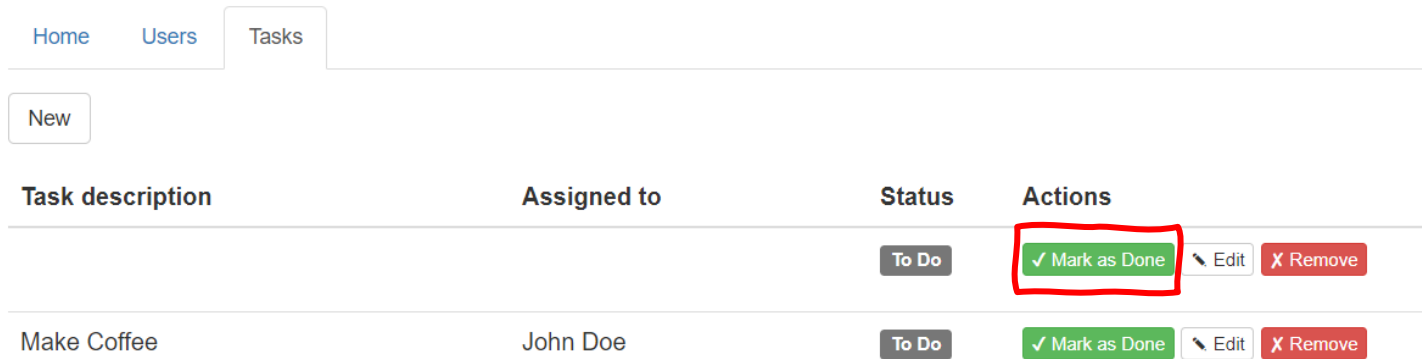
- From the case study conducted to gather feedback on the use of the proposed documentation template it emerged that:
- improved the automatic consistency management between different views of the documentation, in comparison with the one previously used by the practitioner
- it has enhanced the verification of the principles required by the ISO 26262
- Lack in specific handling for functionally safety requirement management



# Research activity: Software Testing

- **Context:**
  - GUI-based test-cases are based on the use of **locators** to identify and interact with elements on a web page
  - Locators are used to target specific elements within a web page like buttons, text fields, links, and more
  - Locators are mainly used to automate the testing process, as they help testers to interact with web elements in a systematic and robust way

# Research activity: Software Testing



Task description	Assigned to	Status	Actions
		To Do	✓ Mark as Done Edit X Remove
Make Coffee	John Doe	To Do	✓ Mark as Done Edit X Remove

Figure 1. Screenshot of an example of a Web Application showing the «Make a Coffee» Task in the «To Do» status

## Absolute Locator:

```
/html/body/div/ui-view/div/ui-view/ui-view/table/tbody/tr[2]/td[4]/div/button[1]
```

## Relative Locatos:

```
//div[@class='container']/ui-view/div/ui-view/ui-view/table/tbody/tr[2]/td[4]/div/button[1]
```

## ROBULA Locator:

```
//tr[2]/td[4]/div/button[1]
```

## Katalon Record Locator:

```
xpath=(.//*[normalize-space(text()) and normalize-space(.)='To Do'])[2]/following::button[1]}
```

## Selenium Locator:

```
xpath=(//button[@type='button'])[2]
```

## CSS Locator:

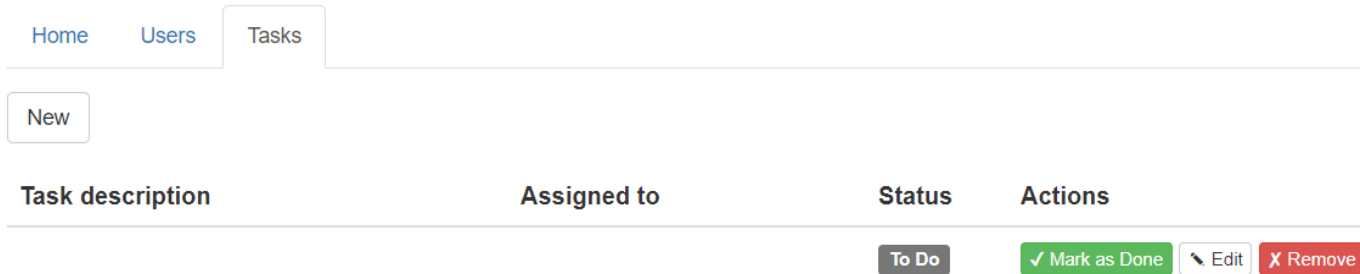
```
css=.btn-success
```

Figure 2. Example of locators used to identify the first «Mark as Done» button

# Research activity: Software Testing

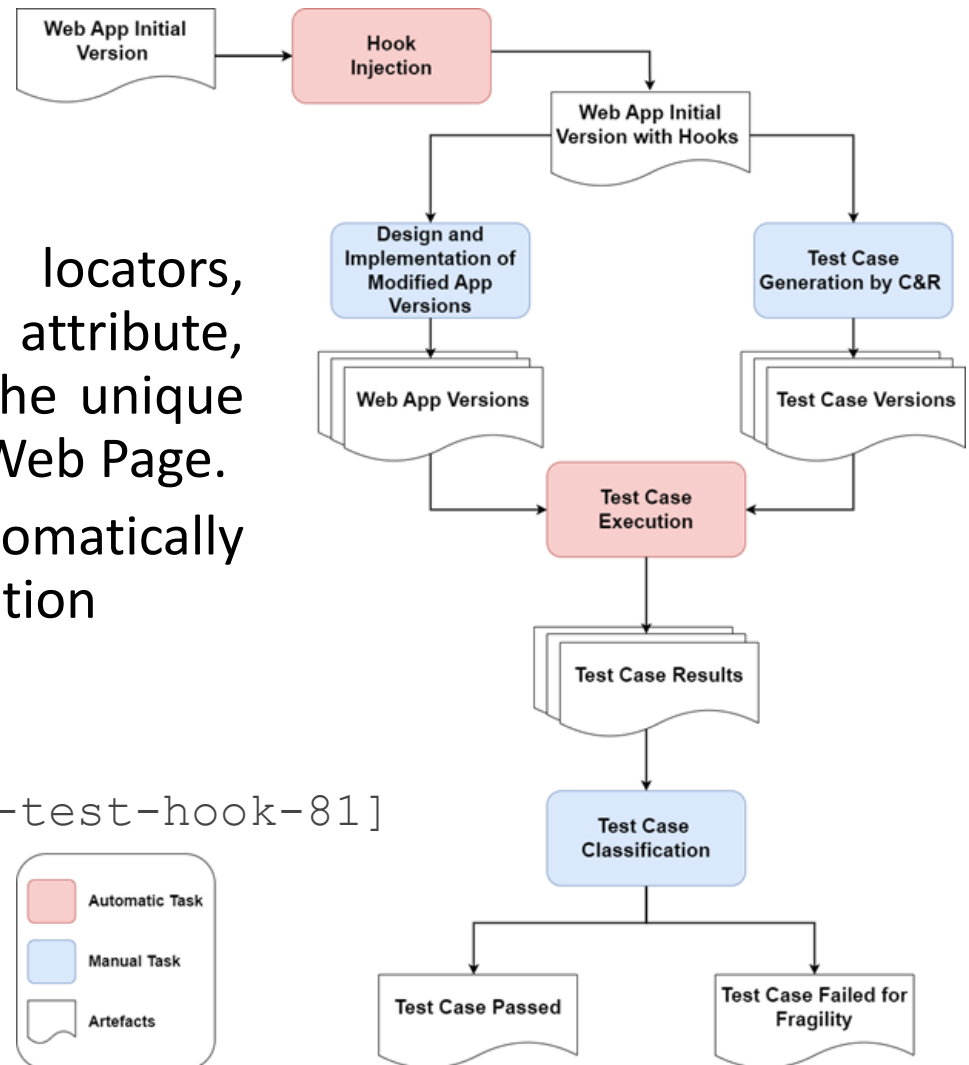
- **Problem:**

- GUI-based test-cases generated by Capture and Replay (C&R) tools suffer from the well-known **fragility** problem: they may break even if small layout changes are operated in a Web application, without modifying the app functionality



- If we want to register the click of the Mark as Done Button, a possible locators suggested by C&R can be:
  - `xpath=//div[2]//button[contains(., '✓Mark as Done')]`
- The Locator is **Fragile**:
  - May broke for localization/changing in the text
  - May broke for button type changing
  - May broke for charted code chaining

# Research activity: Software Testing

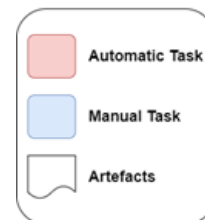


- **Methodology:**

- Definition of “**Hook-Based**” locators, that exploit an HTML tag attribute, referred as “**hook**”, to allow the unique identification of each tag of a Web Page.
- The **hook attribute** are automatically injected inside the web application

Hook Locators:

```
/**[@x-test-hook-73][2]**[@x-test-hook-81]
```



# Research activity: Software Testing

- Results:**

Test Case	A1 : Contact List						A2 : Spotify							
	Locators (*)						Locators							
Results	A	R	RO	K	S	C	H	A	R	RO	K	S	C	H
Passed	58	86	83	74	77	74	88	47	49	64	59	76	69	79
Failed for Obsolescence	7	7	7	7	7	7	7	8	8	8	8	8	8	8
Failed for Fragility	35	7	10	19	16	19	5	37	35	20	25	8	15	5
Total	100	100	100	100	100	100	100	92	92	92	92	92	92	92

- For both two application under test (AuTs) we performed a series of layout changes following a predefined pattern of modification that included:
  - Attribute modifications
  - Text modification
  - Tag type modification
  - Tag type position changes
- The findings suggest that Hook Based locators prove to be more robust compared to the other proposed in the literature

\*A – Absolute; R – Relative;  
 RO – Robula; K – Katalon;  
 S – Selenium; C – CSS Locator;  
 H – Hook-based Locator

# Products

[P1]	<b>M. De Luca</b> , A.R. Fasolino, A. Ferraro, V. Moscato, G. Sperlì, P. Tramontana; “ <i>A community detection approach based on Network Representation Learning for repository mining</i> ”, <i>Expert Systems with Applications</i> , published, 2022. <a href="https://doi.org/10.1016/j.eswa.2023.120597">https://doi.org/10.1016/j.eswa.2023.120597</a>
[P2]	D. Amalfitano, <b>M. De Luca</b> , A.R. Fasolino; “ <i>Documenting Software Architecture Design in Compliance with the ISO 26262: an Industrial Case Study in the Automotive Domain</i> ”, <i>International Conference On Software Architecture (ICSA)</i> , published, 2023. <a href="https://doi.org/10.1109/ICSA-C57050.2023.00022">https://doi.org/10.1109/ICSA-C57050.2023.00022</a>
[P3]	<b>M. De Luca</b> , A.R. Fasolino, P. Tramontana; “ <i>Investigating the Robustness of Locators in Template-based Web Application Testing using a GUI Change Classification Model</i> ”, <i>Journal of System and Software (JSS)</i> , accepted, 2023

# Tutorship

- 12 hours of teaching activities regarding practical lectures/seminars during the course “*Ingegneria del Software*”, Bachelor Degree in Computer Engineering



# Next Year

- To continue my research activities in collaboration with the “Gran Sasso Science Institute (GSSI)” about software metric to assess compliance with ISO 26262 and about the concept of continuous compliance with safety standard
- To investigate a reverse engineering approach to:
  - automatic recover of the architectural documentation of software system (ART – Architectural Recovery Tool)
  - keep up to date the Software Documentation within the safety standard requirement and recommendation
- To continue my research in the filed of software testing
- To continue my tutorship activities in the “Ingegneria del Software” course
- To write my thesis about “Software Development and Software Documentation in Compliance with ISO 26262”

Thank you for the attention!