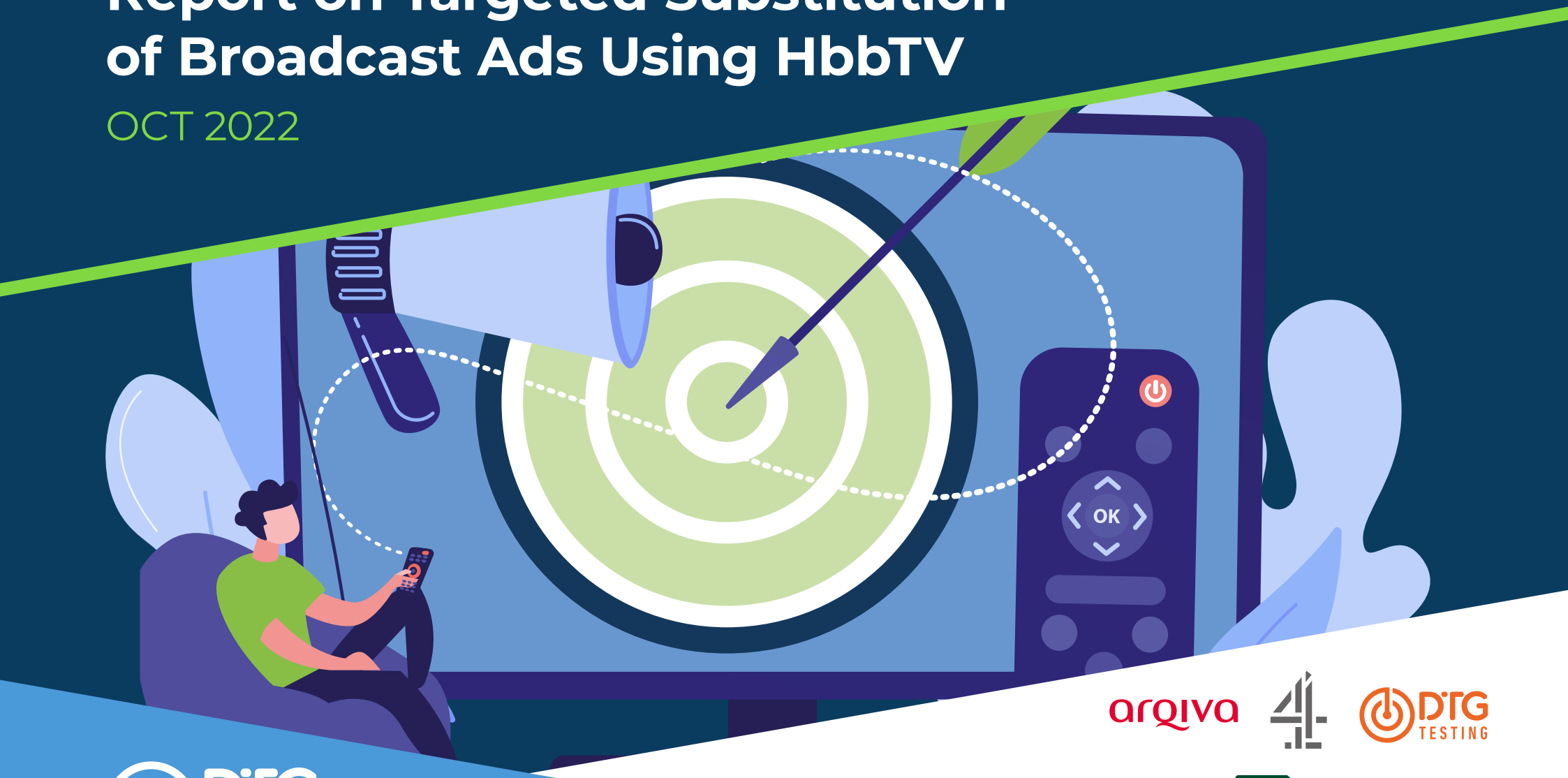
VERSION 1.0

Report on Targeted Substitution of Broadcast Ads Using HbbTV

OCT 2022



DTG
THE CENTRE OF UK DIGITAL TV

arqiva 4 DTG TESTING

Google s&t TPVISION

Contents

1 Executive Summary

HbbTV ("Hybrid Broadcast Broadband TV") is a widely adopted standard implemented in TV receivers in UK homes and is used to receive Digital Terrestrial Television ("DTT"), commonly referred to as Freeview. The standard is currently used by broadcasters for the catch-up "players" that form a key part of Freeview Play but is not used at scale to deliver targeted advertising today. HbbTV allows broadcasters to launch an HTML5 app when viewers tune to a channel.

The DTG convened a cross-industry working group (the DTG "Targeted Advertising Task Group") to research and evaluate the capability of IP-connected HbbTV devices in UK homes to replace broadcast ads with more targeted ads delivered by broadband, as such a capability could enable broadcasters to increase their advertising revenues, is increasingly expected by advertisers and could also improve the relevance of advertising for viewers.

To conduct this research, the group commissioned the development of a simple HbbTV test application to:

- Enable stakeholders to see how well each TV can substitute ads using different methods and the range of results that can be achieved with minimum resource investment
- Identify the performance variation of the installed base in the UK DTT HbbTV market by running the test app in the "DTG Zoo" (DTG's comprehensive collection of TV receivers) and cross-reference against market data to understand reach vs quality trade-offs.

In order to accurately measure the performance of receivers, test content was provided by Channel 4 to which QR codes were added to track the timing of switches. Individual tests were filmed with a fixed camera and all test results were processed programmatically using a set of bespoke scripts developed by TP Vision and Google, with market penetration calculated using data from S&T.

Five tests were run across 100+ devices in the DTG Zoo, representing 95% of receivers in UK homes. The results of the DTG Zoo tests were as follows:

- Most IP-connected TVs which support HbbTV (99% for best performing test) have the capability to switch between broadcast to broadband to customise ad experiences
- Almost two-thirds of IP-connected TVs which support HbbTV (63% for best performing test) can do the switch at an "acceptable viewer experience", defined as dropping 10 or fewer frames at either side of the switch between broadcast and broadband
- Given the total reach of IP-connected DTT TVs which support HbbTV (around two-thirds – remaining devices either not IP-connected or support the older MHEG interactive TV standard), **around half of devices in the UK DTT market are able to support HbbTV broadcast ad substitution at an acceptable viewer experience**

The group has concluded that the potential reach of HbbTV ad replacement which can support a good viewer experience in the UK is sufficiently high for a UK broadcaster to conduct a live trial of such technology, with a goal to commercialise as an advanced TV advertising proposition.

2 Project Description

The DTG End User Experience Group established a cross-industry task group on Targeted Advertising in April 2021, to evaluate the status of HbbTV implementations in currently deployed UK DTT devices for the substitution of broadcast ads with broadband-delivered targeted ads (also known as 'addressable TV') and develop a simple HbbTV application for a demonstration.

The overall aim of the project was to identify the devices' capabilities and if they fulfil quality metrics for broadcast ad replacement. This proof of concept can enable UK broadcasters to adopt the most suitable method and implement tools and solutions to reach maximum devices for substituting broadcast ads with targeted ads in IP-connected HbbTV devices.

Such a capability could enable broadcasters to increase their advertising revenues, is increasingly expected by advertisers and could also improve the relevance of advertising for viewers.

Objectives:

- To create an HbbTV test application and accompanying stream for testing and identifying the current capabilities of the IP-connected HbbTV devices in the UK DTT market for targeted Linear advertising and content substitution using HbbTV. *This includes, but is not limited to, the work from the HbbTV-TA and DVB-TA groups and how that applies to UK DTT-enabled platforms for ad replacement/content substitution.*
- To understand reach vs quality trade-offs related to the substitution of broadcast ads with broadband-delivered (targeted) ads in UK DTT HbbTV receivers.

Technical Goals:

To develop a test/demonstration app with two goals in mind:

- Enabling stakeholders to see the range of results that can be achieved with minimum investment of their own resources.
- Gathering evidence on the performance variation of the installed base in the UK market by running the test app in the DTG receiver zoo.

Ideally this evidence would be cross-referenced against market share/ sales data to produce data about how much of the installed base could be reached and with what quality.

This information could then be used by stakeholders to as the basis of further development in order to either launch a live test with real viewers, or to implement further optimisations to improve either the user experience or the market reach.

Commercial Goals:

Addressable TV propositions, where broadcast ads are replaced by targeted ads can drive incremental revenue for broadcasters, improve targeting and return-on-investment for advertisers and has the potential to improve the relevance of advertising for viewers.

For a major broadcaster to launch an addressable TV proposition using a technology solution, they need to maximise the reach of any such solution, while minimising the development costs, so a key output of this project is the size of the addressable market resulting from the tests. Note that integrating the test/demonstration app with digital ad

servers was outside of the scope of the project and a pre-assembled pod of TV adverts was delivered over broadband.

Quality Metrics:

One key aspect of the project was to assess the user experience of the ad replacement experience, by looking at the following quality metrics for broadcast ad replacement:

- Accuracy of the switch from broadcast to broadband
- Speed of the switch from broadcast to broadband
- Accuracy of the switch back from broadband to broadcast
- Speed of the switch from broadband back to broadcast.
- Risk of advert playback stalling due to network delays
- Whether the first and last frames of an advert are visible

The assessment of quality metrics was achieved by detecting the placement of QR codes within the stream and recording each test using a hand-held video camera.

Key Contributors:

TV industry leaders who invested valuable time and resources in achieving the project's objectives are: Arqiva, Channel 4, DTG Testing, Google, Strategy and Technology (S&T), and TP Vision.

Industry Collaboration:

Initiation of precompetitive collaboration to design a testbed for exploring targeted advertising concepts for a linear broadcast environment involved collaboration from various stakeholders from the UK TV industry to secure key contributors to perform the following tasks:

1. **Creation of the Targeted Advertising HbbTV test application to test the current capabilities of the IP-connected UK DTT HbbTV devices:** DTG commissioned a third-party developer (MIT-xperts) to develop an HbbTV application to evaluate various configurations/profiles that can be used to enable the substitution of the broadcast advert with an IP advert. The selection process was approved by the DTG Targeted Advertising Task Group as per the inputs from the interview panel (Arqiva, TP Vision, and DTG)
2. **Availability of the audio-video content for broadcast video including broadcast adverts and IP digital adverts for creating the HbbTV test application and streams:** Channel 4 supported the project by providing sample videos to enable the development of the DTG HbbTV test application.
3. **Testing on all IP-connected UK DTT HbbTV devices:** DTG supported the project by providing access to the DTG Zoo (the DTG TV collection is the world's largest collection of its kind and represents 95% of the UK free-to-air receiver market) and DTG Testing engineering support. TP Vision and Google also contributed to the DTG Zoo testing by providing engineer support for testing and test result analysis.
4. **Frame timing analysis of switching between broadcast and broadband:** Inclusion of QR codes in the test stream and the development of scripts to enable automated analysis of videos of the tests within the Zoo on the accuracy of switching, including any frames lost. TP Vision and Google developed the scripts for this analysis, which will be made available to DTG members within the UK DTT ecosystem.
5. **Availability of market data of the IP-connected UK DTT HbbTV devices, a key for evaluating the reach vs quality trade-offs:** Strategy & Technology Ltd (S&T) is supporting the project by providing market data on connected devices.

Creation of a Demo Application to Achieve Dynamic Ad Replacement for Free-to-Air TVs Using HbbTV

The following diagram outlines the technical method used to substitute advertising with HbbTV using existing methods which are widely supported by devices in the field. As the current install base of HbbTV devices does not support 'frame accurate' single ad spot replacement, the workflow which is supported requires the **entire break** to be replaced using a switch from broadcast to broadband – and then back again.

As different devices switch at different times (due to the absence of a well specified and widely supported method to ensure frame accurate switches prior to HbbTV 2.0.1), the expectation is that broadcasters will use a 'landing zone' comprising 1-2 seconds of 'sacrificial content', potentially covered by an image to make the transition seamless, this can be an animated GIF image, at either end of the ad break to handle the switch between broadcast and broadband.

Key Contributors

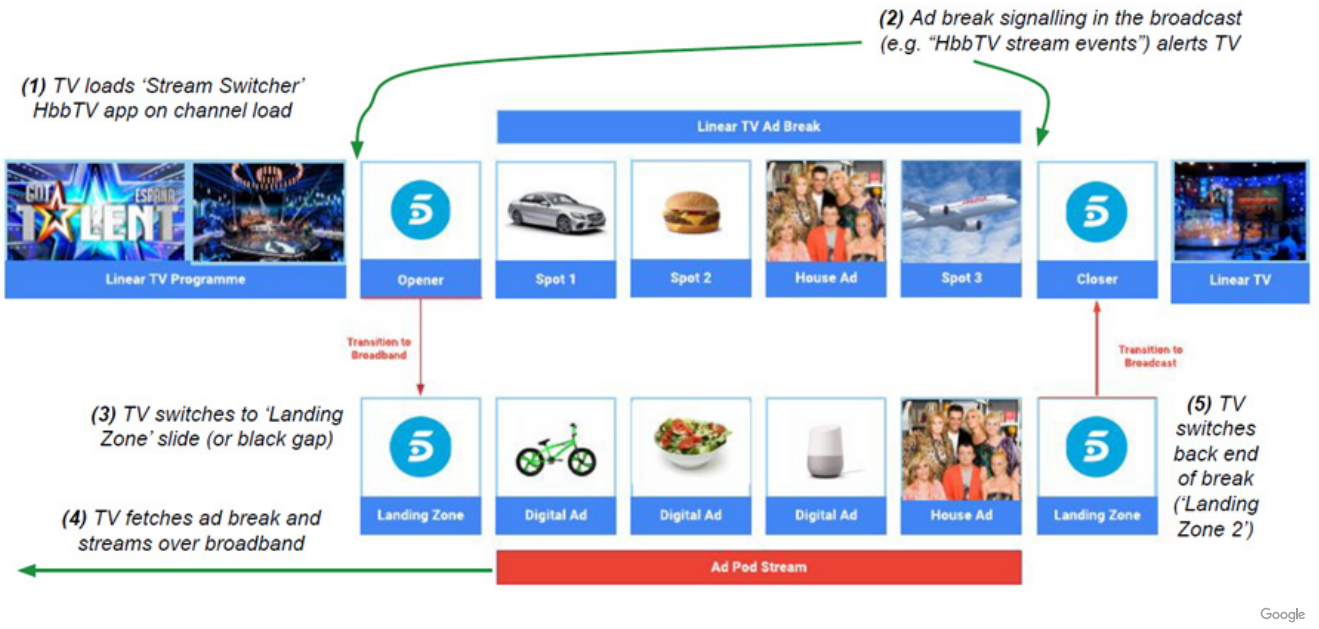


Figure 1 *Linear ad substitution with HbbTV*

In a commercial implementation, it is expected that a 'channel ident' logo would be used as the graphic for the 'landing zone', as these are typically in use within the UK and other TV markets. However, for the purpose of the demonstration app no image was shown, which resulted in the screen briefly going black for a short while during the transition from broadcast to broadband.

The testbed for targeted advertising comprised of:

- "Transport Stream" of Audio & Video supplied by Channel 4 ("Countdown") plus two pods of ads (Linear and Digital)
- HbbTV ad replacement app & web server which supported several different switching methods, to test the user experience of HbbTV ad replacement
- QR codes embedded in the videos to allow automated review of tests on a specific TV set, as recorded by a GoPro camera, to allow tuning of the timing thresholds for the landing zones, and to drive high confidence in the test results.

Five test configurations have been selected to explore on HbbTV devices, using three different streaming protocols (mp4, DASH and MSE), along with three different methods of synchronising timings (HbbTV StreamEvent, TEMI timeline, Presentation Timestamp). These are detailed in section 3.

Device Coverage:

Any UK DTT receiver supporting HbbTV 1.0 (TS 102 796 V1.1.1) or higher versions.

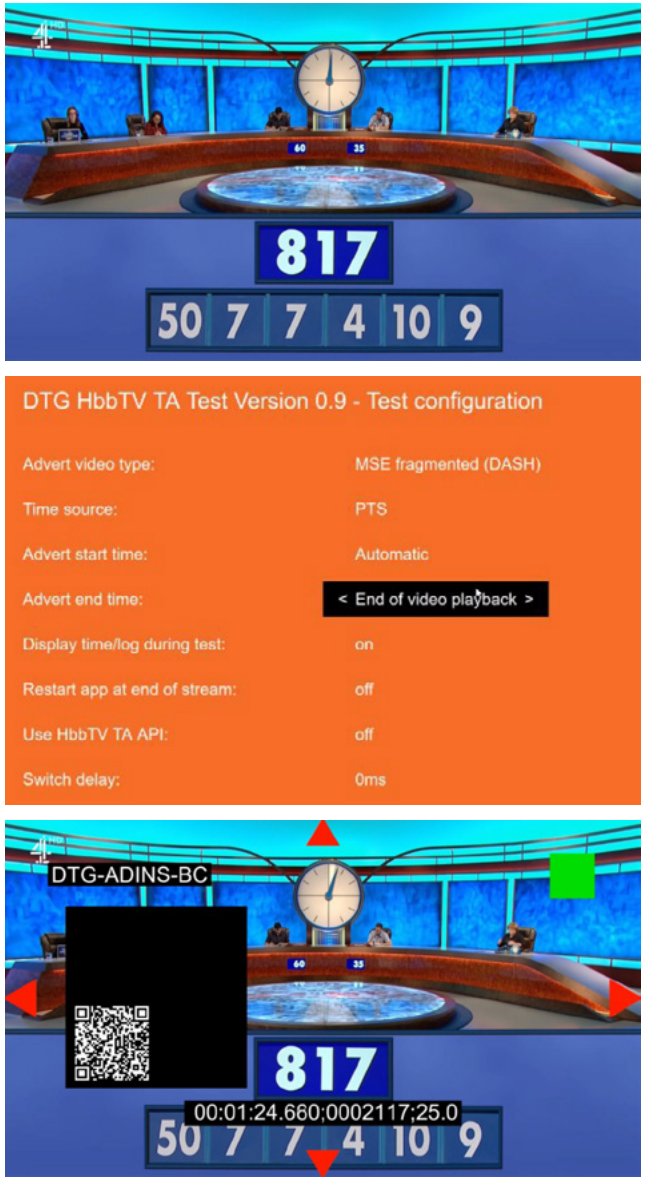


Figure 2 *DTG Targeted Advertising HbbTV test application details*

3 DTG Zoo Test Setup

With the consent from the group members, the following five configuration profiles have been selected for DTG Zoo testing:

- **Test 1: mp4** with start based on **StreamEvent**, end after replacement ads video **playback has completed**
- **Test 2: DASH** with start based on **StreamEvent**, end after replacement ads video **playback has completed**
- **Test 3: MSE** with start based on **StreamEvent**, end after replacement ads video **playback has completed**
- **Test 4: mp4** with start and end based on **TEMI**
- **Test 5: mp4** with start based on **PTS**, end after replacement ads video **playback has completed**

The following test plan has been followed at the DTG Zoo for performing the tests on over 100 HbbTV devices (please see table 2 for expected timings of events):

1. Prior to the start of testing, a channel scan was performed on all devices using the test transport stream with QR codes by playing out into the DTG Zoo.
2. The receiver would then see two channels, “DTG-Landing” and “DTG-Test”.
3. The GoPro camera setup was performed on the mount attached to the shelf in front of the TV. Aim was to have the camera centred and consider whether the Zoo lights or windows were causing any reflections/glare on the TV. The GoPro camera was powered by power cable. Video recording settings were set at 1920x1080p@120fps.
4. Testers were able to run the five test configurations back-to-back without needing to control the transport stream playout. At the start of each test, the tester would enter the config options into the app using the remote control (see table 1 below)
5. Testers captured the test results manually which was automatically reported by the HbbTV test application. However, detailed analysis was done on the recorded videos using the test scripts provided by TP Vision and Google (which checked the exact timings of transitions by reviewing the placement of QR codes).
6. The stream was restarted before starting the first test. After test configuration 5 is completed, the GoPro camera was moved to the next receiver and playout of the transport stream to be restarted from the beginning.

Test Configuration 1	Test Configuration 2	Test Configuration 3	Test Configuration 4	Test Configuration 5
000211010	100211010	200211010	001211010	011111010

Table 1: *Targeted advertising using HbbTV test configuration settings*

Test Step	Time period	Action	Expected Result
1	00:00:00 – 00:02:17	Select channel “DTG-Landing”.	A blank screen is presented, no video or audio.
2	00:00:00 – 00:02:17	Select channel “DTG-Test”.	Countdown video and audio with QR codes is presented with an orange HbbTV application overlaying the video.
3	00:00:00 – 00:02:17	Press record button on GoPro.	GoPro beeps and shows red recording notification.
4	00:00:00 – 00:02:17	Enter the next test configuration to be tested into the app with RCU buttons, submit with OK button.	The orange application closes, Countdown video and audio is now shown with QR codes overlay *(after this, tester has no further action until the adverts have completed)*
5	00:02:17	N/A	(Stream event #1 signalled in transport stream)
6	00:02:38	N/A	(Stream event #2 signalled in transport stream)
7	00:02:40	N/A	(Adverts start, observe whether IP or broadcast adverts presented)
8	00:06:38	N/A	(Adverts finish)
9	00:06:40 – 00:08:30	Report “PASS” or “ERROR” result in test results spreadsheet based on application message.	Application shows either “PASS” or “ERROR” in top-left of display
10	00:08:30	Press record button on GoPro.	GoPro beeps and stops recording.
11		Go to test step 1 for next test configuration, or move GoPro to next TV	

Table 2: *The table above shows the instructions for running each test, which were followed by the engineers in the DTG Zoo.*

Tests have been conducted on over 100 HbbTV devices in the DTG Zoo so far (with manufacture years ranging from 2014 to 2022), with 98 of those devices being identified as active in the UK market. Test engineer support was provided by DTG Testing, TP Vision and Google.

Test time per TV to explore all five test configurations was 1 hour and the total testing effort required to capture the videos from all devices came to about 25 man-days. These videos were then analysed using the automated scripts which were developed by Google and TP Vision for programmatically checking the following:

- If ad insertion happened at all
- When it happened
- How complete the ad break was & whether it was shown at an acceptable quality
- If and when the app switched back.

Test results data of all the devices have been cross-referenced with their market penetration to identify the “reach” number. Market data was supplied by S&T which enabled further analysis and consultation with the group to draw out all the insights from over 500 tests that were performed.

The group also investigated trade-offs between switching time/accuracy and market reach, which are described in section 4.2.

Market data source: *As a leading provider of cross-platform AVoD and FAST services, S&T are responsible for the launch of several HbbTV based applications on the UK Freeview network. In order to achieve the required reach these applications are launched via broadcast AIT on a UK national multiplex that has excellent coverage. The HbbTV applications are auto-launched on viewer navigation to these Freeview channels and in doing so, the user agent strings of the devices are recorded in S&T managed server logs. S&T process these logs to remove all service metadata and personally identifying information before sharing the processed data with DTG. By correlating this S&T supplied data and the results of DTG lab tests it has been possible to determine the approximate reach of each tested approach to Dynamic Ad Substitution on the UK Freeview network.*

4 DTG Zoo Test Result Analysis

DTG Zoo test results of 98 HbbTV devices active in the UK market were analysed for their capability to substitute broadcast advert with broadband advert and for accuracy with which the substitution was performed to identify reach vs quality trade-offs.

4.1 Ad-switch capability test results analysis

Table 3 below shows how many of the 98 TVs tested were observed to successfully substitute a broadcast advert by the operator when the tests were run in the Zoo. When overlaid with market penetration data, the proportion of the market where substitution was successful is higher than the raw number of TVs would suggest in most cases. Some TVs which were not successful in performing a substitution had a relatively low market share.

Table 3 shows most IP-connected TVs which support HbbTV (99% for best performing test) have the capability to switch between broadcast to broadband to customise ad experiences.

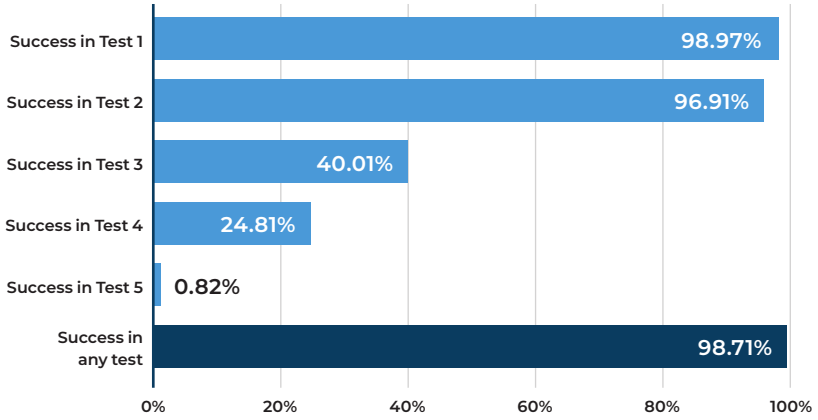


Figure 3: *Ad-switch capability weighted for market reach*

Ad-switch capability	Success in Test 1	Success in Test 2	Success in Test 3	Success in Test 4	Success in Test 5	Success in any Test	DTG Zoo Total devices
No. of devices	81	78	29	34	3	86	98
% of no. of devices	82.65%	79.59%	29.59%	34.69%	3.06%	87.76%	
Weighted for market reach	98.97%	96.91%	40.01%	24.81%	0.82%	99.71%	

Table 3: *Ad-switch capability test results data*

4.2 Reach vs quality trade-off analysis

The recordings of the test runs were analysed using a script to determine the key timing parameters based on the QR codes. This was an iterative process in order to identify thresholds for each of the key performance metrics, to determine what would be considered a "pass". At the end, the following thresholds were adopted:

- In building the test stream, we allowed 5 broadcast frames at either end of the transition to support the switch, but in testing we learned different devices in the Zoo (HbbTV 1.3.1 and above) executed the switch between broadcast and broadband at different times
- In order to choose the right threshold to maximise the reach of this ad substitution method, we looked at the distribution of switch timings, to understand how many frames we should allow a switch to happen early or late and still considered a pass
- The threshold we set was up to 10 frames (UK DTT currently broadcasts at 25 frames per second) of 'sacrificial content' either before or after the expected time of switching, the distribution of switching times suggested that choosing number captured a large cluster of additional devices (the table 5 in 4.3 shows the proportion of devices which were ruled out due to being outside of these thresholds)
- The implication is that a broadcaster implementing such an ad replacement technology would need to allow approximately 25 frames, so this corresponds to 1 second of 'sacrificial content' (we would propose to be covered by a 'landing zone' image) in order to cover the switch between broadcast and broadband

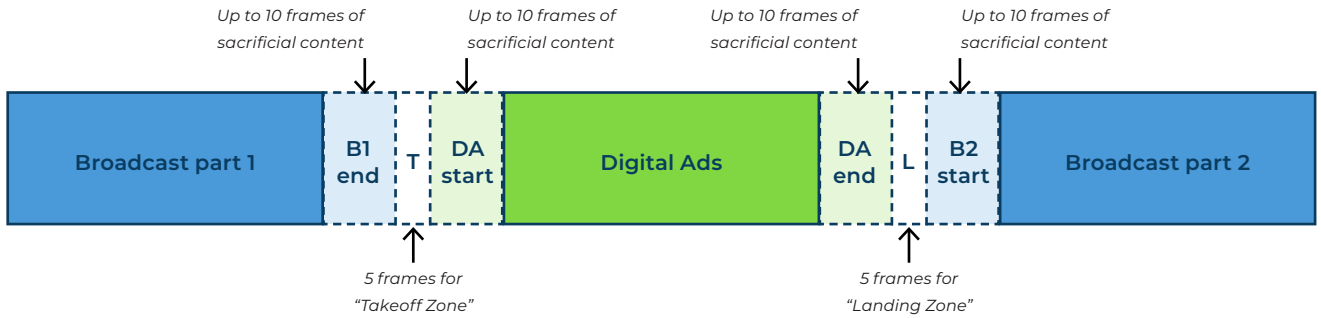


Figure 4: *Expected flow and accepted frame loss at either end of an ad transition*

Within threshold	Success in Test 1	Success in Test 2	Success in Test 3	Success in Test 4	Success in Test 5	Success in any Test	DTG Zoo Total devices
No. of devices	54	61	14	27	3	67	98
% of no. of devices	55.10%	62.24%	14.29%	27.55%	3.06%	68.37%	
Weighted for market reach	43.11%	63.21%	14.63%	22.59%	0.85%	65.35%	

Table 4: *Within threshold test results data*

Table 4 shows the results when those thresholds were inserted in the scripts, in order to show how many devices were able to switch within these thresholds, along with their market reach. As with the previous table, both the raw number of devices with a "pass" according to the thresholds and values weighted for market reach are included.

Table 4 shows almost two-thirds of IP-connected TVs which support HbbTV (63% for best performing test) can do the switch at an "acceptable viewer experience", defined as dropping 10 or fewer frames at either side of the switch between broadcast and broadband.

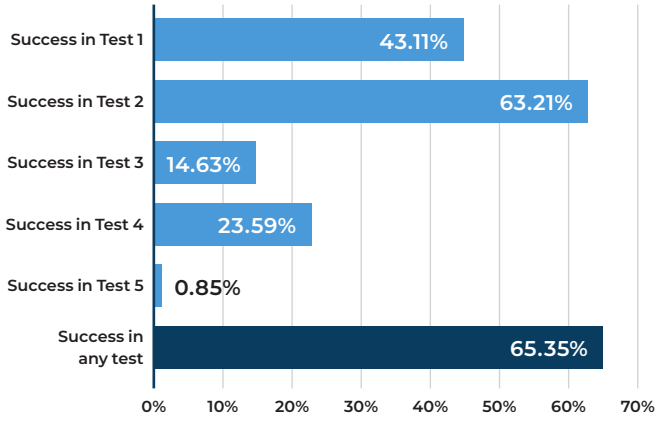


Figure 5: *Reach vs quality trade-off weighted for market reach*

4.3 Combining the results

Comparing the ad-switch capability pass rate to the within threshold pass rate shows us how many of the capable devices were able to do the switch within the thresholds (please refer table 5).

Test 5 uses the HbbTV TA API to perform more efficient switching between broadcast and broadband, see ETSI TS 103 736. Currently this is an optional HbbTV feature, and it does not yet have significant market penetration.

4.4 Implications of market reach analysis

Using publicly available data, we can estimate the total reach of IP-connected HbbTV devices that can support full break ad replacement. Based on current estimates, we believe that around half of all active Freeview devices in UK homes are addressable.

As households typically change their TV set every 7-8 years and newer TVs are more likely to support these methods, we would expect the reach of HbbTV ad substitution to increase by up to 3-5% every year, reaching around 80% by 2030.

Market reach	Success in Test 1	Success in Test 2	Success in Test 3	Success in Test 4	Success in Test 5	Success in any Test
Ad-switch capability market reach	98.97%	96.91%	40.01%	24.81%	0.82%	99.71%
Within threshold market reach	43.11%	63.21%	14.63%	22.59%	0.85%	65.35%

Table 5: *Ad-switch capability vs Within threshold*

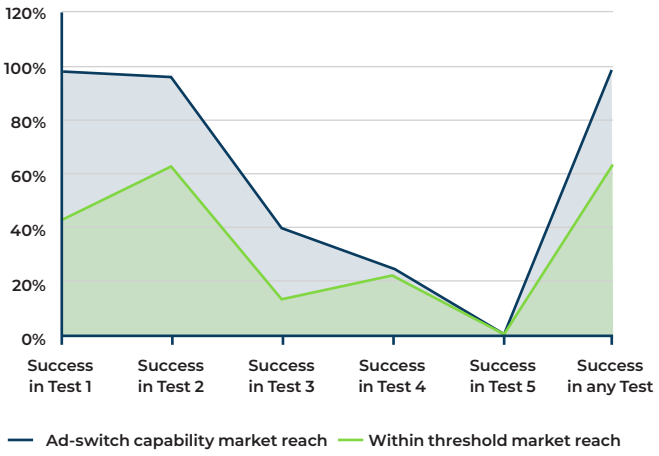


Figure 6: *Market reach ad-switch capability vs within threshold*

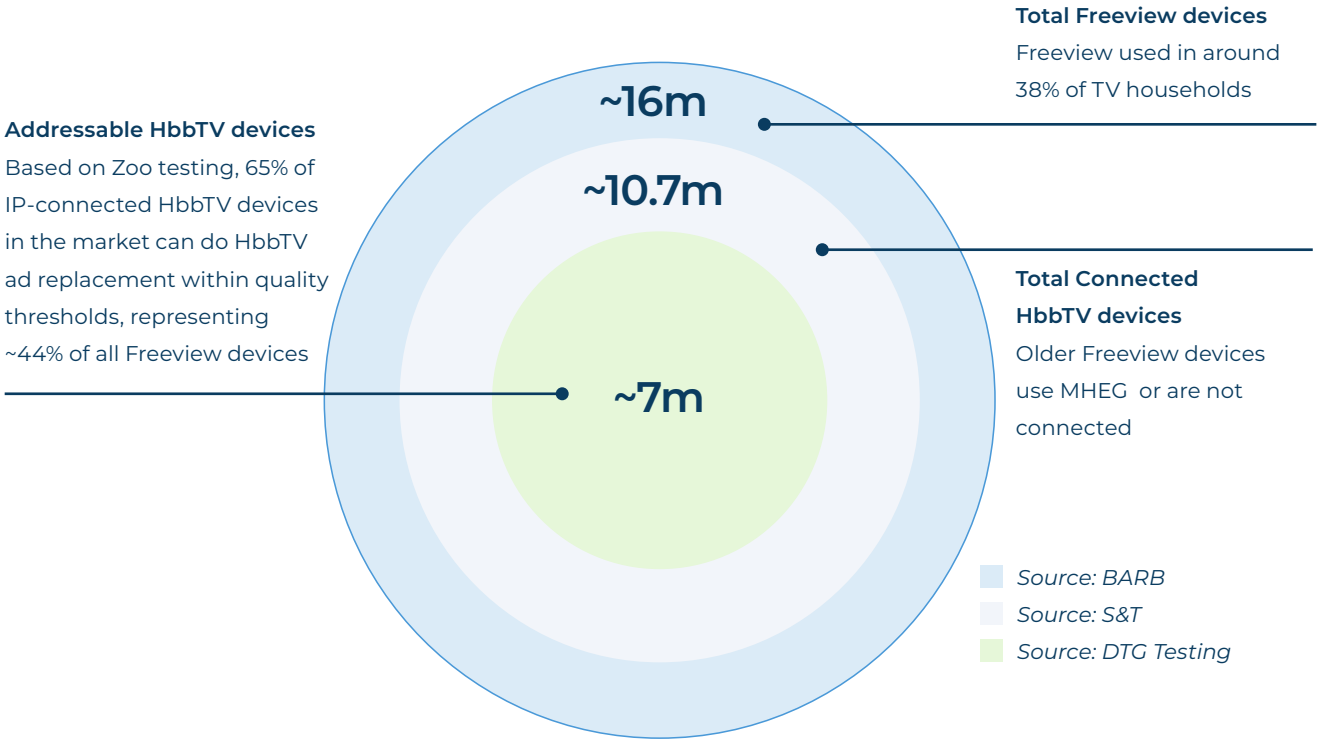


Figure 7: *Market reach for Addressable TV using HbbTV on DTT*

5 Conclusion

The DTG Targeted Advertising Project, initiated by the industry, is an exemplar case study of the UK DTT ecosystem collaborating to advance the industry's adoption of addressable advertising, to support the future of TV funding in the UK. It is a demonstrable marker of UK excellence and agility in precompetitive collaboration.

The DTG Targeted Advertising Task Group has concluded the potential reach of HbbTV ad replacement which can support a good viewer experience in the UK is sufficiently high for a UK broadcaster to conduct a live trial of such technology, with a goal to commercialise as an advanced TV advertising proposition. We estimate that reach at around half of all Freeview devices active in the UK market.

It is notable that different methods of ad substitution have different performance, so any commercial implementation may want to consider either optimising for the highest reach method, combining more than one method, or doing further development to otherwise optimise the reach.

The recommendation is to use a 'landing zone' of 1-2 seconds of sacrificial content at the start and end of any substituted segments (ads or content), to handle the switch from broadcast to broadband, until such time that the HbbTV standard evolves to support frame accurate single ad replacement using HbbTV and the reach of TVs supporting that standard is significant enough to commercialise to make the transition seamless, this can be an animated GIF image.

The project purpose has been achieved and if broadcasters or other industry stakeholders would like to investigate further, the DTG can make the test application and analysis scripts available to DTG members, to allow them to reproduce these tests in future. There are some findings which can be explored further to bridge the gap between visual pass cases and analysed accepted results.

Limitations & scope for further investigation

The least well understood issue with the test results is the loss of frames from the start of the advert. Several options have been identified for modifying the test program and/or test content to enable further investigation of this. These are not mutually exclusive and it may be appropriate or indeed necessary to pursue more than one of them in order to properly understand this and reduce the number of frames lost.

1. Add a configurable option to play the advert using the old A/V control object and not the HTML5 video element
2. Add a configurable option to explicitly seek to the start of the content
3. Encode the advert differently
4. Confirm that the TVs concerned can play the entire advert outside the context of a switch from broadcast
5. Add a configurable offset between when play is called and when the video element is made visible using CSS

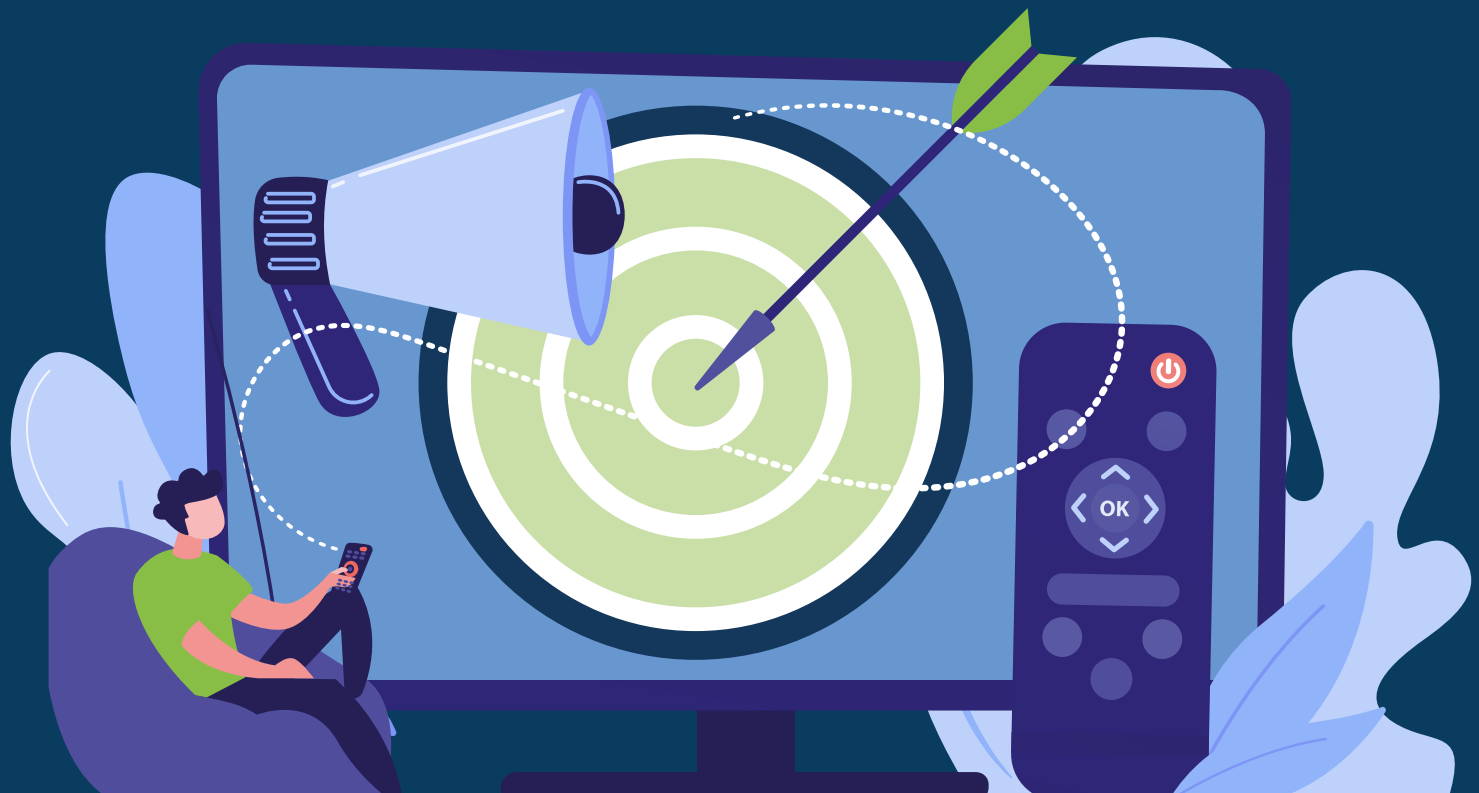
Loss of frames from the end of the advert is also an issue however this is believed to be well understood. It is suspected that TV sets are reporting the end of the advert to the application too early and the application is stopping the playback of the advert before the last video and audio have been shown. This could be investigated by modifying the test program to add a configurable option for a delay between the ended event being detected and the video element being stopped.

6
Test Suite Download Info

The DTG Targeted Advertising HbbTV Test App Suite is available to DTG Full Members free of charge via the DTG FTP site.

To gain access, or for non-members interested in obtaining a license, please contact DTG Customer Services:

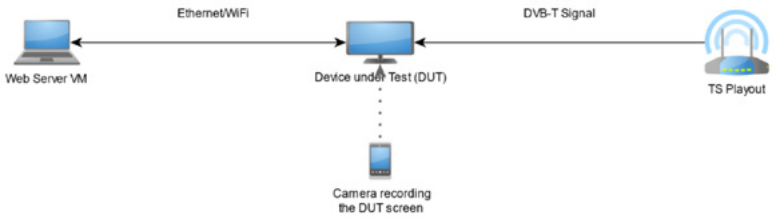
customerservices@dtg.org.uk



Appendix A

DTG Targeted Advertising HbbTV Testing Environment

Short introduction to the Targeted Substitution of Broadcast Ads using HbbTV for the UK DTG TA study. DTG commissioned MIT-xperts GmbH to develop the test app and streams.



Device under Test (DUT)

The Device under Test (referred to as DUT in this document) is the TV or the Set-Top-Box to be tested. A Set-Top-Box needs to be connected to a screen, so the output is visible.

Broadcast transport stream

The DUT is connected to a DVB-T-Playout server which is playing out the test transport stream (TS) with the following parameters:

DVB-T, 474 MHz
8 MHz bandwidth, QAM 64, code rate 2/3, guard interval 1/8, 8k transmission
ONID: 1, TSID: 100, NID: 99 Bitrate: 22117647 bps

The test stream contains two channels:

- **Channel 1 named "DTG-Landing" (Service ID: 1901)**
  Acting as a landing channel with black video / no audio to prepare for launching the actual test application on the other channel
- **Channel 2 named "DTG-Test" (Service ID: 1902)**
  Carries the actual test A/V content with AIT to download the test application as well as TEMI timeline and StreamEvents

The test application signalled in the stream AIT has the following parameters:

URL: http://itv.mit-xperts.com/kuioyerkwhej5dfa-dtg-ta/index.php
Org.ID: 640 (Channel 4)
App.ID: 91
HbbTV 1.1.1 / Service bound

There are two different MPEG TS files:

- with-qr.ts – the Transport stream containing the QR code / time code / frame number / stream name / colour indicator
- clean.ts – the Transport stream containing the original video without any overlay information

Web Server

The test application on the TV needs to be downloaded from a web server. The web server can also be used to report back the log file of the test run.

The AIT in the test stream(s) references the following host name for downloading the application from the web server: itv.mit-xperts.com. The test setup requires you to set up your own web server, and any serious testing should do this.

The server is provided as a VM (Virtual Machine), as an OVA image. The server requires a DHCP server to run (it is a standard Ubuntu 20.04 installation, which can also be configured to have static IP address, for a documentation on how to do this, please read https://linuxize.com/post/how-to-configure-static-ip-address-on-ubuntu-20-04/. In addition to the VM, you also need to set up a DNS server in your local network used by the DUT that resolves the host name itv.mit-xperts.com (A record) to the IP address of your Server VM, as the URL in the AIT of the test stream points to exactly this host name.

Camera

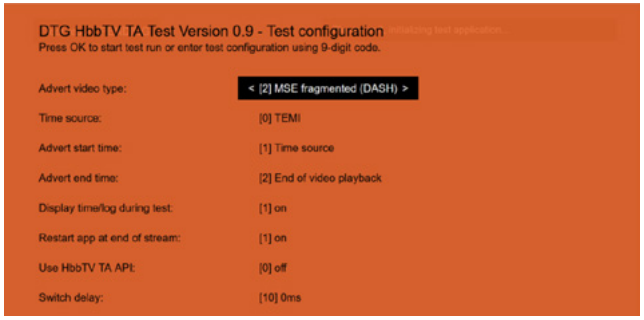
The camera should record the screen of the DUT during the test, so the test run can be analysed later on automatically using the QR codes in the video using the test scripts provided by TP Vision and Google.
Camera used for DTG Zoo Test: GoPro HERO10

Test configuration

The test can be configured both manually (by the user running the application on the TV using the remote control) and automatically (by a configuration file on the web server).

Manual configuration

If manual configuration is enabled in the configuration file, the application will start up with an orange configuration screen which looks like this:



There are two ways for the manual configuration:

- Using the cursor keys: Use up/down to select the setting you want to change, then use left/right to cycle through the possible options of the settings. Press OK to start the test once all settings are configured to your satisfaction.
- Using the number keys: Simply enter a 9-digit code. Each setting is assigned to a digit of this code. For example, the code 201211010 will configure the settings in the screen shot above.

Automatic configuration

The test configuration file is located on the Web Server VM in the following path:

```
/var/www/html/kuioyerkwhej5dfa-dtg-ta/cfg.js
```

To edit it, use your preferred text file editor on the Ubuntu Operating System. Alternatively, you can download the file via a tool like WinSCP, edit it, then upload it again. This also allows automated editing of this file.

Here is a sample configuration file:

```
var CFG = {   “vtype”:2,
  “tsource”:0,
  “starttime”:1,
  “endtime”:2,   “log”:1,
  “restart”:1,
  “taapi”:0,
  “delay”:0,

  // not configurable in GUI:
  “runImmediate”:0,
  “logserver”:1
};
```

For the various settings and their possible options (digits), please see below. There are the following exceptions / additions:

- delay: This is the switch delay in milliseconds. This value can also be negative.
- runImmediate: Set this to 0 to enable manual configuration (the user gets the orange configuration screen with the specified settings as default, but these settings can be changed by the user) or to 1 to skip the manual configuration and start the test immediately
- logserver: The URL pointing to the log server to send the reports to, or use the value 1 to send the log to the same server hosting the application (the Web Server VM). The value 0 disables sending logs to a server.

Description of the settings

Setting ID	Option digit	Description
vtype		**Advert video type**
	0	native player mp4 file: Play a progressive download mp4 file using the native video player on the DUT
	1	**native player fragmented (DASH):** Play a MPEG-DASH file using the native video player on the DUT
	2	**MSE fragmented (DASH):** Play using the fragments from the DASH, but use Media Source Extensions instead of the native video player
tsource		**Time source** (only relevant if starttime or endtime is set to "Time source" or "Automatic")
	0	**TEMI:** Use TEMI timeline to determine the time when to switch
	1	**PTS:** Use Presentation Timestamp of broadcast video to determine the time when to switch
starttime		**Advert start time**
	0	**StreamEvent:** Use the timing when the StreamEvent is received to start the broadband advert
	1	**Time source:** Use the configured time source (see above) to determine when the broadband advert should start
	2	**Automatic:** Try to use the time source, but fallback to StreamEvent timing if the time source is not available on the DUT
endtime		**Advert end time**
	0	**StreamEvent:** Use the timing when the StreamEvent is received to end the broadband advert and switch back to broadcast
	1	**Time source:** Use the configured time source (see above) to determine when the broadband advert should end and the switch back to broadcast should occur
	2	**End of video playback:** When the broadband advert video ends, switch back to broadcast

Setting ID	Option digit	Description
log		**Display time/log during test**
	0	**off:** Do not display any overlay
	1	**on:** Display test status and timing (top-left corner) as well as the test protocol (top-right corner) on top of the video
restart		**Restart app at end of stream**
	0	**off:** Keep the application running when the broadcast stream wraps around
	1	**on:** Restart the application when the broadcast stream wraps around
taapi		**Use HbbTV TA API**
	0	**off:** Use application code to perform the switch between broadcast and broadband
	1	**on:** Use the HbbTV TA API to perform more efficient switching between broadcast and broadband, see ETSI TS 103 736. Check with the manufacturer of the DUT if this option is supported and under which conditions it is available, as this feature is not a mandatory feature in HbbTV and is often licensed to the broadcaster
delay		**Switch delay** (specify an offset/delay when the actual switch to/from broadcast should occur, relative to the specified switch time in the stream)
	00 – 09	**Negative switch delay:** Switch before the actual/specified switch time: 00 = -1000ms, 01 = -900ms, … 09 = -100ms
	10	**No switch delay:** Switch exactly at the actual/specified switch time
	11 – 39	**Positive switch delay:** Switch after the actual/specified switch time: 11 = +100ms, 12 = +200ms, … 39 = +2900ms

Logging to the server

If enabled, the DUT will send the test result to logging server (the Web Server VM by default) which will store the result in one file per IP address:

```
/var/www/html/kuioyerkwhej5dfa-dtg-ta/log/IP.log
```

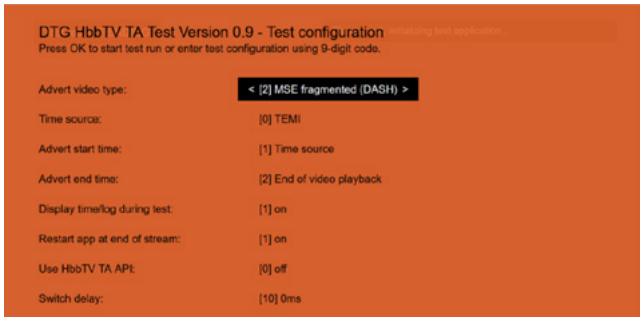
The log file is a JSON file which contains the following items:

- remoteIp: The remote IP address of the DUT
- timeStamp: the UNIX timestamp when the test result was retrieved
- status: “FAIL” or “PASS”
- log: The protocol of the test run as text. The protocol is identical to the one Each entry is separated by a newline character (“\n”).

Test Setup

Test preparations (needs to be done once)

- Start the DVB-T Playout
- Start up the virtual machine running the server
- Scan the channels on the DUT
- Connect the DUT to the virtual machine
- Make sure the DUT thinks it is connected to the Internet and that the DUT can reach the web server. This can be done by switching to the “DTG-Test” channel. If everything is set up correctly, you will see the settings screen looking similar to this:



- Configure the configuration file on the server.

Test procedure (per test run)

- Go to the “DTG-Landing” channel to make sure no HbbTV application is running
- Stay there for at least 5 seconds
- Start recording
- Wait until the test stream starts from the beginning
- Go to the “DTG-Test” channel
- Wait until application starts
- If configuration file on Server is set up for manual configuration (orange config screen appears), perform configuration (see above)
- Test starts
- Wait until time code 00:07:00.00 or later is displayed
- Stop recording

Example test run: https://www.youtube.com/watch?v=Jpxa1bc9y6o

Test time codes

This chapter defines the relevant time codes for both streams:

- DTG-ADINS-BC is the broadcast video
- DTG-ADINS-BB is the broadband ad substitution video

Timeline for Test Stream DTG-ADINS-BC

Time code	Frame number	Description	Colour
00:00:00.040	1	Stream starts / Part 1: "Countdown"	Green
00:02:17.600	3440	*Stream Event #1: Prepare Download (informational)*	Green
00:02:38.460	3962	*Stream Event #2: Start substitution (informational)*	Green
00:02:39.460	3987	*Green "Blocks" optical (informational)*	Green
00:02:40.460	4012	Ad take-off zone / 5 black frames -> *switch to ad substitution*	Yellow
00:02:40.680	4017	Broadcast Ads start / Red	Red
00:06:33.480	9837	"Key Retirement Sponsorship of Afternoons On 4" Trailer (landing zone) *-> switch back to broadcast*	Yellow
00:06:38.440	9961	Programme continues / Part 2: "Countdown"	Green

Timeline for Ad substation video DTG-ADINS-BB

Time code	Frame number	Description	Colour
00:00:00.040	1	Broadband ads start	Blue
00:03:53.000	5825	Last frame of broadband ads	Blue

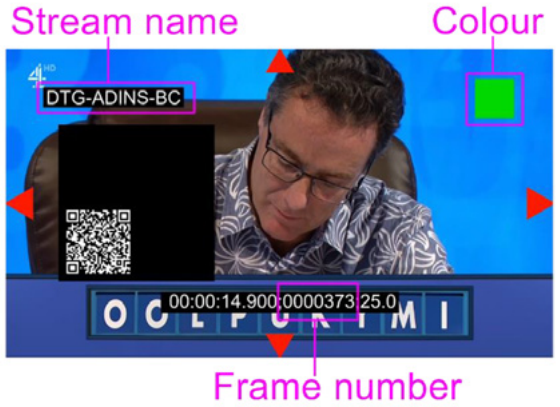
Test analysis

Check recording for the following frames (with a small fuzzy logic accepting a very small amount of dropped frames due to problematic decoding of QR codes after they were captured by your camera):

Stream name	Start frame	End frame	Description	Colour	Visible
DTG-ADINS-BC	3400	4011	Broadcast video part 1 should be visible	Green	Yes
DTG-ADINS-BC	4017	9836	Original broadcast ads should not be visible	Red	No
DTG-ADINS-BC	9961	10100	Broadcast video part 2 should be visible	Green	Yes
DTG-ADINS-BB	1	5825	Broadband ad substitution video should be visible	Blue	Yes

Note: the "yellow" frames with frame numbers 4012-4016 and 9837-9960 are the take-off / landing zones that can be shown but do not have to be shown. Ideally, the take-off zone is not shown and the landing zone is shown completely.

See image below for a reference on how to extract the key information for the analysis. All required information is encoded in the QR code, but also in human readable form on the screen:



In addition to the checks above, the analysis could also report the following information:

Report ID	Description
SWITCH-ACCURACY-BC1	The last frame of the DTG-ADINS-BC (part 1) – 4012 (the ideal switch position). For example, if the frames 4012, 4013, and 4014 are visible in the recording, the result would be 4014 – 4012 = 2 Frames. Ideal value = 0 Frame.
SWITCH-ACCURACY-BC2	The time passed between the last frame of the DTG-ADINS-BC (part 1) and the first frame of the DTG-ADINS-BB. These frames usually are black without any QR code, so here the duration is relevant. Ideal value = 0 Milliseconds.
BROADBAND-FIRST-FRAME	The first frame number of the DTG-ADINS-BB. Ideal value = 1
BROADBAND-LAST-FRAME	The last frame number of the DTG-ADINS-BB. Ideal value = 5825
SWITCH-ACCURACY-BB2	The time passed between the last frame of the DTG-ADINS-BB and the first frame of the DTG-ADINS-BC (part 2). These frames usually are black without any QR code, so here the duration is relevant. Ideal value = 0 Milliseconds.
SWITCH- ACCURACY-BB1	The first frame of the DTG-ADINS-BC (part 2) – 9837 (the ideal switch position). For example, if the first frame detected after the DTG-ADINS-BB is frame number 9900, the result would be 9900 – 9837 = 63 Frames. Ideal value = 0 Frame.

To find out more about the DTG working groups and current work streams,
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