



POLITECNICO DI TORINO

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Master degree course in Computer engineering

Master Degree Thesis

Improved Automation Tools For Wireless Community Network Management

Automation tooling

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Summary

Introduction

The candidate is enrolled in a project called "Senza Fili Senza Confini", conducted by an association born on October 2014.

The organization purpose is to bring broadband connectivity in remote rural areas applying a participatory approach. Nowadays its network expands over a large portion of Piedmont.

The association has started his activity in a single municipality on the basis of an experimental project run by "Politecnico di Torino" from 2010 to 2014. During the years, the number of municipalities has grown and with them the number of base stations, which have increased from 10 to 250, and the number of radios which has increased over 3000. With such a fast growth the management of the network as well as the administrative organization has become more and more complex. It has not been possible to manage anymore the system by hand, so it has been necessary to automatize some operations to improve reliability and enhance management simplicity.

The devices which compose the network are almost totally supplied by two producers: "Mikrotik" and "Ubiquiti". Both are accessible by SSH remote connections.

After studying the critical issues of the system, the candidate has exploited remote control facilities in order to lighten the daily operations of the staff.

The study has been applied in a variety of tools for automation, diagnostic, monitoring and computing:

Tools for automatic analysis of network performances

In the past, network analysis was done by technicians with simple graphical tools, implemented by default into the instrumentation. This worked well with a few number of devices. When the number has increased, it has become impractical.

In order to improve the level of automation, a series of new functionalities have been integrated into the system.

The candidate has designed an administrative Front-End interface. It is composed by a series of div, each one with a different purpose. The first div contains the user information useful for the administrator, like passwords and unified identifiers. The second one contains a map which highlights the user position, most suitable access points and the coverage area of each antenna mounted in the base station. Then there is a div where all the base stations which cover the user area are listed. From this list the administrator has the possibility to change the base station to which the user should be connected. The last three divs allow the administrator to use different facilities: bandwidth test, signal analysis, frequency scan.

Since the network is formed by wireless links, it has been necessary to assemble a tool to monitor the quality of radio signals. A Php code has been developed to interrogate the devices via SSH commands: it opens a new process interrogating the device and it redirects the standard output into a pipe. Then, the function reads the pipe as a file, row by row, to acquire the response of the device. This function is called each night at 4 o'clock for any user and results are stored into a database. Administrators and operators can access the data from the administrator panel.

In a similar way, the candidate has developed functions to perform other operations: Ethernet ports analysis, retrieving number of times the device "goes down" or perform a bandwidth test.

Finally it has been necessary to map the network in a tree structure inside the organization's relational database.

The candidate has created interfaces able to query information inside the db in the form of: device information plus reference to parent device.

A management tool for the warehouse

Previously, there was not any organized classification of the instrumentation available in the warehouse as well as the one implemented on site. Technicians weren't able to track the current position of each single object with the respect to the activity carried out by volunteers.

The candidate has implemented a little sub system which allows volunteers to track and even verify in advance the availability of devices needed for maintenance from their warehouse management page.

The system allows technicians to make reservations for instrumentation in other municipality warehouses.

After a reservation is accepted, the technician who emitted it is informed and he can go to withdraw instrumentation.

Every warehouse reservation is displayed inside a table in the warehouse management page.

From the table technician can accept the reservation.

In each phase, the system informs both technicians via e-mail about the change of the reservation status.

Radio frequencies and network

Each associate, during his enrollment procedure passes through different steps.

During the first step he inserts personal information by means of a form online.

Starting from this information an associate entry is generated inside the database.

From this DMS coordinates the candidate has to develop tools to identify the most suitable base stations, simulating the radio propagation and take into account the geographical context. After, a volunteer is able to verify the position of the user, eventually with help of maps.

On them are highlighted: the area of coverage, markers of user's position and access point's position, a list of access points that are in line of sight with the user. Moreover volunteers are able to retrieve the information given by the user about visibility of access points (aka. photos from their houses).

Tools for automate communications with users

Previously, the system did not offers the possibility to notify automatically associates about the network status. A list of channels was simply defined, on which the volunteers should have added dedicated messages. The candidate has changed this logic. It has been introduced inside the dashboard a new tab named "Notifications" and a function inside the administrator panel able to publish messages inside the "Notifications" tabs of all users connected to all devices inside a network's sub-tree generated with a specified device as root. In addition, the function sends an e-mail and a telegram notification to all involved users. E-mails are sent by a function which exploits the "PHPMailer" framework. The telegram notification is managed by a bot that maps the user's Unified Identifier to a telegram chat id.

Then other modifications have occurred. The previous system the staff had to verify all documents and all photos about user's information and position. Now, in order to lighten this phase, the candidate has developed a sub system, which asks users for pictures of his documents: Identity Card, Fiscal Code; than the sub system manages those photos with Google Vision's OCR in order to extrapolate personal information of the user. At the end it uploads them on DB and on the organization's drive using the GDrive API.

Conclusion

During the thesis the candidate has the opportunity to experiment new and different technologies both for Front-End and Back-End activities. The candidate has the possibility to choose independently which technology is more suitable. He carried out some experiments to choose among his options. For example he compared ChartJS and Google Charts in order to get the best solution for display graphics. Similarly, he experimented with OCRs, where Google Visions proved itself to be a better and more intuitive solution then Tesseract.

Acknowledgements

Voglio ringraziare la mia famiglia e gli amici.

Senza di loro non avrei mai raggiunto questo traguardo.

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Part I

Part One

Chapter 1

General Introduction and synthesis

The candidate has introduced new functions inside the "Senza Fili Senza Confini" 's (from now SFSC), management system.

SFSC takes care of brings broadband connectivity to rural zones, where users are not covered from the main Internet Service Providers.

SFSC's network his composed by several access points on the Piedmont territory.

1.1 The pre-existent system

The pre-existent system is a monolithic single server web application written in Php, Javascript and HTML, deployed on an Apache2 web server. The system is composed mainly by 3 parts.

The first part is an informative website on which users could reads information about the organization and on which they could subscribe to it.

The second part is an interface for specific type of users named referent. A referent can exploit functions that normal users can't, such as navigate db, insert and update users information.

The third part is an administrative control panel on which administrators is able to perform several operations.

In the pre existent system all the users has to subscribe to the organization from a form in the website inserting their personal information.

After that, this information are stored inside the database.

Than the organization asks to them to provide photos of their documents

and information about their geographical position in form of XY DMS coordinates.

1.2 Modifications to the system

We decide to not change the system architecture or migrating it to a RESTfull architecture in order to save time.

The candidate takes in consideration to synthesize all the three part cited above in a single one and this is one of his objectives for the future.

In our vision we want to let the user to do the less operations possible in order to interact with the organization, and we also want to lighten the staff from all the interactions with them. In order to do that we took multiple decisions.

First of all we decided to get rid off the support mailbox with the development of a platform on which the user could be real time informed about his Internet line condition. Then if the automated analysis of the line condition would detect some discrepancy, the system will automatically send a Telegram notification to the staff and will also informs the user with a toast notification in the dashboard home page.

We have also identified a new enrollment process: in order to lighten the staff, the user will not send photos to them anymore but he will upload his documents and his photos into the organization's GDrive directly from the dashboard during the enrollment process, in this way we cut off 3 passages.

All the information are automatically retrieved from the documents by means of an OCR technology based on Google Vision API and them are automatically uploaded on drive by means of Gdrive API.

Also the geographical information has begun automatically obtained; in fact in the new system the user has to upload by himself the photos of his position in relation of the closest access points and he also have to specify with a red circle the position in the photo of the access point, moreover the coordinates of user's installation is computed by the system with the HTML5 geolocation features.

Chapter 2

Network automation and implementation of analysis tools

2.1 Network automation

Inside SFSC organization the administrators used to have a lot of repetitive tasks.

For example they weren't automatically informed if a network device has gone down by any kind of notifications. It was an administrators concern to check the network status at regular intervals.

Furthermore each time a new Access Point implant was installed, were administrator concerns both to upload those information on the database and to generate an administrative file to send to state agencies called SUAP module.

Therefore it has been decided to automatize all those operations.

2.1.1 Network Tree

The candidate feels the necessity to map the network devices inside the database.

In order to do that he retrieves all the information from "The Dude" by means of "Jersey". "Jersey" is a jax-rs API. It allows to develop a JavaEE RESTfull webserver. "Jersey" provides a command to marshall and unmarshall XML files or JAXB classes starting from a schema (e.g. XSD).

Starting from "The Dude"'s XML the candidate has generated JAXB classes. Based on those classes the candidate has created some interfaces. Those interfaces allowed him to store the information inside a web service and retrieve them by means of http methods.

The candidate has choose to use web application to exploits the opportunity of upload data into a NEO4J server. NEO4J is a noSQL database which allows to abstracts data into a graph structure. On this graph are implemented a variety of algorithms such as research for shortest path, and so on.

Besides that the mainly used tree is the one stored into the SQL db. This one is represented by a node and a reference to his father into the node's tuple.

The system is all object-modelled in resources and nodes are the main one. Inside the nodes objects are stored all his attributes: type, and others different attributes depending on type.

2.2 Analysis tools

Each time an administrator felt the necessity to access information about user's antenna signals they has to perform a series of operations. In the same way it has to be done for retrieving information about the frequency usage in his area or for get information about the registration of his Ethernet port or about the number of times his device goes down.

First they have to access the database and retrieve user's antenna's control panel credentials. With those credentials the administrator has to access the control panel and insert a proprietary defined command in order to asks for data.

The administrator also used to monitoring the network status and notify the users by Telegram channels each time a problem was detected.

2.2.1 Tree Visit

In order to automatize the notifications about network status the candidate had exploits the network tree.

Each time a user log inside his diagnostic tool the system pings all the devices starting from the distribution on which user is connected since his network's border router.

If during this pings a device did not respond the user is immediately

notified about it and a notification is sent on a chat group at the attention of the Staff.

2.2.2 Signal Analysis

Signal analysis is performed each time one of two events verifies: an user log into the diagnostic page, at the 4'clock each night called from a Chron job.

In the first case data about the analysis are not published inside database but they are only sent into a report to the staff just in case they detects anomalies.

In the second case data are always published inside the database into two different tables: "Registrazioni", "Registrazioni-Storico".

All the registrations are consulted from the front end platform.

The information retrieved are: the power of signal transmitted in dBm for both polarization of the antennas and both channel of transmission; the ccq, a parameter which represent the quality of the modulations.

2.2.3 Device Analysis

The staff has the necessity to retrieve some parameters about the radios. For example the agreed Ethernet connection capacity, the number of times the link goes down, the port mode (POE out, Forced, etc...).

To provides them candidate has implement specific commands to send to radios.

2.2.4 Bandwidth Test

Bandwidth test available online isn't able to perform a test able to return wright results because they take in consideration all the network's backbones included the Fastweb ones which not depends from SFSC.

So, in order to provide users with a tool really able to give wright results, the candidates has decided to write a custom remote bandwidth test.

Chapter 3

Radio-electric analysis automation

3.1 Cartographic and geographic analysis

SFSC always had the necessity to map the user installation's position in order to map the network and in order to know if the user should be able to be connected to one of the organization's access points.

Moreover during the front office operations the staff needs to access in a fast way those information.

3.1.1 Visibility test

In order to simplify the access to the information the candidate has designed a tool who allows administrators and operators to analyze the geographical position of user from geographical entities on a map.

Those entities are displayed on a OpenStreetMap on Leaflet. They are portions of circle and represent the area of coverage of the distribution point.

Leaflet give the possibility to draw only full circumferences and not portions of them.

So via Composer the candidate had to integrate a free to use Leaflet plugin able to draw the portion of the circle.

When an operator or an administrator want to test the visibility they have just to select an user a push a button, than all tests are done automatically.

The test take in consideration the position of the user in relation to the distribution with some tolerances about the distances.

3.2 QGis

Following the state agencies requests the association has produced a series of files readable on QGis which represent all the point which compose the network.

QGis is a free and open source Geographic Information System. It allows to visualize geo object inside a map and provides several tools to work with those objects.

The association has fulfilled those requests exploiting the network tree defined from "The Dude"'s XML.

3.2.1 3D Buildings

For retrieving the elevation quota of the access points the candidate has interrogate geodata given by the ARPA portal of Piedmont.

Those data are stored inside a DEM file. A Digital Elevation Model (DEM) file places structs of data basing on the information about their position. Those structs include the information about access point elevation quota.

The candidate extrapolates them interrogating the DEM matrix row by row.

Chapter 4

Communications automation

Previously to communicate with users the staff have mainly two options: Telegram channels and e-mails.

Both wasn't good enough for the purpose, indeed happens that Telegram for some problem deleted all the users chats and channels, this led to losing a lot of useful data of users.

The mails also presents some problem. The only way to send them was with a button on the administrator panel which sends mail to all selected users. The main problem of this solution was that an administrator should know and write the list of all users interested by the messages.

The candidates needs so to develop a system able to communicate with users without the risk of data loosing and possibly without the annoying necessity to insert all user mails one by one.

4.1 Mailing

All the mails of the system are sent with "PHPMailer" on Gmail API SMTP services.

Previously it was defined a function on which were hard coded all kinds of messages that could be sent by the system. This bring to an unreadable and unmanageable code.

The candidate developed a new function which takes the mail object, text and recipients as parameters. This allows to reuse the function in different parts of the code.

4.1.1 Mailing system

The mailing system works this way:

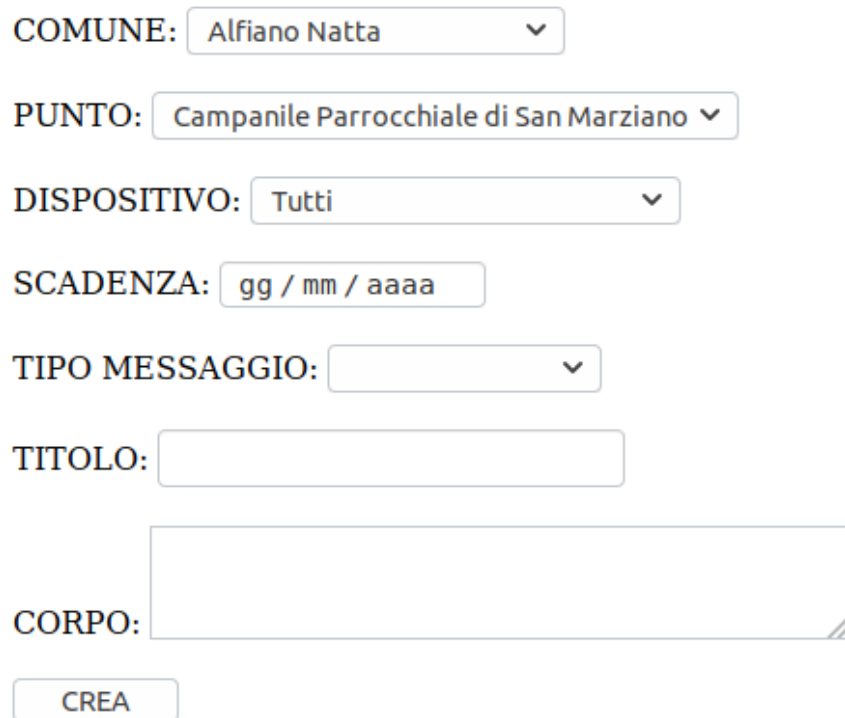
1. First and administrator has to choose a municipality. After that a select HTML tag is populated with all the access points into the municipality. In a similar way another select is populated with all the devices which make up the access point.
2. After the selection of the device the administrator had to insert a text and an object for the message. Then he can send it.
3. When the message is sent the system analyzes the network tree and computes a sub tree with the chosen device as root. After the sub tree is computed, the system store in an array all his leaves. Then from those are identified all users interested from the fault.
4. After the users are identified, a mail is sent to all of them and a message is loaded inside the DB Messages table on which is stored only the broken down device ID number.
5. The system then climb up the three from the broken device to the tree root and take notes of all crossed nodes.
6. Finally: a notification is loaded in the dashboard "Notifiche" tab of all the users connected to one of the crossed nodes.

4.2 Telegram

Telegram is widely used into the system. Telegram provides bots. Bots are little automated programs able to run commands after their insertion on a command line.

Bots retrieves CLI inserted commands in two ways:

1. The first way is to use webhook. Web hook is an asynchronous method which lives on a server page and listens on an a register waiting for commands. Each time a command is received the web hook enter a switch case iterating on the command name and when it found the wright bracket it runs the linked function.



The form consists of several input fields and a button. The fields are: 'COMUNE:' with a dropdown menu showing 'Alfiano Natta'; 'PUNTO:' with a dropdown menu showing 'Campanile Parrocchiale di San Marziano'; 'DISPOSITIVO:' with a dropdown menu showing 'Tutti'; 'SCADENZA:' with a text input field containing 'gg / mm / aaaa'; 'TIPO MESSAGGIO:' with a dropdown menu; 'TITOLO:' with a text input field; and 'CORPO:' with a larger text input field. At the bottom is a button labeled 'CREA'.

Figure 4.1. Administrator notification tool

2. The other way is the "getUpdates()" which interrogates the register in long polling.

The candidate has developed two of those bots both based on the webhook paradigm.

4.2.1 Telegram Bots

The first one did not contemplate user's commands. It responds only to the "sendMessage()" command sent by the server. After receiving the command, the bot send a message to a chat. This bot, named "AssistenzaBot" sent to the staff the users reports created in the dashboard.

The second bot is the more sophisticated one. It defines several CLI commands, for example "start" "stop" etc... The more important command defined is the "aggiungimi" command.

4.2.2 The "Aggiungimi" command

An user who wants to receive network notification should enrolled to the notifications list. He has to sent the "aggiungimi" command followed by his fiscal code.

After receiving the command the webhook map the fiscal code passed as parameter to a chat-id given inside the response to the command of the webhook.

Finally when the system needs to notify a specific group of users it retrieves their chat-id and simply sent the communications to all their chats with the bot.

Part II

Part Two

Chapter 5

Dashboard

It was planned to give to associates a platform to analyze their broadband connection and to communicate with the staff. Indeed the assistance mailbox of the staff wasn't sustainable anymore so it been become urgent to find alternatives.

The candidate has developed a dashboard tho solve the problem.

Into the dashboard an user can access all useful information about his association status and his connectivity.

He can also analyze his connection signals and perform a bandwidth test.

Moreover the dashboard is a centraliser of all the communications with associates. Indeed all the notification about the network status are transmitted by it and the associates has to use it in order to communicate with the staff.

5.1 Technologies

For the development of the dashboard several framework has been exploited. All maps are displayed with "Leaflet".

The Front-End is made with a framework named "Onsen" which allows to write a single code both for web and mobile access.

Charts are displayed with "Google Charts".

The document OCR is made with "Google Vision" and then those documents are uploaded on the association's drive with the "Google Drive API".

All the telegram operations uses the "Telegram-bot-PHP-API".

All the e-mails are sent with "PHPMailer" authenticated with the "GMail API".

5.1.1 Onsen UI

From the Onsen homepage:

"Tools for developing sharp, useful mobile apps are a key part of any developer toolkit. A framework-agnostic full-stack tool like Onsen UI can go a long way in helping developers build mobile apps that matter. "

"Onsen" is a framework which allows developers to write manageable, cross-platforms, faster on mobile code.

It defines tag ready to use that has also to be called inside the code, like bootstrap.

5.1.2 Google Developers Services

Google Developers is Google's site for software development tools, application programming interfaces , and technical resources. The site contains documentation on using Google developer tools. There are APIs offered for almost all of Google's popular consumer products.

From the services available on the site the candidates has exploit:

1. GDrive API:

"The Drive API allows you to create mobile, web, and desktop apps that read, write, and sync files in Google Drive."

The GDrive is system is made in a form of a big tree. All nodes of the tree represent a file or a folder. Each file contains the reference id of his parent folders. With the GDrive API the developer has control on all aspects of drive from permissions to creation and modification of files.

2. Google Charts:

"Google Charts provides a perfect way to visualize data on your website. From simple line charts to complex hierarchical tree maps, the chart gallery provides a large number of ready-to-use chart types.

The most common way to use Google Charts is with simple JavaScript that you embed in your web page. You load some Google Chart libraries, list the data to be charted, select options to customize your chart, and finally create a chart object with

an id that you choose. Then, later in the web page, you create a <div> with that id to display the Google Chart."

3. Google Vision OCR

"Derive insights from your images in the cloud or at the edge with AutoML Vision or use pre-trained Vision API models to detect emotion, understand text, and more."

5.2 Implementation

For the implementation the candidate has identified 4 main parts: authentication, notification, communication and diagnostics.

5.2.1 Authentication

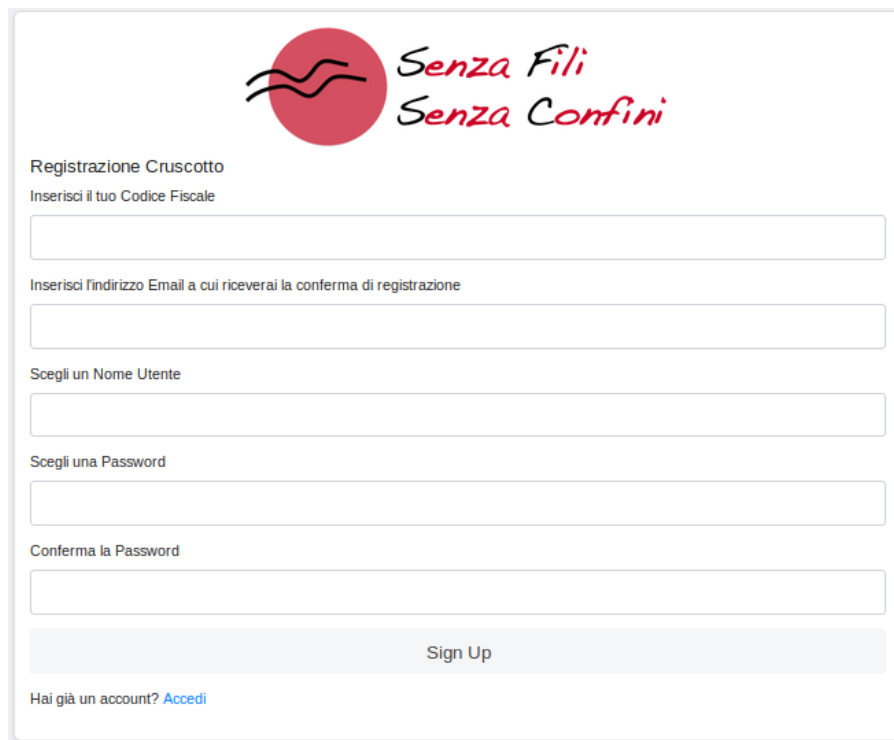
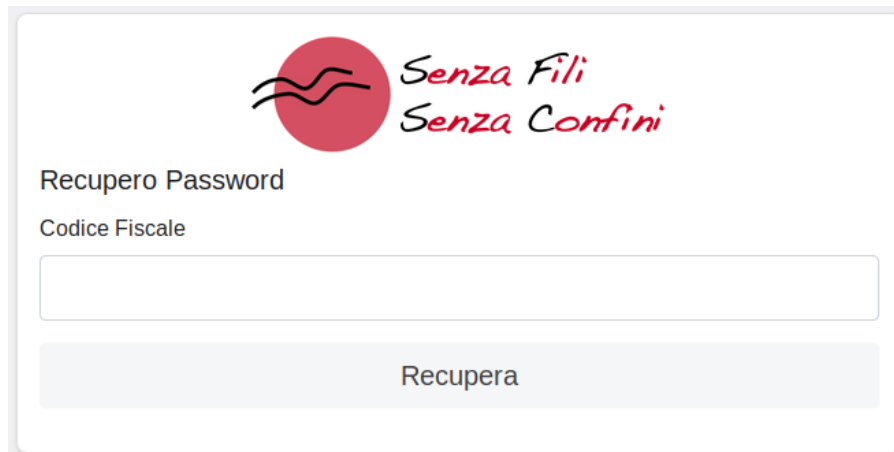
The image shows a web registration form for 'Senza Fili Senza Confini'. At the top is the logo, which consists of a red circle with three wavy lines to its left, followed by the text 'Senza Fili' and 'Senza Confini' in a red, handwritten-style font. Below the logo, the text 'Registrazione Cruscotto' is displayed. The form contains five input fields: 'Inserisci il tuo Codice Fiscale', 'Inserisci l'indirizzo Email a cui riceverai la conferma di registrazione', 'Scegli un Nome Utente', 'Scegli una Password', and 'Conferma la Password'. A 'Sign Up' button is located below the password fields. At the bottom left, there is a link that says 'Hai già un account? Accedi'.

Figure 5.1. Dashboard user login

The authentication of the associates is made in two trances; first the associate has to join the association from a page in the informative websites.



The screenshot shows a web form titled "Senza Fili Senza Confini" with a logo consisting of a red circle and three wavy lines. Below the logo, the text "Recupero Password" is displayed. Underneath, the label "Codice Fiscale" is followed by a single-line text input field. At the bottom of the form is a light gray button labeled "Recupera".

Figure 5.2. Dashboard retrieves password



The screenshot shows a web form titled "Senza Fili Senza Confini" with the same logo as Figure 5.2. Below the logo, the text "Recupero Nome Utente" is displayed. Underneath, the label "Codice Fiscale" is followed by a single-line text input field. At the bottom of the form is a light gray button labeled "Recupera".

Figure 5.3. Dashboard retrieves username

After the association is done, the associate has to enrolled inside the dashboard using the same fiscal code use in the association phase. In this way the candidate has been able to link the associate registries information to the ones useful for the dashboard login. After the registration phase the candidate receive an email asking for the confirmation of the email address. In the email text is placed a button which links to a php code, passing a token code as parameter. The Php page verify if the token in the argument is the same stored for the associate into the database, if it's, than the associate became definitively enrolled in the dashboard.

5.2.2 Notification

All notification for users are published into the "Notifiche" tab of the dashboard. When a notification is published, the date time when it has been published and the date of its deadline are saved. When an associate enter the dashboard the number of unread notifications since the last logout is showed in the "Notifiche" tab. An associate is able to see the notifications only since they're deadline is not expired.

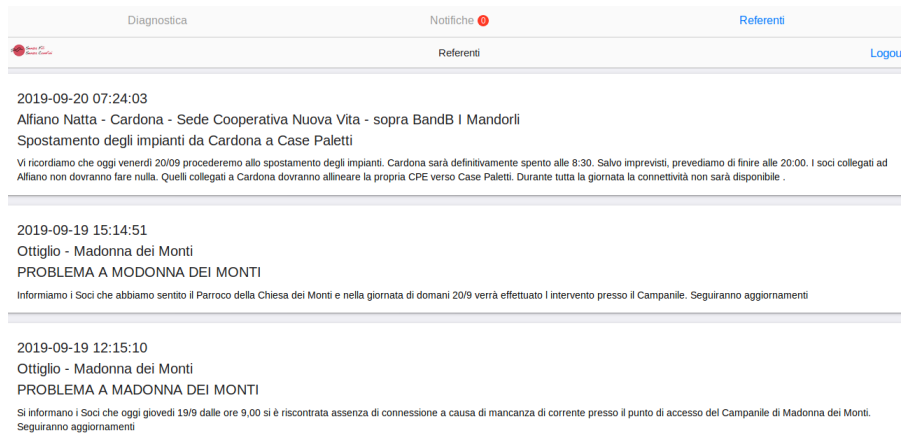


Figure 5.4. Dashboard notifications

5.2.3 Communication

Still not developed (See future improvements).

5.2.4 Diagnostics

After log into their dashboard is displayed to associates a series of information about their data and their connectivity. Information are split into 4 cards.

1. The first card contains associate's information, computed data about his link capacity and radio powers of signal.
2. The second card show the results of a connectivity test as the results of the CPE interrogation about the interfaces negotiated speed and the number of link downs since the last reboot.

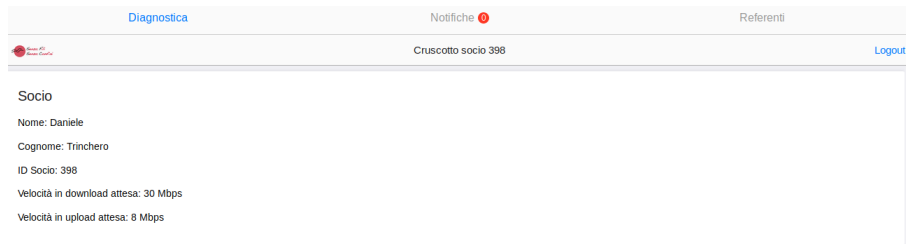


Figure 5.5. Dashboard user resume

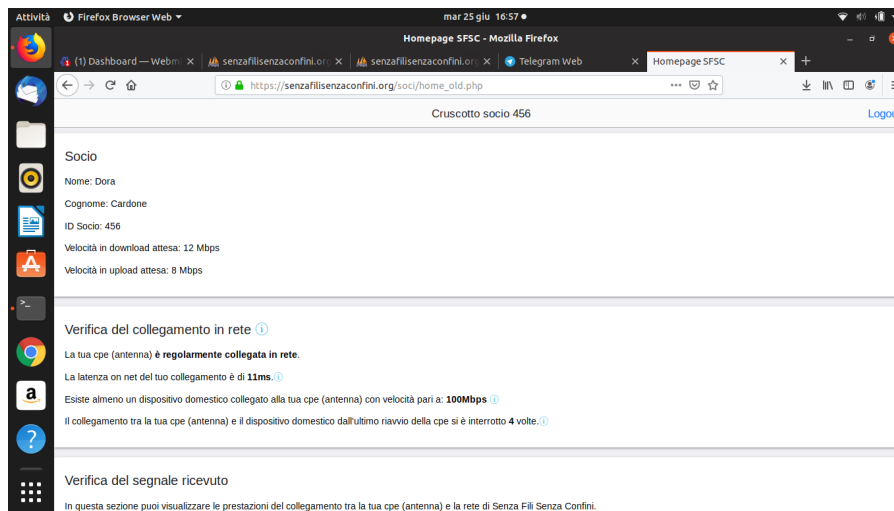


Figure 5.6. Dashboard connectivity analysis

3. The third card shows the power level of signals emitted to and received from the CPE. The system allows to retrieve those data in automatic way each 3 seconds by means of a button.
4. The fourth and last card allows user to perform a bandwidth test over 20 seconds. Test result are displayed into a chart displayed with Google Charts.

5.2 – Implementation

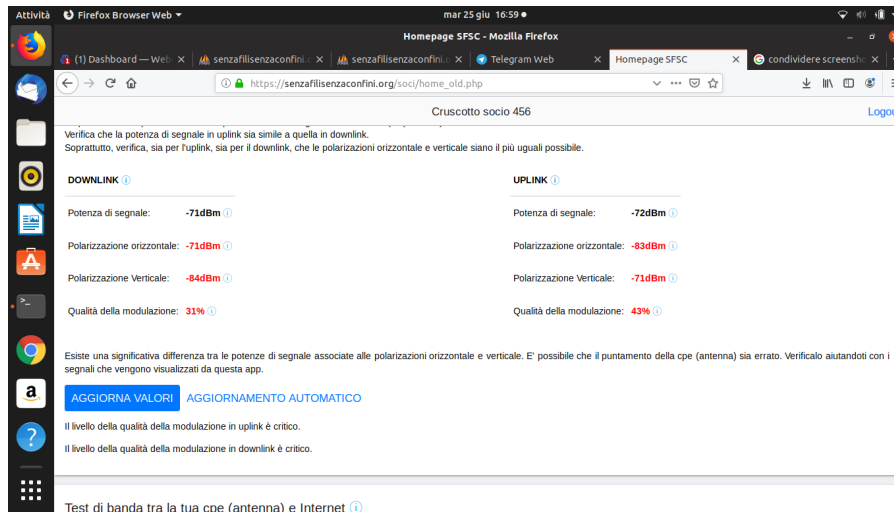


Figure 5.7. Dashboard signals analysis

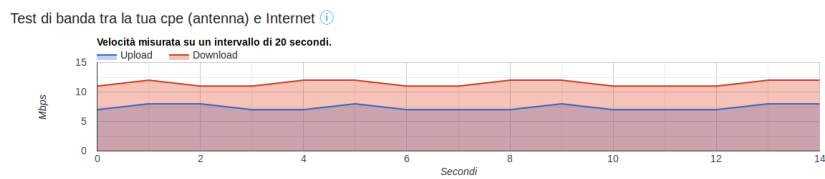


Figure 5.8. Dashboard signals analysis

Chapter 6

Administrator panel

In order to simplify the associates assistance the candidate has created a page on which administrators should exploits all tools described below.

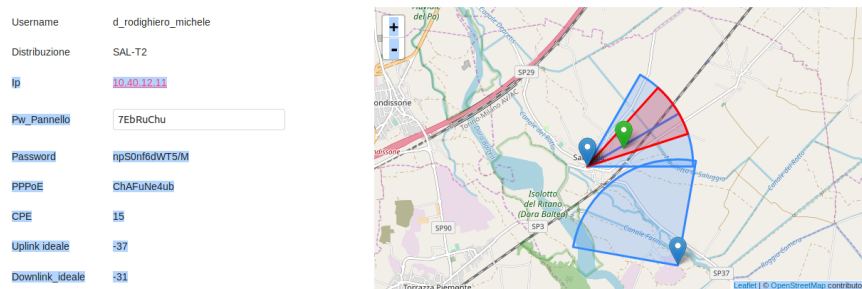


Figure 6.1. Admin page maps

Parametri speed test:		
Tcp	Udp	Duration
<input type="checkbox"/>	<input checked="" type="checkbox"/>	20
<input type="button" value="Bandwith test"/>		

Parametri ping:	
Ping count:	Indirizzo da pingare:
5	
<input type="button" value="Ping"/>	

Ottieni livelli di segnale:
<input type="button" value="Signal test"/>

Frequency scan:
<input type="button" value="Frequency scan"/>

Figure 6.2. Admin page tools

6.1 Visibility analysis

After entering the associate's assistance page and administrator is able to consult his location in relation to the access points one. Crossing those data with ones given by user about their visibility, administrators are able to choose the more suitable access point.

6.2 Frequency Test

A script has been developed. It interrogates antennas about signals of SSID it detect. Results are stored in a temporary file inside the antenna memory. It is necessary to wait for the completion of both the frequency scan and the storing of results into the memory. So the script put the device in a state of idle. Finally the script ask for the stored file.

Frequency scan:

MAC	SSID	FREQ	SIGNAL	PROTOCOL	PRIVACY
CC:2D:E0:27:2F:7E	'Cocconato5'	5200/20/ac	-75	nv2	privacy
CC:2D:E0:AC:06:3D	'Cocconato2'	5520/20/ac	-41	nv2	privacy
B8:69:F4:34:70:96	'Cocconato6'	5600/20/ac	-83	nv2	privacy
CC:2D:E0:A7:B3:50	'Cocconato1'	5600/20/ac	-59	nv2	privacy
CC:2D:E0:27:2F:8A	'Cocconato3'	5680/20/ac	-79	nv2	privacy

Figure 6.3. Admin page frequency test results

6.3 Tool to move an user from an access point to another

In order to move an user under another access point was required a very long series of operations: fill 5 field in the database, interrogate user antenna, user old distribution, the user new distribution. It has been choose to automatize also this aspect. The new script interrogates user antennas and send them a command in order to change the SSID on which connect to and the password for the connection. The script then modify the information in the database about the user position and for the user authentication (Radius credentials for radcheck and radreply).

Verifica Copertura del socio 2811

Visualizza elementi Filtra:

#	Punto di Accesso		Distanza			Angolo					Socio	
	Nome Distribuzione	Nome Punto Accesso	Min	Max	Effettiva	Min	Max	Effettivo	Bordo Sx	Bordo Dx	Numero di soci	
0	Saluggia 3	Saluggia - Capoluogo - Torre Piezometrica	0.00	2.00	0.76	60.00	90.00	64.335	4.335	25.665	29	<input type="button" value="SCEGLI"/>
1	Saluggia 4	Saluggia - Capoluogo - Torre Piezometrica	0.00	2.00	0.76	30.00	60.00	64.335	34.335	-4.335	31	<input type="button" value="SCEGLI"/>
2	Saluggia T2	Saluggia - Capoluogo - Torre Piezometrica	0.00	2.00	0.76	42.00	72.00	64.335	22.335	7.665	32	<input type="button" value="SCEGLI"/>
3	Sorin NordOvest	Saluggia - Sorin - Torre Piezometrica	0.00	2.30	2.42	280.00	370.00	334.867	54.867	35.133	13	<input type="button" value="SCEGLI"/>
#	Nome Distribuzione	Nome Punto Accesso	Min	Max	Effettiva	Max	Min	Effettivo	Bordo Sx	Bordo Dx	Numero di soci	

Vista da 1 a 4 di 4 elementi Precedente Successivo

Nuove Info Utenti

Username	ID Distribuzione	IP_Privato	IP_Pubblico	Password_Pannello	
d_rodighiero_michele	SAL-T2	10.40.12.44	172.16.4.200	7EbRuChu	npSc
Password_PPPOE	Modello	Livello_ideale_uplink	Livello_ideale_downlink	CPE_Comprata	
ChAFuNe4ub	<input type="button" value="Mikrotik LHG 5 ac"/>	-37.391496802264	-31.391496802264	0	No

Figure 6.4. Admin page change access point

6.4 Tool for ministerial paper generation

State agencies ask to the association to provide data about base stations frequency and location, for the location they want to know the absolute altitude, the altitude of the buildings on which it resides and cadastral information like sheet number and cadastral number. Has been write a script which retrieves all this data and which store them into a CSV (comma separated value) file. The CSV than is computed in QGis for define a series of geo point representing all the access point of the association.

Part III

Part Three

Chapter 7

Conclusions and future programs

During the thesis the candidate has the opportunity to experiment new and different technologies both for Front-End and Back-End activities. The candidate has the possibility to choose independently which technology is more suitable. He carried out some experiments to choose among his options. For example he compared ChartJS and Google Charts in order to get the best solution for display graphics. Similarly, he experimented with OCRs, where Google Visions proved itself to be a better and more intuitive solution than Tesseract. In order to improve the scalability and develop a system able to cover a worldwide dimension. It has been planned to migrate to a RESTful system. It has been planned to make a review of the database ER diagram and of the system structure. It has been planned to change the operating system because a lot of packages are not available for Amazon Linux. It has also been planned to change the logging procedures using Elasticsearch in order to let data become more accessible.

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