HOMEWORK 4

(Software Engineering CS487)

Design a hospital management system (HMS) for a large hospital (1 patient and several sensors per room; many rooms across multiple floors)

a) Caregivers must have real-time awareness of each patient's status

b) Caregivers must respond to patient emergencies quickly

c) Maintenance workers must respond to sensor failures quickly

1. Rewrite each requirement to remove ambiguity (1 pt)

a) Real-time Awareness for Caregivers

To ensure caregivers have real-time awareness of each patient's status, the HMS must incorporate the following features:

Continuous Patient Monitoring

- The HMS will be integrated with a network of sensors installed in each patient's room, continuously monitoring vital signs such as heart rate, blood pressure, oxygen levels, temperature, and other relevant health indicators.
- These sensors will transmit the collected data to the central HMS database in real-time, with a maximum delay of 5 seconds between data collection and storage.

Caregiver Dashboard

- The HMS will provide a centralized dashboard interface for caregivers, displaying the current status of all patients under their care.
- The dashboard will present each patient's information, including their name, room number, and the latest updates on their vital signs, in an easy-to-read and visually intuitive format.
- The dashboard will use color-coding and visual cues to quickly highlight any patients whose vital signs have reached critical levels, requiring immediate attention.
- Caregivers will be able to access the dashboard from their workstations, as well as through mobile devices, ensuring they have constant access to patient information.

Real-time Data Updates

- The patient information displayed on the caregiver dashboard will be updated in real-time, reflecting the latest sensor data collected from the patient rooms.
- The HMS will ensure that the maximum delay between data collection and display on the dashboard does not exceed 5 seconds, providing caregivers with the most current and accurate information about their patients' conditions.

b) <u>Quick Response to Patient Emergencies</u>

To enable a quick response to patient emergencies, the HMS will implement the following protocols:

Emergency Detection and Alerting

- The HMS will continuously monitor the patient's vital signs and use predefined thresholds to detect any critical changes that may indicate a medical emergency.
- When a patient's vital signs cross these critical thresholds, the HMS will immediately trigger an emergency alert, which will be sent to the assigned caregiver's mobile device and the central nursing station.

Caregiver Acknowledgment

- Upon receiving the emergency alert, the assigned caregiver will be required to acknowledge the alert within 30 seconds, either by confirming their awareness or escalating the alert to a more senior colleague.
- If the caregiver does not acknowledge the alert within 30 seconds, the HMS will automatically escalate the alert to a higher-level caregiver or supervisor.

Caregiver Response Time

- Once the emergency alert has been acknowledged, the assigned caregiver must physically arrive at the patient's location within 3 minutes to assess the situation and provide the necessary medical intervention.
- The HMS will track the caregiver's response time and log the information for quality assurance and performance review purposes.

Escalation and Collaboration

- If the assigned caregiver is unable to reach the patient's location within the 3-minute window, the HMS will automatically escalate the alert to a more senior colleague, who must then respond within an additional 2 minutes.
- The HMS will facilitate seamless communication and collaboration between the caregivers involved, ensuring a coordinated and effective emergency response.

c) <u>Quick Response to Sensor Failures</u>

To ensure a quick response to sensor failures, the HMS will implement the following protocols:

Sensor Monitoring and Failure Detection

- The HMS will continuously monitor the status of all sensors installed in the patient rooms, performing regular self-checks and diagnostics to detect any malfunctions or failures.
- When a sensor failure is detected, the HMS will immediately trigger a maintenance alert, identifying the specific sensor and its location.

Maintenance Notification and Acknowledgment

- The maintenance alert will be sent to the assigned maintenance staff's mobile devices, as well as the central maintenance station, within 1 minute of the sensor failure detection.
- The maintenance staff will be required to acknowledge the alert within 5 minutes, either by confirming their awareness and initiating the repair process or escalating the alert to a more senior technician.

Maintenance Response and Repair

- Once the maintenance alert has been acknowledged, the assigned maintenance staff must initiate the repair or replacement process within 15 minutes from the time of the initial alert.
- The HMS will track the maintenance staff's response time and the duration of the repair process, ensuring that sensor failures are addressed in a timely manner.

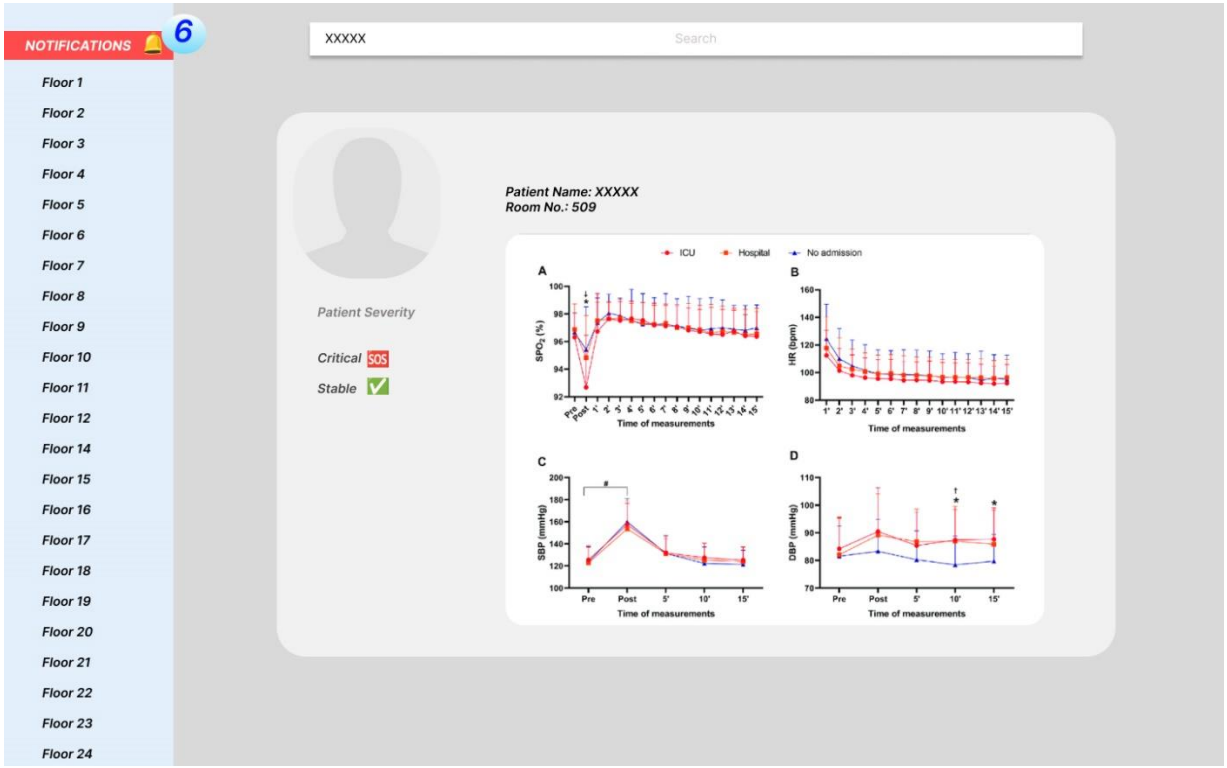
Escalation and Collaboration

- If the assigned maintenance staff does not acknowledge the alert within 5 minutes or fails to initiate the repair process within 15 minutes, the HMS will automatically escalate the alert to a more senior technician, who must then respond within an additional 10 minutes.
- The HMS will facilitate communication and collaboration between the maintenance staff, ensuring a coordinated and efficient response to sensor failures.

By implementing these detailed protocols, the Hospital Management System (HMS) will ensure that caregivers have real-time awareness of patient status, can respond quickly to emergencies, and maintenance staff can address sensor failures in a timely manner, ultimately improving patient care and safety.

2. Depict a UI which presents the status of each patient on a single screen and explain how it provides SA (1 pt)

- This is a simple UI, which displays previous and present readings of Heartbeat, Oxygen Levels, Blood Pressure of the patient. Also, we can access any other patient records using the search tool by their name or room number.
- Notifications – We get notified if any patient needs assistance or even if there are any sensor failures.



3. Specify a protocol that maximizes the likeliness of patient emergencies being handled quickly (1 pt)

Protocol for Handling Patient Emergencies

- Continuous Monitoring: Vital signs are monitored in real-time with predefined critical thresholds.
- Alert System: An automated system immediately notifies the caregiver via handheld devices if thresholds are crossed.
- Acknowledgment: Caregivers must acknowledge the alert within 30 seconds. If not acknowledged, the alert escalates to another caregiver or supervisor.
- Response Timing: Caregivers must reach the patient within 3 minutes of the initial alert to assess and respond to the emergency.
- Documentation: Post-intervention, caregivers must document the response time and action taken, which is reviewed for quality assurance.

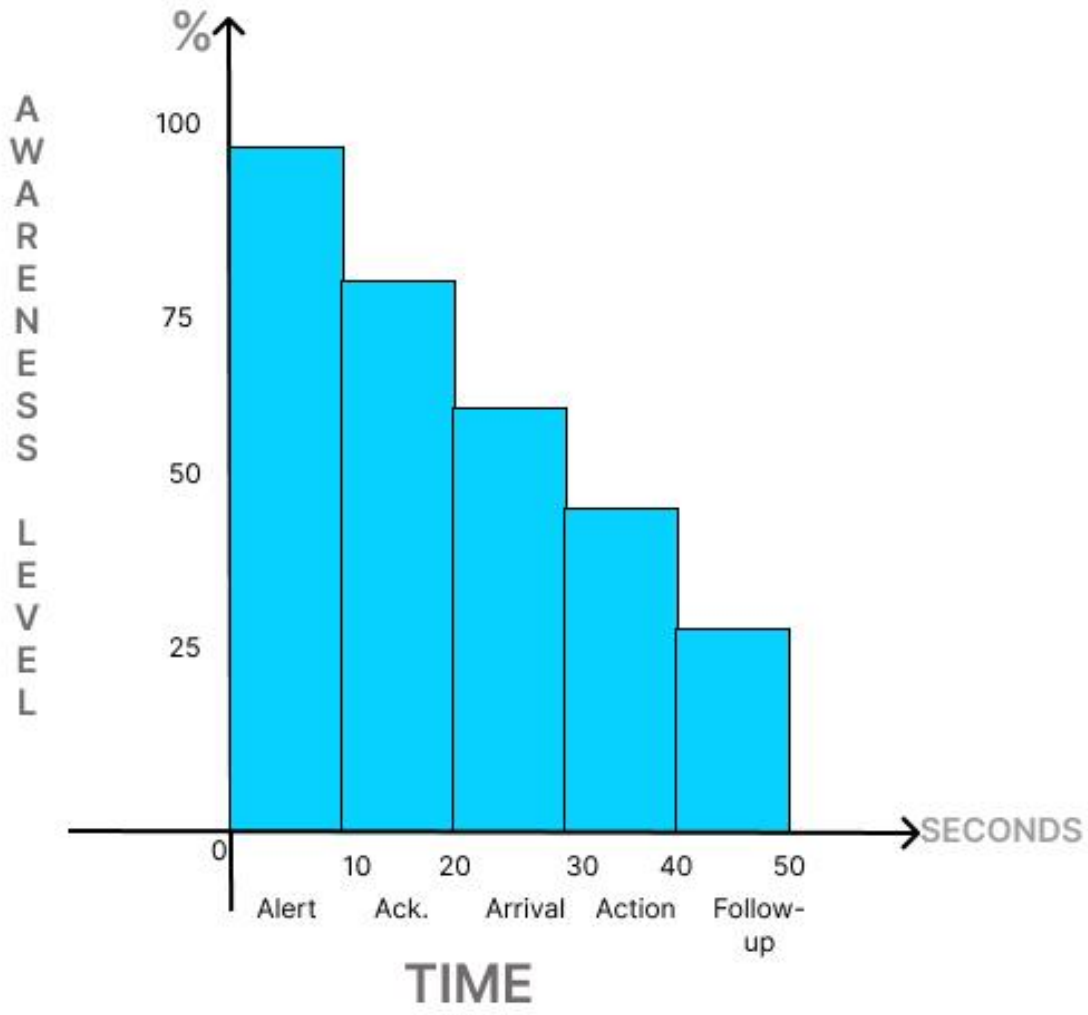
- If multiple emergencies occur simultaneously, prioritize the alerts based on the severity of the patient's condition and dispatch the most appropriate caregiver for each emergency.

4. Specify a protocol that maximizes the likeliness of sensor failures being fixed quickly (1pt)

- Protocol for Addressing Sensor Failures
  - Sensor Check: Sensors perform self-checks every 5 minutes to ensure functionality. Any failure triggers an immediate alert.
  - Maintenance Notification: Alerts are sent to maintenance staff's handheld devices and logged in the central system.
  - Acknowledgment and Action: Maintenance staff must acknowledge the alert within 5 minutes and start corrective action within 15 minutes.
  - Repair Tracking: All steps from detection to resolution are tracked in the system for accountability and future reference.
- If multiple sensor failures occur simultaneously, prioritize the alerts based on the criticality of the sensor and dispatch the most appropriate maintenance worker for each failure.
- Maintain an inventory of spare sensors and automatically dispatch a replacement to the location of the failed sensor, allowing the maintenance worker to quickly replace it.

5. Plot awareness over time for an emergency (1 pt)

- This graph illustrates the critical timeline from the detection of an emergency to the caregiver's response, highlighting the importance of each phase in ensuring patient safety.
  - 0-10 Seconds: Alert is generated and sent to the caregiver.
  - 10-20 Seconds: Caregiver acknowledges the alert.
  - 20-30 Seconds: Caregiver arrives at the patient's location.
  - 30-50 Seconds: Caregiver assesses and initiates medical intervention.
  - Post 50 Seconds: Follow-up actions are taken, and the situation is monitored.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AWARENESS LEVEL
100
75
50
25
0
10
20
30
40
50
SECONDS
Alert
Ack.
Arrival
Action
Follow-up
TIME