sendinel

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Developer Manual for Sendinel

Sending SMS and Phone Calls to Patients
http://www.sendinel.org

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Contents

1. Introduction

Welcome to the Development of Sendinel. On the following pages you will find useful information that should enable you to further develop Sendinel. Please note, that this manual is for developers only. When you read this, you should be familiar with Sendinel. If you do not know Sendinel yet please check the User Manual, the Installation Manual and the other resources that are provided on the Sendinel website http://www.sendinel.org.

2. Used Technology

In the following the technologies that are used in Sendinel are explained. Depending on which part of Sendinel you want to work on, you should be more or less familiar with the concerning technology. All used technologies are published under an Open Source License and can be downloaded for free from the internet.

HTML/CSS

Since the front-end of Sendinel is a web application, HTML is used to define the structure of the webpages and CSS is used to define the style of the webpages. If you want to do anything that the user is supposed to see you should be well-familiar with both.

JavaScript

JavaScript is used for logic in the user interface. Nearly everywhere where you can see forms, JavaScript is active. The JavaScript library jQuery is used to aid the development in JavaScript.

http://jquery.com/

Django/Python

Django is the web framework which holds most of the business logic of Sendinel. It also handles the database connection. The database used as default is SQLite, which needs no extra server but saves a whole SQL database in a file. Django uses Python as it's programming language. Major parts of Sendinel are implemented using Django so you should be familiar with it.

http://www.djangoproject.com/
http://www.python.org/
http://www.sqlite.org/

Asterisk

The Asterisk telephony server handles SMS and VoiceCalls. The "chan_datacard" module connects the Asterisk server to the 3G USB stick.

http://www.asterisk.org/

Java

The Bluetooth client application sends information via Bluetooth from the server via a terminal computer to a patient. It is written in Java.

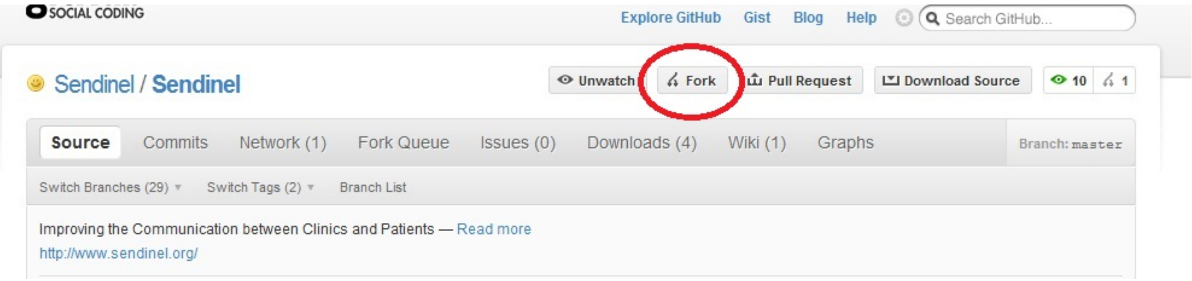
http://java.sun.com/

3. How to Get Started

3.1. Forking Sendinel on github

The best option to obtain Sendinel if you want to further develop on it would be to fork from our GitHub page http://GitHub.com/sendinel/sendinel.
First you have to have a GitHub account. If you don't have one yet, you need to click on "Login" in the upper right corner, then on "(Pricing and Signup)". Then you can choose which GitHub account you want to have. If you don't mind that all your repositories are public, having a GitHub account is for free.
If you are logged in, you can then fork Sendinel. How to do that, you can read under http://help.GitHub.com/forking/.

The fork button is there:



Improving the Communication between Clinics and Patients — Read more
http://www.sendinel.org/

Figure 1: Click on the fork button to fork from Sendinel

3.2. Tests

You now have your own forked branch of Sendinel. We developed Sendinel in a test driven way, so it is good if you know where to find the tests and how to run them. In the section "Architecture" you find an overview of our app and directory structure. Each app is having a /test directory, where the python tests for that app live in. Examples are backend/tests, groups/tests and web/tests.
If you want to run the tests, you need to have a console opened and you need to be in the Sendinel/sendinel directory. Then enter the command *python manage.py test* to run all tests. If you only want to run the tests of one of the apps, just add the corresponding appname to it, for example *python manage.py test web*.
The tests mostly use */backend/tests/backend_test.xml* as underlying fixtures. Fixtures contain initial data sets. The fixtures described in*/backend/tests/backend_test.xml* are available in the tests if they are included.

3.3. Final Adjustments

DEBUG = TRUE In order to see proper error messages when you run sendinel on a local server, you need to set the DEBUG variable to True. To do that, please open the /sendinel/settings.py file. You will find the DEBUG variable at the beginning of the document.

Starting the Development Server If you want to run sendinel on the development server, you need to open the console and switch to Sendinel/sendinel. Then enter *python manage.py runserver*

4. Overview over Sendinel

Sendinel is split into the following parts:
The *user interface* which is implemented as a web application
The *data handling* which is done by Django in a database
The *output part* where data is fetched and sent via Asterisk

The general flow of data is, that the user enters data via the user interface on a client computer, this data is processed and saved on the server and eventually sent via SMS, Voice Call (via Asterisk) or Bluetooth (via the client computer again). Information sent via Asterisk must be processed by the scheduler (to be found in /sendinel/backend/scheduler.py), which polls the database for new messages. These messages are represented as a *"Sendable"* datatype, which is an abstract class in */sendinel/backend/models.py*. There are two types of messages (represented as subclasses of Sendable): Notifications and InfoServices.

4.1. Notifications

Notifications are messages to inform or remind patients of appointment. Every notification has a type. Our system initially has the notification types "vaccination", "follow-up consultation" and "lab results". The text sent to the patient is saved as a template in the NotificationType. For example the template for the vaccination is "please remember the vaccination at the $hospital on $date". $hospital and $date are variables that get their content from the data saved in the Notification. The following variables are available:

- $hospital
- $date
- $time

These variables are replaced by the real values when a new notification is created. New variable can be introduced in the Notification method "reminder_text()".

4.2. InfoServices

Patients can be subscribed to InfoServices. Therefore an InfoMessage represents a group of patients for a specific topic. By default InfoServices are used for "arrival of medicine" notifications and group messages. Sending a message to all patient of a InfoService is done with an InfoMessage. In contrast to Notifications, an InfoMessage does not use templates but sends the text directly entered for that InfoMessage.

4.3. Use Case: Create and send a notification about the arrival of lab results

When the users fill out the form to inform a patient about the arrival of lab results and clicks on ”next”, a new Patient object is created with the newly entered phone number. Also, a Notification object is created. Because lab results are sent immediately, the date and time are set to today, 12:00 o’clock. Since notifications are always sent one day before the appointment, this message will be sent immediately.
After optional authentication, the information is saved in the database and a ScheduledEvent is created. The ScheduledEvent object is the unit that contains all information in order to send the notification.
The file /sendinel/backend/scheduler.py has the method ”run()” which searches every second for any ScheduledEvents that need to be sent. So when the ScheduledEvent object is saved in the database, it is immediately found by the scheduler method. The scheduler then calls get_data_for_sending() on the ScheduledEvent object and receives an OutputData object. There are various OutputData subclasses, one for each way_of_communication. In our case, the users could have only chosen between sms and phonecall. So let’s say an SMSOutputData object is created. This object is then handed over to the Voicecall class (Sendinel/sendinel/backend/voicecall.py) which handles the sending of the SMS via the Asterisk server.

5. Architecture

5.1. Diagrams

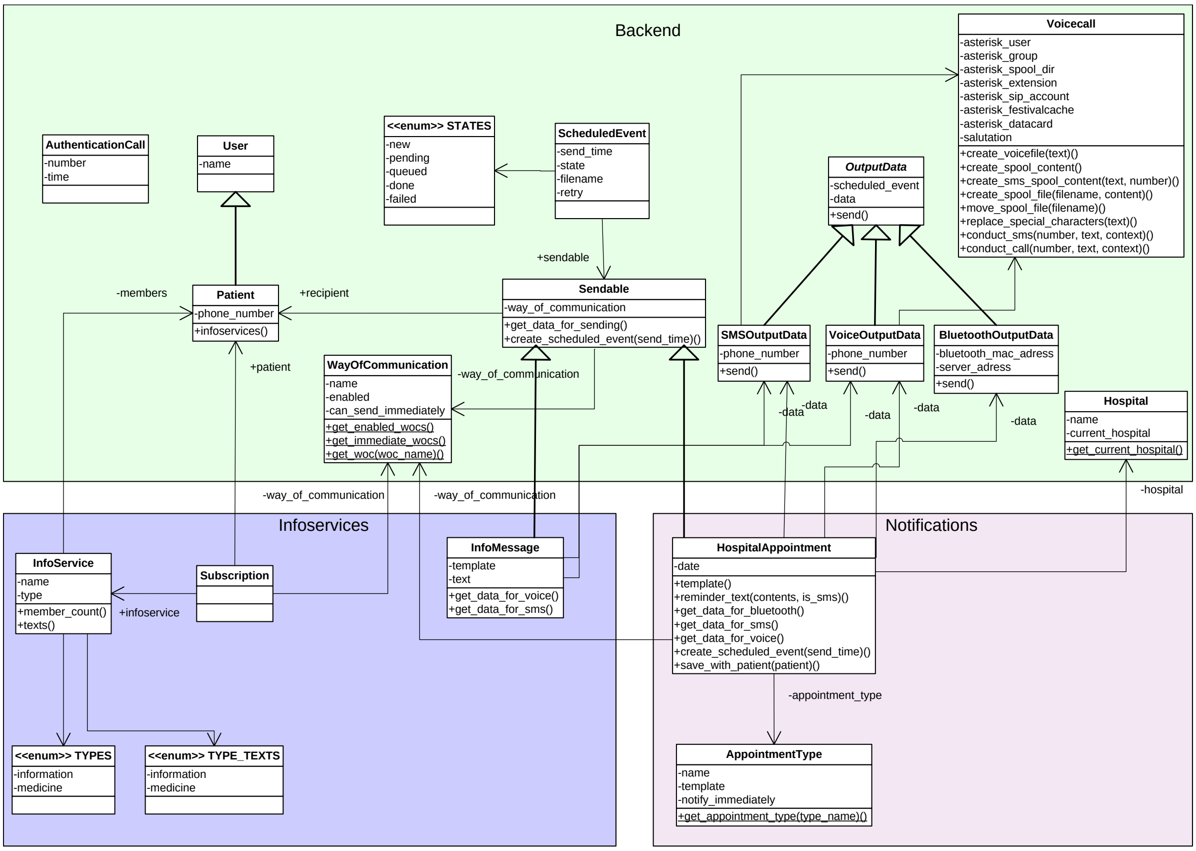


Figure 2: The Class Diagram. Bigger version in appendix A.2

The backend of Sendinel consists of three big modules:

Core

This module is in the "backend" app. It is where things come together and get dispatched again.

- An *AuthenticationCall* is saved in the database by the Asterisk server when somebody ring to authenticate themselves.
- *Patient* holds the patient-related data.
- A *Sendable* is something that can be sent. It knows how something should be sent to whom.
- A *ScheduledEvent* knows when to send what. It is connected to either an *InfoMessage* or a *Notification*

InfoServices

This module is in the "infoservices" app. This is where groups and InfoServices are managed.

- An *InfoService* represents a topic for which patients can be subscribed to.
- A Patient can be subscribed to an InfoService through a *Subscription*
- An *InfoMessage* represents a message to all members of an InfoService

Notifications

This module is in the "notifications" app.

- A *NotificationType* holds the information like template and name of Notifications
- A *Notification* has a NotificationType. The notification knows when it should be send and via Sendable also knows to whom.

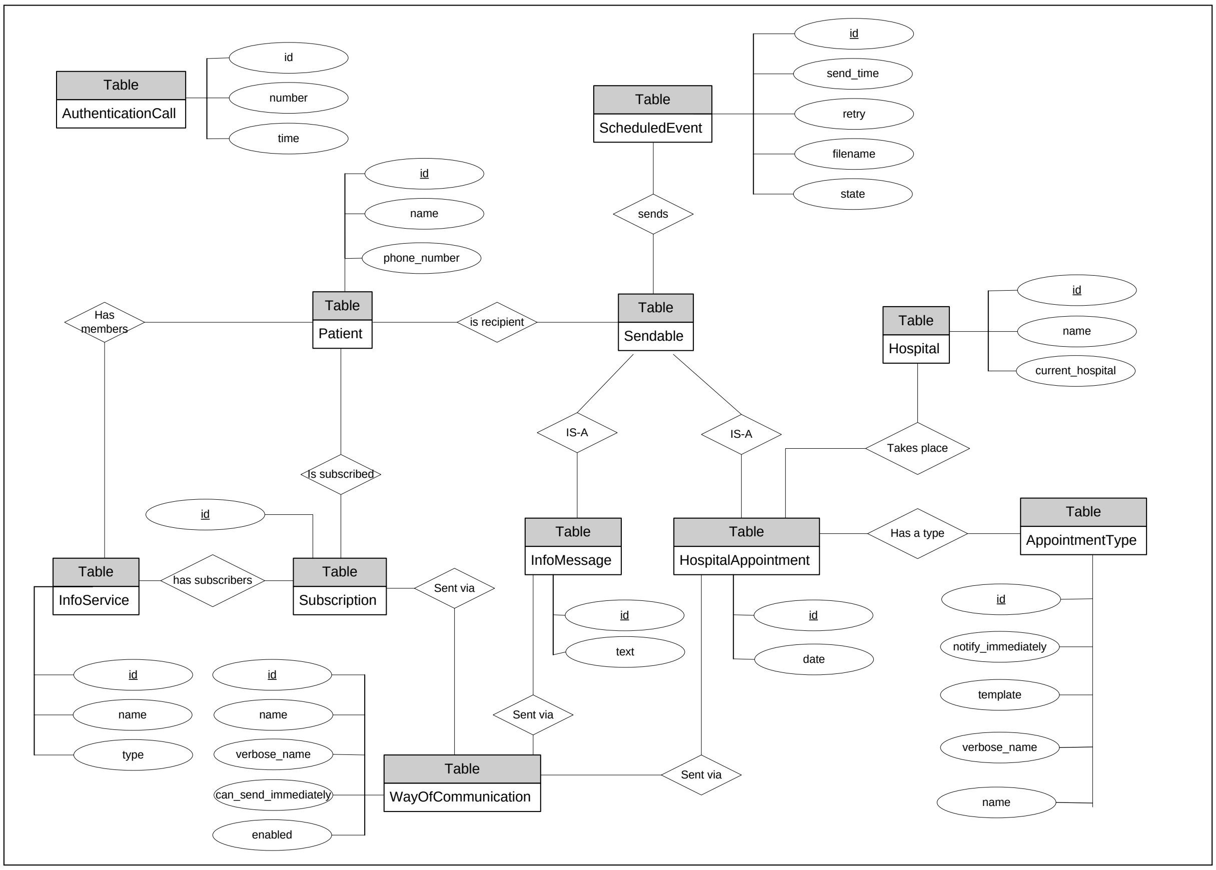


Figure 3: The Entity-Relationship Diagram. Bigger version in appendix A.1

5.2. Files and Folders

Following are the folders in the root directory:
If you have little time, the most important folder is sendinel. Its subfolders are explained in

the second table.

Folder	Description
/BluetoothServer	This Java code is the BluetoothServer running on the terminal computer. A compiled version is in /dist which you can start with java -jar BluetoothServer. You can also use the Installer on Windows computers.
/configs	This is where sample config files can be found. Sendinel relies a lot on other components at it is essential that these components are configured right, which is why we provide these sample configurations.
/hudson	During development we use Hudson as our Continuous Integration system. In this folder our configuration for is saved. If you want to use Hudson as well, these config files might give you a good starting point how to configure it. http://hudson-ci.org/
/sendinel	This is where the actual application is.

Lets dig deeper into /sendinel:

Folder	Description
/asterisk	In log_call.py is the method that is used to write incoming Authentication-Calls from Asterisk to the Database.
/backend	This app has been described in the architecture overview as "core".
/groups	Groups are regular infoservices about a certain topic.
/infoservices	Infoservices define a group of people who should be informed about the same topic.
/locale	The localisation files are here.
/media	This directory holds all files directly served by the webserver. This includes all JavaScript, CSS and image files.
/medicines	Medicines are infoservices where the patients are informed once about the arrival of the medicine they were waiting for.
/notifications	Notifications have already been described in the overview and architecture.
/templates	The Django HTML Templates are saved here. Every app is having it's own template sub-directory.
/web	This app holds everything front-end related, that does not fit in other apps.

6. Good To Know

To populate the database the fixtures from /backend/fixtures can be used. Go to the sendinel root directory and enter either *python managy.py loaddata backend* to load a minimal set of data for Sendinel to work or *python manage.py loaddata backend_test* to load a more extended set of test data.

6.1. How to translate Sendinel

Sendinel supports the translation to other languages with dedicated language files. The background is well explained in the Django documentation
http://docs.djangoproject.com/en/dev/topics/i18n/localization/

- Go to the /sendinel directory
- Enter *python manage.py makemessages -l de* where "de" is your specific language code. This creates a translation file for all html templates.
- Enter *python manage.py makemessages -d djangojs -l de* where "de" is your language code again. This create a translation file for all javascript files.
- Now go to */sendinel/locale/{your_language_code}* and edit/translate the files *django.po* and *djangojs.po*.
- When you are finished go back to /sendinel and enter *python manage.py compilemessages*
- Now you can now switch the language in your browser by going to *web/language_choose*

New code should be translated as well. This is well described in the Django documentation:
http://docs.djangoproject.com/en/dev/topics/i18n/internationalization/

7. The Asterisk telephony server

Asterisk is an open-source telephony server. It can be attached to the public telephone network to allow incoming and outbound calls. This connection can be established via a broad range of connections like Voice Over IP or ISDN. Initially Asterisk was designed for Linux, but it was ported to other operating systems as well.

7.1. How does Asterisk work?

Connections to other elements in the telephony network are called channels. A channel which allows to connect the Asterisk server to the mobile telephone network is *chan_datacard* (described later).

One of Asterisk's central elements is the dialplan configuration. It contains information about what is supposed to happen if a specific number is dialed from one of the connected telephones or if an external call arrives. Those items are called extensions and actually are small programs. Those programs are able to react to user input, control the program flow, play sound files, run external applications etc.

7.1.1. A channel for 3G data cards

To connect the Asterisk to the telephony network the channel *chan_datacard* can be used. It was designed to work with *Huawei* USB 3G data modems (at the moment mainly the model *K3520/E169*).

7.2. Sending outbound messages

The Asterisk server offers a special mechanism for invoking calls from external applications. This mechanism is called *spooling*. To spool a call, a text file with a certain syntax has to be put into the Asterisk spool directory, which is in most cases located in */var/spool/asterisk/outgoing*

One important fact to consider is that the spool file first has to be created and saved in a temporary location. Asterisk requires the file to "appear" in the spool directory in one file system operation, so a move command has to be used. If the *Archive* flag is set in the spool file, it will be copied to a special folder after the call has been conducted successfully or eventually failed. The file at this new location will contain a *Status* entry which contains information about how the call was handled. This file also contains information about each retry for conducting the call.

Creating the described spool files from a Django based web application is not very complicated because it only requires basic access to the computer's file system. The code for sending can be found in */sendinel/backend/voicecall.py*. The starting points are *conduct_call()* and *conduct_sms()*.

7.2.1. Enqueueing automated voice calls

The following steps explain how a voice call is sent from the web application:

1. the systems gets a request to conduct a call to a certain number with a given text

2. the text is passed to a text-to-speech engine and a voice file is generated

3. the spool file is created at a temporary location: the path to the voicefile and the destination phone number are entered into an already existing template
4. the user running the Asterisk server is granted full file systems permissions to the spool file
5. the spool file is moved from its temporary location to the Asterisk spool directory

After that the Asterisk server processes the file automatically:

- the specified number is called by the Asterisk telephony server
- after the called person picks up, the dialplan extension is executed
- the commands of the extension are executed step-by-step (e.g playing a salutation, playing the main text etc.)
- if the called person did not pick up, the call is re-scheduled

It is also possible to replace the execution of a dialplan extension by specifying a application to be run. The application is only executed if the callee answers the call.

7.2.2. Enqueueing SMS

The spooling mechanism of the Asterisk server was initially only created for conducting calls. Because calls are conducted synchronous, that means that e.g. content is played exactly the moment, the called person picks up the call. Short messages are sent asynchronously without the need for the callee to pick up.

To send a short message from the Asterisk server only the internal application *DatacardSendSMS()* has to be called. The problem at this point is that it is not possible to queue running an application through a spool file without somebody answering the call. This means that a separate extension has to be created, which serves as a dummy callee. It answers the call; waits for some time and hangs up again.

This means that for sending short messages a call to this dummy number is spooled. As soon, as the callee answers the call (in this case immediately, because it is our dummy callee), the dialplan extension is executed and from within it, the command for sending SMS is launched. The parameters for this call can be passed through the call spool file, using the *Set* command. Those variables are globally available.

7.3. Scheduling

If only calls but no SMS are to be spooled, the scheduling can be completely done by the Asterisk server. All spool files can be put into the spool directory at the same time and will be processed by Asterisk one after another. Sending SMS with *chan_datacard* is more problematic because as described above an indirect kind of sending is used.

Therefore the *scheduling* is done by a separate component of the Sendinel system: the *scheduler*. It checks regularly if message elements are due and ensures that only one item is active at a time in the Asterisk spool queue. This is accomplished by evaluating the status codes from the spool files that already were processed. Once a call is finished by Asterisk, the next one is scheduled by the Sendinel scheduler.

7.4. Status evaluation and error handling

As described earlier the status of a call can be read from the processed spool file. The Sendinel scheduler does this job and enters the evaluated data into the database for the corresponding *Scheduled Event*. The status in the database may be one of the following:

- *new*: The event has been created by the Sendinel scheduler, but was not processed yet
- *pending*: The Sendinel scheduler is currently processing the event, this means needed sound files are rendered and the Asterisk spool file is generated
- *queued*: The spool file was passed to the Asterisk spool directory
- *failed*: Sending the message/conducting the call failed; this may happen due to the fact that all retries failed or the Asterisk server set the status to *failed*
- *done*: The event was successfully processed by the Asterisk server

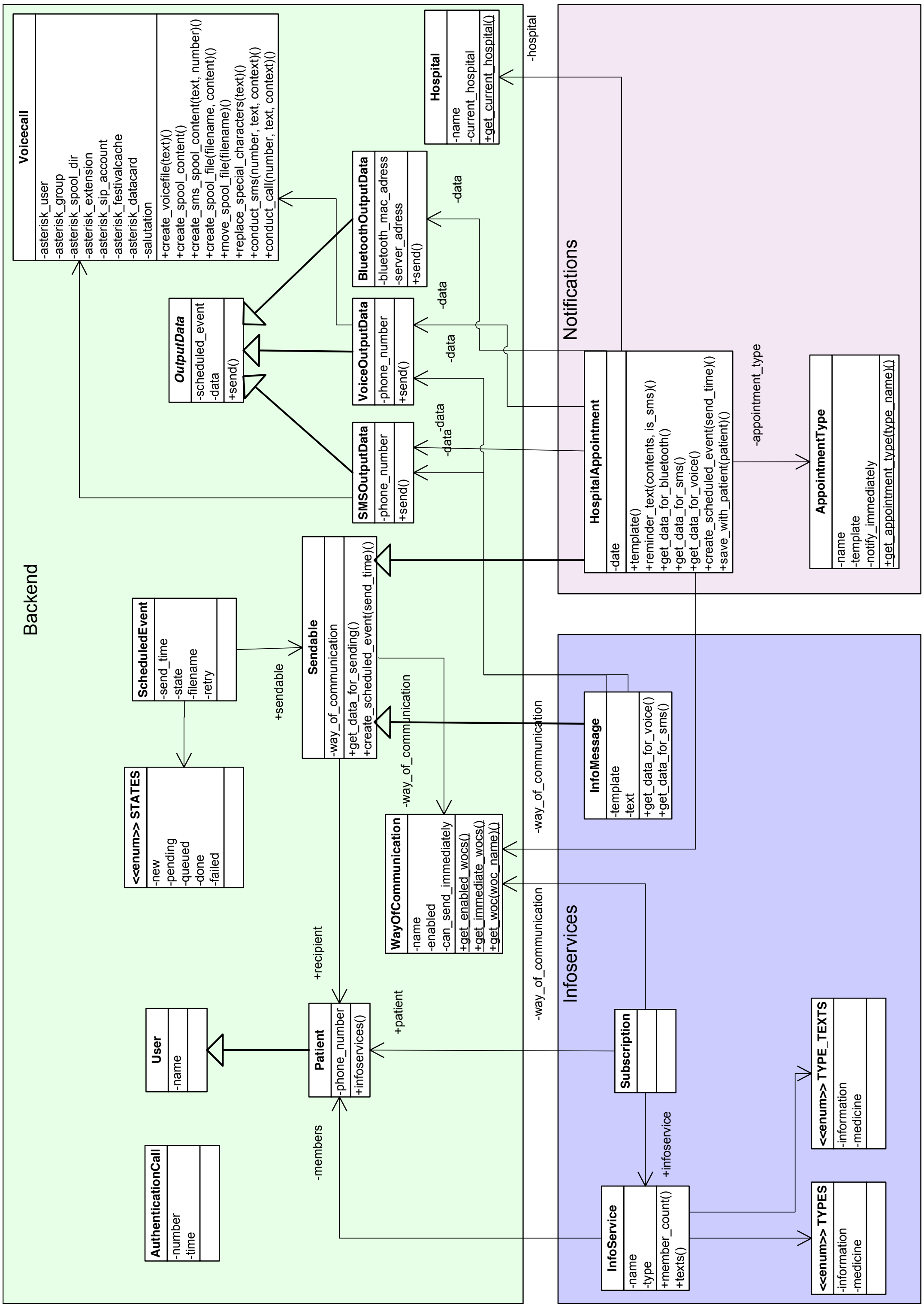
The Asterisk server can also return the status *Expired*, which is handled by the Sendinel scheduler. The event is re-scheduled as set in the configuration.

7.5. Authentication

The Sendinel authentication mechanism is based on recognising the *Caller ID* of incoming calls. When a call arrives in the *extension for incoming calls*, a special *AGI* (Asterisk Gateway Interface) script is started, which passes the data of the caller to the python script */sendinel/asterisk/call_log.py*. This script writes the data to Sendinel's database from. When the data is read by the user interface the authentication is done.

A. Diagrams

A.1. Class-Diagram



A.2. ER-Diagram

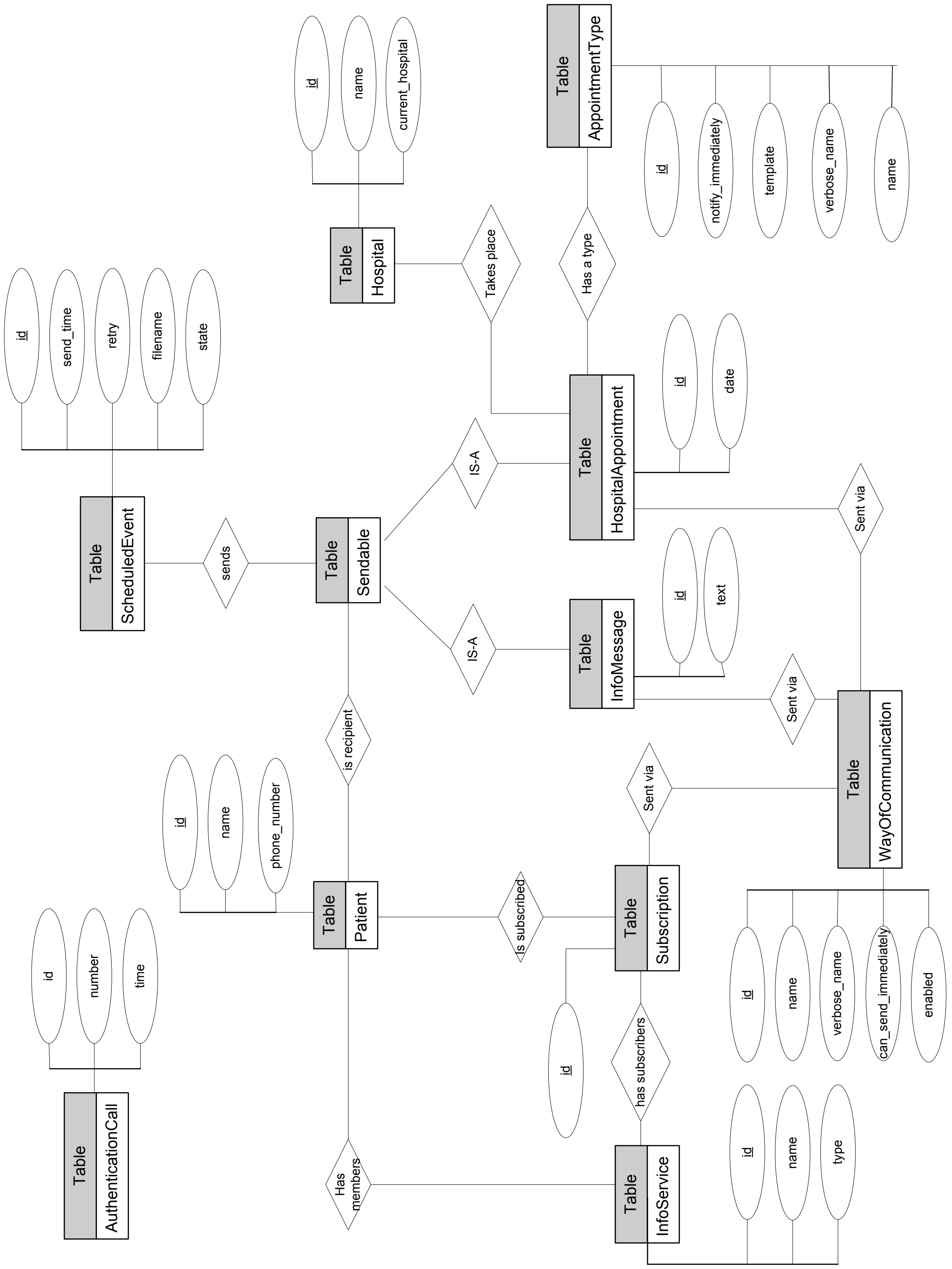


Table
ScheduledEvent
id
send_time
retry
filename
state
sends
Table
Sendable
IS-A
IS-A
Table
Hospital
id
name
current_hospital
Takes place
Table
AppointmentType
id
notify_immediately
template
verbose_name
name
Has a type
Table
HospitalAppointment
id
date
Sent via
Table
InfoMessage
id
text
Sent via
Table
WayOfCommunication
id
name
verbose_name
can_send_immediately
enabled
Sent via
is recipient
Table
Patient
id
name
phone_number
Is subscribed
Table
Subscription
id
has subscribers
Table
InfoService
id
name
type
Has members
Table
AuthenticationCall
id
number
time