

UNIVERSITY OF TWENTE.

Hybrid Broadcast Broadband TV protocol & its privacy concerns

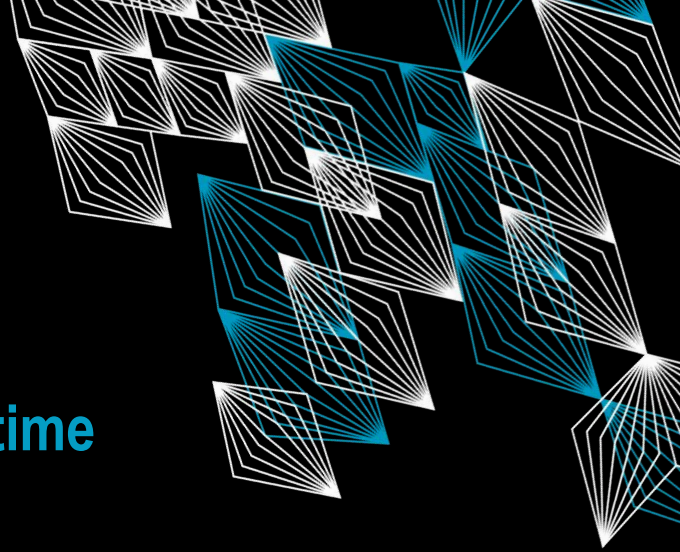
With a focus on the Italian landscape

Introduction

1.7 billion TV households worldwide

In Western Europe, average television viewing time per person amounts to 240 minutes per day

How to keep television at pace with new digital media being developed?



What is HbbTV?



Is an initiative started in 2009 by an industrial consortium comprising industry leaders.

It aims “ at harmonising the broadcast and broadband delivery of entertainment services to consumers through connected TVs, set-top boxes and multiscreen devices.”

What is HbbTV?

RaiPlay

Molto più di quanto immagini

ACCEDI

CONTINUA SENZA ACCOUNT

Non sei registrato? Vai su raiplay.it/registrati oppure continua senza registrazione, avrai accesso a tutte le dirette streaming e potrai consultare l'offerta On Demand

SI SMART

powered by cinetion

Canali TV ON AIR



SI Live 24



Edizione: Locali zone

RTL
102.5

102.5 ON DEMAND

HOME

OSPITI

NEWS

MUSICA

ORIGINALS & PODCAST

Musica



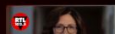
Sport



Spettacolo



Politica



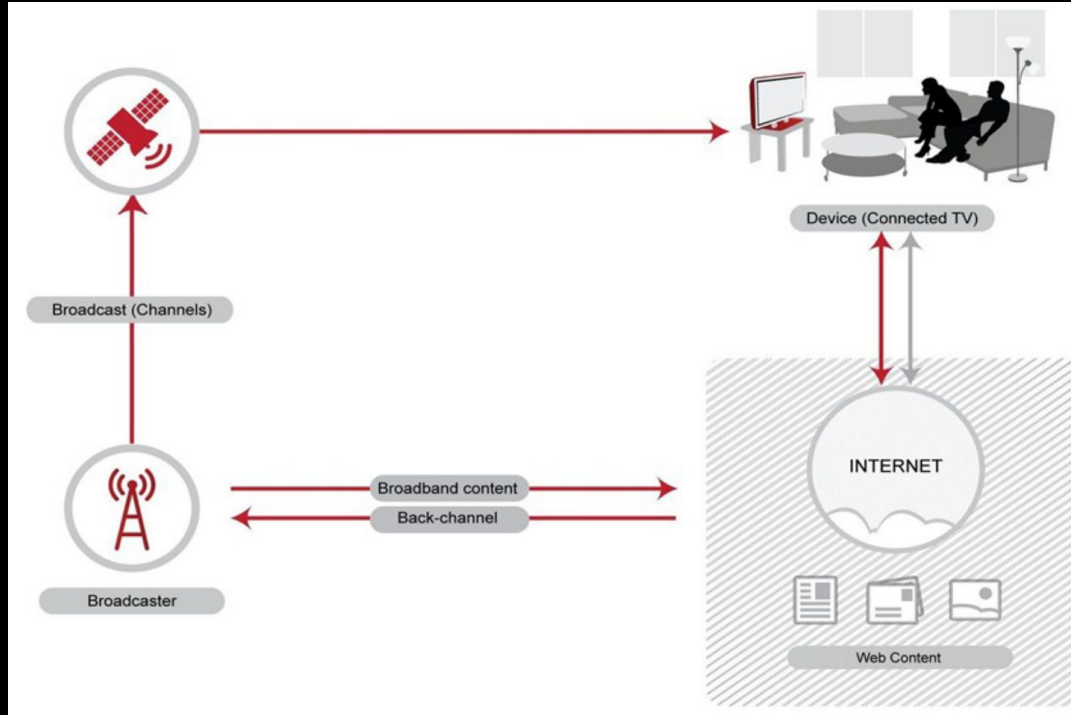
Like

La tua città

Curiosità

Videoclip

What is HbbTV?

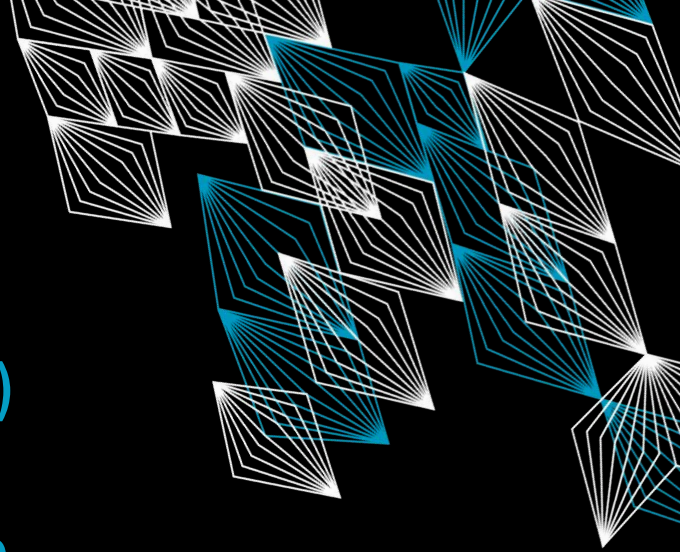


Technical specifications

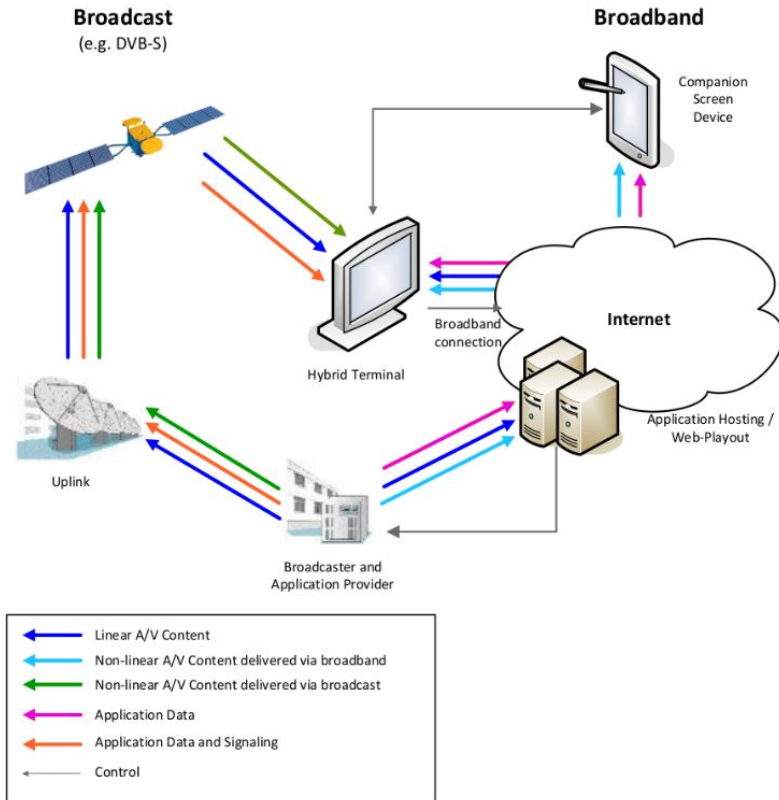
Two different connections in parallel:

1. Broadcast Digital Video Broadcasting (DVB) network
2. Internet connection via broadband interface

The Internet-delivered HbbTV applications are embedded as a link in the DVB stream sent by the broadcaster, which will be then extracted and loaded in the background of the browser



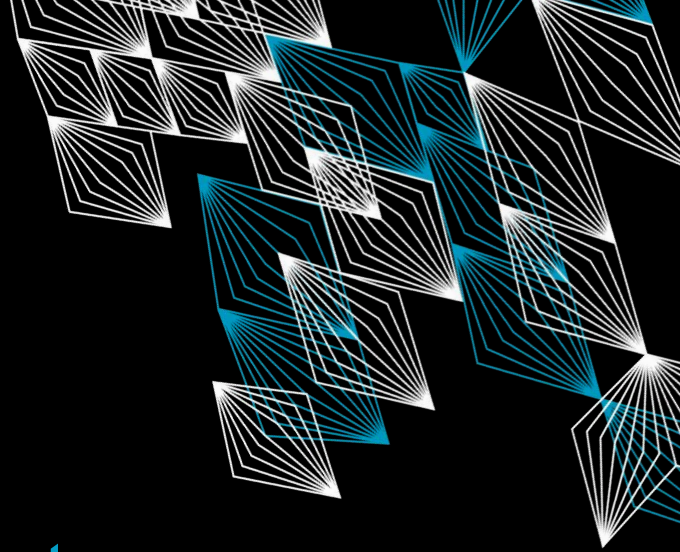
Technical specifications



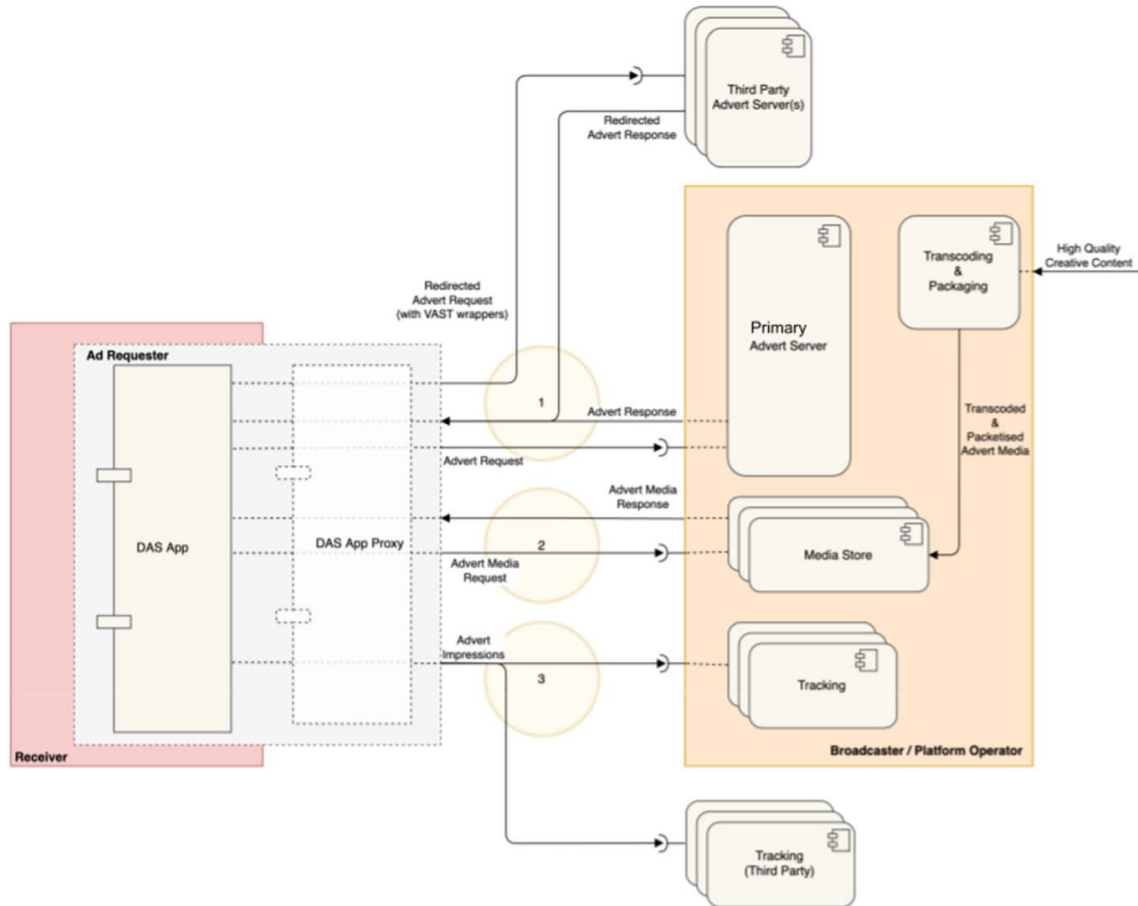
Dynamic Advertising

Dynamic Ad Insertion; adverts are broadband-delivered

Addressable TV enables broadcasters to segment TV audiences and show ads tailored to each audience through collected data.



Dynamic Advertising

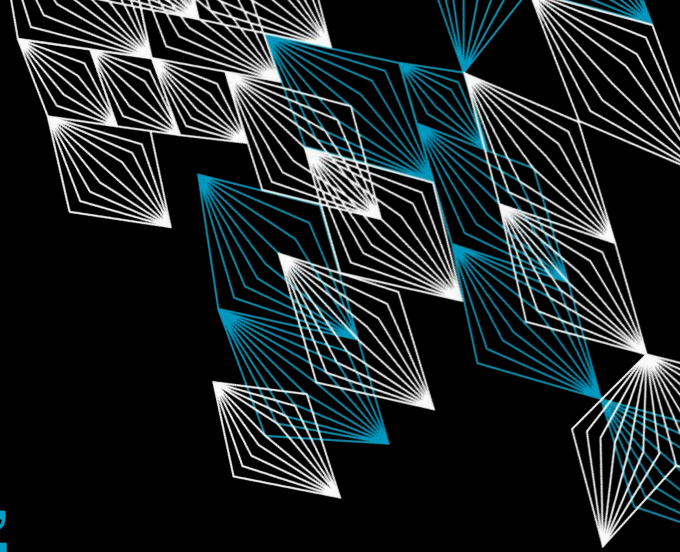


Adoption Rates

Italy: 25 million TV households, 4.05 million represent HbbTV connected devices

Germany: 38.52 million TV households; in 2014, already 92% of Germany's smart TVs supported HbbTV

The Netherlands: 17 million households; Over 90% of the households are watching TVs through proprietary Set-Top Boxes (STBs)



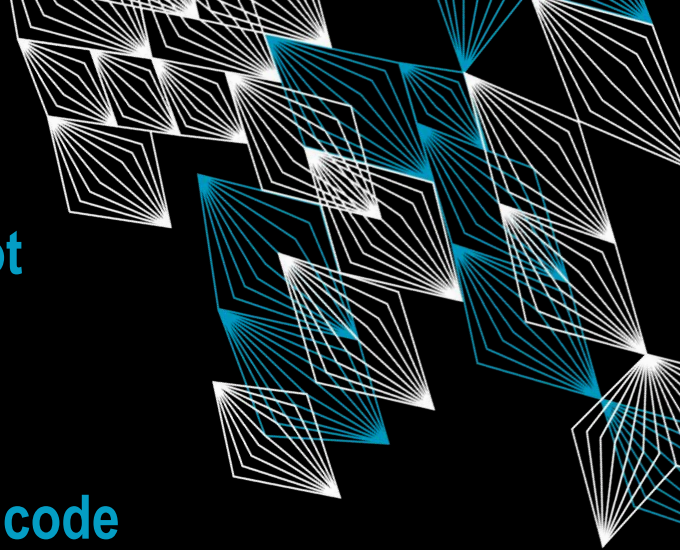
Major Security & Privacy Concerns

The adoption of TLS is strongly suggested but not mandatory

HbbTV application run inside a built-in browser displaying HTML content and running JavaScript code

A malicious actor can replace the URL pointing to the HbbTV application through a DVB/DMS-CC injection

The user can be tricked to click a malicious link, fake news banners can be displayed

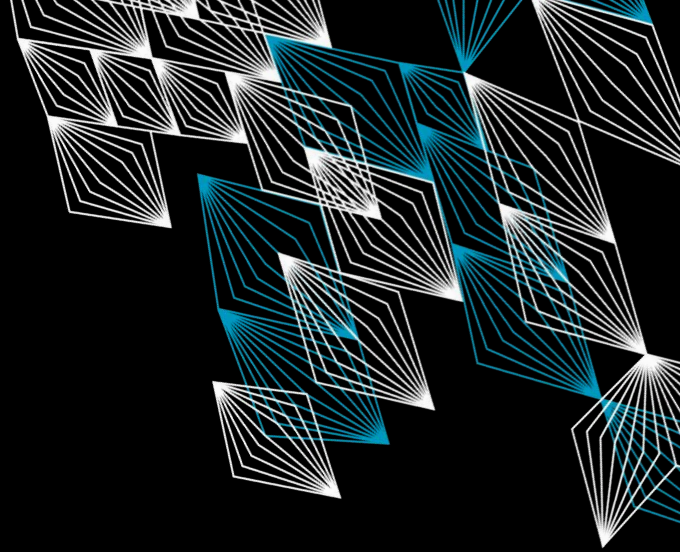


Major Security & Privacy Concerns

Privacy issue linked to (third-party) tracking. In 2013, 13 out of 66 German stations used Google-Analytics to track users

Attackers might also exploit this feature to spam fake analytics

TV can also be used to attack further devices in the user LAN

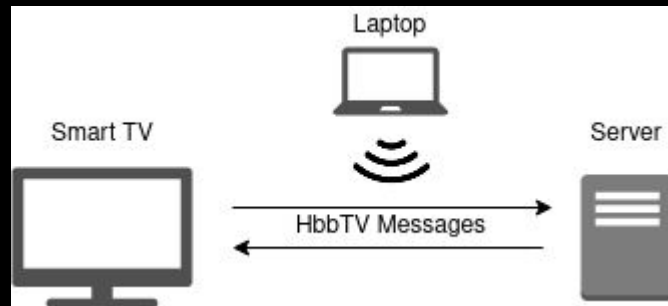


Related Work

Ghiglieri and Waidner (2015): three different tests in 2012, 2014 and 2015 analyzing HbbTV dataflow from smart TVs to broadcasters

Grouped German TV channels by probability of consumer tracking, with A representing the lowest probability and D, the highest

Noticed an improvement over the years, but not a significant one

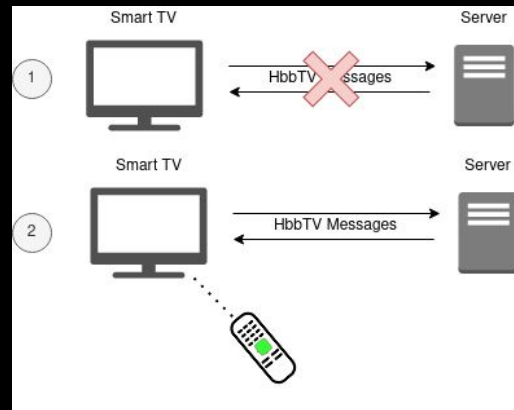


Related Work

Ghiglieri and Tews (2014): Privacy Protector solution

Best way to protect from data leaks and privacy issues is disconnect TV from the Internet; this is not acceptable

Privacy Protector enables users to decide whether to consent data transmission or not.



Related Work

Ghiglieri (2016): Survey on the awareness of the risks linked to HbbTV and Smart TVs

200 participants; only 16% of them mentioned at least one risk linked to Smart TVs; 7% were able to mention a concrete consequence

More than 67% stated that they would be willing to spend time and/or money to get both functionality and privacy

Related Work

Bozza (2019): hijack of the DVB connection using the TSDuck library and a modulator (HiDes UT-100c)

....

We'll see more in the next slides! :)

Ref: <https://www.youtube.com/watch?v=2yeahbhPu9o>

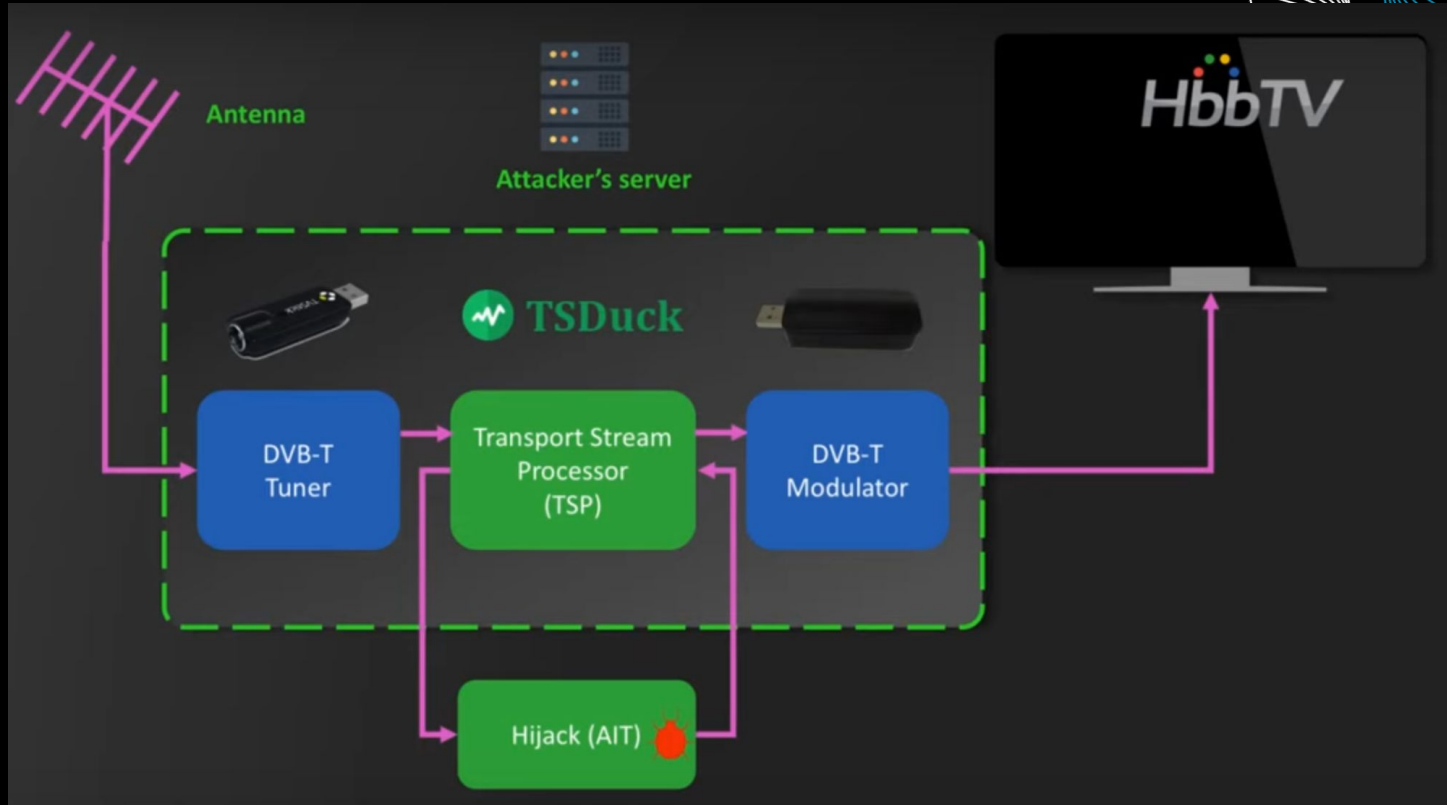
Setup for DVB Hijack

What we need?

1. HiDes UT100C modulator;
2. Antenna;
3. C++ TSDuck library (tsduck.io);
4. Laptop (either with Windows or Linux).



Setup for DVB Hijack



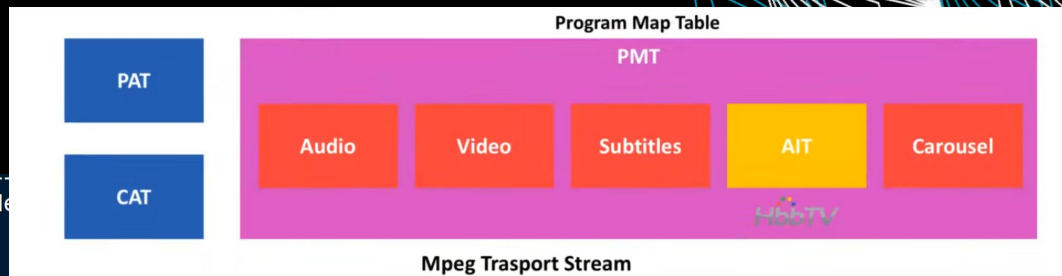
DVB Stream Injection

Extraction of HbbTV startup links sent by the different broadcasters

```
Service: 0x218C (8588), TS: 0x0004 (4), Original Network ID: 0x00000000
Service name: Rai 1 HD, provider: Rai
Service type: 0x01 (Digital television service)
TS packets: 533,296, PID's: 11 (clear: 11, scrambled: 0)
PMT PID: 0x01AC (428), PCR PID: 0x01B6 (438)
```

| PID | Usage | Access | Bitrate |
|--------|--|--------|---------------|
| Total | Digital television service | C | 7,762,295 b/s |
| 0x01AC | PMT | C | 15,923 b/s |
| 0x01B6 | AVC video (1920x1080, main profile, level 4.0) | C | 6,799,402 b/s |
| 0x01C1 | AC-3 Audio (ita, AC-3, 3/2 (L,C,R,SL,SR), @48k) | C | 460,588 b/s |
| 0x01C2 | MPEG-1 Audio (eng, Audio layer II, 128 kb/s, stereo) | C | 137,853 b/s |
| 0x024C | Teletext (ita, Initial Teletext page) | C | 112,803 b/s |
| 0x028A | MPEG-1 Audio (Oth, Audio layer II, 64 kb/s, stereo) | C | 75,192 b/s |
| 0x07D1 | MPEG-2 Private sections (AIT) | C+ | 4,453 b/s |
| 0x07D2 | MPEG-2 Private sections (AIT) | C+ | 4,453 b/s |
| 0x0BB9 | DSM-CC U-N (MHP Object Carousel) | C+ | 100,082 b/s |
| 0x0BBA | DSM-CC U-N (HbbTV) | C+ | 50,041 b/s |
| 0x0C1D | DSM-CC Stream Descriptors | C+ | 1,499 b/s |

(C=Clear, S=Scrambled, +=Shared)



DVB Stream Injection

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DVB Stream Injection

```
<tsduck>
<AIT version="0" current="true" test_application_flag="false" application_type="0x0010">
  <application control_code="0x02">
    <application_identifier organization_id="0x00000360" application_id="0x000A"/>
    <transport_protocol_descriptor transport_protocol_label="0x00">
      <http>
        <url base="https://tivuon-hbbtv.tivu-alchemy.net/">
        </http>
      </transport_protocol_descriptor>
      <application_descriptor service_bound="true" visibility="3" application_priority="255">
        <profile application_profile="0x0000" version="1.4.1"/>
        <transport_protocol label="0x00"/>
      </application_descriptor>
      <application_name_descriptor>
        <language code="ITA" application_name="tivuon! app"/>
      </application_name_descriptor>
      <simple_application_location_descriptor initial_path="index.html?configuration=DTTprod"/>
    </application>
  <application control_code="0x02"> ...
</application>
  <application control_code="0x01"> ...
</application>
  <application control_code="0x02"> ...
</application>
</AIT>
</tsduck>
```

0x01 AUTOSTART
0x02 PRESENT
0x04 KILL
0x07 DISABLED

DVB Stream Injection

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</application>
  <application control_code="0x01">...
</application>
  <application control_code="0x02">...
</application>
</AIT>
</tsduck>
```

0x01 AUTOSTART
0x02 PRESENT
0x04 KILL
0x07 DISABLED

Let's try it!

What are the commands?

1. Find the UHF (Ultra High Frequency) of the channel we are interested in (SportItalia in our case):

```
tsscan -u -l --first-channel 4 --last-channel 5 --verbose
```

2. Capture that specific UHF for 100 seconds:

```
tsp -v -I dvb --uhf 26 -P until --seconds 100 -O file Sportitalia.ts
```

3. Convert the ts file into a txt to analyze its content:

```
tsp -I file .\Sportitalia.ts -P analyze --title "SportItalia" -o  
.\sportitalia.txt -O drop
```


Let's try it!

4. **Extract specific streams linked to AIT PID and put them into binary files:**

```
tsp -v -I file .\Sportitalia.ts -P until --seconds 100  
-P filter -p 0x07D2 | tstables -m -b .\sportitalia.si
```

5. **Convert the binary file into XML to make it easily readable:**

```
tstabcomp.exe -d Sportitalia.si
```

6. **Open the files with VSCode (or any other editor) and look for the 0x0010 code that is related to the HbbTV app**
7. **Those are the links to be replaced to perform a DVB injection!**

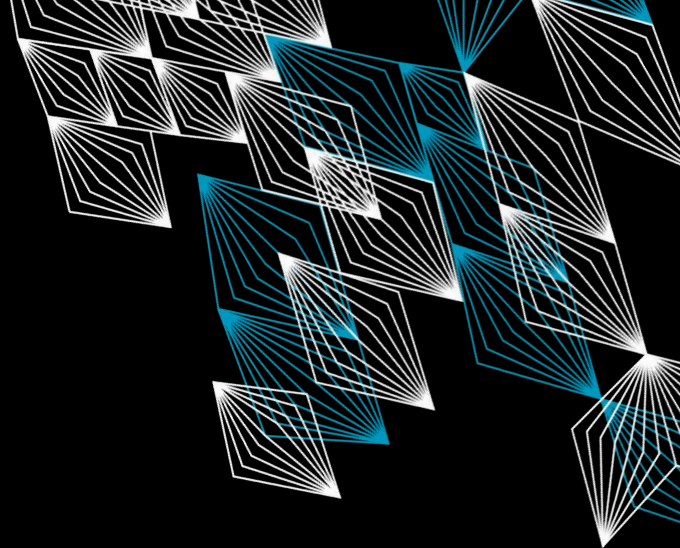
Installation Links

Install TSDuck library:

- <https://tsduck.io/download/tsduck/>

Install HiDes drivers:

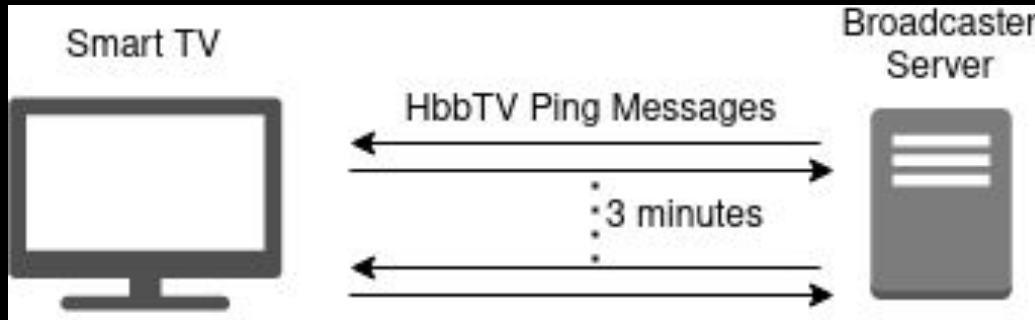
- <https://tsduck.io/download/hides/>



Results

Cookies have long expiration dates ranging from 2021 to 2048

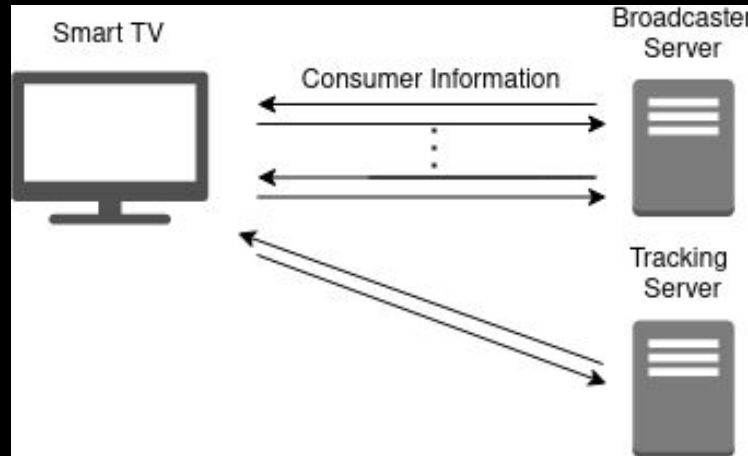
Some broadcasters perform periodic requests every X minutes to check if the consumer is still watching

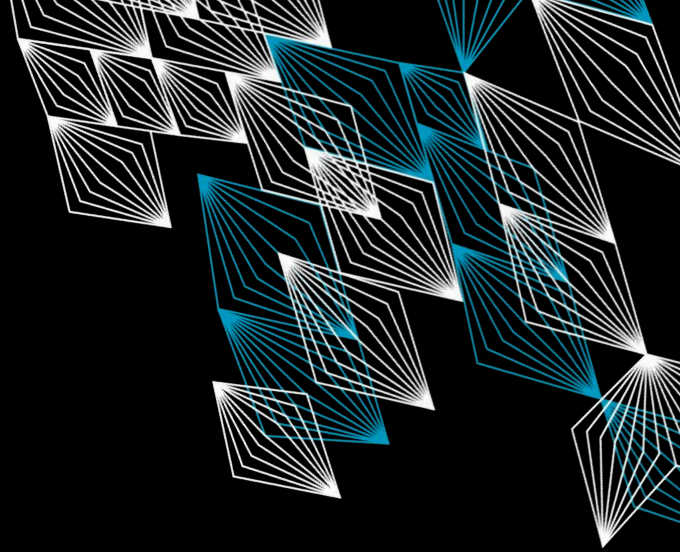


Results

Most of the channels adopt some tracking and targeted ad delivery mechanism, e.g. Google Analytics, Google Tag Manager, doubleclick and smartclip

Some channels do not display any privacy notice to consumer





Thank you!

Any questions?

For further questions contact me @
carlotta.tagliaro@gmail.com