

Analysis and Implementation of the Authentication Protocol 802.1x

A. I. A. Jabbar, Ph.D
Assistant Professor
Department of Electrical Engineering
Mosul University

Harith G. A.
M.Sc. Student
Department of Electrical Engineering
Mosul University

ABSTRACT

The security of wireless networks against hacker attacks depends on some parameters and special configurations. Authentication is considered as one of the most important security parameter in computer networks [1]. The communication for example between users through the internet must be authenticated by both sides in order to prevent hackers from pretending any one of them [2]. Authentication process has the function to allow or prevent users from accessing the wireless network like IEEE 802.11b or 802.11g, it can be applied also to wired networks [3].

IEEE 802.1X [4] is the famous standard which uses Extensible Authentication Protocol (EAP) to authenticate users before giving them access to the network [5]. The process of authentication is extended to include RADIUS protocol which is designed to authenticate remote users within special organizations, then upgraded to include most of the operating systems and computer networks. It is now the most famous and applicable protocol for authenticating remote users [6].

Recently, the operating system Android has dominated other operating systems, it is based on Linux core and has the capability to support 802.1x and other security protocols [7]. In this paper, 802.1x protocol is applied to authenticate users using windows 7 and Android operating systems, a comparison to show the main differences between them is introduced successfully in mixed (computer & mobiles) network.

Keywords

IEEE 802.1x, EAP, RADIUS, Ubuntu, PEAP, MS-CHAPv2, ANDROID, IOS, Windows 7

1. INTRODUCTION

The first element of the IEEE 802.1X protocol is the supplicant, which is the device that wants to join the computer network. The second element is the authenticator, which is the device or controller that controls access to the network. The third element is the authentication server [8].

It is worth to mention that the Security Protocol IEEE 802.1X can be obtained by installing FreeRADIUS (the most widely deployed RADIUS server in the world) onto the free operating system Ubuntu server [9].

The rapid deployment of 802.1x in the internet applications generates what is called daloRADIUS which is an advanced RADIUS web platform. It provides efficient user management, accounting, graphical reporting, and can be integrated with Google Maps for geo-locating (GIS). daloRADIUS can be written either in PHP or in JavaScript, It is based on a FreeRADIUS and can support many database

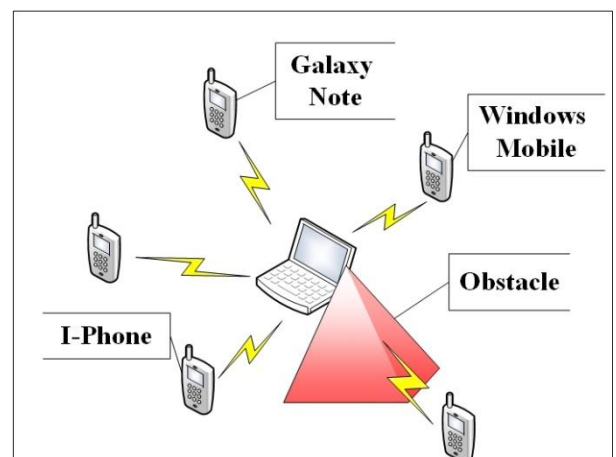
systems like the popular MySQL, MsSQL, and many others [10].

Practically, windows 7 and Android operating systems are provided with the necessary software's to authenticate subscribers using 802.1x protocol. Conventionally, if the authentication server is installed on the desktop (stationary server) then it is possible to authenticate users within pure computer networks or within a mixed (mobile & laptop) network reliably. Installing the Android sever software in portable laptop may suffer from some difficulties because of its variable position, this may cause the portable server to be a hidden terminal to the other users leading to a failing authentication process. In this paper, a pure mobile network is designed and implemented practically showing the successful and failing authentication processes.

2. THE PROPOSED MOBILE NETWORK

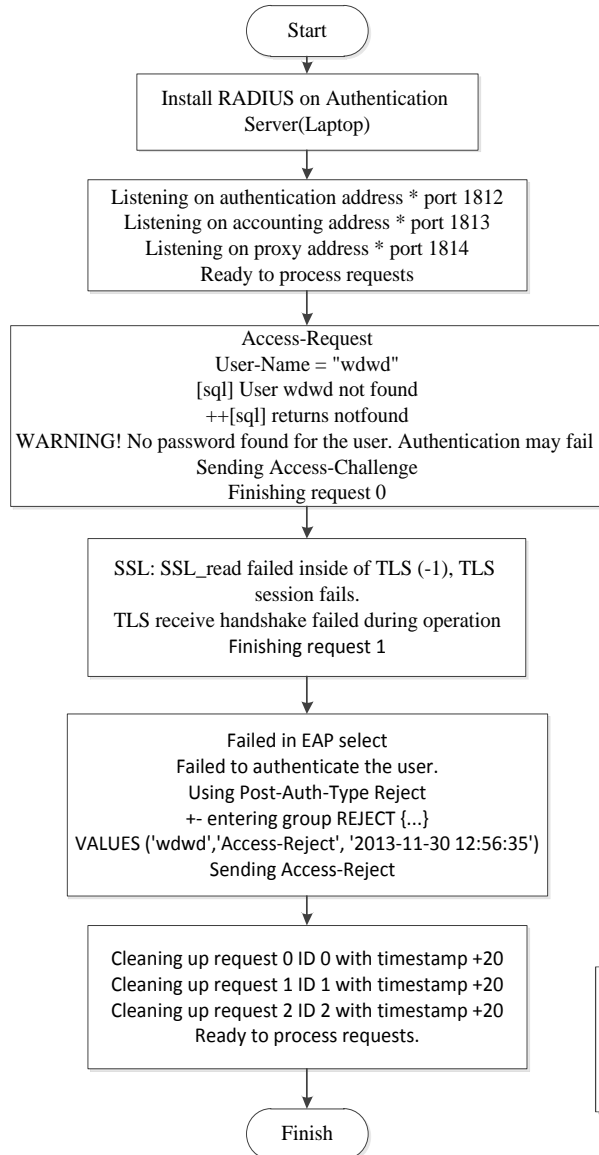
The mobile network shown in Figure 1 is designed according to the following assumptions: -

1. The number of mobiles is equal to 8.
2. The protocol of authentication provided by Android is installed on a portable laptop.
3. The area of the network is equal to 100m².
4. The hidden terminal problem may be existed according to the positions of the mobiles with respect to the obstacles within the area. Figure 1 shows a possible subscriber distribution within the proposed network.
5. The supporting protocols associated with 802.1x protocol are Protected EAP (PEAP) and MS-CHAPv2.
6. Samsung Galaxy, iPhones and laptops are the types of mobiles being used with the operating systems Android,

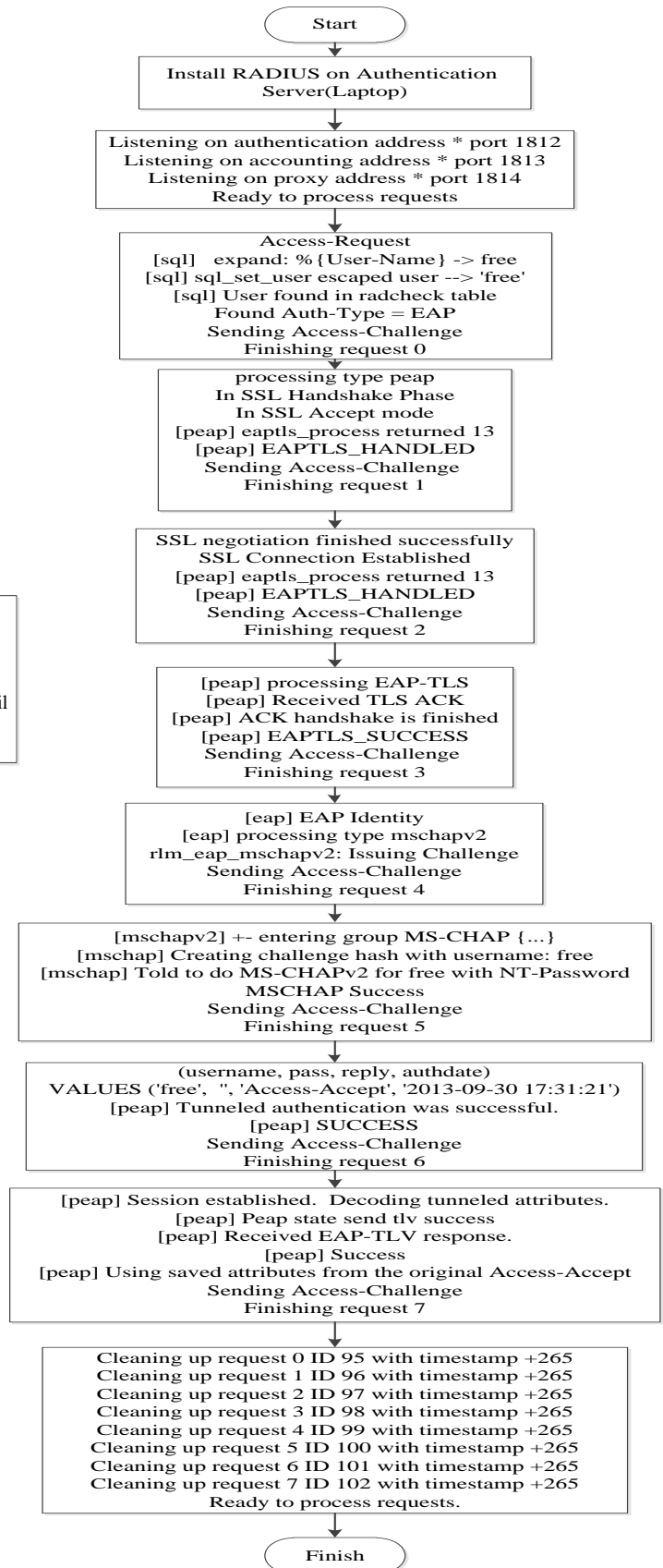


3. THE INSTALLATION PROCESS OF 802.1X

Wireless networks provide an alternative networking option when traditional wired networks are impractical. The Ubuntu Server is the operating system which provides secure wireless local area network (WLAN). The flowcharts shown in Figure 2 provide comprehensive guidance on how to install the 802.1X protocol (Successful & Failure Authentication process) onto portable laptop.



A- Failure process



B- Successful process

Fig 2: Successful and Failure processes according to the 802.1X protocol

4. PRACTICAL RESULTS

4.1 Successfully access process

As mentioned in the figure 2, The Authentication between the portable laptop and any mobility needs eight basic stages (request 0–request 7) to be a successful process.

Figure 3 displays some of the successful process results between the portable laptop and M3.

```
Ready to process requests.
rad_recv: Access-Request packet from host 192.168.1.1 port 42967, id=0, length=15
1
  User-Name = "free"
  NAS-IP-Address = 192.168.1.1
  NAS-Port = 6
```

A- Starting of authentication process & checking the username

```
Found Auth-Type = EAP
# Executing group from file /etc/freeradius/sites-enabled/default
+- entering group authenticate {...}
[peap] EAP Identity
[peap] processing type tls
[tls] Initiate
[tls] Start returned 1
++[peap] returns handled
Sending Access-Challenge of id 0 to 192.168.1.1 port 42967
EAP-Message = 0x010200061920
Message-Authenticator = 0x00000000000000000000000000000000
State = 0xbfea053abfe81c3a8d502375a676e396
Finished request 0.
```

B- Selecting authentication type & sending Access-Challenge

```
[peap] (Outer): SSL negotiation finished successfully
SSL Connection Established
[peap] eaptls_process returned 13
[peap] EAPTLS_HANDLED
++[peap] returns handled
Sending Access-Challenge of id 2 to 192.168.1.1 port 42967
EAP-Message = 0x0104004119001403010001011603010030457bb1cd1e2cc35033a266
4e10f676d575c76ecee13c5cf8f71f15cd99aefc80865361ecbbe8bf1389c33ec7a66bbbe
Message-Authenticator = 0x00000000000000000000000000000000
State = 0xbfea053abdee1c3a8d502375a676e396
Finished request 2.
```

C- SSL connection established & finishing request 2

```
[peap] processing type tls
[peap] Received TLS ACK
[peap] ACK handshake is finished
[peap] eaptls_verify returned 3
[peap] eaptls_process returned 3
[peap] EAPTLS_SUCCESS
[peap] Session established. Decoding tunneled attributes
[peap] Peap state TUNNEL ESTABLISHED
++[peap] returns handled
```

D- ACK handshaking & tunnel established

```
+- entering group authenticate {...}
[peap] EAP Identity
[peap] processing type mschapv2
rlm_eap_mschapv2: Issuing Challenge
++[peap] returns handled
```

E- MS-CHAPv2 is the method using in authentication process

```
[mschapv2] +- entering group MS-CHAP {...}
[mschap] Creating challenge hash with username: free
[mschap] Told to do MS-CHAPv2 for free with NT-Password
[mschap] adding MS-CHAPv2 MPPE keys
++[mschap] returns ok
MSCHAP Success
++[eap] returns handled
```

F- Applying hash function using MS-CHAPv2

```
stauth (username, pass, reply, authdate)
VALUES ('free',
'', 'Access-Accept', '2013-10-01 16:13:50')
rlm_sql (sql) in sql_postauth: query is INSERT INTO radpostauth
VALUES (username, pass, reply, authdate)
('free', '', 'Access-Accept', '2013-10-01 16:13:50')
rlm_sql (sql): Reserving sql socket id: 2
rlm_sql (sql): Released sql socket id: 2
++[sql] returns ok
} # server inner-tunnel
```

username/password
Authentication successfully
Access-Accept

G- Access-Accept of the authentication process

```
[peap] Peap state send tlv success
[peap] Received EAP-TLV response.
[peap] Success
[peap] Using saved attributes from the original Access-Accept
User-Name = 'free'
[eap] Freeing handler
++[eap] returns ok
Sending Access-Accept of id 22 to 192.168.1.1 port 45887
User-Name = 'free\000'
MS-MPPE-Recv-Key = 0xad1919c163c96c370adf93d0a1d72e9f0eb503e5490'
cc75cbe64b524
MS-MPPE-Send-Key = 0x50fdea0dcabb85b4ebab2fcc633f171cf592c429b13:
61757e54bf6bb
EAP-Message = 0x03080004
Message-Authenticator = 0x00000000000000000000000000000000
Finished request 7.
Going to the next request
Waking up in 4.8 seconds.
Cleaning up request 0 ID 15 with timestamp +11
Cleaning up request 1 ID 16 with timestamp +11
Cleaning up request 2 ID 17 with timestamp +11
Cleaning up request 3 ID 18 with timestamp +11
Cleaning up request 4 ID 19 with timestamp +11
Cleaning up request 5 ID 20 with timestamp +11
Cleaning up request 6 ID 21 with timestamp +11
Cleaning up request 7 ID 22 with timestamp +11
Ready to process requests.
```

Finishing of the 8th stges

Cleaning all requests

H- Finishing of all requests & ready to another process requests

Fig 3: shows the processing steps of the authentication between the portable laptop and M3

4.2 Failure access request

The unsuccessful authentication process passes through three stages only, It begins with request 0 and ends with request 2, the process of checking user's access (wdwd as a username) is achieved in the first stage, the authentication between the laptop and M4 will be failed because of the obstacle between them. Figure 4 shows the steps of a failed authentication process.

```
Ready to process requests.
rad_recv: Access-Request packet from host 192.168.1.1 port 41718. id=0. length=151
User-Name = "wdwd"
NAS-IP-Address = 192.168.1.1
NAS-Port = 0
```

New username

A- Trying another user name

```

username = 'wdwd' ORDER BY id
[sql] expand: SELECT groupname FROM radusergroup WHERE
username = '%{SQL-User-Name}' ORDER BY priority -> SELECT groupname
FROM radusergroup WHERE username = 'wdwd' ORDER
BY priority
rlm_sql (sql): Released sql socket id: 2
[sql] User wdwd not found
++[sql] returns notfound

```

International Journal of Computer Applications (0075-8887) 2014

B- This username does not exist in RADIUS

```

++[expiration] returns noop
++[logintime] returns noop
[pap] WARNING! No "known good" password found for the user. Authentication may fail because of this.
++[pap] returns noop

```

C- No password found for this username database

```

SSL: SSL_read failed inside of TLS (-1), TLS session fails.
TLS receive handshake failed during operation
[peap] eaptls_process returned 4
[peap] EAPTLS_OTHERS
[eap] Handler failed in EAP/peap
[eap] Failed in EAP select
++[eap] returns invalid
Failed to authenticate the user.
Using Post-Auth-Type Reject
# Executing group from file /etc/freeradius/sites-enabled/default
+- entering group REJECT {...}
[sql] expand: %{User-Name} -> wdwd
[sql] sql_set_user escaped user --> 'wdwd'

```

D- Failure of EAP selection & Putting username in rejecting group

```

('wdwd',
'Access-Reject', '2013-10-04 17:51:08')
rlm_sql (sql): Reserving sql socket id: 4
rlm_sql (sql): Released sql socket id: 4
++[sql] returns ok
[attr_filter.access_reject] expand: %{User-Name} -> wdwd
attr_filter: Matched entry DEFAULT at line 11
++[attr_filter.access_reject] returns updated
Delaying reject of request 2 for 1 seconds
Going to the next request
Waking up in 0.9 seconds.
Sending delayed reject for request 2
Sending Access-Reject of id 2 to 192.168.1.1 port 57945
EAP-Message - 0x04030004
Message-Authenticator - 0x00000000000000000000000000000000
Waking up in 3.9 seconds.
Cleaning up request 0 ID 0 with timestamp +17
Cleaning up request 1 ID 1 with timestamp +17
Waking up in 1.0 seconds.
Cleaning up request 2 ID 2 with timestamp +17
Ready to process requests.

```

Fig 4: shows the unsuccessful authentication between the portable laptop and M4

4.3 Comparison between the authentication process of Galaxy note, iPhone and laptop

By taking samples from each of the eight stages of successful authentication of Android, IOS and windows 7 operating systems, Table (1) shows a comparison between the different devices under test.

Table 1. A comparison between the authentication process of Galaxy note, iPhone and laptop

	Galaxy note	IPhone	Laptop
Operating system	Android	IOS	Windows 7
Request (0, 1, 2, 3)	Identical	Identical	Identical
NO of EAP Messages	4	2	2
Acct-Interim-Interval (Request 4)	60	60	–
Request (5)	Replacing User-Password	Replacing User-Password	–
Request (6, 7)	Identical	Identical	Identical

Appendix [A] shows samples of the results which are obtained during the authentication processes of the different operating systems and mobiles (devices).

5. CONCLUSION

The security protocol 802.1x is Characterized by its capability of working with different types of devices (Samsung Galaxy Note, iPhone and Laptop) and under various operating systems such as Android, IOS and Windows 7.

It is found that eight stages are required for successful authentication (i.e. Authorized user). On the other hand, it is also proven that in the case of unauthorized users or the presence of obstacles between the client and the authenticator, three stages are sufficient to stop authentication process.

As a consequence, the remaining stages will be hidden and out of reach by the unauthorized users. This fact makes

802.1x so secure against different hackers attacks. Concerning the devices under test, this paper proves that Samsung Galaxy Note provides higher security than the other types.

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Appendix [A] Samples of authentication process

1- The following figure shows the number of EAP messages required during the authentication process of the different devices.

The screenshot displays three panels of authentication logs. The top panel is for Galaxy Note (Android), the middle for I-Phone (IOS), and the bottom for Laptop (Microsoft Windows 7). Each panel contains four numbered EAP messages, each followed by a long hexadecimal string. The messages are:

- 1 EAP-Message = [hex string]
- 2 EAP-Message = [hex string]
- 3 EAP-Message = [hex string]
- 4 EAP-Message = [hex string]

The screenshot shows two windows side-by-side. The top window is titled "Galaxy Note & I-phone (Android, IOS)" and displays the following text: "++[pap] returns noop", "Found Auth-Type = EAP", a separator of exclamation marks, "!!! Replacing User-Password in config items with Cleartext-Password. !!!", another separator, "!!! Please update your configuration so that the 'known good' !!!", a third separator, "!!! clear text password is in Cleartext-Password, and not in User-Password. !!!", and a fourth separator. The bottom window is titled "Laptop (Windows 7)" and displays: "++[pap] returns noop", "Found Auth-Type = EAP", and "# Executing group from file /etc/freeradius/sites-enabled/inner-tunnel".

2- The displayed page below shows that password warning is presented in Android and IOS, but it is absent in windows 7.