Call Redirection System

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Contents

Chapter 1

Introduction

1.1 Problem

A common problem in institutions taking up medium and large buildings is redirection of incoming telephone calls to appropriate employees, especially if they are often not in their own room, at their own desk etc. What's more, any change in the organization, such as moving an employee to another room, or supplying him or her with a telephone, can change the phone number at which he or she wants to answer phone calls. There are more imaginable causes of difficulties with phone numbers. While some of them can be resolved (e.g. by assigning a secretary to this job), others do not seem to be so easy to cope with. Besides, traditional, non-automatic solutions become completely insufficient at some level of complexity.

1.2 Solution

Having a system that makes it possible to localize an employee inside a building (such as Abng system at the Institute of Computer Science at the University of Mining and Metallurgy), we can design and develop another system which can redirect automatically incoming phone calls. It is also necessary to provide the institution with a digital call exchange, which can be programmed and controlled by a computer.

It is noteworthy that this solution gives us much more that just increasing the effectiveness of call redirection. We can integrate this system with such facilities as voice mail, playing messages and easy customization of the way the digital exchange reacts to phone calls (separately for each employee).

1.3 Call Redirection System

Call Redirection System is an implementation of the solution mentioned above. Our main goal is to design and implement basic features of this system. However, we try to make it as universal as possible so that any later modifications and extensions will not be too difficult. It is planned to work at the Institute of Computer Science at the University of Mining and Metallurgy, Cracow, Poland. It will be part of the ABng system, which makes it possible to localize employees if they are inside the institute.

Chapter 2

System Functionality

2.1 Use Cases

Figure 2.1 shows how the system functions from its users' point of view.

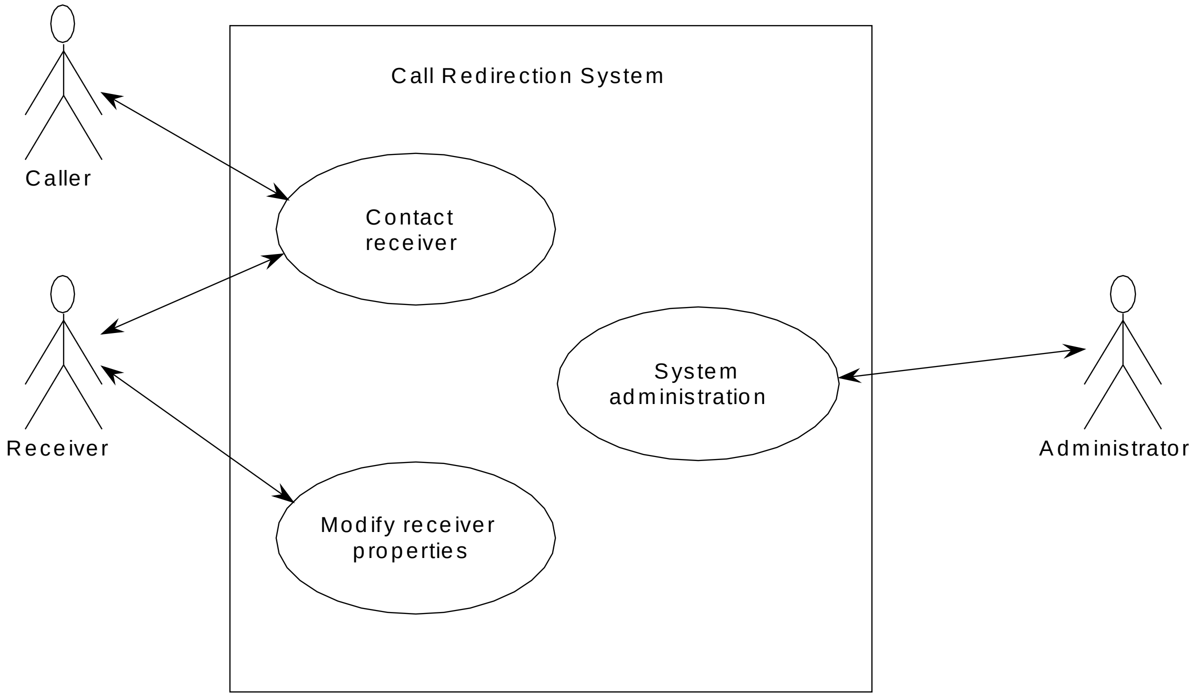

Figure 2.1: Call Redirection System - Use cases

There are three kinds of actors: **caller**, **receiver** and **administrator**. A caller is any person who wants to get in touch with one of the employees. A receiver is any employee who has a badge and thus can be localized if he or she is inside the building. An administrator is any employee whose job is to take care of the system.

A caller gets touch with the telephone exchange (by dialling the phone number of the institution) and then he or she can get in touch with the desired person. If the person is not available, he or she can listen to the message ("away message") or record voice mail. All that depends on how the system is configured by the administrator or the receiver.

A receiver is notified when a phone call comes (this can obviously be a phone ring or something less usual, e.g. a badge beep). This happens only if the system is able to localize the receiver and the receiver wants to answer phone calls. The receiver can configure the system so that it reacts in a specific way to the incoming phone calls (voice mail etc.). An administrator can configure all aspects of the system (including shutting it down and starting it up). This part has not been yet designed.

2.2 Handling the Incoming Calls

This section describes in more detail what operations are executed when a phone call comes. All this can be graphically presented in a sequence diagram (see Figure 2.2).

When somebody becomes connected with the telephone exchange, he or she hears a welcome message. Then he or she dials a number. If the number does not belong to a set of numbers handled by our system (i.e. **logical telephone numbers** of employees), the call is handled usually. If it is a logical number, the telephone exchange gets in touch with the Telephone Exchange Interface described earlier. This object upcalls CRM, which handles the call (see Chapter 4). CRM replies somehow by returning a command to the Telephone Exchange Interface, which in turn issues an appropriate command to the real exchange. Possible system replies are as in the diagram (see also Chapter 3).

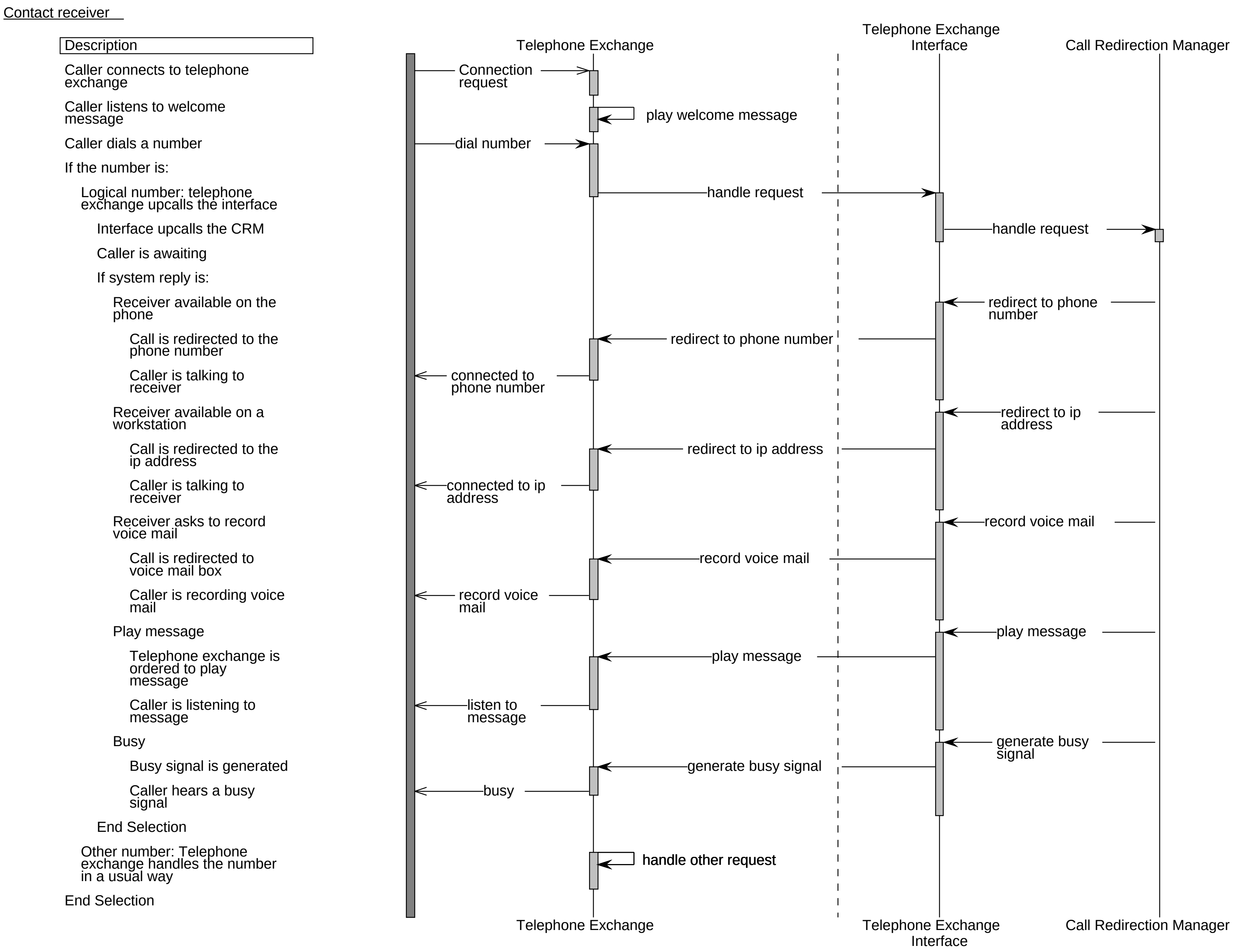

Figure 2.2: Operations executed when a phone call comes

Chapter 3

General Structure of the System

The general structure of the system is presented in Figure 3.1.

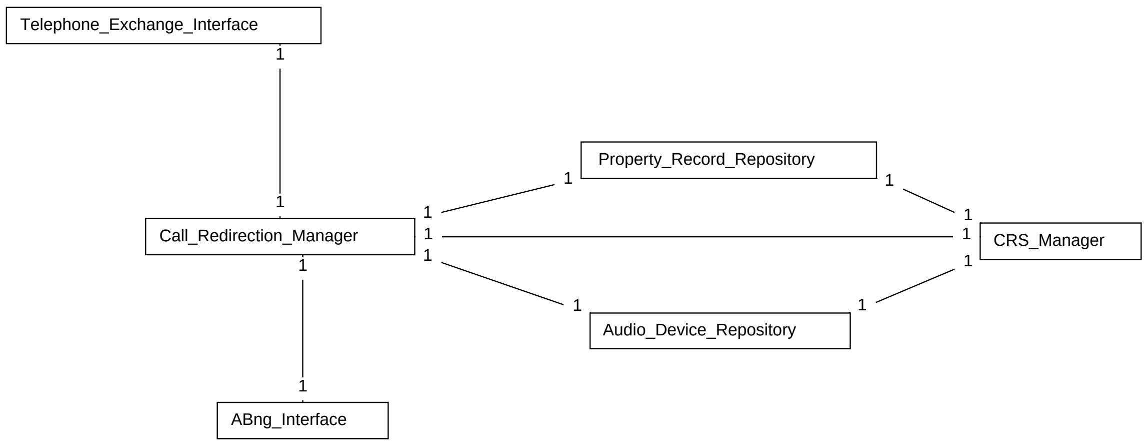

Figure 3.1: The main classes of the Call Redirection System

The core of the system is the **Call Redirection Manager** (later referred to as CRM). The instance of this class decides how to handle incoming phone calls. This is achieved by gathering needed information from various repositories available to our system and determining the desired reaction. Some details are given in Chapter 4.

The most important purpose of **Telephone Exchange Interface** is to allow us to separate the core of the system from the real telephone exchange, so that we can keep the system device-independent. The exchange notifies CRM when a phone call comes. Then CRM can return one of the commands provided by the interface:

Redirect to a phone This switches the incoming call to a telephone identified by a number.

Redirect to a computer The call is redirected to a computer (equipped with a microphone, a speaker and some dedicated software). The computer is identified by its Internet address (symbolic name or IP address). We do not plan to implement this operation now. However, our system will be ready for a future implementation of this function.

Play an away message This command orders the exchange to play a given message and disconnect.

Record voice mail The caller is asked to leave a message which is recorded.

Reply with a "busy" signal The caller hears a "busy" signal.

Property Record Repository will be described later in Chapter 5. It is now enough to say that it stores information about the user's settings controlling the behaviour of the system in case of calls coming to the given user.

Audio Device Repository is a repository that maps audio device ids onto real telephone numbers or Internet addresses of computers. We decided to use abstract audio devices instead of telephone numbers or Internet addresses because this is easier and more flexible. Each device in this repository is related to one location. This means that the device is one of "default" devices in the location, i. e. they can be used when incoming calls are redirected to the location rather than to a specific device, and the location is not the receiver's home location.

This repository is also described later.

ABng Interface is a class which will contact with ABng system. Its purpose is to contain all the code related to ABng so that any change in ABng will require modifications in this class only (with maybe minimal modifications of other classes).

Call Redirection System Manager — this class will be a kind of interface for future programs for system administrators. It will provide miscellaneous operations, not yet designed.

Chapter 4

Determining the System Reply

Let's have a look how exactly CRM determines what kind of reply should be given to an incoming calls. The Telephone Exchange Interface upcalls CRM, it calls one of its operations, *find_reply*. The algorithm is shown in Figure 4.1.

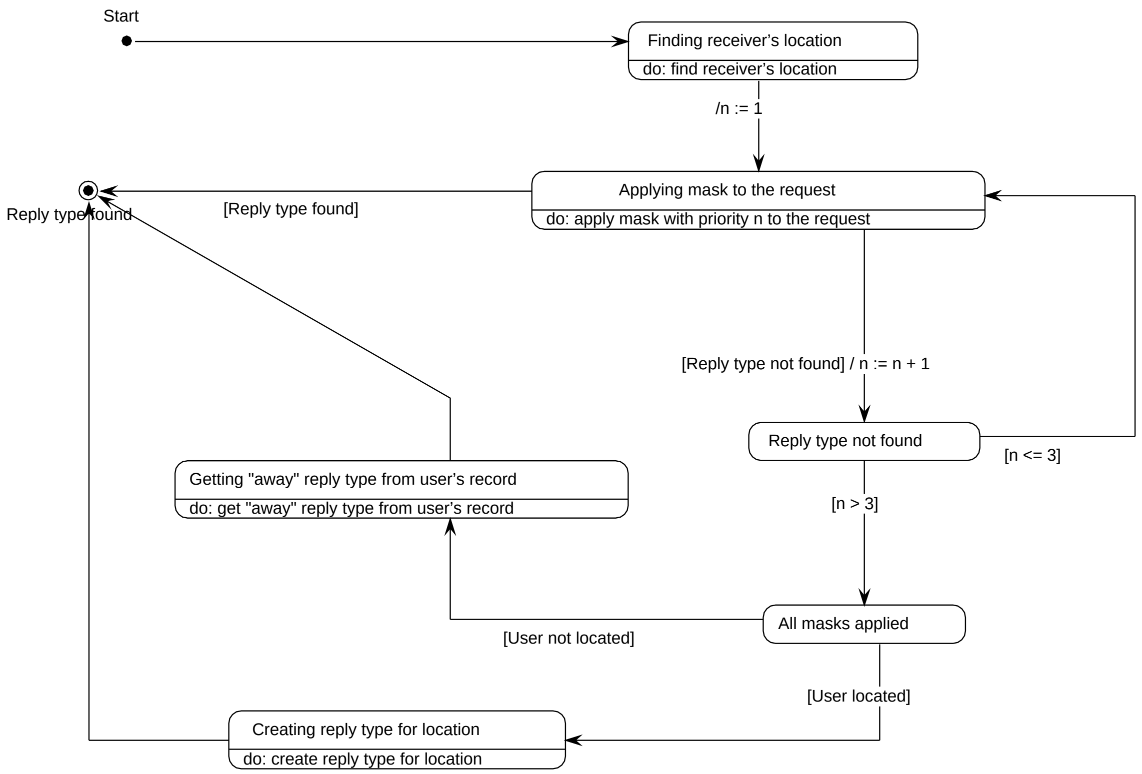

Figure 4.1: *find_reply* operation

An important thing here is to understand *masks*. A mask is an object that takes the incoming call (caller's number, receiver's location etc.) and, if it can, decides how to reply. It it cannot, the call should be processed further. This way the call may be "masked-out" at some point of the process. Masks can be very simple — e.g. just redirecting all calls to some telephone number — or quite complex. We plan to implement three different masks, which are described later.

Masks are configured for every receiver separately. They are applied to the incoming call in the order determined by priorities of the masks, which can be set in any non-ambiguous way.

CRM gets from the Telephone Exchange Interface the receiver's logical number, which identifies him or her, and possibly the caller's telephone number. This information will be used by the masks.

The first step of the algorithm is to localize the receiver. This is done by calling ABng. The location of the receiver is another piece of information taken into account by the masks. Even if the receiver cannot be localized, the process continues. Then the three masks are applied. If any of them succeeds, i.e. finds the type of reply, the process ends. If all of them fail, some default action is carried out. Namely, if the receiver has been found in a location, the reply type is to redirect the call to one of default audio devices in the location. If the receiver has not been found, the reply type is obtained from the receiver's property record, prepared especially for this case.

We emphasize that almost all behaviour of our system can be implemented with the mechanism of masks. The default actions will not be used in most cases.

In case of redirection of the call to a default audio device in some location, there is something more to do. CRM asks the audio device repository to get the number of one of default audio devices in the location.

If we finally have an audio device, we must translate it to a real computer address or phone number (or maybe something else in the future). This is achieved by querying the audio device repository.

Chapter 5

Repositories Used by Call Redirection System

5.1 Property Record Repository

This repository contains property records, one for each employee. An employee can configure the system behaviour by modifying his or her record. Figure 5.1 shows a class diagram for a property record.

As we can see, every record has three different masks.

1. **General_Mask** is a mask which works on any call, no matter what the caller's number is or where the receiver is. This mask can be used, for instance, to make the system answer to all calls "I am now very busy, please call later".

2. **Caller_Mask** is sensitive to the caller's number. An employee can use it to redirect calls from some numbers to a given phone number, for example. This mask contains a set of records, and every such record maps a caller's number onto a reply type. If the caller's numer is unknown or is not found in the set, the mask ignores the call. Otherwise, the appropriate reply type is returned.

3. **Location_Mask** is similar to the preceding one but deals with locations. LocationMask will usually contain a record mapping the employee's home location onto his or her home audio device.

5.2 Audio Device Repository

This is a repository that allows to translate abstract audio device ids to real computer addresses or telephone numbers. It is related to the Location Description Repository. (See also Chapter 3).

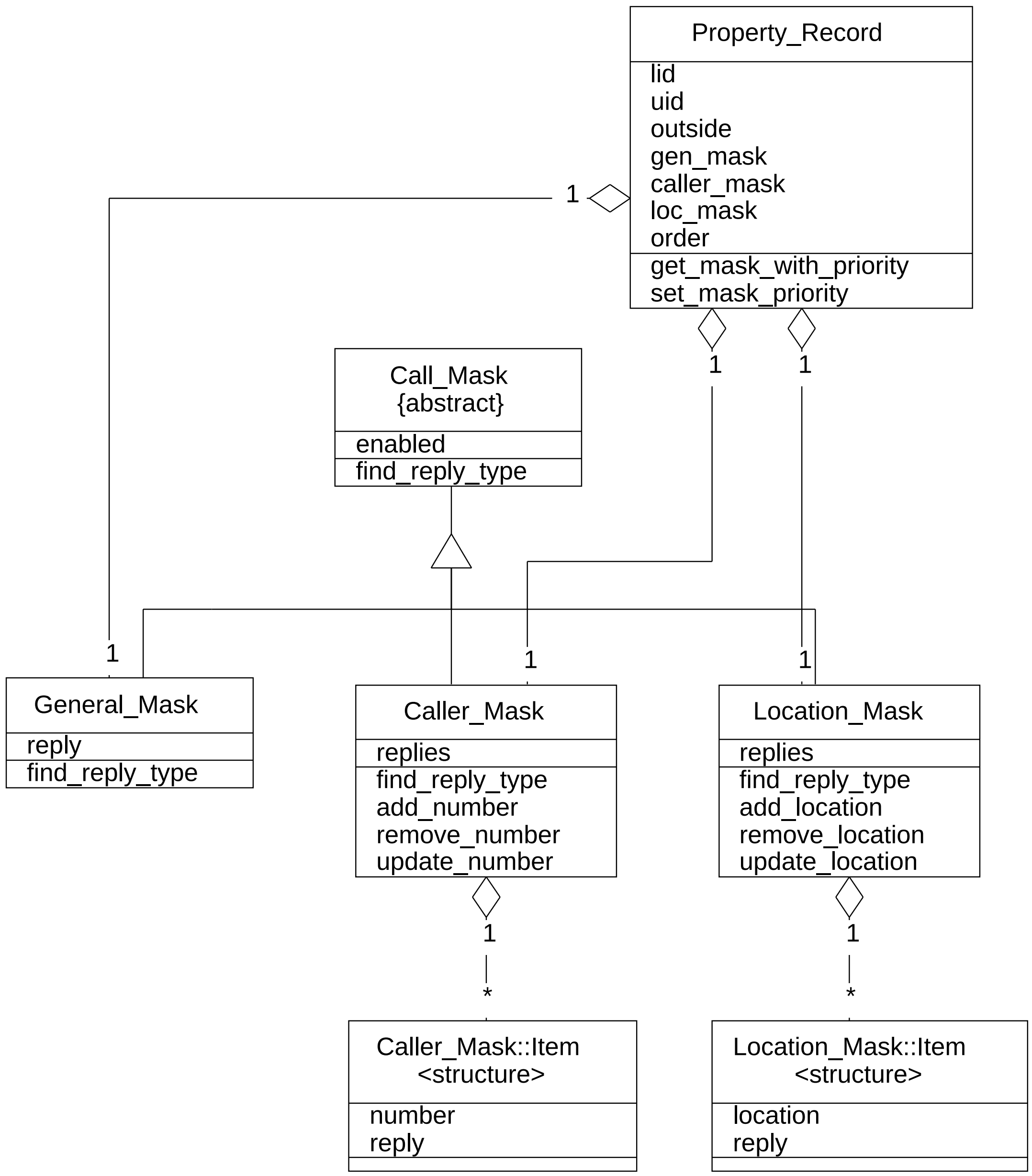

Figure 5.1: *Property_Record* class and related classes