A) Product Backlog :

1) As a parent, I want to create an account so that I can have a profile to set profile information and use the system.

- The parent should be able to set a username, password, gender,phone number, number of children using the system, as well as the children's names, ages, genders.
- The parent should provide the home address and specify how often they want to be updated on their child's vitals and sleeping status.

2) As a parent, I want to login to the application so that I can access my profile in the system.

- The user (parent) could choose between a single-step authentication process (username and password) or a two-step authentication process (password and biometric authentication).

3) As a parent, I want to edit my profile information and to be able to edit it in the system.

- Update the information entered in step 1 of the backlog.

4) As a parent, I want to set up geofencing zones around my home in each room so that the system can track the approximate location of my child at any given moment.

5) As a system, I want to be provided by the user with the house outline to implement the geofencing system.

6) As a parent, I want to be able to view when my child enters or leaves a geofencing zone so that I can monitor their whereabouts.

- The geofencing system will always update the whereabouts of the child to the most recent one with an approximate delay of 30 sec due to the nature of the system. The parent can

access this feature through the application if they want to know the last location of their child at any given moment.

7) As a parent, I want to be able to view the child's vital signs(temperature , heart rate , oxygen saturation) in order to act accordingly.

- The vital signs will be tracked with a vital signs bracelet that the child will be wearing , where it will report to the application interface all the vital signs of the child at any given moment , the bracelet will also communicate with the alert system and update it continuously to react to any kind of danger to the child's life. We used the Apple watch series 8 to determine the vitals that are relatively easy to measure using a bracelet. In this process we excluded some metrics that were unattainable to measure e.g. blood sugar level, cholesterol level.

8) As a parent, I want to be able to see the history of my child's location so that I can learn more about his behavior over time.

9) As a parent, I want to receive alerts when my child is outside of a designated geofencing zone or in an area they're not supposed to be in so that I can take proper action.

- We will divide the geofencing zones into three categories: Red, Yellow and Green Zones. Green zones are where the infant is in the place that the parent desires them to be e.g. bedroom or living room. Yellow zones are places where the child is not supposed to be in, but there is no danger or threat imposed on them from being there e.g. Siblings' or Parents' bedrooms, bathrooms, or certain parts of the kitchen. Red zones are places where there is danger facing the infant from being at them e.g. outside the vicinity of the house, 1 ft. away from the stove.

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10) As a parent, I want to integrate the system with other home systems like the electricity system and the natural gas system so that the system can shut these systems immediately in case of the child being near them at any given time.

11) As a parent, I want to assign my emergency contacts in case of an emergency (such as a sign of danger in the child's vitals) who can be physically present in the location of my child.

- The parent should enter the emergency contact's name, phone number, address, and email address. (An email should be sent to the emergency contact to request his/her consent to being an emergency contact)

12) As an emergency contact, I want to be able to access the system (from the parent's perspective) in case of the mentioned emergencies

- To define an emergency, we say that the parent is not at the household (could be determined by the parent setting it manually or optionally, by getting access to the parent's phone location) and at least one of the child's vitals is in critical condition (e.g. Heart rate below 40 bpm)
- In the case of emergency, the emergency contact will be provided with the same interface of the system as the parent but without editing access.

13) As a parent I want to choose whether or not I want to receive notifications regarding instances of crying of my child.

B) Sprint Backlog & planning :

The goal of this sprint : To complete all requirements specified in the sprint backlog, which include creating the diagrams and the high-level design of components like the geofencing and alert systems. As well as to implement the alert system component, create a test suite for it and apply the test suite. We also plan to provide screens (using figma) that are prototypes of the mobile application's interface and appearance. Finally, provide the necessary documentation to help us as much as possible in the final delivery. The documentation includes explanations of the new diagrams, the code and figma screens as well as a retrospective of how the team functioned as a unit and a sprint review to describe the improvements that the product went through.

The plan to deliver this sprint :

The estimated effort to be exerted (in hours) : Total hours: 24 divided across three work days. We estimate the creation of diagrams will take about a third of the total duration, which equates to 8 work hours. This is because:

- Additional classes should be added to the class diagram
- A use case diagram should be created that describes the interactions between the parent and the application with respect to checking data regarding the infant or getting alerts
- An activity diagram to describe the flow of operations that occur once the parent checks on the child within the application
- Sequence diagrams that describe the sequence of operations between the parent, application, geofencing system, alert system.

We estimate that implementing and testing the alert system will take approximately 12 work hours.

The remaining 4 work hours will be utilized in documenting the progress of the sprint

The detailed sprint backlog :

1. As a parent, I want to be able to view the child's vital signs(temperature , heart rate , oxygen saturation) in order to act accordingly.

- The vital signs will be tracked with a vital signs bracelet that the child will be wearing , where it will report to the application interface all the vital signs of the child at any given moment , the bracelet will also communicate with the alert system and update it continuously to react to any kind of danger to the child's life. We used the Apple watch series 8 to determine the vitals that are relatively easy to measure using a bracelet. In this process we excluded some metrics that were unattainable to measure e.g. blood sugar level, cholesterol level.

2. As a parent I want to choose whether or not I want to receive notifications regarding instances of crying of my child.

- For certain toddler ages, children cry frequently without necessarily having a dangerous situation taking place. In such cases, we want to give the parents the liberty to turn on/off alerts that are sent by the bracelet that picks up patterns off child crying.

3. As a parent, I want to receive alerts when my child is outside of a designated geofencing zone or in an area they're not supposed to be in so that I can take proper action.

- We will divide the geofencing zones into three categories: Red, Yellow and Green Zones. Green zones are where the infant is in the place that the parent desires them to be e.g.

bedroom or living room. Yellow zones are places where the child is not supposed to be in, but there is no danger or threat imposed on them from being there e.g. Siblings' or Parents' bedrooms, bathrooms, or certain parts of the kitchen. Red zones are places where there is danger facing the infant from being at them e.g. outside the vicinity of the house, 1 ft. away from the stove.

4. As a parent, I want to set up geofencing zones around my home in each room so that the system can track the approximate location of my child at any given moment.

- Very related to requirement three, but we want to add that this feature should always be available should any change to the geofenced zones is desired by the parent e.g. the family moved to another household or the child grew up and is allowed to access more locations around the house.

5. As a parent, I want to be able to view when my child enters or leaves a geofencing zone so that I can monitor their whereabouts.

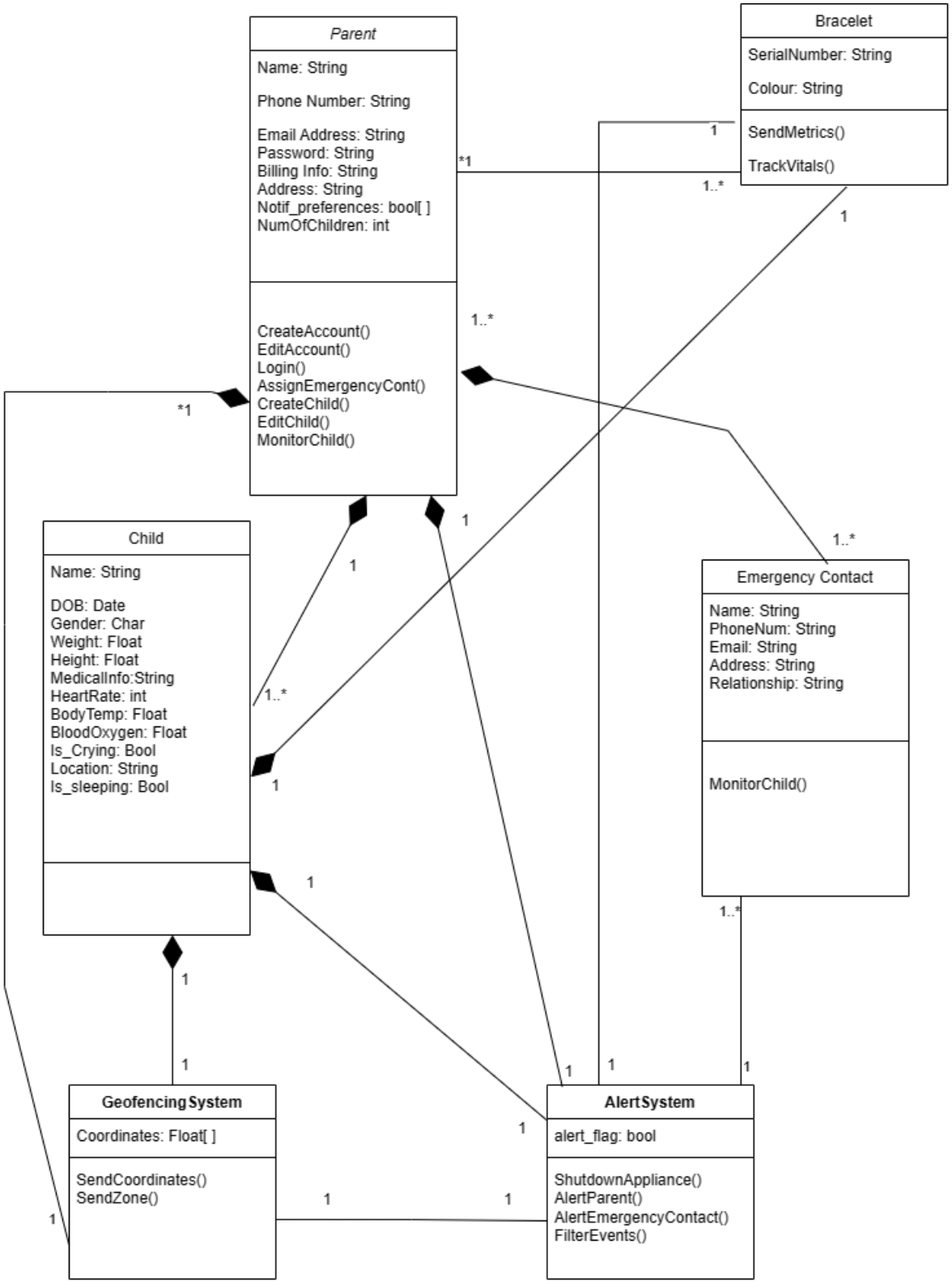
- The geofencing system will always update the whereabouts of the child to the most recent one with an approximate delay of 30 sec due to the nature of the system. The parent can access this feature through the application if they want to know the current location of their child at any given moment.

6. As a parent, I want to integrate the system with other home systems like the electricity system and the natural gas system so that the system can shut these systems immediately in case of the child being near them at any given time.

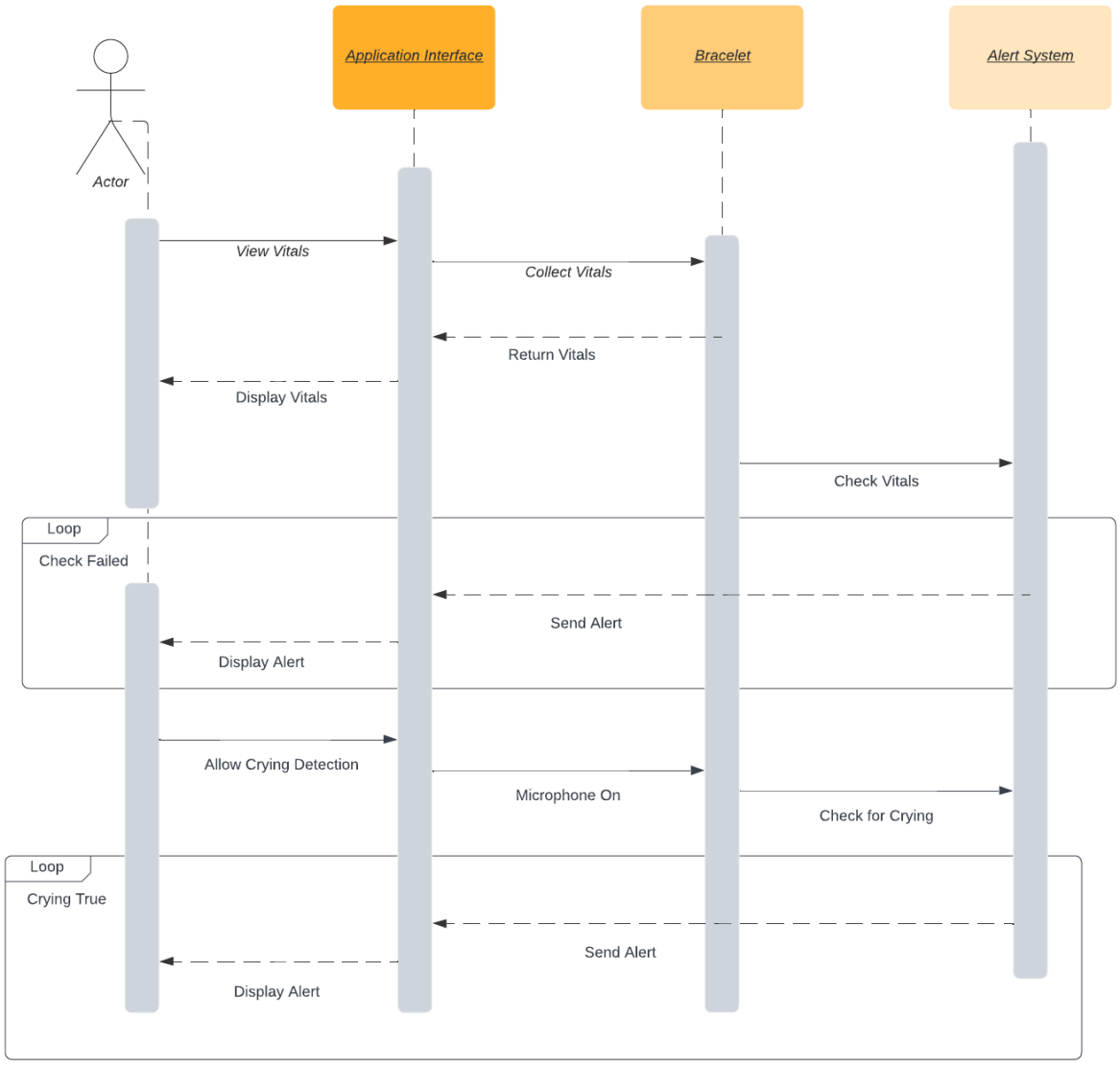
   -This feature would be particularly useful for parents who want to minimize the risk of their child being injured by electricity or natural gas systems. It would also provide an additional layer of safety and security, especially in case of emergency situations. It is

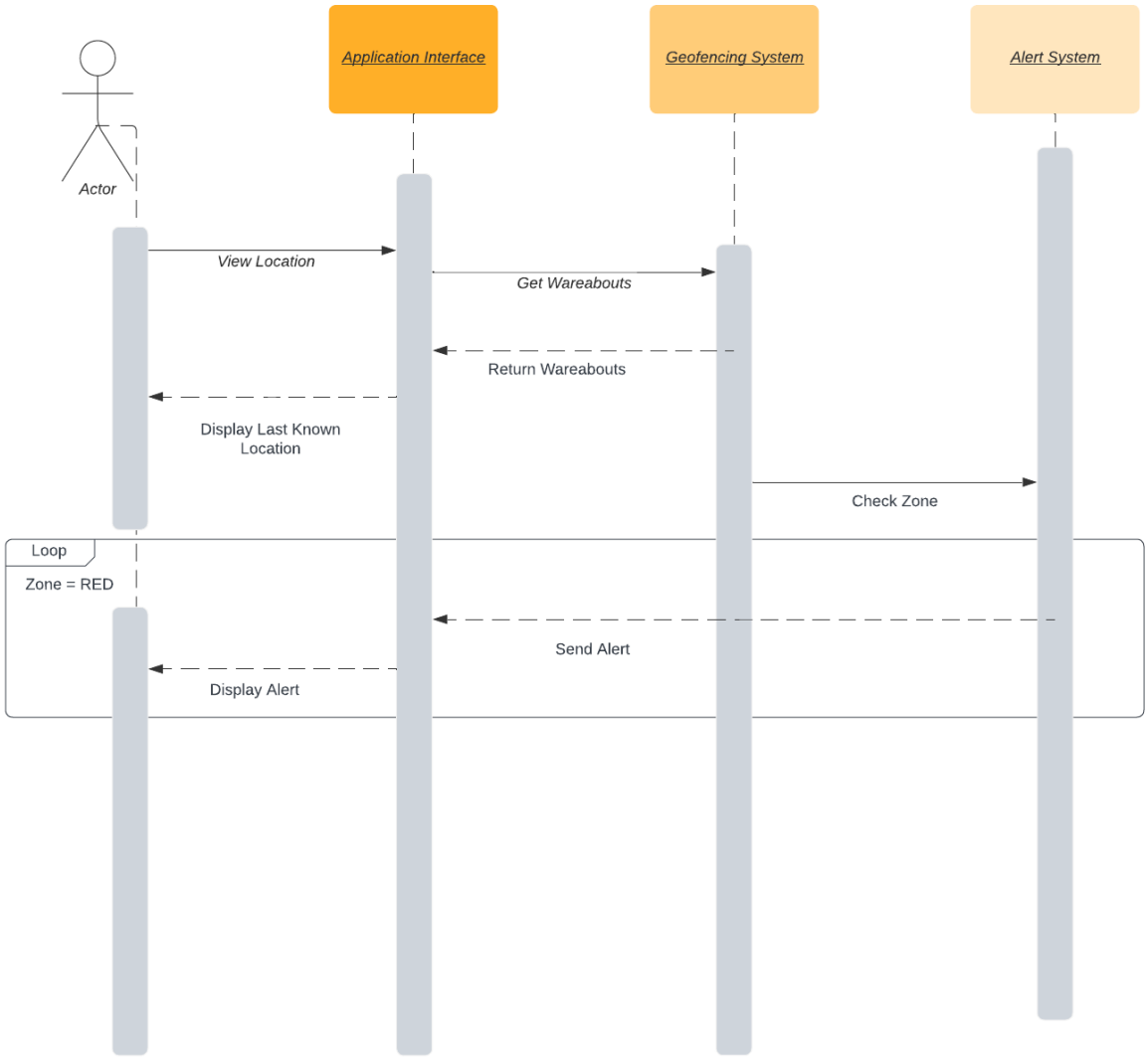
important to mention that this -as well as the vital tracking system- is a real-time system, in that there is a contingency of a safety hazard should the system fail. That is why we require a reliability figure of 90%.

C) Class diagram (edited from previous sprint) :



D) Sequence diagrams :




Application Interface
Geofencing System
Alert System
Actor
View Location
Get Wareabouts
Return Wareabouts
Display Last Known Location
Check Zone
Loop
Zone = RED
Send Alert
Display Alert

E) Test cases :

Black Box Testing Using Partitioning With Boundary Values

The variables are as follows : the temperature of the child , the heart rate of the child , the oxygen saturation of the child , the continuous crying instances of the child , whether the child's location is a red zone.

This test suite was created with the purpose of testing every possible combination of flags amounting to 32 test cases, which is a relatively feasible amount of test cases to run. We decided not to minimize the number of test cases by doing analysis on which test case(s) are redundant.

Test case ID	Test case description	Test Steps	Test data	Expected results	Actual results	Pass / Fail
TU01	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate below 60 or above 120, oxygen saturation below 92, a case of continuous crying, the body temperature falling below 35 or going above 39 and the child is in a red zone	Give heart rate alert , oxygen saturation alert ,continuous crying alert,body temperature alert and a red zone alert	As Expected	Pass
TU02	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate below 60 or above 120, oxygen saturation below 92, a case of continuous crying, the body temperature falling below 35 or going above 39 and the child is in a green zone	Give heart rate alert , oxygen saturation alert ,continuous crying alert and a body temperature alert	As Expected	Pass
TU03	Check Vitals	Retrieve data from the geofencing system and the	Heart rate below 60 or above 120, oxygen saturation below 92, a case of continuous	Give heart rate alert , oxygen saturation alert ,continuous	As Expected	Pass

		bracelet	crying, the body temperature is normal and the child is in a red zone	crying alert and a red zone alert		
TU04	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate below 60 or above 120, oxygen saturation below 92, a case of continuous crying, the body temperature is normal and the child is in a green zone	Give heart rate alert , oxygen saturation alert and continuous crying alert	As Expected	Pass
TU05	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate below 60 or above 120, oxygen saturation below 92, no continuous crying ,the body temperature falling below 35 or going above 39 and the child is in a red zone	Give heart rate alert , oxygen saturation alert ,body temperature alert and a red zone alert	As Expected	Pass
TU06	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate below 60 or above 120, oxygen saturation below 92, no continuous crying, the body temperature falling below 35 or going above 39 and the child is in a green zone	Give heart rate alert , oxygen saturation alert and a body temperature alert	As Expected	Pass
TU07	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate below 60 or above 120, oxygen saturation below 92, no continuous crying, the body temperature is normal and the child is in a red zone	Give heart rate alert , oxygen saturation alert and a red zone alert	As Expected	Pass
TU08	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate below 60 or above 120, oxygen saturation below 92, no continuous crying the body temperature is normal and the child is in a green zone	Give heart rate alert and an oxygen saturation alert	As Expected	Pass

TU09	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate below 60 or above 120, oxygen saturation is normal, a case of continuous crying, the body temperature falling below 35 or going above 39 and the child is in a red zone	Give heart rate alert ,continuous crying alert,body temperature alert and a red zone alert	As Expected	Pass
TU10	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate below 60 or above 120, oxygen saturation is normal, a case of continuous crying, the body temperature falling below 35 or going above 39 and the child is in a green zone	Give heart rate alert ,continuous crying alert and a body temperature alert	As Expected	Pass
TU11	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate below 60 or above 120, oxygen saturation is normal, a case of continuous crying, the body temperature is normal and the child is in a red zone	Give heart rate alert ,continuous crying alert and a red zone alert	As Expected	Pass
TU12	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate below 60 or above 120, oxygen saturation is normal, a case of continuous crying, the body temperature is normal and the child is in a green zone	Give heart rate alert and a continuous crying alert	As Expected	Pass
TU13	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate below 60 or above 120, oxygen saturation is normal, no case of continuous crying, the body temperature is falling below 35 or going above 39 and the child	Give heart rate alert,a body temperature alert and a red zone alert	As Expected	Pass

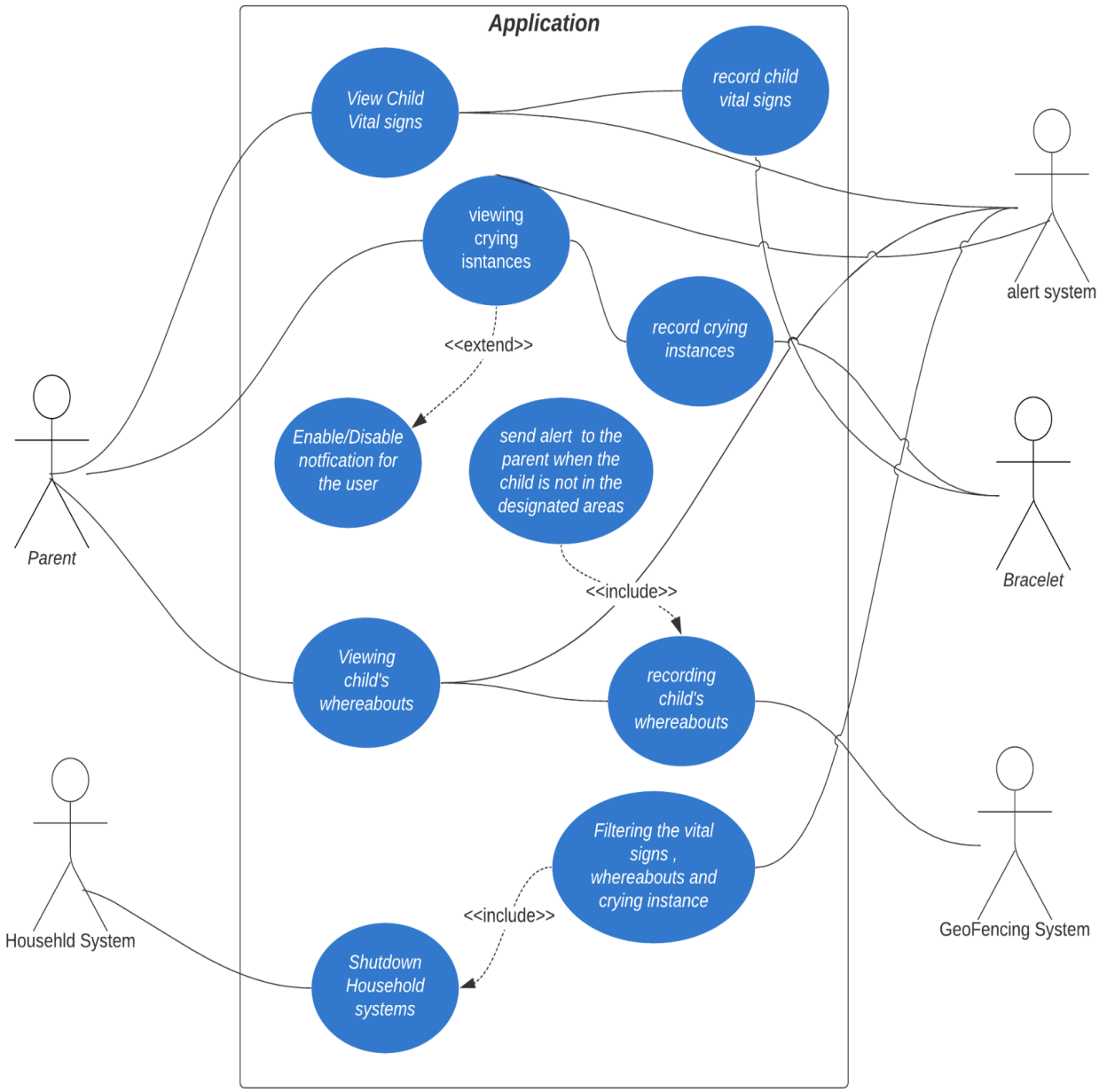
			is in a red zone			
TU14	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate below 60 or above 120, oxygen saturation is normal, no case of continuous crying, the body temperature is falling below 35 or going above 39 and the child is in a green zone	Give heart rate alert and a body temperature alert	As Expected	Pass
TU15	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate below 60 or above 120, oxygen saturation is normal, no case of continuous crying, the body temperature is normal and the child is in a red zone	Give heart rate alert and a red zone alert	As Expected	Pass
TU16	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate below 60 or above 120, oxygen saturation is normal, no case of continuous crying, the body temperature is normal and the child is in a green zone	Give heart rate alert	As Expected	Pass
TU17	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate sis normal , oxygen saturation below 92, a case of continuous crying, the body temperature falling below 35 or going above 39 and the child is in a red zone	Give oxygen saturation alert ,continuous crying alert,body temperature alert and a red zone alert	As Expected	Pass
TU17	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate is normal , oxygen saturation below 92, a case of continuous crying, the body temperature falling below 35 or going above 39 and the child is in a red zone	Give oxygen saturation alert ,continuous crying alert,body temperature alert and a red zone alert	As Expected	Pass

TU18	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate is normal , oxygen saturation below 92, a case of continuous crying, the body temperature falling below 35 or going above 39 and the child is in a green zone	Give oxygen saturation alert ,continuous crying alert and a body temperature alert	As Expected	Pass
TU19	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate is normal, oxygen saturation below 92, a case of continuous crying, the body temperature is normal and the child is in a red zone	Give oxygen saturation alert ,continuous crying alert and a red zone alert	As Expected	Pass
TU20	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate is normal, oxygen saturation below 92, a case of continuous crying, the body temperature is normal and the child is in a green zone	Give oxygen saturation alert and continuous crying alert	As Expected	Pass
TU21	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate is normal, oxygen saturation below 92, no continuous crying ,the body temperature falling below 35 or going above 39 and the child is in a red zone	Give oxygen saturation alert ,body temperature alert and a red zone alert	As Expected	Pass
TU22	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate is normal, oxygen saturation below 92, no continuous crying, the body temperature falling below 35 or going above 39 and the child is in a green zone	Give oxygen saturation alert and a body temperature alert	As Expected	Pass

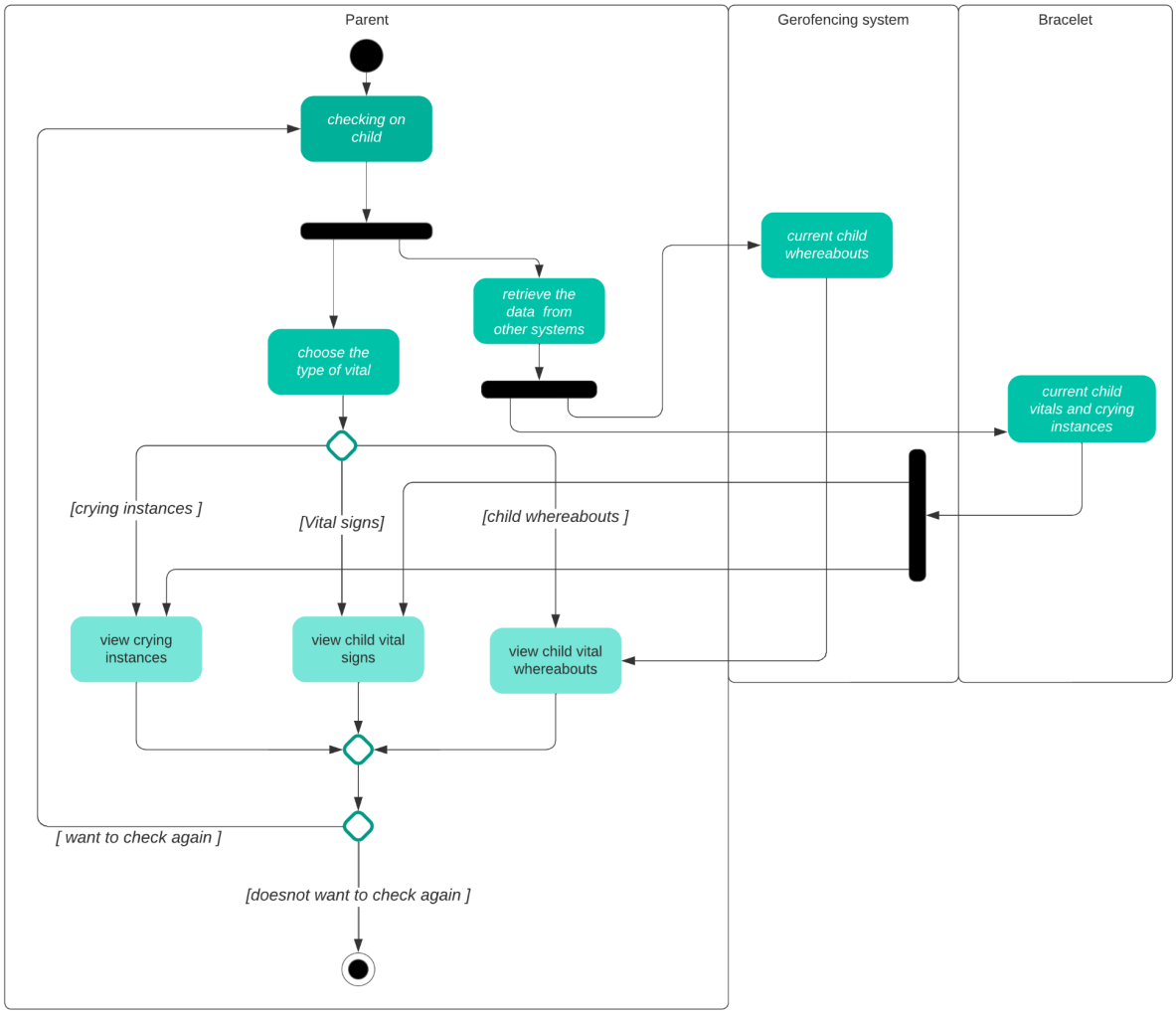
TU23	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate is normal, oxygen saturation below 92, no continuous crying, the body temperature is normal and the child is in a red zone	Give oxygen saturation alert and a red zone alert	As Expected	Pass
TU24	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate is normal, oxygen saturation below 92, no continuous crying the body temperature is normal and the child is in a green zone	Give an oxygen saturation alert	As Expected	Pass
TU25	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate is normal, oxygen saturation is normal, a case of continuous crying, the body temperature falling below 35 or going above 39 and the child is in a red zone	Give continuous crying alert,body temperature alert and a red zone alert	As Expected	Pass
TU26	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate is normal, oxygen saturation is normal, a case of continuous crying, the body temperature falling below 35 or going above 39 and the child is in a green zone	Give continuous crying alert and a body temperature alert	As Expected	Pass
TU27	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate is normal, oxygen saturation is normal, a case of continuous crying, the body temperature is normal and the child is in a red zone	Give continuous crying alert and a red zone alert	As Expected	Pass
TU28	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate is normal, oxygen saturation is normal, a case of continuous crying, the body temperature is	Give a continuous crying alert	As Expected	Pass

			normal and the child is in a green zone			
TU29	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate is normal, oxygen saturation is normal, no case of continuous crying, the body temperature is falling below 35 or going above 39 and the child is in a red zone	Give a body temperature alert and a red zone alert	As Expected	Pass
TU30	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate is normal, oxygen saturation is normal, no case of continuous crying, the body temperature is falling below 35 or going above 39 and the child is in a green zone	Give a body temperature alert	As Expected	Pass
TU31	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate is normal, oxygen saturation is normal, no case of continuous crying, the body temperature is normal and the child is in a red zone	Give a red zone alert	As Expected	Pass
TU32	Check Vitals	Retrieve data from the geofencing system and the bracelet	Heart rate is normal, oxygen saturation is normal, no case of continuous crying, the body temperature is normal and the child is in a green zone	No alerts are given	As Expected	Pass

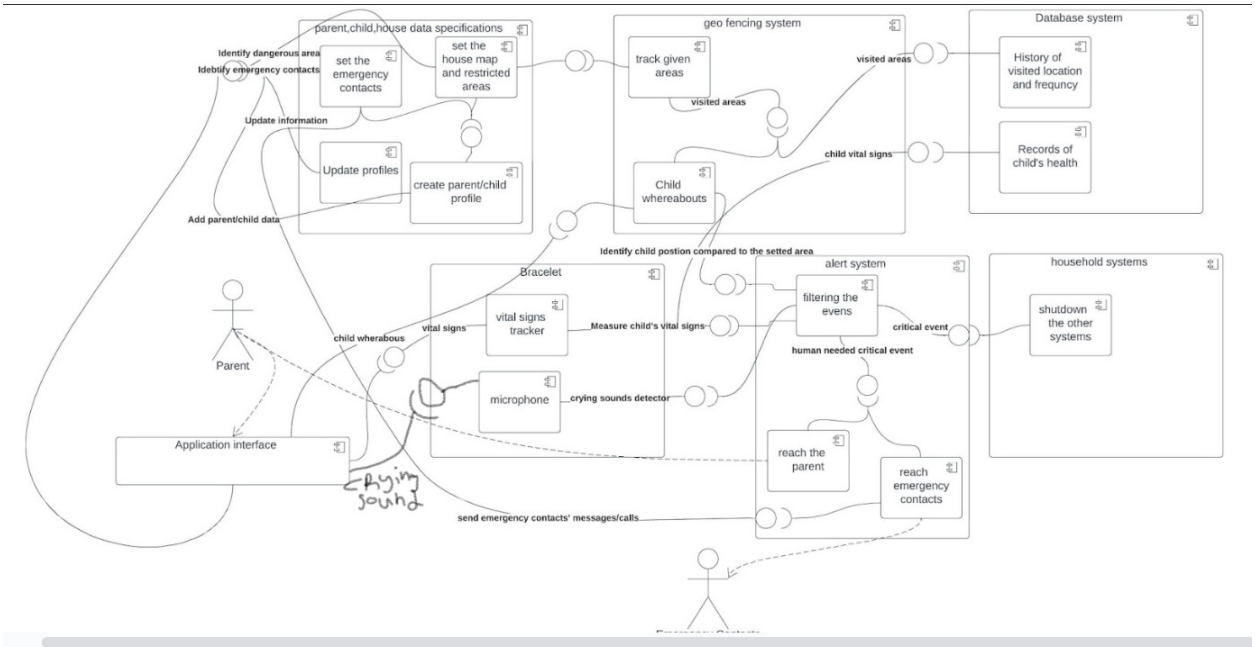
F) Use case diagram :



G) Activity diagram :



Component Diagram (edited from previous sprint):



H) Sprint review:

We feel that the product has started to take shape by virtue of the first component (alert system) being implemented and tested successfully using the C++ programming language. The choice between python and C++ was taken fast because not all team members were familiar with python. We only implemented black box testing this sprint owing to the fact that white box testing is a very fresh topic for our team. The system is now providing all of the aforementioned metrics about the child to the parent and is able to successfully report any deviations to the parent and the emergency contacts. The system is implemented in a way that would make it easy to implement other components e.g. application, database etc. and make these new components compatible with the existing ones. We also feel that the diagrams at this point are very close to completion in a way that allows an outsider to comprehend the what, how, and why of the system in a relatively short amount of time. We also provided screens that represent the front end of the

application, though we could have spent more time improving the user experience and giving it more aesthetic.

I) Sprint Retrospective :

Work hours update: Due to the nature of the alert system, we decided to use the observer design pattern in the implementation. We utilized ChatGPT in understanding how the alert system will incorporate the observer design pattern, which reduced the number of work hours two fold. What remained was to edit the code provided by chatGPT as well as debugging it and providing it with our test suite. It is important to note that ChatGPT provided us with multiple versions of the implementation which could open a future opportunity to apply n-version programming and subsequently exceed our reliability requirements. We also spent an additional 2 work hours to reprimand the work we delivered in the last sprint

The process to make the product was not as smooth as we thought it would be as we faced many problems. while working in a group, the communication was effective and coordinated their efforts towards a shared goal. Also, we establish clear roles and responsibilities, setting objectives, and creating a plan of action. Each group member is willing to listen to and consider one another's ideas and perspectives, and work collaboratively to address any challenges or obstacles that arise. We started doing the daily huddles about six days prior to the delivery deadline. In the creation of the different types of diagrams, members of the team took the

responsibility of completing one type of diagram each. When it came to coding, we implemented pair programming in the process of prompting, modifying, and debugging the codes provided by chatGPT. Creating the test suite was the fruit of the work of two team members, and the documentation was carried out by one member of the team while frequently polling other team members. The division of the workload was not predetermined in the sprint planning, but rather constantly changing in the agile process. Although some team members felt unfairly charged with overwhelming tasks in the beginning, the team soon provided assistance to those team members in a way that made them content and did not affect the quality of the product.

Links:

The link to our github repository is here. This link contains the alert system class that was created using C++ and the observer design pattern and 5 test cases as well as a README file explaining the code.

The link to our figma demo is here.