OLD SKEWL HACKING:
DVB-T BLACK BUTTON PIVOT

November 2016

Adam “Major Malfunction”
Laurie

Who Am I?

Director – Aperture Labs – aperturelabs.com

http://adamsblog.aperturelabs.com/

DEF CON Goon – Quartermaster

POC @ DC4420 – DEF CON London

http://dc4420.org

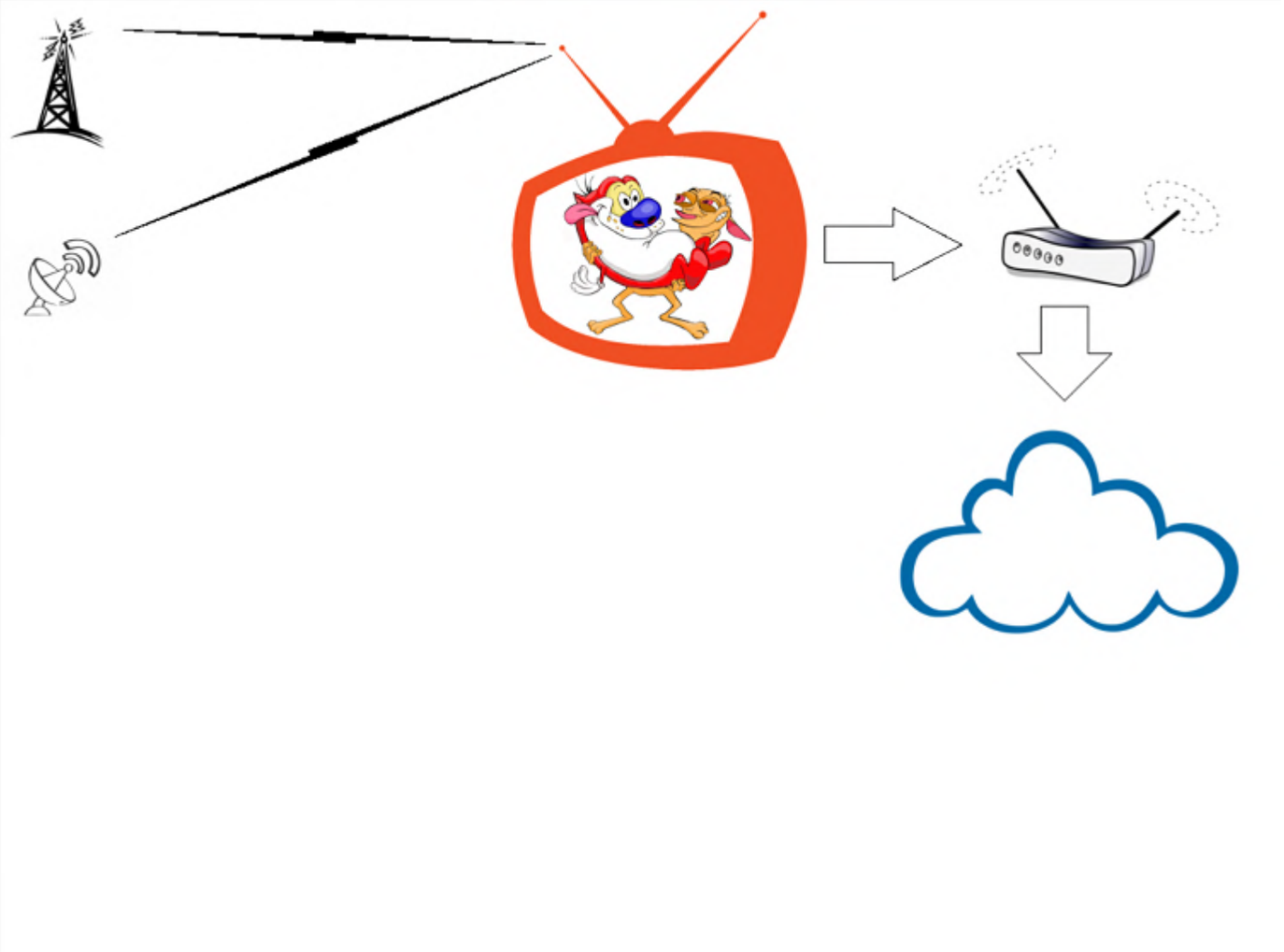
OLD SKEWL HACKING:
DVB-T BLACK BUTTON PIVOT

Thanks to Mike Ossman and Dominic Spill for the HackRF hardware!

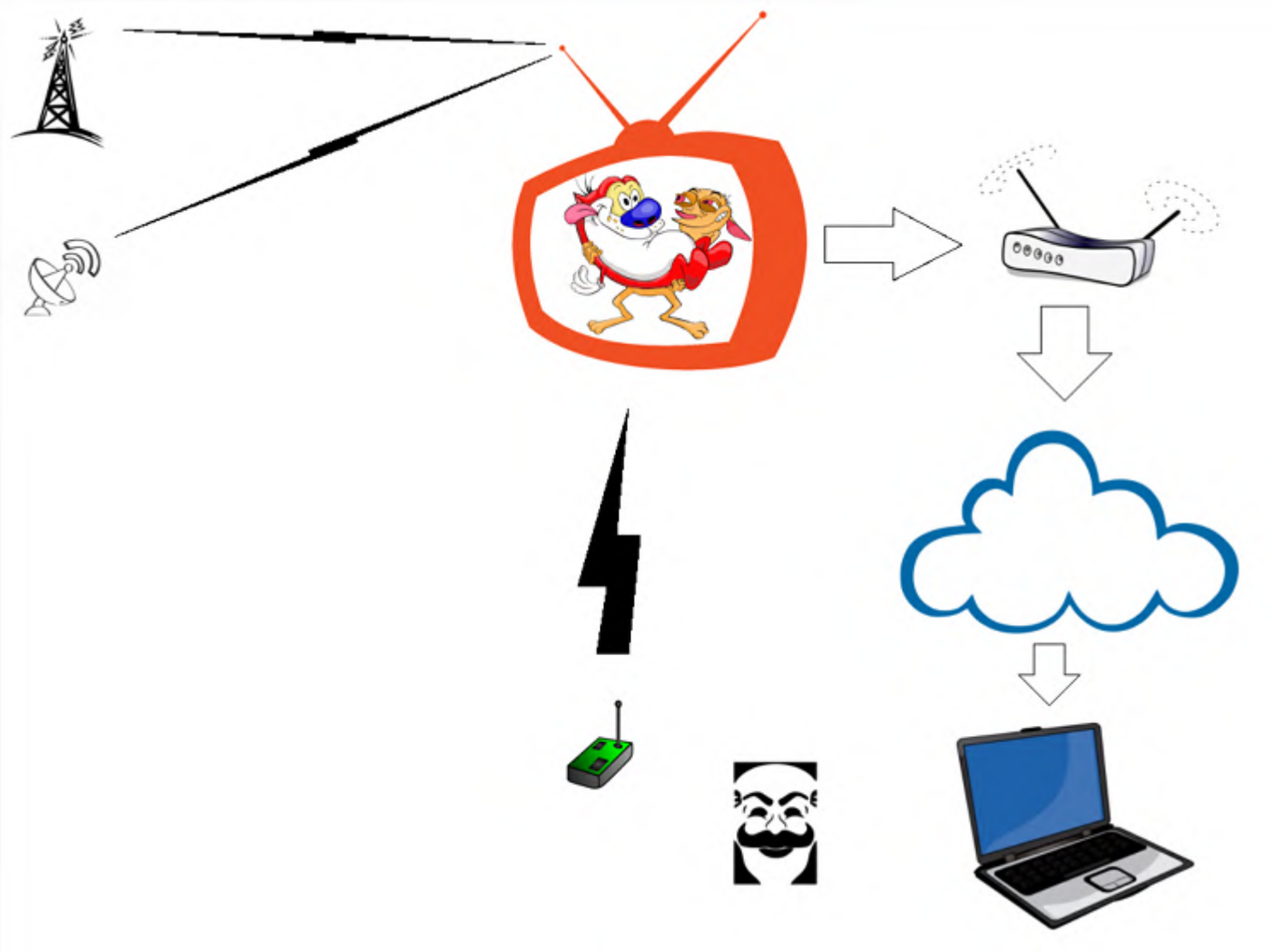
https://greatscottgadgets.com/

Just to really show my appreciation, here's what I'm doing with my new toy...

OLD SKEWL HACKING:
DVB-T BLACK BUTTON PIVOT



OLD SKEWL HACKING:
DVB-T BLACK BUTTON PIVOT



Why?

- TV Hacking

Why?

- TV Hacking
  - In hotels via Infra-Red

Why?

- TV Hacking
  - In hotels via Infra-Red
    - Free Pay Per View
    - Other in-room services
      - Mini Bar
      - Checkout
      - Telephone bills/logs
      - Wakeup Alarm
    - Hotel management servers
      - Billing
      - Info screens

Why?

- TV Hacking
  - In hotels via Infra-Red
  - At home via Satellite

Why?

- TV Hacking
  - In hotels via Infra-Red
  - At home via Satellite
    - Free Pay Per View
      - intercept feed signal from live events
    - Find hidden/interesting streams
    - Data as well as Audio / Video

Why?

- TV Hacking
  - In hotels via Infra-Red
  - At home via Satellite
  - At home via DVB-T

Why?

- TV Hacking
  - In hotels via Infra-Red
  - At home via Satellite
  - At home via DVB-T
    - Free Pay Per View
      - Bypass Premium Rate phone “unlock”
    - MHEG adopted as national standard

Why?

From Wikipedia:

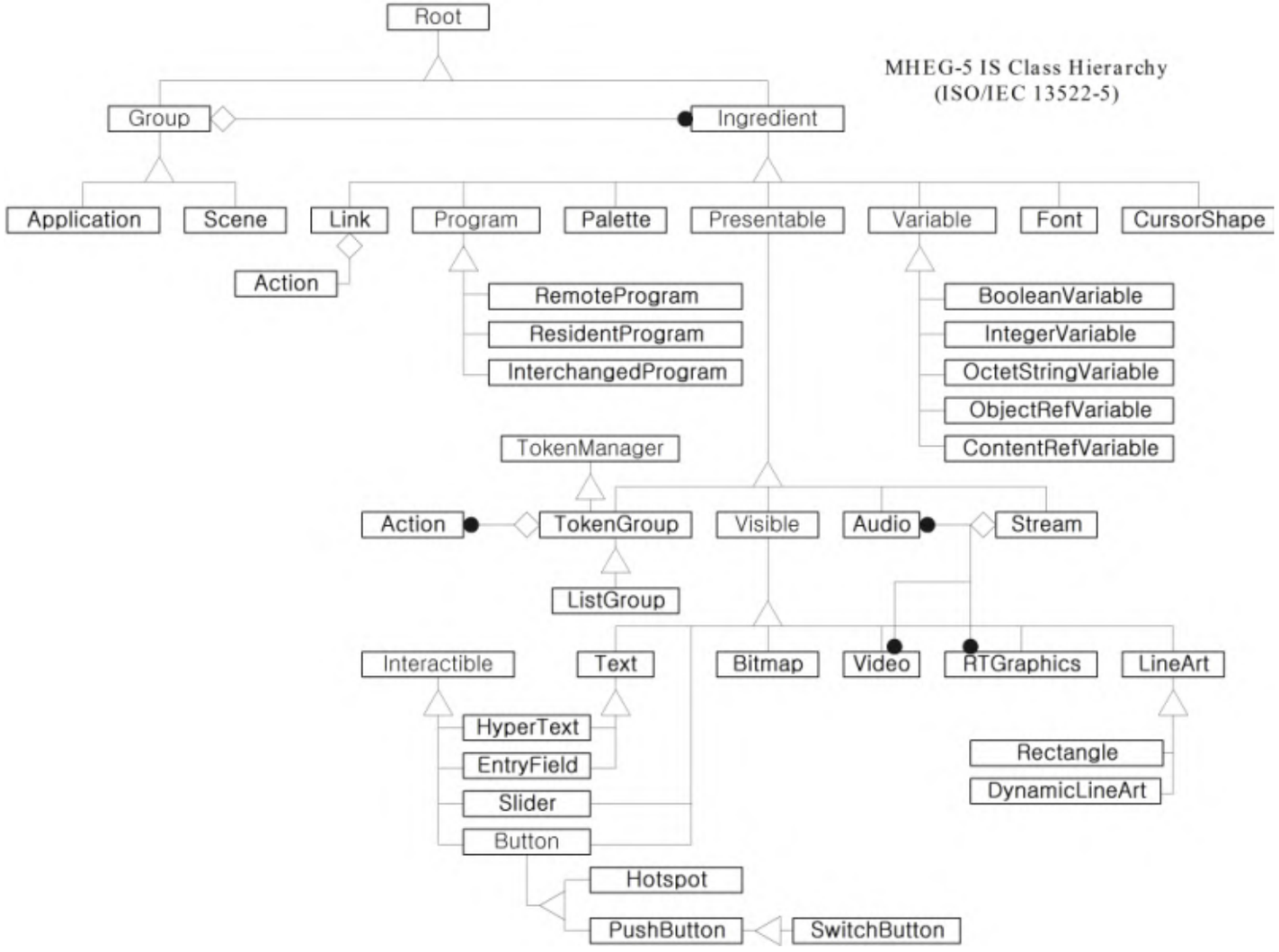
"MHEG-5, or ISO/IEC 13522-5,[1] is part of a set of international standards relating to the presentation of multimedia information, standardised by the Multimedia and Hypermedia Experts Group (MHEG). It is most commonly used as a language to describe interactive television services."

Why?

ALL (compliant) UK TVs are vulnerable to MHEG attacks...

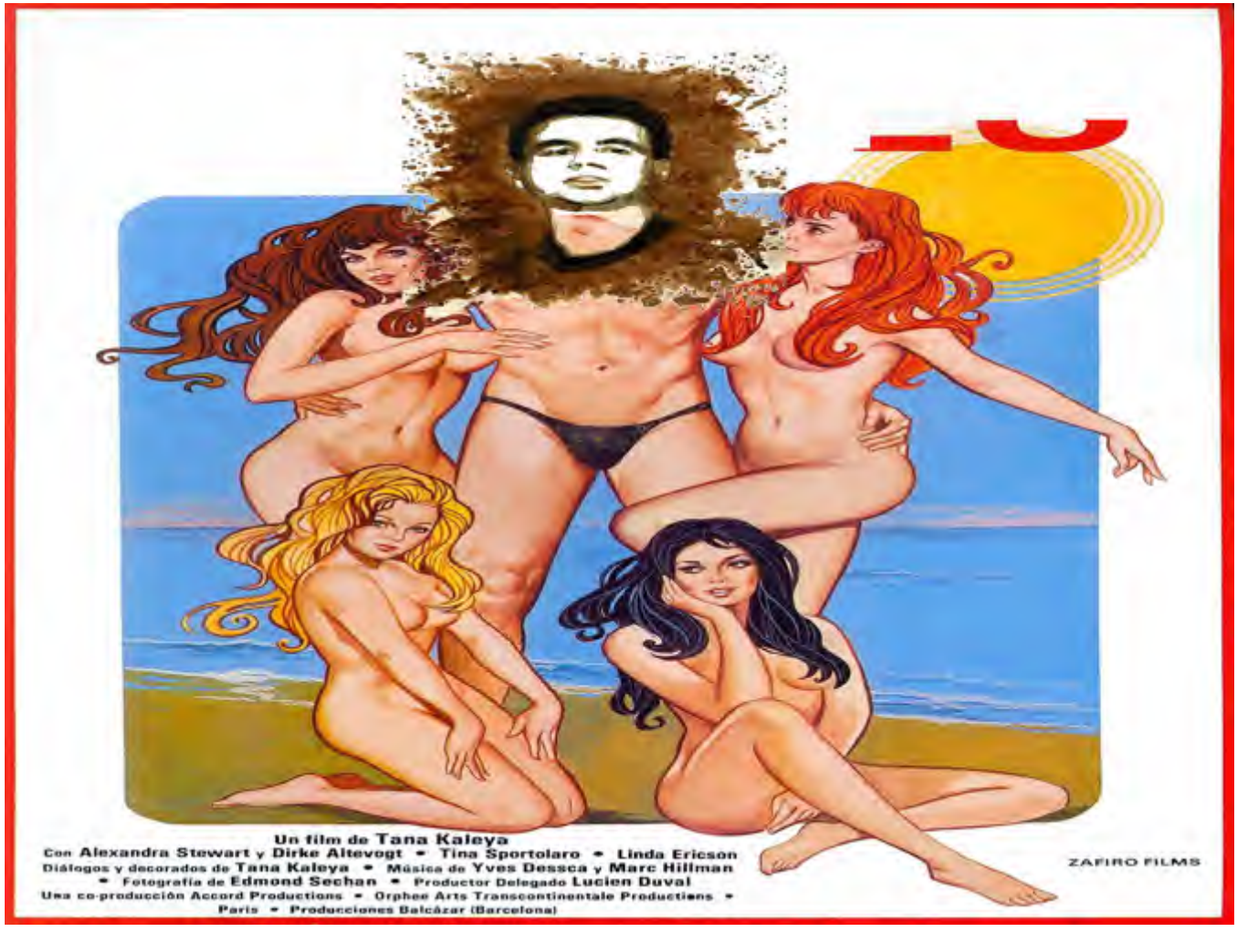
http://dtg.org.uk/publications/dbook.html

Why?


MHEG-5 IS Class Hierarchy
(ISO/IEC 13522-5)
Root
Group
Ingredient
Application
Scene
Link
Program
Palette
Presentable
Variable
Font
CursorShape
Action
RemoteProgram
ResidentProgram
InterchangedProgram
BooleanVariable
IntegerVariable
OctetStringVariable
ObjectRefVariable
ContentRefVariable
TokenManager
Action
TokenGroup
Visible
Audio
Stream
ListGroup
Interactible
Text
Bitmap
Video
RTGraphics
LineArt
HyperText
EntryField
Slider
Button
Rectangle
DynamicLineArt
Hotspot
PushButton
SwitchButton

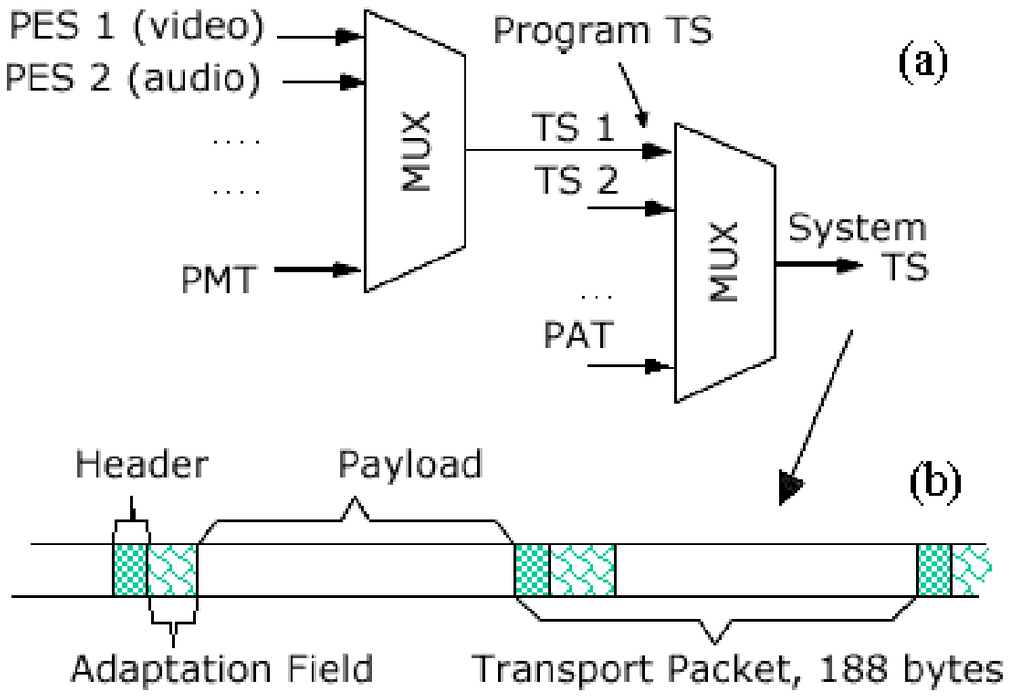
DEF CON talk: Porn Free!

- https://www.youtube.com/watch?v=1RPmpJi3VRM



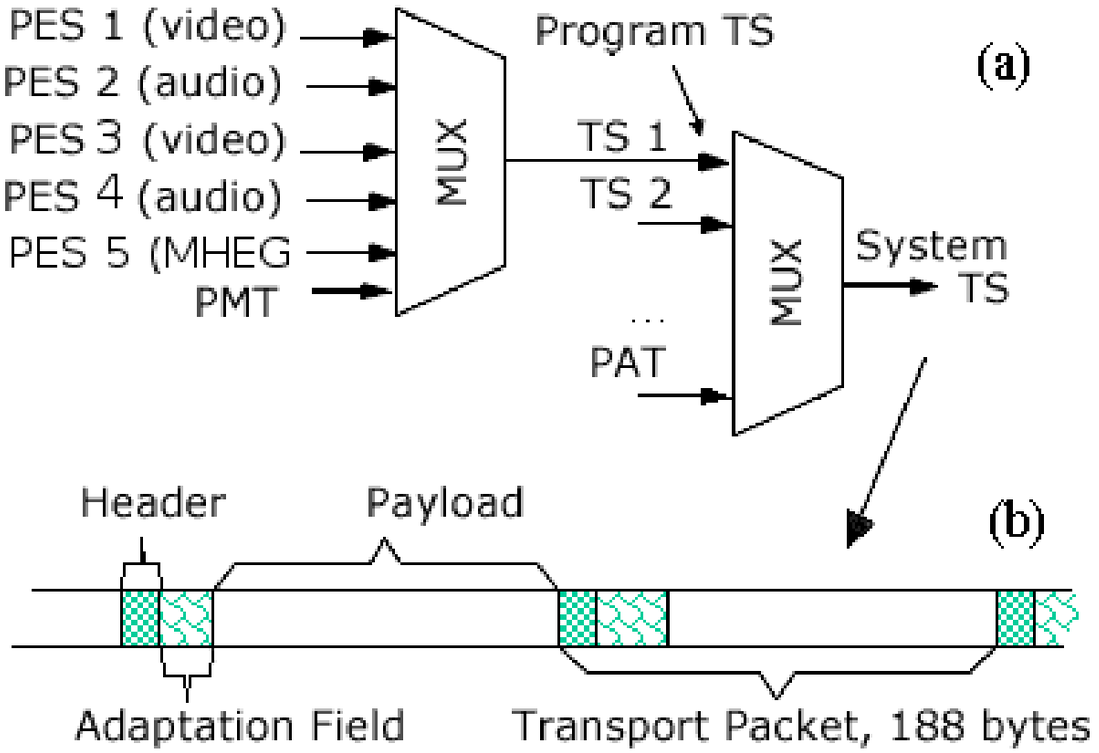
What's going on?

- Pornographer broadcasts blank video & audio streams in PES 1 & 2 (advertised in the PID/PAT etc.)



What's going on?

- MHEG loads and streams PES 3 & 4 only after validation / payment.



Capturing the MHEG

- Standard DVB-T dongle
- rb-download
  - http://redbutton.sourceforge.net/

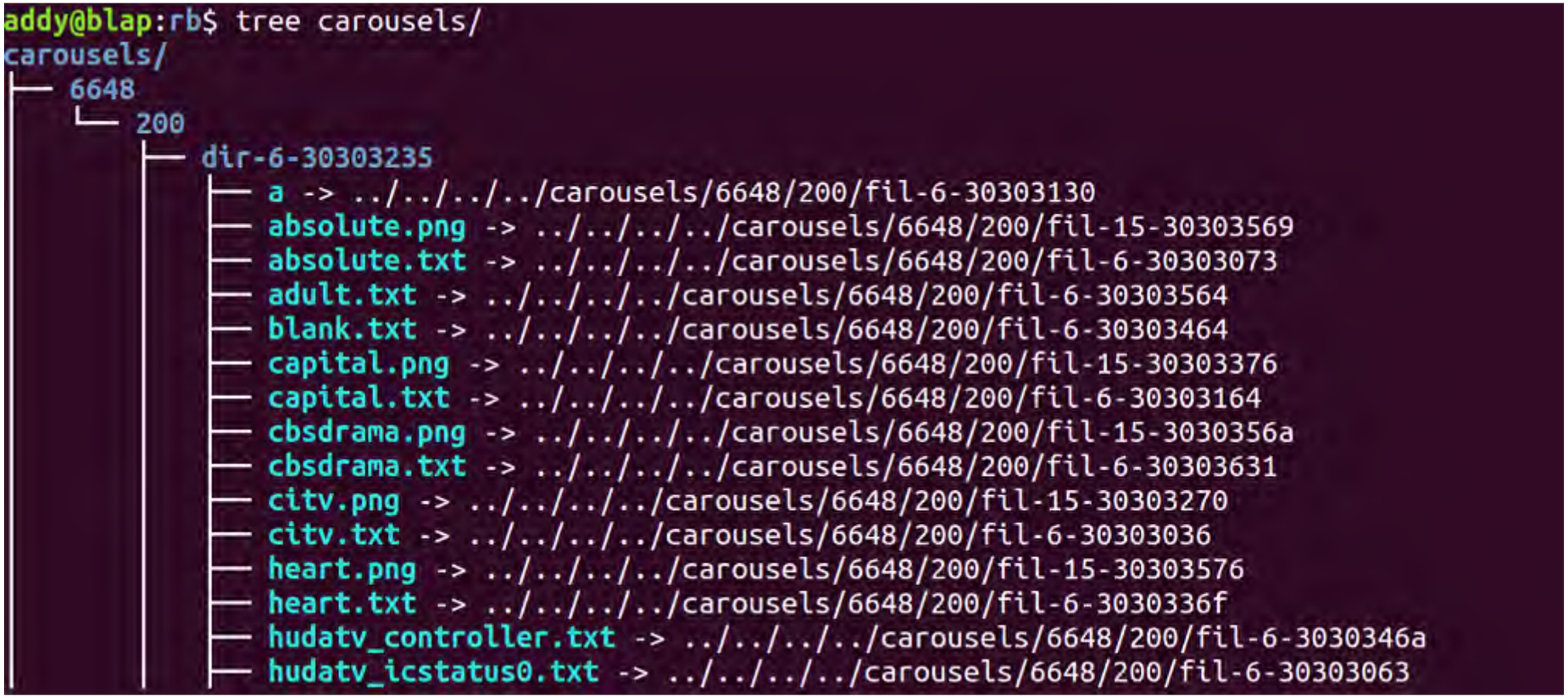
What's there?

- Images
- Certs
- 'binary executable'
  - ASN.1
  - Effectively source code

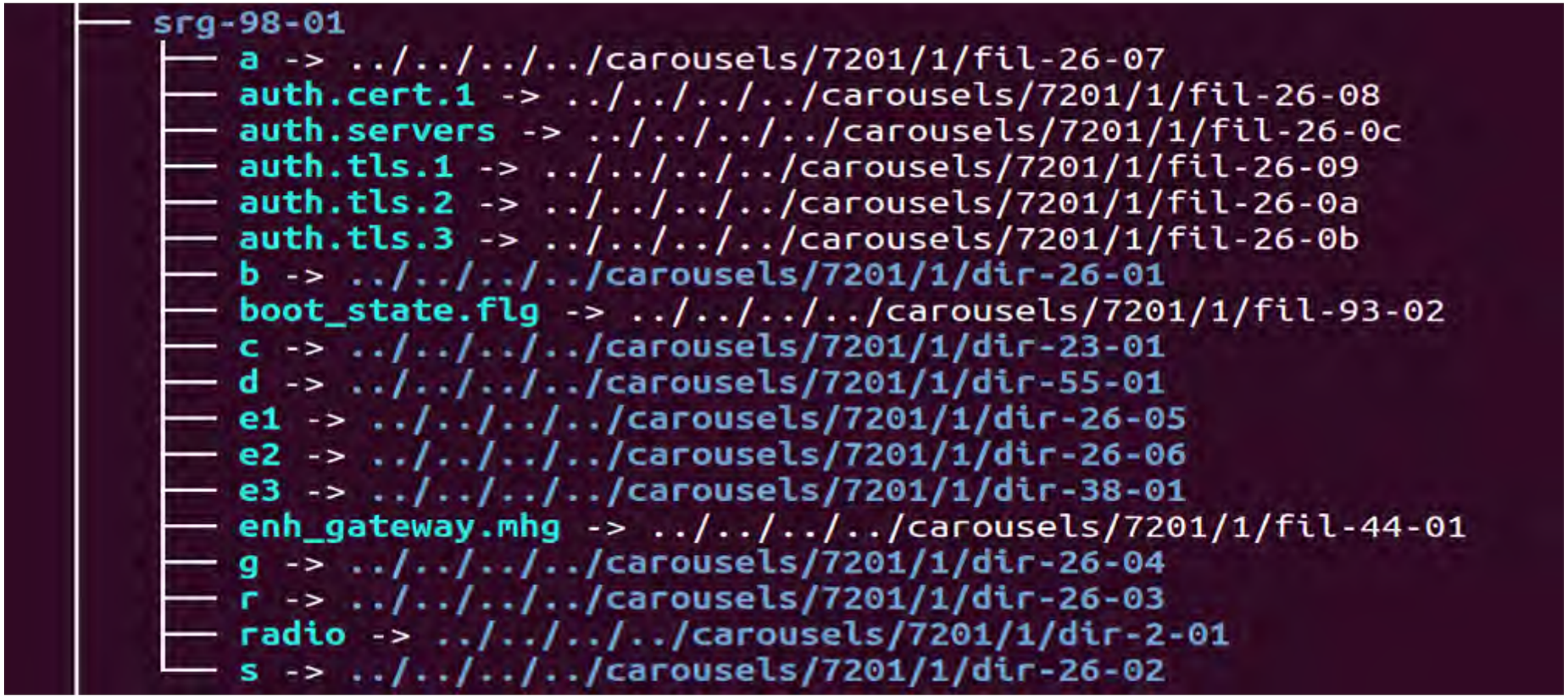
Data structure

```
addy@blap:rb$ tree services/
services/
├── 14576 -> ../carousels/6648/200/srg-0-30303030
├── 15232 -> ../carousels/6648/200/srg-0-30303030
├── 4162 -> ../carousels/7201/1/srg-92-01
└── 4544 -> ../carousels/7201/1/srg-92-01
```

Data structure



Data structure



Images


itv2
+1


TELEVISION
X


Absolute
Radio


itv3
+1


itv Be.


CBS drama


Xpanded TV


itv4
+1


STUDIO 66

Certificates

```
00000000  00 01 00 03 c0 30 82 03  bc 30 82 02 a4 a0 03 02  |.....0...0......|
00000010  01 02 02 08 0e 65 1a d2  b3 e5 23 c7 30 0d 06 09  |.....e....#.0...|
00000020  2a 86 48 86 f7 0d 01 01  05 05 00 30 81 9e 31 0b  |*.H........0..1.|
00000030  30 09 06 03 55 04 06 13  02 47 42 31 0f 30 0d 06  |0...U....GB1.0..|
00000040  03 55 04 07 0c 06 4c 6f  6e 64 6f 6e 31 29 30 27  |.U....London1)0'|
00000050  06 03 55 04 0a 0c 20 42  72 69 74 69 73 68 20 42  |..U... British B|
00000060  72 6f 61 64 63 61 73 74  69 6e 67 20 43 6f 72 70  |roadcasting Corp|
00000070  6f 72 61 74 69 6f 6e 31  17 30 15 06 03 55 04 0b  |oration1.0...U..|
00000080  0c 0e 46 4d 54 20 47 72  65 65 6e 68 6f 75 73 65  |..FMT Greenhouse|
00000090  31 3a 30 38 06 03 55 04  03 0c 31 42 42 43 20 47  |1:08..U...1BBC G|
000000a0  72 65 65 6e 68 6f 75 73  65 20 50 72 6f 64 75 63  |reenhouse Produc|
000000b0  74 69 6f 6e 20 53 65 72  76 65 72 73 20 61 6e 64  |tion Servers and|
000000c0  20 53 65 72 76 69 63 65  73 20 43 41 30 1e 17 0d  | Services CA0...|
000000d0  31 35 31 30 33 30 31 31  33 30 30 32 5a 17 0d 31  |151030113002Z..1|
000000e0  38 30 37 32 30 31 31 34  37 30 32 5a 30 81 ab 31  |80720114702Z0..1|
000000f0  25 30 23 06 09 2a 86 48  86 f7 0d 01 09 01 16 16  |%0#..*.H........|
00000100  42 42 43 52 42 54 65 61  6d 45 78 74 40 62 62 63  |BBCRBTeamExt@bbc|
00000110  2e 63 6f 2e 75 6b 31 1d  30 1b 06 03 55 04 03 0c  |.co.uk1.0...U...|
00000120  14 42 72 6f 61 64 63 61  73 74 20 52 65 64 20 42  |.Broadcast Red B|
00000130  75 74 74 6f 6e 31 1a 30  18 06 03 55 04 0b 0c 11  |utton1.0...U....|
00000140  50 72 6f 64 75 63 74 69  6f 6e 20 53 65 72 76 65  |Production Serve|
00000150  72 31 29 30 27 06 03 55  04 0a 0c 20 42 72 69 74  |r1)0'..U... Brit|
00000160  69 73 68 20 42 72 6f 61  64 63 61 73 74 69 6e 67  |ish Broadcasting|
00000170  20 43 6f 72 70 6f 72 61  74 69 6f 6e 31 0f 30 0d  | Corporation1.0.|
```

Code (ASN.1)

```
00001560  01 00 0a 01 06 02 01 64  bf 3f 82 01 6d bf 76 2c  |.......d.?..m.v,|
00001570  30 07 04 02 2f 61 02 01  15 04 21 0d 52 65 64 20  |0.../a....!.Red |
00001580  6b 65 79 20 70 72 65 73  73 65 64 2c 20 6c 6f 61  |key pressed, loa|
00001590  64 20 76 6f 64 20 73 74  72 65 61 6d bf 81 54 25  |d vod stream..T%|
000015a0  02 01 55 bf 81 63 1e 04  1c 2f 69 6d 61 67 65 73  |..U..c.../images|
000015b0  2f 62 75 74 74 6f 6e 73  2f 72 65 64 2d 77 61 69  |/buttons/red-wai|
000015c0  74 2e 70 6e 67 bf 78 2a  30 07 04 02 2f 61 02 01  |t.png.x*0.../a..|
000015d0  22 30 07 04 02 2f 61 02  01 1c 30 16 bf 81 63 07  |"0.../a...0...c.|
000015e0  bf 81 6c 03 02 01 55 bf  81 65 07 bf 81 6c 03 02  |..l...U..e...l..|
000015f0  01 56 bf 81 41 12 02 01  4b 30 0d bf 81 6c 03 02  |.V..A...K0...l..|
00001600  01 56 bf 81 6a 02 05 00  bf 81 54 1d 02 01 55 bf  |.V..j.....T...U.|
00001610  81 63 16 04 14 2f 69 6d  61 67 65 73 2f 61 76 61  |.c.../images/ava|
00001620  6c 70 61 39 30 2e 70 6e  67 bf 78 2a 30 07 04 02  |lpa90.png.x*0...|
00001630  2f 61 02 01 22 30 07 04  02 2f 61 02 01 1c 30 16  |/a.."0.../a...0.|
00001640  bf 81 63 07 bf 81 6c 03  02 01 55 bf 81 65 07 bf  |..c...l...U..e..|
00001650  81 6c 03 02 01 56 bf 81  41 12 02 01 4a 30 0d bf  |.l...V..A...J0..|
00001660  81 6c 03 02 01 56 bf 81  6a 02 05 00 bf 81 3a 0b  |.l...V..j.....:.|
00001670  02 01 4a 02 02 00 a2 02  02 01 a2 bf 81 54 36 02  |..J..........T6.|
00001680  01 57 bf 81 63 2f 04 2d  68 74 74 70 3a 2f 2f 74  |.W..c/.-http://t|
00001690  72 61 63 6b 65 72 2e 61  76 61 6c 70 61 2e 6f 72  |racker.avalpa.or|
000016a0  67 2f 76 6f 64 2f 6d 68  65 67 74 65 73 74 2f 42  |g/vod/mhegtest/B|
000016b0  42 42 2e 74 73 bf 81 54  0a 02 01 59 bf 81 61 03  |BB.ts..T...Y..a.|
000016c0  01 01 ff bf 73 03 02 01  7e bf 81 5b 0d 02 01 59  |....s...~..[...Y|
000016d0  02 01 01 bf 81 61 03 01  01 ff b4 2d 02 02 00 8a  |.....a.....-....|
000016e0  bf 3e 09 02 01 00 0a 01  06 02 01 68 bf 3f 1a bf  |.>.........h.?..|
000016f0  81 32 09 30 07 04 02 2f  61 02 01 0d bf 81 30 09  |.2.0.../a.....0.|
00001700  30 07 04 02 2f 61 02 01  00 9f 33 01 04 bf 34 08  |0.../a....3...4.|
00001710  02 02 02 d0 02 02 02 40                           |.......@|
```

Code (Decoded)

```
  { :Link 137
    :InitiallyActive FALSE
    :EventSource 0
    :EventType UserInput
    :EventData 100
    :LinkEffect (
      :Append ( ( '/a' 21 ) '=0DRed key pressed, load vod stream' )
      :SetVariable ( 85 :GOctetString '/images/buttons/red-wait.png' )
      :Call ( ( '/a' 34 ) ( '/a' 28 )
            :GOctetString :IndirectRef 85
            :GContentRef :IndirectRef 86
      )
      :SetData ( 75 :NewRefContent ( :IndirectRef 86 ) )
      :SetVariable ( 85 :GOctetString '/images/avalpa90.png' )
      :Call ( ( '/a' 34 ) ( '/a' 28 )
            :GOctetString :IndirectRef 85
            :GContentRef :IndirectRef 86
      )
      :SetData ( 74 :NewRefContent ( :IndirectRef 86 ) )
      :SetBoxSize ( 74 162 418 )
      :SetVariable ( 87 :GOctetString 'http://tracker.avalpa.org/vod/mhegtest/BBB.ts' )
      :SetVariable ( 89 :GBoolean TRUE )
      :Activate ( 126 )
      :TestVariable ( 89 1 :GBoolean TRUE )
    )
  }
  { :Link 138
    :EventSource 0
    :EventType UserInput
    :EventData 104
    :LinkEffect (
      :Run ( ( '/a' 13 ) )
      :Quit ( ( '/a' 0 ) )
    )
  }
)
:InputEventReg 4
:SceneCS 720 576
```

MHEG vulns

TV can connect to remote HTTP/HTTPS to obtain content:

- Reveal IP of victim
- malicious content – images/streams
- **may** be signed/trusted
- other? e.g. buffer overflow etc.

Content can be more MHEG

- **must** be signed / trusted
- trust certs provided in broadcast stream

MHEG vulns:

TV **ALWAYS** trusts broadcast data...

MHEG vulns:

TV **ALWAYS** trusts broadcast data...

The standard says that's OK.

Live Demos

1. Broadcast webcam
2. Broadcast existing transport stream
    2a. With data services
3. Capture and replay live TS
    3a. With data services
4. MiTM live TS
5. Capture and decode MHEG
    5a. Re-use to create own MHEG prog
6. Mux own MHEG data stream with Audio/Video stream
7. Todo: Live TS MiTM re-mux with replaced data stream
    6a. Handy wrapper to calculate nasty numbers
8. Test against DVB-S, DVB-C.

Tools

- Hack-RF
  - Gnu-Radio Companion
  - ffmpeg/avconv
  - OpenCaster
  - Avalpa
    - http://www.avalpa.com/
  - Big Buck Bunny
    - https://peach.blender.org/

- DVB-T2 dongle
  - dvblast, netcat
  - mhegc
    - http://redbutton.sourceforge.net/

Broadcast webcam

Credit to Clayton Smith for providing example:

http://www.irrational.net/2014/03/02/digital-atv/

And for fixing gnu-radio and generally providing help and assistance.

https://github.com/gnuradio/gnuradio/pull/807

(should now be in main branch)

Broadcast webcam

Connect HackRF direct to TV receiver to be legal…

Be careful to keep gain low to avoid receiver damage (start low and monitor signal quality with receiver menu system / info)

Broadcast webcam

Get correct mux rate with 'dvbtrate 8':

https://github.com/drmpeg/dtv-utils

Start TX python listener script:

./dvbt-hackrf-receiver.py 1234

Start webcam muxer:

```
avconv -f alsa -i pulse -f video4linux2 -s 640x480 -i /dev/video0  -vcodec mpeg2video -s 640x480 -r 60 -b 4000000 -acodec mp2 -ar 48000 -ab 192000 -ac 2 -muxrate 6032086 -mpegts_transport_stream_id 1025 -mpegts_service_id 1 -mpegts_pmt_start_pid 0x1020 -mpegts_start_pid 0x0121 -f mpegts -y -metadata service_name="<insert channel name here>" tcp://127.0.0.1:1234
```

Broadcast TS

2. Broadcast existing transport stream

    2a. With data services

Broadcast existing transport streams

gnuradio-companion dvbt_mheg-samples.grc

1 - single audio/video stream

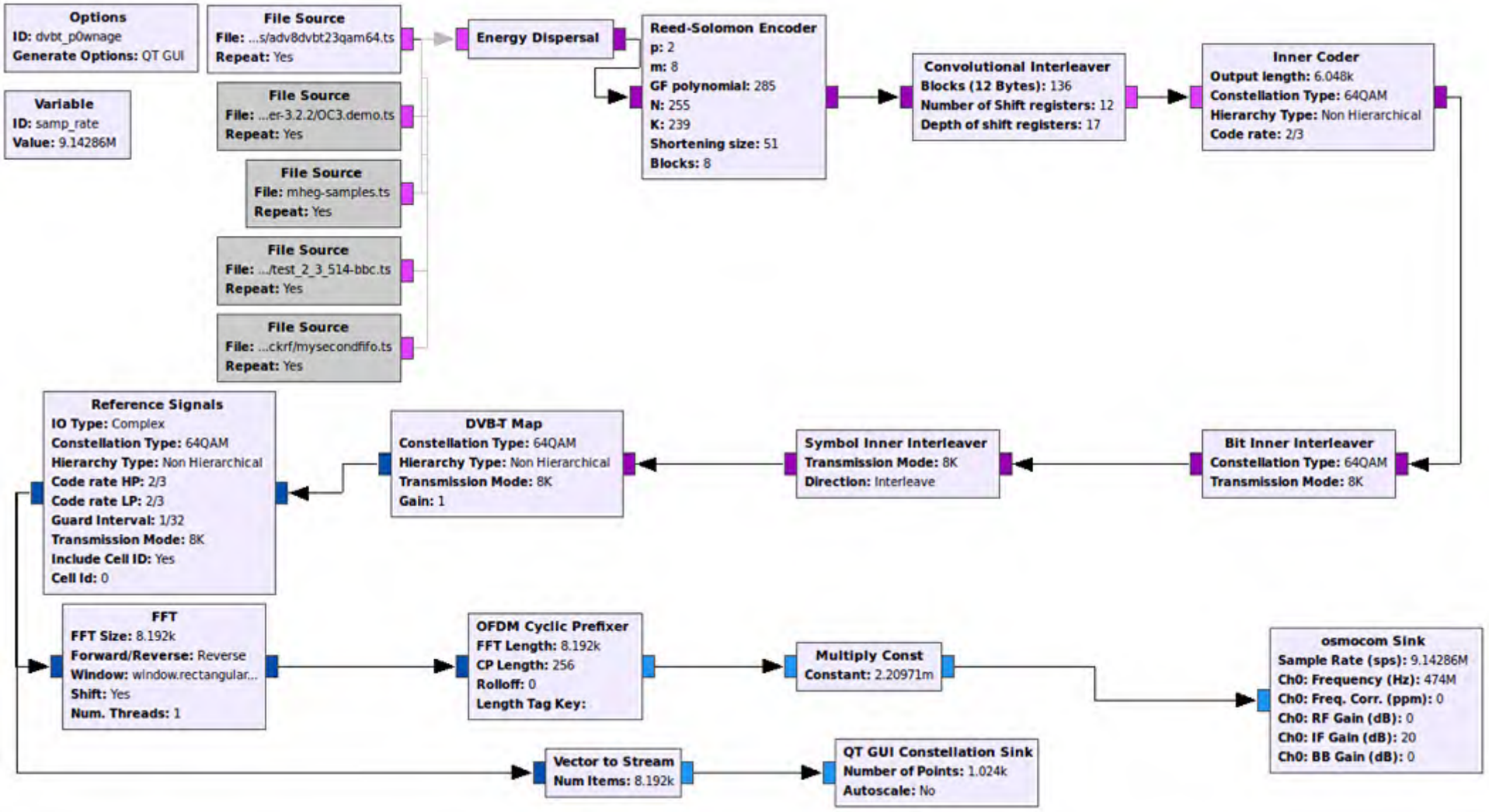
2 – multiple audio/video streams + different data types (TXT / HbbTV / MHEG)

3 – multiple complex MHEG services

4 – UK full transponder 10 x TV / 16 x Radio plus all data: Red-Button, EPG etc.

5 – black-button attack!

Broadcast existing transport streams



Broadcast existing transport streams with my own app...

Input from fifo:

gnuradio-companion dvbt_mheg-samples.grc

tscbrmuxer b:2300000 firstvideo.ts b:188000 firstaudio.ts b:3008 firstpat.ts b:3008 firstpmt.ts b:1500 firstsdt.ts b:1400 firstnit.ts b:1000000 carousel-ransom.ts b:2000 firstait.ts b:9772084 null.ts>myfirstfifo.ts &

tsstamp myfirstfifo.ts 13225001 > mysecondfifo.ts

Broadcast existing transport streams

Who needs the BBC?

With just a laptop and an SDR you have the power to broadcast.

Broadcast existing transport streams

Who needs the BBC?

With just a laptop and an SDR you have the power to broadcast.

I love living in the future!