
SOD Assignment

Contactless Diagnosis

Service Oriented Design 2021

Group: On-Campus Group 11

Member names: (Zhaolin Fang, Xuan Zhou, Yunshan Wang, Leonardo Kuffo)

Emails: (z2.fang/x9.zhou/y47.wang/l.x.kufforivero @student.vu.nl)

VUnetIDs: (zfg210, xzu460, ywg253, lko290)

Master program and Track: Computer Science - SEG, BDE

October 29, 2021

Contents

| | | |
|-----------|---|-----------|
| 1 | Business Domain | 6 |
| 1.1 | Usage Scenarios | 6 |
| 1.2 | Participants | 6 |
| 2 | Functional Requirements | 9 |
| 2.1 | Patient Data Monitoring | 9 |
| 2.2 | Illness Prediction and Diagnosis | 9 |
| 2.3 | Treatment | 10 |
| 2.4 | Prevention | 10 |
| 3 | Quality Requirements | 11 |
| 3.1 | Performance | 11 |
| 3.2 | Privacy | 12 |
| 3.3 | Scalability | 12 |
| 3.4 | Reliability | 13 |
| 4 | Business Services | 14 |
| 4.1 | Patient Data Monitoring | 14 |
| 4.2 | Illness Prediction and Diagnosis | 18 |
| 4.3 | Treatment | 21 |
| 4.4 | Prevention | 25 |
| 4.5 | Context Model | 28 |
| 5 | Design Space | 29 |
| 6 | Sustainability Strategies | 33 |
| 7 | Software Decomposition of Business Services | 35 |
| 8 | Participant Service Inventory Identification | 43 |
| 8.1 | Drug Prescription Distribution Place | 43 |
| 8.2 | Insurance Company | 44 |
| 8.3 | Third Party Device Provider | 45 |
| 8.4 | Healthcare Service Provider | 46 |
| 9 | Service Contract Identification | 49 |
| 10 | Business Service Network | 52 |
| 11 | Design View | 52 |

Change Log

| N. | Name | Feedback | Description |
|-----|---|--|---|
| 1. | Phillips as a generic participant | "In assignment 2 use a generic name instead of Phillips" | We use Healthcare Service Provider instead of Phillips. This change was in all the document (Section 1.1, Section 1.2, Business Domain Model, Section 4.3, Section 5: Con#1, Cr#2) |
| 2. | Thinking in terms of Services | "Keep in mind that we do not develop system but services" | We use the term Service instead of System. This change was made in many parts of the document (Section 2.3.Description, Section 3.3.Rationale, Section 4.3.DetailedOperationalDescription). |
| 3. | Section 1.2: Figure 1 Wrong Caption | N/A | Changed the Figure 1 caption from Business Service Model to Business Domain Model. |
| 4. | Section 1: Table 2 | "The description of data storage is not depicted in the domain model" | Deleted the description of data storage and data management services for Medical Centers. |
| 5. | Section 2.1: Patient Data Monitoring | "Rename the track to be Patient Data Monitoring. Fixed the grammar errors" | We renamed the tracking FR and BS to be Patient Data Monitoring. |
| 6. | Section 2.2: Illness Prediction and Diagnosis | "The description of how the service predict the disease is vague" | We clarified the prediction functionality by rewriting and rephrasing this section. |
| 7. | Section 2.2: Illness Prediction and Diagnosis | "Sentence sounds a bit off and need to be rephrase" | We clarified the prediction functionality by rewriting and rephrasing this section. |
| 8. | Section 2.3: Clarification | "What do you mean by 'appointments are close'?" | Clarified that this refers to the appointment scheduled date being near to the current date. |
| 9. | Section 3.1: More detail & rewriting | "I am not sure whether it is related to performance or sounds more related to availability!" | Removed irrelevant sentences. Added descriptions of performance related to our functionalities and explained the rationale in more detail. |
| 10. | Section 3.2: More detail & rewriting | "The rationale should clearly explain why a certain QA is relevant into your proposed business services" | Added some explanations about which service needs to ensure privacy of user data and why it needs to protect data. |
| 11. | Section 3.3: More detail & rewriting | "Section 3.3: Be more clear on the criteria to achieve scalability as a Quality Requirement based on our Business Services aspects." | In the description we added how and under which conditions we are going to measure scalability. In the rationale we explained why scalability is key to one of functional requirements. |

| | | | |
|-----|---|---|---|
| 12. | Section 3.4: Reliability | "Description of Reliability is out of SOD Scope" | We rewrote the description to describe reliability as a quality requirement of our functionalities more accurately |
| 13. | Section 3.4: Reliability | "Rationale is not good" | We rewrite the rationale |
| 14. | Section 4: End Users as Participants | "End users should not be identified as participants" | We removed end users (i.e. Patients and Medical Staff) from involved participants (Section 4.1, 4.2, 4.3, 4.4). |
| 15. | Section 4: Detailed Operational Description | "Detailed Operational Description should contain more detail". | Added more detail to the Detailed Operational Description to depict in a more accurate way the activity diagrams (Section 4.1, 4.2, 4.3, 4.4). |
| 16. | Section 4.1: Patient Data Monitoring | "The activity diagram has some problem and the description should be more detailed" | Fixed activity diagram based on the suggestions |
| 17. | Section 4.2: Illness Prediction and Diagnosis | "Wrong Unique ID number" | Changed the Unique ID number |
| 18. | Section 4.2: Illness Prediction and Diagnosis | "Activities with human involvement should not be identified as software candidates" | Put the "Medical Stuff Corrects Diagnosis" process out of the Diagnosis Adjustment Service candidate |
| 19. | Section 4.2: Illness Prediction and Diagnosis | "Missing some of the services in the use case diagram" | Added missing services: Diagnosis Service and Notification Service |
| 20. | Section 4.2: Illness Prediction and Diagnosis | "Missing relationship of Classes with medical staff and patient dependency" | Fixed Data Model |
| 21. | Section 4.3: Detailed Operational Description | "What if the treatment contains appointments?". | Added explicitly in the description the behaviour what would happen in this situation: "If the treatment includes appointments, the appointments details are added to the generated report" |
| 22. | Section 4.3: Data Model | "Missing relationship of Classes with Service Candidates and Patient dependency" | Fixed Data Model. Mapped each class to a Service Candidate and inverse the arrow between Patient and Treatment to correctly depict the relationship. |
| 23. | Section 4.4: Activity Diagram | "Inspection is not part of a software service candidate". | Removed the Inspection Service candidate from the activity and use case diagrams. |
| 24. | Section 4.4: Data Model | "Missing relationship of Classes with Service Candidates and Patient & Medical Staff dependency." | Mapped each class to a Service Candidate and inverse the arrow between Patient & Medical Staff and Prevention to correctly depict the relationship. |

| | | | |
|-----|--|---|---|
| 25. | Section 5: Con#1 | "Inaccurate word in the concern name." | Changed "usable" to "trustworthy" to describe more accurately our concern. |
| 26. | Section 5: Con#1-Opt#1 Description | "How and which service or service candidate is responsible for that?" | Rewrote how the chosen option is being reflected in our BS's and added a more detailed rationale of the decision. |
| 27. | Section 5: Con#1-Opt#1 Rationale of decision | "this could have been further stretched" | We explain more in detail the rationale of the decision to accept this option. |
| 28. | Section 5: Figure 3: QOC notation of Con#1 | "Missing which service candidate implements the accepted option." | Detailed in the diagram description which Service Candidate maps to the accepted option. |
| 29. | Section 5: Con#2-Opt#1 Evaluations | "Map with BS" | We mapped every option with our business services. |
| 30. | Section 5: Con#2 Options Descriptions | "Incorrect interpretation of criterias" | Rewrote every evaluation for each criteria addressing the comments made on each. |
| 31. | Section 5: Con#2-Opt#2-Cr#2 Evaluation | "I am not convinced with this motivation" | We rewrote the evaluation. |
| 32. | Section 5: Con#2-Opt#2-Cr#4 Evaluation | "Cost is unrelated to this criteria" | We rewrote the evaluation. |
| 33. | Section 5: Con#2-Opt#3-Cr#3 Evaluation | "Explain motivation better" | We rethought and rewrote the evaluation motivation. |
| 34. | Section 5: Figure 4: QOC notation of Con#2 | "Incorrectly labeled option." | Fixed option label to the correct one (i.e. Digitize Reports). In addition to this, a more detailed description of the diagram was added and changes were made according to the changes on the evaluation criteria. |
| 35. | Section 6: Sustainability Strategies | "Sentences with mistakes in Action #1 and #2" | Rewrote Action#2 and Action#3 |

Responsibility

| Section | Team Member |
|--|---|
| Section 1: Business Domain | Xuan Zhou |
| Section 2: Functional Requirements | Xuan Zhou |
| Section 3: Quality Requirements | Yunshan Wang |
| Section 4: Business Services Section 4.1: Business Services BS1 Section 4.2: Business Services BS2 Section 4.3: Business Services BS3 Section 4.4: Business Services BS4 | Leonardo Kuffo Xuan Zhou Yunshan Wang Leonardo Kuffo Zhaolin Fang |
| Section 5: Design Space | Zhaolin Fang |
| Section 6: Sustainability Strategies | Yunshan Wang |
| Section 7: Software Decomposition of Business Services | Zhaolin Fang |
| Section 8: Participant Service Inventory Identification | Leonardo Kuffo |
| Section 9: Service Contract Identification | Yunshan Wang |
| Section 10: Business Service Network | Leonardo Kuffo |
| Section 11: Design View | Xuan Zhou |

1 Business Domain

Under the outbreak of the COVID-19 pandemic, a huge unbalance is formed between the fast-growing health demand and the lack of specialists and health supplies. Furthermore, the risk of going to a medical center is relatively high. Hence, people are usually unwilling to seek medical attention for minor illnesses. In addition to this, due to the increased number of medical emergencies, patients will usually have to wait long times for an appointment. For this reason, as our Service Oriented Design project, we propose remote contact-less diagnosis as a solution to treat illnesses without the patient having to wait long times for an appointment or having to take risks going to a medical center seeking for attention. This project integrates the world's top medical resources to enable patients to immediately request services when they have symptoms. Patients can avoid long waiting times in (or before) appointments. Thus, reducing the risk of getting illnesses from going to the medical center. Thanks to our services, patients will be able to enjoy medical services anywhere, anytime.

1.1 Usage Scenarios

Our main goal is to provide contact-less diagnosis for users (i.e. Patients) attending Medical Centers that integrates with the Healthcare Service Provider services. First, users (i.e. Patients) will register an account in the Healthcare Service Provider through a Medical Center asking for prevention, monitoring, diagnosis, or treatment services. The medical center evaluates the request and proceeds to attend the patient depending on their request. A) Prevention: A patient that has antecedents among its relatives may want to prevent a specific illness. In this case, patients are able to receive preventive treatments from the medical center thanks to the AI models implemented in the Healthcare Service Provider services. These services generate preventive treatments based on patients antecedents & health data. B) Monitoring: A patient that wants to keep track of their health could use the Patient Data Monitoring service. Patients are eligible for this service after registering an account or after being previously diagnosed with an illness that requires continuous monitoring. Patient Data Monitoring consists on the patient using a tracking device provided by a third party device provider that is constantly measuring and sending patients' data to the medical center. Furthermore, this patient monitoring will send alerts to the Medical Center in case of an emergency. For example, if a patient has been diagnosed with a cardiovascular disease, our Patient Data Monitoring service will measure and record the patient's blood pressure constantly. Furthermore, an alert service is always listening to patients' data in case of anomalies. C) Diagnosis: Patients that have undergone examination or patients that have went through the Data Monitoring process are eligible for contact-less diagnosis. The latter is possible thanks to Artificial Intelligence (AI) models implemented in our services. D) Treatment: After a diagnosis has been made, treatment recommendations are generated thanks to AI models implemented in our services. The medical center sends the treatment to the patient and the treatment invoices are automatically remitted to insurance companies. Automatic prescription dispensing for the patient is also available on this phase.

1.2 Participants

In our business service there are two types of participants: Stakeholders & End Users. As stakeholders we have the Healthcare Service Provider, Medical Center, Third Party Device Provider and Drug Prescription Distribution Place. On the other hand, the end users are Patient and Medical Staff. Figure 1 presents a diagram in which the participants and their business interaction is described. Table 1 explains each one of these participants in detail and the role they have in our business

domain model.

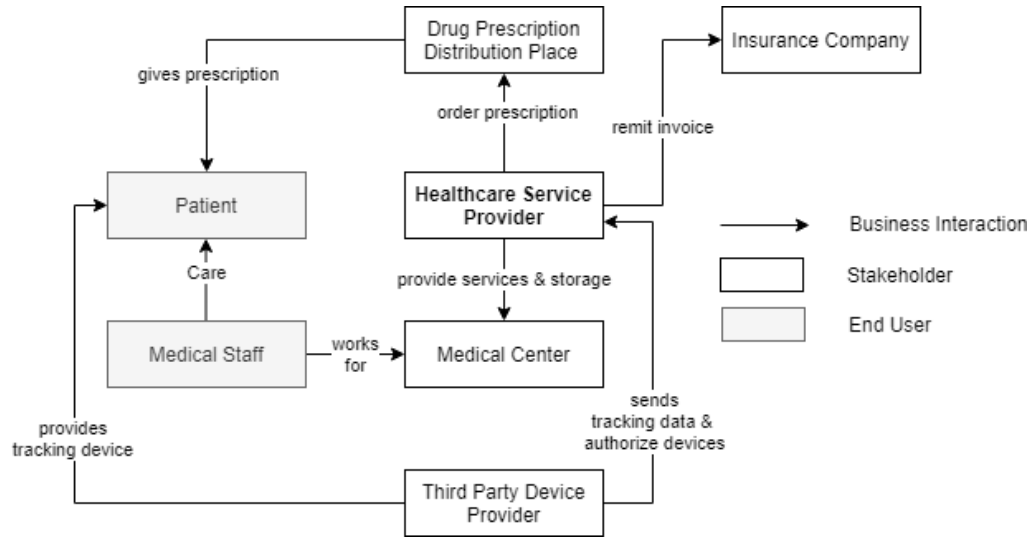


Figure 1: Business Domain Model - In the usage scenarios, the Healthcare Service Provider rests as the core of the participants. The Medical Center implements the Healthcare Service Provider services. The Healthcare Service Provider remits invoices of patients to Insurance Companies and order patients prescriptions to Drug Distribution Prescription Place. The patients prescriptions is then given to Patients by the Drug Distribution Prescription Place. The Third Party Device Provider facilitates tracking devices to patients. By using these devices, they send patients' tracking data to the Healthcare Service Provider and provides an authorization mechanism for their devices. Finally, Medical Staff end users (e.g. doctors, nurses) reports their job by using the Service Based Application (SBA) of the Medical Center and take care of Patients when necessary.

Table 2: Overview of involved participants

| Participant | Role | Description |
|--------------------------------------|-----------------------------|--|
| Healthcare Service Provider | Service Provider & Consumer | Provide software services and storage service to Medical Centers and receives patient's data sent from Third Party Devices Providers. In addition to this, Healthcare Service Provider consume services from Insurance Companies and Drug Prescription Distribution Place to remit invoices and order prescriptions respectively. Finally, it consumes a service from the Third Party Device Provider to authorize trustworthy tracking devices. |
| Medical Center | Service Consumer | Consumes the Healthcare Service Provider services to provide Tracking, Diagnosis, Treatment and Prevention services to patients. |
| Medical Staff | End User | Use Medical Center services through and SBA to help in the diagnosis, treatment and prevention of patients illness. |
| Patient | End User | Is attended by the Medical Staff. Patients use the Tracking service thanks to a device provided by a Third Party Device Provider. In addition to this, Drug Prescription Distribution places gives them prescriptions. |
| Drug Prescription Distribution Place | Service Provider | Provides the Healthcare Service Provider with services to order prescriptions for patients. |
| Insurance Company | Service Provider | Provide the Healthcare Service Provide with services to remit invoices of patients. |
| Third Party Device Provider | Service Provider & Consumer | Provides patients with tracking devices to track their health data. In addition to this, it provides the Healthcare Service Provider with a Devices Authorization Service in order to recognize trustworthy devices. Finally, it consumes the Healthcare Service Provider services in order to send the patients' monitored data. |

2 Functional Requirements

In this section, we present the four main functional requirements of the project. These requirements are linked to the vision of the stakeholders and follow the business domain usage scenarios. Each functional requirement has a different purpose, which we describe in detail below.

2.1 Patient Data Monitoring

| | Description |
|-------------|--|
| Short Name | Patient Data Monitoring Phase |
| Identifier | FR1 - Patient Data Monitoring Phase |
| Description | This functionality will be able to collect and store patients' health data such as blood pressure, heart rate, blood glucose level, etc. Data will be collected using an authorized device from a Third Party Device Provider. Using this data, we will generate daily reports and send it to patients by email. Daily reports should include charts with the monitored data plotted in a timeline. Finally, if the tracked patient's data reaches past a warning line, an alert will be sent to the Medical Center. |

2.2 Illness Prediction and Diagnosis

| | Description |
|-------------|---|
| Short Name | Illness Prediction and Diagnosis Phase |
| Identifier | FR2-Illness Prediction and Diagnosis |
| Description | <p>Monitored personal health data (i.e. blood pressure, heart rate, blood glucose level), and other patients' indicators such as medical record of familiar diseases or previous illness (if available) are going to be used to predict diseases risk and diagnose on-going illness. This data should be used as input for an AI model that predicts the diseases the patients are most susceptible to suffer. The output of the model will be a list of diseases in order of the probability the patient has to suffer them. Diseases should be listed as follows: the name, the symptoms, the type, the susceptible population and risk factors.</p> <p>After that, the medical staff will reappraise the results of the prediction. In doing so, they will remove extreme cases and adjust the results for specific patient's situations. The final diagnosis result should include the personal information of the patient, the symptoms, as well as its related diseases. Finally, the diagnosis report will be sent to the patient by Email to give the patient an overview of their diagnosis.</p> |

2.3 Treatment

A treatment phase should start after a patient of a medical center has been diagnosed with a specific illness.

| | Description |
|-------------|--|
| Short Name | Treatment Phase |
| Identifier | FR3-Treatment |
| Description | This functionality automatically generate reports containing a recommended treatment procedure for the patient based on their medical record and diagnosed illness. The medical staff should then evaluate, decide and report the treatment procedure that will be used on the patient. Treatment procedures should consist of one or both of the following: a) Drugs prescription and b) appointment scheduling. In the case of drug prescription, prescriptions orders must be automatically generated and sent to the nearest drug prescription distribution place. The information of the appointments should be sent to the patient by email and reminders are sent by Email when the appointments scheduled date is close. The invoice of any treatment procedure should be automatically sent to the patient insurance company. |

2.4 Prevention

Following FR3-Treatment, our fourth functional requirement is Prevention, identified as FR4-Prevention.

| | Description |
|-------------|--|
| Short Name | Prevention |
| Identifier | FR4-Prevention |
| Description | This functionality enables the software service to give advice to people who have been diagnosed with a certain disease in order to prevent complications or more serious diseases related to it. This functionality is based on the confirmed disease of the patient and the patient's data from the database. It will provide the patient preventive measures under three aspects - regular exercise plan, diet and a timetable - as a report. During the execution of the preventive measures, FR4-Prevention can also use the FR1 - Patient Data Monitoring Phase functionality to further monitor the patient's data to dynamically adjust the preventive measures. |

3 Quality Requirements

In this section, we present the four most relevant quality requirements for our functional requirements. Each quality requirement was carefully chosen based on a rationale according to our business domain, which is described in detail in the tables below.

3.1 Performance

| | Description |
|-------------|---|
| Identifier | QR1-Performance |
| Short name | Performance |
| Description | The Patient Data Monitoring Phase must process incoming data as quick as possible. The data should be transferred and processed within 1 second. On the other hand, AI models in the Illness Prediction and Diagnosis must give predictions within 3 seconds when given an input. Reports generation and sending must be achieved in less than 1 second. Database service should handle 200,000 read transactions per minute in the order of milliseconds. |
| Rationale | In the Patient Data Monitoring Phase, every second wasted in data transferring and processing result in less time to alert the patient in moments when their data have reached a warning line. Therefore the performance in transferring and processing patient's tracked data is of vital importance for the Patient Data Monitoring Phase. In addition to this, the Illness Prediction and Diagnosis models must have a quick response from an input for patients and medical staff to gain trust in the service. |

3.2 Privacy

| | Description |
|-------------|---|
| Identifier | QR2-Privacy |
| Short name | Privacy |
| Description | Our services must reliably protect users' sensitive information. Privacy protection must be applied in the acquisition, transmission and usage of users' sensitive information and data. Only authorized devices in secure networks must be used to transfer patient's monitored data. Furthermore, users should be able to properly control how their data is used through transparent policies. Users' privacy data should have exceptional protection mechanism. |
| Rationale | Our four main business services all involve the acquisition, transmission, query and use of user data. This data is extremely sensitive. Thus, data leakages may cause personal damage, financial loss, reputation damage, identity theft, fraud, discriminatory treatment, etc. Good privacy protection measures can not only ensure the normal and efficient operation of business services, but also increase users' credibility and users' loyalty. |

3.3 Scalability

| | Description |
|-------------|--|
| Identifier | QR3-Scalability |
| Short name | Scalability |
| Description | Scalability is the service's ability to attend to a higher number of clients without having degraded performance. Our services should perform efficiently (i.e. less than 1 second in response time) regardless of the number of users using our functionalities through the SBA. That is, even if the number of transactions are tripled from one day to another. |
| Rationale | Every day more and more people start using IoT devices to monitor and track their vital signs. Furthermore, they rely on technology to manage their medical appointments or prescriptions. If the Patient Data Monitoring Phase is unable to scale properly alongside the number of users, they will start facing a degraded performance in the application. Hence, the importance of Scalability as a service aspect. Lack of Scalability will result in possible trust issues from the end-user toward the SBA implementing the service. |

3.4 Reliability

| | Description |
|-------------|--|
| Identifier | QR4-Reliability |
| Short name | Reliability |
| Description | Our services should be reliable in the prediction and diagnosis results it generates. Our prediction and diagnosis model should have 95% accuracy, and get better everyday using feedback from the Medical Staff. |
| Rationale | Reliability guarantees users trust. This will help to maximize the services longevity. If the service's reliability can not be guaranteed, users' credibility will go down. Furthermore, if our predictions have low accuracy it becomes unusable. In addition to this, low service reliability may increase the workload and economic cost of subsequent service maintenance, as well as irreparable waste. |

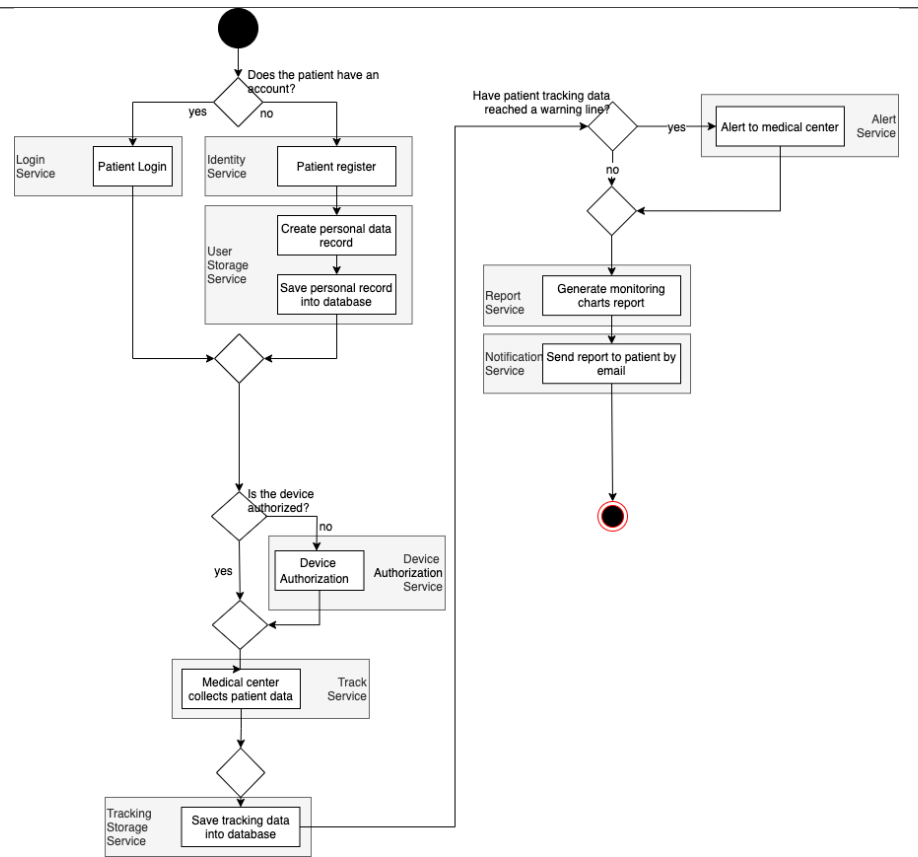
4 Business Services

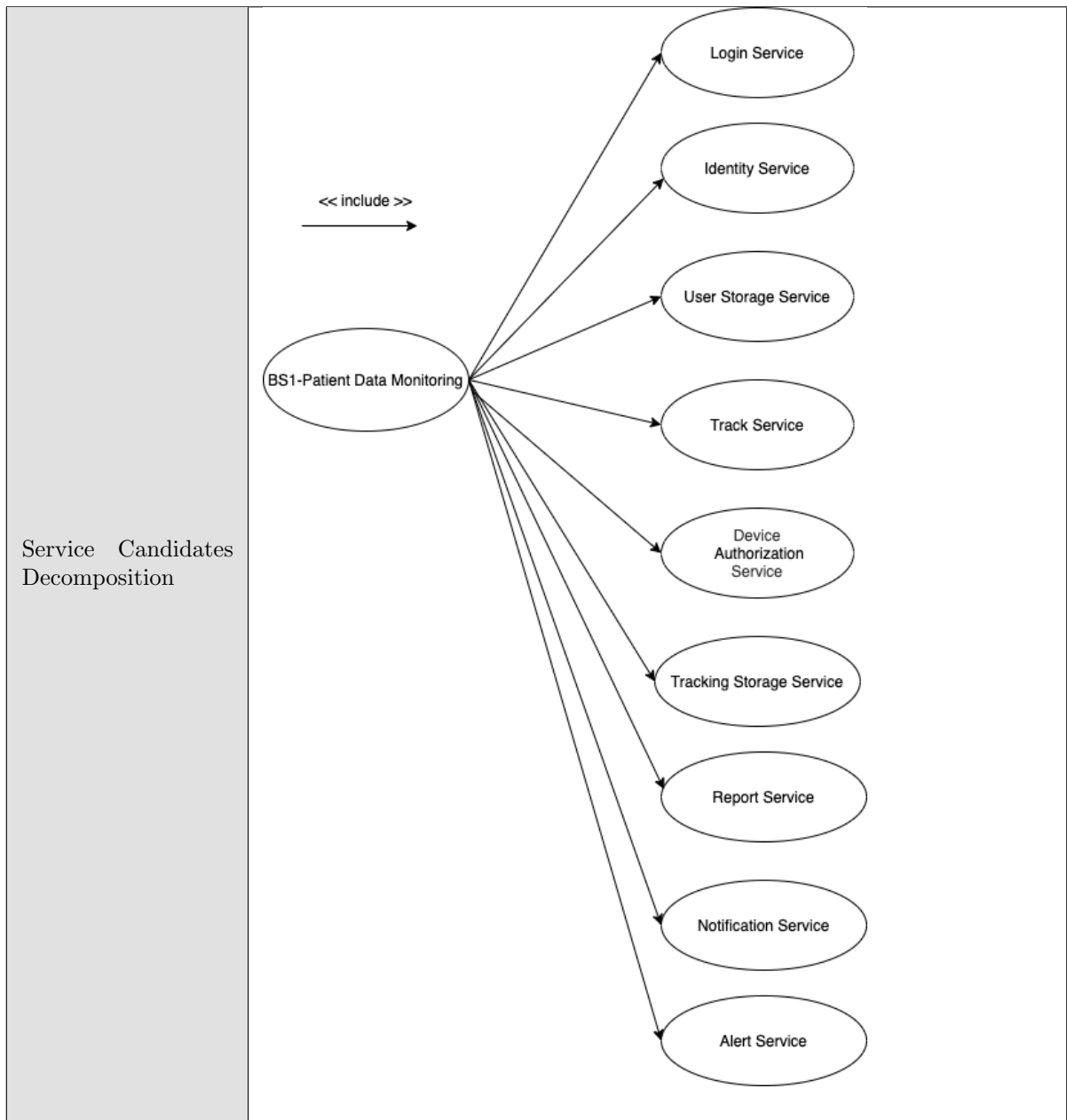
The following section will present our four business services directly mapped from the functional requirements presented in Section 2. For each business service, we present the involved participants and a detailed operational description. In addition to this the service behaviour is presented as an activity diagram which identifies the service candidates and service operation candidates. Furthermore, the service candidates decomposition is then presented using use case diagrams. Finally, a data model depicting which service candidates' instantiate or use which classes is presented. At the end of this section all the service candidates from the four business services are presented in a context model. The latter also presents the business interactions that stakeholders have with our service candidates.

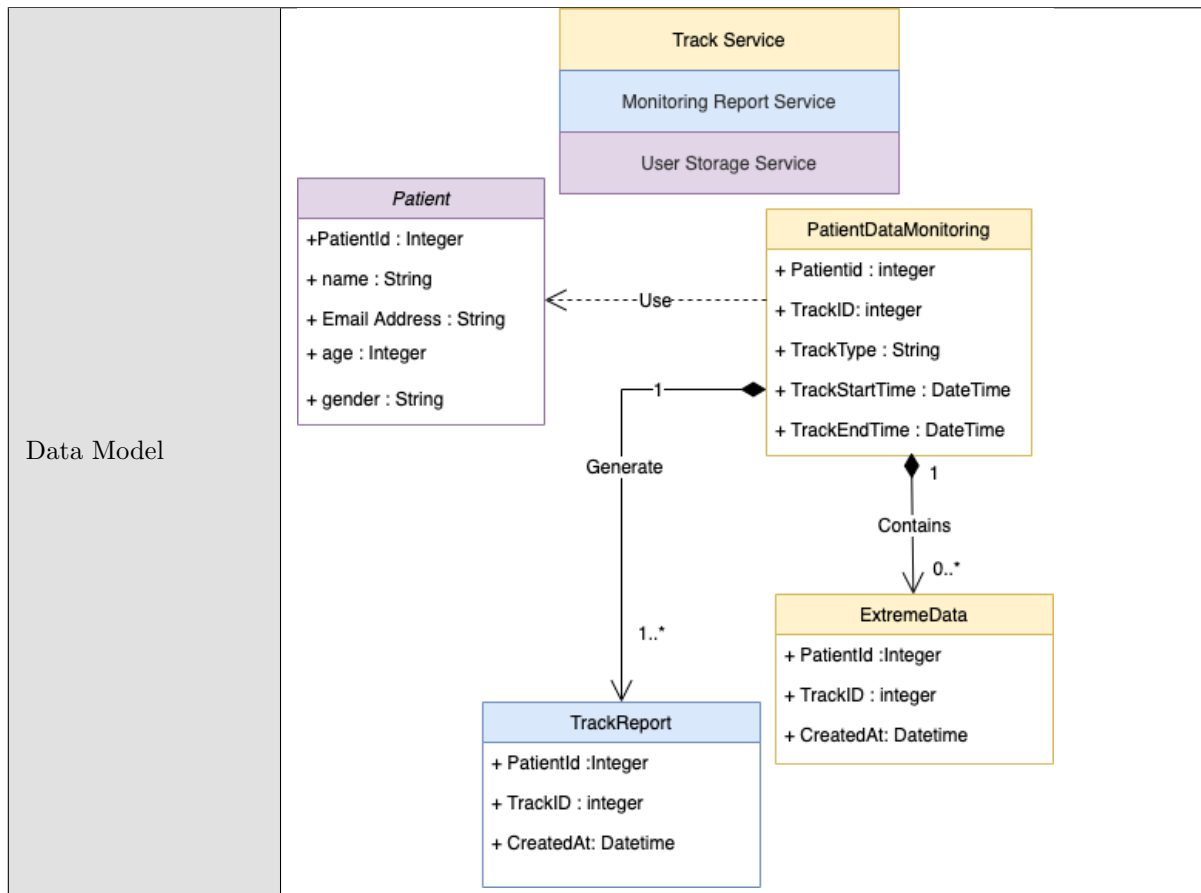
4.1 Patient Data Monitoring

| Field | Description |
|----------------------------------|--|
| Unique ID | BS1-Patient Data Monitoring |
| Short Name | Patient Data Monitoring |
| Involved Participants | Medical Center, Healthcare Service Provider |
| Detailed Operational Description | First, patients will be able to login, or register (in case they do not have an account). Then, the patient tracking device must be authorized to be considered trustworthy by the service. Afterwards, patient's health data is collected by the device, sent to the Medical Center and stored into a database. If the monitored data reaches a warning line, the service will send an alert to the Medical Center. Finally, the stored data is used to send daily chart report to the patient by email. This service behaviour assumes the user have a device acquired from an authorized device provider. |

Service Behavior

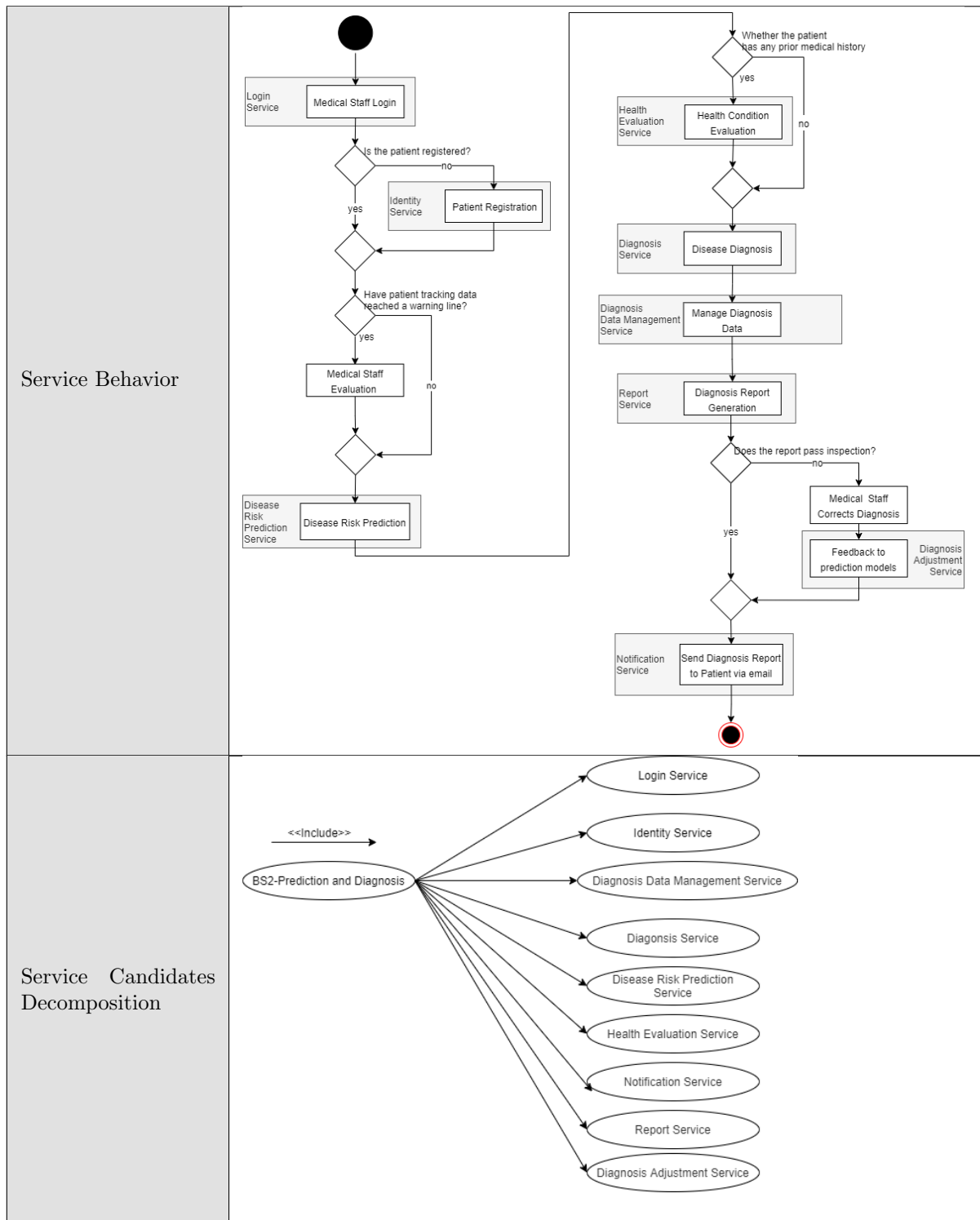


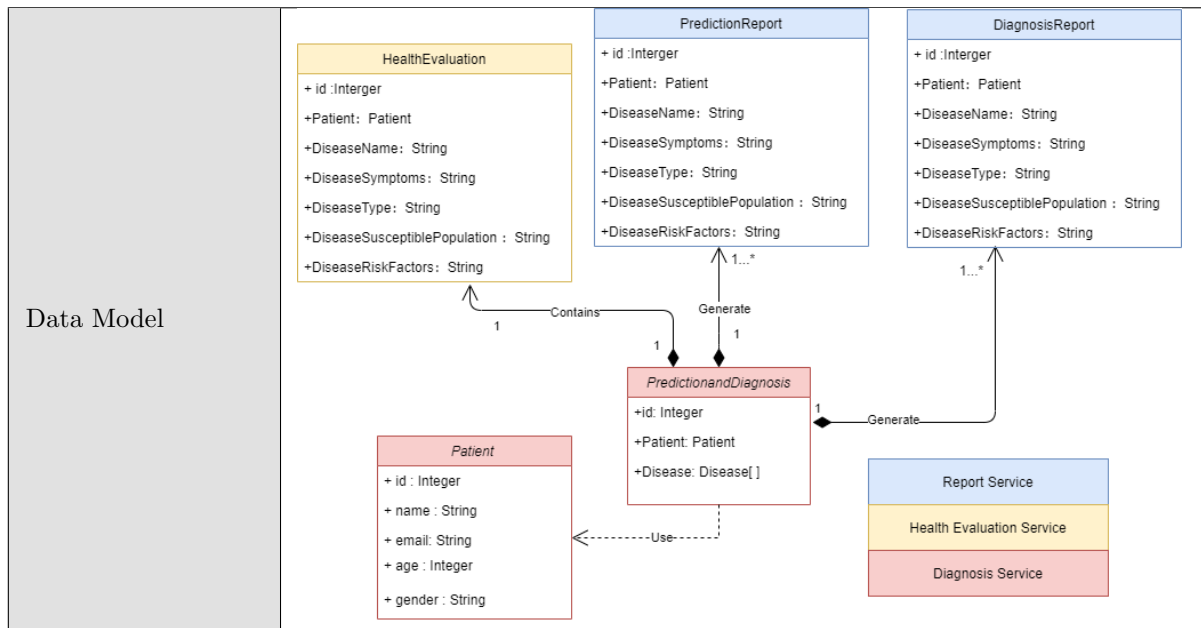




4.2 Illness Prediction and Diagnosis

| Field | Description |
|----------------------------------|--|
| Unique ID | BS2-Prediction and Diagnosis |
| Short Name | Illness Prediction and Diagnosis |
| Involved Participants | Healthcare Service Provider |
| Detailed Operational Description | <p>First, patients will be able to login, or register (in case they do not have an account). The latter will confirm the patients' identity. If the patient has gone through BS1 and their data have reached a warning line a Medical Staff will evaluate the situation. Next, the service will generate a first prediction of the diseases the patient is in risk of suffering based on their tracking data. If the patient have any prior medical history, these are also evaluated and used for further predictions. Next, the service do a final diagnosis prediction based on all the available information of the patient. Then, predictions are stored and a report is generated. The report contains the possible diseases presented in order of the probability of the patient suffering it. If there is any problem in the report, the Medical Staff can adjust it and give feedback of the correct diagnosis to the prediction model considering all the patient information into account. Finally, the report is sent to the patient by email.</p> |

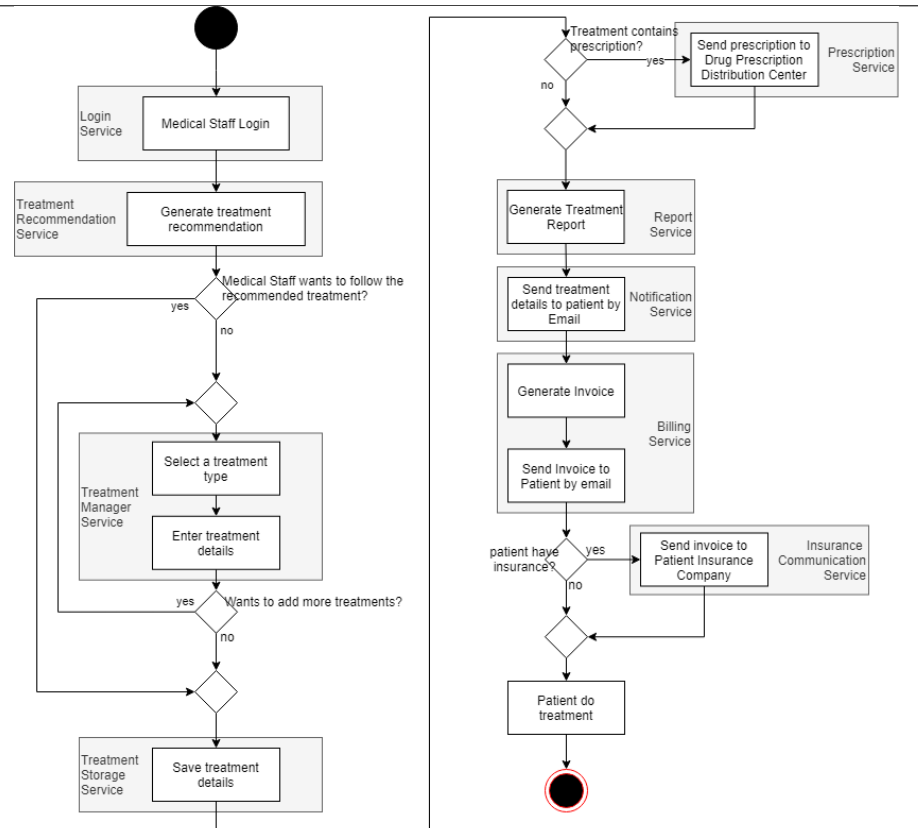


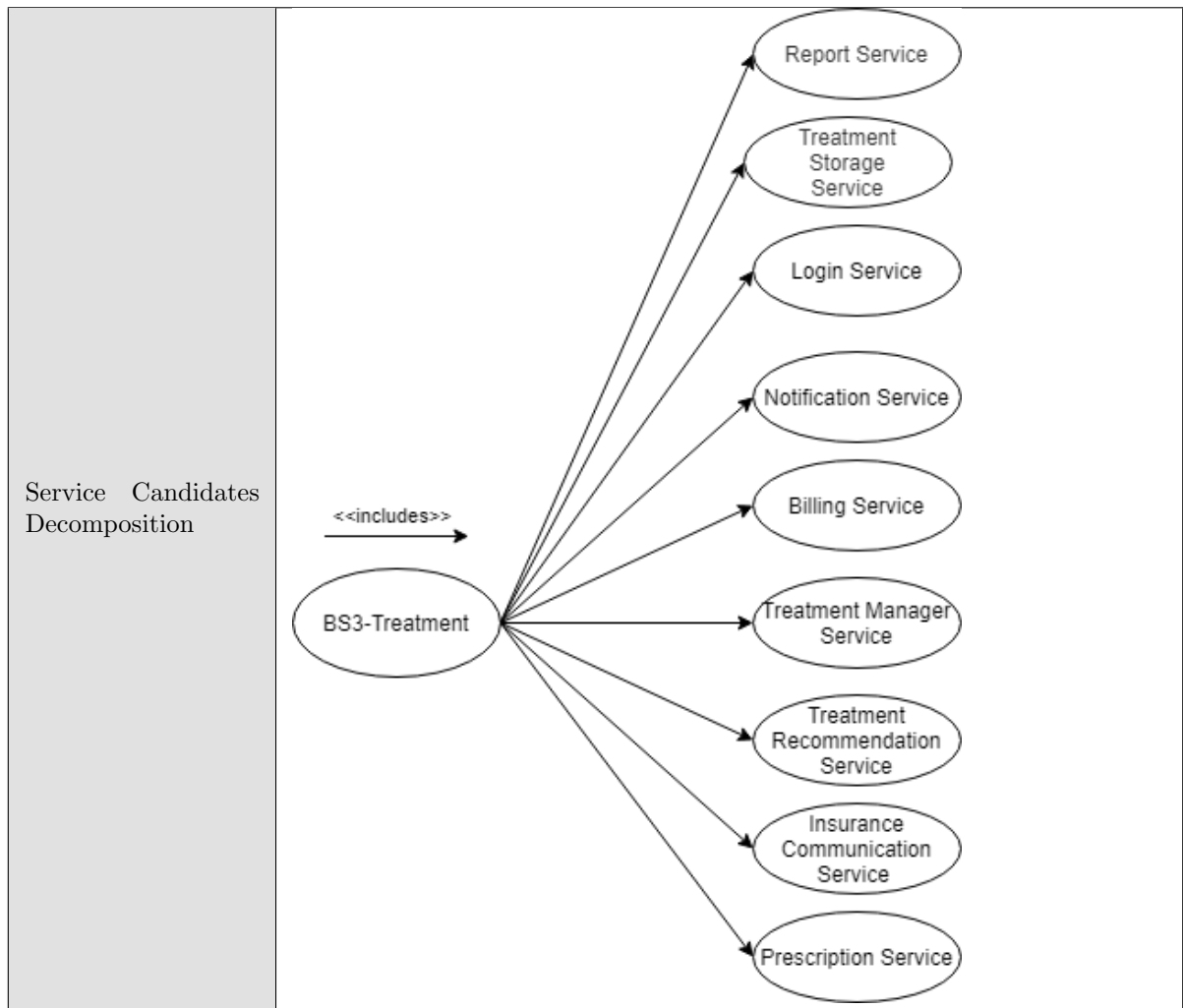


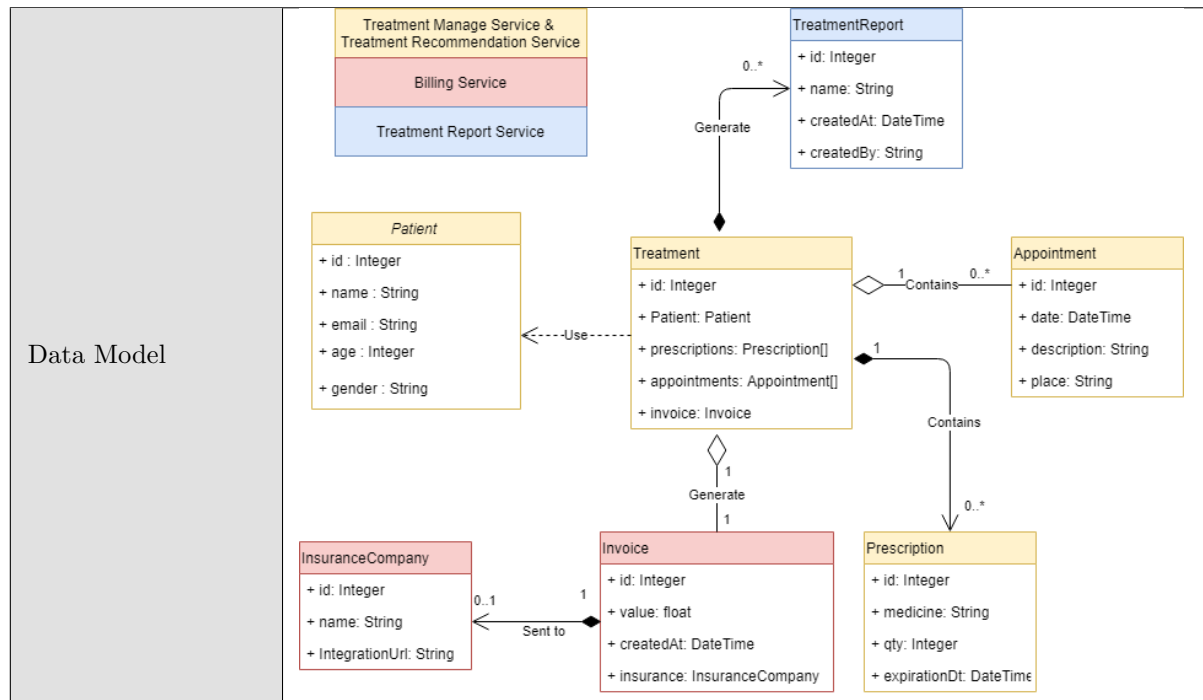
4.3 Treatment

| Field | | Description |
|--------------------|----------|---|
| Unique ID | | BS3-Treatment |
| Short Name | | Treatment |
| Involved | Partici- | Medical Center, Drug Prescription Distribution Place, Insurance Company, Healthcare Service Provider |
| pants | | |
| Detailed | Opera- | Once authorized, the medical staff is able to generate a report containing a recommended treatment procedure for the patient based on their medical record and diagnosed illness. The usage of this treatment is at discretion of the medical staff. If the medical staff decides not to use the recommended treatment, it must then enter the treatment procedure that will be used on the patient. Treatment procedures consist of one or both of the following: a) Drugs prescription and b) appointment scheduling. Appointments can include one or more of the following: therapy sessions, monitoring consultations, medical exams, surgery, or appointments with specialists from other medical centers. For both of them the medical staff must enter the details in the SBA which implements the service. Once the medical staff finish entering the treatment details, they are saved into the treatment storage. If the treatment includes prescriptions, the service automatically generates and sends a prescription order to the nearest drug prescription distribution place of the patient's home address. The patient can also choose to receive the prescription at home. Home delivery of prescriptions is entirely managed from the drug prescription distribution place site. If the treatment includes appointments, the appointments details are added to the generated report. Finally, a report containing treatment details (i.e. prescriptions and/or appointments) is generated and is sent to the patient by email. Next, the respective invoice for the treatment is generated and sent to the patient by email. The invoice is also automatically sent to the patient insurance company if the patient is insured. Then the patient is able to do the treatment. |
| tional Description | | |

Service Behavior

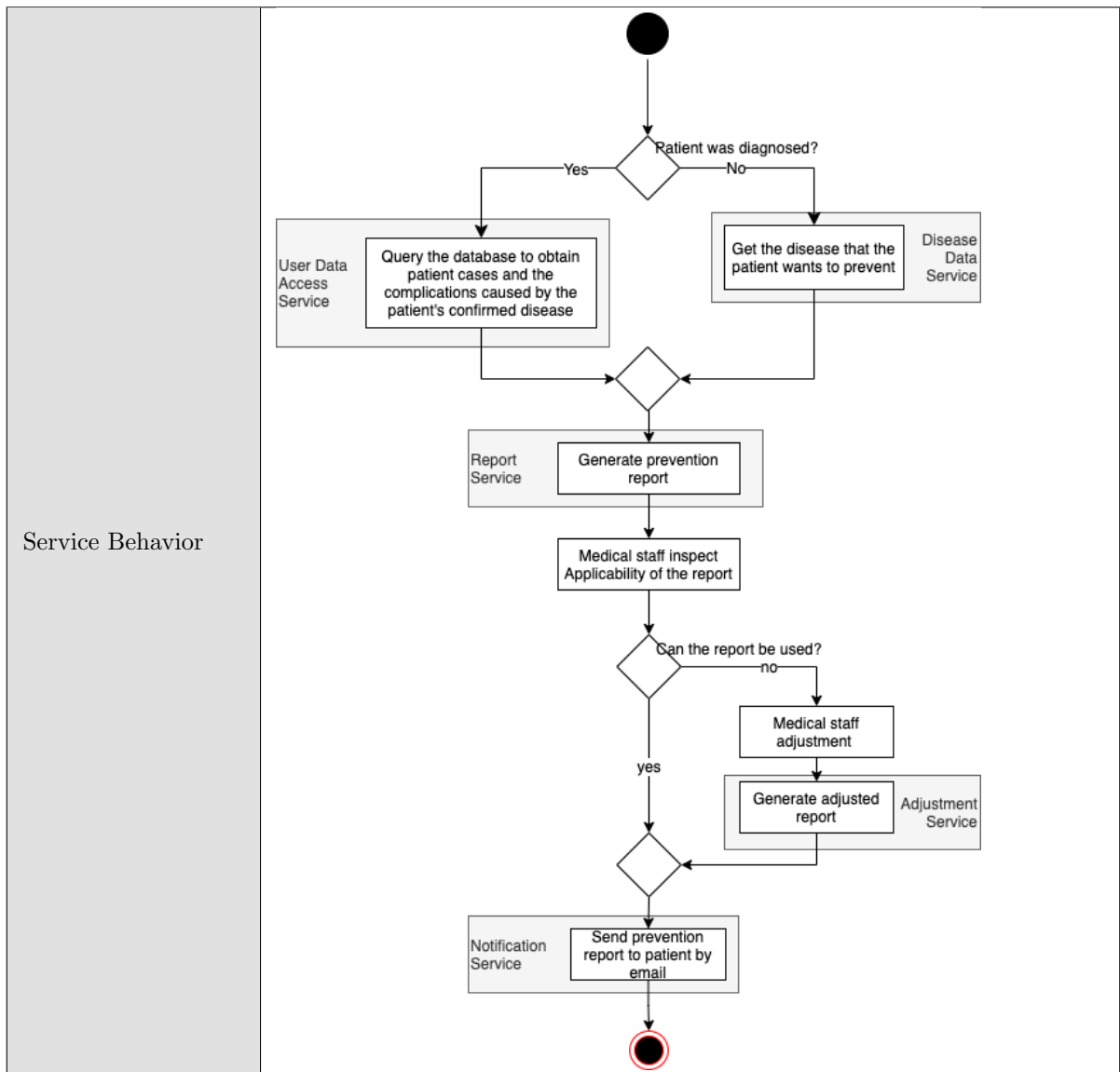


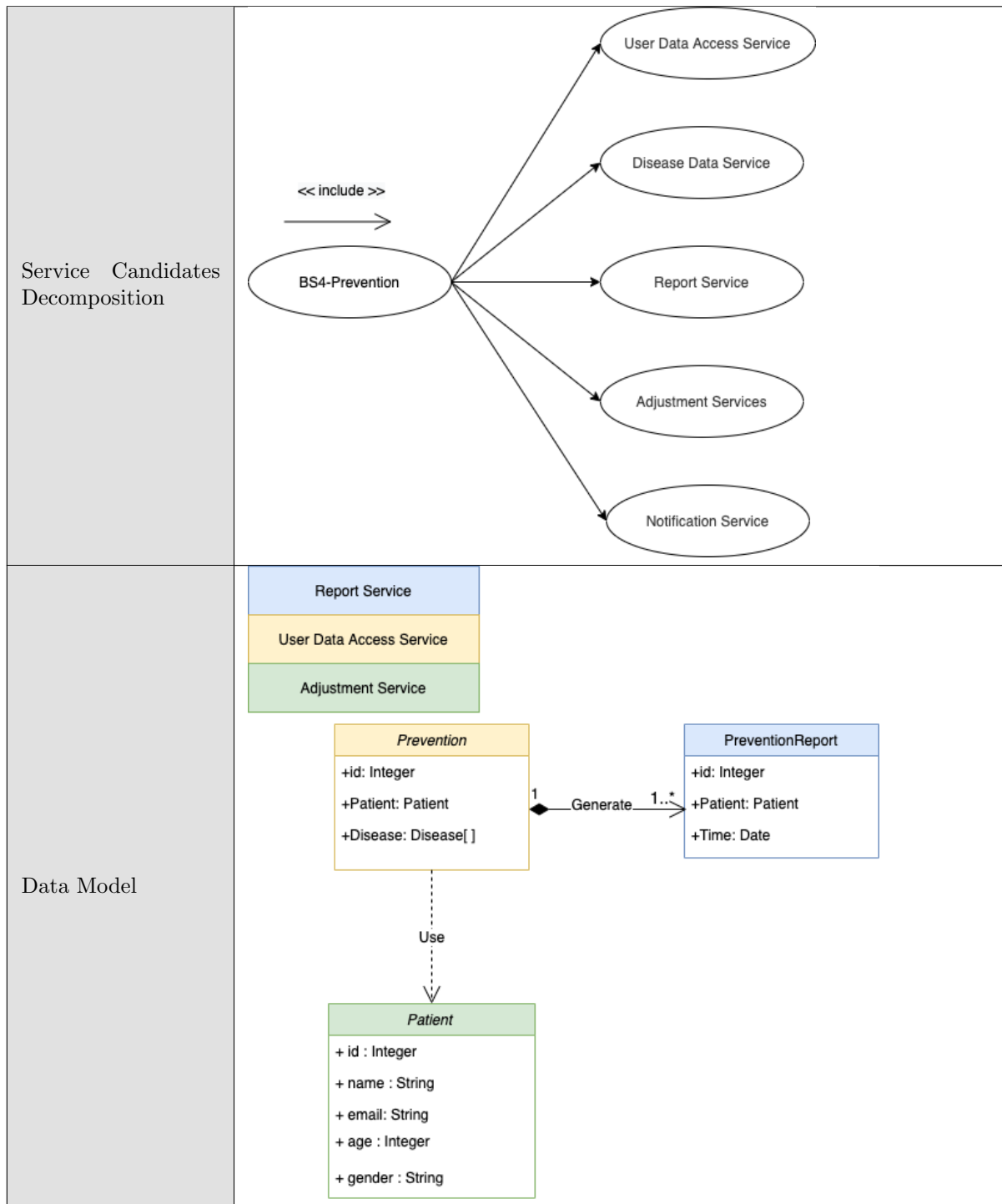




4.4 Prevention

| Field | Description |
|----------------------------------|---|
| Unique ID | BS4-Prevention |
| Short Name | Prevention |
| Involved Participants | Healthcare Service Provider |
| Detailed Operational Description | First, the Prevention service will verify whether the patient has been previously diagnosed by BS2. If yes, the user data access service will obtain the patient's medical record and relevant data from the database. If not, the disease data service will obtain the user's intention (i.e. diseases the patient wants to prevent). Next, the report service will generate a prevention report including diet structure, training plan and timetable regarding the disease the patient is willing to prevent. Next, this report is submitted for inspection carried out by the medical staff. If the prevention report is suitable for the patient, the notification service will send the report to the patient by email. If there is any problem in the report, the Medical Staff can adjust it and submit it to the report service to regenerate a new report which will finally be sent to the patient by email. |





4.5 Context Model



Figure 2: Context model of the service candidates including stakeholders and their role. That is, if the stakeholder is a service provider or service consumer

5 Design Space

In this section we will present the two main designs concerns we have detected in our project. The first concern is based on our business domain and the second one is based on a green sustainability strategy. We describe both concerns using the AK design-space modeling template (AK-SPAM) and the QOC (Question - Option - Criteria) notation.

For each concern we propose and describe three options. Each option is evaluated based on our quality requirements presented in Section 3. It is important to say that for our second concern, we also evaluate our quality requirements from a green sustainability point of view.

Finally, for each concern we present a diagram summarizing the QOC analysis for each concern.

Table 7: AK-SPAM for Con#1

| | |
|--|---|
| Concern (Identifier:Description) | Con#1: How can we make sure the tracking data is trustworthy? |
| Ranking Criteria (Identifier:Name) | Cr#1: Reliability Cr#2: Privacy Cr#3: Performance Cr#4: Scalability |
| Option 1 | |
| Identifier:Name | Con#1-Opt#1: Devices authorization |
| Description | The device sending patients' data must be from an authorized device provider and it must be authorized regularly. Device Authorization Service in BS1 will manage this authorization. |
| Status | Accepted |
| Relationships | None |
| Evaluation | <p>Cr#1: All devices that sends data will be strictly authenticated. Furthermore, before starting the data transmission, the patient must check and accept usage permission. Illegitimate data will not be allowed to enter the service. Therefore, this option supports reliability.</p> <p>Cr#2: Since access to devices will be scrutinized, the risk of user information leakage and unauthorized access to data will be minimized. In this way, privacy is directly supported by this option.</p> <p>Cr#3: The authorization of devices does not affect the data storage and processing speed. Therefore, this option is neutral to the performance criteria.</p> <p>Cr#4: Device's authorization does not affect the capacity of the service to scale. Hence, this option is neutral to the scalability criteria.</p> |
| Rationale of decision | Even though devices authorization has no impact on Cr#3 (Performance) and Cr#4(Scalability), we found that it strongly supports reliability and privacy due to illegitimate data filtering. Hence, avoiding storage of untrustworthy data and minimizing risk of information leakage. Therefore, the decision has been made to accept this option. |

| Option 2 | |
|-----------------------|---|
| Identifier:Name | Con#1-Opt#2: Filtering corrupted/outlier data |
| Description | BS1 must be able to reject outlier data points sent by the authorized devices. Outlier data points are defined as measurements which are inside an impossible range (e.g. negative values of blood pressure). If measurements are inside possible range of value, then the service must accept it. |
| Status | Rejected |
| Relationships | None |
| Evaluation | <p>Cr#1: Reliability is supported. Filtering extreme values in the data allows for trouble-free operational transmission. More importantly, the data used as input for our models will be trustworthy. Hence, improving the models reliability.</p> <p>Cr#2: This option is neutral for privacy since it will only apply a filtering action to the incoming data.</p> <p>Cr#3: Performance is neutral. Since there will be less stored data, the speed of the data processing could be improved. However, we expect the percentage of outlier data to be extremely low. Hence, performance would not be significantly challenged or supported.</p> <p>Cr#4: Filtering outlier data will not increase the amount of tracking data or patients using the service. Therefore, it is neutral for scalability.</p> |
| Rationale of decision | This option has been rejected because it only support Cr#1 (Reliability). |
| Option 3 | |
| Identifier:Name | Con#1-Opt#3: Local Storage Synchronization |
| Description | If a device suffers a disconnection from the network, once it reconnects our services must be able to receive all the data locally recorded meanwhile the device was disconnected. |
| Status | Rejected |
| Relationships | None |
| Evaluation | <p>Cr#1: As data will not be lost even when connection intermittenencies happen, the completeness of the data of the patient will always be preserved. Hence, this option strongly supports reliability.</p> <p>Cr#2: This option is neutral to privacy criteria due to the synchronization not adding any security breaches to the patients data.</p> <p>Cr#3: If a massive network outage happens, when the devices reconnect to the network, the services will receive a high number of requests. Hence, challenging performance.</p> <p>Cr#4: For the same reason stated in Cr#3, this option will also challenge scalability due to the elevated number of clients requesting services.</p> |
| Rationale of decision | This option has been rejected because it does not support Privacy and it challenges performance and scalability. |

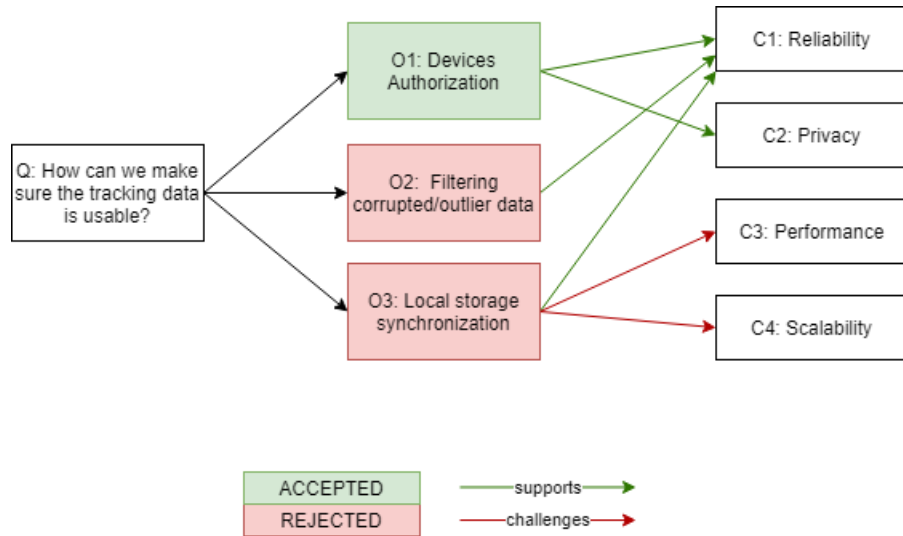


Figure 3: QOC notation of Con#1 - Option 1: Devices Authorization is accepted and it maps to our Service Candidate: Device Authorization Service, used in BS1.

Table 8: AK-SPAM for Con#2

| | |
|---------------------------------------|--|
| Concern (Identifier:Description) | Con#2: How can we reduce the patient's ecological footprint? |
| Ranking Criteria (Identifier:Name) | Cr#1: Reliability Cr#2: Privacy Cr#3: Performance Cr#4: Scalability |
| Option 1 | |
| Identifier:Name | Con#2-Opt#1: Digitize Reports |
| Description | Digitize medical reports and notifications by maximizing automated communication with patients through email. |
| Status | Accepted |
| Relationships | None |
| Evaluation | <p>Cr#1: Digitize Reports is positive for reliability since all data used inside the digital report and the report itself comes directly from an authorized source.</p> <p>Cr#2: Digitize Reports positively impact the privacy of our services as digital reports can be kept safer than physical reports, and are less prone to leakage or misuse.</p> <p>Cr#3: This option is negative in terms of performance because a large number of digital report need to be generated and sent. This will impact the performance of services.</p> <p>Cr#4: This option positively impact the scalability due to a large number of reports that can be generated and sent concurrently to patients in contrast to reports sent by post email.</p> |
| Rationale of decision | This option has been accepted since it supports three of our criterias. |

| Option 2 | |
|-----------------------|--|
| Identifier:Name | Con#2-Opt#2: Contactless Diagnosis |
| Description | By implementing contactless patients diagnosis through BS1 (Patient Data Monitoring Service) and BS2 (Diagnosis Service), it will not be necessary for patients to have face-to-face diagnosis in a medical center. |
| Status | Accepted |
| Relationships | None |
| Evaluation | <p>Cr#1: Contactless Diagnosis is neutral to the reliability of the service. This is due to the diagnosis prediction accuracy not being affected by whether the doctor has contact with the patient or not.</p> <p>Cr#2: This option will positively impact privacy due to the minimized exposure of patients information. The information of the patient will only be shared between the Medical Center and the patient itself. Hence, the likelihood of information leakage is greatly reduced.</p> <p>Cr#3: Contactless diagnosis makes possible to diagnose patients in just a few seconds. Hence, positively supporting the performance of the service.</p> <p>Cr#4: Scalability will be supported since more patients can be diagnosed in contrast to in-person diagnosis.</p> |
| Rationale of decision | This decision has been accepted since it supports three of our criterias. Furthermore, it does not challenge any criteria. |
| Option 3 | |
| Identifier:Name | Con#2-Opt#3: Contactless Tracking |
| Description | Implement contactless patients health monitoring without the patient necessity to recurrently assist to a medical center. |
| Status | Accepted |
| Relationships | None |
| Evaluation | <p>Cr#1: Contactless tracking will impact reliability positively. Since the tracking of patients' health is available anytime, anywhere with regular feedback for the patient. Hence, the patient will gain trust towards the tracking service.</p> <p>Cr#2: The confidentiality of data is positively affected since the patient data does not have intermediaries between him/her and the Healthcare Service Provider. Furthermore, patients are sure that their data is authentic thanks to the regular feedback they receive from the tracking device and from our services.</p> <p>Cr#3: Contactless tracking will impact negatively on BS1 performance. This is due to the higher amount of patient's data that the service will have to digest and process.</p> <p>Cr#4: Scalability is positively impacted since many more patients are able to track their health without using physical resources from the hospital.</p> |
| Rationale of decision | This option has been accepted since it supports three of our criteria. |

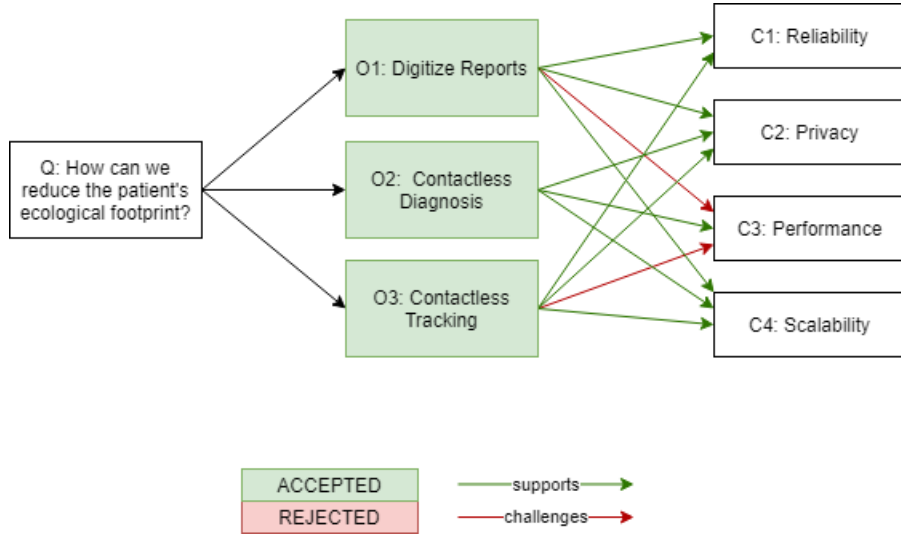


Figure 4: QOC notation of Con#2: All the options were accepted. Option 1 maps to the service candidate: "Report Service". Option 2 maps to our Business service BS2. Finally, option 3 maps to our Business Service BS1.

6 Sustainability Strategies

In this section we present a sustainability strategy for our project. A sustainable development strategy is of great value to the long-term development and ecological protection of enterprises. In the process of service maintenance, we should not only pay attention to the quality requirements, but also consider the sustainability of the services. In this section, we describe our sustainability goal. Furthermore we will describe sustainability strategies as actions to be implemented in our services design to achieve that goal. The sustainability strategy goal described in this section was presented as a concern (i.e. Con#2) in the previous section.

Table 9: Strategy Description Table

| Field | Description |
|-------------|--|
| Unique ID | SE1-Reduce Patients Eco Footprint |
| Short Name | Reduce Patients Ecological Footprint |
| Description | This goal aims to reduce patients ecological footprint as a sustainability strategy. This environmental goal is mapped to our Con#2: "How to reduce the patient's ecological footprint?" in Section 5. |

| | |
|-------------------------------|---|
| Action #1 | <p>Description: Digitalize Reports: Digitize medical reports and notifications by maximizing automated communication with patients through email.</p> <p>Effect: Reduce paper materials used.</p> |
| Action #2 | <p>Description: Contactless Diagnosis: By implementing contactless diagnosis, patients do not need to travel to see a doctor. Therefore, they will reduce the frequency of using transport that emits CO2.</p> <p>Effect: Reduce patient CO2 emissions.</p> |
| Action #3 | <p>Description: Contactless Tracking: Implementing contactless tracking of patients' health will reduce the use of physical resources used by Medical Staff at in-person appointments with patients.</p> <p>Effect: Reduce medical waste.</p> |
| Type of Strategy | Service Awareness |
| Relevance for Business Domain | By the means of sustainable development, the government can effectively reduce the expenditure on medical costs and maximize the utilization of medical resources. Our sustainable services utilization can reduce patients' ecological footprint. In addition to this, implementing sustainability strategies in the design ensures the services longevity. |
| Diagram | <div> <div> <p>ACTIONS</p> <div> <p>ACTION #1: Digitize medical reports and notifications by maximizing automated communication with patients through email.</p> <p>ACTION #2: By implementing contactless patients diagnosis, patients do not need to travel to see a doctor</p> <p>ACTION #3: By implement contactless patients health monitoring, Medical Centers reduces their in-person appointments</p> </div> </div> <div> <p>GOAL</p> <div> <p>Reduce Patients Ecological Footprint</p> </div> </div> <div> <p>reduce paper materials used</p> <p>reduce patient CO2 emissions</p> <p>reduce medical waste</p> </div> <pre> graph LR A1["ACTION #1: Digitize medical reports and notifications by maximizing automated communication with patients through email."] -- "reduce paper materials used" --> G["Reduce Patients Ecological Footprint"] A2["ACTION #2: By implementing contactless patients diagnosis, patients do not need to travel to see a doctor"] -- "reduce patient CO2 emissions" --> G A3["ACTION #3: By implement contactless patients health monitoring, Medical Centers reduces their in-person appointments"] -- "reduce medical waste" --> G </pre> </div> |

7 Software Decomposition of Business Services

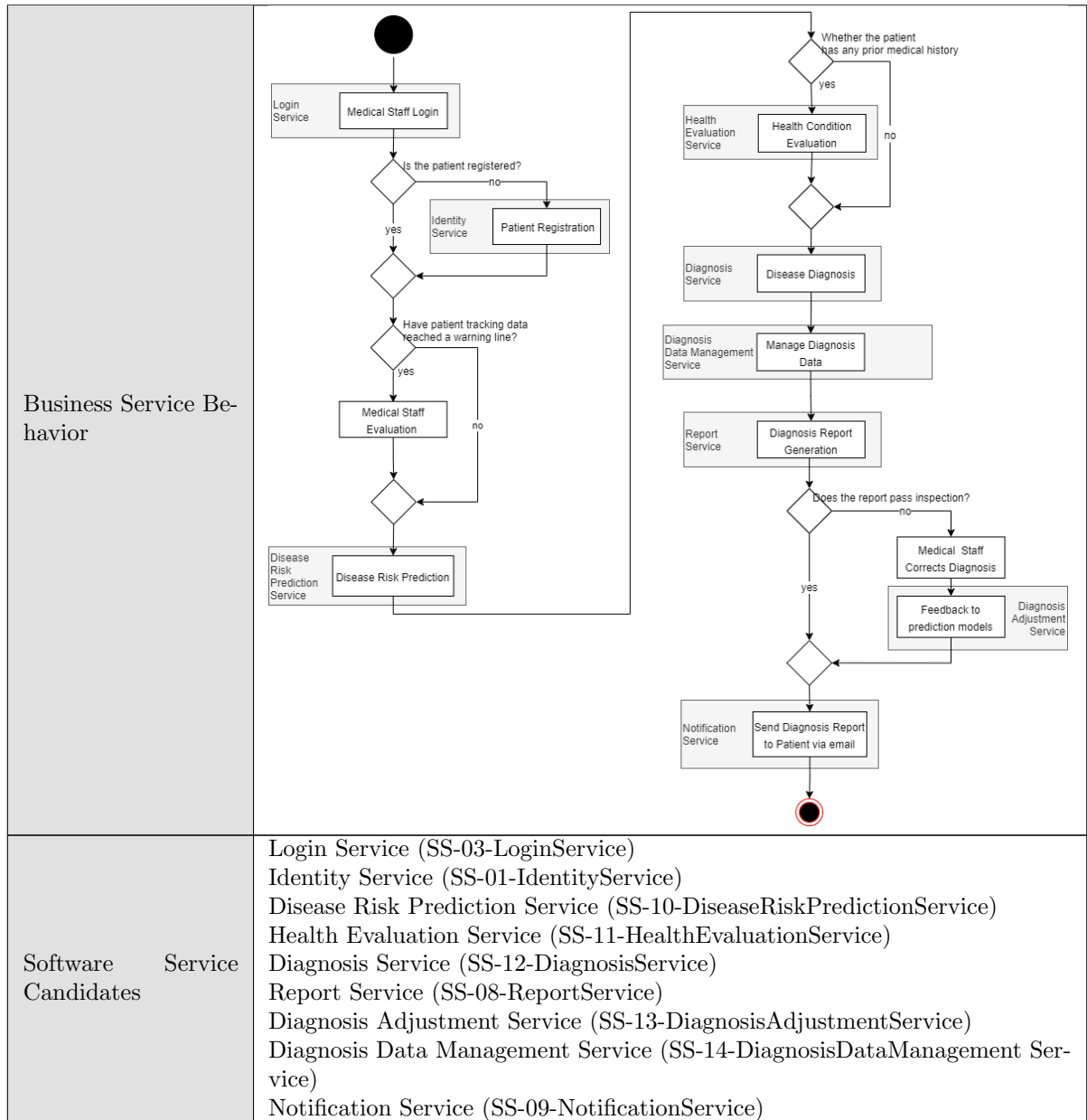
The following section illustrates the business services presented in section 4 as a list of service candidates. This decomposition is based on the perspective of the Healthcare Service Provider, which is the provider of the business services. Each business service decomposition presents their software service candidates and a diagram classifying the types of decomposed services candidates as hybrid, task, entity, or utility. In addition to this, each diagram has a description, and service candidates are given a unique ID.

Table 10: Business Service Definition

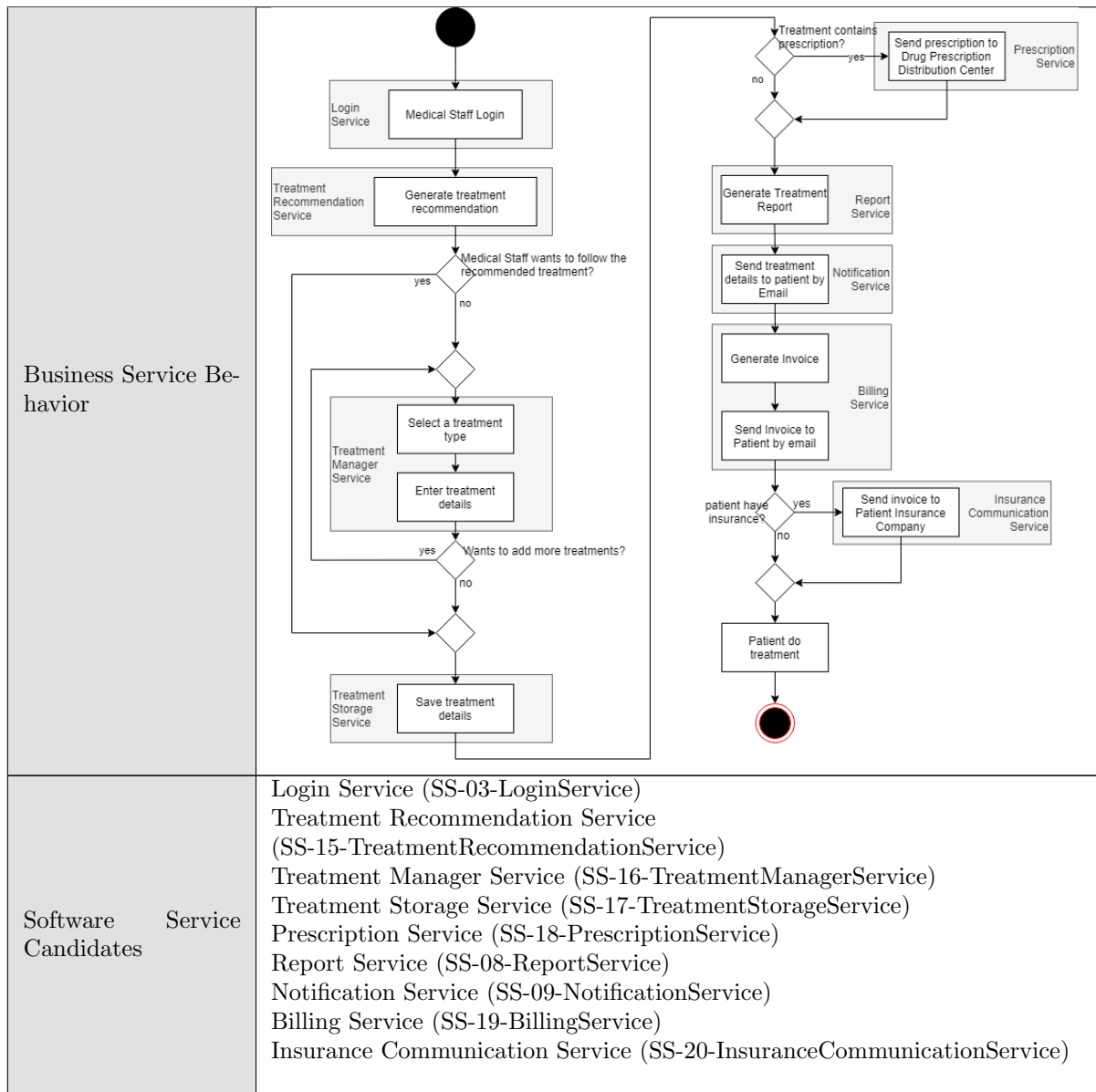
| Field | Description |
|---------------------------|--|
| ID | BS1-Patient Data Monitoring |
| Name | Patient Data Monitoring |
| Business Service Behavior | <pre> graph TD Start(()) --> D1{Does the patient have an account?} D1 -- yes --> PLogin[Patient Login] D1 -- no --> PRegister[Patient register] PRegister --> CRecord[Create personal data record] CRecord --> SRecord[Save personal record into database] PLogin --> Merge(()) SRecord --> Merge Merge --> D2{Is the device authorized?} D2 -- no --> DAuth[Device Authorization] D2 -- yes --> MCD[Medical center collects patient data] DAuth --> MCD MCD --> D3{ } D3 --> STrack[Save tracking data into database] STrack --> D4{Have patient tracking data reached a warning line?} D4 -- yes --> Alert[Alert to medical center] D4 -- no --> GReport[Generate monitoring charts report] GReport --> SendEmail[Send report to patient by email] SendEmail --> End((())) </pre> |

| | | |
|---------------------|---------|--|
| Software Candidates | Service | Identity Service (SS-01-IdentityService) User Storage Service (SS-02-UserStorageService) Login Service(SS-03-LoginService) Device Authorization Service (SS-04-DeviceAuthorizationService) Track Service (SS-05-TrackService) Track Storage Service (SS-06-TrackStorageService) Alert Service (SS-07-AlertService) Report Service (SS-08-MonitoringReportService) Notification Service (SS-09-NotificationService) |
|---------------------|---------|--|

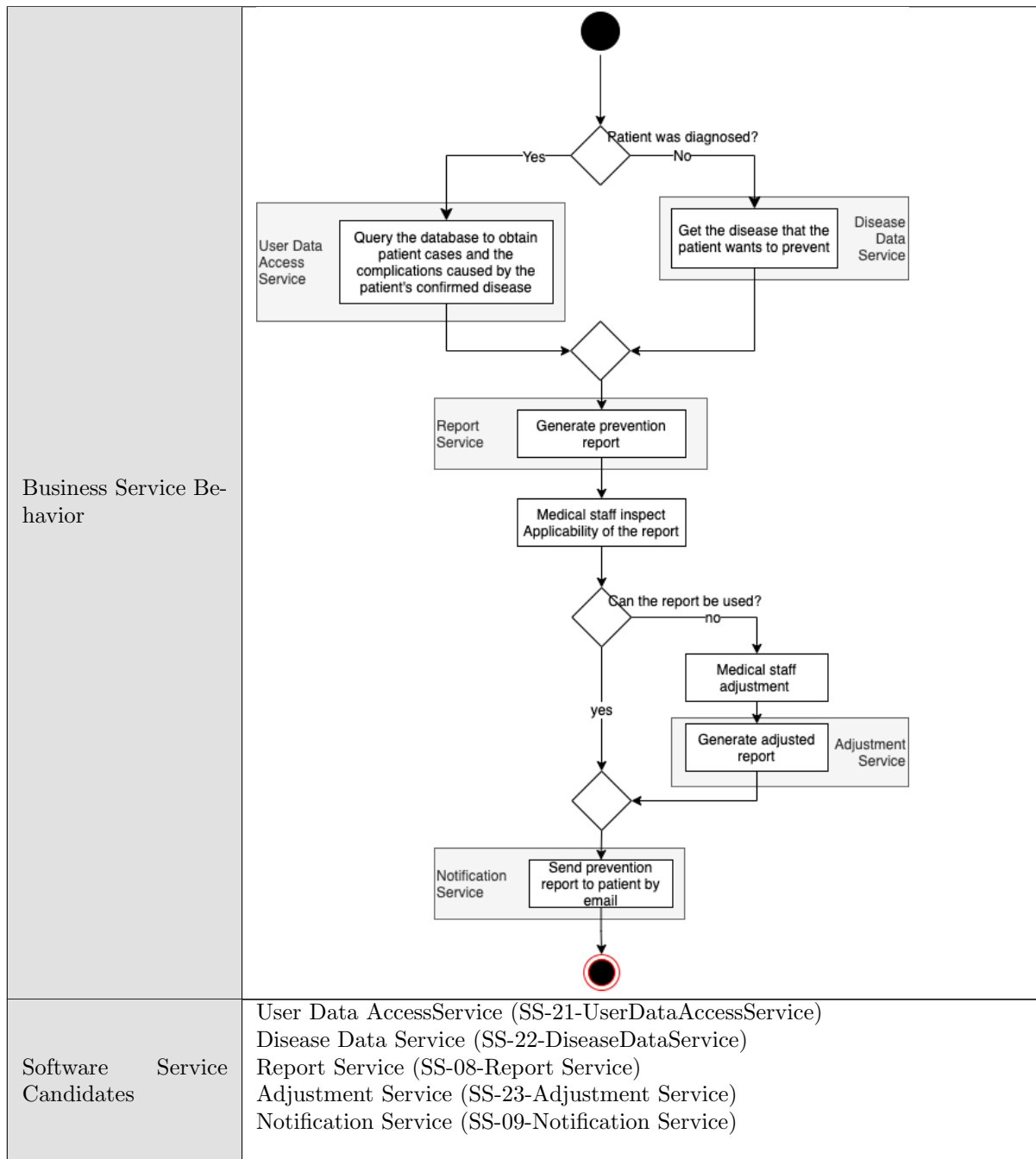
| | | |
|---------|---|------------------------------|
| Diagram | | |
| | <p>Our business service BS1-Patient Data Monitoring is a HYBRID service since it is composed of services of different types.</p> <p>Device Authorization Service, Identity Service, Report Service, Login Service and Notification Service are considered as UTILITY services since they have utility functionality. They are independent of the business service and can be reused in other business services.</p> <p>User Storage Service and Track Storage Service are considered ENTITY services since they are in charge of CRUD operations regarding the treatment entity.</p> <p>Finally, the rest of the services are considered as TASK services since they are core to the functionality of our business service.</p> | |
| | ID | BS2-Prediction and Diagnosis |
| | Name | Prediction and Diagnosis |

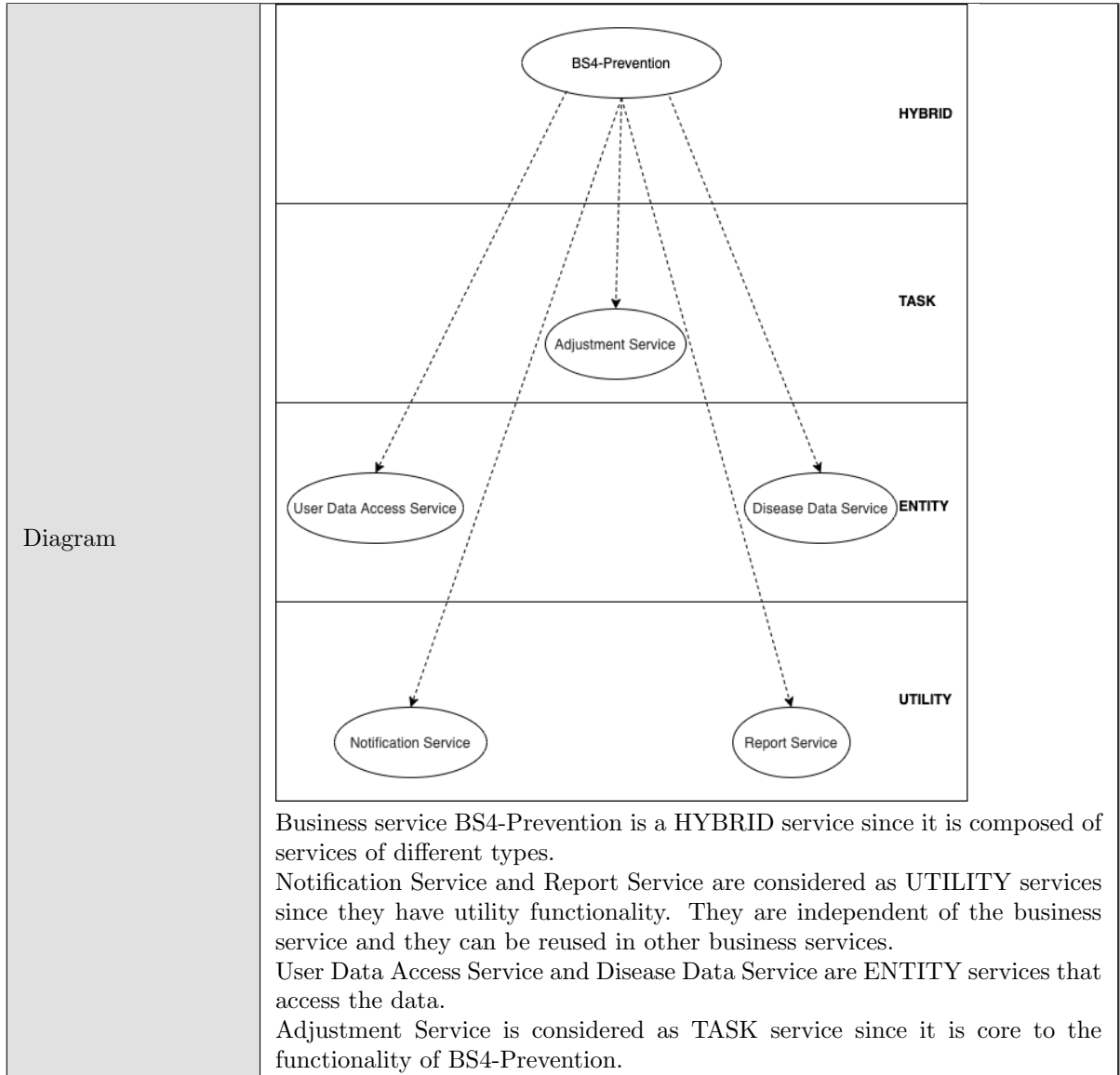


| | | |
|---------|--|---------------|
| Diagram | | |
| | <p>Our business service BS2-Prediction and Diagnosis is a HYBRID service since it is composed of services of different types.</p> <p>Disease Risk Prediction Service, Health Evaluation Service, Diagnosis Service and Diagnosis Adjustment Service are considered as TASK services as they execute specific functionalities within the diagnosis services.</p> <p>Diagnosis Data Management Service is considered as an ENTITY service since it offers access to the functionalities of our diagnosis services.</p> <p>Login Service, Identity Service, Notification Service, Report Service are considered as UTILITY services. They are independent of the business service and can be reused in other business services.</p> | |
| | ID | BS3-Treatment |
| | Name | Treatment |



| | | |
|---------|---|-----------------------|
| Diagram | | |
| | <p>Our business service BS3-Treatment is a HYBRID service since it is composed of services of different types.</p> <p>Login Service, Notification Service, Report Service, Insurance Communication Service and Billing Service are considered as UTILITY services since they have utility functionality. They are independent of the business service and can be reused in other business services.</p> <p>Treatment Storage Service and Treatment Manager Service are considered ENTITY services since they are in charge of CRUD operations regarding the treatment entity. Finally, the rest of the services are considered as TASK services since they are core to the functionality of our business service.</p> | |
| | ID | BS4-Prevention |
| | Name | Prevention |





8 Participant Service Inventory Identification

The following section describes the service inventory of each ones of the participants which have a role of service providers (i.e. Drug Prescription Distribution Place, Insurance Company, Third Party Device Provider and Healthcare Service Provider). In each inventory, the services are classified as Hybrid, Task, Entity or Utility from the perspective of the respective participant.

8.1 Drug Prescription Distribution Place


Table 11: Service Inventory of Drug Prescription Distribution Place

| Field | Description |
|---|---|
| ID | INV-01-DrugPrescriptionDistributionPlace |
| Name | Drug Prescription Distribution Place Service Inventory |
| Participant | Drug Prescription Distribution Place |
| Constituent Software Service Candidates | Prescription Service (SS-18-PrescriptionService) |
| Diagram | |
| Diagram Description | From the perspective of the Drug Prescription Distribution Place the Prescription Service is a task service since it is core to the business of this participant. |

8.2 Insurance Company

Table 12: Service Inventory of Insurance Company


| Field | Description |
|---|---|
| ID | INV-02-InsuranceCompany |
| Name | Insurance Company Service Inventory |
| Participant | Insurance Company |
| Constituent Software Service Candidates | Insurance Communication Service (SS-20-InsuranceCommunicationService) |

| | | |
|---------------------|---|------|
| Diagram | HYBRID | |
| |  | TASK |
| | ENTITY | |
| | UTILITY | |
| Diagram Description | From the perspective of the Insurance Company the Insurance Communication Service is a task service since it is core to the business of this stakeholder. | |

8.3 Third Party Device Provider

Table 13: Service Inventory of Third Party Provider

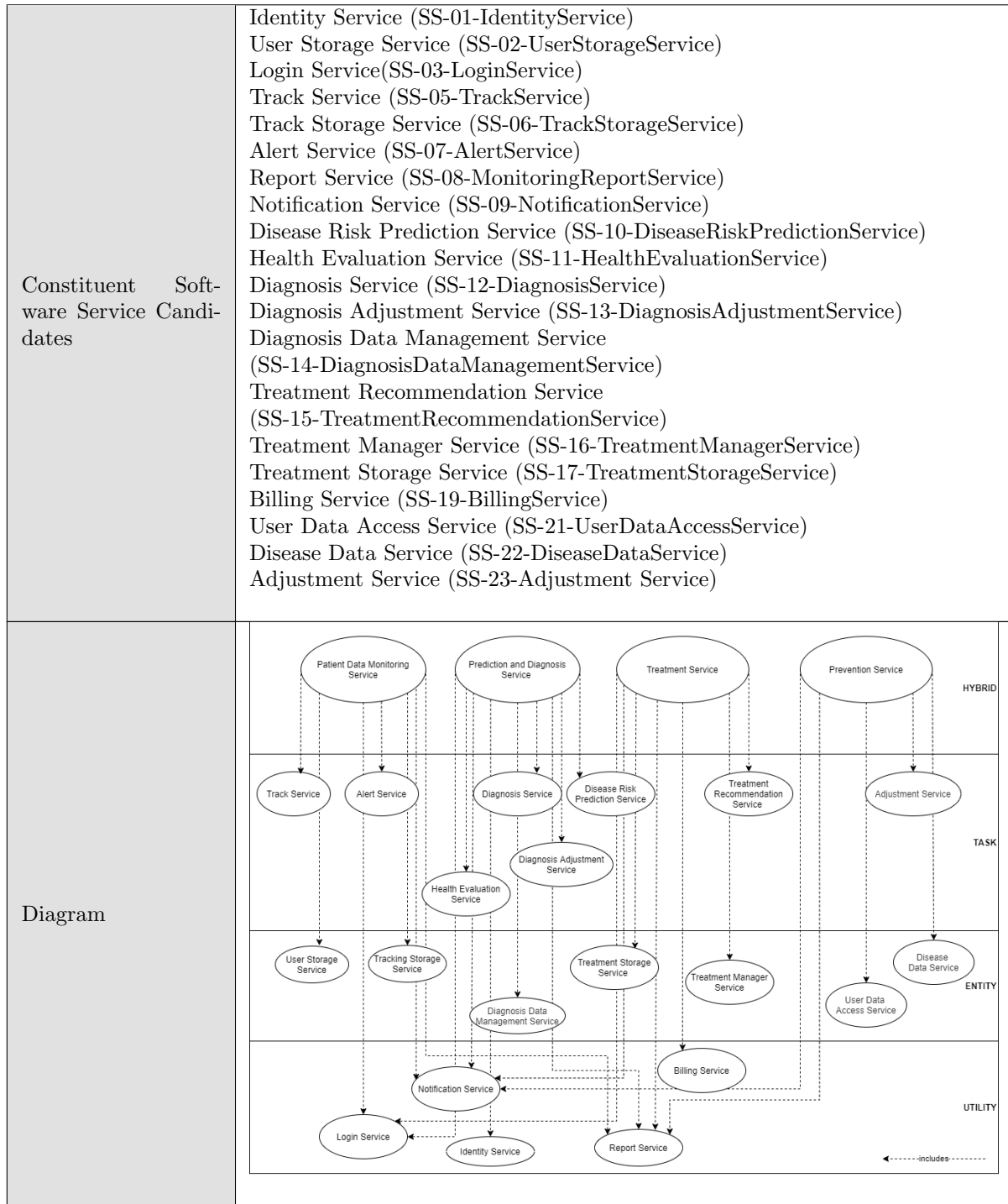
| Field | Description |
|---|---|
| ID | INV-03-ThirdPartyDeviceProvider |
| Name | Third Party Device Provider Service Inventory |
| Participant | Third Party Device Provider |
| Constituent Software Service Candidates | Device Authorization Service (SS-04-DeviceAuthorizationService) |

| | | |
|---------------------|--|---------|
| Diagram | | HYBRID |
| |  | TASK |
| | | ENTITY |
| | | UTILITY |
| Diagram Description | From the perspective of the Third Party Device Provider the Device Authorization Service is a task service since it is core to the business of this stakeholder. | |

8.4 Healthcare Service Provider

Table 14: Service Inventory of Healthcare Service Provider

| Field | Description |
|-------------|---------------------------------------|
| ID | INV-04-HealthcareServiceProvider |
| Name | Healthcare Service Provider Inventory |
| Participant | Healthcare Service Provider |



| | |
|---------------------------------------|---|
| <p>Diagram Descrip- tion</p> | <p>The inventory of the Healthcare Service Provider contains our four business services as hybrid services. Each one of these services includes other services. Alert Service, Track Service, Health Evaluation Service, Diagnosis Service, Diagnosis Adjustment Service, Disease Risk Prediction Service, Treatment Recommendation Service and Adjustment Service are task services since they are core to the business of the Healthcare Service Provider. On the other hand, User Storage Service, Tracking Storage Service, Diagnosis Data Management Service, Treatment Storage Service, Treatment Manager Service, User Data Access Service and Disease Data Service are considered as entity services since they are in charge of CRUD operations regarding entities in our services. Finally, Login Service, Identity Service, Notification Service, Report Service and Billing Service are considered as utility services due to their utility functions. They are independent of the business service and they can be reused in other business services (as seen in the diagram).</p> |
|---------------------------------------|---|

9 Service Contract Identification

The following section will identify the service contracts needed to operate our business services presented in section 4. Services contracts are identified using the service inventories presented in the previous section. Figure 5 depicts the identification process of the service contracts needed for our business services to operate. Finally, we present and describe each identified contract in detail using SoaML Service Contracts notation.

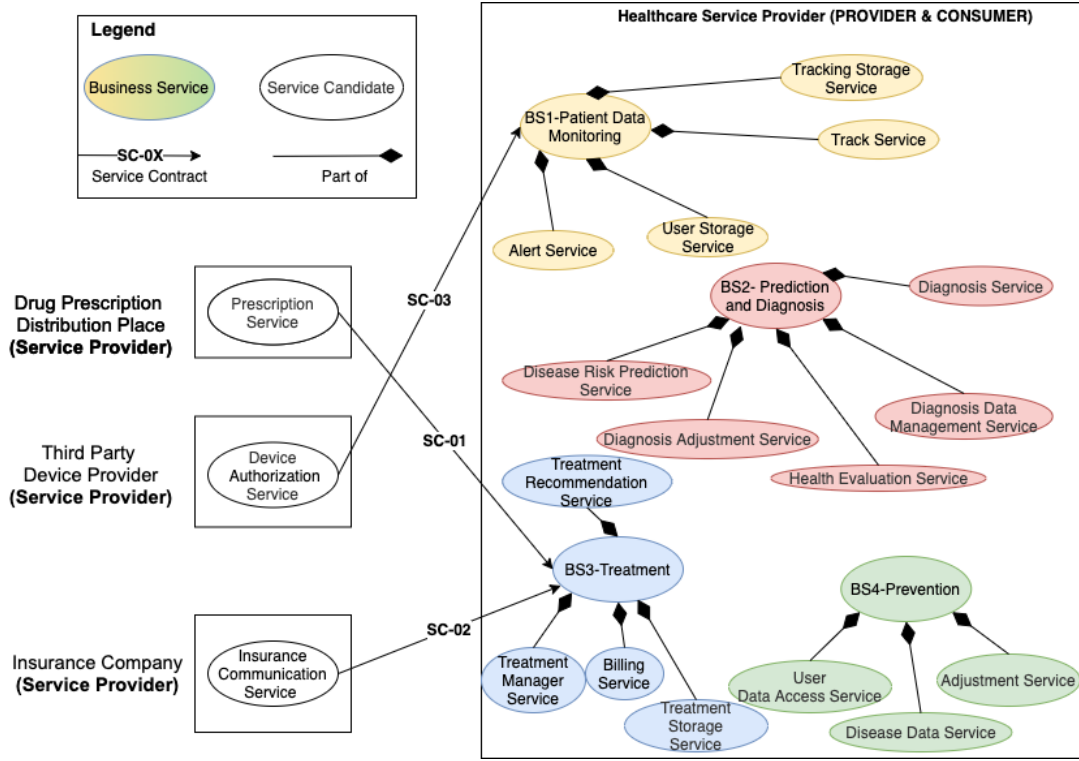


Figure 5: Service Contract Identification for our business services. We identified three service contracts.

Table 15: Overview of the Identified Service Contracts

| Field | | Description |
|-----------------------|-----------|---|
| ID | | SC-01-InsuranceCommunication |
| Name | | Insurance Communication |
| Involved Participants | | Insurance Company Healthcare Service Provider |
| Service Diagram | Structure | <pre> sequenceDiagram participant Provider as <<Provider>> Provider : Insurance Company participant Consumer as <<Consumer>> Consumer : Healthcare Service Provider Provider --> Consumer </pre> |

| Field | | Description |
|--------------------------|-------------------|---|
| ID | | SC-02-Prescription |
| Name | | Prescription |
| Involved Participants | Partici- pants | Drug Prescription Distribution Place Healthcare Service Provider |
| Service Diagram | Structure | |

| Field | | Description |
|--------------------------|-------------------|--|
| ID | | SC-03-DeviceAuthorization |
| Name | | Device Authorization |
| Involved Participants | Partici- pants | Third Party Device Provider Healthcare Service Provider |
| Service Diagram | Structure | |

10 Business Service Network

The following section will use the service contracts described in the previous section to build a business service network presented as a Service Architecture Diagram using SoaML notation.

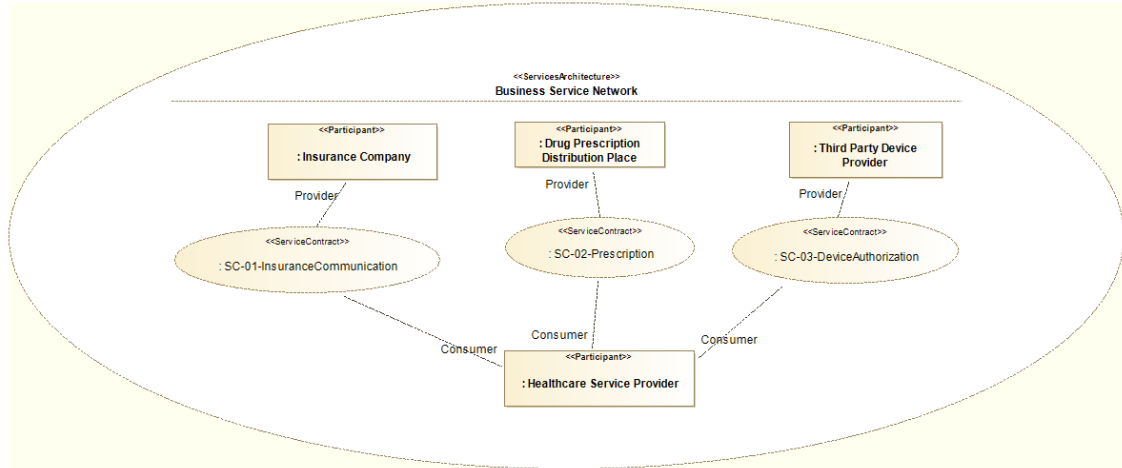


Figure 6: Business Service Network

11 Design View

In this section we describe a design view in detail illustrating the design solution of Opt#3: Contactless Tracking mapped in our Con#2: "How to reduce the patient's ecological footprint?"

| Field | Description |
|-----------------------|--|
| Viewpoint name | VP01 - Contactless Tracking |
| Viewpoint description | The goal of this viewpoint is to show how the envisaged business services help in reducing the ecological footprint of the handling of contactless Patient Data Monitoring from the perspective of the Medical Center. |
| Design concern | Con#2: How can we reduce the patient's ecological footprint? |

