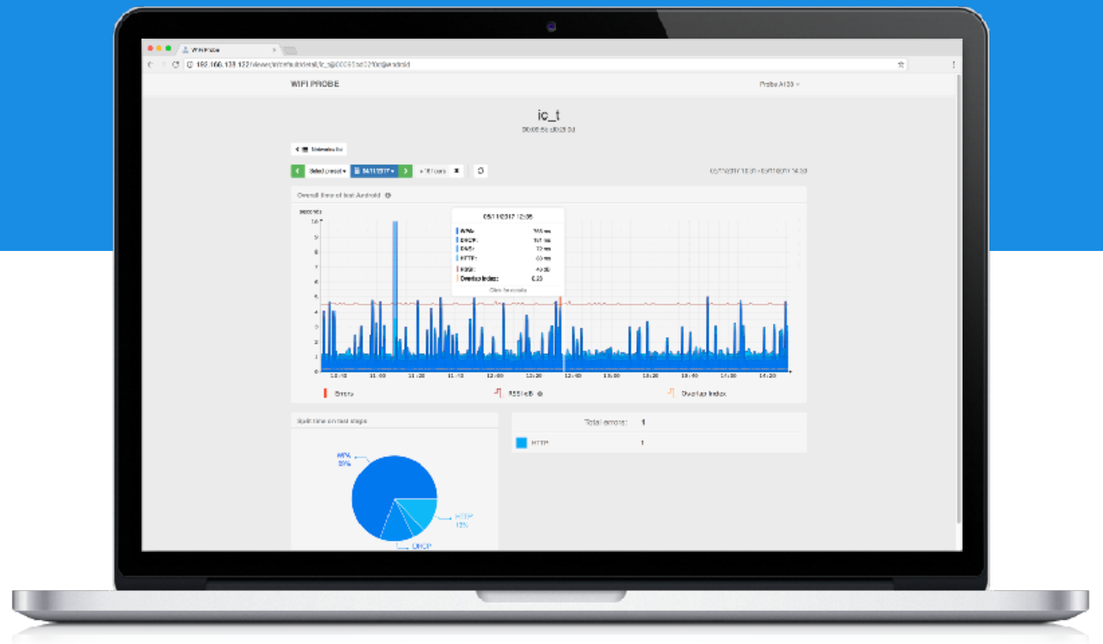
WiFiProbe
Case study on ConnectBrowse scripted test



ConnectBrowse scripted test

- The goal of the test is to carry-out and measure the steps and protocol interactions that happen when a smartphone connects to a Wi-Fi network and browses Internet sites
- Whenever Android connects to a Wi-Fi network carries-on a series of actions in order to determine the icon to show on the top status bar:

Connected to the Internet via Wi-Fi

Connected to Wi-Fi without connect to the Internet

step 1: CONN

- Using the same wpa_supplicant software stack used in Android, the commands to scan, configure and connect to the network are issued by way of the wpa_cli command interface
- The complete outputs of the wpa_supplicant daemon and of the wpa_cli command line interface are logged
- The elapsed time from the issue of the "*select_network*" wpa_cli command to the reception of the "*Associated with <bssid mac>*" event message is measured and plotted as time of the CONN phase, it corresponds to the time used to establish the radio connection with the Access Point
- Not receiving the "*Associated with <bssid mac>*" event in 20 sec is considered failure for the step

step 1: CONN log

```
Logs from wpa_supplicant:

1518775130.512565: Successfully initialized wpa_supplicant
1518775136.332418: RT8811prb4: Trying to associate with 00:1e:52:6c:91:5f (SSID='ic_t' freq=2472 MHz)
1518775136.466021: RT8811prb4: Associated with 00:1e:52:6c:91:5f
1518775136.964431: RT8811prb4: WPA: Key negotiation completed with 00:1e:52:6c:91:5f [PTK=CCMP GTK=CCMP]
1518775136.964619: RT8811prb4: CTRL-EVENT-CONNECTED - Connection to 00:1e:52:6c:91:5f completed [id=0 id_str=]

CLI wpa_cli log:

wpa_cli v2.3
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See README for more details.

Interactive mode

> status
wpa_state=DISCONNECTED
p2p_device_address=40:a5:ef:de:e6:7e
address=40:a5:ef:de:e6:7e
uuid=96436da6-d771-5af6-b45f-c84bedc4a6b9
> scan
OK

<3>CTRL-EVENT-SCAN-STARTED
>
<3>CTRL-EVENT-SCAN-RESULTS
>
***** Scan time: 4486 ms

> scan_results
bssid / frequency / signal level / flags / ssid
00:1e:52:6c:91:5f   2472      -60       [WPA2-PSK-CCMP][ESS]          ic_t
68:72:51:66:11:e1   2432      -82       [WPA2-PSK-CCMP][ESS]          bandidos
00:18:4d:2d:e3:10   2447      -86       [WPA2-PSK-CCMP][ESS]          ic_s
28:cf:da:b2:14:2f   2422      -89       [WPA2-PSK-CCMP][ESS]          ic_1
> bss 00:1e:52:6c:91:5f
id=0
bssid=00:1e:52:6c:91:5f
freq=2472
beacon_int=100
capabilities=0x0411
qual=0
noise=0
level=-60
tsf=0000030471767500
age=1
ie=000469635f74010482848b9603010d2a01002f0100301401000000fac040100000fac040100000fac040100000fac02000032080c1218243048606cdd070003
9301660001dd06001018020100
flags=[WPA2-PSK-CCMP][ESS]
ssid=ic_t
> add_network
0
> set_network 0 ssid "ic_t"
OK
> set_network 0 key_mgmt WPA-PSK
OK
> set_network 0 psk "*********"
OK
> bssid 0 00:1e:52:6c:91:5f
OK
> list_network
network id / ssid / bssid / flags
0         ic_t      00:1e:52:6c:91:5f   [DISABLED]
> select_network 0
OK
>
<3>Trying to associate with 00:1e:52:6c:91:5f (SSID='ic_t' freq=2472 MHz)
>
<3>Associated with 00:1e:52:6c:91:5f
>
***** Connect time: 137 ms
```

step 2: AUTH

- Using the same wpa_supplicant software stack used in Android, the commands to scan, configure and connect to the network are issued by way of the wpa_cli command interface
- The complete outputs of the wpa_supplicant daemon and of the wpa_cli command line interface are logged
- The elapsed time from the completion of the radio connection with the Access Point to the reception of the "CTRL-EVENT-CONNECTED" event message is measured and plotted as time of the AUTH phase ,it corresponds to the time used to authenticate with the Access Point
- Not receiving the "CTRL-EVENT-CONNECTED" event in 20 sec is considered failure for the step

step 2: AUTH log

```
CLI wpa_cli log:

<3>WPA: Key negotiation completed with 00:1e:52:6c:91:5f [PTK=CCMP GTK=CCMP]
>
<3>CTRL-EVENT-CONNECTED - Connection to 00:1e:52:6c:91:5f completed [id=0 id_str=]
>
***** Auth time: 499 ms

> status verbose
bssid=00:1e:52:6c:91:5f
freq=2472
ssid=ic_t
id=0
mode=station
pairwise_cipher=CCMP
group_cipher=CCMP
key_mgmt=WPA2-PSK
wpa_state=COMPLETED
p2p_device_address=40:a5:ef:de:e6:7e
address=40:a5:ef:de:e6:7e
uuid=96436da6-d771-5af6-b45f-c84bedc4a6b9
> signal_poll
RSSI=-60
LINKSPEED=54
NOISE=9999
FREQUENCY=2472
> quit
```

step 3: DHCP

- Once connected to the Wi-Fi network the next step is to get the network configuration parameters using the Dynamic Host Configuration Protocol (DHCP)
- The ISC DHCP open source dhclient Linux command, has been instrumented to measure the time to complete the "*DHCP offer/request/acknowledgement*" messages exchange following a "*DHCP discovery*" sent by the Wi-Fi Probe
- The complete verbose output of the dhclient command is logged
- The elapsed time returned by the dhclient command is plotted as time of the DHCP phase
- Not receiving a DHCP offer in 20 sec is considered failure for the step, as well as not receiving configuration data for the Domain Name Server(s)

step 3: DHCP log

```
dhclient log:

Internet Systems Consortium DHCP Client 4.3.1
Copyright 2004-2014 Internet Systems Consortium.
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For info, please visit https://www.isc.org/software/dhcp/

***** reason=PREINIT
***** interface=RT8811prb4
Listening on LPF/RT8811prb4/40:a5:ef:de:e7:3f
Sending on   LPF/RT8811prb4/40:a5:ef:de:e7:3f
Sending on   Socket/fallback
DHCPDISCOVER on RT8811prb4 to 255.255.255.255 port 67 interval 8
DHCPREQUEST on RT8811prb4 to 255.255.255.255 port 67
DHCPOFFER from 192.168.138.254
DHCPACK from 192.168.138.254
***** reason=BOUND
***** interface=RT8811prb4
***** new_ip_address=192.168.138.203
***** new_network_number=192.168.138.0
***** new_subnet_mask=255.255.255.0
***** new_broadcast_address=192.168.138.255
***** new_routers=192.168.138.254
***** new_domain_name=base.inrete.it
***** new_domain_name_servers=192.168.138.254
***** new_netbios_name_servers=192.168.138.254
bound to 192.168.138.203 -- renewal in 1098491 seconds.
```

step 4: PING

- For a first assessment of the quality of the connection, a set fo 20 ICMP ping packets with a delay of 0.5 sec from one packet to next, are sent to the default router IP address received by the DHCP server
- The complete output of the ping command is logged
- The average rtt time of the ping command is plotted as time of the PING phase
- A packet with a rtt above 2 seconds is considered in the packet loss count
- Not receiving back at least 16 of the 20 ICMP packets in 15 sec (having more than 20% packet loss) is considered failure for the step

step 4: PING log

```
ping log:

/bin/ping -c 20 -i 0.5 -n -q -s 512 -w 15 -W 2 -I RT8811prb2 192.168.255.1
PING 192.168.255.1 (192.168.255.1) from 192.168.255.205 RT8811prb2: 512(540) bytes of
data.

--- 192.168.255.1 ping statistics ---
20 packets transmitted, 20 received, 0% packet loss, time 9521ms
rtt min/avg/max/mdev = 2.743/10.197/62.067/12.660 ms
```

step 5: GDNS

- To verify if the Wi-Fi network provides Internet connection, the Android OS tries to contact the specific Google server "*clients3.google.com*", which hostname must be resolved to the IP address
- To validate the DNS service of the Wi-Fi network, instead of a low level system call "*gethostbyname*", the Linux command dig is used in a verbose mode
- The complete output of the dig command is logged
- The elapsed time of the dig command is plotted as time of the GDNS phase
- Not resolving the hostname to an IP address in 10 sec is considered failure for the step

step 5: GDNS log

```
dig log:

; <<>> DiG 9.9.5-9+deb8u14-Debian <<>> @192.168.138.254 -4 -t A clients3.google.com +qr +nostats
; (1 server found)
;; global options: +cmd
;; Sending:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 41606
;; flags: rd ad; QUERY: 1, ANSWER: 0, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
;; QUESTION SECTION:
;clients3.google.com.                   IN        A

;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 41606
;; flags: qr rd ra; QUERY: 1, ANSWER: 2, AUTHORITY: 4, ADDITIONAL: 5

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
;; QUESTION SECTION:
;clients3.google.com.                   IN        A

;; ANSWER SECTION:
clients3.google.com.          90        IN        CNAME     clients.l.google.com.
clients.l.google.com.         91        IN        A         216.58.205.78

;; AUTHORITY SECTION:
google.com.                   117742    IN        NS        ns3.google.com.
google.com.                   117742    IN        NS        ns2.google.com.
google.com.                   117742    IN        NS        ns4.google.com.
google.com.                   117742    IN        NS        ns1.google.com.

;; ADDITIONAL SECTION:
ns1.google.com.               290543    IN        A         216.239.32.10
ns2.google.com.               290543    IN        A         216.239.34.10
ns3.google.com.               290543    IN        A         216.239.36.10
ns4.google.com.               290543    IN        A         216.239.38.10

***** address: clients.l.google.com.
216.58.205.78
```

step 6: G204

- The Android OS does access the URL "*http://clients3.google.com/generate_204*", to validate the Internet connectivity it expects to receive a response having the headers:
    - HTTP/1.1 204 No Content
    - Content-Length: 0
- To measure the access to the above URL, it the Linux command curl is used in verbose timing mode
- The complete output of the curl command is logged
- The "time_total" measured by the curl command is plotted as time of the G204 phase
- Not having an HTTP response 20 sec, or not receiving the "*204 No Content*" header is considered failure for the step

step 6: G204 log

```
curl log:

* Added clients3.google.com:80:216.58.205.78 to DNS cache
* Hostname was found in DNS cache
*   Trying 216.58.205.78...
* Local Interface RT8811prb4 is ip 192.168.138.203 using address family 2
* Local port: 0
* Connected to clients3.google.com (216.58.205.78) port 80 (#0)
> GET /generate_204 HTTP/1.1
> Host: clients3.google.com
> Accept: */*
> User-Agent: Dalvik/2.1.0 (Linux; U; Android 7.1.1; Nexus 5X Build/N4F26T)
> Connection: Keep-Alive
>
< HTTP/1.1 204 No Content
< Content-Length: 0
< Date: Wed, 08 Nov 2017 11:50:45 GMT
<
* Connection #0 to host clients3.google.com left intact
☰☰☰
***** url_effective : http://clients3.google.com/generate_204
***** time_connect : 0.548
***** time_namelookup : 0.000
***** time_pretransfer : 0.549
***** time_starttransfer : 0.647
***** time_total : 0.648
***** http_code : 204
***** size_header : 83
***** size_bodydownload : 0
```

step 6: BROWSE

- To gave a measurement for the experience of a human user, browsing the web over the WiFi Internet connection, the access time to the Bing search engine page is measured
- The access and download time of the static content of the page at the URL "*http://www.bing.com*", is measured using the Linux command wget
- The output of the wget command in verbose mode is parsed and collapsed to provide the relevant information about the number of files, total size, elapsed time and speed
- To have a value congruent with the other steps, given the KB/s speed measured by the wget command, the equivalent time in msec per megabyte of download is computed and plotted as time of the BROWSE phase
- Not receiving the complete static page in 20 sec, is considered failure for the step

step 6: BROWSE log

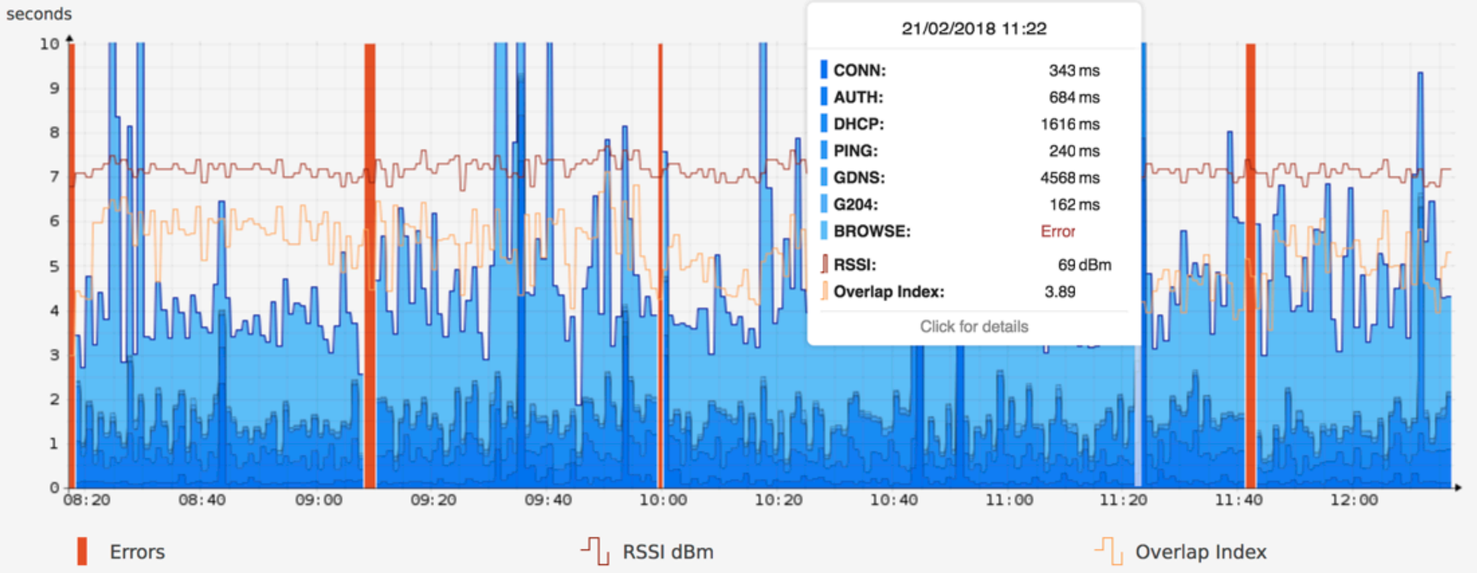
```
wget log on 'http://www.bing.com/':

FINISHED --2018-02-16 14:51:18--
Total wall clock time: 0.8s
Downloaded: 6 files, 115K in 0.2s (756 KB/s)
1291 msec per megabyte
```

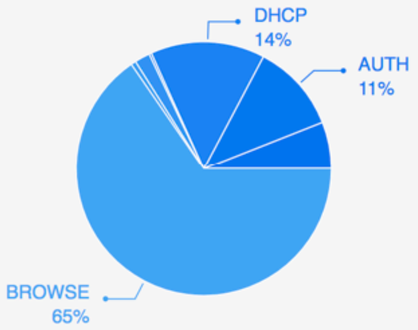
DemoProbe > IGAP
00:11:6b:ea:84:d0 (Digital Data Communications Asia Co.,Ltd)

Last 4 hours | Select custom range | 21/02/2018 08:17 - 21/02/2018 12:16

Overall time of test ConnectBrowse



Split time on test steps



Total errors: **8**

CONN:	6
PING:	1
BROWSE:	1

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