Security Vulnerabilities of Popular Smart Home Appliances

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About the Presenter:

- Fida Hussain is currently a full time PhD student at Canterbury Christ Church University working on IoT to develop security framework for Smart Home Automation.
- Fida has published a book chapter on Intrusion Detection System(IDS) on Smart Home security “Hybrid Intrusion Detection System for Smart Home Applications” published in Developing and Monitoring Smart Environments for Intelligent Cities, IGI Global 2021.
- Fida has published paper on Smart Home security “Integrated Security Scheme for Smart Home” published in Conference: 2018 14 th International Conference on Natural Computation, Fuzzy Systems and Knowledge Discovery (ICNC-FSKD) At: Huangshan, China.
- Fida worked for three years as IT Consultant for hospitality company since 2014 to 2017 after graduating with MSc in Computing from Canterbury Christ Church University in 2012.

Today's Agenda

1. Introduction
2. Review of related work
3. Network security threats for IoT in the SH
   a. Eavesdropping attacks
   b. Denial of Service (dos) De-authentication attacks
   c. MITM(Man-In-The-Middle) attacks
4. Methodology (Smart Home testbed)
5. Results
6. Conclusions and future work

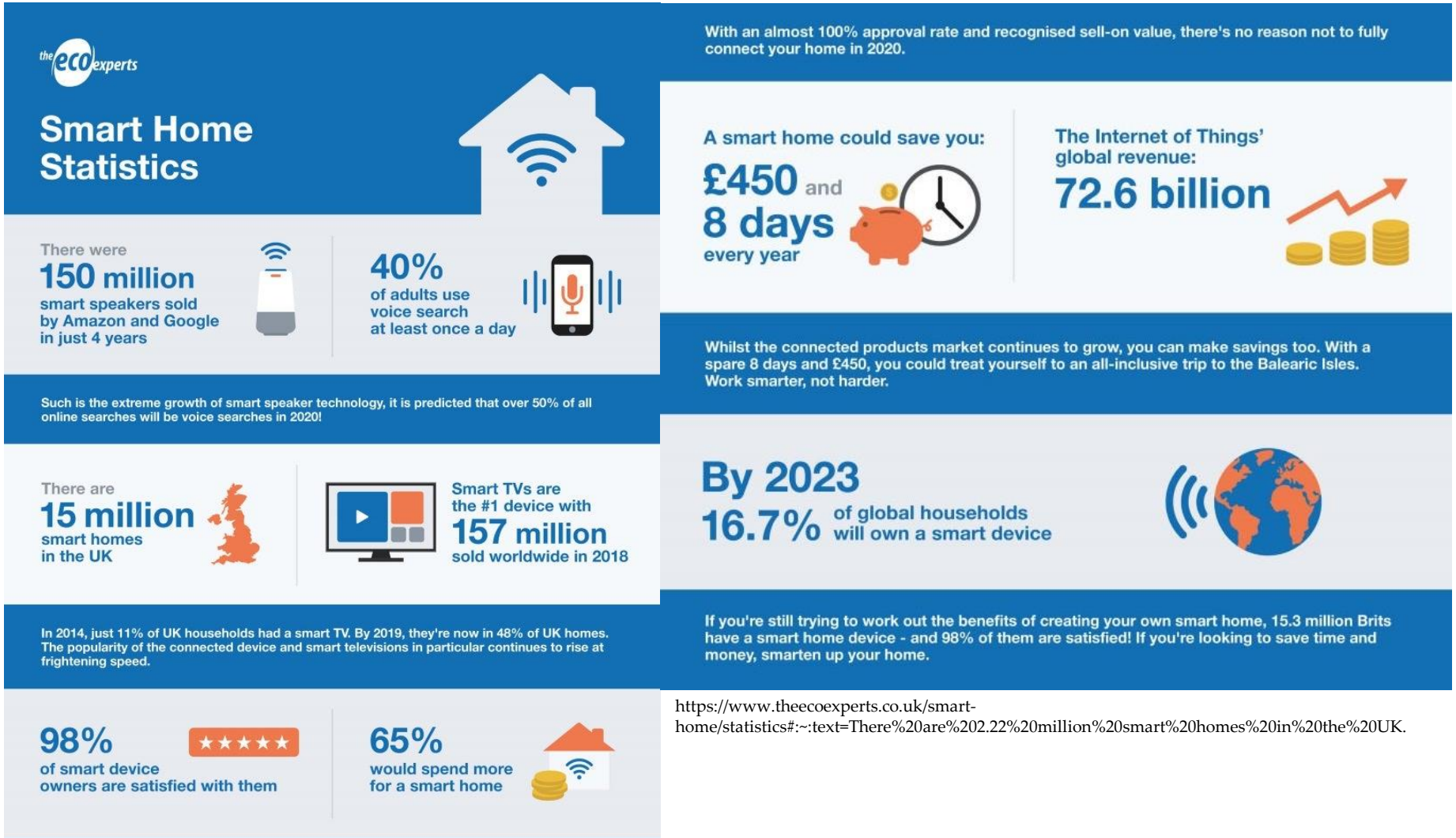
Introduction

Smart Home (SH) is a user-oriented home communication system where gadgets are interconnected through a local network and exposed to the internet, so that it can be remotely controlled from anywhere through the internet by using network or mobile devices (smartphone or tablet).

https://www.presentationload.com/smart-home-oxid.html

Introduction

Source: Josh Jackman(theecoexperts)



https://www.theecoexperts.co.uk/smart-home/statistics#:~:text=There%20are%202.22%20million%20smart%20homes%20in%20the%20UK.

Review of related work

1. Risk analysis of a fake access point attack against Wi-Fi network
2. Smart Home Automation Security: A Literature Review
3. Automated Fake Access Point Attack Detection and Prevention System with IoT Devices
4. Vulnerability Analysis of IP Cameras Using ARP Poisoning
5. Vulnerabilities in IoT Devices for Smart Home Environment
6. Vulnerability Studies and Security Postures of IoT Devices: A Smart Home Case Study

NETWORK SECURITY THREATS FOR IOT IN THE SH

1. By 2021, **35 billion IoT devices** will be installed around the world (Source: techjury)

2. The shipment volume of global Wi-Fi (Wireless Fidelity) enabled devices in 2019 reached 3.05 billion (Source: Research and markets)

Table 1.Wireless protocols and their features

Wireless Protocols	**Wi-Fi**	**ZigBee**	**Z-Wave**	**Bluetooth**	**6LoWPAN**
Standardization	IEEE 802.11a/b/g	IEEE 802.15.4	Proprietary	IEEE 802.15.1	IETF
Frequency band	2.4 GHz, 5 GHz	868/915MHz, 2.4 GHz	900 MHz	2.4GHz	868MHz, 900MHz and 2.4 GHz
Range, m	46 m/ 92 m	10-100	30	1, 10, 100	20
Security algorithm	WEP, WPA, WPA2	AES-128	AES-128	E0, E, E21, E22, E3, 56-128 bit	AES- 128
Topology	one-hop	star, tree, mesh	star, mesh	p2p, scatternet	mesh
Channel bandwidth	22MHz	0.3/0.6MHz, 2MHz	300kHz,400 kHz	1MHz	600kHz,2MHz, 5MHz

Network security threats for IoT in the SH

1. Eavesdropping attacks
2. Denial of Service (DoS) De-authentication attacks
3. MITM (Man-In-The-Middle) attacks

Network security threats for IoT in the SH

Eavesdropping attack

1. Eavesdropping attack is an important first step to launch any type of attack on IoT device
2. To sniff the network traffic in wireless networks
3. Illegally impersonating a legal IoT device to gather information via sniffing

Network security threats for IoT in the SH

Denial of Service (DoS) De-authentication attacks

1. It is the pre-connection of the DoS attack
2. Device send deauthentication frame to leave the network
3. frames are unencrypted
4. Attacker can easily spoof these frames

Network security threats for IoT in the SH

MITM(Man-In-The-Middle) attack

- MITM attack can be implemented through different ways but in the testbed, it has been implemented by using two methods,

1) Fake Access Point (AP)
2) 2) by using ARP poisoning

Methodology(Smart Home testbed)

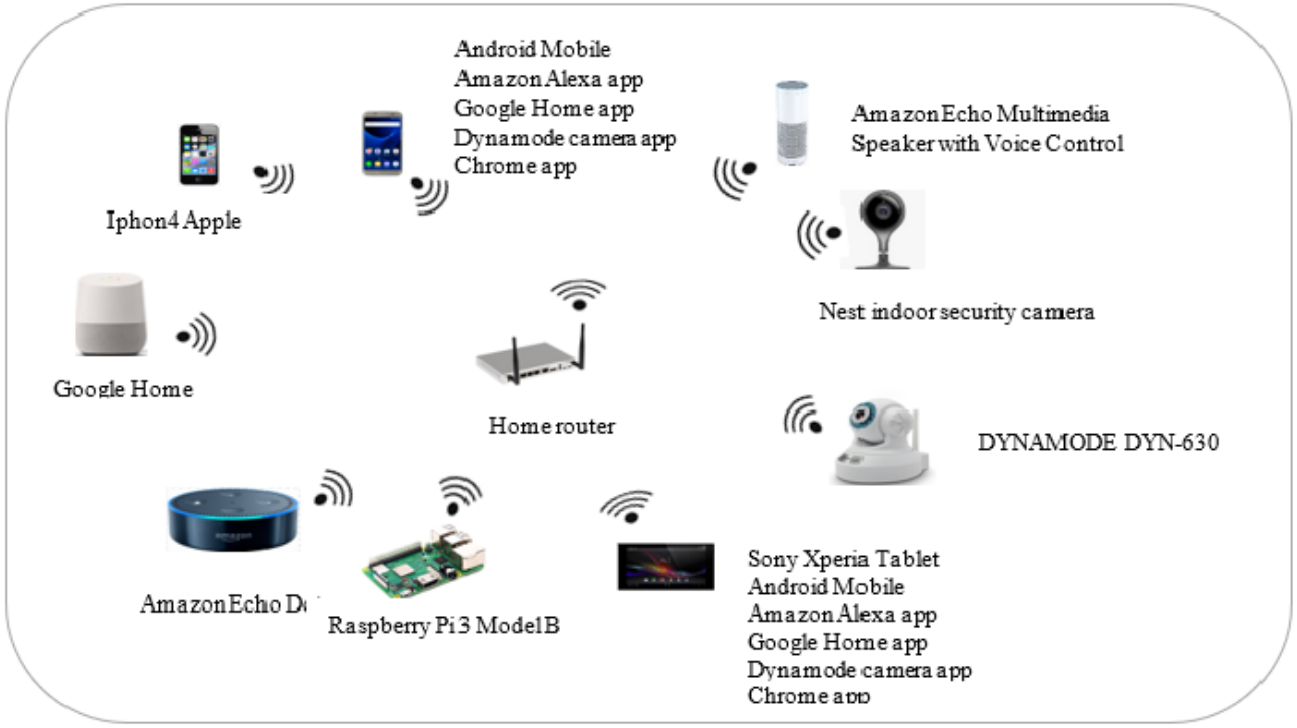


Figure 1. Smart Home TESTBED

Tools and applications used

1. Kali Linux is operating on the attacking machine
2. Alfa AWUS036NHA 2.4 GHz and Alfa AWUS036ACH 2.4 & 5 GHz
3. Airodump-ng
4. Man-In-The-Middle framework (MITMf) tool
5. Using a scanning tool, such as NMAP, to know the MAC address of the target device
6. To analyses the data packets Wireshark has been used

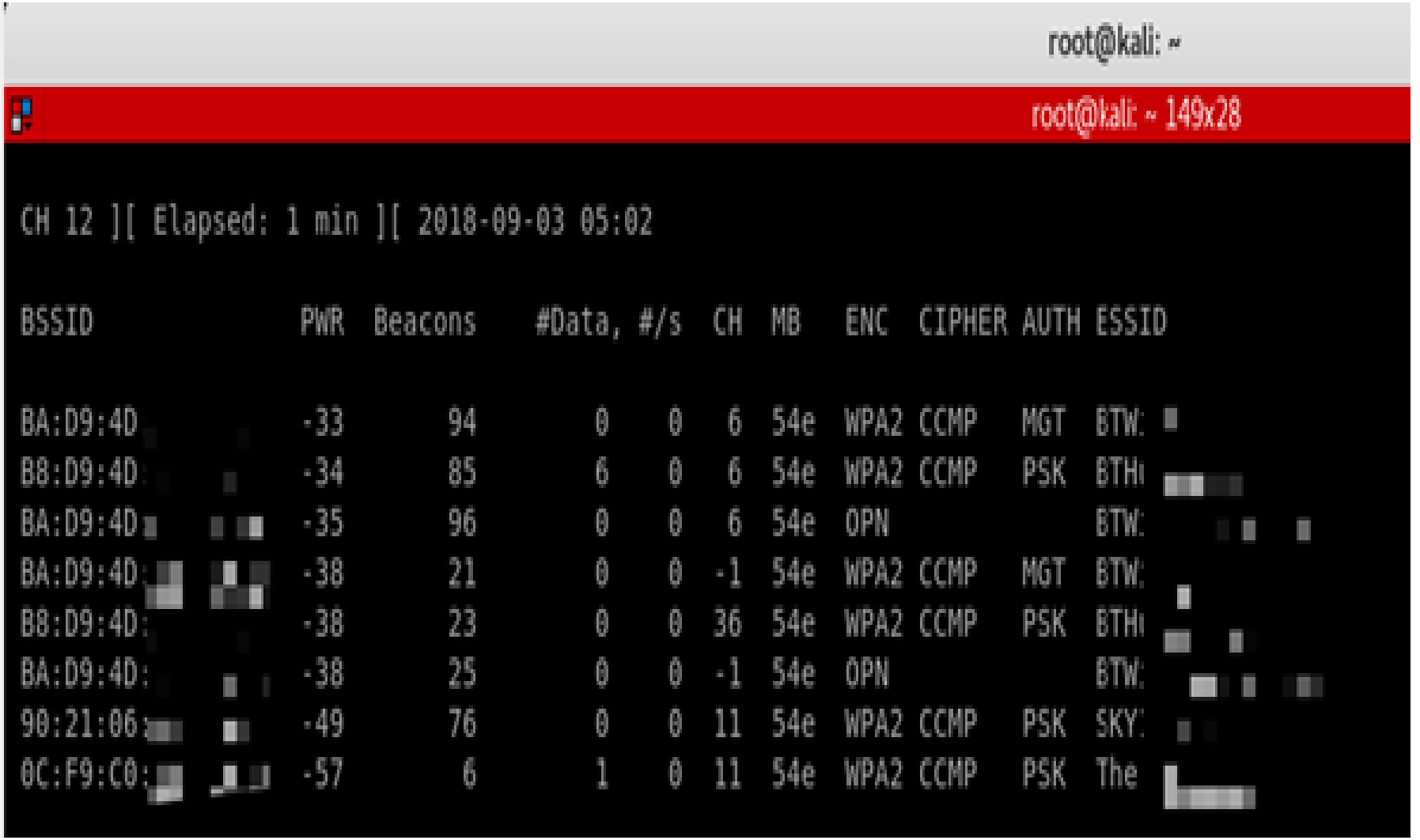
Alfa AWUS036NHA 2.4 GHz

Alfa AWUS036ACH 2.4 & 5 GHz

Results (Sniffing or spoofing)

1. Collecting information in this stage is important in order to launch a furth er attack

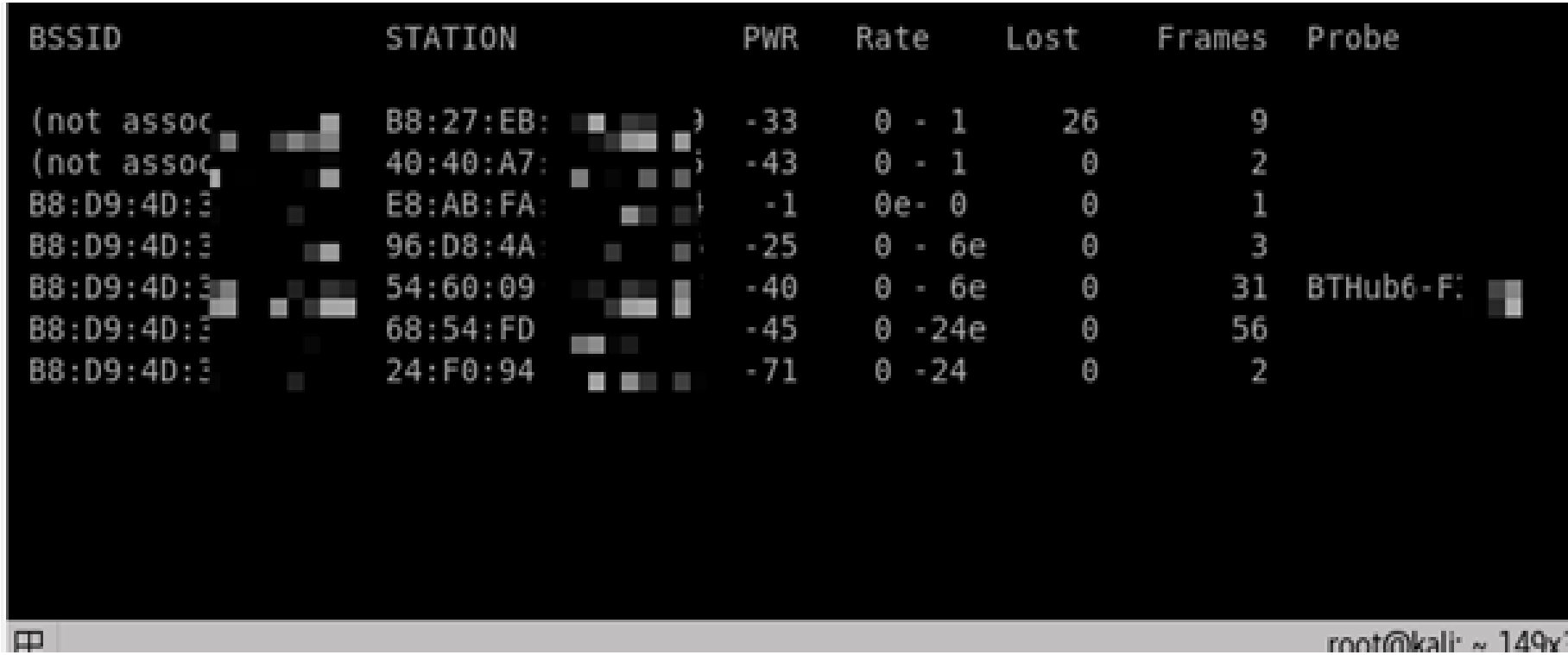
2. On the target device sniffs all the traffic without a connection to an AP



Results(De-authentication attack)

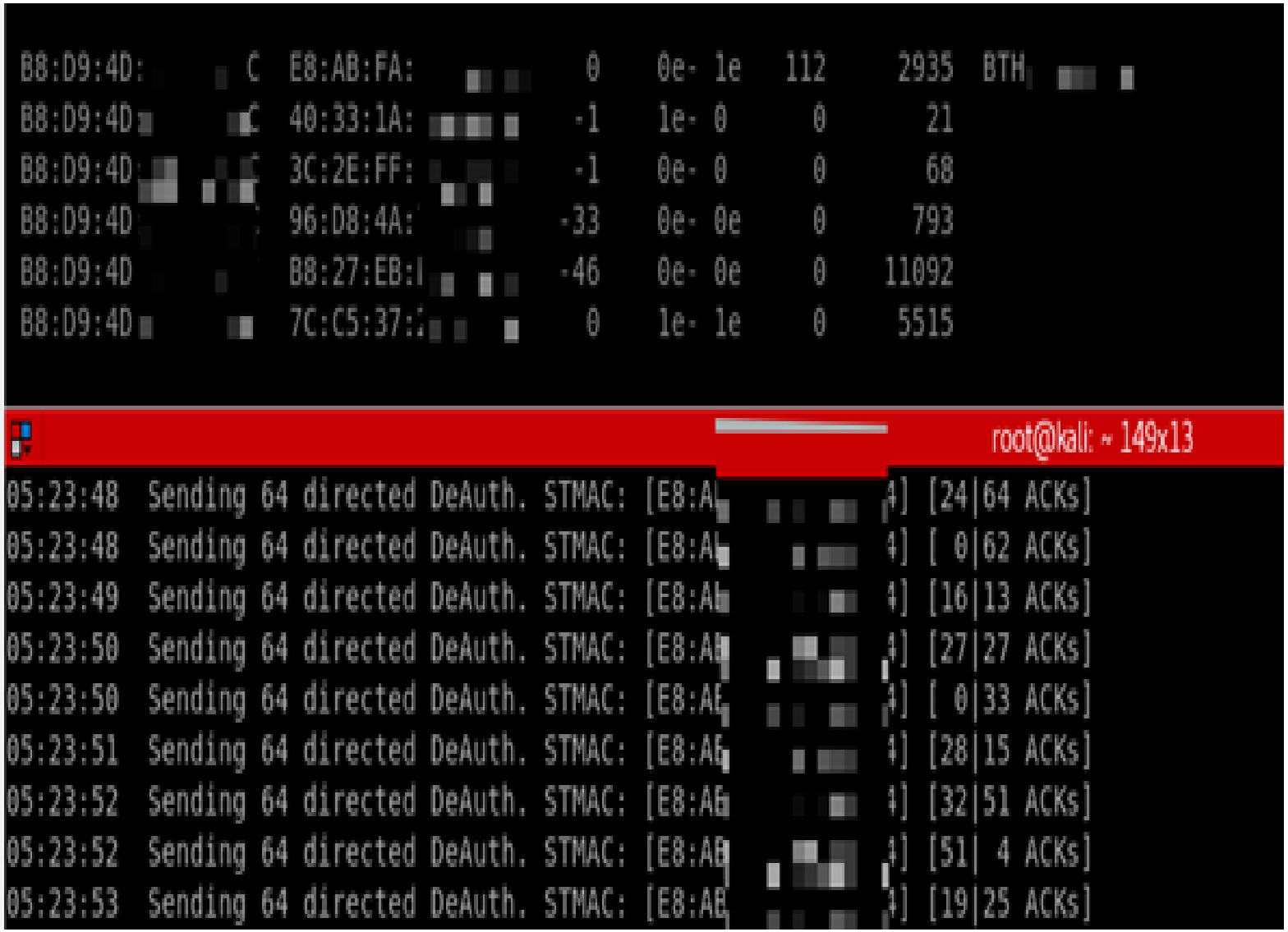
1. Airodumpng with MAC address of AP is needed to be launched.

2. Shows the MAC address of the connected device to the target AP



Results (De-authentication attack)

Successful launch of de-authentication for a certain defined time period



Results (De-authentication attack)

Table 2. Results of De-authentication attack

IoT Appliances	De-authentication Attack
Amazon Echo Google Home Amazon Echo Dot	Connection interrupted and unable to disable its connection from the AP.
Android Mobile (Model no.SM-G935F, SM-G930F) Nest Cam Indoor Security Camera	Connection interrupted and disabled it sometimes from the connected AP.
DYNAMODE DYN-630 Iphon4 Apple Raspberry pi-3 Sony Xperia Tablet	Connection interrupted and disabled it from the connected AP

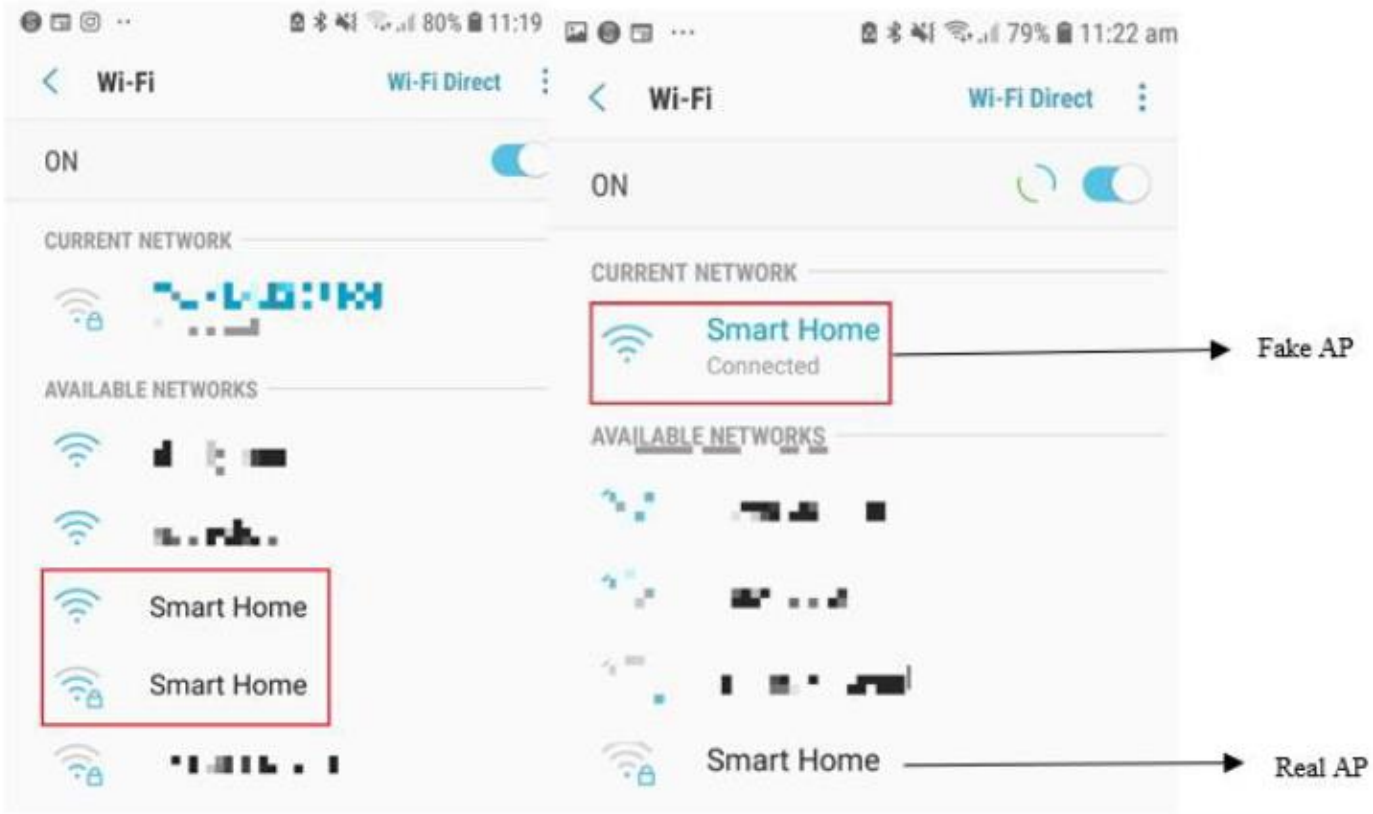
Results (Men In The Middle Attack)

- There are different ways to implement MITM attacks but in the testbed, it has been implemented by using two methods

    1) Fake Access Point

    2) By using ARP poisoning

Fake Access Point




```
wlan0: STA 2c:0e:3d:68:fe:e6 IEEE 802.11: disassociated
MANA - Directed probe request for actual/legitimate SSID 'Smart Home' from 2c:0e:3d:68:fe:e6
MANA - Directed probe request for actual/legitimate SSID 'Smart Home' from 2c:0e:3d:68:fe:e6
wlan0: STA 2c:0e:3d:68:fe:e6 IEEE 802.11: authenticated
wlan0: STA 2c:0e:3d:68:fe:e6 IEEE 802.11: associated (aid 1)
wlan0: AP-STA-CONNECTED 2c:0e:3d:68:fe:e6
MANA - Successful association of 2c:0e:3d:68:fe:e6 to ESSID 'Smart Home'
```

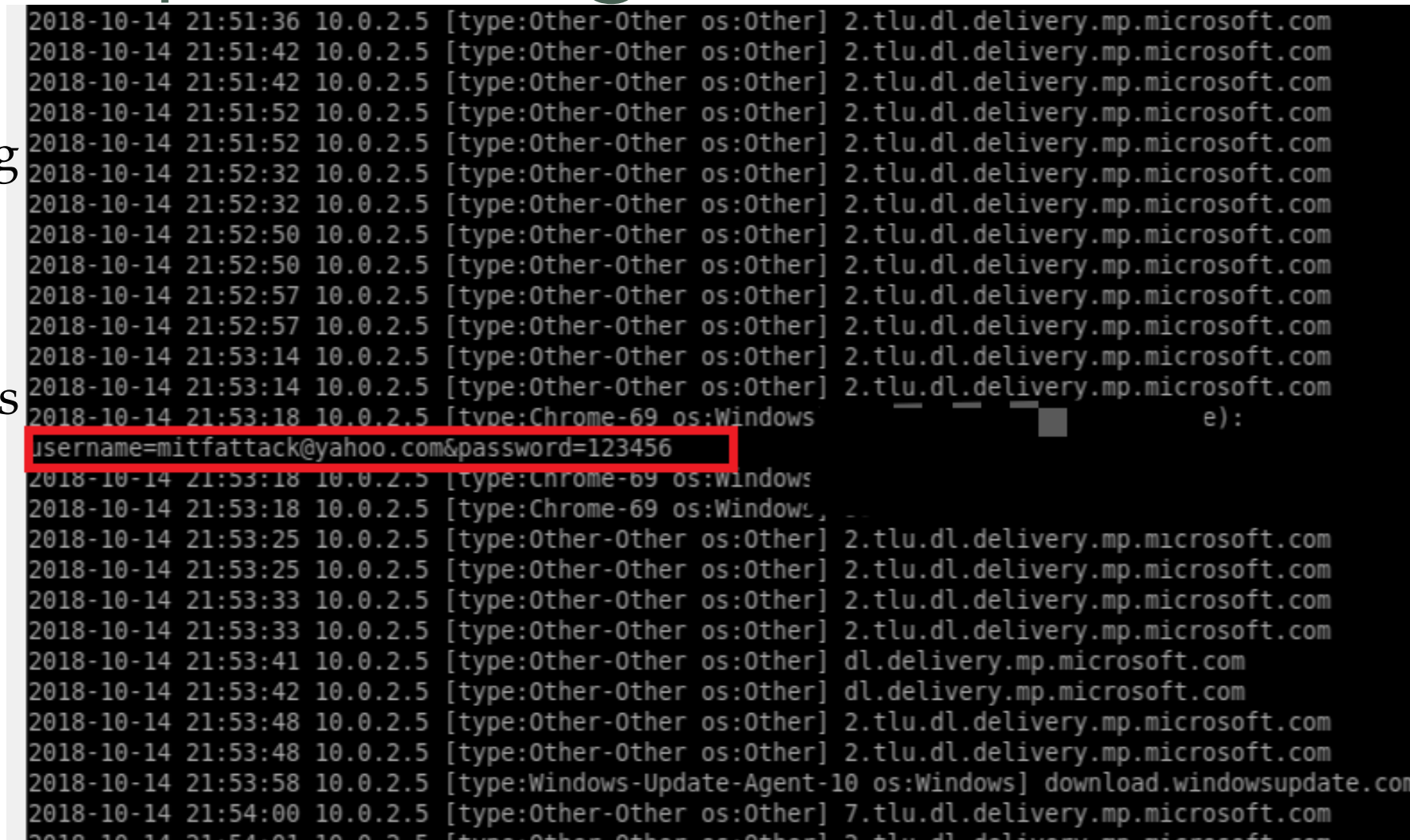
Figure 5. Victim connected to fake AP

By using ARP poisoning

1. In Kali Linux, MITMf tool was used to perform ARP poisoning

2. Using a scanning tool, such as NMAP, to know the MAC address of the target device

3. To further capture and analyses the data packets, the attacker can use Wireshark.



Conclusions and future work

- This paper demonstrates that due to vulnerabilities remaining in some SH devices they are prone to attacks such as eavesdropping, DoS and MITM.
- If adequate security measures are not taken it could have serious implications for SH devices.
- It is hoped to use the testbed in the future to study how SH devices can be secured from these attacks

The end

Thank you and any questions ?