Software Engineering

Books or notes are **not** allowed.
Write only on these sheets. **Concise** and **readable** answers please.

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COVID contact tracing

To limit the diffusion of a virus during an epidemic it is essential to trace the contacts of people, and in case person P shows to be infected, find and treat all persons who did contact P in the previous period (say 14 days). Since most people carry a mobile phone with them, a mobile phone is probably the best way to support the tracing of contacts.

A contact tracing system (CTS) is made of two parts. One on a mobile phone (CTS_app) and one on a server (CTS backend). CTS_app should be able to recognize a contact with another person (i.e. another device with the same CTS_app installed), and store it. The recognition of a contact is made using the Bluetooth chip in the mobile phone. Using a defined protocol CTS_app-A sends at regular intervals a signal, and listens to the same signal from another CTS_app-B. When a match of two signals happen, each CTS_app estimates the distance of the other device (using an algorithm based on the Bluetooth signal power attenuation) and the duration of the contact. A contact is traced only if the duration and the distance pass certain thresholds (ex <2meters for > 15min).
The contact must record the duration, the average distance, and the ID of the other device. For privacy reasons the ID of a device must not be the IMEI of the device, nor the SIM number. The ID of the device is recomputed every day, using a seed based pseudo random number generator (given the same seed, the generator produces the same sequence of random numbers).
The seed is produced by the CTS_backend when a CTS_app is installed on a device, and sent to the CTS_app.

When the owner of a phone (call her A) becomes COVID infected, she may signal this using the CTS_app, that sends the information to the CTS_backend. In its turn the backend records the information, and broadcasts the seed associated to A to all devices / CTS_apps registered on the server.

Each CTS_app every day receives the seeds and, using the same pseudo random number generator algorithm, checks if there was a contact. In case, it notifies the owner, who is then free to contact his doctor for further analyses.

On the backend various statistical epidemiological analysis are computed (such as number of new infected per day, per area) and made available to the health authority.

In the following you should analyze and model the CTS system.

1 – a. Define the **context diagram** (including relevant interfaces)

The CTS_app and CTS_backend are part of the system (see description), so they are inside the system and should NOT appear as actors.
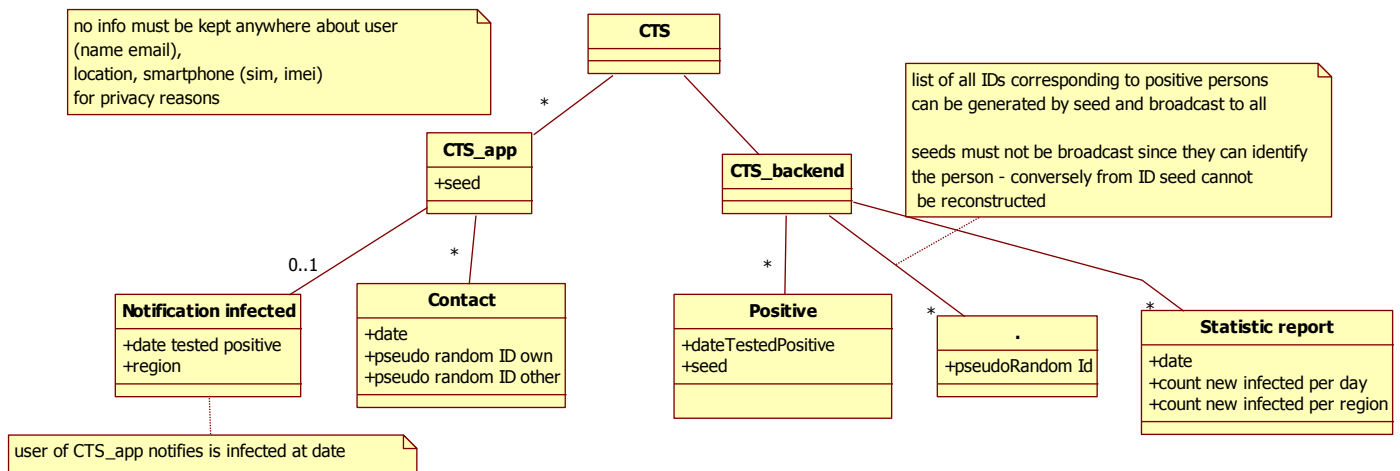Another device is an essential actor, since CTS_app is mostly about recognizing a contact with another device having the app installed. Bluetooth is a means (the physical interface) to interact with another device, and not an actor.
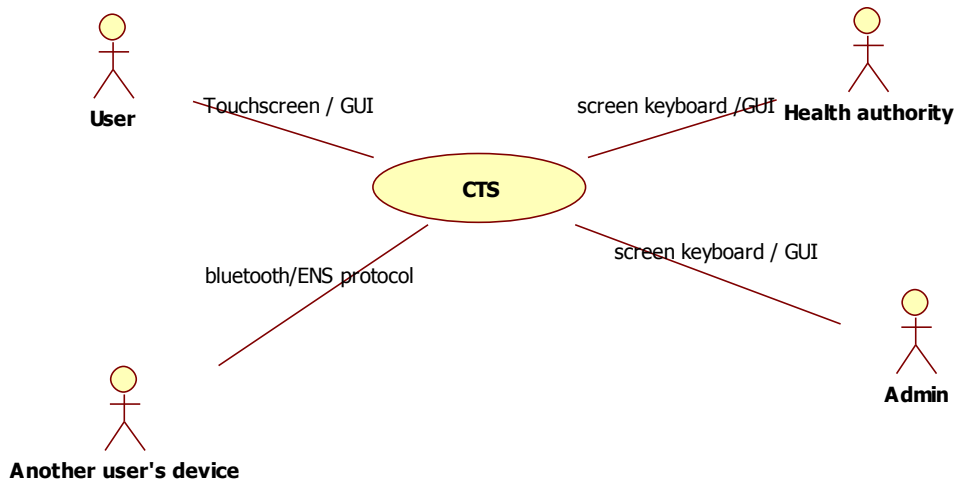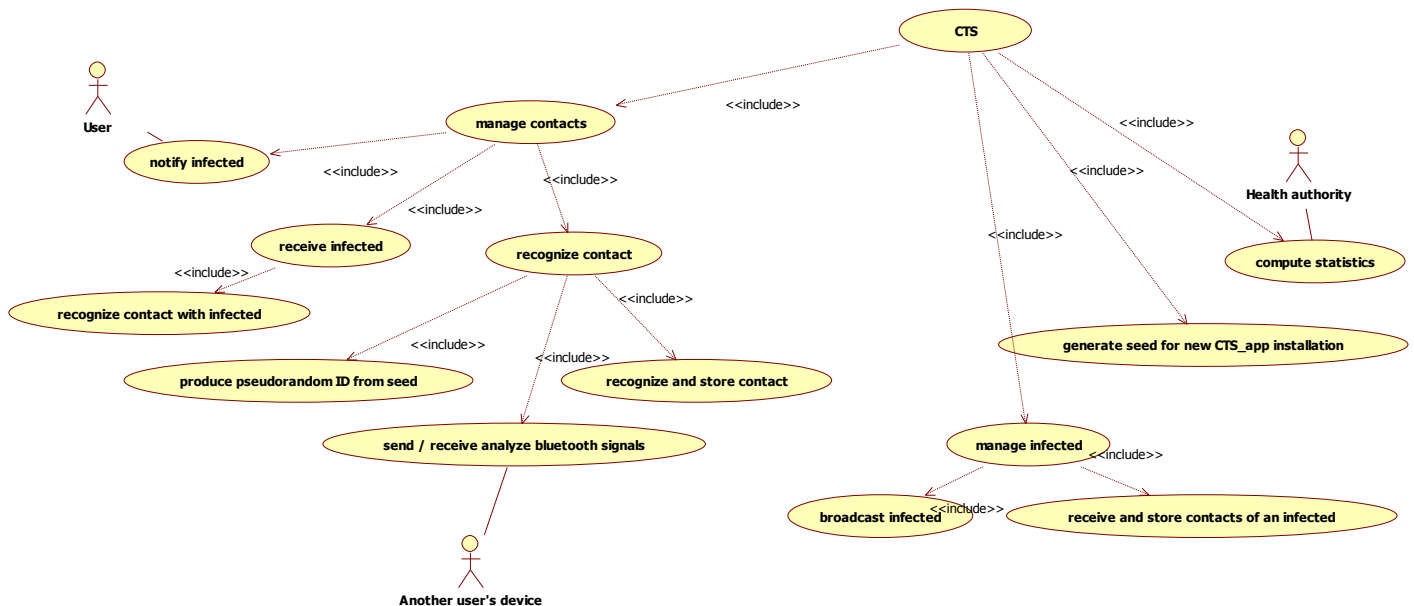

Actor	Physical interface	Logical interface
User	touchscreen	GUI
Another user's device (with CTS_app installed)	Bluetooth	Exposure notification system protocol
Health Authority	PC	GUI

1-b Define the **glossary** (key concepts and their relationships) (UML class diagram) for the CTS System

Remark that sim, imei, name, surname, location of users should NOT be saved for privacy reasons.
The seed received by CTS_backend must be stored in CTS_app. Conversely the ID associated to CTS_app changes, so Contact must store it. Instead the solution with Contact being an association class between CTS_app and another device does not work, because the ID associated with CTS_app changes.

no info must be kept anywhere about user (name email),
location, smartphone (sim, imei)
for privacy reasons

CTS

list of all IDs corresponding to positive persons can be generated by seed and broadcast to all

seeds must not be broadcast since they can identify the person - conversely from ID seed cannot be reconstructed

CTS_app
+seed

CTS_backend

Notification infected
+date tested positive
+region

Contact
+date
+pseudo random ID own
+pseudo random ID other

Positive
+dateTestedPositive
+seed

.
+pseudoRandom Id

Statistic report
+date
+count new infected per day
+count new infected per region

user of CTS_app notifies is infected at date

1-c Draw the Use Case Diagram for the CTS system. For each Use Case give self-explainable long names, or a short textual description

CTS

User

manage contacts

notify infected

receive infected

recognize contact

recognize contact with infected

produce pseudorandom ID from seed

recognize and store contact

send / receive analyze bluetooth signals

Another user's device

compute statistics

Health authority

generate seed for new CTS_app installation

manage infected

broadcast infected

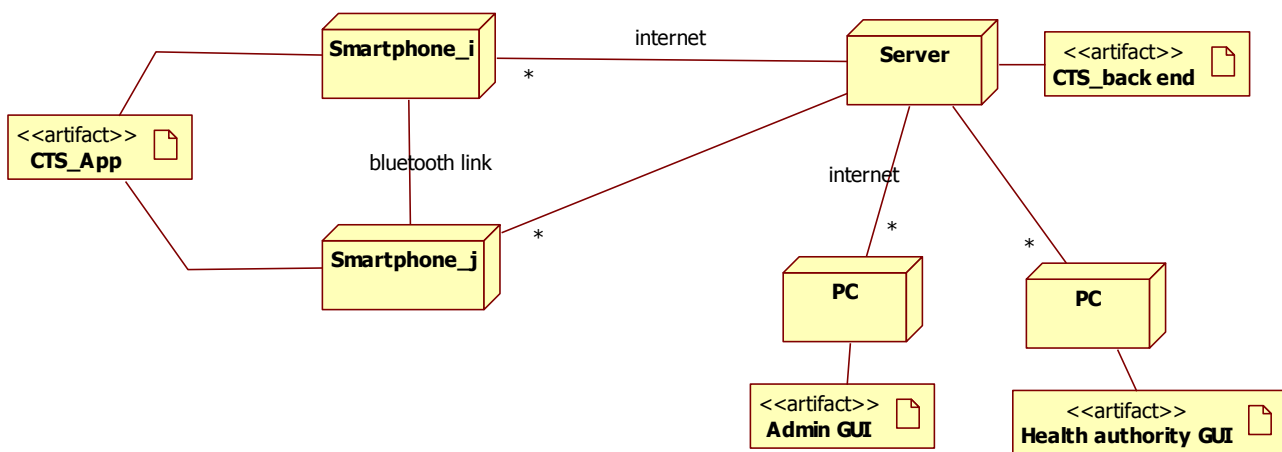receive and store contacts of an infected

<<include>>

1-d Draw the deployment diagram

3

CTS_app and CTS_backend are software components, so they should be modeled as artifacts (not as nodes)
Simplest version of the diagram:

More complete version, showing the interaction between devices via Bluetooth:

2-What is the meaning of 'exhaustive testing', and when is it feasible?

Applying all possible inputs to a function (or program) and checking all outputs are correct. Doing so guarantees correctness. It is feasible only when all possible inputs are in limited number (in practice this is very rare).

3-When a project reuses external components, how the activities of requirements and design are impacted?

Req: search and evaluate components, do gap analysis between what is required, what is offered by components
Design: integrate components in design (possibly using wrappers, adapters)

4-In a maintenance process, what are the possible types of a change?

Corrective, enhancement, evolutive