

Proposal for a solution to improve access to mathematics and philosophy education in Senegal thanks to SDN and IPTV

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Abstract— The purpose of this article is to contribute to the access to quality education in Mathematics and Philosophy for all children in the country, including those in remote areas of the capital, through an IPTV platform. To do this, we offer an SDN network integrated into an IPTV infrastructure in order to have an agile and automated interactive platform, but capable of video streaming. Interactivity is managed by Verto-FreeSwitch, agility, streaming and automation are the responsibility of SDN. The interactive IPTV server performs a multicast broadcast for learners. With a web browser or an IPTV client, learners can follow courses and interact in real time with teachers via the Verto-FreeSwitch module.

The use of SDN allows to benefit from a better configuration of equipment to optimize data storage servers, but when coupled with IPTV they allow democratization of access to Mathematics and Philosophy courses.

Keywords— Automation, E-learning, IPTV, SDN, Streaming

I. INTRODUCTION

Having qualified teachers in sufficient numbers for the whole country can be a big indicator for appreciating a nation's educational system. It has been proven that having enough qualified teachers has a positive impact on teaching lessons, particularly in basic disciplines such as Mathematics and Philosophy. This is why the shortage of qualified teachers in Mathematics and Philosophy in many regions of Senegal poses a serious problem of access to quality training, especially for high school students. This shortage of teachers in the two disciplines far exceeds the number two hundred across the national territory. In this context, the PACKET (Program to improve the quality of ethics and transparency) advocates democratic access to remove this public education service, which is a right for all children in Senegal [1]. This is why the resolution of this question becomes a development issue because in many localities students cannot do the S1 streams (mathematics and physical sciences specialty) or else training in philosophy is at a discount. Hence the need to see by what educational means to resolve this problem by using in particular STEM or e-learning. Science Technology, Engineering and Mathematics in English STEM is an innovative

concept which aims to promote the teaching of science, Technology, engineering and Mathematics in formal and informal contexts [2]. STEM training can be administered either face-to-face or remotely. Distance education and / or online learning is a form of education provided by an establishment which does not involve the presence of the teacher responsible for giving it where it is received [3, 4] thanks to the exchange of audio, video, chat messages, etc. Television is evolving to include less traditional methods of service delivery. Satellite, cable and terrestrial links have long been its methods of providing services. However, a recent move has been made to take advantage of the dominance of Internet Protocol (IP) in communications to facilitate the creation of a new television broadcasting service called IPTV. IPTV differs considerably from conventional Internet video (IV): IPTV is a paid subscription for the live broadcast of many television channels, which corresponds to the free download of a video. It is not possible to buffer each channel before reading because subscribers are not willing to wait several seconds for each channel change. The software defined network (SDN) is a new network paradigm that separates the data level and the control level. SDN is based on the principle of providing a programming interface (API) for data packet transfer devices such as switches and routers, allowing programming of network elements and the entire network, thereby creating a dynamic, flexible, automated and manageable architecture [5][6]. The main idea of SDN is to transfer the intelligence of the network to a fundamental element called a controller. Currently there are several OpenFlow switches.

Currently a lot of researches have been produced by researchers from around the world, notably in STEM, e-learning in order to solve a certain number of training problems. However, the proposals of these works, although very important, did not tackle the question from the angle of improving access to Mathematics and Philosophical education in a developing country or suggest costly solutions. This is why we are relying on the integration of SDN into an IPTV platform in order to solve the problem of improving access to quality

education in Senegal with an inexpensive and accessible solution.

This article is therefore a contribution to access to quality education in Mathematics and Philosophy for all children in the country, including those in remote areas of the capital thanks to an IPTV platform in which SDN technology is integrated. We also offer the automation of the reception part of that platform thanks to SDN [7] as well as the management of streaming. This facilitates access to services and the diversification of terminals. This is another step in managing an IPTV infrastructure and responds to the challenges posed by increasing traffic and the complexity of the network.

This document is divided into four main parts. The first part describes the state of research. The second part is the basic proposition of this article. Section 3 explains and analyzes the results of the simulation. Section 4 concludes that the document presents future work.

II. STATE OF THE ART

E-learning has become a constantly evolving area of research. Several approaches have been proposed for the real-time broadcasting of audio / video streams in the context of distance learning [8, 9]. Currently it uses various technologies including IPTV and SDN.

The authors [10] propose a platform based on IPTV and adapted to distance learning. This solution allows the distribution of high definition video content to a large number of users. However, the proposed solution causes learners to lose interactivity.

The authors [11] propose an improvement in the interactivity and the quality of service of ODL platforms by exploiting the power of IPTV. However, the document does not address issues related to the automated management of network equipment.

[12] provides a framework for the implementation of an online learning service based on software that serves as a reference or guide to analyze, discuss, design and assess the viability of its application in an educational environment. The authors used converged platforms to display video on multiple screens, anywhere, in a connectivity scenario. This can encourage more flexibility and benefit students. In this sense of flexibility, [7] proposes a functional architecture for an IMS-IoT platform integrating SDN and the automation of the transport layer and the control layer of that architecture in order to facilitate management, access to users, to diversify user terminals. In the distance learning register and STEM [9] presents a collaborative software development platform allowing actors from traditional and virtual universities geographically distant to work on a software development project using current programming languages by making available provision of the various actors of these digital and traditional universities which practice e-learning in a development environment including instant messaging, audio and video. [13] presents an online platform aiming to improve

STEM teaching, thus enabling actors from traditional and virtual universities, geographically distant, to collaborate through practical work. It provides a preconfigured environment for laboratories. A solution is also proposed for the Moodle e-learning platform, to create virtual classrooms, integrating video, audio, chat, audio recording of different actors [14]. It discusses a digital solution that enables universities to extend the functionality of their distance learning platform to improve not only their model of delivering educational content, but also their assessment of learners' knowledge. It is based on WebTRC and is tested for teaching languages and Mathematics. In the context of software defined networks and multicast networks, [15] presents a centralized approach to managing source-specific multicast traffic flows, based on a software defined network. Its approach is suitable for hybrid IP / SDN networks, where network nodes behave by default like conventional IP routers, but whose packet transmission behavior can be customized for specific flows via a control plane activated by OpenFlow.

The authors of [16] propose a platform that can be used for the development of integrated applications for a wide variety of devices and allowing a wide and inexpensive distribution of educational content. The proposed solution can also be used in developing countries with low Internet penetration or at prohibitive bandwidth prices. [17] presents some of the latest advances in the use of iDTV for educational purposes, offering the learner active participation in the course. It also explores the possibilities of increasing the power of iDTV by offering interactive home learning and presenting exceptional development issues and experience, respectively. [18] proposes an architecture for distance training in rural areas based on IPTV.

All of this work has the merit of offering innovative solutions, even revolutionary ones, and constitutes an important contribution in the field. However, these solutions can be improved thanks to the automation techniques of the IPTV platform provided by the SDN. Added to this is the integration of IPTV and SDN networks, in order to contribute to democratic access to the public education service through IPTV services in disadvantaged areas by diversifying the terminals of reception remove in order to help resolve the problem of the deficit of quality education in Mathematics and Philosophy.

III. PROPOSITION

We propose to integrate the SDN into an IPTV platform in order to give an equal chance to Senegalese students, in particular in the teaching of Mathematics and Philosophy. We also offer video streaming and automation of a part of the proposed architecture (reception part) using two scripts written in python. This facilitates user access to the network and the diversification of terminals (smartphone, tablet, computer, Smart TV, etc.). This use

of SDN also makes it possible to control user terminals. The following figure represents the architecture we offer:

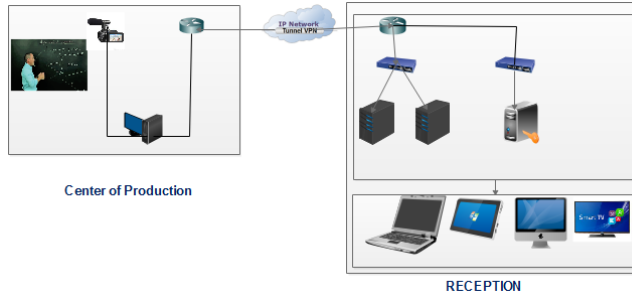


Figure 1. Proposed Architecture

The proposed architecture is made up of a production / dissemination of educational content and a reception part. In the production / broadcast part we have the presentation of a lesson by a teacher. This presentation is recorded using a camera before being retrieved on a computer which is responsible for broadcasting via the router and the VPN tunnel connecting the two blocks.

At the exit of the tunnel, the contents arrive at the router which is responsible for conveying them to the various recipients (storage or broadcasting).

This proposal addresses the problem of the shortage of Mathematics and Philosophy teachers in remote regions which it wishes to resolve via the architecture above.

This IPTV architecture integrates a FreeSWITCH server which is an open source IP telephony solution developed in C language. It is capable of directly providing native services to browsers, such as videoconferencing, interactive voice response (IVR) without using a gateway. It also allows thanks to the verto module to offer interactivity to an IPTV platform through web browsers so as to promote an exchange on educational content.

We can also use smartTV to have innovative and interactive services on broadcast and broadband networks. Broadband hybrid television (HbbTV) uses elements of specification existing in other standards [19].

This architecture allows the network of the multiplex operator to benefit from all the agility of an SDN network but also to benefit from programmability [7]. This makes television services (IPTV, HbbTV, VoD, Catchup TV, etc.) available. This accessibility of IPTV and other services is an easy and serious option for solving the problem of online teaching and learning. This also makes it possible, in a country like Senegal, to remedy the lack of teachers in Mathematics and Philosophy in certain disadvantaged localities. Under the supervision of the Ministry of National Education, experienced and highly qualified teachers will provide the authority with quality courses for students in the areas concerned. Using a thin client or any other compatible device, all the students concerned will have access to resources by simple subscription. Better yet, the catch-up TV service will allow learners to review the course they want without connection, if necessary. This will have a positive impact on the quality of teaching and learning and will allow all

learners in the country to benefit from equal training opportunities.

IV. RESULTS AND DISCUSSION

For the results, we wrote two scripts in python, one for the automation of the reception part of the IPTV platform and the other for the management of video streaming. The following figures show the results of our tests. To do these tests, we used the Mininet network simulator. This simulator allowed us to automate as well as streaming. This allowed us not only to emulate the different entities of the party concerned but also to test the multicast video streams. Thus, the figures show the launch of the program via a simple python command from a terminal. It is only after this step that the system starts the network equipment (router, switch, server hosts, CLI, etc.) immediately after the configuration of the computers. If the process is successful, the terminal displays mininet.

```
root@sanbathese-VirtualBox:~/mininet# python diffusionIPTV.py
*** Creating network
*** Adding controller
Unable to contact the remote controller at 127.0.0.1:6633
*** Adding hosts:
Freeswitch IPTV Portable R0 Smarttv Tablette VoIP
*** Adding switches:
S1 S2
*** Adding links:
(100.00Mbit 10ms delay 0.00000% loss) (100.00Mbit 10ms delay 0.00000% loss) (S1, Freeswitch) (S1, R0) (100.00Mbit 10ms delay 0.00000% loss) (100.00Mbit 10ms delay 0.00000% loss) (S1, VoIP)
(100.00Mbit 10ms delay 0.00000% loss) (100.00Mbit 10ms delay 0.00000% loss) (S2, IPTV) (100.00Mbit 10ms delay 0.00000% loss) (100.00Mbit 10ms delay 0.00000% loss) (S2, Portable) (S2, R0) (100.00Mbit 10ms delay 0.00000% loss) (100.00Mbit 10ms delay 0.00000% loss) (S2, Smarttv) (100.00Mbit 10ms delay 0.00000% loss) (100.00Mbit 10ms delay 0.00000% loss) (S2, Tablette)
*** Configuring hosts
Freeswitch IPTV Portable R0 Smarttv Tablette VoIP
```

Figure 2. Launching the script

```
00Mbit 10ms delay 0.00000% loss) (S2, Smarttv) (100.00Mbit 10ms delay 0.00000% loss) (100.00Mbit 10ms delay 0.00000% loss) (S2, Tablette)
*** Configuring hosts
Freeswitch IPTV PC Portable R0 Smarttv Tablette VoIP
*** Starting controller
c0
*** Starting 2 switches
S1 S2 ... (100.00Mbit 10ms delay 0.00000% loss) (100.00Mbit 10ms delay 0.00000% loss) (100.00Mbit 10ms delay 0.00000% loss) (100.00Mbit 10ms delay 0.00000% loss) (100.00Mbit 10ms delay 0.00000% loss) (100.00Mbit 10ms delay 0.00000% loss) (100.00Mbit 10ms delay 0.00000% loss) (100.00Mbit 10ms delay 0.00000% loss) (100.00Mbit 10ms delay 0.00000% loss)
*** Table de routage du routeur:
Kernel IP routing table
Destination Gateway Genmask Flags Metric Re
f Use Iface
127.0.0.0 * 255.0.0.0 U 0 0
0 R0-eth1
127.0.0.0 * 255.0.0.0 U 0 0
0 R0-eth2
*** Starting CLI:
mininet>
```

Figure 3. Following the launch of the script and display of the routing table

```
mininet> pingall
*** Ping: testing ping reachability
Freeswitch -> IPTV PC Portable R0 Smarttv Tablette VoIP
IPTV -> Freeswitch PC Portable R0 Smarttv Tablette VoIP
PC -> Freeswitch IPTV Portable R0 Smarttv Tablette VoIP
Portable -> Freeswitch IPTV PC R0 Smarttv Tablette VoIP
R0 -> Freeswitch IPTV PC Portable Smarttv Tablette VoIP
Smarttv -> Freeswitch IPTV PC Portable R0 Tablette VoIP
Tablette -> Freeswitch IPTV PC Portable R0 Smarttv VoIP
VoIP -> Freeswitch IPTV PC Portable R0 Smarttv Tablette
*** Results: 0% dropped (56/56 received)
mininet>
```

Figure 4. Communication test of the broadcast server

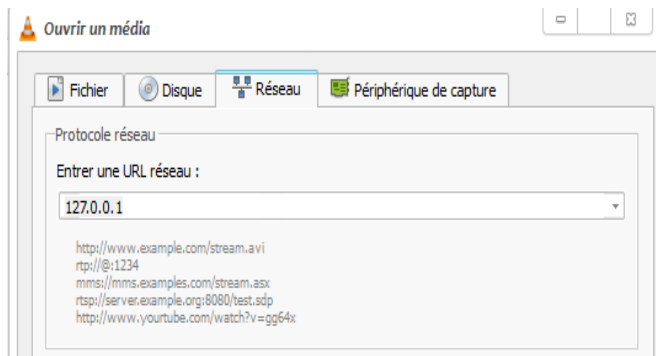


Figure 5. Streaming process

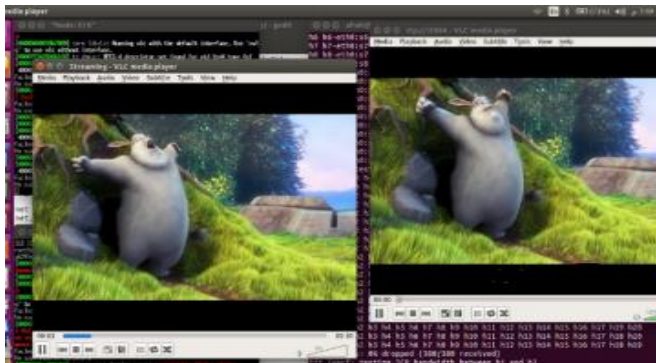


Figure 6. Video streaming test

On the basis of these tests, we can say that this proposal constitutes an important contribution in the sense that it allows better management of the IPTV platform and access to educational content anytime and anywhere, in particular. Thanks to automation, this platform makes also it possible to manage interactivity which gives learners the possibility of interacting with trainers. In addition, it allows teachers and learners, through a bidirectional communication, to share and learn using any terminal. This will allow learners in remote areas to take quality courses in Mathematics and Philosophy without moving. This automation is more than important. When a component relies on manual processes, it can become a bottleneck. The use of administrative tools and data center switches for advanced automation [7] allows IT departments to eliminate this type of bottleneck. At the same time, network automation helps increase agility and reliability, accelerate deployments and improve the performance of critical business applications. We also see from Figures 5 and 6 that this platform makes video streaming for better sharing of educational content to IPTV subscribers. This guarantees the diffusion of the same flow towards the different learners.

V. CONCLUSIONS

Our document proposes to integrate the SDN into an IPTV architecture IPTV platform. Thanks to streaming and automation, it guarantees better management of the network and quality of services. This contributes, thanks to the system of distance learning, to make available educational contents at anytime and in anywhere. All this

also facilitates network management, user access, diversification of user terminals, etc. The technologies used to perform this work are described without forgetting the various challenges raised by these technologies.

This article is for us the center of future work that can go beyond the simulations that we performed to try to set up a physical test environment or balance the loads of the different servers.

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