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Implementing A Web Radio For Enhancing Communication Processes In Academic Institutions: A Case Study At The Federal Institute Of Education, Science And Technology Of Rondônia - Campus Porto Velho Zona Norte

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Abstract:
Internal communication is essential for the proper functioning of educational institutions. Problems such as the lack of clear communication channels and the lack of integration between departments can compromise internal communication. At the Federal Institute of Education, Science and Technology (IFRO), Campus Porto Velho Zona Norte, current communication involves physical visits, emails and class leaders to disseminate information, but information is often lost. This article proposes the use of a web radio as a communication and entertainment instrument to optimize communication between students. The prototype development methodology was used to create Web Radio. The infrastructure used a Debian 12 server on Amazon Web Services. Docker containers have been adopted to improve security and scalability. Icecast2 was chosen as the audio server, and Apache2 Server as the web server. Applications have been configured to capture and transfer audio. The process of deploying the broadcast management service was detailed, including creating a container, updating the software, installing systemctl and Icecast2, and configuring server parameters. A bash script was created for automatic startup. In addition, the Sam Cast software settings for broadcasts were explained.

Key Word*: Internal communication; Web radio; Docker; Icecast2; Streaming.*

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I. Introduction

Internal communication within educational institutions is a vital component for their proper functioning and the achievement of educational objectives. However, several issues can arise and compromise this communication. One of the most evident problems is the lack of clear and well-defined communication channels. When communication channels are not established adequately, students and works can feel disoriented, which can lead to confusing or even lost information.[1]

The lack of integration between departments is also an issue affecting internal communication. Isolated and non-integrated departments can lead to gaps in information and limited collaboration, affecting efficiency and the overall quality of the institution.[1]

At the Federal Institute of Education, Science and Technology of Rondônia (IFRO), Campus Porto Velho Zona Norte, the current communication method involves physically visiting classrooms to provide announcements, using email for communication, and delivering information to class leaders for dissemination among their peers. However, in many instances, the information gets lost within the communication chain.

In light of this need, it becomes interesting to discuss a way to optimize communication among students at IFRO Campus Porto Velho Zona Norte. Therefore, the objective of this work is to propose the utilization of web radio as an instrument, discussing its significance as a communication and entertainment tool, addressing its characteristics, advantages, and challenges.

A web radio is a digital radio or, more commonly known, an online radio. Its transmission occurs in real-time via streaming over the Internet. By broadcasting their daily programming online, AM and FM radio stations extend their reach and audience within their programming schedule.[2]

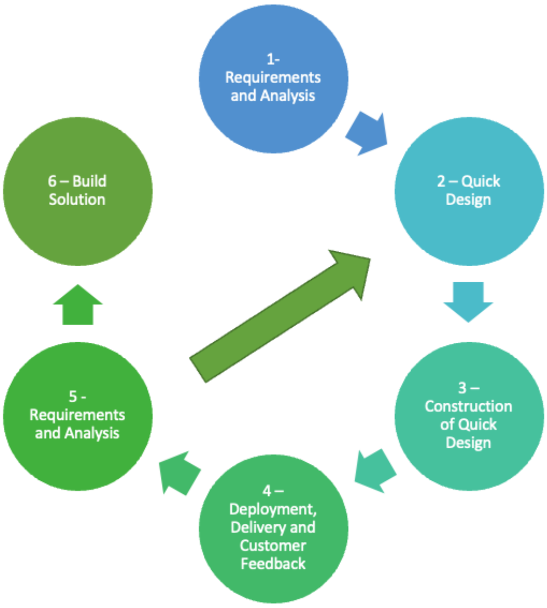
Streaming is the process of transmitting and playing content - such as music, videos, or games - in real-time over the Internet. Streaming is a technology that allows users to access videos or listen to music from any location with Internet access, without the need to download the content to their device. Instead, these media are stored on content provider servers or transmitted in real-time audio and video services.[3]

The present article is divided into the following sections: 2 - Materials and Methods, which presents the methodology used for the development and implementation of the web radio, as well as the necessary tools for its use; 3 – Results and Discussion, which outlines the radio's implementation process and its manner of use; 4 - Conclusions and References.

II. Material And Methods

For the development of the Web Radio, prototyping development methodology was used, it is a valid technique that can be perfectly employed if the system to be developed has the characteristics of having dynamic queries, interacting strongly with people, or having an algorithm or combinatory processing that needs to be developed in an evolutionary way. The creation of a prototype is a job that must be done interactively following the cycle shown in Figure 1.

Figure 1: Life cycle of the prototyping process used to develop the Web Radio.[4]


1- Requirements and Analysis
2 – Quick Design
3 – Construction of Quick Design
4 – Deployment, Delivery and Customer Feedback
5 - Requirements and Analysis
6 – Build Solution

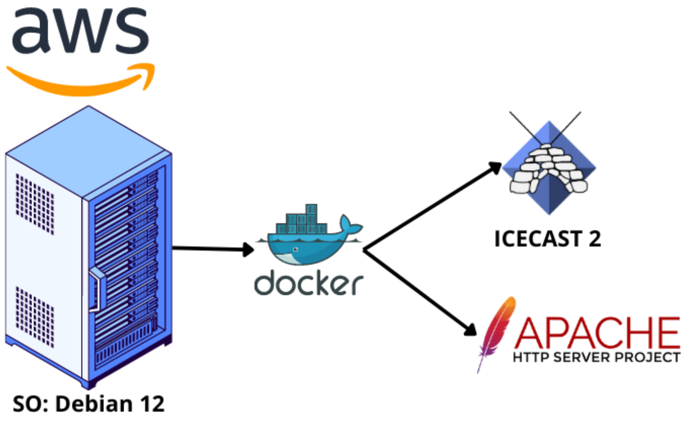
Similar to all software development approaches, prototyping begins with requirement gathering. During this phase, customers and developers constantly interact, facilitating the gathering of system requirements and functionality. A "quick design" is then developed, focusing on the aspects defined by the user. Rapid design leads to building a prototype that is evaluated by the customer/user and used to refine the requirements. Prototyping is an efficient software-engineering paradigm. The prototype will be built to serve as a basis for defining the requirements. Finally, the prototype will then be discarded, at least in part, and a real software will be designed, taking quality and maintainability into consideration.[4]

The necessary tools for development were divided into: Infrastructure and Operation Applications. For the Web Radio infrastructure the architecture is presented in Figure 2. Server with Debian 12 operating system was utilized, hosted on a machine allocated in Amazon Web Services, known as AWS. Debian is an operating system with fully-featured for servers, workstations and home desktop[5]. Amazon Web Services is a cloud service that can be used to for building, testing, and managing applications and services through a network of servers managed by Amazon in various locations all over the world.[6]

As a means of enhancing application security and scalability, the utilization of containers emerges as a noteworthy solution. Embracing this approach addresses the imperative to mitigate security risks and bolster the application's capacity to dynamically adapt to variable demands. By encapsulating components, libraries, and dependencies within isolated environments, containers minimize the attack surface and promote heightened security by preventing adverse interference between different parts of the system. Additionally, the inherent ability of containers to be self-contained and self-scalable contributes significantly to the robustness of the infrastructure, enabling elastic and efficient scaling in accordance with workload requirements. Consequently, container adoption emerges as a proactive response to the intricate demands of security and scalability, endowing applications with a resilient and adaptable architecture in dynamic scenarios. Thus, Docker was chosen due to its well-established success both in the container market and within the DevOps ecosystem.[7]

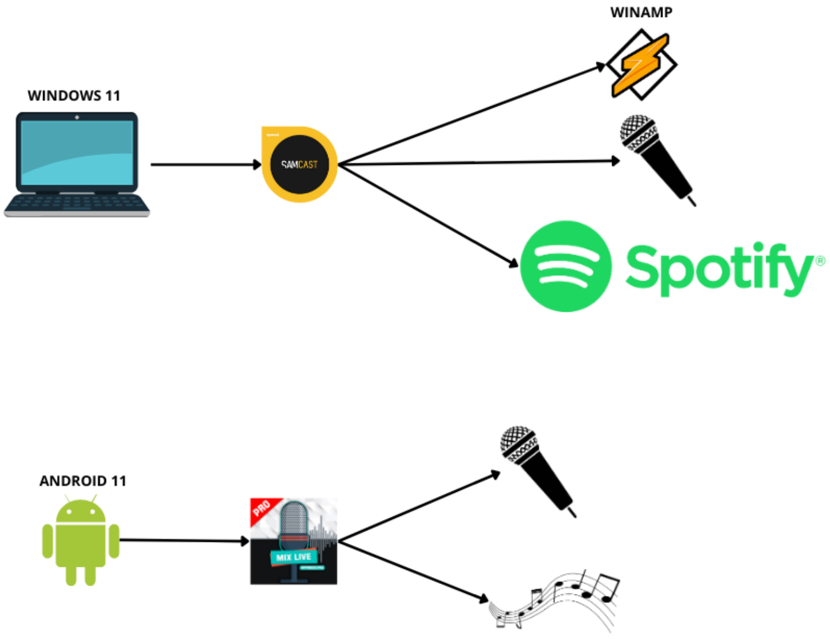
Icecast2 was selected as the audio streaming server, maintained by Xiph.org and distributed under the GNU GPL version 2 license[8]. As a web service, the Apache2 Server was chosen. It is an open-source HTTP server designed for modern operating systems, offering a secure, efficient, and extensible service that delivers HTTP services in compliance with current HTTP standards [9].

Figure 2: Infrastructure for Web Radio.



For Operation Applications are necessary the software's for capture and transferring the audio to the server and software for to play the music or voice messages records. Two testing environments were employed. The first testing environment involved operating the radio from a computer utilizing the Windows operating system. Through the utilization of the SamCast software, multiple encoders, including one of the most widely used, MP3, could be configured from a single interface. This streamlined the process of transmitting data to the Icecast2 server [10]. In this manner, various audio players can be utilized, such as Winamp, Windows Media Player, or even Spotify. Therefore, the user can send messages through the microphone or record a voice message and schedule its repetition in the file queue. The second testing environment revolved around operating the radio through a smartphone, utilizing the Android operating system, version 11. Through the use of the APPRADIO.PRO MIX LIVE application, audio files can be played from a list of imported files within the app, or the device's own microphone can be employed. The Figure 3 present the architecture propose.

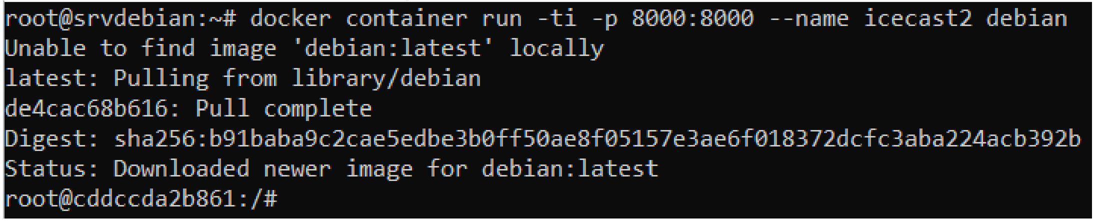
Figure 3: Operation Applications for Web Radio.



III. Results and Discussion

To deploy the radio transmissions management service, a container is created from the Debian image, named "icecast2", with interactive access to the terminal. It maps the host system's port 8000 to the container's port 8000, allowing external access to the service inside the container. The Icecast2 service uses port 8000 for access. During container creation, port mapping occurs to direct incoming and outgoing requests. The result of the command will be similar to that shown in Figure 4. The following command was used for this: docker container run -ti -p 8000:8000 --name icecast2 debian

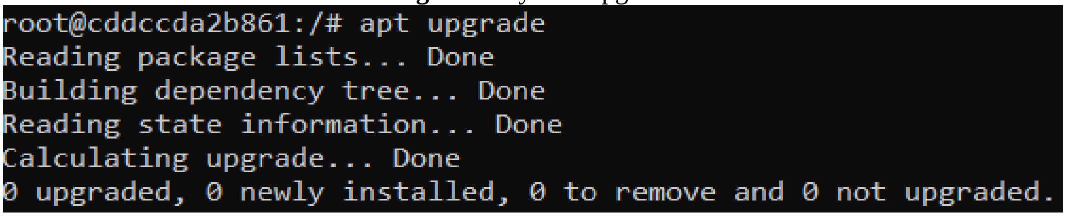
Figure 4: Start of configuration



```
root@srvdebian:~# docker container run -ti -p 8000:8000 --name icecast2 debian
Unable to find image 'debian:latest' locally
latest: Pulling from library/debian
de4cac68b616: Pull complete
Digest: sha256:b91baba9c2cae5edbe3b0ff50ae8f05157e3ae6f018372dcfc3aba224acb392b
Status: Downloaded newer image for debian:latest
root@cddccda2b861:/#
```

After creating the container, it is extremely important to run the "apt upgrade" command, in order to update the software version and ensure the incorporation of the latest security fixes and functional improvements. This ensures a more stable and protected environment. The result will be shown in Figure 5. For this, the following command was used: apt upgrade

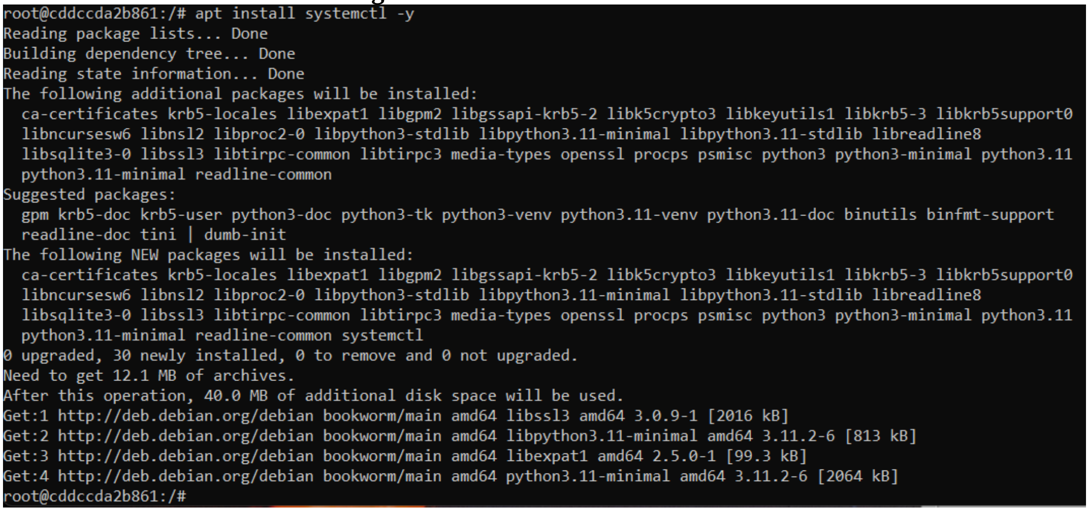
Figure 5: System upgrade



```
root@cddccda2b861:/# apt upgrade
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
Calculating upgrade... Done
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
```

After completing the upgrade procedure, as the systemctl software is not installed in the standard Debian image, it is of paramount importance to install the systemctl software, which is a requirement for the Icecast2 software. The result will be shown in Figure 6. For this, the following command was used: apt install systemctl -y

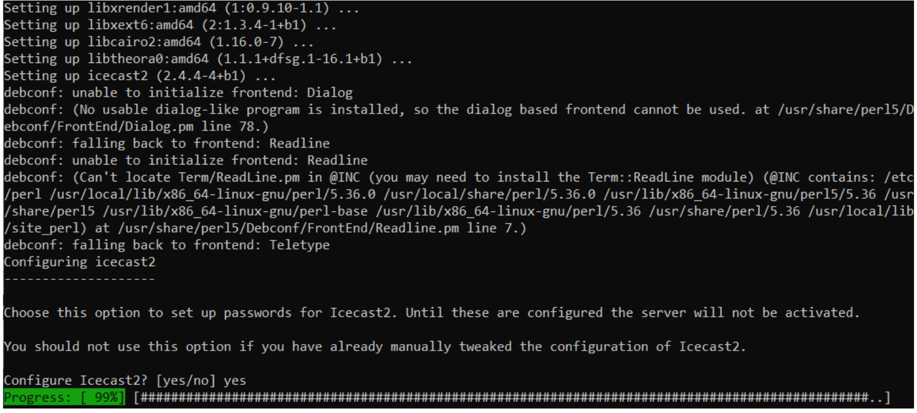
Figure 6: Basic software installation



```
root@cddccda2b861:/# apt install systemctl -y
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  ca-certificates krb5-locales libexpat1 libgpm2 libgssapi-krb5-2 libk5crypto3 libkeyutils1 libkrb5-3 libkrb5support0
  libncursesw6 libnsl2 libproc2-0 libpython3-stdlib libpython3.11-minimal libpython3.11-stdlib libreadline8
  libsqlite3-0 libssl3 libtirpc-common libtirpc3 media-types openssl procps psmisc python3 python3-minimal python3.11
  python3.11-minimal readline-common
Suggested packages:
  gpm krb5-doc krb5-user python3-doc python3-tk python3-venv python3.11-venv python3.11-doc binutils binfmt-support
  readline-doc tini | dumb-init
The following NEW packages will be installed:
  ca-certificates krb5-locales libexpat1 libgpm2 libgssapi-krb5-2 libk5crypto3 libkeyutils1 libkrb5-3 libkrb5support0
  libncursesw6 libnsl2 libproc2-0 libpython3-stdlib libpython3.11-minimal libpython3.11-stdlib libreadline8
  libsqlite3-0 libssl3 libtirpc-common libtirpc3 media-types openssl procps psmisc python3 python3-minimal python3.11
  python3.11-minimal readline-common systemctl
0 upgraded, 30 newly installed, 0 to remove and 0 not upgraded.
Need to get 12.1 MB of archives.
After this operation, 40.0 MB of additional disk space will be used.
Get:1 http://deb.debian.org/debian bookworm/main amd64 libssl3 amd64 3.0.9-1 [2016 kB]
Get:2 http://deb.debian.org/debian bookworm/main amd64 libpython3.11-minimal amd64 3.11.2-6 [813 kB]
Get:3 http://deb.debian.org/debian bookworm/main amd64 libexpat1 amd64 2.5.0-1 [99.3 kB]
Get:4 http://deb.debian.org/debian bookworm/main amd64 python3.11-minimal amd64 3.11.2-6 [2064 kB]
root@cddccda2b861:/#
```

After completing the systemctl software, the Icecast2 software installation process will be carried out, at the end of the installation you will be asked to configure the parameters, type yes to perform the configuration. The result will be shown in Figure 7. The execution will be carried out through the command: apt install icecast2 –y

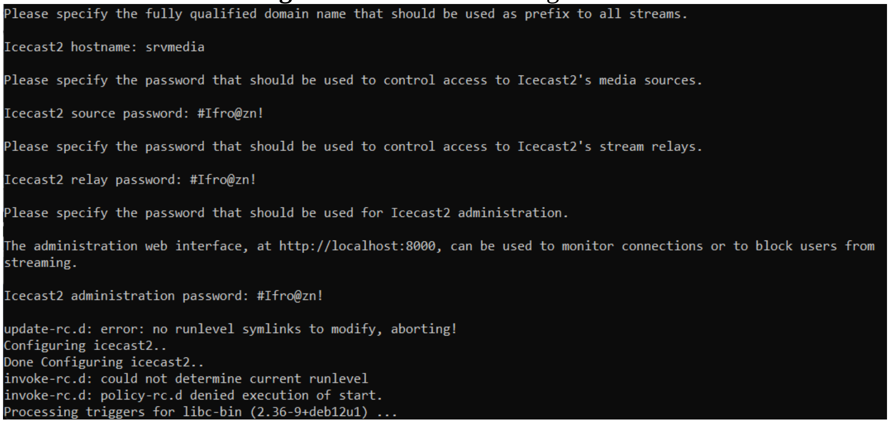
Figure 7: Installing and configuring the Icecast2 software



```
Setting up libxrender1:amd64 (1:0.9.10-1.1) ...
Setting up libxext6:amd64 (2:1.3.4-1+b1) ...
Setting up libcairo2:amd64 (1.16.0-7) ...
Setting up libtheora0:amd64 (1.1.1+dfsg.1-16.1+b1) ...
Setting up icecast2 (2.4.4-4+b1) ...
debconf: unable to initialize frontend: Dialog
debconf: (No usable dialog-like program is installed, so the dialog based frontend cannot be used. at /usr/share/perl5/D
ebconf/FrontEnd/Dialog.pm line 78.)
debconf: falling back to frontend: Readline
debconf: unable to initialize frontend: Readline
debconf: (Can't locate Term/ReadLine.pm in @INC (you may need to install the Term::ReadLine module) (@INC contains: /etc
/perl /usr/local/lib/x86_64-linux-gnu/perl/5.36.0 /usr/local/share/perl/5.36.0 /usr/lib/x86_64-linux-gnu/perl5/5.36 /usr
/share/perl5 /usr/lib/x86_64-linux-gnu/perl-base /usr/lib/x86_64-linux-gnu/perl/5.36 /usr/share/perl/5.36 /usr/local/lib
/site_perl) at /usr/share/perl5/Debconf/FrontEnd/Readline.pm line 7.)
debconf: falling back to frontend: Teletype
Configuring icecast2
--------------------

Choose this option to set up passwords for Icecast2. Until these are configured the server will not be activated.

You should not use this option if you have already manually tweaked the configuration of Icecast2.

Configure Icecast2? [yes/no] yes
Progress: [ 99%] [################################################################################################..]
```

Once the configuration process has started, you will be asked for the name of the streaming server, the access port to the service and the access passwords, resulting in Figure 8.

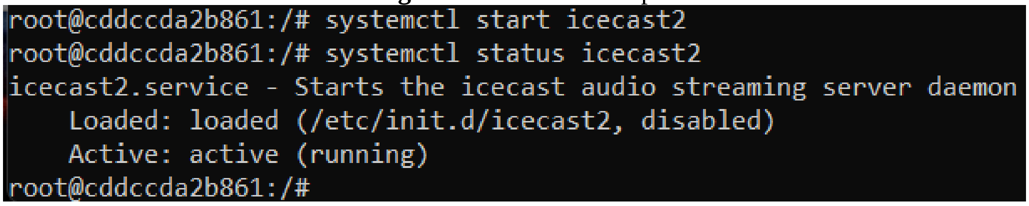
Figure 8: Parameters configuration



```
Please specify the fully qualified domain name that should be used as prefix to all streams.

Icecast2 hostname: srvmedia

Please specify the password that should be used to control access to Icecast2's media sources.

Icecast2 source password: #Ifro@zn!

Please specify the password that should be used to control access to Icecast2's stream relays.

Icecast2 relay password: #Ifro@zn!

Please specify the password that should be used for Icecast2 administration.

The administration web interface, at http://localhost:8000, can be used to monitor connections or to block users from
streaming.

Icecast2 administration password: #Ifro@zn!

update-rc.d: error: no runlevel symlinks to modify, aborting!
Configuring icecast2..
Done Configuring icecast2..
invoke-rc.d: could not determine current runlevel
invoke-rc.d: policy-rc.d denied execution of start.
Processing triggers for libc-bin (2.36-9+deb12u1) ...
```

Once the Icecast2 software installation and parameterization process has been completed, it is necessary to enable the service and check its active status, resulting in Figure 9. The service is enabled using the following command: systemctl start icecast2

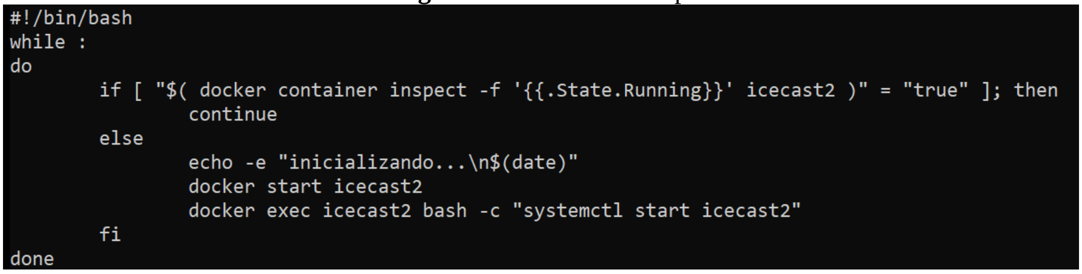
Figure 9: Services startup



```
root@cddccda2b861:/# systemctl start icecast2
root@cddccda2b861:/# systemctl status icecast2
icecast2.service - Starts the icecast audio streaming server daemon
    Loaded: loaded (/etc/init.d/icecast2, disabled)
    Active: active (running)
root@cddccda2b861:/#
```

After enabling the Icecast2 initialization service, a bash script was created, which will perform the automatic initialization of the icecast2 service in the container, as can be seen in Figure 10:

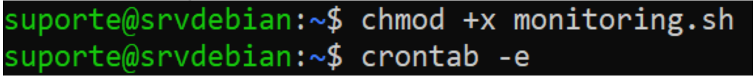
Figure 10: Services startup



```
#!/bin/bash
while :
do
        if [ "$( docker container inspect -f '{{.State.Running}}' icecast2 )" = "true" ]; then
                continue
        else
                echo -e "inicializando...\n$(date)"
                docker start icecast2
                docker exec icecast2 bash -c "systemctl start icecast2"
        fi
done
```

After creating the bash script, it is necessary to apply execution permission to the script, and then crontab was opened to add the script to the task scheduling service, as can be seen in Figure 11:

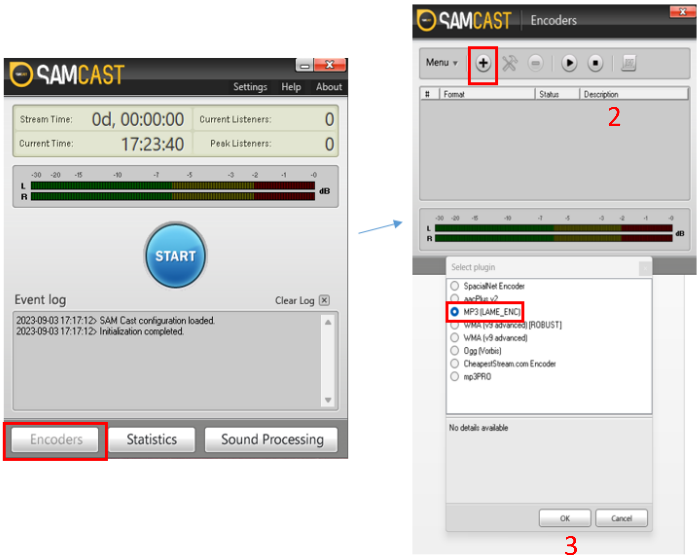
Figure 11: Applying execute permission



```
suporte@srvdebian:~$ chmod +x monitoring.sh
suporte@srvdebian:~$ crontab -e
```

Once the services are configured on the Icecast2 server, it is time to configure the computer and the mobile device that will be the player for the transmissions. The first software to be configured is Sam Cast, after the standard installation, open the Sam Cast software and open the Encoders tab as shown in figure 12: In the Encoders tab, it is necessary to select the " + " button, after selecting the plugin option " MP3 (LAME_ENC)" and click OK, as shown in figure 12:

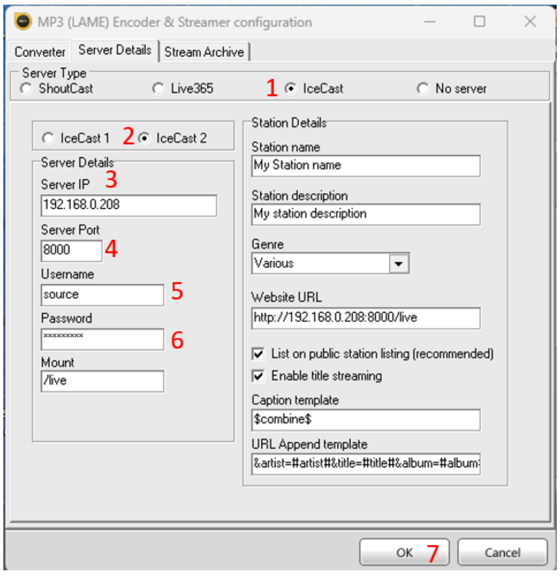
Figure 12: Configuring Encoders



```
2023-09-03 17:17:12> SAM Cast configuration loaded.
2023-09-03 17:17:12> Initialization completed.
```

Next, the Icecast2 server addresses will be added, in marking 1 the type of server is selected, in the case under study it is IceCast. In tag 2, the version of the Icecast server is selected, in this case version 2. In tag 3, the IP address of the server is placed. Marking 4 contains the port on which the Icecast server is listening. Marking 5 and 6 is the username and password that will be used to connect to the Icecast server. Marking 7 completes the configuration as shown in figure 13.

Figure 13: Samcast server address configuration



Server Type: ○ ShoutCast ○ Live365 ● IceCast ○ No server

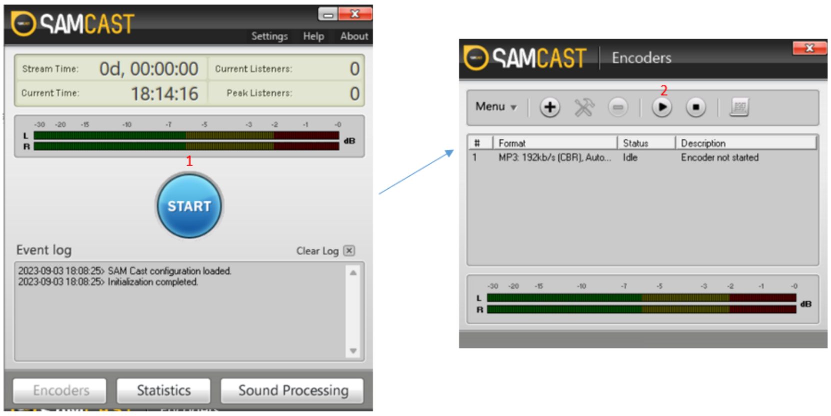
○ IceCast 1 ● IceCast 2

Server Details
Server IP: 192.168.0.208
Server Port: 8000
Username: source
Password: xxxxxxxxx
Mount: /live

Station Details
Station name: My Station name
Station description: My station description
Genre: Various
Website URL: http://192.168.0.208:8000/live
☑ List on public station listing (recommended)
☑ Enable title streaming
Caption template: $combine$
URL Append template: &artist=#artist#&title=#title#&album=#album#

Settings made, it is time to start the SamCast application so that it can connect to the server and thus start online transmissions. At dial 1, the Samcast transmission starts and at dial 2, the Encoder transmission starts, as shown in figure 14.

Figure 14: Starting Samcast



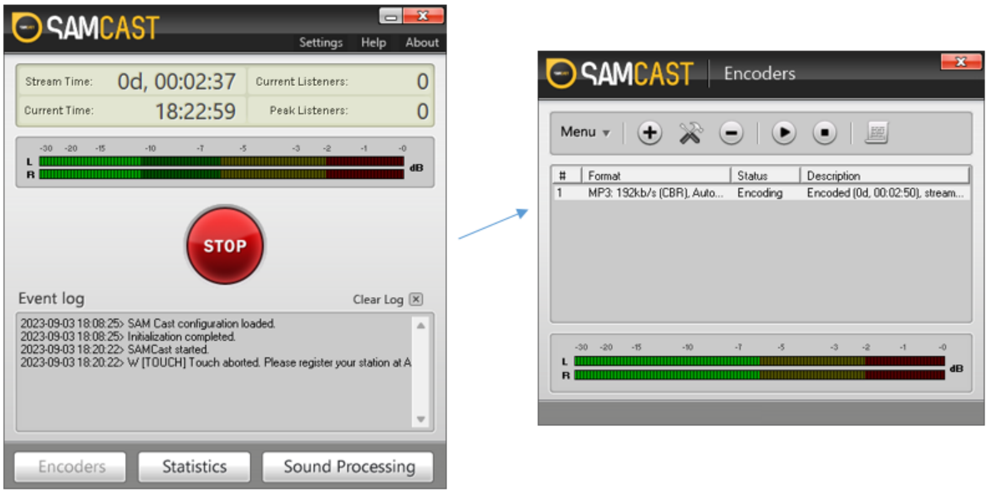
Stream Time: 0d, 00:00:00
Current Time: 18:14:16
Current Listeners: 0
Peak Listeners: 0

```
2023-09-03 18:08:25> SAM Cast configuration loaded.
2023-09-03 18:08:25> Initialization completed.
```

#	Format	Status	Description
1	MP3: 192kb/s (CBR), Auto...	Idle	Encoder not started

Transmission services started correctly, the return will be as in figure 16:

Figure 14: Streaming service started successfully.



Stream Time: 0d, 00:02:37
Current Time: 18:22:59
Current Listeners: 0
Peak Listeners: 0

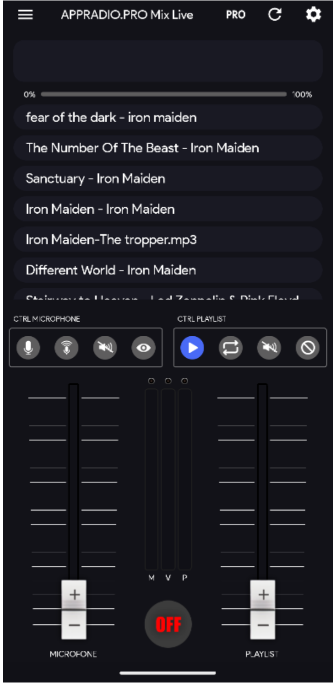
```
2023-09-03 18:08:25> SAM Cast configuration loaded.
2023-09-03 18:08:25> Initialization completed.
2023-09-03 18:20:22> SAMCast started.
2023-09-03 18:20:22> W [TOUCH] Touch aborted. Please register your station at A
```

#	Format	Status	Description
1	MP3: 192kb/s (CBR), Auto...	Encoding	Encoded (0d, 00:02:50), stream...

With the transmission service started and connected, just choose a preferred player and all media played will be transmitted to the web radio.

For online transmissions from a mobile device with Android Operating System, the Mix Live application will be used, with the use of this application it is necessary to have a playlist saved on the device, in this way the application will play the content stored locally. The configuration is performed by clicking on item 1 as shown in figure 15:

Figure 15: Starting online streaming from an Android device



fear of the dark - iron maiden

The Number Of The Beast - Iron Maiden

Sanctuary - Iron Maiden

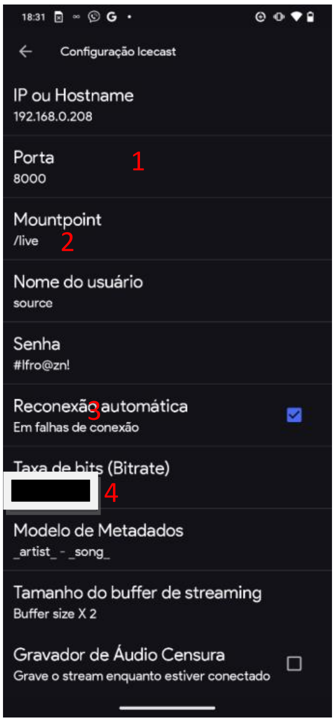
Iron Maiden - Iron Maiden

Iron Maiden-The tropper.mp3

Different World - Iron Maiden

After opening the configuration, it is time to add the server connection information. In item 1 the IP address or hostname is added. In item 2, the Icecast2 listening port is added. In item 3 and 4 the name and password are added. As we can see in figure 16.

Figure 16: Icecast2 server setup on Android device



Configuração Icecast

IP ou Hostname
192.168.0.208

Porta
8000

Mountpoint
/live

Nome do usuário
source

Senha
#lfro@zn!

Reconexão automática ☑
Em falhas de conexão

Taxa de bits (Bitrate)
[redacted]

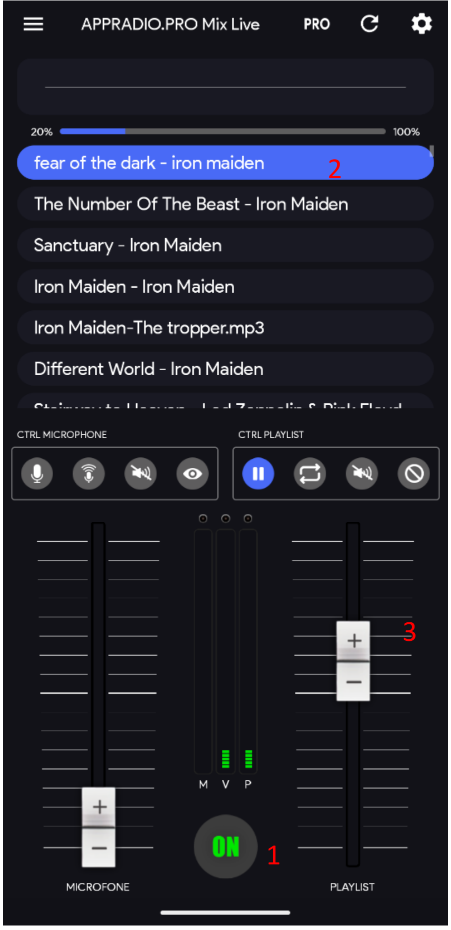
Modelo de Metadados
artist - _song_

Tamanho do buffer de streaming
Buffer size X 2

Gravador de Áudio Censura ☐
Grave o stream enquanto estiver conectado

Once the settings have been made as instructed, it is time to make the connection, for that, just press the “off” button to turn on your transmission, select the audio that will be played and increase the volume of the playlist, as shown in figure 17.

Figure 17: Playing the audio



fear of the dark - iron maiden

The Number Of The Beast - Iron Maiden

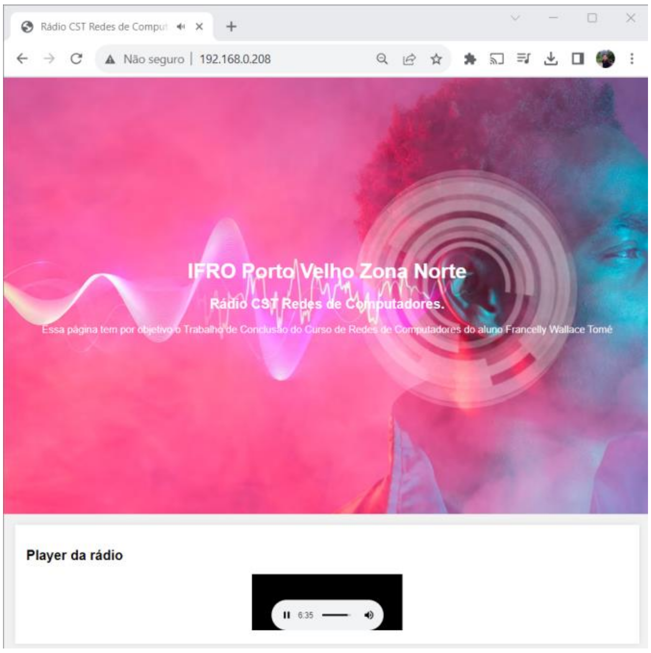
Sanctuary - Iron Maiden

Iron Maiden - Iron Maiden

Iron Maiden-The tropper.mp3

Different World - Iron Maiden

Once the transmission settings are done, the client just needs to access the address made available for radio access, in the example the address will be the IP of the server, as shown in figure 19:



IFRO Porto Velho Zona Norte

Rádio CST Redes de Computadores.

Essa página tem por objetivo o Trabalho de Conclusão do Curso de Redes de Computadores do aluno Francelly Wallace Tomé

Player da rádio

IV. Conclusion

The educational environment requires clear and objective communication at all times. Internal communication is a key to the success of the organization. The lack of communication between departments and students creates information gaps and hinders the progress of various processes.

At the Federal Institute of Education, Science and Technology of Rondônia (IFRO), Campus Porto Velho Zona Norte, there are information gaps that need to be overcome. Given this scenario, the proposed solution was the implementation of a web radio as a communication instrument between the institution and students.

Web radio offers a flexible and dynamic platform for real-time transmission. The planet is experiencing the digital era, people are constantly connected, therefore, the implementation of a web radio is the perfect fit for communication in the institution. Functioning not only for information and news, but also as a form of entertainment.

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