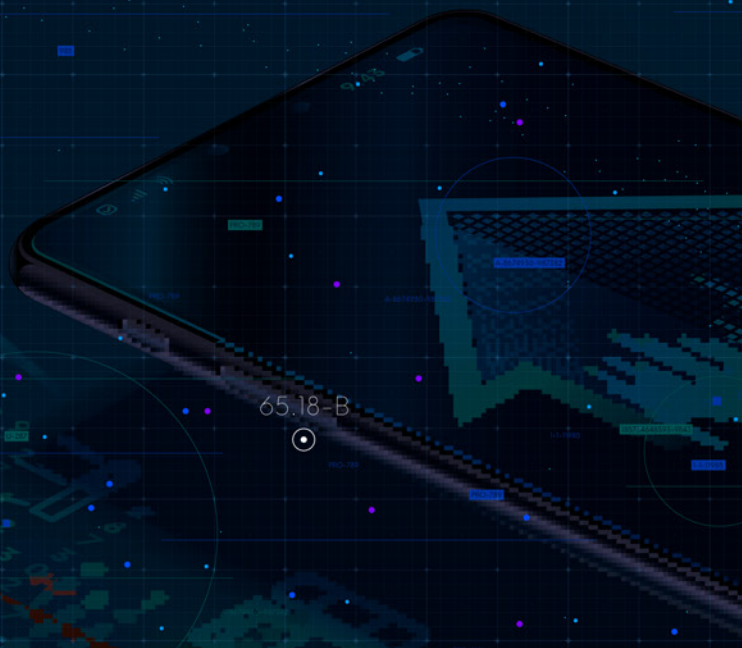
WHITEPAPER

Bitdefender



Security

Maximus Answer DualCam Video Doorbell

www.bitdefender.com

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Foreword

Internet-connected doorbells with motion-sensing and notification capabilities have become extremely popular among smart home enthusiasts. Convenient and easy to use, they are often regarded as the first line of physical security defense, but these devices often end up exposing private customer information or granting attackers access to the customer network.

As the creator of the world's first smart-home cybersecurity hub, Bitdefender constantly audits popular IoT hardware for vulnerabilities that might affect customers if left unaddressed. *This research paper, part of a series developed in partnership with* **Tom's Guide,** *aims to shed light on the security of the world's best-sellers in the IoT space.*

Device at a glance

The Maximus Answer DualCam Video Doorbell is a dual-camera IoT device with night-vision capabilities. It is designed to monitor both the entrance and packages left on the porch with a 180-degree view, day or night.

The good

- Use of OpenVPN tunneling with unique client certificates to prevent eavesdropping on traffic
- Signed firmware binary to ensure integrity
- Overall good security practices

The bad

- The device does not validate the server certificate on HTTPS connections
- Logs and video alerts can be intercepted using trivial man-in-the-middle attacks

1. Cloud-device communication:

a. Authentication/Identification

The device uses OpenVPN to establish a connection with the server (vpn.kunasystems.com). The connection requires a client certificate that is unique for each camera and is stored on the flash memory in production.

The device also stores a 32-character hexadecimal secret that, together with a nonce, can be hashed into a token. Some services require the token and the nonce value so the server can verify that the message originated from the camera.

b. Communication protocols used:

- OpenVPN protocol – for most of the communication
- HTTPS – for uploading recordings to an AWS S3 bucket, sending logs and firmware update

c. Communication channel security:

The OpenVPN protocol is secure against tampering and eavesdropping. A warning in the log files suggests that the server certificate is not verified (*WARNING: No server certificate verification method has been enabled. See http://openvpn.net/howto.html#mitm for more info.*)

This could theoretically allow an attacker to impersonate the server, but the attack requires knowledge of both the ta.key file (to authenticate TLS connections), and a way to trick the camera into connecting to the rogue server.

The HTTPS protocol is used in sending logs to logs-01.loggly.com and recordings to a bucket on s3.amazonaws.com. Both connections are vulnerable to a man-in-the-middle attack, as the camera does not verify the server certificate. As a result, an attacker sitting between the camera and the servers could intercept the uploaded logs and recordings.

Intercepted upload request:

```
PUT /kuna--production--us-east-1--recordings/V1C441908132/2021_08_13__14_50_48+0300/V1C441908132-2021_08_13__14_50_48+0300-0
HTTP/1.1
Host: s3.amazonaws.com
Accept: */*
x-amz-content-sha256: a5031ed6c854dcd45c5966a276a4408fdc2cadc47125da07ed966ac5f2bec067
x-amz-date: 20210813T115109Z
x-amz-meta-timestamp: 2021-08-13 14:51:09
x-amz-security-token:
FwoGZXIvYXdzEP3/////////wEaDOrin+pcfiMnmrTaBiKpAh4SGyqMrRsKogalbvlc1skaz5CRqwR0YHjMaP6fQA+7sHGj/lK756i4jyUsvZCxNN3EBIlMtMiOEC
Lej//o9/xMAsSsZwN1/sjMsOzzOxj63A0k+q/MnJFbJUahHo7KCavRpP+5QkZpVa1ngz8kbkCGWGGxCaC9tBp2lHqpw7l329Kv65BNWHUuE8HoDfVWczi/LXzWwo9L
GW7zvK5qlsZA9LL/Vwz8fnHX+KXaMZxsmU3I19QdatmLNCheuYWvWx5jGwsikpoRsxfhHXQC7goXTZvgjVBldYL5tmV8GDYhSscSB3DQnoF2BF3K4C73Zn+Ha70RZ7
OlqQKfggDUCKOHI9u6WolJxFOdECNX8D6TV8XvD43SeMEItOJ3Mr9kMoJpvi8TBUUwMyiZudmIBjItBirsI6l5K/cHHBMgkmdpYYxrVjdb1aNdzsUDCgNtKbISmRXK
OBF7EKDzd+3S
Authorization: AWS4-HMAC-SHA256
Credential=ASIA2HDF7UJZP34IY5W4/20210813/us-east-1/s3/aws4_request,SignedHeaders=host;x-amz-content-sha256;x-amz-date;x-amz-me
ta-timestamp;x-amz-security-token,Signature=3a44d4c21fd0418873d137f5c837949b14962f7b4858c30390a08939a96b9665
Content-Type: video/MP2T
Content-Length: 1460572
Connection: close

G`f
```

Intercepted logging request:

```
POST /bulk/61391be8-d772-47c3-ae83-75618406854a@41058/tag/KUNA_VJW01,V1C441908132,30080473,master/ HTTP/1.1
Host: logs-01.loggly.com
Accept: */*
Content-Type: text/plain
Content-Length: 7302
Expect: 100-continue
Connection: close

{"timestamp":"2021-08-13T14:50:38.449256-0300","id":422,"severity":"info","facility":1,"appName":"kuna_img_control","j":{"fn":
"_daynight_mode_detect","t":"avg-gain:19 raw-gain:19"}}
{"timestamp":"2021-08-13T14:50:48.096214-0300","id":423,"severity":"info","facility":1,"appName":"kunamonitor","j":{"fn":"kunad
b_notify_wait","t":"DB key DB_BUTTON_STATE was updated, calling handlers"}}
{"timestamp":"2021-08-13T14:50:48.096256-0300","id":424,"severity":"info","facility":1,"appName":"kunaimage","j":{"fn":"kunadb_
notify_wait","t":"DB key DB_BUTTON_STATE was updated, calling handlers"}}
{"timestamp":"2021-08-13T14:50:48.255446-0300","id":425,"severity":"info","facility":1,"appName":"kunarest","j":{"fn":"kunarest
_handle_params_patch","j":{"patch_data": {"prerecorded_msg": 3}}}}
{"timestamp":"2021-08-13T14:50:48.258319-0300","id":426,"severity":"info","facility":1,"appName":"kunaaudio","j":{"fn":"kunadb_
notify_wait","t":"DB key DB_PRERECORDED_MESSAGE was updated, calling handlers"}}
{"timestamp":"2021-08-13T14:50:48.262746-0300","id":427,"severity":"info","facility":1,"appName":"kunarest","j":{"fn":"kunarest
_handle_params_get","j":{"get_data": { "play": "none", "volume": 59 },}}}
{"timestamp":"2021-08-13T14:50:48.545591-0300","id":428,"severity":"error","facility":1,"appName":"kunamonitor","j":{"fn":"_sys
tem_monitor_signal_main","t":"sigwait failed with errno=4"}}
{"timestamp":"2021-08-13T14:50:48.568889-0300","id":429,"severity":"error","facility":1,"appName":"kunamonitor","j":{"fn":"_sys
tem_monitor_signal_main","t":"sigwait failed with errno=4"}}
```

d. Information sent in logs:

Even though the logs could be intercepted, they do not contain sensitive information that could be useful to an attacker. Most of the messages pertain to the functioning of the camera. The surrounding Wi-Fi networks and their MAC addresses are transmitted, as well as the name of the current network.

The password for the current network is not transmitted.

f. Firmware update:

The user can manually force the check for a firmware update, but the device will also periodically check for a new version of the firmware.

If a new version is available, the camera will request the firmware and its signature from update.kunasystems.com. The request can be intercepted with a man-in-the-middle attack, but the firmware is signed. This means that any modifications to the binary will result in a signature mismatch. The binary will be discarded in this case. An attacker can't forge the signature, as it requires the private certificate corresponding to the public key used to check the signature.

2. Local network:

No ports can be accessed on the local interface because of *iptables* rules that drop any incoming connection. CVE-2019-14899 was tested in order to hijack the VPN connection, but the camera is not vulnerable.

3. Setup:

At first, the Kuna application connects to the camera using Bluetooth. To initiate the setup, the device sends back the surrounding Wi-Fi networks, its serial number, common name and a nonce. The app sends the serial number together with the common name and the nonce to server.kunasystems.com. The server then replies with a token (the SHA1 hash of the nonce + secret) that will be sent to the camera along with the Wi-Fi credentials.

The Bluetooth connection can be established at any time to change the Wi-Fi network, but only the camera owner can initiate it. This is enforced by the secret known only by the camera and the server. If an attacker wishes to change the network, they would need either the secret to create the token, or the token provided from the server. The secret is unknown, and the server sends the token to the owner only.

4. Application – cloud communication:

The requests that control the camera, manage the account, or ask for a recording are sent to server.kunasystems.com. They must contain a token that is received at login. To modify the camera's settings, the user requires its serial number. An attacker who knows the serial number cannot modify settings, as ownership is validated.

To access a recording, the user receives a pre-signed URL that leads to the file in an AWS bucket.

For live streaming, a WebSocket Secure connection is made to video.kunasystems.com. The first request contains the authentication token in the following format:

```
wss://video.kunasystems.com:443/ws/rtsp/proxy?authtoken=<token>
```

After the connection is established, a custom protocol is used to set up a proxy between the application and the camera. First, the serial number of the camera - as well as the token - must be provided for authentication. After that, RTSP messages will be routed through this connection and the camera starts sending the video stream.

5. Hardware access:

The pins for a UART serial connection are exposed on the camera. The boot process can be observed on this connection, and at the end of it a password protected console is provided. The password for the root user is the secret mentioned earlier, and it's unknown.

Serial login prompt:

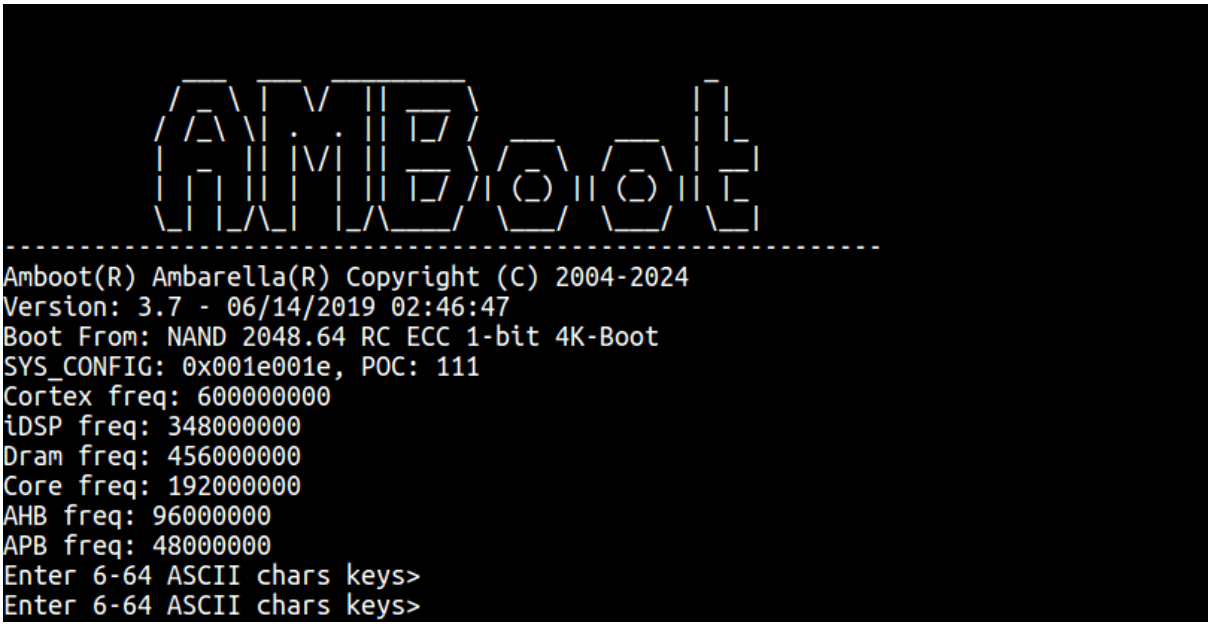
```
  : values=3
count : 20[    9.447064] buf : reg-value:0x02:0x81
[    9.450882] pData = reg-value:0x02:0x81
[    9.454922] [SKL_POWER]skylight_power_chage_regs 175 [    9.460026] 20 reg-value:0x02:0x
81
[    9.460026]


Welcome to Kuna
Kuna login: crond[557]: crond (busybox 1.24.1) started, log level 8
```

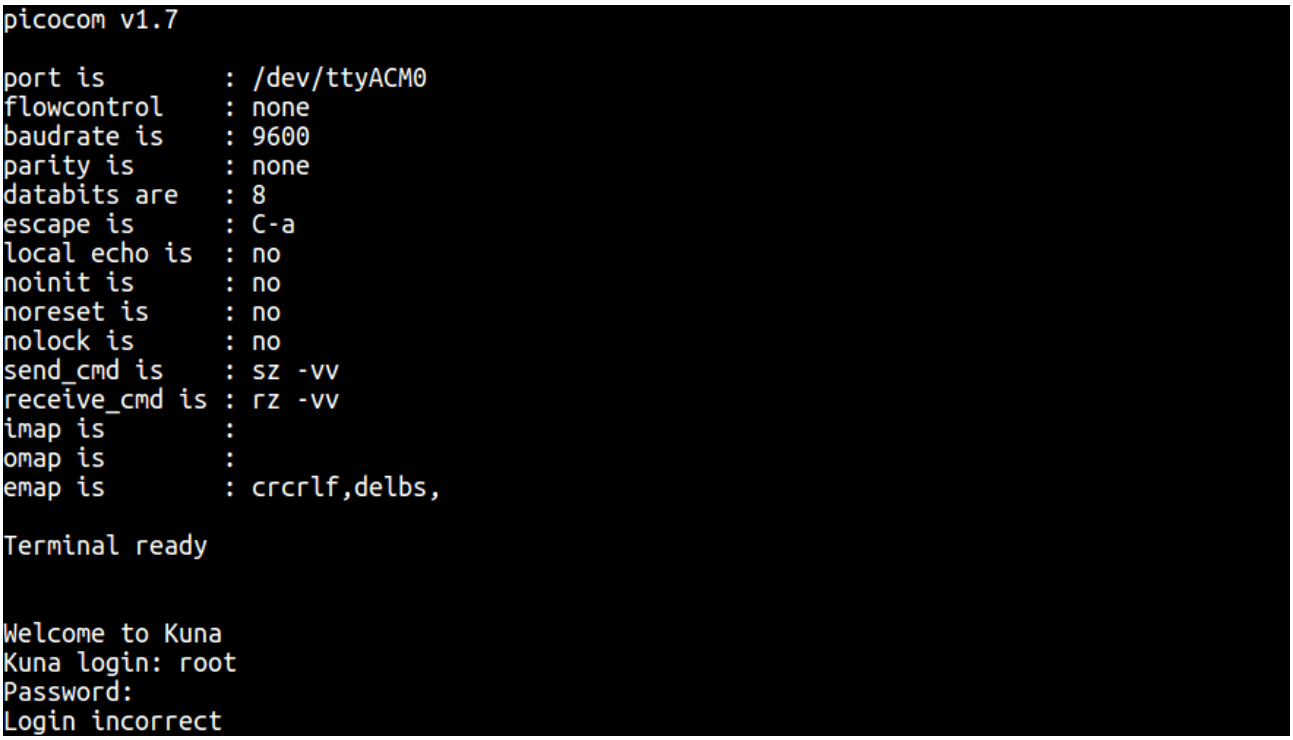
The boot process can be interrupted by shorting the TX and RX pins. The Ambarella bootloader will ask for a password to access its console, but this password is unknown.

The UART connection is also accessible over USB, but it also requires the password for the root user.

Amboot login prompt:



USB serial login prompt:



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UNDER THE SIGN OF THE WOLF

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