



DEPARTAMENTO DE ENGENHARIA ELÉTRICA E ELETRÔNICA

Programação C++ para Sistemas Embarcados

Final Project: Intercom

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1 Introduction

The final project for the course C++ programming for embedded systems consists of an access control using a smartphone. Considering an electronic lock controlled by a computer running a C++ program, users can employ their smartphones to have access to a restricted area (e.g. research laboratories, classrooms, ...). All the information presented in the following sections are available at GitHub: [Intercom Hello World - Images](#).

2 Product Tree

The Intercom project's product tree is shown in figure 1:

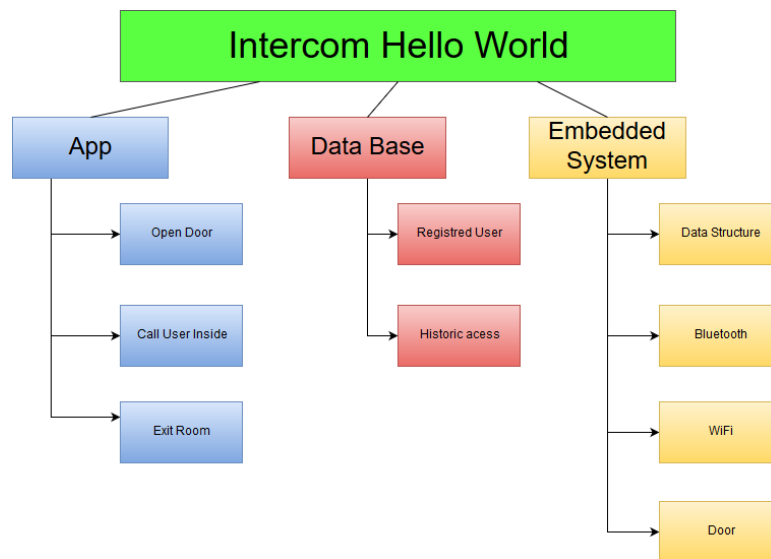


Figure 1: Product Tree

3 Work breakdown structure (WBS)

The Intercom project's WBS is shown in figure 2:

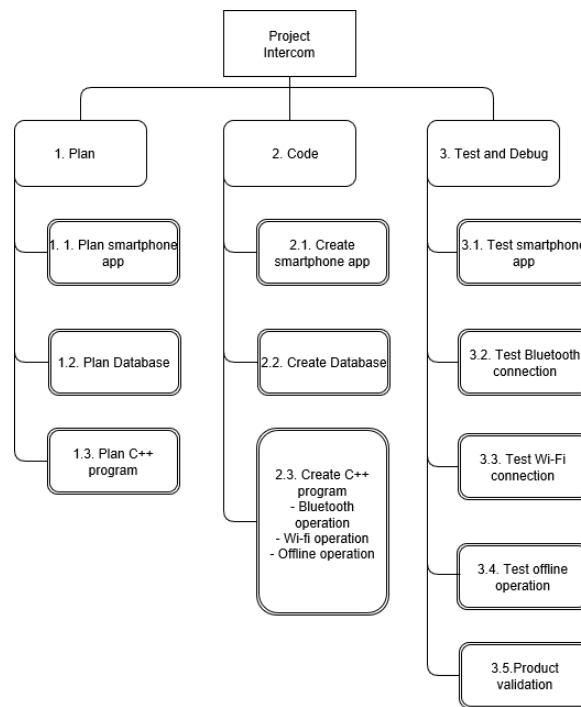


Figure 2: Work Breakdown Structure

4 Requirements

The requirements with correct mark they will be present in the system and the the requirements without mark still to be analyzed.

- Smartphone: used to unlock the door (bluetooth connection), and to call someone who is in the room (wi-fi connection).
- Computer: receives the requests from the smartphone, and takes the proper actions (e.g. unlock the door, send a list of people to the smartphone, ...).
- Electronic lock (maglock): controlled by the computer.
- Wi-fi router: used by the smartphone to have access to a webpage.

The smartphone's app may be developed in any language.

The software for the computer will be written in C++.

4.1 Smartphone functionalities

A very simple Graphical User Interface (GUI), with two buttons: "Access"; and "Intercom". A third button can be used by the user to tell the system that he/she is leaving the room. When the "Access" option is chosen:

- The app should turn the Bluetooth on (in case it was off).
- The app sends the unlock request to the computer.
- The app will receive a message from the computer describing the status of the request.
- After have received the message from the computer, the app must switch the Bluetooth back to off (in case it was off before).

When the "Intercom" option is chosen:

- The app should run the smartphone's QR code reader, in order to obtain a website link (or allow the user to type a website link).
- The app will send a request to the computer, in order to receive the list of names and contact information of everyone who is in the room.

When the "Exit" option (the third button) is chosen:

- A request is sent from the app to the computer, telling that the user is leaving the room.

4.2 Computer functionalities

- Must present a registration system, written in C++, to allow the administrator to add, to remove, and to make modifications in the list of people allowed to enter the room.
- The list must have:
 - The user's ID.
 - The user's Name.
 - The user's contact data (e.g. Phone number)
 - The user's allowed period (date / time).

✓ Correct.
- The registration system should use a data structure (e.g. linked list, ...) to manage the users that are in the room.

✓ Correct.
- There must be also a file to keep all the users data saved. This file can be as simple as discussed in the classes, or it could be a SQL database, accessed through C++.

✓ At first a file but can be changed.
- Must present a module, written in C++, to provide reports regarding the users (e.g. list of users in the room between two dates/times, ...).

✓ Correct.
- Must present a bluetooth module, written in C++, to establish a connection with the smartphone, in order to receive the requests, and to send the status messages.

✓ Correct.
- Must present a module, written in C++, to manage the smartphone requests (e.g. access request, intercom, user leaving the room, ...).

✓ Correct.
- Must present a module, written in C++, to access the electronic lock. The interface between the electronic lock, and the computer, should be defined by the developer.

✓ The access to the electronic lock will be through one of the GPIO ports of Raspberry.
- Must present a module, written in C++, to answer the smartphone requests received through wi-fi. Basically, this module will send to the smartphone a list of people who is in the room, and their contact data. The protocol to be used over wi-fi can be defined by the developer. For instance, the computer may run a web server, and provide a website with the list of people in the room.

- ✓ Use a Apache Server.

The system must be designed for on-line and off-line operation modes. This means that the smartphone should be able to unlock the door, even with no Internet connection (using the Bluetooth interface). The intercom functionality also should work with no Internet connection, through the local network available in the room.

5 Detailed schedule

The Intercom project's schedule is shown in figure 3:

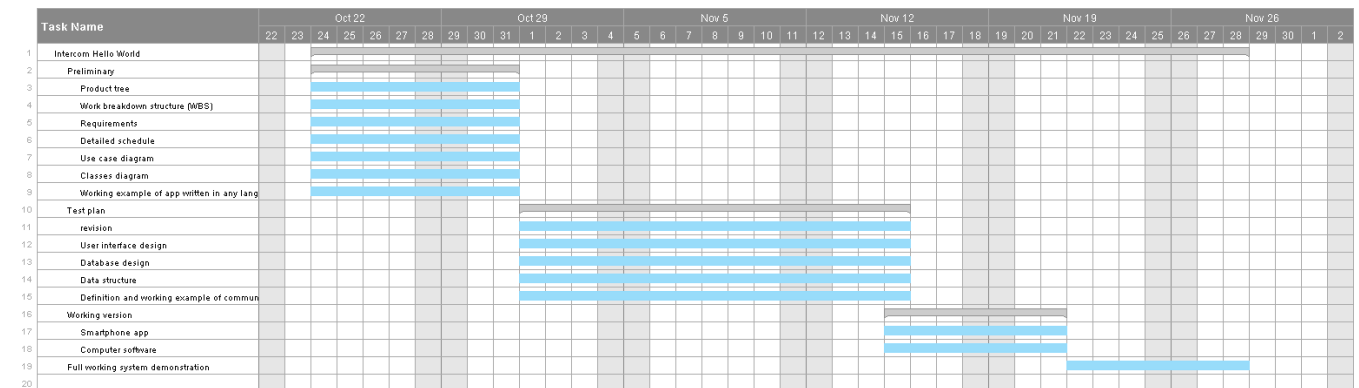


Figure 3: Detailed Schedule

6 Use case diagram

The Intercom project's use case diagram is shown in figure 4:

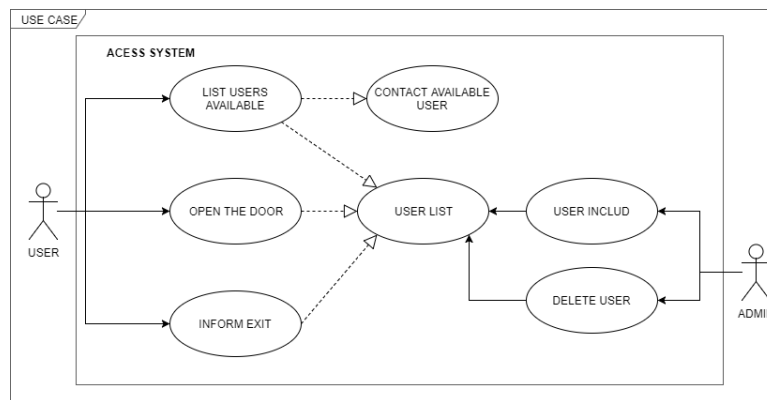


Figure 4: Use Case Diagram

7 Classes diagram

The Intercom project's classes diagram is shown in figure 5:

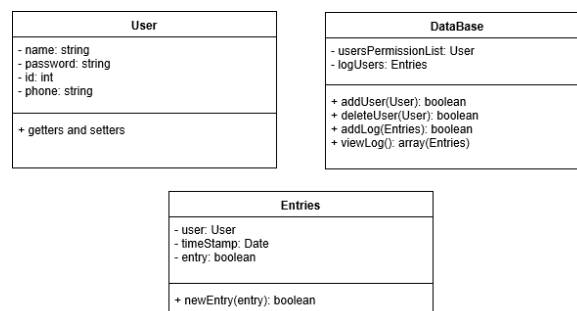


Figure 5: Classes Diagram

8 Sequence diagram

The Intercom project's sequence diagram is shown in figure 6:

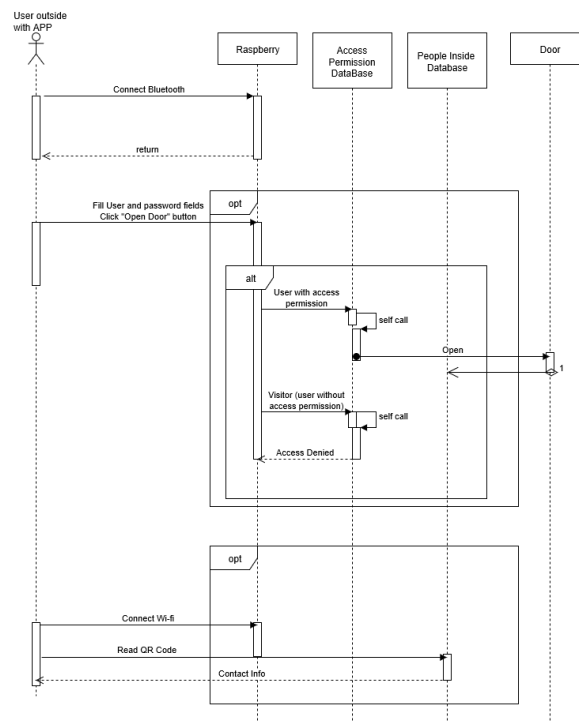


Figure 6: Sequence Diagram

9 User Manual

Welcome and congratulations for acquiring the Hello World Intercom System! This user manual will help you setting up your new intercom system to put it to use. First of all, let's clarify what this system was design to do.

This system consists of an access control using a smartphone. Considering an electronic lock controlled by a computer running a C++ program, users can employ their smartphones to have access to a restricted area (e.g. research laboratories, classrooms, ...).

9.1 Getting started

- Employee

1. Access the local server from your research or work facility and register your username and password in the database.
2. Download the android app (Sorry, iPhone users!). [Figure 7]
3. Pair bluetooth with Raspberry Pi.

- Visitor

1. Download the android app. [Figure 7]
2. Pair bluetooth with Raspberry Pi.

9.1.1 How to Use

- Registered User (Employee):

- Open android app
- Connect bluetooth

- Fill in username and password
- Click "Open door".
- Unregistered User (Visitor):
 - Open android app
 - Connect to local wi-fi host (information in app)
 - Click "Read QRCode" and scan the code by the door.
 - You will be redirected to a webpage with a list of the available employees inside and their contact information.
 - Call one of the available employees to enter (charges may be applied depending on your cellphone service) or use Whatsapp.

For additional information, please visit our GitHub page: [Hello World Intercom System](#).



Rede: abc

Senha: 123

Figure 7: Android App

10 Test Plan Execution

1. Before beginning the tests, we need to make sure all equipments are turned on. These equipments include a smathphone, the Raspberry PI, the router and the computer running the local server.
2. Test of bluetooth connection through the smartphone app: first of all, enable the smartphone bluetooth of two devices, then open app in one devide and "click on "connect bluetooth" button, select the other device which you just enabled bluetooth. If it connects, the bluetooth app operation works. Next time it must work connecting with Raspberry.
3. Test QRCode read through the smartphone app: first of all, make sure your phone has a QRCode reader, if not, you must install one. After that, open the app then click the "QRCode" button. It should open the QRCode reader of your smartphone.
4. Test QRCode: first of all, make sure the smarttphone is connected to a wi-fi network, then scan the QRCode generated and see if it loads the desired webpage.
5. Test Database: run executable on local server and wait for raspberry pi response. Try to add users in the database and check if the informations were successfully saved into the database.
6. Test Raspberry analog output for access granted or denied: run program that switches the output from high to low and vice-versa. The test can be verified by connecting a LED to the output and observe if it lights up.
7. Test entries database: input a valid user and password and click "open door". Then read QRCode and check if a list with the valid user is available.
8. Test overall system: Connect everything and performe the following:
 - Input a valid user and password and click "open door", then check if LED blinks (or door opens).
 - Input an invalid user and password and click "open door", then check if LED stays "quiet" (or door doesn't open) and if you receive the message "Access Denied! Read QRCode"
 - Connect to local wi-fi network using the available info in the app, click QRCode button, read the QRCode which is next to the door and check if it loads the webpage with a list of autorized people inside. This list should contain the name and contact information of the valid user (first item).

11 Performance Analysis

We weren't able to complete the performance analysis due to the reasons presented in section 13.

12 Source code

The source code is available at GitHub: [Intercom Hello World](#).

13 Reasons that lead to project incompleteness

According to planned, every member dedicated the 10 work hours per week. This amount of time was established to accommodate the other university obligations and internships.

Table 1: Worked hours throughout project

Team Members	Planned	Total hours
Bruno	40 H	50 H (10 H extra)
Cristina	40 H	45 H (5 H extra)
Erich	40 H	45 H (5 H extra)
Guilherme	40 H	45 H (5 H extra)

Due to the complexity of the project, poor planning and lack of experience using Raspberry Pi and bluetooth libraries with C++ programming we were not able to integrate all functionalities.

We were able, however, to complete some of the proposed requirements separately. Such as:

- ✓ Android app
- ✓ Functioning database with MySQL
- ✓ QRCode wireless connection and website redirection
- ✓ Local server using Apache 2.0
- ✓ Configuring Raspberry Pi as bluetooth device and server
- ✓ Working Raspberry analog output for access granted or denied