

Team Project: Developing and testing a software-based prototype of an AED¹

Due Fri December 8th at 11:59pm

Use Case 1: Battery Self-Test for the AED

Primary Actor: User

Scope: Utilizing AED

Level: User Goal

Stakeholders and Interests:

User: Wants to ensure the AED is operational and ready for use.

AED Plus Developer: Wants the simulation to accurately represent the AED's self-test functionality.

Precondition: The AED Plus is not being used, and is turned off.

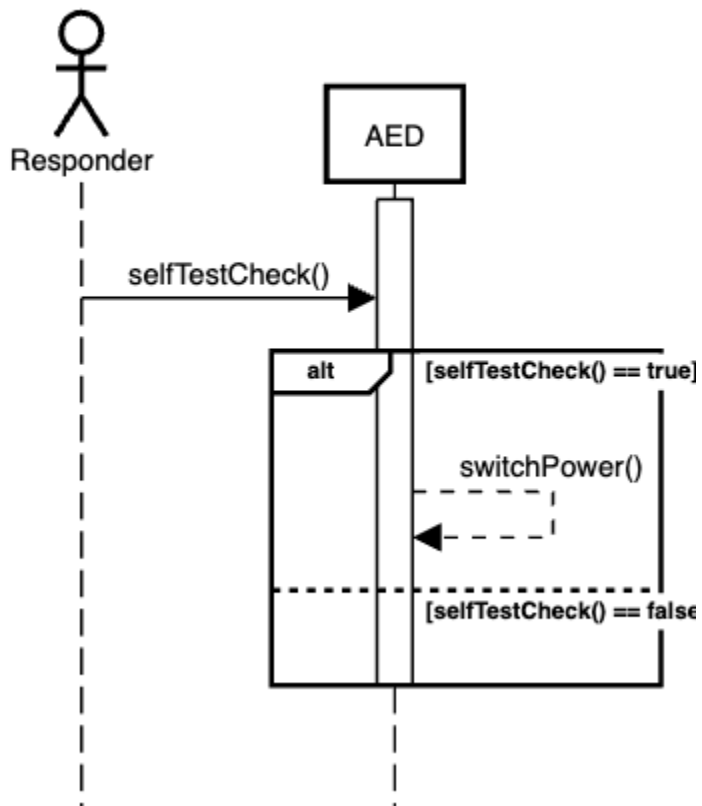
Post-condition: The AED Plus simulation is powered on, has completed the battery self-test successfully, and is ready for operation

Main Success Scenario:

1. The user opens the battery compartment and replaces the old battery with new ones, closing the compartment
2. The AED performs a Self-Test (Use Case 2)
3. The Fully Automatic AED Plus prompts the user to press the Battery Reset Button, located inside the battery compartment.
4. The user presses the Battery Reset Button, resetting the unit's battery usage indicator to full charge.

Sequence Diagram 1 - Battery Self-Test for the AED

Power On Self-Test



Use Case 2: Power On Self-Test for the AED

Primary Actor: User

Scope: Utilizing AED

Level: User Goal

Stakeholders and Interests:

User: Wants to ensure the AED is operational and ready for use.

AED Plus Developer: Wants the simulation to accurately represent the AED's self-test functionality.

Precondition: The AED Plus is available to use, has sufficient power and is on

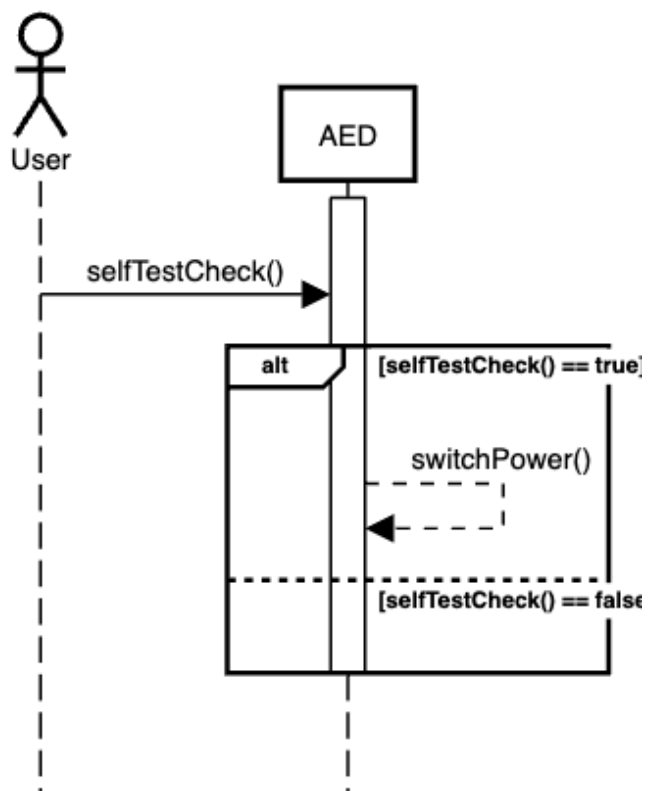
Post-condition: Electrode pads are correctly placed on the simulated patient's chest.

Main Success Scenario:

1. The AED checks that the battery usage indicator shows adequate battery capacity remaining.
2. The AED confirms that the defibrillation electrodes are properly pre-connected to the device.
3. The AED ensures that the ECG signal acquisition and processing electronics are functional.
4. The AED validates that the device's defibrillator electronics are functional and can charge and discharge at 200 joules.
5. The AED confirms the proper function of the Fully Automatic AED Plus microprocessor electronics and the integrity of its software.
6. The AED checks that CPR monitoring and compression depth detection are functional.
7. The AED ensures that voice prompts are functional.
8. The AED indicates visually and audibly "UNIT OK" to confirm that the AED Plus simulation has successfully completed the power-on self-test and is operational.

Sequence Diagram 2 - Power-On Self Test

Power On Self-Test



Use Case 3: AED Guiding User to Place Electrode Pads

Primary Actor: Responder

Scope: Utilizing AED

Level: User Goal

Stakeholders and Interests:

Responder: Need to effectively place Electrode Pads on victims to lay the foundation for heart rhythm analysis.

AED Plus Developer: Aims to ensure that the AED provides clear and accurate instructions for placing electrode pads during an emergency.

Patient: Requires prompt and effective Electrode Placement to increase heart rhythm analysis success rate.

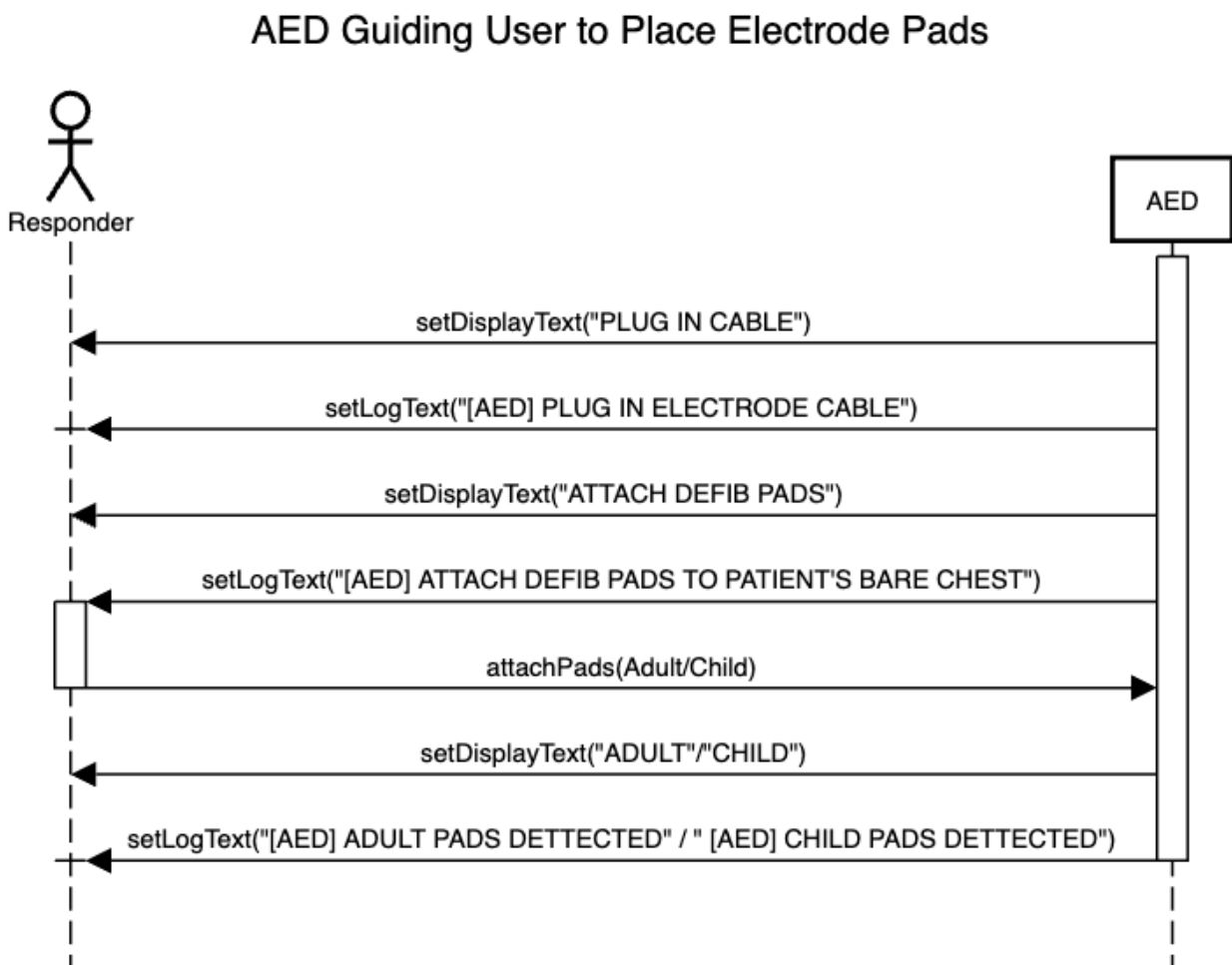
Precondition: The AED Plus is turned on and ready.

Post-condition: The AED Plus has guided the responder through placing the electrode pads, enhancing the heart rhythm analysis success rate.

Main Success Scenario:

1. The AED, through voice and visual prompts, advises the user to plug in the electrode cables in order to connect the electrode connector.
2. The AED, through voice and visual prompts, advises the user to place adhesive electrode pads on the victim's bare chest.
3. The AED distinguishes between Adult Pads and Child Pads based on the patient's age group, providing specific guidance.
4. The AED guides the user to ensure the correct placement of the electrode pads, for adult pads: Placement on the adult patient's chest following AED instructions. For Child Pads Placement on a child's chest according to the AED's specific guidelines.
5. The user follows the AED's guidance for proper electrode placement, ensuring the pads are securely adhered to the designated locations on the patient's chest.

Sequence Diagram 3 - AED Guiding User to Place Electrode Pads



Use Case 4: AED performing Heart Rhythm Analysis

Primary Actor: Responder

Scope: Utilizing AED

Level: User Goal

Stakeholders and Interests:

Responder: Need to use the AED to analyze heart rhythm in a patient in order to identify whether shock is necessary or not.

AED Plus Developer: Aims to ensure that the AED heart rhythm analysis functions seamlessly and accurately during an emergency.

Patient: Seeks treatment to address whatever cardiac arrhythmia they are dealing with.

Precondition: The AED Plus is operational and electrode pads are placed.

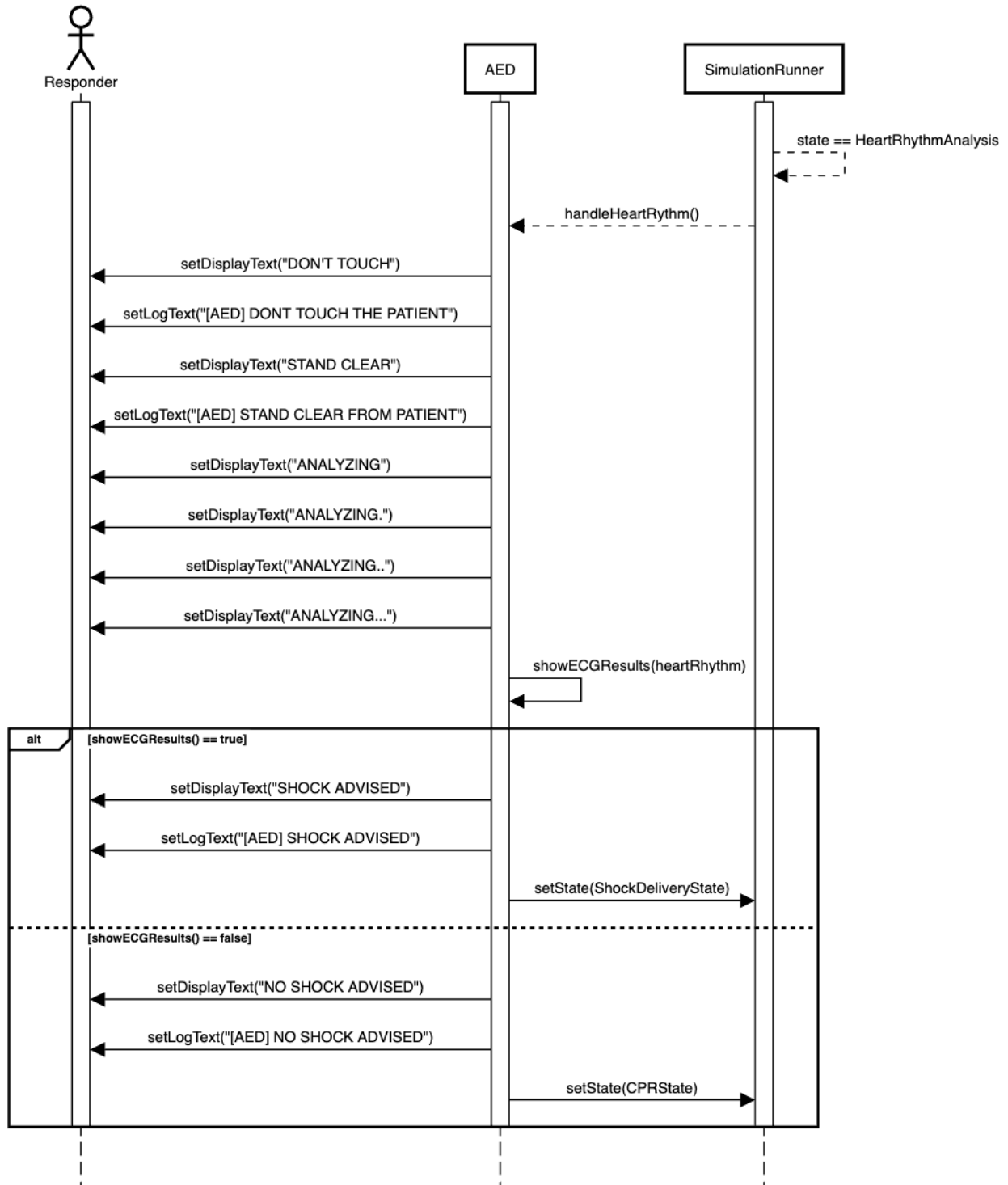
Post-condition: The AED Plus has successfully analyzed the heart rhythm .

Main Success Scenario:

1. The AED Plus advises the responder not to touch and move away from the patient
2. The AED Plus automatically analyzes the patient's heart rhythm without the responder touching the patient at this point.
3. AED analyzes a heart rhythm that is either shockable or non-shockable.

Sequence Diagram 4 - AED Performing Heart Rhythm Analysis

AED Performing Heart Rhythm Analysis



Use Case 5: AED Guiding User for Shock Delivery

Primary Actor: Responder

Scope: Utilizing AED

Level: User Goal

Stakeholders and Interests:

Responder: Need to effectively deliver a shock with guidance from the AED to revive a victim.

AED Plus Developer: Aims to ensure that the AED provides clear and accurate instructions for delivering a shock during an emergency.

Patient: Requires effective shock to increase chances of survival.

Precondition: The AED Plus is operational and heart rhythm analysis has revealed the heart rhythm is shockable.

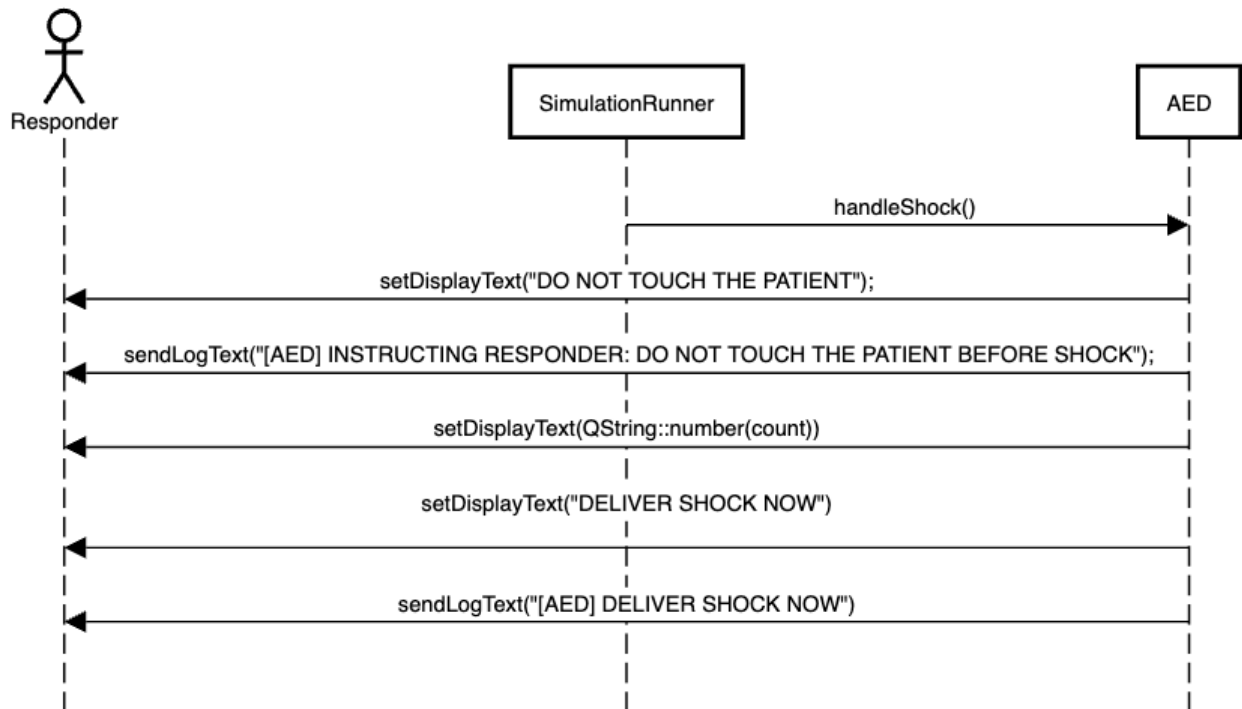
Post-condition: The AED Plus has guided the responder to deliver a shock, enhancing the chances of survival for the patient.

Main Success Scenario:

1. Upon detecting a shockable rhythm, the AED prompts the responder to deliver a shock.
2. The AED displays a clear visual indicator or text, along with audible instructions, signaling the need for a shock.
3. The responder ensures that no one is in contact with the patient and presses the designated button on the AED to administer the shock.
4. The AED display/voices a countdown down from 3 and delivers a controlled electrical shock to the patient's heart.

Use Case 5: AED Guiding User for Shock Delivery

AED Guiding User for Shock Delivery



Use Case 6: AED Guiding User for CPR

Primary Actor: Responder

Scope: Utilizing AED

Level: User Goal

Stakeholders and Interests:

Responder: Need to effectively perform CPR with guidance from the AED to revive a victim.

AED Plus Developer: Aims to ensure that the AED provides clear and accurate instructions for performing CPR during an emergency.

Patient: Requires prompt and effective CPR to increase chances of survival.

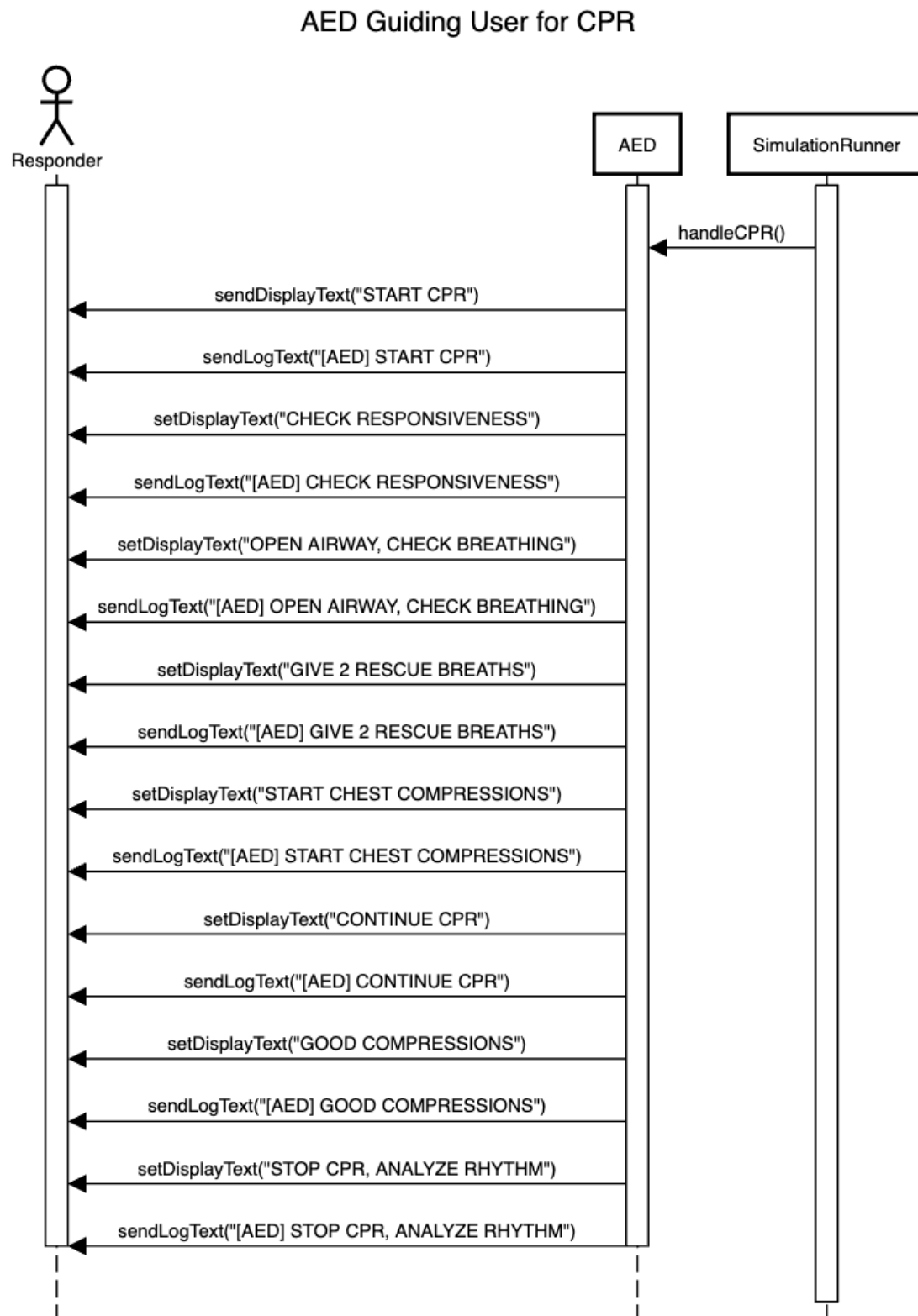
Precondition: The AED Plus is operational.

Post-condition: The AED Plus has guided the responder through CPR, enhancing the chances of survival for the patient.

Main Success Scenario:

1. The AED plus identifies the need for CPR in the emergency situation.
2. The AED Plus provides audio and visual prompts, guiding the responder through each stage of the CPR process, including:
 - a. Staying calm and focusing on the rescue effort.
 - b. Checking the victim for responsiveness and calling for help.
 - c. Opening the victim's airway and assessing breathing.
 - d. Instructing the responder to give two rescue breaths if the victim is not breathing.
 - e. Prompting the responder to perform chest compressions.
3. The AED Plus continues to monitor the patient's heart rhythm, providing real-time feedback on the quality and depth of chest compressions.
4. The AED Plus may prompt the responder to adjust the depth or rate of chest compressions if needed.
5. The AED Plus guides the responder on when to stop CPR and analyze the patient's heart rhythm.
6. If necessary, the AED Plus delivers shocks and advises the responder to resume CPR as needed.
7. The AED Plus continues this cycle until the arrival of professional medical help.

Sequence Diagram 6: AED Guiding User for CPR



Use Case 7: User Utilizing AED for Patient with Shockable Heart Rhythm

Primary Actor: Responder

Scope: Utilizing AED

Level: User Goal

Stakeholders and Interests:

Responder: Need to effectively perform CPR with guidance from the AED to revive a victim.

AED Plus Developer: Aims to ensure that the AED provides clear and accurate instructions for performing CPR during an emergency.

Patient: Requires prompt and effective CPR to increase chances of survival.

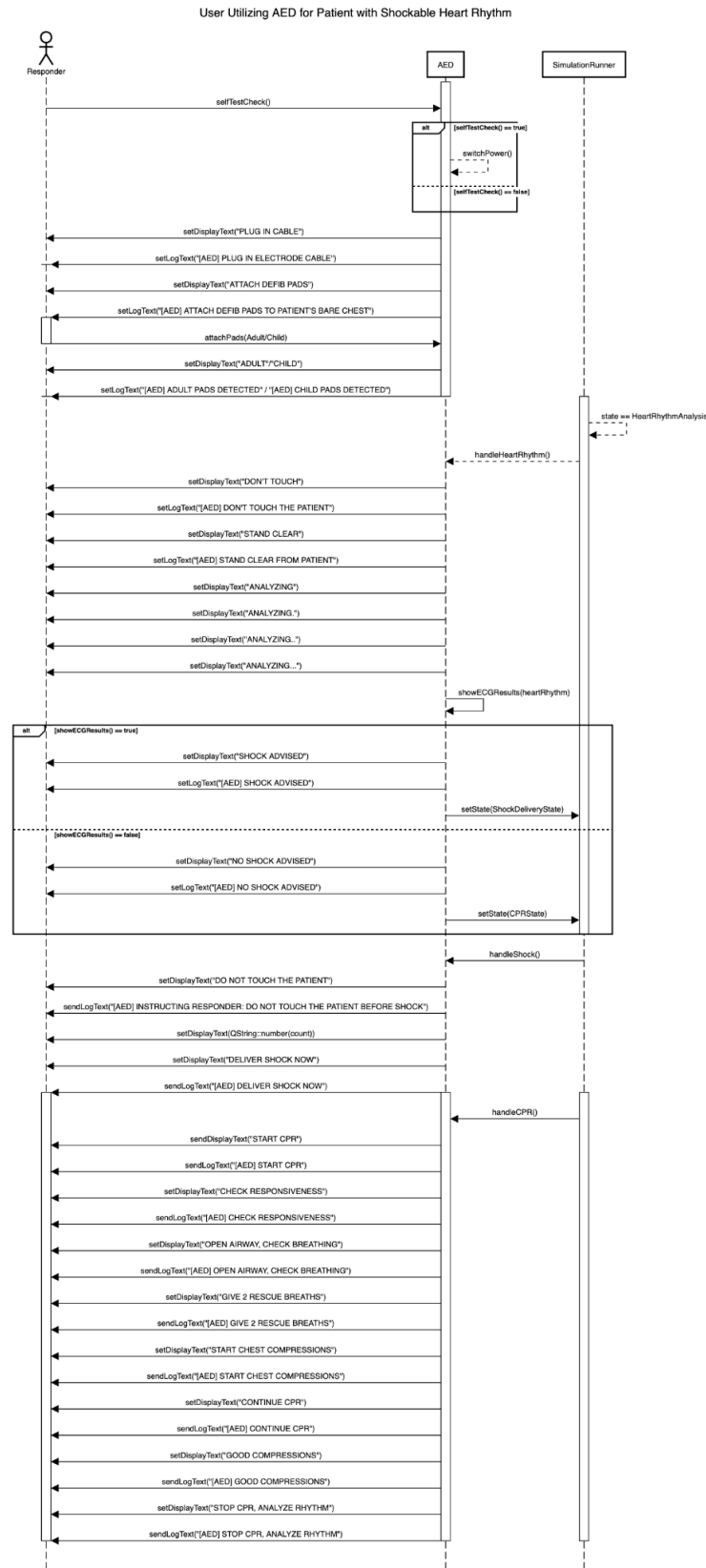
Precondition: The AED Plus is operational.

Post-condition: The AED Plus has guided the responder through CPR, enhancing the chances of survival for the patient.

Main Success Scenario:

1. The responder turns on the AED Plus, initiating a self-test to ensure its proper functionality. (Use Case 1)
2. The AED provides visual and audible indications that it is operational.
3. The responder places the adhesive electrode pads on the patient's bare chest. (Use Case 3)
4. The AED Plus analyzes the patient's heart rhythm through the electrodes. It monitors the electrical activity to determine whether a shockable rhythm is present. (Use Case 4)
5. The AED Plus determines that the patient's heart rhythm is shockable (i.e., either ventricular fibrillation or ventricular tachycardia).
6. The AED Plus guide the user to deliver a shock to the patient. (Use Case 5)
7. The AED Plus instructs the responder to perform CPR for a specified duration. It may continue to monitor the patient's heart rhythm and provide feedback on the quality and rate of chest compressions during CPR. (Use Case 6)
8. The AED Plus may continue to monitor the patient's condition, providing further instructions or assistance as needed.

Sequence Diagram 7: User Utilizing AED for Patient with Shockable Heart Rhythm



Use Case 8: User Utilizing AED for Patient with Non-Shockable Heart Rhythm

Primary Actor: Responder

Scope: Utilizing AED

Level: User Goal

Stakeholders and Interests:

Responder: Need to effectively utilize AED to revive a victim with .

AED Plus Developer: Aims to ensure that the AED provides clear and accurate instructions during an emergency.

Patient: Requires utilization of AED to increase chances of survival.

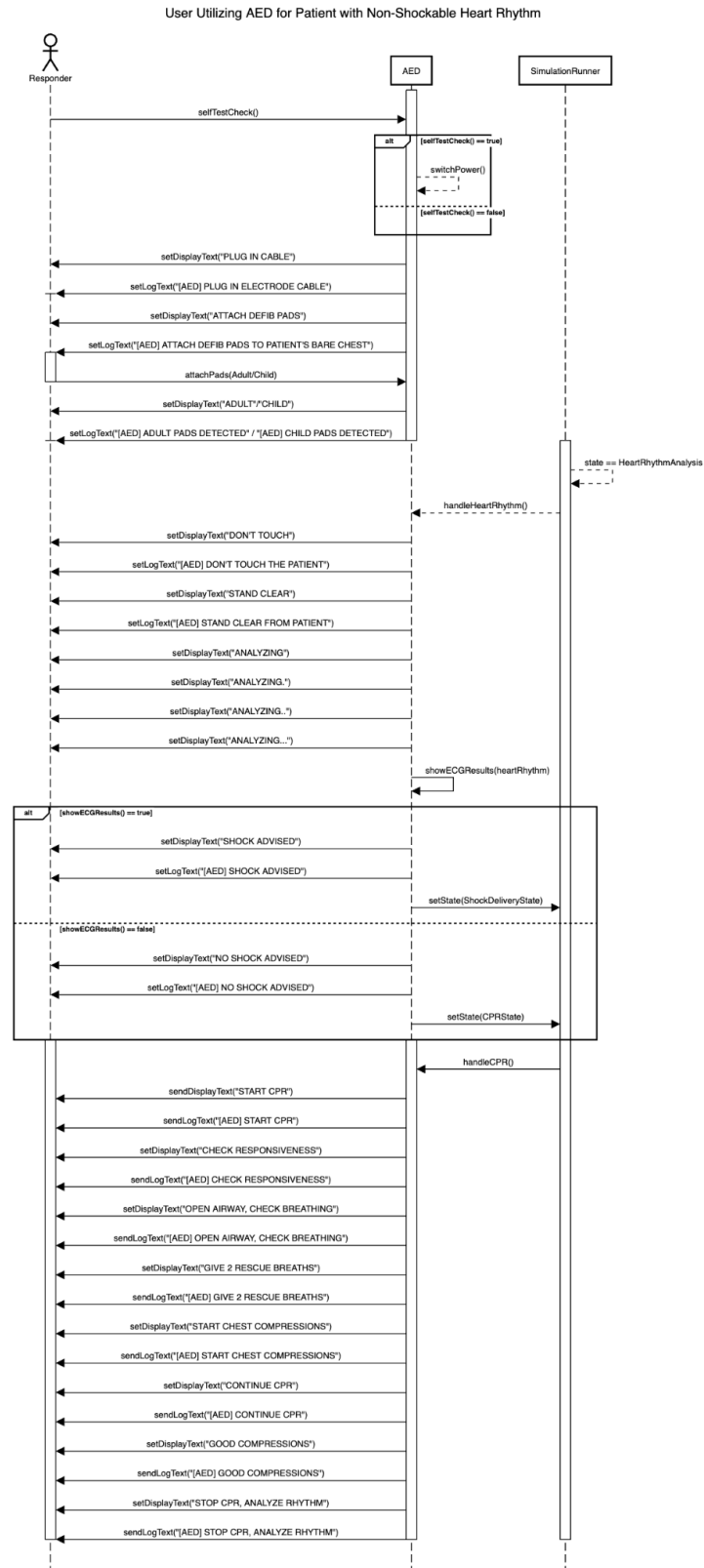
Precondition: The AED Plus is operational.

Post-condition: The AED Plus has guided the responder through to using the AED, enhancing the chances of survival for the patient from a shockable heart rhythm.

Main Success Scenario:

1. The responder turns on the AED Plus, initiating a self-test to ensure its proper functionality. (Use Case 1)
2. The AED provides visual and audible indications that it is operational.
3. The responder places the adhesive electrode pads on the patient's bare chest. (Use Case 3)
4. The AED Plus analyzes the patient's heart rhythm through the electrodes. It monitors the electrical activity to determine whether a shockable rhythm is present. (Use Case 4)
5. The AED Plus determines that the patient's heart rhythm is non-shockable (i.e., not ventricular fibrillation or ventricular tachycardia).
6. The AED Plus instructs the responder to perform CPR for a specified duration. It may continue to monitor the patient's heart rhythm and provide feedback on the quality and rate of chest compressions during CPR. (Use Case 6)
7. The AED Plus may continue to monitor the patient's condition, providing further instructions or assistance as needed.

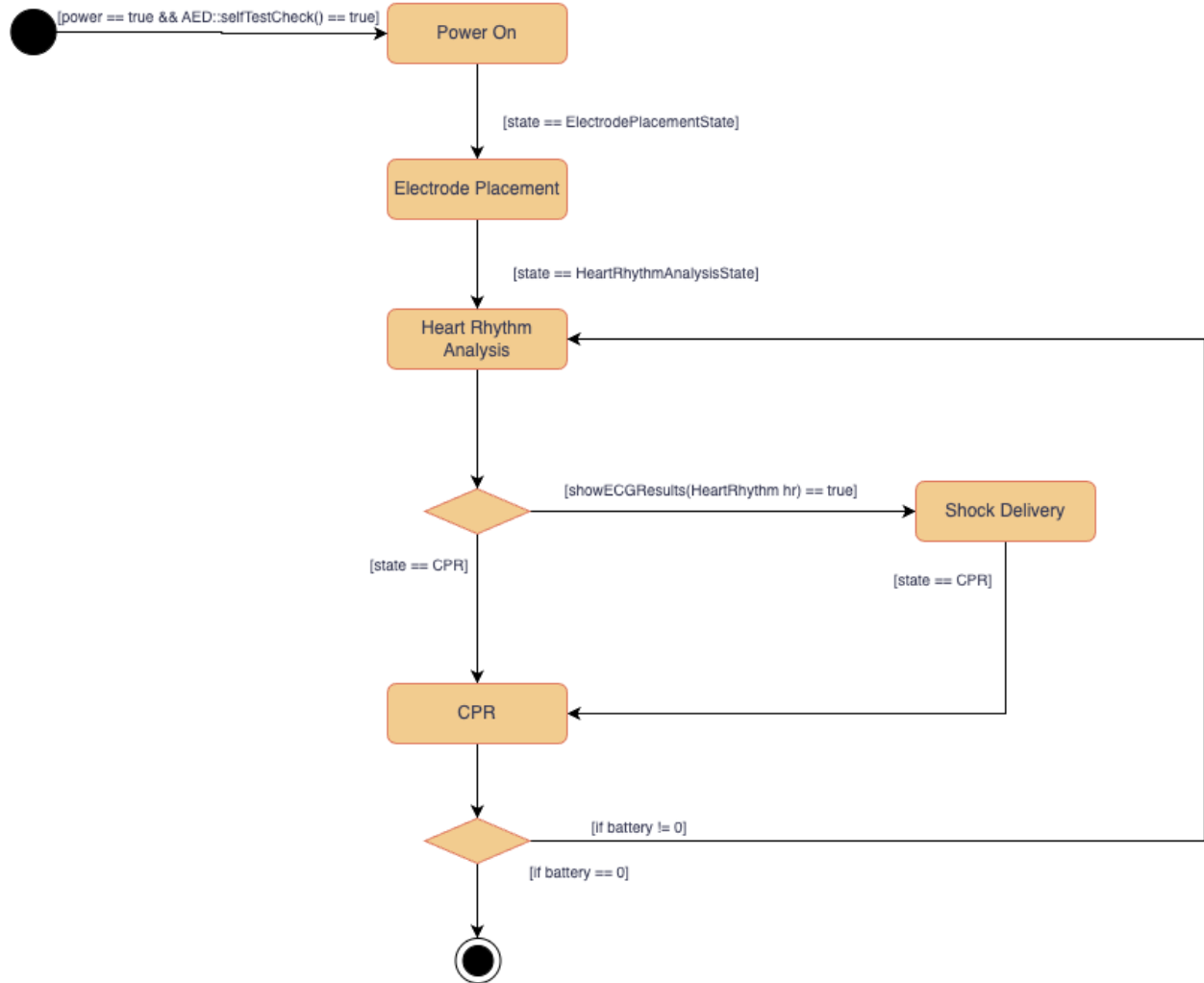
Sequence Diagram 8: User Utilizing AED for Patient with Shockable Heart Rhythm



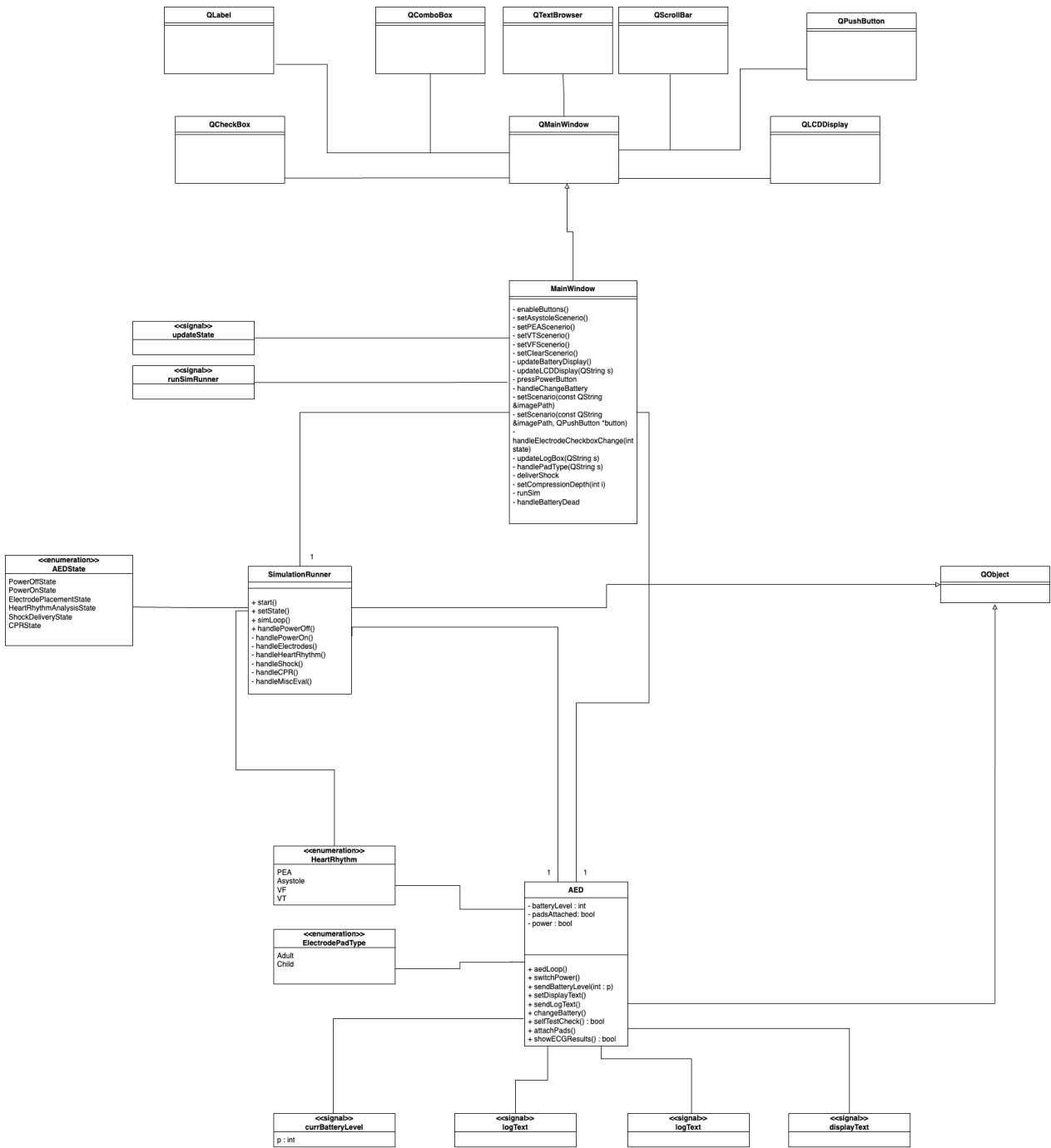
Use Case Diagram



AED State Diagram



UML Class Diagram



Traceability Matrix

ID	Requirement	Related Use Case	Fulfilled By	Test	Description
1	The AED has a Power Button that turns on/off the AED	N/A	MainWindow	Press Power On button and notice change in Battery Level and AED Display	Verify that pressing the Power Button turns the AED on and off.
2	When the AED is turned on it should be able to perform a power on self-test	Use Case 1	AED	After Press Power On button, notice change in output that showcases self test being ran	Execute the power on self-test and confirm that the AED performs the necessary diagnostic checks.
3	If the power on self-test passes then the AED will be turned on and ready to use	Use Case 1	AED	After Press Power On button, notice change in output that showcases all tests in power on self test in successful and AED is working	Confirm that the AED powers on and becomes operational when the power on self-test is successful.
4	If the power on self-test failed then the AED will be turned off and it will prompt the user to change the batteries	Use Case 1	AED	After Press Power On button, notice change in output that showcases battery being too low which turns off the AED	Ensure that the AED prompts the user to change batteries if the power on self-test fails.
5	When new batteries are installed, the AED performs a self test to	Use Case 2	AED	After Press Change Batteries	Validate that after installing new batteries, the

	determine if AED is operational			button, notice change in output that showcases battery self test being performed	AED conducts a self-test to assess its operational status.
6	If self test fails, AED will fail to power on and AED will prompt responder to change batteries	Use Case 2	AED	After Press Change Batteries button, notice a change in output that showcases battery self tests being performed and failing.	Verify that the AED does not power on and instructs the user to replace batteries if the self-test fails.
7	If self test succeeds, AED will prompt user to hit the reset battery button and the battery will reset to 100%	Use Case 3	AED	After Press Change Batteries button, notice a change in output that showcases battery self test being performed and succeeding to allow the battery to be back to 100%.	Confirm that the AED prompts the user to reset the battery status after a successful self-test.
8	The AED comes with 2 different kinds of electrode pads (Adult and Child) that the responder can choose from	Use Case 3	MainWindow	User is able to select and apply which type of Pad they want through the QComboBox	Ensure that the AED provides options for selecting Adult or Child electrode pads.
9	The responder is able to place the electrode pad and the AED will detect which type of pad is connected	Use Case 3	AED, SimulationRunner	User is able to check the box and apply the electrode pad to the patient and the AED	Validate that the AED can identify the type of electrode pad connected by the responder.

				will signify/detect which type it is	
10	The AED undergoes Heart Rhythm Analysis and determines if the patient's heart rhythm is shockable or not	Use Case 4	SimulationRunner	After the Pads have been placed the output/Display shows the feedback of the heart rhythm analysis	Confirm that the AED performs Heart Rhythm Analysis to assess the shockability of the patient's heart.
11	If the Heart Rhythm Analysis determines it is shockable, the AED will switch to the shock delivery state.	Use Case 4	AED, SimulationRunner	The display shows that the heart rhythm is shockable (Meaning it is VF or VT)	Verify that the AED transitions to the shock delivery state if the Heart Rhythm Analysis indicates shockability.
12	If a shock is not detected, the AED will transition straight into the CPR state	Use Case 4	SimulationRunner	The display shows that the heart rhythm is unshockable (Meaning it is Asystole or PEA)	Ensure that the AED enters the CPR state when no shockable rhythm is detected during Heart Rhythm Analysis.
13	The responder will press a button that will deliver the shock to the patient then transition into the CPR state	Use Case 5	TBA	After pressing the deliver shock button the AED will deliver the shock and switch to the CPR state through outputs	Validate that pressing the shock delivery button transitions the AED into the CPR state.
14	The AED provides clear steps for the responder to perform CPR	Use Case 6	SimulationRunner	The AED CPR instructions can be seen on the output in which the user can follow	Verify that the AED displays clear instructions for the responder to perform CPR.

15	The AED can repeat the process of delivering shocks and performing CPR until EMS arrives	Use Case 6	TBA	The outputs follows that the AED can go from the CPR state to the Shock state again and simulation ends when EMS comes	Confirm that the AED can cycle through delivering shocks and providing CPR instructions until EMS arrives.
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Design Patterns

→ **Observer Pattern:**

- ◆ The Observer pattern can be applied to notify various components (e.g., display, logging box) about changes in the AED state. When the AED state changes (e.g. electrodes are placed, shock delivered), the observers are notified to update their views or perform specific actions.

→ **State Pattern:**

- ◆ The State pattern can be used to represent different states of the AED (e.g., idle, charging, delivering shock). The AED object can alter its behavior dynamically based on its internal state, allowing for a clear and modular representation of different operational modes.

→ **Template Method Pattern:**

- ◆ The Template Method pattern can be employed to define the overall structure of an algorithm for AED operation. The skeleton of the algorithm can be provided in a superclass, with specific steps overridden by subclasses representing different AED models.