# Rules Based Alerting System

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# Introduction

This document serves to provide a formulation of the user stories and the requirements of a patient alerting system. The core project involves around monitoring a stream of patient data sent in pulses. Each patient data is consolidated from the body sensors and packed as a JSON format string. This data is the input for the alerting system. The system is expected to give outputs as normal, warning and critical alerts based on defined rules. These rules are customizable on the patient and the device need.

Clinical User

Normal  
Warning  
Critical

Alerting System

Patient data in JSON at regular intervals

# Explanation of Terms

CRUD – Create, Read, Update, Delete  
Clinical User – Doctor, Nurse Station  
Vitals – Vital sign data which comprises heart rate, blood pressure, SpO2 etc.  
Devices – Devices that read vital signs  
Normal – Shows that condition of patient being monitored is normal  
Warning – Shows that condition of the patient is worsening and vitals might go out of range  
Critical – Indicates that patient needs urgent attention

# User Stories

1. As a clinical user, I want to register the devices available in the hospital so that it can be ready to use when a patient is admitted.
2. As a clinical user, I want to register the hospital infrastructure (beds) so that I can monitor the usage of the beds.
3. As a clinical user, I want to register the patients so that their personal information is stored permanently.
4. As a clinical user, I want to register Doctors in the hospital so that they can monitor their patients when required
5. As a clinical user, I want to receive patient vitals so that I can monitor them
6. As a clinical user, I want to store patient vital signs so that I can view the patient history
7. As a clinical user, I want to monitor the received vitals so that I can alert the patient’s doctor and the relevant nurse if the vitals are out of normal range
8. As a clinical user, I want to provide authentication so that any non-clinical user cannot access the services
9. As a clinical user, I want to admit a patient so that he can be assigned a doctor, a bed and devices to monitor his health
10. As a clinical user, I want to silence an alert once I have been notified so that I can attend to the patient while monitoring other patients also.
11. As a clinical user, I want to alert the doctor if the patient’s health is deteriorating to a critical state so that the doctor can attend to the patient.

## User Story 1:

As a clinical user, I want to register the devices available in the hospital so that it can be ready to use when a patient is admitted.

### Acceptance Criteria:

1. Should receive device ID, valid input range and default ranges with type and message for each type during registration
2. Default ranges is assumed to cover all values in valid input range
3. Default input ranges is assumed not to overlap
4. Device ID should not be repeated for registration of new device
5. Updation of device should be able to update all the fields of the device
6. During updation, existing Device ID must be provided and valid values for other fields is assumed to be provided
7. Registered devices must be readable at a later time
8. Registered devices must be accessible by their device ID
9. Deletion of devices must be possible by device ID

## User Story 2

As a clinical user, I want to register the hospital infrastructure (beds) so that I can monitor the usage of the beds.

### Acceptance Criteria:

1. A bed must be registered based on Campus, Floor number, Wing, Room Number and Bed Number
2. At registration, the total number of beds in a room must be provided
3. Once registered, each bed must be a separate entity and individually accessible
4. Each bed must contain information indicating if it is empty or not
5. The occupancy status of the bed must be updateable
6. Deletion of beds in a room must be possible
7. The beds must be accessible room wise, wing wise, floor wise and campus wise
8. The bed number must be auto generated on registration and must always start from 0 for every room.
9. Addition and deletion of beds must be room wise
10. Addition of rooms, wings, floors and campuses must be possible implicitly
11. Addition of beds must be possible without altering the pre-existing beds in the room
12. Deletion of beds must happen from the higher bed numbers to the lower ones

## User Story 3:

As a clinical user, I want to register the patients so that their personal information is stored permanently.

### Acceptance Criteria:

1. Must receive patient Name, Address, Contact No, Emergency contact number, blood group and history of illnesses during registration
2. Patient ID must be auto generated
3. Updation of patient must be based on the patient ID
4. During updation, all parameters of the patient must be changeable apart from patient ID
5. For a patient ID, it must be possible to append history of illnesses at a later date
6. Updation must be possible only for an existing patient ID
7. Deletion of patient must be possible based on patient ID
8. Deletion must be valid only for existing patient ID
9. Patient must be accessible based on patient ID
10. Patients must also be queryable based on any other parameter and must return a patient or a list of patients

## User story 4:

As a clinical user, I want to register Doctors in the hospital so that they can monitor their patients when required

### Acceptance Criteria:

1. During registration, Doctor Name, department, contact Details, Work status and patients being treated by the doctor have to be provided
2. The unique doctor ID must be autogenerated
3. Adding or Deleting of the patient list must be possible based on doctor ID and patient Id
4. Updating work status must be possible without having to update the rest of the information based on Doctor iD
5. Updation of all the fields in the doctor database must be possible based on doctor ID
6. Updation must be possible only for existing doctor ID and patient ID
7. Deletion of Doctor must be possible based on Doctor ID
8. Deletion must be valid only for valid Doctor IDs
9. Doctors must be accessible status wise and department wise
10. Doctor must be readable based on Doctor ID

## User 5:

As a clinical user, I want to receive patient vitals so that I can monitor them

### Acceptance Criteria:

1. Vitals input must be in Json string format :

{"patient id": "TRJIW432", "SPO2": 96, "pulse rate": 75, "temperature": 98.6}

1. PatientID received must be a valid ID
2. All devices must be registered in the patient admission
3. Values received is assumed to be of the correct format

## User Story 6:

As a clinical user, I want to store patient vital signs so that I can view the patient history

### Acceptance Criteria:

1. If patient vital signs of a registered patient are received, it is stored in the corresponding storage system
2. If vital signs of an unregistered patient are received, they are discarded
3. The previous vitals must be accessible at a later stage
4. The most recent vitals must be accessible if required
5. If an additional device is added to the patient, the previous vitals must be retained and the future vitals must be stored along with the new device data
6. If a device is removed from the patient, the previous vitals must be retained for the existing devices but not the deleted device
7. If other parameters of the patient are updated, the vitals storage unit must remain unchanged.
8. After discharge, the data must be discarded

## User Story 7:

As a clinical user, I want to monitor the received vitals so that I can alert the patient’s doctor and the relevant nurse if the vitals are out of normal range

### Acceptance Criteria:

1. Received vitals compared with normal ranges for each patient
2. If vitals are in normal range, no alert is raised
3. If vitals are in warning range, only nurse is alerted
4. If vitals are in critical range, nurse and doctor are alerted
5. Vitals and normal ranges are assumed to be correct
6. Patient’s Doctor is alerted based on status
7. If status is unavailable, another doctor in the same department is alerted

## User Story 8:

As a clinical user, I want to provide authentication so that any non-clinical user cannot access the services

### Acceptance criteria

1. Login/Logout Service must be provided
2. Sign Up feature must not be provided and it must be done during registration
3. Authentication is required for Doctor’s Service and for registration service but not the nurse monitoring service
4. On registration, the username and password must be auto generated
5. An option to change the password for a particular user must be provided
6. Services must be accessible only after login and must not be accessible after log out

## User Story 9:

As a clinical user, I want to admit a patient so that he can be assigned a doctor, a bed and devices to monitor his health

### Acceptance Criteria:

1. Admission of patient possible only if patient is already registered in the database
2. During Admission, Illness, doctor, diagnosis, bed number, date of admission and devices to be connected must be provided
3. The normal ranges can be set manually or the default ranges for the device can be used. This can be decided based on previous history
4. The devices connected can be updated, i.e. A new device can be added or an existing device can be removed
5. All fields except patient ID must be updateable
6. After discharge, the current illness and diagnosis must be updated in the patient history structure in the patient registration unit.
7. After discharge, the data must be discarded

## User Story 10:

As a clinical user, I want to silence an alert once I have been notified so that I can attend to the patient while monitoring other patients also.

### Acceptance Criteria:

1. Alert silencing must be handled in 2 places, client side and server side. A feature to silence alert on the server side is being provided. Alert must be silenced on server side if it is being silenced for everyone
2. Alert silencing feature is possible only from the nurse station
3. Silences all the alerts of that patient
4. Alert silencing has to be manually turned on or off and will not automatically turn on/off under any scenario

## User Story 11:

As a clinical user, I want to alert the doctor if the patient’s health is deteriorating to a critical state so that the doctor can attend to the patient.

### Acceptance Criteria:

1. Feature provided only to the nursing station
2. Alerting applicable only if there is a warning alert and the nurse deems it to be critical
3. If there is no alert (normal vitals), doctor cannot be alerted
4. Alerting possible based on Patient ID and device ID
5. If vitals enter into critical range, doctor automatically gets alerted
6. If vitals fall back to normal range, alert to doctor is de-asserted
7. On alerting a doctor, a single alert is sent to the doctor

# Workflow According to Requirements

The service is broadly classified into 2 types:

* Registration Mode
* Monitoring Mode

## Registration Mode

In the registration mode, there are hospital specific services available.

* Device Registration
* Doctor Registration
* Patient Registration
* Hospital Bed Registration
* Patient Admission

## Monitoring Mode

* Doctor Data Service
* Nurse Data Service
* Doctor Monitoring Service
* Nurse Monitoring Service
* Vitals Data Service

The details of each service will be mentioned in the APIs section.

# APIs

## Additional Doctor Data Service

Provides readable and self-explanatory APIs for reading patient admissions, registrations, doctors and doctor status.

## Additional Nurse Data Service

Provides readable and self-explanatory APIs for reading patient registrations, admissions and doctors.

## Device Registration Service

Provides CRUD operations for devices.

## Doctor Monitoring Service

Allows doctors to monitor their patients remotely. Also allows doctors to receive alerts and vital signs as per subscription.

## Doctor Registration Service

Provides CRUD operations on all doctors.

## Hospital Bed Registration Service

Provides CRUD operations for beds in the hospitals.  
While registering, ‘HospitalBeds’ BedNumber property takes the amount of beds to be added or deleted. Not the actual bed number itself. E.g, if you choose to register BedNumber = 5, then 5 beds will be registered.

While deleting, it is the same as above. But it only deletes non occupied number of beds. In case BedNumber > Unoccupied Beds, it will not delete any of the beds.

In Read beds, the input should be converted to string in the format "{Campus}-{Floor}-{Wing}-{RoomNumber}-{BedNumber}".

In ReadEmptyBeds, the list of empty beds is returned. But it filters according to the above format. E.g If the ReadEmptyBed filter has only "{Campus}-{Floor}-{Wing}” string, then it shows the list of empty beds in that particular wing. Alternatively, if you only provide “{Campus}”, then it will give the list of the number of empty beds in that campus.

## Nurse Monitoring Service

Allows nurses to monitor their patients. Also allows them to receive alerts and vital signs as per subscription, alert the doctor and mute/unmute the alerts.

## Patient Admission Service

Allows user to admit, update, read, discharge patients and also add or remove devices from a patient.

## Patient Registration Service

Provides CRUD operations for patients.

## Vitals Data Service

Allows system to write vitals data into repository.