XXXIII Annual Meeting of the Division of Particles y Fields of the Mexican Society of Physics

APPLICATION OF A SOFTWARE ENGINEERING METHODOLOGY IN THE CONTROL SYSTEM DESIGN OF A SINGLE DETECTOR IN A HIGH ENERGY PHYSICS (HEP) EXPERIMENT

Dr. Juan Carlos Cabanillas Noris

Dr. Mario Iván Martínez Hernández
Dr. Ildefonso León Monzón
Dr. Solangel Rojas Torres

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DPC-SMF

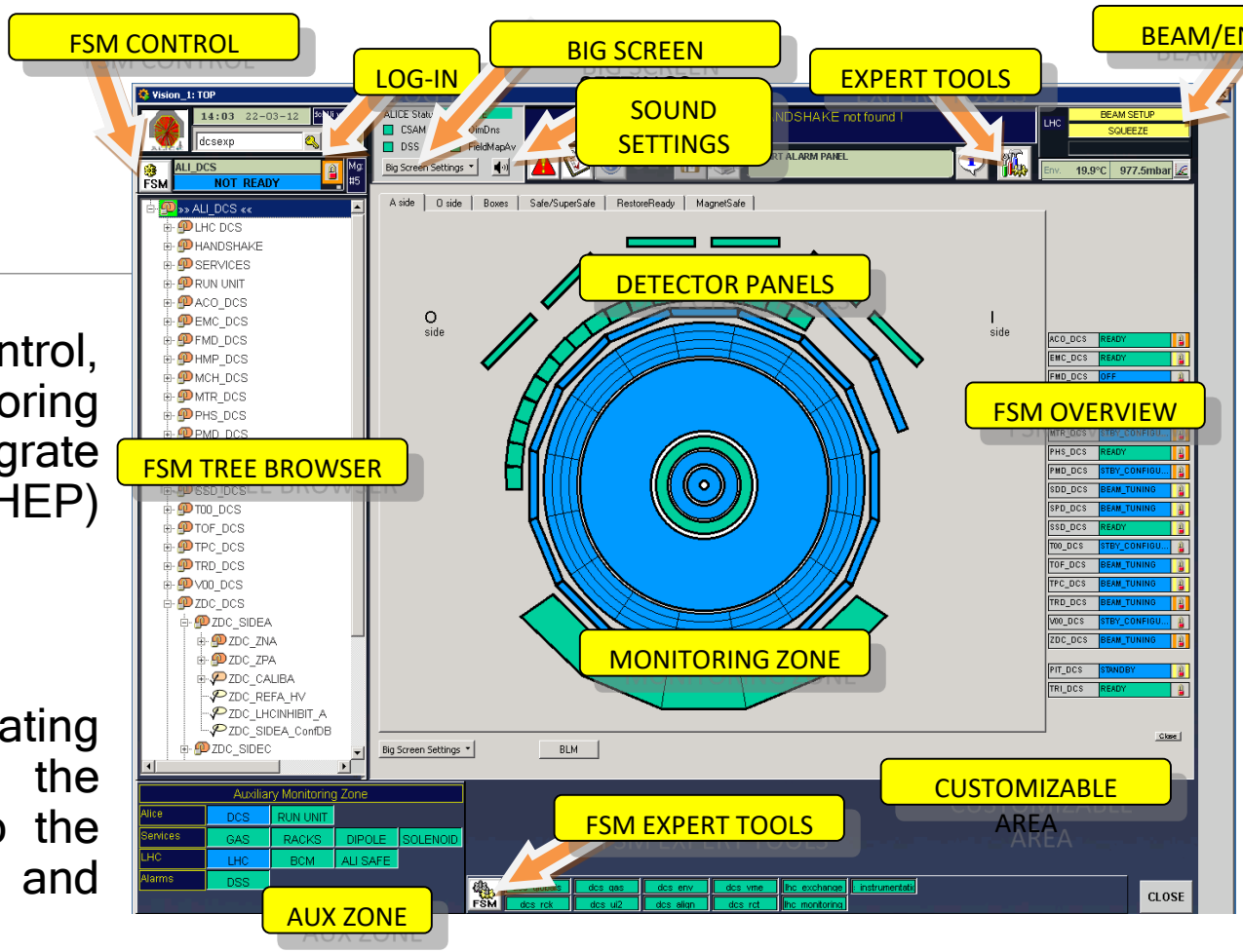
DETECTOR CONTROL SYSTEM (DCS)

- The DCS allows the control, configuration and monitoring of the elements that integrate a High Energy Physics (HEP) experiment.

- DCS oversees coordinating of all processes in the experiment, according to the status of the systems and subsystems;

- As well as monitoring data.

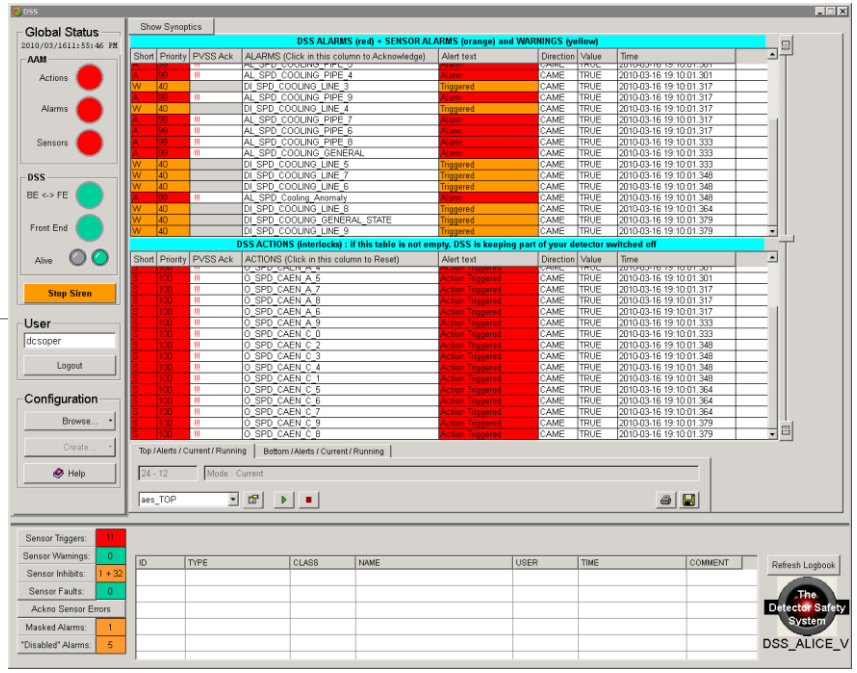
- Ensures safe, reliable, and uninterrupted operation of the experiment.

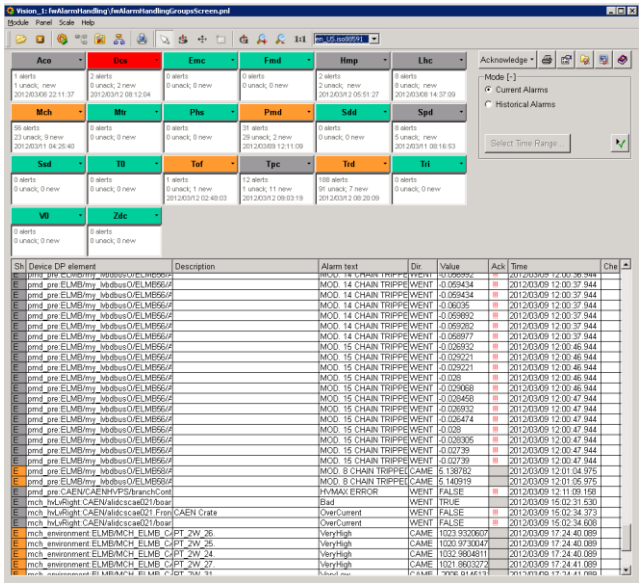


DETECTOR CONTROL SYSTEM (DCS)

- Serves as an important communication exchange point, providing:

a) Data for detector operation
b) Physics analysis
c) Safety systems
d) External services (including the accelerator).





OBJETIVE

- Due to the relevance of the previously mentioned is important to:
  - *Develop a standardized methodology to model the design and operation process of a control software.*
  - *Using software-engineering techniques.*

- This proposal uses Rational Unified Process (RUP) to model a control system of a detector considering the:
  - *Workflow of requirements,*
  - *Analysis*
  - *Coding*
  - *Tests for all phases of this model;*

- Through application of associated UML (Unified Modeling Language) models.

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SYSTEM MODELING

- This methodology to model a DCS is presented from point of view of the three main actors** (stakeholders) involved in the software development process of this system.

- Applying five UML diagrams that contain the essentials of the system development.

- It is worth mentioning that the actors that participate in the use cases can be people or subsystems (software, modules, logbook, web browser, etc.).

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SYSTEM MODELING

- Three main stakeholders defined are:
  a) *Detector Expert* (DE)
  b) *Expert of the Central DCS of the Experiment* (ECDCS)
  c) *Operator of the Central DCS of the Experiment* (OCDCS).

- Finally, the models provide insight into system requirements can generate an abstraction to simplify and gather the most important characteristics of this system;

- Despite huge conceptual and structural differences between one detector and another.

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SYSTEM MODELING

Actors / stakeholders:

- Expert in the Detector (ED)
- Expert in the Central DCS (ECDCSC)
- Operator in the Central DCS (OCDCS)

For each actor were defined:

- *General Characteristics*
- *Requirements Analysis*
  - *Functional → system should do (elements)*
  - *No Functional → system as a whole (Efficiency)*

UML Diagrams

- ❑ Diagrams / Tables of Use Cases
- ❑ Context Diagram
  - *Analysis Model*
    - ❑ UML Activity Diagrams
  - *Design Model* (Static Structures)
    - ❑ UML Class Diagrams
  - *Dynamic View*
    - ❑ UML Sequence Diagrams
    - ❑ State Diagrams
- ❑ Tree Diagrams (Hierarchy of nodes)

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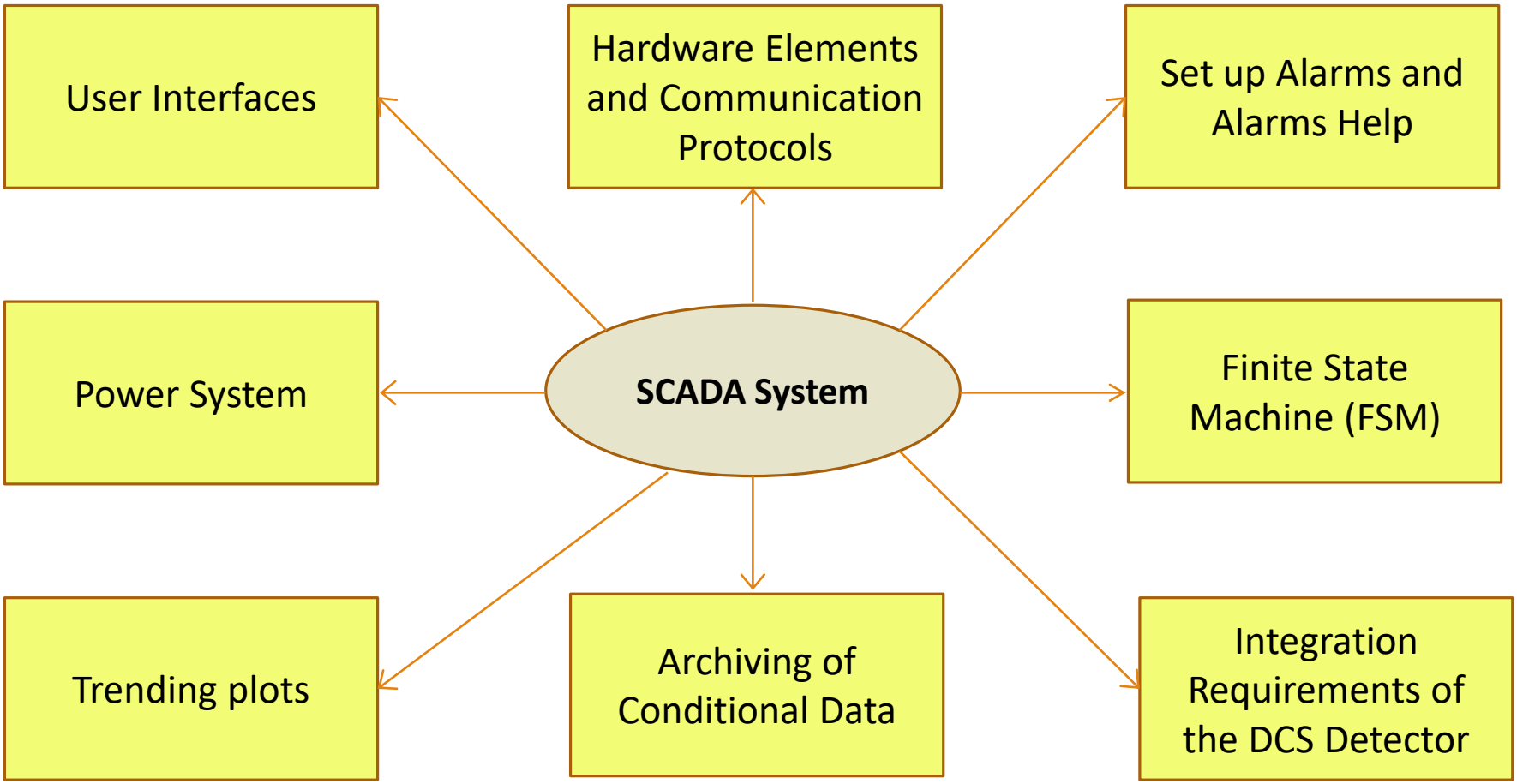
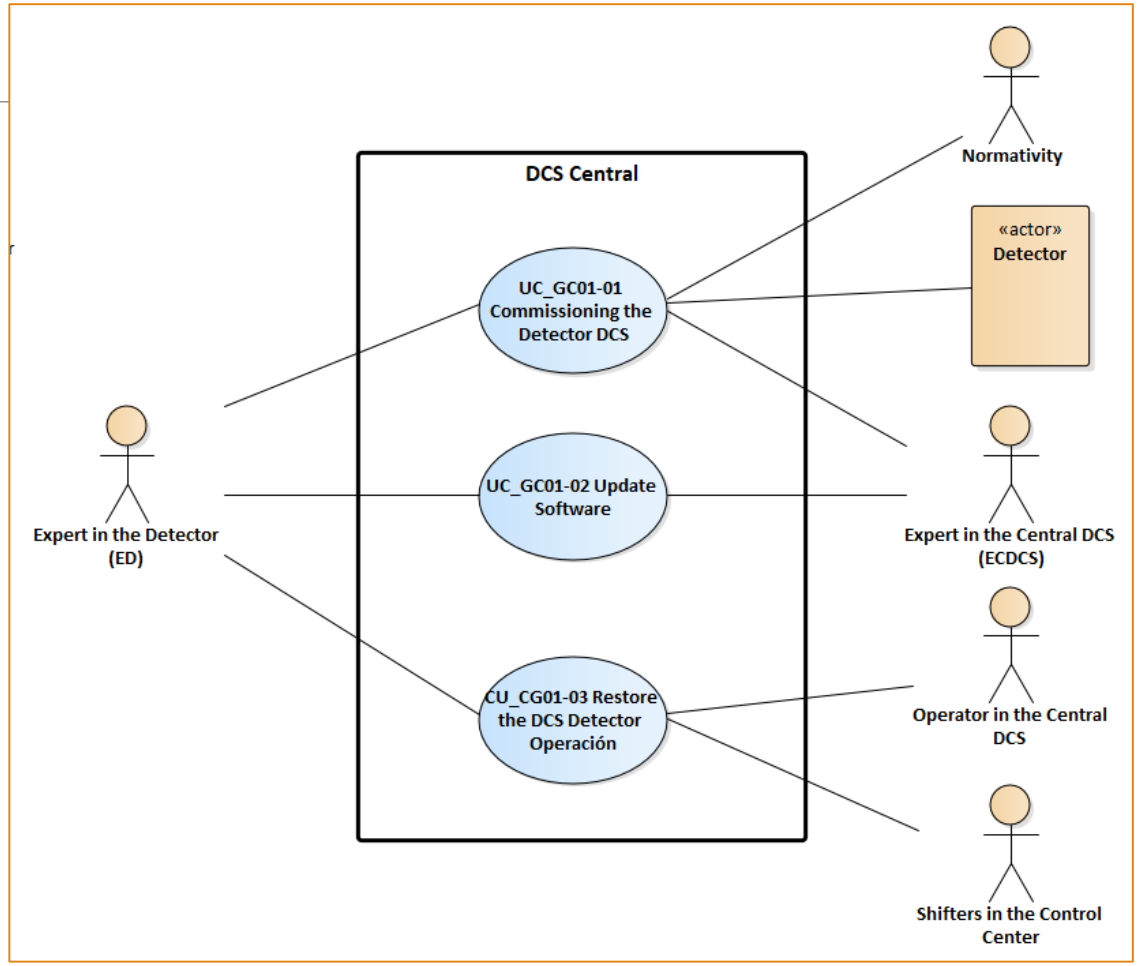
IMPORTANT ASPECTS IN DCS DESIGN



METHODOLOGY

General Characteristics

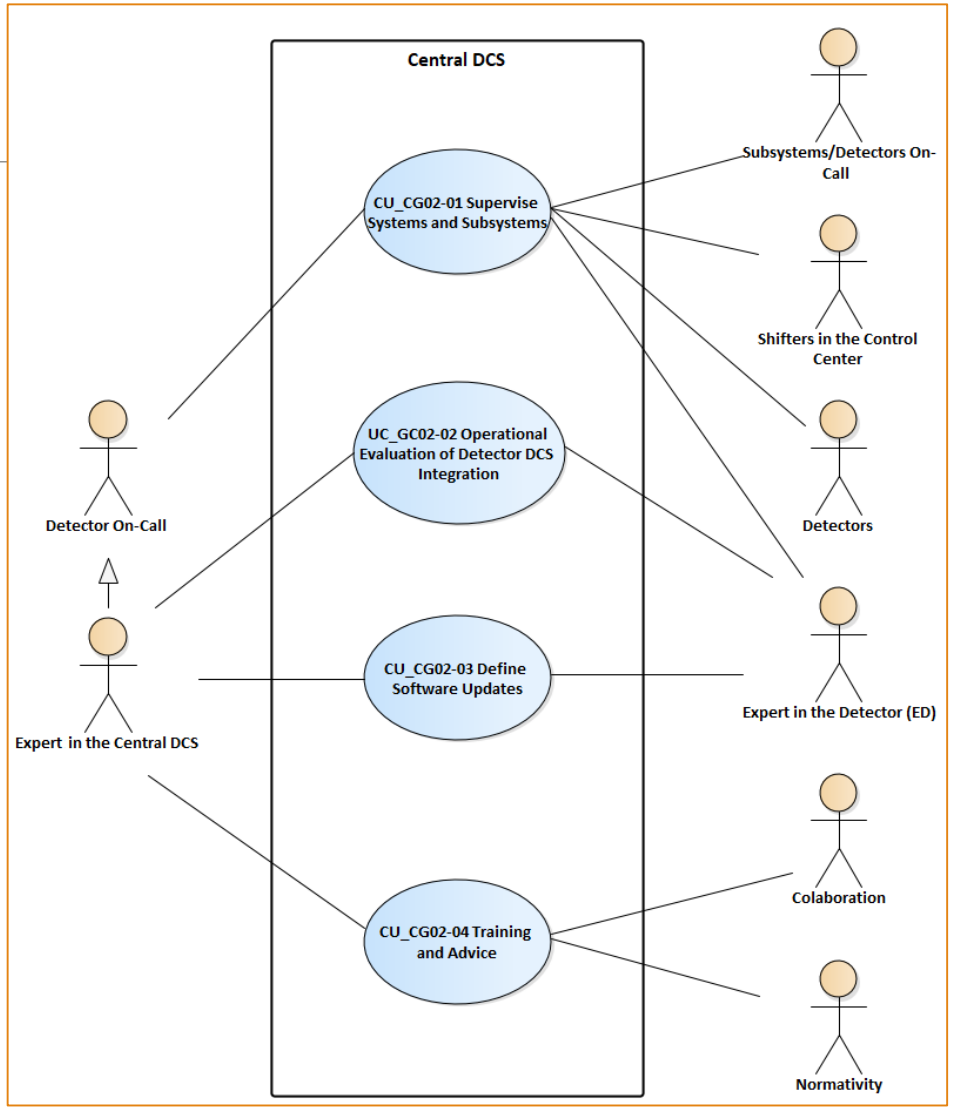
Actor: **Expert in the Detector (ED)**



METHODOLOGY

General Characteristics

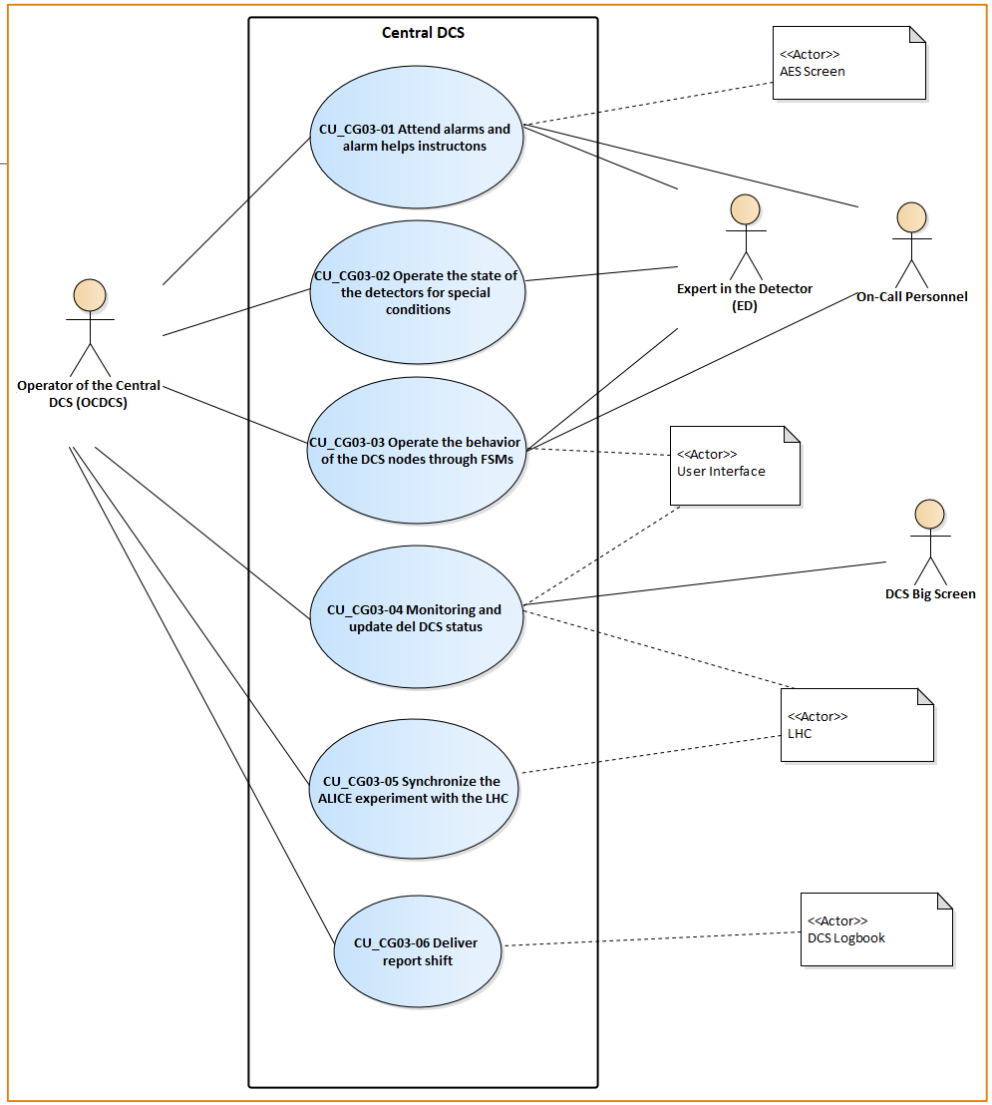
Actor: **Expert of the Central DCS of the Experiment (ECDCS)**



METHODOLOGY

General Characteristics

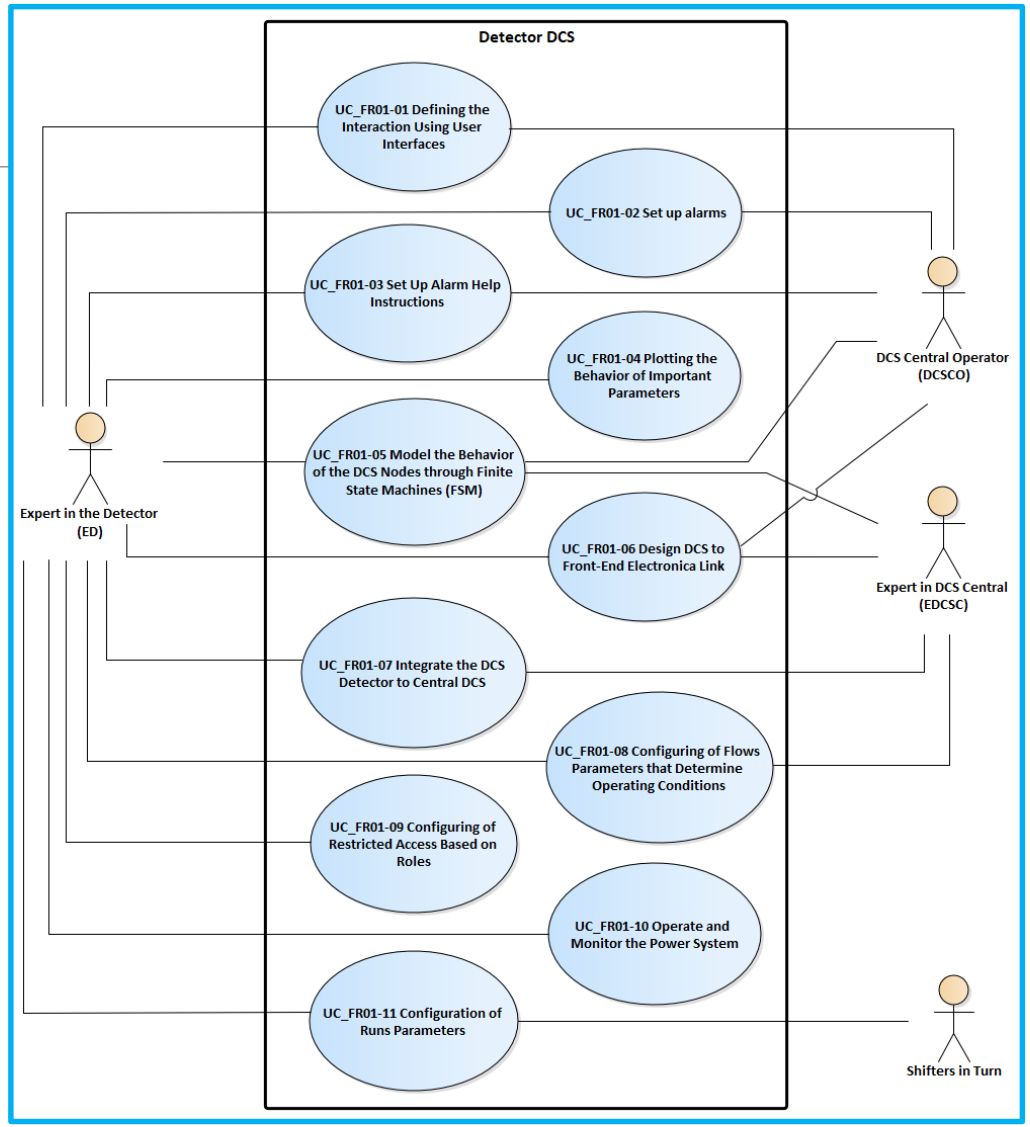
Actor: **Operator of the Central DCS of the Experiment (OCDCS)**



METHODOLOGY

Main Software Requirements

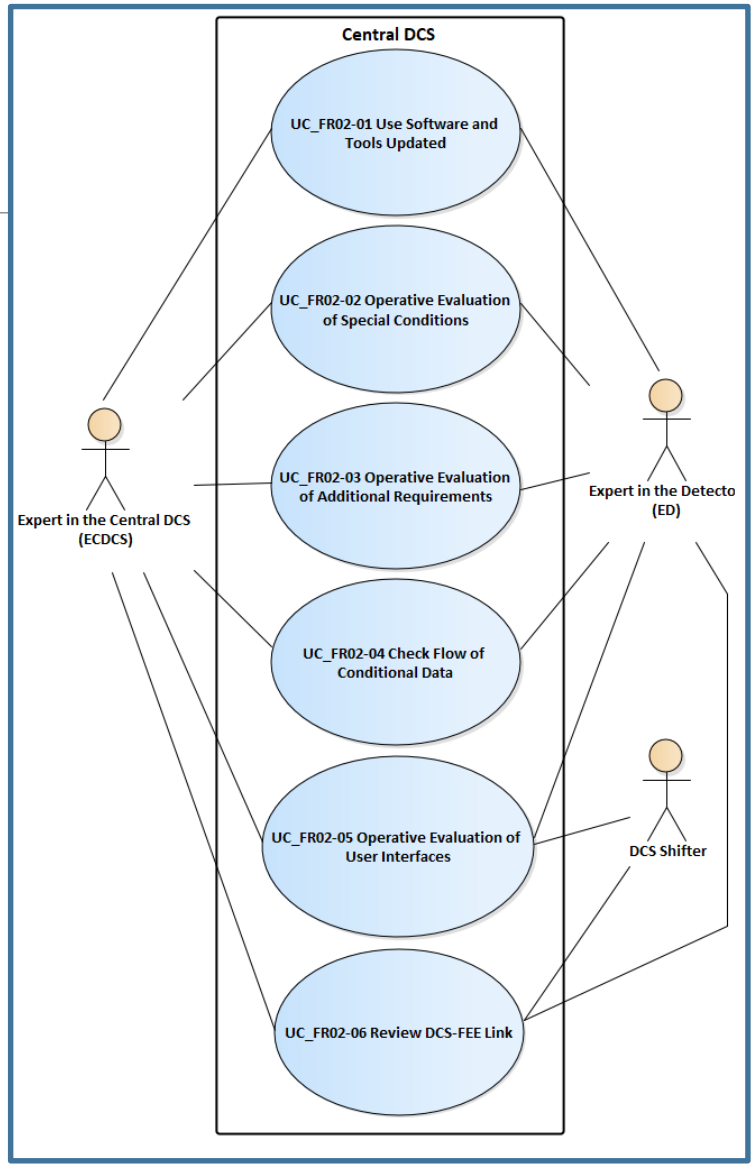
Actor: **Expert in the Detector (ED)**



METHODOLOGY

Main Software Requirements

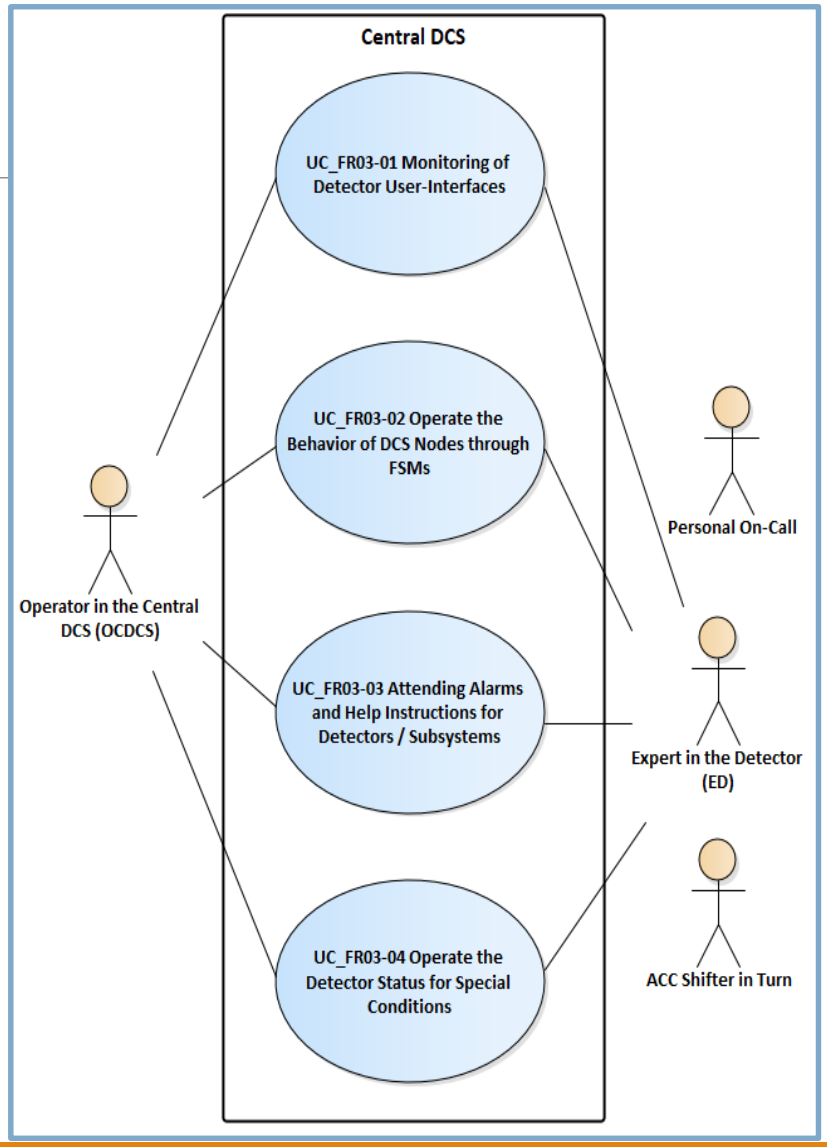
Actor: **Expert of the Central DCS of the Experiment (ECDCS)**



METHODOLOGY

Main Software Requirements

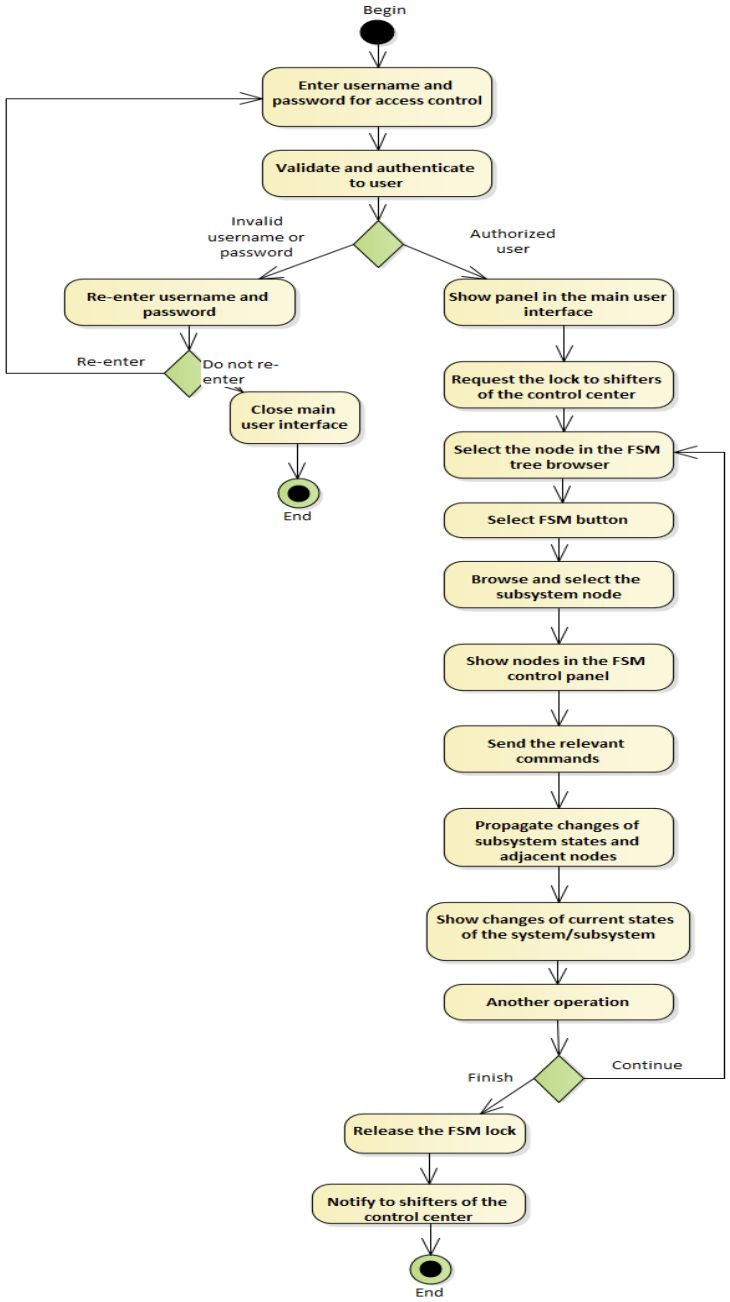
Actor: **Operator of the Central DCS of the Experiment (OCDCS)**



METHODOLOGY

Activities Diagram

Actor: **Expert in the Detector (ED)**

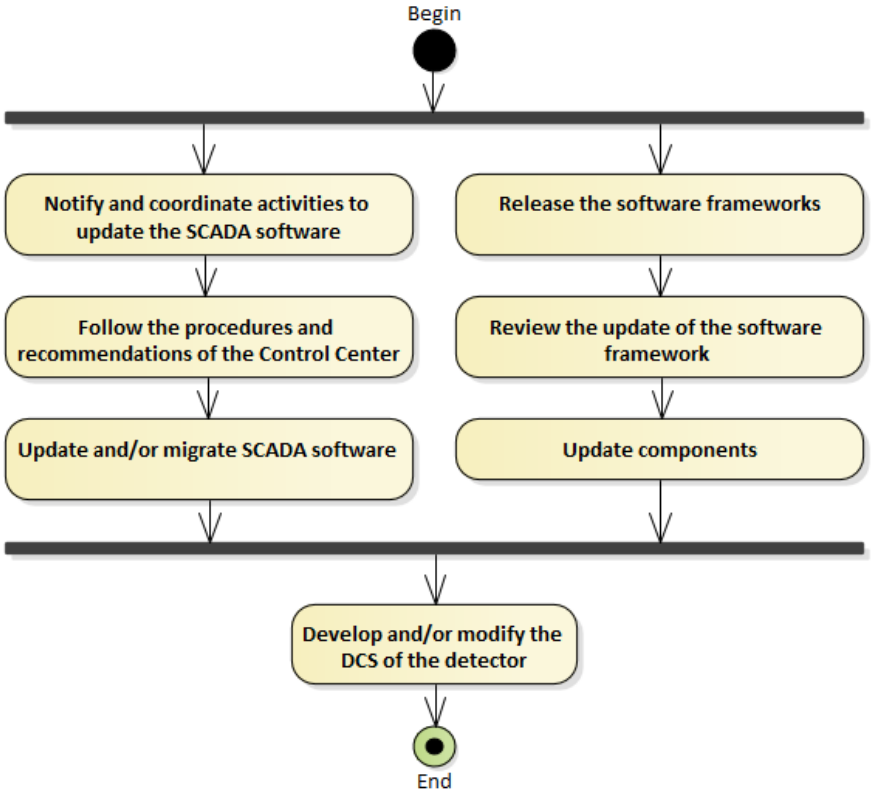


Activity Diagram of the Use Case CU_RF01-05:
Model the Behavior of the DCS Nodes through Finite State Machine (FSMs)

METHODOLOGY

Activities Diagram

Actor: **Expert of the Central DCS of the Experiment (ECDCS)**

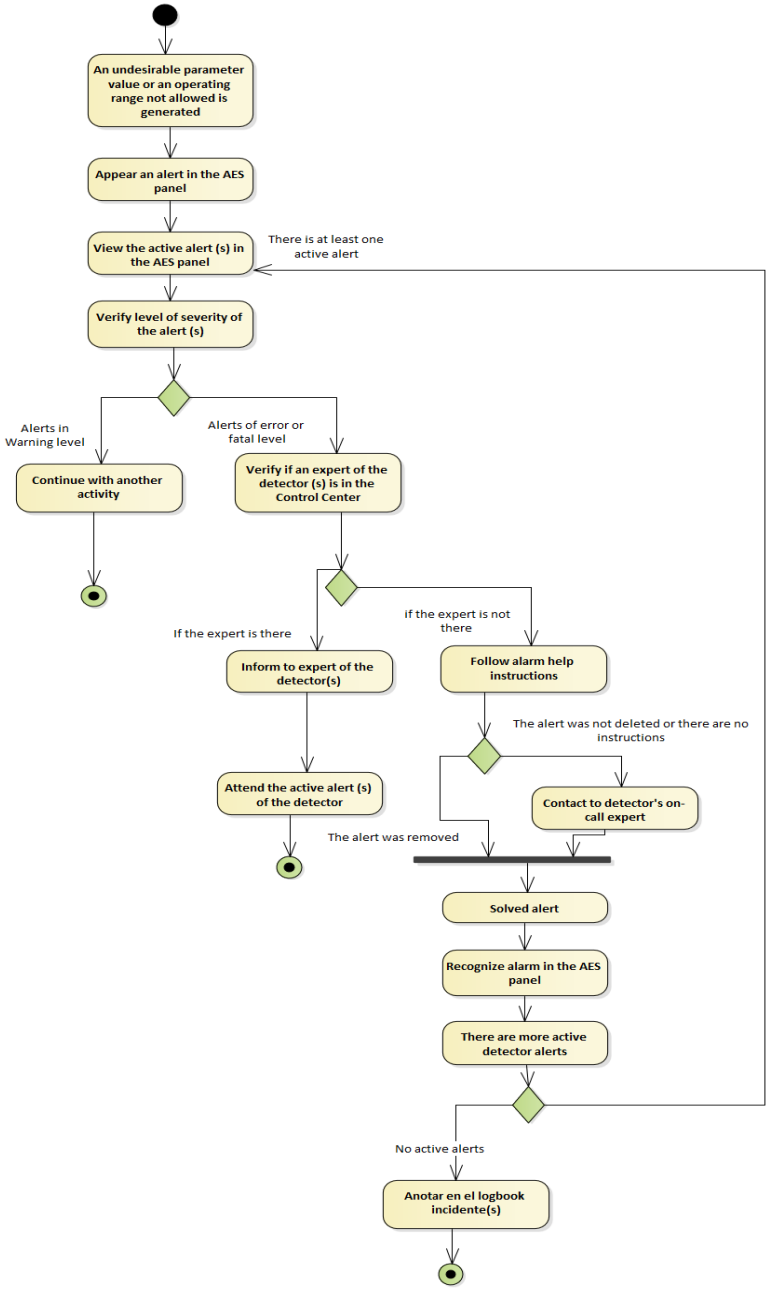


Activity Diagram of the Use Case CU_RF02-01:
Use software and Tools Updated

METHODOLOGY

Activities Diagram

Actor: **Operator of the Central DCS of the Experiment (ECDCS)**

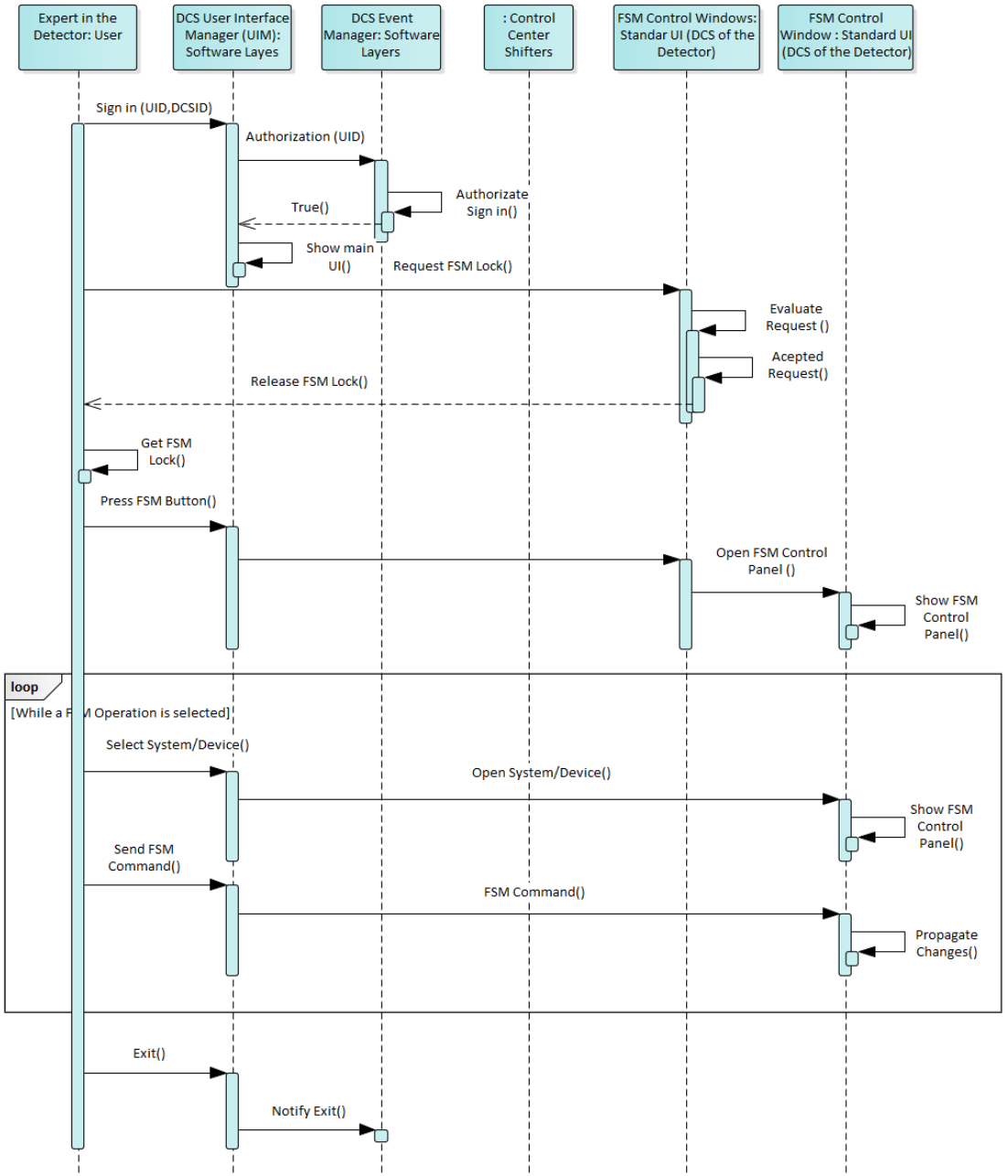


Activity Diagram of the Use Case CU_RF03-03:
Attending Alarms and Help Instructions for Detectors/Subsystems

METHODOLOGY

Sequence Diagram

Actor: **Expert in the Detector (ED)**



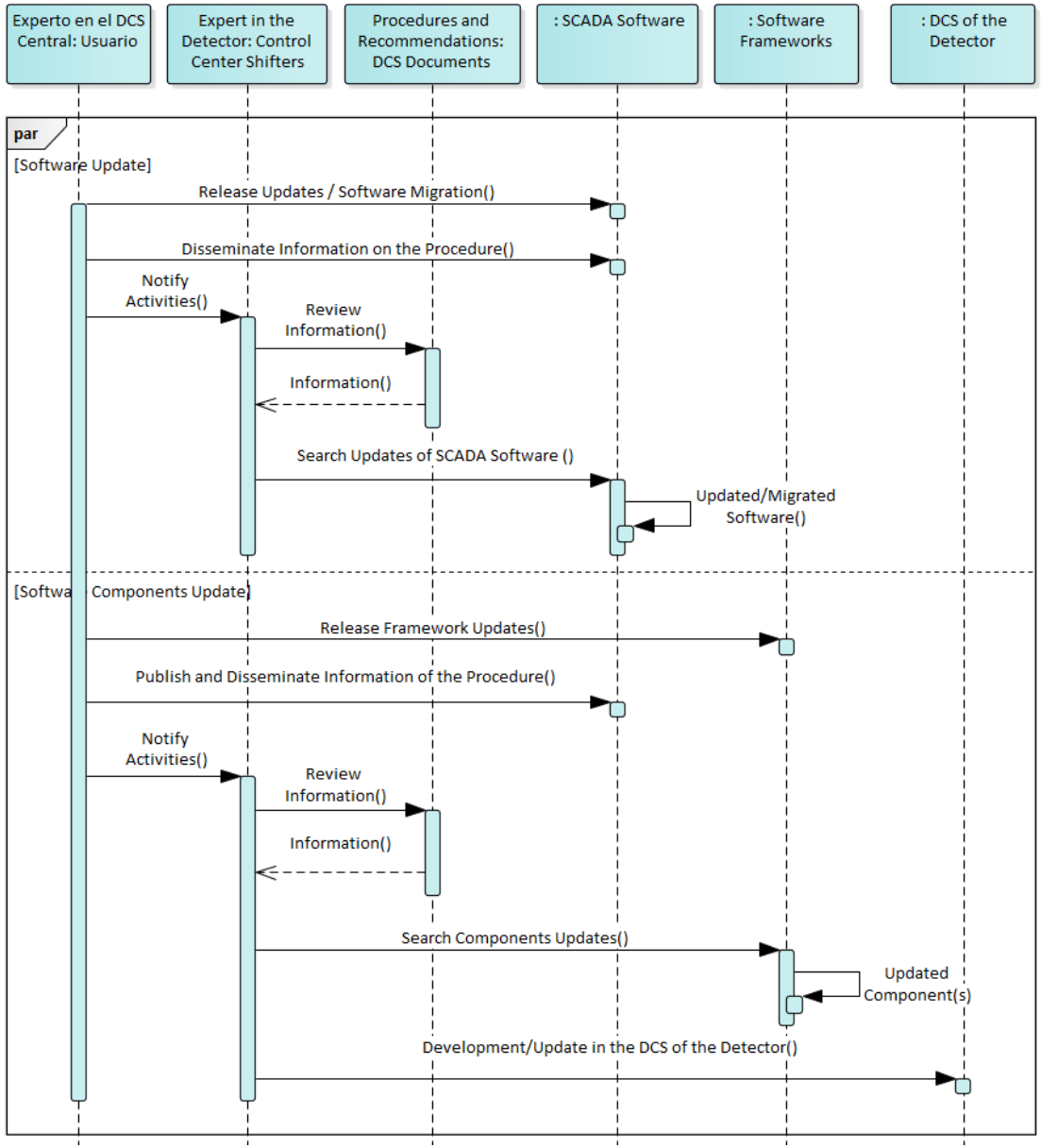
Sequence Diagram of the Use Case CU_RF01-05: *Model the Behavior of the DCS Nodes through Finite State Machine (FSMs)*

METHODOLOGY

Sequence Diagram

Actor: **Expert of the Central DCS of the Experiment (ECDCS)**

Sequence Diagram of the Use Case CU_RF02-01:
Use software and Tools Updated

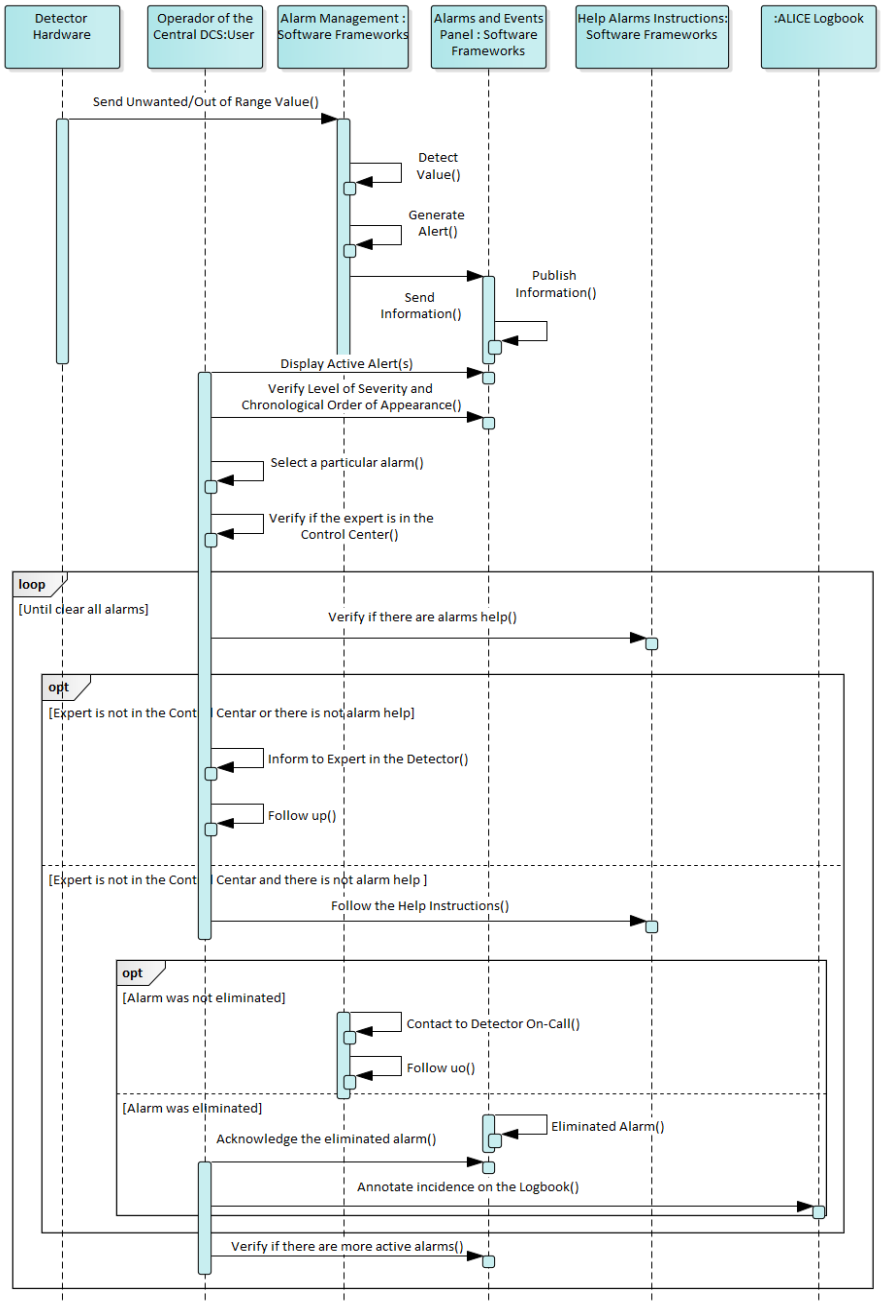


METHODOLOGY

Sequence Diagram

Actor: **Operator of the Central DCS of the Experiment (OCDCS)**

Sequence Diagram of the Use Case CU_RF03-03:
Attending Alarms and Help Instructions for Detectors/Subsystems



Conclusions

- It is important the definition and documentation of the design process, commissioning and operation of a detector control system (DCS) in high-energy experiments in a general way, especially for the staff that initiate in these interest topics (detector on-call, DCS shifters, members of a detector collaboration, etc.).

- The design of this methodological analysis of the DCS of the ALICE experiment for what will be LHC Run-3 is being finishing.

- This analysis is expected to be applied in the development of the control system for new FDD detector in the new LHC run in ALICE.

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Thanks!