Adriana Collaguazo
acollag@espol.edu.ec
FIEC

Irving Valeriano
ivaleria@espol.edu.ec
FIEC - CTI

Rebeca Estrada
restrada@espol.edu.ec
FIEC – CTI

Josué Tomalá
jotopozo@espol.edu.ec
FIEC

Escuela Superior Politécnica del Litoral

PARES & NONES
Un break científico

WIFI-CROWD SPY: A NOVEL CROWD-COUNTING SYSTEM

PROBLEM

In many countries, there is a requirement to keep public and work spaces safe due to COVID-19. In fact, indoor spaces must be monitored to control the allowed capacity, which can vary depending on the alert level of a city at a given time.

Figure 1. Indoor crowd control

GENERAL OBJECTIVE

Propose a system that allows us to estimate the number of people inside a building to control its maximum allowed capacity per office using the existing IT infrastructure in a building.

PROPOSAL

The main components of the proposed system are a desktop application that allows access via SSH to the WLCs, a backend service for persistence purposes, and an advanced mobile application that allows the user to set the maximum capacities and to receive alerts in case these capacities are exceeded, as shown in Figure 2. The experimental tests were carried out in the building of the Information Technology Center of the ESPOL University. Although some people can have several devices simultaneously connected to the WiFi network. To address this inconvenience, we implemented an Apriori algorithm to create association rules based on a dataset that contains mainly MAC addresses and usernames. The algorithm is carried out as follows:

- Given a transaction dataset containing a set of items $S_i = \{i_1, i_2, i_3, \ldots in\}$
- $X \Rightarrow Y$ where X is the device's mac address and Y is the username

In our approach, three metrics are used to determine if a candidate can be considered as an association rule: support, confidence, and lift.

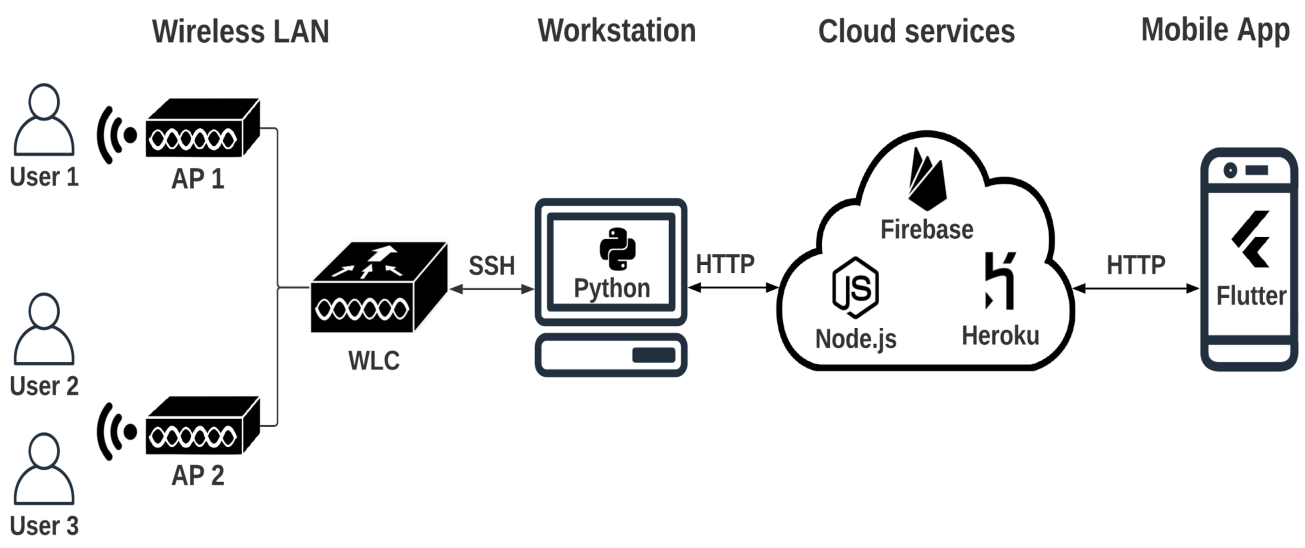

Figure 2. WiFi Crowd Spy System Model

Support: $$\sigma(X \Rightarrow Y) = \frac{freq(X,Y)}{N} \quad (1)$$

Confidence: $$C(X \Rightarrow Y) = \frac{\sigma(X \Rightarrow Y)}{\sigma(X)} \quad (2)$$

Lift: $$L(X \Rightarrow Y) = \frac{C(X \Rightarrow Y)}{\sigma(Y)} \quad (3)$$

RESULTS

The Apriori Algorithm uses a dataset with information on the connections to the WLAN network that occurred between October and December 2021. For these tests, the dataset was divided into two parts for generating the association rules and validating them as follows in Table I.
In Figure 3, different test cases using device detection times of 5, 10, 25, and 40 seconds to determine the average detection time for the alert reception using the proposed mobile application. The time is measured when the Wifi option is enabled on a device until the notification arrives in the administrator's mobile application.
In addition, Figure 4 shows the number of persons per APs for a full week from September 18 to September 22, 2021. When an overcrowded area is detected in a network, an alert is sent to the devices of the building infrastructure.

Training Data (%)	Validation Data (%)	Accuracy
20	80	96.73
30	70	99.97
50	50	100
60	40	100

Table I. Accuracy of Association Rules

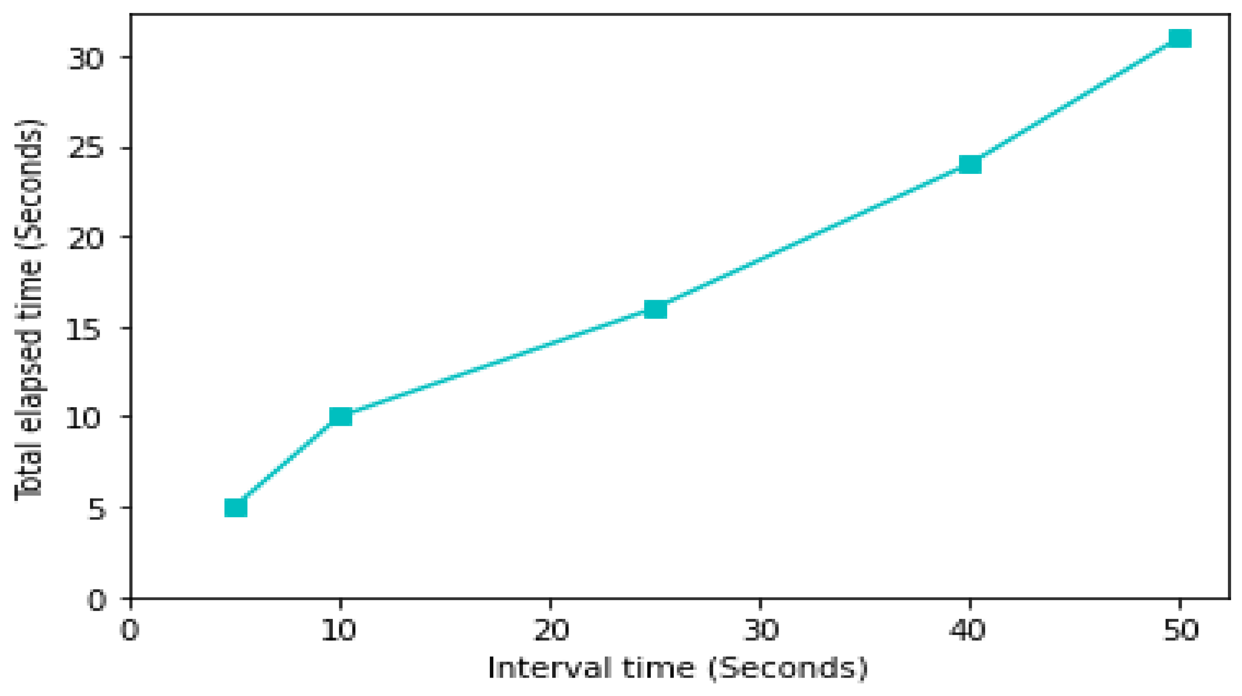

Figure 3. Average time of device alert detection

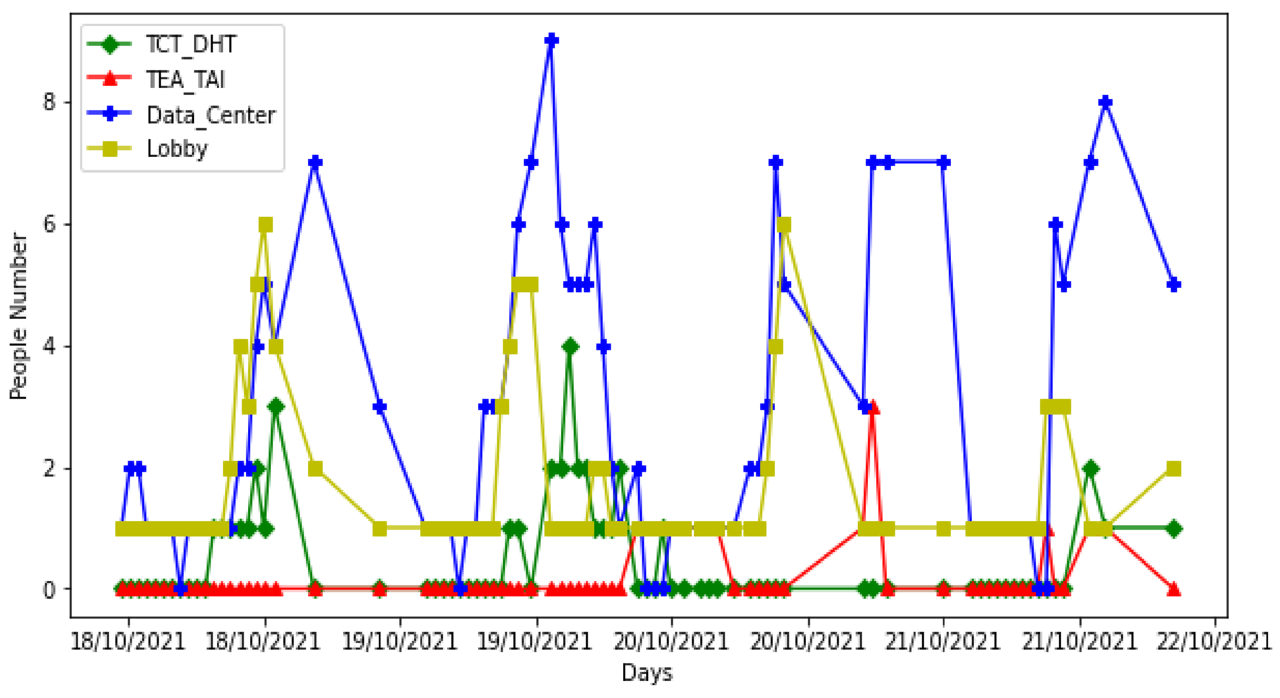

Figure 4. Number of people per APs

FINDINGS

Our proposal is a scalable solution that can be configured for different environments providing information and alerts to the building administrator. The apriori algorithm was used to create association rules between MAC addresses and usernames to count the corresponding user only once. In future work, we will investigate including more configuration features in the mobile application that enable us to detect the social distance restriction and the use of machine learning to predict the non-compliance with the capacity restriction and to reduce the notification arrival time.