Wi-Fi channels and Ad-Hoc Infra Toggle

Mini Project for the Degree of

Master of Computer Applications

by

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May 2023

Acknowledgment

We are expressing our sincere gratitude to all those who have contributed to successfully completing this college project report.

Firstly, we would like to thank my project guide, **Prof. Neeraj Tyagi,** for providing me with invaluable guidance and support throughout the project. Their constant encouragement, insightful feedback, and constructive criticism helped me to improve my work and achieve better results.

We also extend my heartfelt thanks to all the faculty members of our college who have taught me various subjects that have contributed to the development of our knowledge and skills.

We would like to acknowledge the contribution of my classmates and friends, who have provided me with their valuable insights and support during the project. Their encouragement and motivation have been instrumental in keeping me focused and motivated.

Finally, we would like to thank everyone who has contributed to this project in any way. Your support and encouragement have been invaluable in making this project a success.

Special thanks to **Dr. Mayank Pandey.**

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Goals of the project

★ Design the map for the Wi-Fi access point layout in the Swami Vivekanand Boys Hostel.

★ Develop a method to stream movies between two devices in auto-switch mode between ad hoc and infrastructure.

1. Wireless LAN

Wireless local area networks use infrared or radio waves to connect wireless devices to a network and enable data transmission between users within the coverage area without the restrictions of wire and cable.

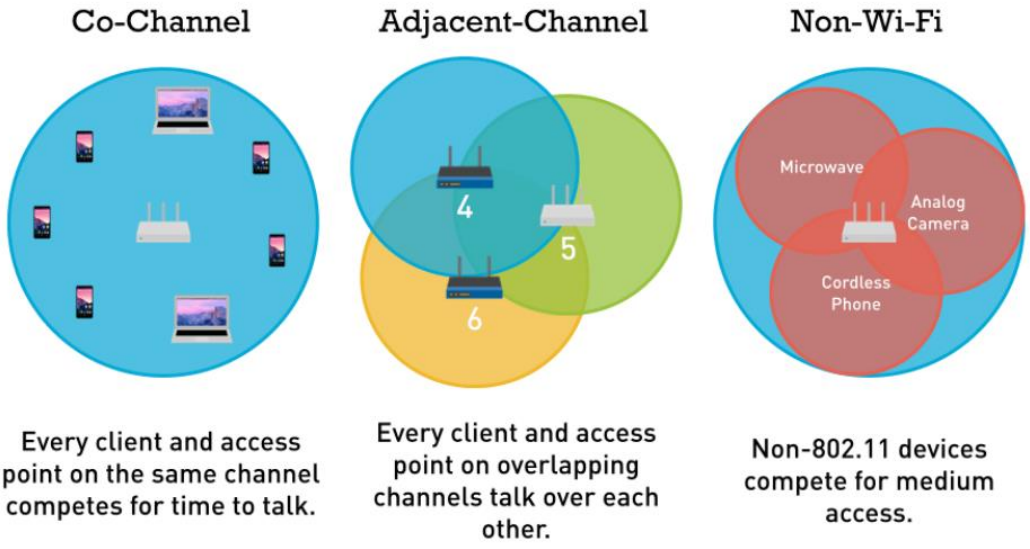
1.1 Wi-Fi Standards

Wireless standards are a set of services and protocols that dictate how your Wi-Fi network (and other data transmission networks) acts. The most common wireless standard we know is the IEEE 802.11 Wireless LAN.

1.2 The 802.11 standard for a wireless network

IEEE Standard	802.11b	802.11a	802.11g	802.11n	802.11ac
Release Year	1999	1999	2003	2009	2012
Frequency	2.4GHz	5GHz	2.4GHz	2.4or5GHz	5GHz
Data Rate	11Mbps	54Mbps	54Mbps	600Mbps	1Gbps
Modula-tion	DSSS	OFDM	DSSS,OFDM	OFDM	OFDM

2. Wi-Fi Channels

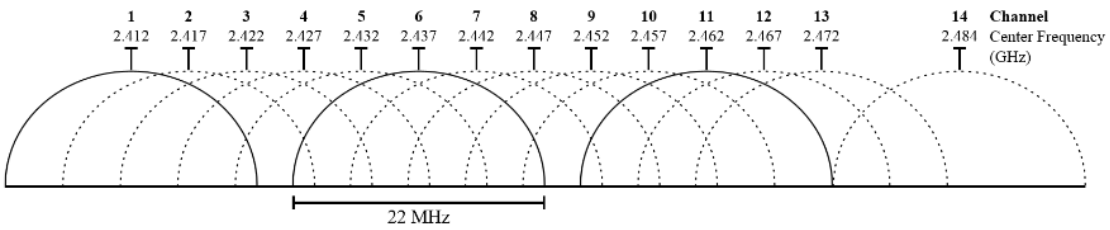


There are two frequency bands that are available for working on Wi-Fi.

1. 2.4GHz Band
2. 5GHz Band

2.1 Channels on the 2.4GHz band

There are 13 channels available on the 2.4GHz band, channels 1 – 13. You should never use overlapping channels that are close to one another. This is so that the interference between two radio signals, which occurs when their frequency overlap, can be avoided. There are only actually three channels out of the 13 that may be used entirely without any overlap, as the majority of the channels overlap. You can use channels 1,6, and 11 on three different Wi-Fi transmitters without them overlapping each other.

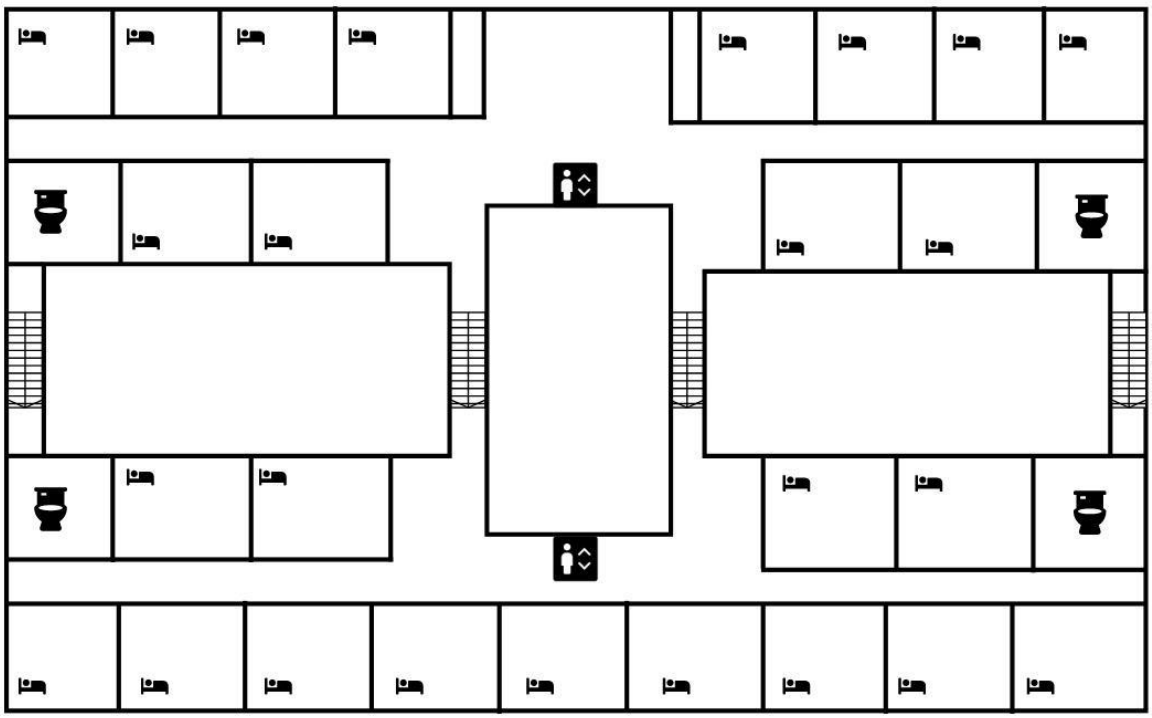


Additionally, you might use (1,6,12), (1,7,13), or (1,8,13). But there is a reason why 1,6,11 is preferable to the other combinations. This is due to the fact that if two nearby Wi-Fi devices are operating on the same radio channel, they will be able to recognize one another and possibly cooperate to reduce interference. However, if they operate on dissimilar channels that overlap, they cannot detect one another and cannot stop the interference.

2.2 Channels on the 5GHz band

On the 5GHz spectrum, there are a lot more non-overlapping channels accessible. No channels are overlapped since the 5GHz channels are further distant from one another. The 24 non-overlapping channels in the 5GHz Wi-Fi channel spectrum are split into four groups called UNII-1, UNII-2, UNII-2 extended, UNII-3, and ISM. Each part has its own suggested applications and limitations. Additionally, each channel is 20 MHz broad, with a 20 MHz gap between each channel. The best 5G Wi-Fi channels are generally 36, 40, 44, and 48 since they have the lowest channel overlap rates.

3. SVBH Floor Plan



The SVBH floor has a total of 12 rooms in one wing and has two wings on each floor. It stretches to 70m long and 50m wide. For such an architecture, we need to assign minimal access points with optimum coverage.

The current state of SVBH does not have any access points, but it works on LAN.

To study the range and interference of the CISCO router, we tested the access points available in the Patel Hostel building based on their range, frequency, and channel setup.

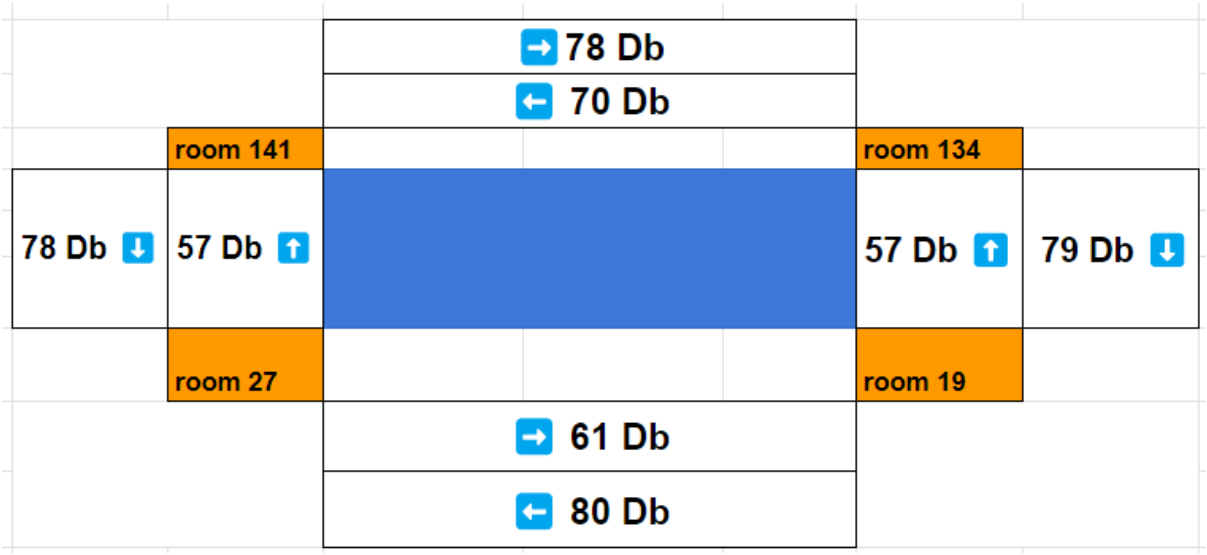
We studied four routers of the mentioned MAC address, two on the ground floor, and the rest were installed at first.

ROOM NO	MAC ADDRESS	FREQ	CHANNEL
19	C4: B3 : 6A: 1D : F3 : 0F	5 GHZ	64
27	C4: B3 : 6A: 1D : F6 : C0	2.4 GHZ	11
134	C4: B3 : 6A: 91 : 61 : 00	2.4 GHZ	11
141	C4: B3 : 6A: 91 : 5C : 0F	5 GHZ	60

As it is clearly visible from the table above, two routers were of 5GHz and two of 2.4GHz in alternate sequences. This is done to minimize interference between the channels of the same band.

This was the reading of the signal strength and distance between each router from each room (point of connection).

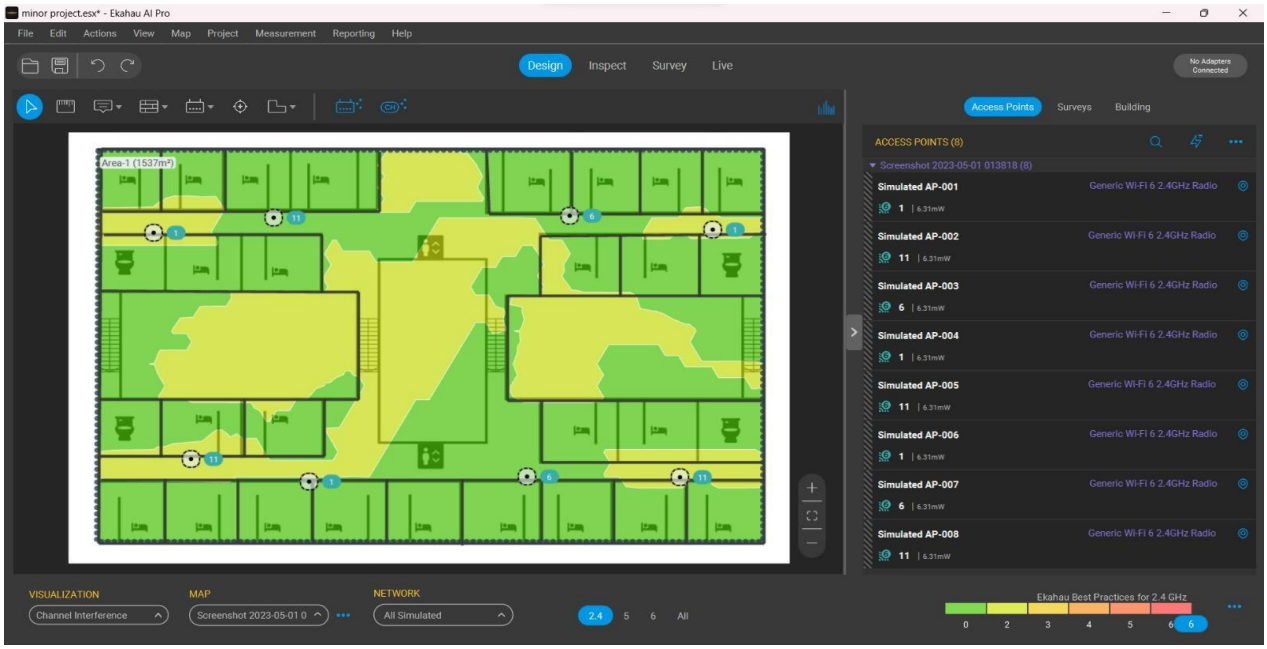
	C4: B3 : 6A: 1D : F3 : 0F	C4: B3 : 6A: 1D : F6 : C0	C4: B3 : 6A: 91 : 61 : 00	C4: B3 : 6A: 91 : 5C : 0F
ROOM 19	DISTANCE - 0 M STRENGTH - 46 DB	DISTANCE - 22 M STRENGTH - 61 db	DISTANCE - 4 M STRENGTH - 79 Db	NA
ROOM 27	DISTANCE - 22 M STRENGTH - 80 DB	DISTANCE - 0 M STRENGTH - 59 DB	NA	DISTANCE - 4 M STRENGTH - 78 DB
ROOM 134	DISTANCE - 2 M STRENGTH - 57 DB	NA	DISTANCE - 0 M STRENGTH - 41 DB	DISTANCE - 22 M STRENGTH - 78 DB
ROOM 141	NA	DISTANCE - 2M STRENGTH - 57Db	DISTANCE - 22 STRENGTH - 70 DB	DISTANCE - 0 STRENGTH - 42 DB



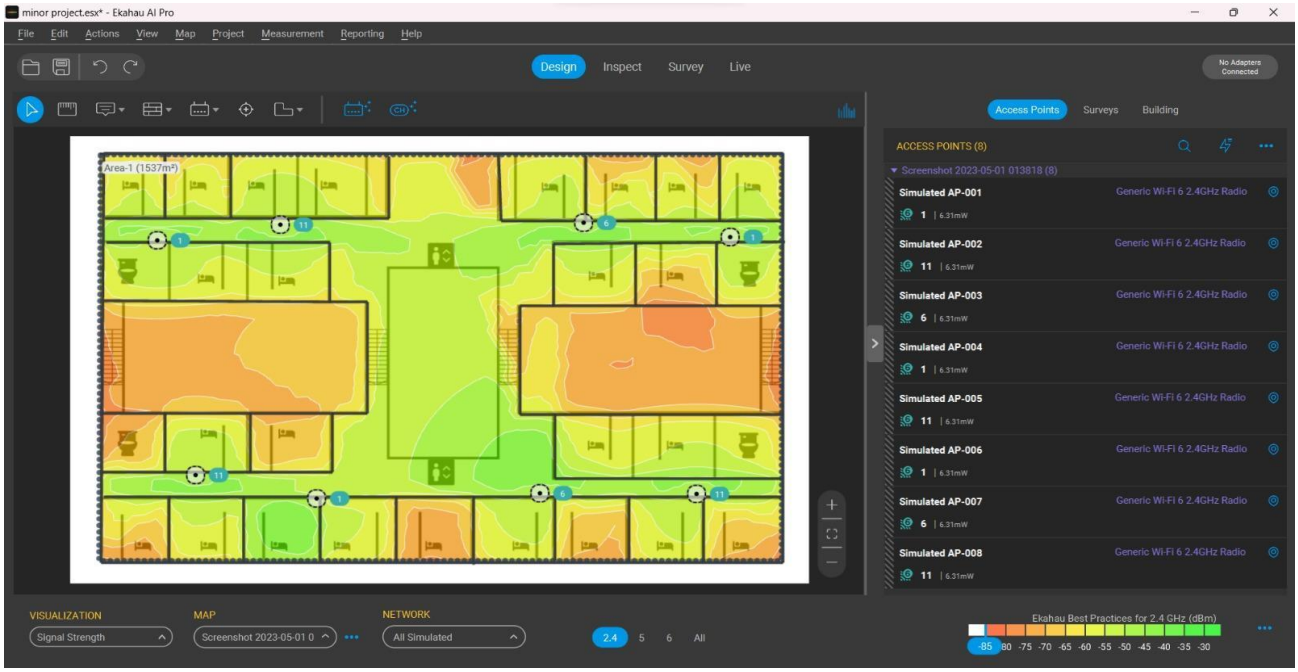
The above graph shows the layout of the four rooms and four access points that we tested. It shows that vertically upward coverage of the APs is approx. 57 dB., and horizontal coverage is around 70-80 dB.

We generated the following map for the first floor of SVBH using a site planning software called *Ekahau Pro.*

The following heatmap shows signal interference of Wi-Fi signals of the same frequency. The light green portion has 1 or 2 interference, and dark green shows 0 interference.



This heatmap shows the signal strength for the Wi-Fi access points. the greener portion shows good coverage of the Wi-Fi. and the red or orange portion shows the weak strength of the Wi-Fi.



4. What is an Ad-Hoc mode and Infrastructure mode?

There are two types of Wi-Fi modes

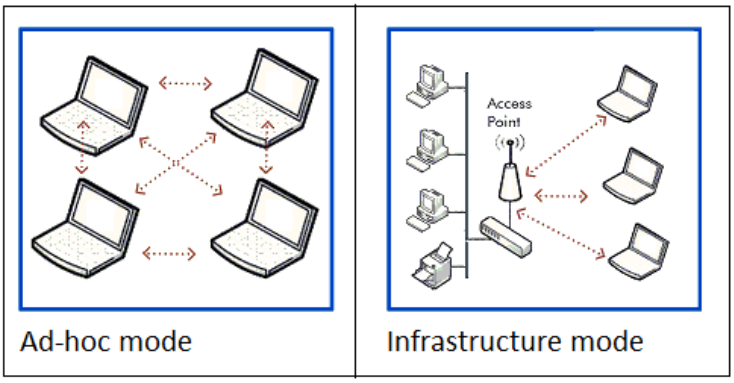
- **Infrastructure**
- **Ad-hoc**

4.1 Infrastructure mode:

Infrastructure mode is a method that is used to connect to wireless networks, which allows devices such as laptops and smartphones to connect to a wireless network through an Access Point. Wireless Access Points are typically routers connected to computers. It is the basic wireless connection that our routers by default establish.

4.2 Ad-Hoc

In Ad-Hoc mode, unlike infrastructure mode, devices communicate with each other directly instead of relying on access points as in wireless LANs for data transfer and communication. In this mode, all devices connect in a peer-to-peer communication manner, meaning that each device acts as both a client and an Access Point at the same time. The wireless adaptors of the devices need to be configured to enable Ad hoc Mode. In this mode, you must use the same channel name and SSID for a live connection.



5. Creating Ad-Hoc Infra Toggle Mode

We need to create a program that switches between Ad-Hoc mode and infrastructure mode automatically. The purpose of this is that when we stream a movie from one device to another device, If the access point connecting the two devices in infrastructure mode switches off, the program will automatically detect that and toggle the connection into ad-hoc mode.

5.1 Connection in Ad-Hoc Mode

The following shell script is used to set the device into Ad-Hoc mode.

```
#! /bin/sh
sudo iw dev
sudo iwconfig wlp2s0 mode ad-hoc
sudo iw dev
sudo ip link set wlp2s0 up
sudo rfkill unblock Wi-Fi
sudo ip link set wlp2s0 up
sudo iw dev wlp2s0 ibss join ibstest 2412 key d:1:5chrs
sudo iw dev
sudo iw dev wlp2s0 link
sudo ip addr add 192.168.0.150/24 broadcast 192.168.0.255 dev wlp2s0
sudo ip route add 192.168.0.0/24 dev wlp2s0
```

We created and save the above file with the name ‘createAdhoc.sh’ and run it in the terminal on the two devices that we need to connect in ad-hoc mode.

In the second device, we will change the IP address from 192.168.0.150/24 to 192.168.0.175/24 like

“ sudo ip addr add 192.168.0.175/24 broadcast 192.168.0.255 dev wlp2s0 ”

Once we save the file and run it on the terminal, we will get the following output:

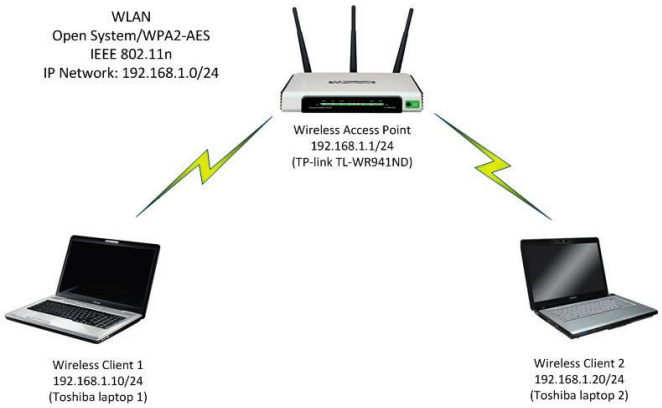
```
manish@manish-TUF-Gaming-FX505DY-FX505DY:~/Desktop/nitin$ ./createAdhoc.sh
[sudo] password for manish:
phy#0
        Interface wlp2s0
                ifindex 3
                wdev 0x1
                addr dc:f5:05:27:70:7b
                type managed
                txpower 20.00 dBm
                multicast TXQ:
                        qsz-byt qsz-pkt flows   drops   marks   overlmt hashcol
                        16565   108     167     0       0       0       0
phy#0
        Interface wlp2s0
                ifindex 3
                wdev 0x1
                addr dc:f5:05:27:70:7b
                type IBSS
                txpower 20.00 dBm
                multicast TXQ:
                        qsz-byt qsz-pkt flows   drops   marks   overlmt hashcol
                        16565   108     167     0       0       0       0
RTNETLINK answers: Operation not possible due to RF-kill
command failed: Operation not supported (-95)
phy#0
        Interface wlp2s0
                ifindex 3
                wdev 0x1
                addr dc:f5:05:27:70:7b
                type managed
                txpower 20.00 dBm
                multicast TXQ:
                        qsz-byt qsz-pkt flows   drops   marks   overlmt hashcol
                        16565   108     167     0       0       0       0
Not connected.
RTNETLINK answers: File exists
```

To check if the ad hoc connection has been established, we ping the connected device using its IP address.

```
root@piyush-Inspiron-5570:/home/piyush# ping 192.168.0.150 -c 10
PING 192.168.0.150 (192.168.0.150) 56(84) bytes of data.
64 bytes from 192.168.0.150: icmp_seq=1 ttl=64 time=5.05 ms
64 bytes from 192.168.0.150: icmp_seq=2 ttl=64 time=0.940 ms
64 bytes from 192.168.0.150: icmp_seq=3 ttl=64 time=0.970 ms
64 bytes from 192.168.0.150: icmp_seq=4 ttl=64 time=1.12 ms
64 bytes from 192.168.0.150: icmp_seq=5 ttl=64 time=1.03 ms
64 bytes from 192.168.0.150: icmp_seq=6 ttl=64 time=11.3 ms
64 bytes from 192.168.0.150: icmp_seq=7 ttl=64 time=1.37 ms
64 bytes from 192.168.0.150: icmp_seq=8 ttl=64 time=2.02 ms
64 bytes from 192.168.0.150: icmp_seq=9 ttl=64 time=0.980 ms
64 bytes from 192.168.0.150: icmp_seq=10 ttl=64 time=0.916 ms
```

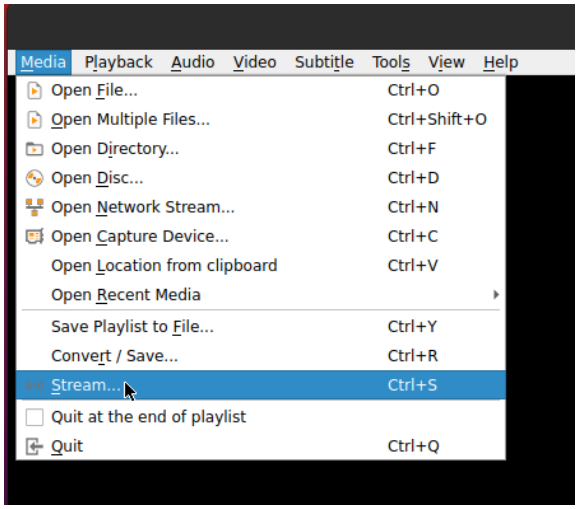
5.2 Connection through Access Point

We connect two devices through an access point and give each device a static IP address.

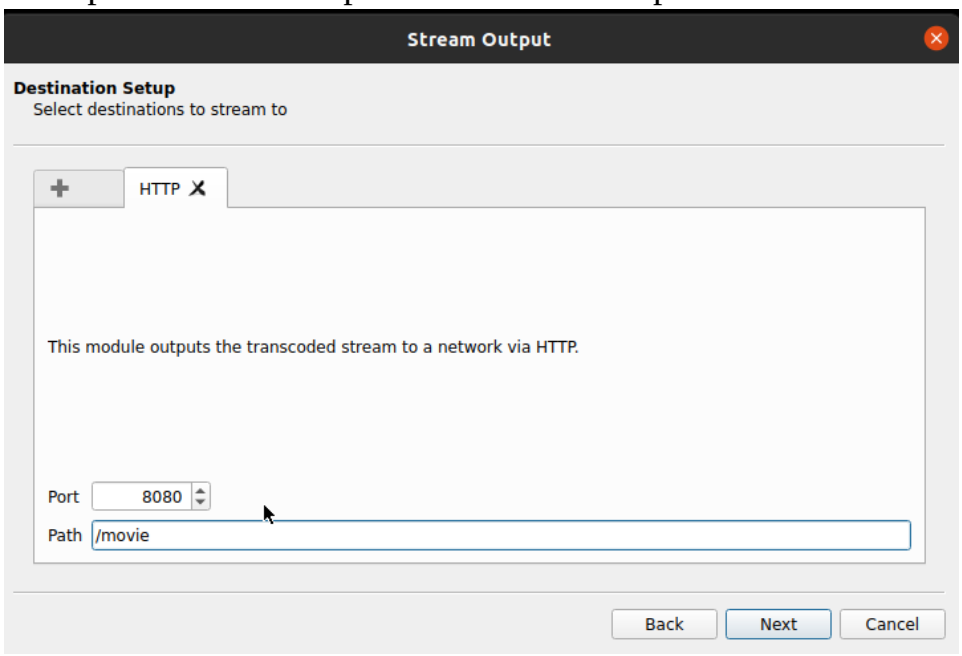


5.3 Setting up VLC Client and Host

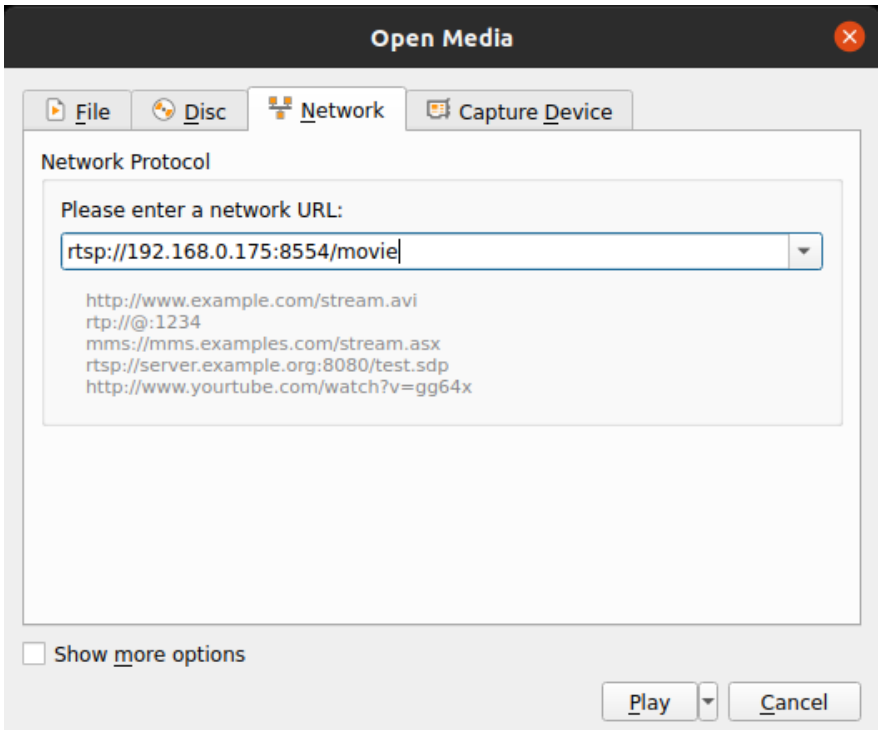
Now we set up our VLC Host laptop where we start the movie. Let us make the first device with IP 192.168.0.150/24 as a host. Then do the following steps:



Set a port number and path on the host computer.

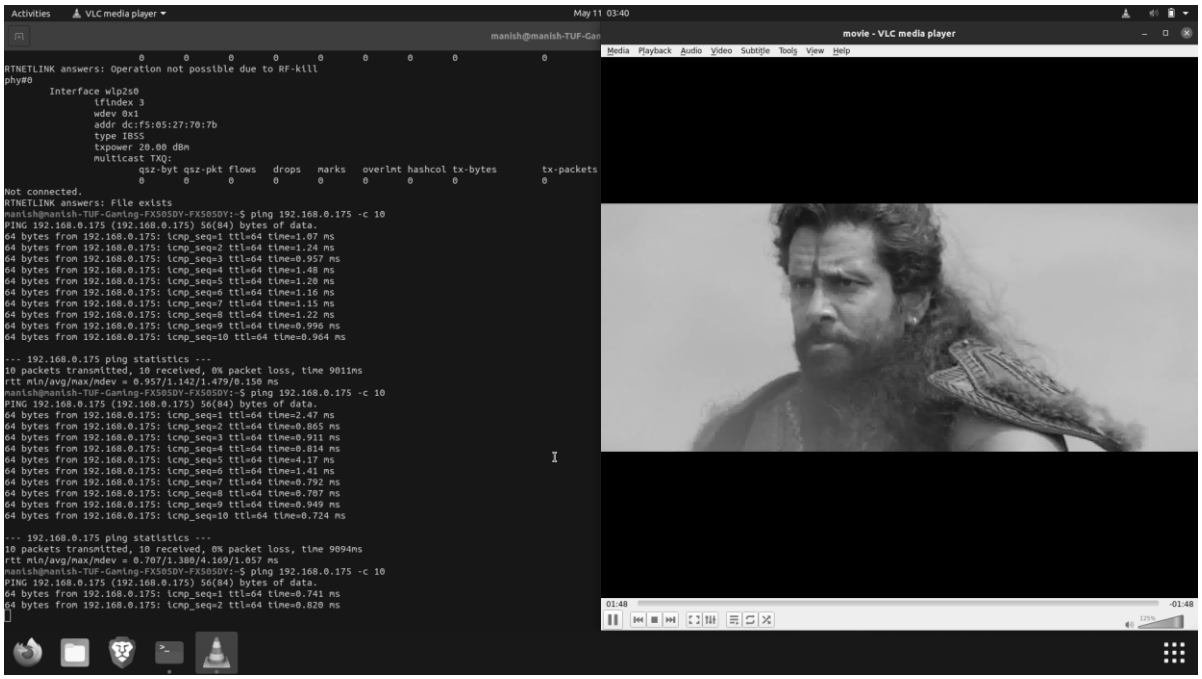


For the VLC client device, we input the IP address and port number in the following manner:

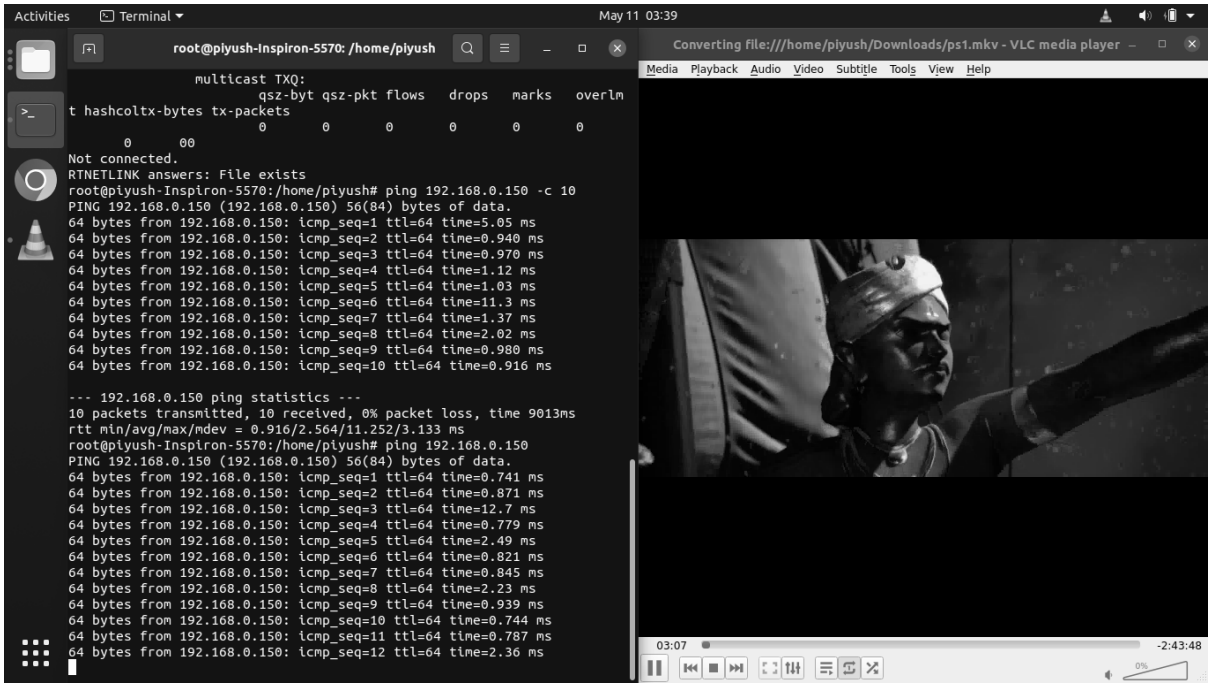


Now the streaming is live and working. We can see the movie streaming on the client laptop that is being played on the host laptop.

This is a screenshot of the client side of the laptop



This is a screenshot from the host side of the laptop



5.4 Connection in auto switch/toggle mode

```
#!/bin/bash

# Set the IP address of the server
server_ip="192.168.0.175"
# Set the access point network details
ap_ssid="TP_link_0755"
ap_password="nitin80085"
# Set the ad hoc network details
adhoc_ssid="ibstest"
adhoc_password="5chrs"
video_file="http://192.168.0.175:8080/movie"
adhoc=1

# Function to check network connectivity
check_network() {
    ping -c 1 $server_ip > /dev/null 2>&1
    return $?
}

# Function to switch to access point mode
switch_to_ap() {
    echo "Switching to access point mode..."
    current_ssid=$(nmcli -t -f active,ssid dev Wi-Fi | awk -F: '$1=="yes" {print $2}')

    if [ "$current_ssid" == "$ap_ssid" ]; then
        echo "Already connected to access point. Resuming playback..."
        #vlc "$video_file"
        #vlc --file-caching=50000 --network-caching=10000 "$video_file"
    else
        sudo nmcli radio Wi-Fi on
        sudo nmcli device Wi-Fi connect "$ap_ssid" password "$ap_password"
        echo "Connected to access point. Resuming playback..."
        #vlc "$video_file"
        #vlc --file-caching=50000 --network-caching=10000 "$video_file"
    fi
}

switch_to_adhoc() {
    echo "Switching to ad hoc mode..."
    adhoc_connection=$(nmcli -t -f NAME con show --active | grep "$adhoc_ssid")

    if [ -n "$adhoc_connection" ]; then
        echo "Ad hoc network already created. Resuming playback..."
        #vlc --file-caching=50000 --network-caching=10000 "$video_file"
        #vlc "$video_file"
    else
      sudo nmcli radio Wi-Fi off
      sudo iw dev
      sudo iwconfig wlp2s0 mode ad-hoc
      sudo iw dev
      sudo ip link set wlp2s0 up
      sudo rfkill unblock Wi-Fi
      sudo ip link set wlp2s0 up
      sudo iw dev wlp2s0 ibss join ibstest 2412 key d:1:5chrs
```

```
        sudo iw dev
        sudo iw dev wlp2s0 link
        sudo ip addr add 192.168.0.150/24 broadcast 192.168.0.255 dev wlp2s0
        sudo ip route add 192.168.0.0/24 dev wlp2s0
        echo "Connected to ad hoc network. Resuming playback..."
        #vlc --file-caching=50000 --network-caching=10000 "$video_file"
    fi
}


# Check the network availability periodically
while true; do
    check_network
    if [ $? -eq 0 ]; then
        # Access point is available, switch to it
        echo "Ping Not available ap mode"
        switch_to_ap
    else
        # Access point is not available, switch to ad hoc mode
        switch_to_adhoc
    fi

    # Wait for some time before checking the network again
    sleep 2
done
```

Save the above code as ‘toggle.sh’

Change the file permission as executable using the command chmod 777 toggle.sh

Now run this file in the terminal using ./toggle.sh

Now we have completed all our steps and both the device is ready and connected in auto toggle mode.

6. Conclusion

6.1 Summary of the project

In the hostel access point map project, we assign four access points on each wing, each of 2.4 GHz. This kind of layout will provide optimal coverage of good strength of wi-fi signal, especially inside the rooms and the lobby where the Wi-Fi will be most used.

The weak signal area is limited to the common rooms, elevator shafts, and washrooms, where Wi-Fi will be least used.

In the second part of the project, we establish the connection between two different devices in auto-switch mode i.e., the device connection will toggle from infrastructure mode to ad hoc mode or vice versa depending upon whether we are getting any signal from the access point.

6.2 Learning from the Project

Wi-Fi Networks: Gained knowledge on different Wi-Fi modes and how to configure a bunch of Wi-Fi Access points for optimal performance.

Effective communication: The importance of clear and regular communication between team members cannot be overstated. This can help to avoid misunderstandings and ensure everyone is on the same page.

Planning and organization: Proper planning and organization can help ensure the project stays on track and meets its objectives. This can include creating a project timeline, breaking down tasks into manageable chunks, and assigning responsibilities.

Flexibility and adaptability: Projects rarely go exactly according to plan, so being flexible and adaptable is crucial. This can involve adjusting timelines, revising objectives, or changing strategies as needed.

Continual learning: Projects can be great opportunities to learn new skills or technologies. Keeping an open mind and seeking out opportunities to learn can help ensure continued growth and development.

7. References

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- Ad hoc wireless networks: Architecture and protocols/Murthy C S R