King Fahd University of Petroleum and Minerals

College of Computer Sciences and Engineering (CCSE)

Computer Engineering Department (COE)

COE 444: Internetwork Design and Management

Project Report

A simulation of COVID-19 notification system (Tabaud app)

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Abstract

Tabaud app is a smart phone application developed by Google and Apple the two technology giants as an emergency response for the world pandemic that known as COVID-19. In this project, I have simulated the application using packet tracer simulation tool and I have focused mainly on the networking aspects of the application. As for reaching the internet I implemented two methods to do so, the first one is by accessing the internet through a home gate router that is connected to the ISP. And the second one is through the cellular tower. So, the user of the APP can send and receive data to and from the database using the two methods. Tabaud app depends on the new Bluetooth protocol (BLE5) for exchanging beacons data between APP users. For reducing the traffic congestion, an ACL was implemented at the ISP router to allow only the email protocols because in this project email is used for notification.

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I. Introduction

After few months from the pandemic, researchers, inventors and technological solutions started to solve the world crisis that started at the end of the year 2019 in china. Apple and Google have collaborated to come up with a solution that reduce the risk for people especially those who must come to work such as medical staff and security workers. The danger of the pandemic increases in social dense places. Apple's and Google's solution was meant to help in social distancing. The app works as following, first when you open the app you need to allow access to Bluetooth to be used in broadcasting beacons, a technology exists in Bluetooth version 5 (BLE5) and also to scan others' beacons. The exchange of the beacons should be within a certain range was not mentioned clearly, however, for my project I made it 2 meter to comply with MOH in Saudi Arabia. After exchanging beacons, a secret key is updated periodically, however, in my project I used email instead. The data is stored in each user's database. If someone is tested positive, the testing authority, the ministry of health (MOH), will update its database to include this person. The final step was designed to be optional to the app user which is to claim that you have tested positive. When the user clicks the claim button, first his id is compared to that saved data on the MOH database and if it matches then the data posted in his database related to people who was near to them will be retrieved. Then he will send to them a warning message to notify them that he was tested positive and he was near to them with in the past 14 days.

II. Description of the problem

The problem is that people during the COVID-19 pandemic should have social distance that is more than 2 meters as suggested by the experts. And since people need each other and they have to engage for several reasons to do several activities and that can not happen in long hours quarantine that was applied in the beginning of the pandemic. So, there came the solution of Apple and Google to return the social situation to its normal as soon as possible and here goes their application.

III. Literature survey

A. Modeling the combined effect of digital exposure notification and non-pharmaceutical interventions on the COVID-19 epidemic in Washington state

This paper is addressing the impact of digital tracing systems in reducing the negative effects that happened due to the separation of COVID-19 pandemic. The paper proved that the reduction of deaths after using such systems reduced by 6% and the infection was reduced by 8%. So, the paper suggests taking these complementing solutions to the medical solutions seriously as they are affective and helpful [1].

IV. Discuss of different design approaches

My project is a simulation of an already designed and existed system, however, I have added and modified somehow in the design to be compatible with the packet tracer simulator. I will discuss in this section both the need of a chosen design approach by the original designers and the reasons and limitations that forced me to add or modified on a certain part of the original design.

A. Exchanging user data

The main design was depending on Beacons in exchanging data that is one of Bluetooth 5 (BLE5) technologies. Beacon technology was chosen due to its ability of broadcasting multiple beacons in few seconds for variety of ranges that would be helpful in a social distancing App.

My design choices: Either I exchange data using beacons or by email but I have chosen beacons.

Justification: Since beacons technology is available in packet tracer simulator and since email is not compatible to do such function, so I chose beacons technology.

Functionality: As seen in ***Figure 1,*** Beacons broadcaster must be run at the start continuously, then the beacons scanners will read the data and post it in the data base.

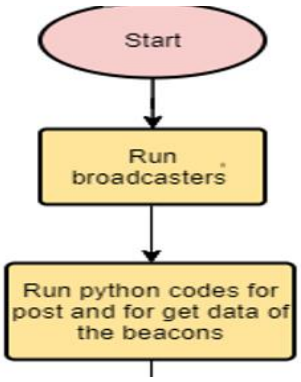

Figure 1 – Beacons flowchart

B. Database

The project depends on database for two things, for posting the beacons data and for verifying the infection claiming.

My design choices: I was hoping to find a way to utilize database within the packet tracer simulator, but I couldn't. Another available option is to use cloud-based database and I went with this option.

Justification: Since I have no experience with databases before this project, I tried to learn the fastest and easiest way to deploy a database and since the only option that works with my implementation is the cloud-based database, so I have found Google's cloud database called firebase that met the project's requirements.

Functionality: A TCP connection will start between the SBC device (client) in the packet tracer and my personal computer (server) to allow accessing Firebase database. Then as shown in ***Figure 2*** the beacons data will be posted to the database in real time, also another database is used for verification as it's MOH database.

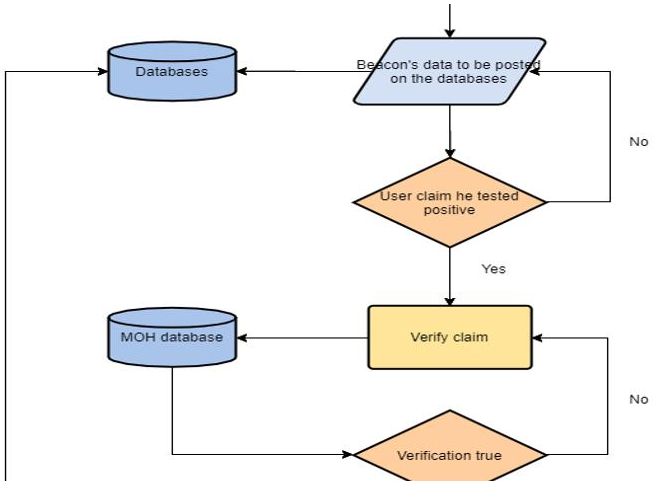

Figure 2 – Databases

C. Internet access

The internet access is an essential part in this project design since there is a periodical action taken using the internet that is posting beacons data into the database.

My design choices: Since the App is meant to be for smart phones and the main two internet access methods used in smart phones is either through a home gateway router or through a cellular tower. So, I decided to go with both methods.

Justification: I chose to implement the two methods since they are essential alternatives in smart phones as shown in ***Figure 3***.

Functionality: It provides an access to the internet.

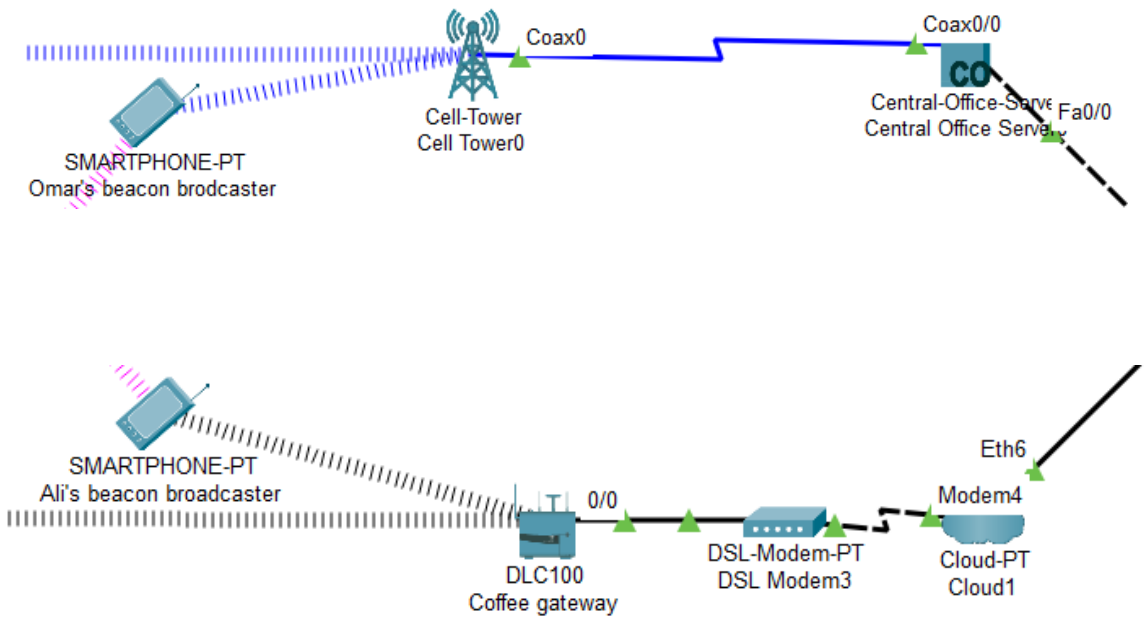

Figure 3 – Internet access methods

D. Access control list (ACL)

Access control list was added as an additional feature to the project. The project was designed to send email to the other party if the first one was tested positive. So the following protocols will be needed to do so which are DNS, STMP and POP3. And the access list was used to allow only these protocols as shown in to reduce traffic congestion so that will help in allowing fast traffic for the email notification.

My design choices: ACL control should be applied at interface g0/0 that is Omar's interface and interface g0/2 that is Ali's interface as shown in ***Figure 4***. Since there are specific protocols that should be allowed that are STMP, POP3 and DNS, so I must use extended ACL because standard ACL does not support specifying protocols and in the extended ACL I have to either specify both the source and destination or specify only the destination and make the source "any". And what I could do in my project is to only specify the destination.

Justification: I choose to specify the destination only because the source IP address will change near to the router, so I choose the source to be "any".

Functionality: It allows only protocols that needed by email that are STMP, POP3 and DNS as shown in ***Figure 4***.

```
Router#show access-lists
Extended IP access list Omar
    10 permit udp any host 192.168.2.3 eq domain
    20 permit tcp any host 192.168.2.2 eq smtp
    30 permit tcp any host 192.168.2.2 eq pop3
Extended IP access list Ali
    10 permit udp any host 192.168.2.3 eq domain
    20 permit tcp any host 192.168.2.2 eq smtp
    30 permit tcp any host 192.168.2.2 eq pop3
```

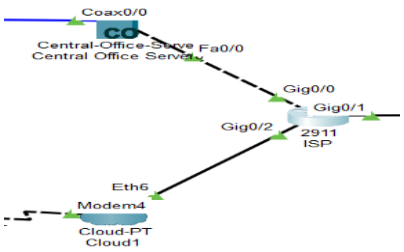

Figure 4 – Access control list

V. Description of the implemented code

As displayed in ***Figure 5*** below, The system at the start will run beacons broadcasters continuously, then the TCP session must be started between the SBC(client) in packet tracer that was written in JS and my personal computer (server) that was written in python and this session is to allow cloud database (Firebase) access. After that, the beacons data will be posted on the database periodically. Then the process of posting will continue until an infection claim take place, if so, the claim will be verified from the MOH by comparing the claimer ID with the data saved in the MOH database, if the claimer ID was found then his claim will be verified otherwise it will be rejected. After successful verification, the data that saved in the database will be retrieved which are the IDs of people those were near to you within the past 14 days. After retrieving their IDs which is in this case the email address, a notifying email will be sent to them saying “I have tested COVID19 positive and I was near to you within the past 14 days”.

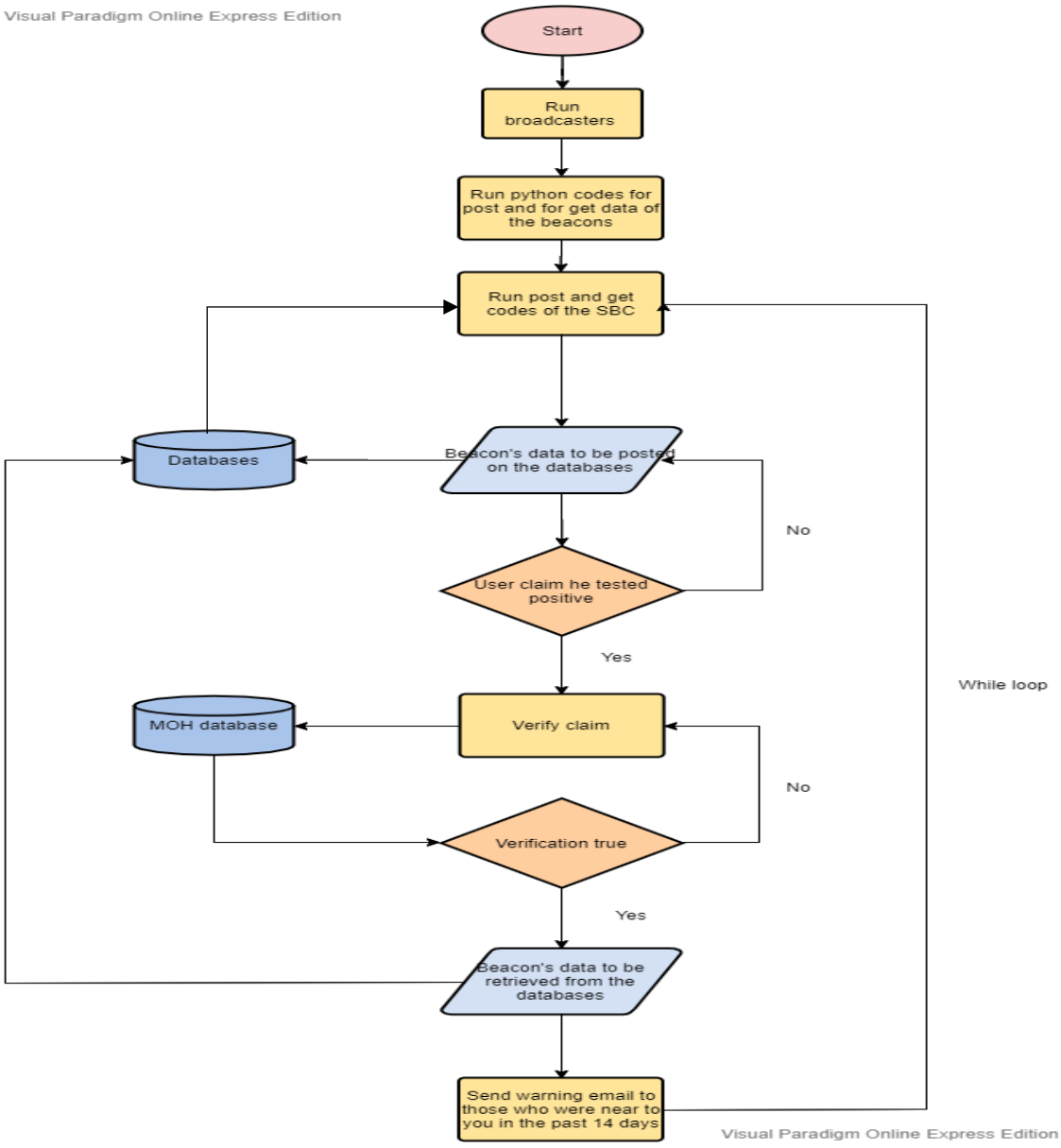

Figure 5 – Flowchart

VI. Discussion of the results

The system as implemented will exchange beacons data between two devices that represent smart phones in the real application. Also, the data will be posted into real cloud database called Firebase and it will be retrieved when a claim raises. In addition to these functionalities, an extended ACL was implemented to permit only email protocols that are STMP, POP3 and DNS. The mentioned implementations have several limitations compared to the real implementation. For example, the design was customized to work only with two devices while the real application was designed to work with as much device as possible, and this limitation was because the purpose of this project is to simulate the core of idea without its complexity because packet tracer cannot support such idea with its extended version. Another limitation is that the ID shared between the parties in the real application was a secret key but in my implementation was an email, and that to exchange the notification messages in a way the supported by packet tracer. Last but not least limitation is that the source address in the ACL was "any" and it will be better if it was specified but I couldn't figure out a way to do so.

VII. Conclusions

In this project, I have simulated the Tabued app that was designed and invented by Google and Apple, thanks to their beacon technology that is part of BLE5. The application broadcasts beacons and it saves them in its database then when a user claim that he was tested positive then it will verify his claim against the MOH database and if the claim was true then the data, in this case are the email address, will be retrieved and an email message will be sent to those who were near to him in the past 14 days.

References

[1] M. Abueg *et al.*, "Modeling the combined effect of digital exposure notification and non-pharmaceutical interventions on the COVID-19 epidemic in Washington state," *bioRxiv,* 2020.