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Master thesis

Analysis and performance monitoring of a large WiFi network

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Chapter 1

Introduction

1.1 Towards a WiFi Monitoring Tool

As for other universities around the world, the Catholic Univeristy of Louvain offers a large wireless network throughout its different campus. This network provides a direct and reliable connection to all of the students, staff, teachers and researchers of the university at all time. The problem with the UCL infrastructure is that it is quite huge and it is always changing. The UCL/SRI team, which is responsible for the effective development of that infrastructure and its connection with the outside world, is always trying to improve the connectivity on the site by adding access point or upgrading the Cisco controllers for instance.

Because of that complexity, the management and the efficiency of that network has become quite difficult and buggy. Indeed, the logfiles produced by the controllers are very verbosed which induce an arduous and tricky work of decryption when the team wants to find and trace a problem that occured before on the system. Furthermore, there are more and more users trying to get a connection on the campus (laptops, smartphones,...). This might causes some disturbance on the network that leads to connectivity problems for the direct user.

In this thesis, we discuss the implementation of a WiFi monitoring tool that will help the network administrators managing the wireless infrastructure. To achieve that, we proceed in two steps. First of all, we collect all the information that travels over the network. Those information come from heterogeneous sources (from controllers logfiles to active monitoring logs through customized routers). Second, we have to analyze and process that raw data in a way that is understandable and readable for the end users.

1.1.1 Data Gathering

To work properly, our monitoring tool needs to gather data from the UCL wireless network. These data comes from various places and are quite heterogeneous. Indeed, our system implementation gathers and stores into our private server the logfiles containing all the information about the RADIUS, LDAP and DHCP servers as well as the information about the different WiSMs (Wireless Services Modules). Thanks to those logfiles we have a complete overview of the network status and components at any time.

Moreover, we have designed a custom OpenWRT router that authenticate itself on the UCL network to check if there is a problem or not during the connection phase. This gives active network status information compared to the passive one stored on the server.

1.1.2 Data Analysis

The core will be responsible to centralized, analyse and take the action accordingly the information received from the probes. Its actions will mainly depend on the access that it will have the network. Typical action would be to adapt the controller or inform precisely the administrator of the problems detected. Most of the time, there most difficult is not to be aware of the problem but to understand the causes of it.

Throughout this thesis we explain what are the main issues encountered today on the university wireless network and how our monitoring tool is helping the network administrators managing this system. In a first chapter, we present the working environment, and more specifically, the UCL Internet infrastructure. We also discuss the different types of logs we use in our tool. In the following chapter, we present all the network components and protocols used inside the network and where connectivity problems can occur. Finally we provide and describe an implementation of our monitoring tool and we deploy it on the network to gather results and feedback.

1.2 State of the art

Here we present the state of the art of wireless network monitoring.

Chapter 2

Working Environment Overview

2.1 UCL Internet Infrastructure

The Catholic University of Louvain (UCL) is one of the biggest universities in Belgium. It gathers almost 30.000 students and about 10.000 other members from staff to teachers and researchers.
The university also owns several student campus. The headquarters of the UCL is located in the city of Louvain-la-Neuve. The campus gathering the health sciences is located in Woluwe-Saint-Lambert and more recently the cities of Tournai and Mons as well as Charleroi were added to the list.
Faced with such a scale, it is vital for the Catholic Univeristy of Louvain to develop a reliable and efficient Internet connection and wireless network able to deliver a connectivity throughout its campus and all users at all time.
The purpose the University enrolled in is to provide an Internet access and a connectivity according to the type of user who wants to connect. To do this, there are 3 main networks at the Catholic University of Louvain, each with a different SSID
. The univeristy also participates in the projet `eduroam` (which stands for education roaming). Eduroam is the secure, world-wide roaming access service developed for the international research and education community[4].
The eduroam system is a RADIUS-based infrastructure that uses the 802.1X security technology to allow for inter-institutional roaming. It allows the users visiting another institution connected to eduroam to log on to the WLAN using the same credentials the user would use if he were at his home institution[5].
The Catholic University of Louvain thus has a fourth network available with the SSID `eduroam` allowing the foreign students to be able to get an Internet connection at any

time on the university locations.
The available networks at UCL are the following:

- `student.UCLouvain`: Only for the students enrolled for the current year at UCL.
- `UCLouvain`: Only for university staff as well as for the researchers.
- `visiteurs.UCLouvain`: Accessible for guests invited by the university.
- `eduroam`: Education Roaming access.

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Conclusion and Future Talks

7.1 Conclusion

Appendix A

Source Code

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Bibliography

[1] Serge Bordères and Nat Makarévitch. *Authentification réseau avec Radius : 802.1x, EAP, FreeRadius*. Eyrolles, Paris, 2006. ISBN 2-212-12007-9. URL `http://opac.inria.fr/record=b1128764`. Les protocoles étudiés dans cet ouvrage peuvent être trouvés sur le site http://www.rfc-editor.org.

[2] Jeff Smith, Jake Woodhams, and Robert Marg. *Controller-Based Wireless LAN Fundamentals: An end-to-end reference guide to design, deploy, manage, and secure 802.11 wireless networks*. WebEx Communications, 1st edition, 2010. ISBN 1587058251, 9781587058257.

[3] M.L. Gress and L. Johnson. *Deploying and Troubleshooting Cisco Wireless LAN Controllers*. Cisco Technology Series. Pearson Education, 2009. ISBN 9781587140501. URL `http://books.google.be/books?id=YLHvHGGx5AEC`.

[4] Terena. What is eduroam?, June 2012. URL `http://www.eduroam.org`.

[5] Belnet. Belnet eduroam service, 2011. URL `http://www.eduroam.be`.