Healthcare system

January 12, 2025

1 Domain Description

The focus of the domain is on the general bureaucratic structure of entities related to healthcare. The base of all action is a healthcare facility and its owner, some business entity. These are either private, or state-owned. Private entities are internationally identifiable and do not depend on a specific state. On the other hand, each state has its own state entity, the details of which depend on specifics of the underlying state structure.

We distinguish healthcare facilities into doctor offices (general practitioner, etc.) and larger composites such as hospitals, which consist of multiple departments. Each department has one doctor in a leading position and some doctor staff subordinated to the department and its head. To become the head of department, the doctor needs a minimum of 10 years of practice experience to retain some respect from his subordinates.

Every doctor must have a schedule to follow. This schedule is composed of multiple time slots of varying length to fit different types of visit for which the patients made an appointment. Visits always occur in the same location that the doctor works in. That is, the healthcare facility, not department (if they are part of one), because it can happen that the given department is full in capacity, but other parts of the facility are available.

Visits are first reserved. After the patient attends the visit, they become completed. They can also be cancelled, in which case the time slot is no longer usable. Visits can be without further specification, or of a specific kind, such as a preventive check-up, which requires at least a 30-minute time window. During a visit, multiple smaller interventions can be performed. Or, in case of an operation, the visit itself is a bigger intervention.

Doctors are paid for any intervention that occurred in addition to the completed visits of every patient. The means of payment are outside our interests.

Patients occasionally need medication with a specific effective substance to cure their disease. Some medications can only be acquired with a prescription from the doctor. However, doctors must avoid prescribing patients medications with the same effective substance as those patients actively use. Medication beyond its due date becomes unusable. Both individual customers and companies in the private sector can purchase medication.

Medicines can be bought at the pharmacy. Some medicines can only be purchased with a special prescription, which also has its own expiration date. You can only get the medicine at the pharmacy after paying for the purchase.

2 Constraints

- 1: Doctor can be the head of department only if he has more than 10 years of experience.
- 2: Business entity can be either state, or private.
- 3: The doctor cannot prescribe another medication with the same effective substance that the patient is actively using.
- 4: Preventive Check-ups are minimum 30 minutes long
- 5: Visits occur in the same place as the doctor works in.

3 OCL Expressions

```
context: Head of department
inv: Doctor.yearsOfDoctorExperience >= 10

context: Business entity
inv: oclIsTypeOf(Private entity) <>
        oclIsTypeOf(State entity)

context: Doctor::prescribe(
                    m: Medication,
                    for: Patient
                  ): Prescription
pre: not for.activelyUses.exists(
           pm: Medication |
           pm.effectiveSubstance = m.effectiveSubstance
         )

context: Preventive check-up
inv: Visit.scheduledOn.length > 30

context: Visit
inv: location = scheduledOn.from
                  .for.worksIn
```

4 OntoUML Diagram

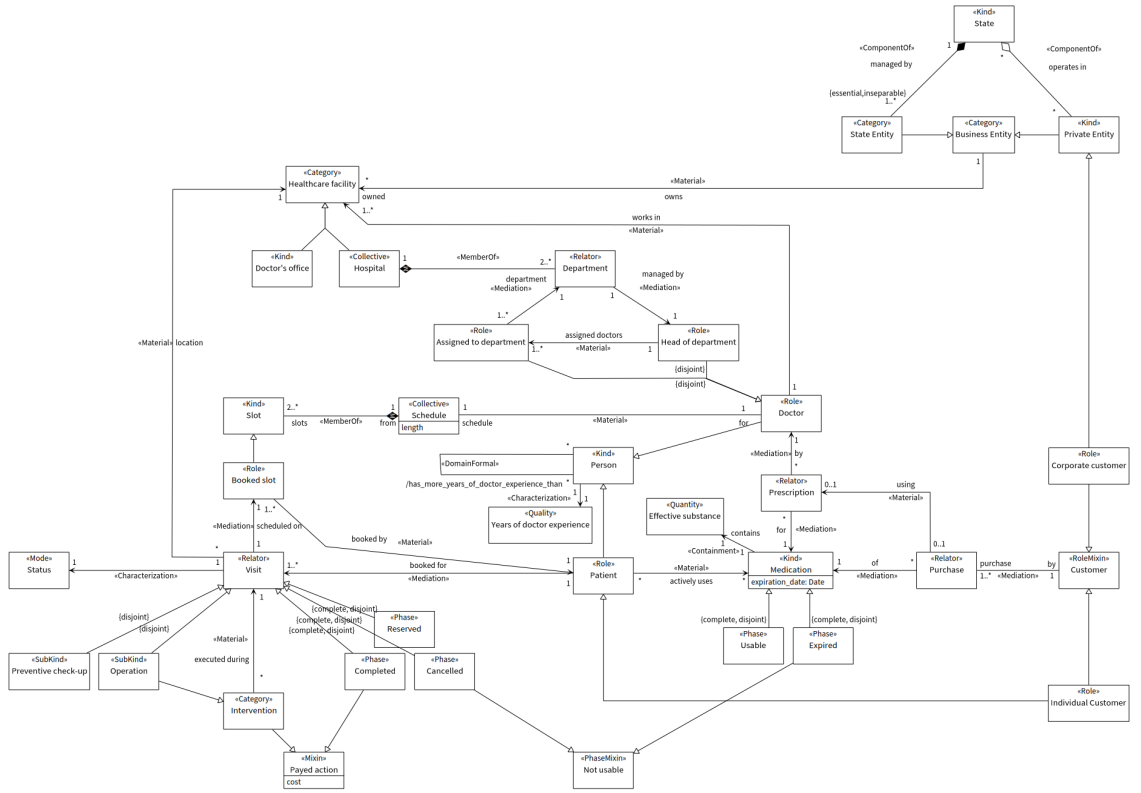

Figure 1: OntoUML diagram

4.1 Anti-Patterns

- Doctor role is bound to a Schedule collective, because his calendar cannot be just a one-time/single event - that would mean he is just stepping in for someone else.
- Intervention has only one major type specified, with other existing, but not mentioned for the sake of simplicity (vaccination, wound disinfection, blood transfusion, ...)
- Medication is not dependent on Prescription, nor Purchase, but Purchase and Prescription must be associated with some Medication and Purchase acts as the binding relation for Customer. Prescription also needs a Doctor who wrote it, but the doctor doesn't care about the Prescriptions he made (if any).
- Healthcare Facility has some uniqueness to it - mainly its location, which is being used, but in case of a public building with multiple individual Doctor's Offices inside, we can see that the location doesn't suffice for identity determination. But it does suffice for the typical Visit which is described by the location and the specific doctor that we booked the Visit with. Similarly can be argued for the place ownership by Business Entity and as the Doctors work place.
- State parts are one or the other, as described by the OCL. No State Entity can be also Private.
- Department has no mediation overlap - Doctor subroles are clearly marked as disjoint and therefore a single Doctor can never have both roles.

4.2 Construct Table

Construct	Count	List
Kind	6	Person, Medication, Slot, State, Private Entity, Doctor's Office
SubKind	2	Preventive Check-up, Operation
Role	6	Head of/Assigned to Department, Doctor/-Patient, Booked Slot, Corporate/Individual Customer
Phase	5	Reserved, Canceled, Completed, Usable, Expired
Category	4	State+Business Entity, Healthcare Facility, Intervention
RoleMixin	1	Customer
PhaseMixin	1	Not usable
Mixin	1	Payed Action
Functional Complex	2	State $\leftarrow$ Private/State Entity
Part	2	State $\rightarrow$ Private/State Entity
Quantity	1	Effective Substance
Collective	2	Schedule, Hospital
Quality	1	Years of doctor experience
Mode	1	Status
Relator	4	Department, Visit, Prescription, Purchase
Formal Relation	1	Doctor: has more years of experience than

5 UML Diagram

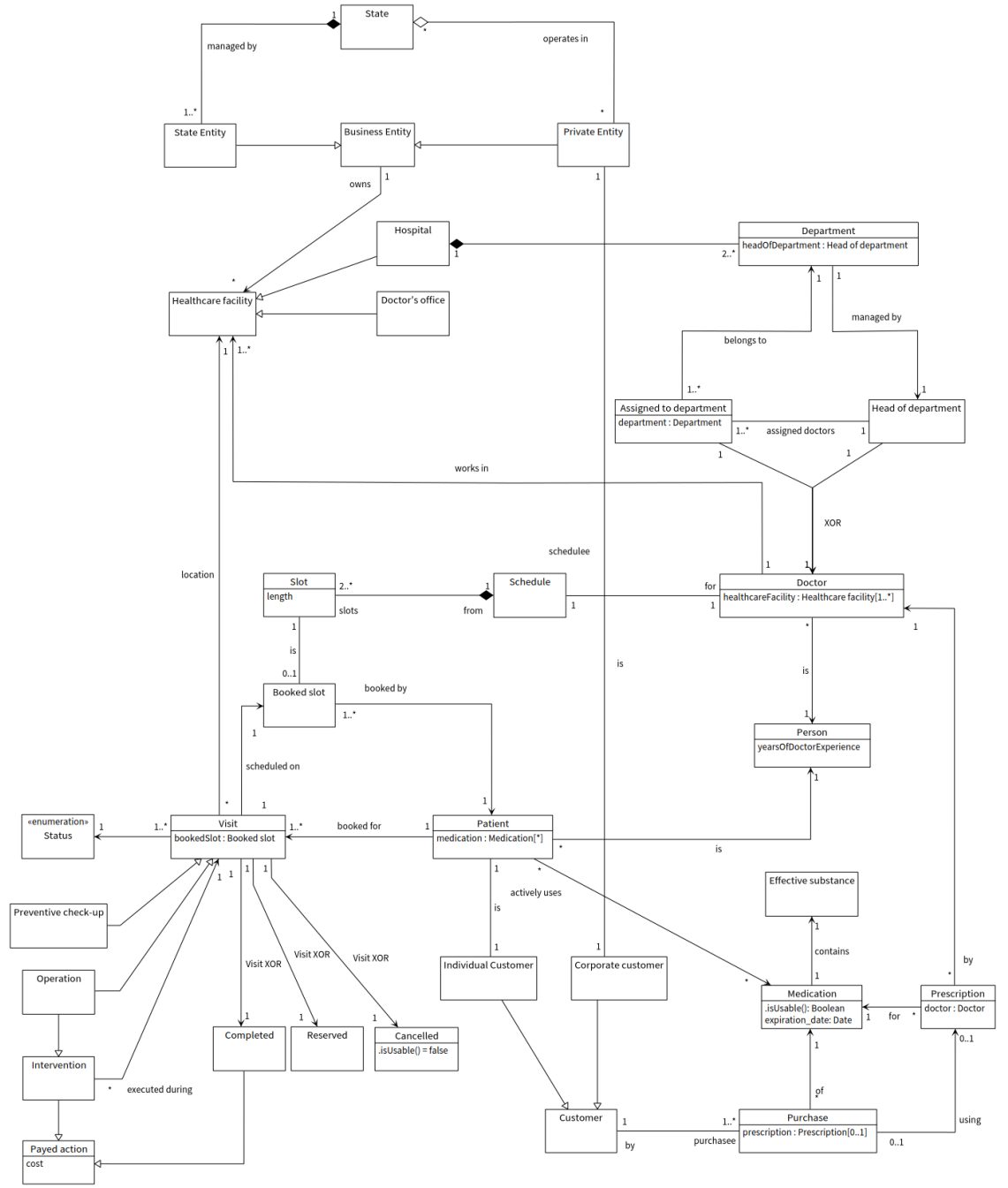

Figure 2: UML diagram

6 BPMN model

Model for the process of reserving a visit.

When reserving a time slot for a preventive check-up, there is nothing else we need to know. However, that is not the case for all other types of visit. In such cases, the doctor must contact the patient to gather the additional information he needs for the given type of visit, or just to resolve ambiguities in the original patient's description. The doctor then updates the description and confirms the slot. After a slot is confirmed (by the system automatically or by the doctor), the system sends the patient a notification of the slot confirmation.

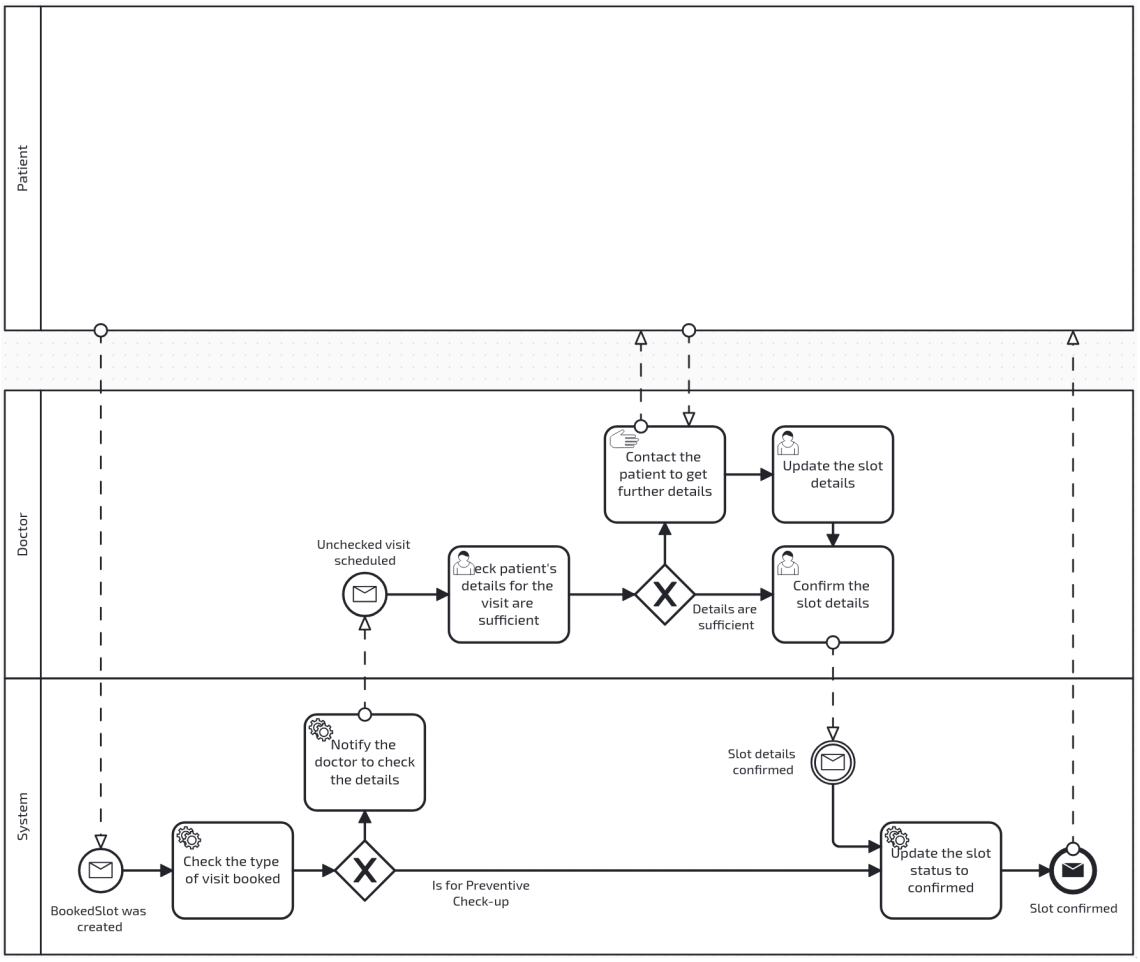

Figure 3: BPMN

7 DEMO model

7.1 Extended TPT

Table 2: Create reservation

ID (of transaction kind)	**T01**
Transaction kind	Create reservation
Product kind	Booked slot
Initiator (actor role)	Patient
Executor (actor role)	Doctor with free slots
Order Request	Patient requests a slot provided details for the visit
Order Promise	not applicable
Order Decline	Doctor wants more details about the visit (intent, patient's state)
Result Declare	The booked slot has been confirmed
Result Accept	not applicable
Result Reject	not applicable
Revoke-rq	Patient wants to reschedule or cancel the visit
Revoke-pm	not applicable
Revoke-da	The doctor realizes he's missing some crucial details about the patient's state to be able to perform an operation
Revoke-ac	not applicable

Table 3: Visit Execution

ID (of transaction kind)	**T02**
Transaction kind	Visit Execution
Product kind	Completed Visit
Initiator (actor role)	Patient
Executor (actor role)	Doctor during a visit
Order Request	Patient comes to visit
Order Promise	The doctor will inform that he is ready to accept the patient
Order Decline	Patient or Doctor did not arrive
Result Declare	Doctor considers visit completed
Result Accept	Patient is satisfied with the visit outcome
Result Reject	Patient wants a prescription for some medication or has more questions
Revoke-rq	Patient cancelled visit
Revoke-pm	not applicable
Revoke-da	not applicable
Revoke-ac	Patient found out that doctor didn't resolve his problem and wants to schedule another visit

Table 4: Patient gets prescription

ID (of transaction kind)	**T03**
Transaction kind	Patient gets prescription
Product kind	Prescription
Initiator (actor role)	Patient
Executor (actor role)	Prescription Doctor
Order Request	The patient asks the doctor for a prescription for some medication
Order Promise	The doctor agrees with that
Order Decline	Doctor refuses the request
Result Declare	Doctor gives the prescription
Result Accept	Patient gets the prescription
Result Reject	Patient wants a different medication
Revoke-rq	Patient decides not to use medication that requires a prescription
Revoke-pm	During the visit, it was discovered that the use of a certain drug is not possible for health reasons
Revoke-da	Impossible
Revoke-ac	Impossible

Table 5: Purchase of Medication

ID (of transaction kind)	**T04**
Transaction kind	Purchase of Medication
Product kind	Medication
Initiator (actor role)	Customer
Executor (actor role)	Pharmacy Employee
Order Request	The customer asks for some medication which requires prescription
Order Promise	The employee will start processing the order
Order Decline	Prescription is no longer valid
Result Declare	The employee will bring medication from the warehouse
Result Accept	Customer will pay for this medication
Result Reject	Customer rejected payment
Revoke-rq	Customer wanted something else
Revoke-pm	Medication was not in stock
Revoke-da	Impossible
Revoke-ac	Impossible

Table 6: Procedure execution

ID (of transaction kind)	**T05**
Transaction kind	Procedure (Intervention) execution
Product kind	Procedure carried out on patient
Initiator (actor role)	Patient
Executor (actor role)	Procedure specialist (Doctor)
Order Request	Patient comes for the scheduled procedure
Order Promise	Doctor prepares for the procedure
Order Decline	not applicable
Result Declare	Doctor says the procedure was carried out successfully
Result Accept	Patient doesn't notice any obvious issues
Result Reject	Patient is in a lot of pain and wants something against that before concluding the operation
Revoke-rq	not applicable - the patient already knows everything and would have canceled the schedule for the procedure if he got any concerns
Revoke-pm	Doctor has no space to perform the procedure due to an urgent patient coming in
Revoke-da	After a later check-up on the procedure results the doctor notices an imperfection that must be undone
Revoke-ac	Later after the procedure the patient starts having some issues he consideres related to the procedure

7.2 Organisation Construction Diagram (OCD)

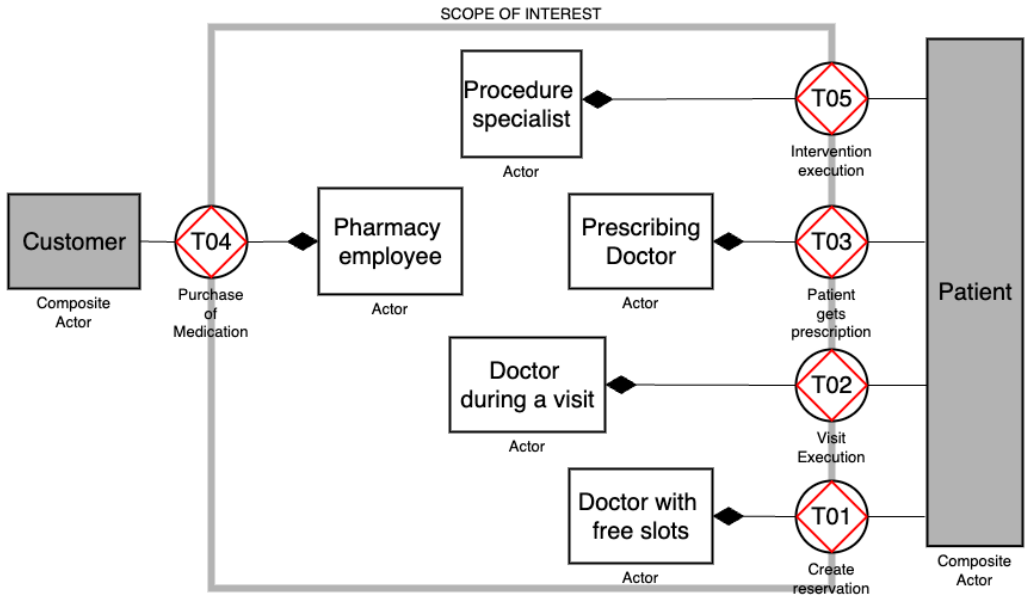

Figure 4: OCD