Live Streaming at Scale

A DTG analysis of latency and accessibility functionality across a summer of sport

NOVEMBER 2024

DTG
THE CENTRE OF UK DIGITAL TV

Contents

Overview 3
Devices Overview 4
Test Setup Overview 5
Comparative Analysis 6
- Device Performance during Wimbledon and Olympics 7
- Comparison of 2024 Live Sport events IP Streaming Performance with the Coronation of King Charles III in 2023 8
- Device Performance during Paralympics 9

Key Findings and Recommendations 10

DTG
THE CENTRE OF UK DIGITAL TV

Overview

The DTG (Digital TV Group) conducted a comparative analysis of devices used during three major live events over the summer of 2024 —Wimbledon, the Olympic Games, and the Paralympic Games. The selection of devices was based on their availability to cover a range of content delivery options and configurations in the UK for viewing live sports. While not all platforms could be included, a representative selection was analysed. The report focuses on key performance factors such as reliability, connectivity, latency, ease of setup, and overall efficiency across the three events as well as accessibility functions and availability.

Building on similar tests conducted by DTG last year during the Coronation of King Charles III, this analysis provides an opportunity to review improvements, enhancements, and the current state of platforms and devices. The evaluation captured in this report is intended solely to reflect the current state of the devices, platforms, and applications, offering an objective assessment of their performance and developments observed during the live events.

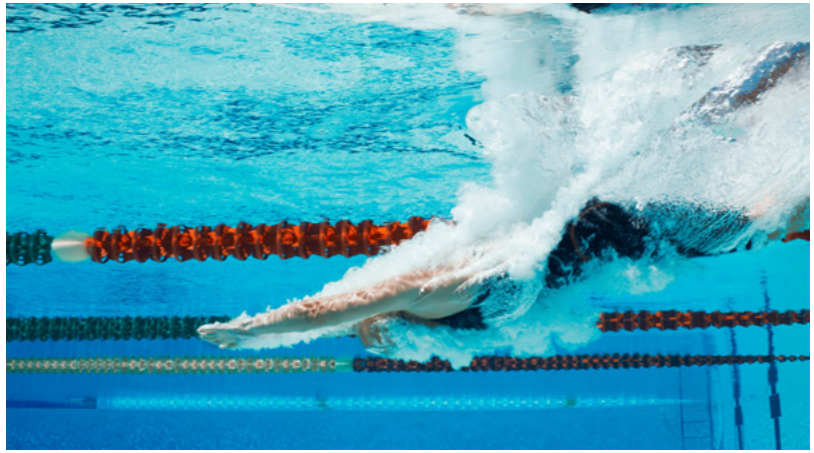
DTG's expert engineers conducted tests to compare the live broadcast signals (terrestrial and satellite) with the live IP streams (Freely, Sky Glass, BBC iPlayer, Channel 4 app). The tests were carried out during:

Event Name	Date	Event Location	Testing Date
Wimbledon	01 July - 14th July 2024	UK	Friday 12th July 2024 at DTG, London
Olympic Games	26 July – 11 August 2024	Paris	Friday 9th August 2024 at DTG, London
Paralympic Games	28 August – 8 September 2024	Paris	Friday 30th August 2024 at DTG, London

DTG THE CENTRE OF UK DIGITAL TV

Devices Overview

Using the DTG Zoo, the largest receiver collection in Europe, tests were conducted by DTG Testing engineers across 19 devices, carefully selected to represent a comprehensive range of the most widely-used TV platforms, TV operating systems, mobile devices, tablets, and laptops, ensuring broad coverage across all major device categories and operating environments.



The tests were carried out across the following devices and platforms:

- DVB-T2 Freeview terrestrial channel 101 BBC One HD + 104 Channel 4 HD
- DVB-S2 Freesat channel 101 BBC One HD + 104 Channel 4 HD
- Sky Glass - BBC One HD IP channel + Channel 4 HD IP channel
- Freely BBC One HD IP channel + Channel 4 HD IP channel
- YouView PVR
- Console
- Apple iPad
- Apple iPhone
- Android phone
- Android tablet
- Laptop displaying the BBC iPlayer webpage + Channel 4 webpage
- A range of 4K resolution TVs covering all the UK best-selling manufacturers

DTG
THE CENTRE OF UK DIGITAL TV

Test Setup Overview

The BBC holds the broadcasting rights for Wimbledon and the Olympics; therefore, BBC One HD was tested alongside BBC iPlayer. For the Paralympics, Channel 4 HD was compared with the Channel 4 app. In the testing setup, devices were configured to access either BBC One HD/Channel 4 HD using Satellite feed, terrestrial feed and by launching the BBC iPlayer or Channel 4 app.

A wired connection was established for all devices (Virgin Media, total bandwidth 900+ Mbps), except for 5 devices (mobiles, tablets and a laptop), which were connected to the DTG Wi-Fi network (90+ Mbps). For accessibility testing, subtitles were enabled wherever possible.

In BBC iPlayer, the live stream for Olympics was selected. To evaluate the availability of UHD streaming, the UHD option was selected; if unavailable, the HD stream was selected. Subtitles were enabled during testing. If they couldn't be activated on the live stream, another program within the app would be started to enable subtitles, then returned to the live stream.

Latency Testing Methodology

Latency was monitored using a laptop displaying a webpage containing the current time, accurate to milliseconds, allowing measurements to be calculated precisely to the second.

A GoPro camera was positioned to capture the entire testing environment in a frame, enabling the observation of all devices presenting content simultaneously.

Throughout the events, three separate 15-minute video recordings were captured at various intervals using a GoPro, each recorded at a resolution of 3840x2180 and a frame rate of 100fps.

Data Collection Process

Following the recording, the video file was imported into video editing software (Avidemux). A reference point, typically a distinguishable camera transition (e.g. a scoreboard display during a change of ends), was selected at a midpoint in the video to ensure consistent identification across all screens.

The time on the laptop at which this reference point appeared for the first screen was recorded. The video was then advanced frame by frame until the reference point appeared on the next screen, at which point the corresponding laptop time was noted. This process was repeated for all remaining screens.

Once all times were captured, the delays for each device were calculated by averaging the time differentials between the delivery closest to live (DVB-S2 Freesat) and the recorded time on each screen captured for all three video recordings. This procedure was carried out to obtain a representative average of the latency relative to the closest live presentation.

Comparative Analysis

Wimbledon test setup (Figure 1) clearly demonstrates latency visible by different camera angles and player's box shown on devices. The same latency was observed during Olympics test setup (Figure 2). For the Paralympics tests (Figure 3), several devices were displaying black screens. This issue was traced back to the Channel 4 app, where a number of devices lacked the option to view "Live TV" through the application. Some devices had a menu option for "Live TV", while others did not, limiting our ability to test live TV functionality in comparison with the broadcast output.

Figure 2 *Olympics test setup*

Figure 1 *Wimbledon test setup*

Figure 3 *Paralympics test setup*

Device Performance during Wimbledon and Olympics

During the Wimbledon testing, UHD feeds (Figure 4) were evaluated when available, comparing performance across satellite and terrestrial broadcasters. At the top of Figure 4, the closest broadcaster platforms are displayed. Sky Glass consistently outperformed others, while most devices experienced a delay relative to each other, with significant delays seen in Android mobile and tablet devices. However, one premium brand Smart TV exhibited a significantly longer delay at 76 seconds.

Similarly, during Wimbledon testing of the BBC One HD feed (Figure 5), the satellite and terrestrial broadcasters were closest to live. The same Sky Glass model continued to perform slightly ahead of others as with the UHD feed. The overall delay for UHD feeds averaged 46.5 seconds, while HD feeds showed an average delay of 41.5 seconds. The performance relative to live event timings for the Olympics (Figure 6) showed slight improvements compared with Wimbledon.

The latency comparison across different platforms and devices during Wimbledon and Olympics showed significant variation, with BBC One HD on DVB-T2 (Freeview Play) offering the lowest delay at just over 2 seconds behind the DVB-S2 (Freesat) broadcast, making them the fastest platforms.

Mid-Latency: Sky Glass exhibited latency of around 25 seconds.

Most platforms, including BBC iPlayer on Freeview Play Premium brand TVs, YouView PVR, Console, iPhone, iPad, and web browser, experienced moderate latency in the 37 to 40-second range.

High Latency: Devices like Android phone and tablet tended to have higher delays, approaching one minute. At the highest end, BBC iPlayer on a Premium brand Smart TV had the longest delay, exceeding one minute.

iPlayer testing results – Centre Court feed (UHD if available)

Average iPlayer time behind broadcast when UHD: **46.5 seconds**

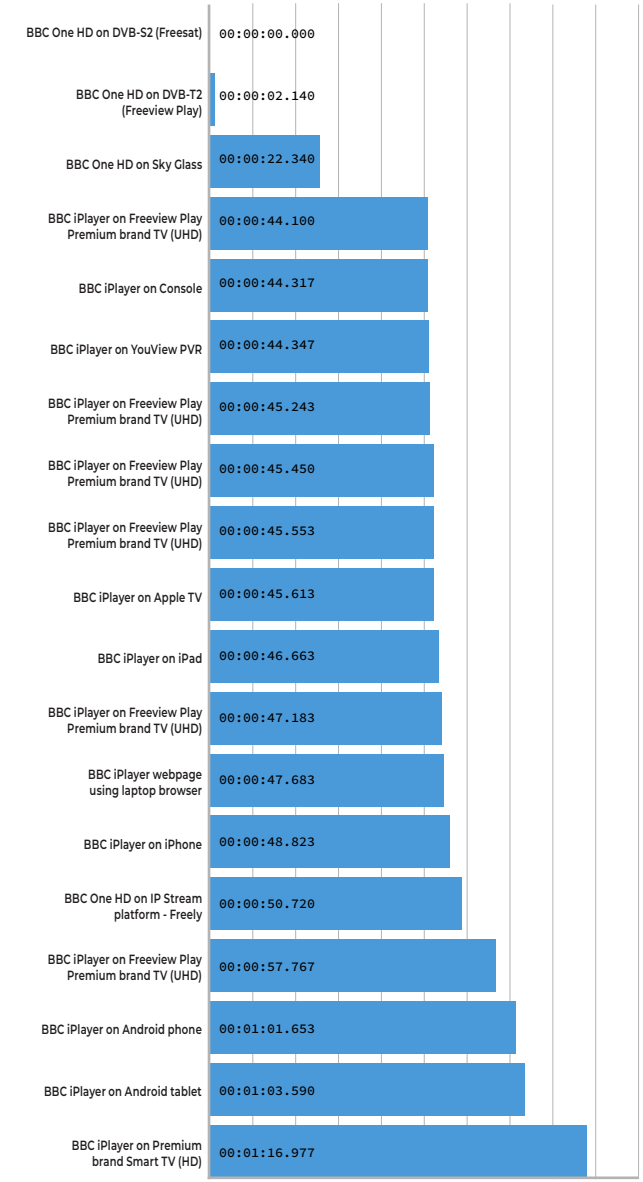


Figure 4 *Wimbledon Centre Court (UHD feed if available) test analysis*

iPlayer testing results – BBC One feed (HD only)

Average iPlayer time behind broadcast when HD: **41.5 seconds**

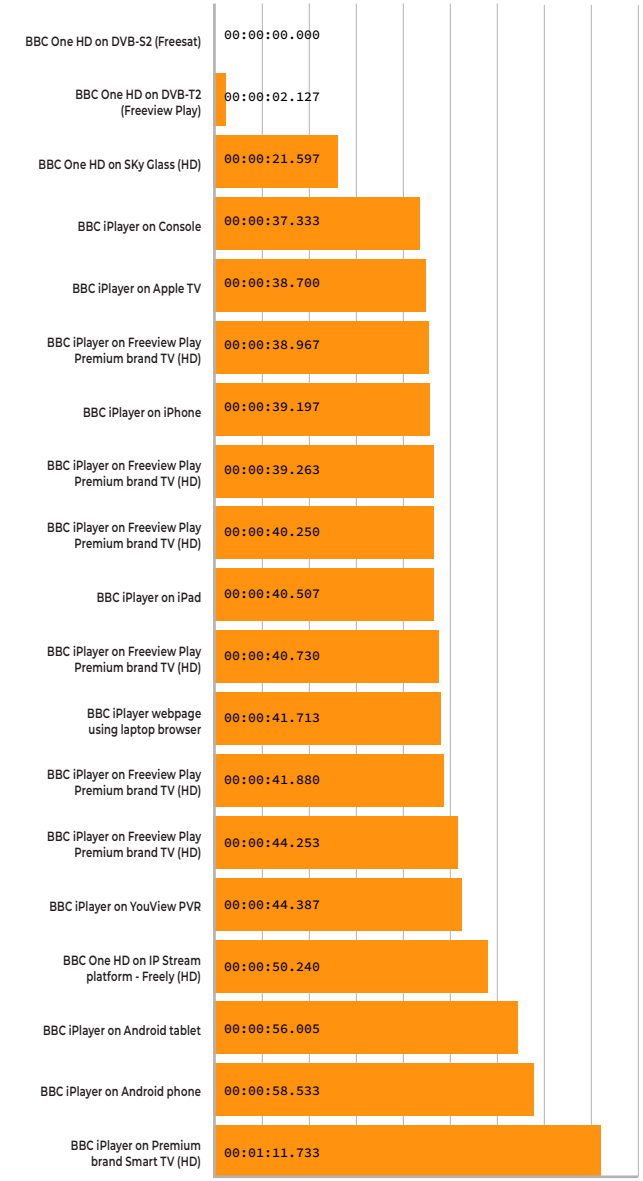


Figure 5 *Wimbledon BBC One (HD feed) test analysis*

Overall, from IP streaming perspective, BBC One HD on Sky Glass leads in IP stream performance, while BBC iPlayer on Premium brand Smart TV lagged the most in terms of latency.

Comparison of 2024 Live Sport events IP Streaming Performance with the Coronation of King Charles III in 2023

The BBC One HD and BBC iPlayer comparison between Wimbledon and Olympics in 2024 (Figure 5 and 6) and the Coronation of King Charles III in 2023 (Figure 7) shows significant improvements in latency across various devices and platforms.

Last year, the average live IP stream time lag behind broadcast for the Coronation of King Charles III was measured at 55.9 seconds. In contrast, the average time behind broadcast for the Olympics this year is calculated to be 40 seconds. This improvement can be seen in figures 6 and 7, which provide the information on the platforms that have experienced advancements in performance.

These findings demonstrate that BBC is making considerable progress in bringing the IP streaming experience as close as possible to traditional broadcast standards.

It is worth noting that broadcast delays didn't change, therefore the fastest platforms observed during testing are still DVB-C, DVB-S2, and DVB-T2.

From IP streaming perspective, the BBC iPlayer on Console saw the largest improvement, reducing latency by over 34 seconds.

BBC iPlayer on a Premium brand Smart TV, which had the highest latency in 2024, showed a significant improvement of nearly 29 seconds compared with 2023.

iPlayer testing results – BBC One HD feed

Average iPlayer time behind broadcast: **40.1 seconds**

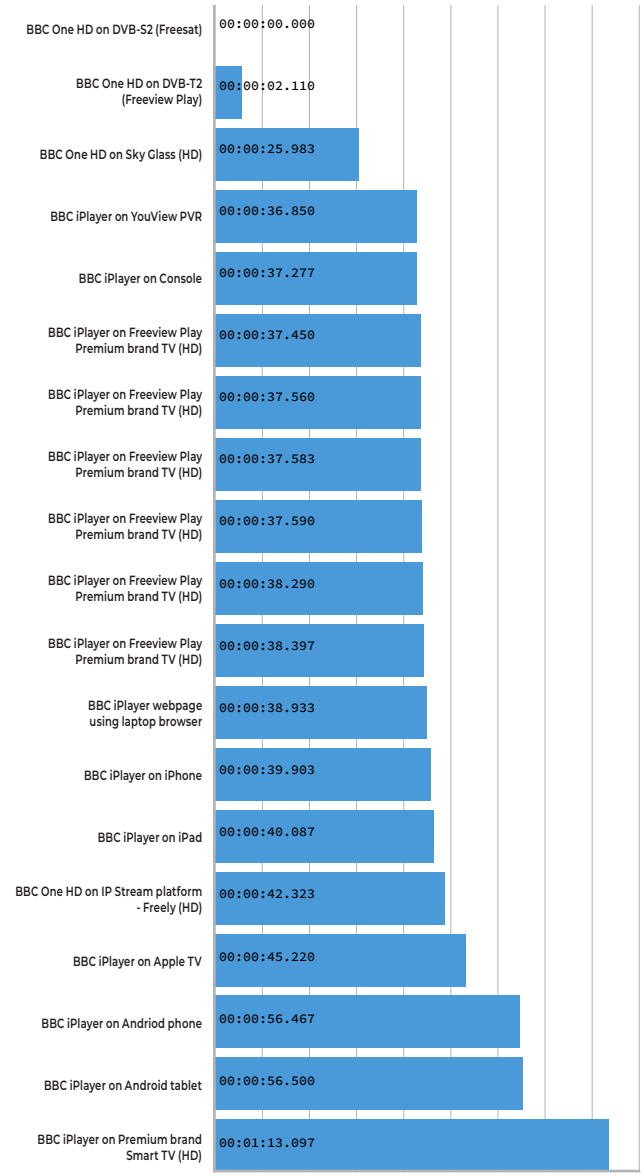


Figure 6 *Olympics BBC One (HD feed) test analysis*

iPlayer testing results – Coronation of King Charles III 2023

Average iPlayer time behind broadcast: **55.9 seconds**

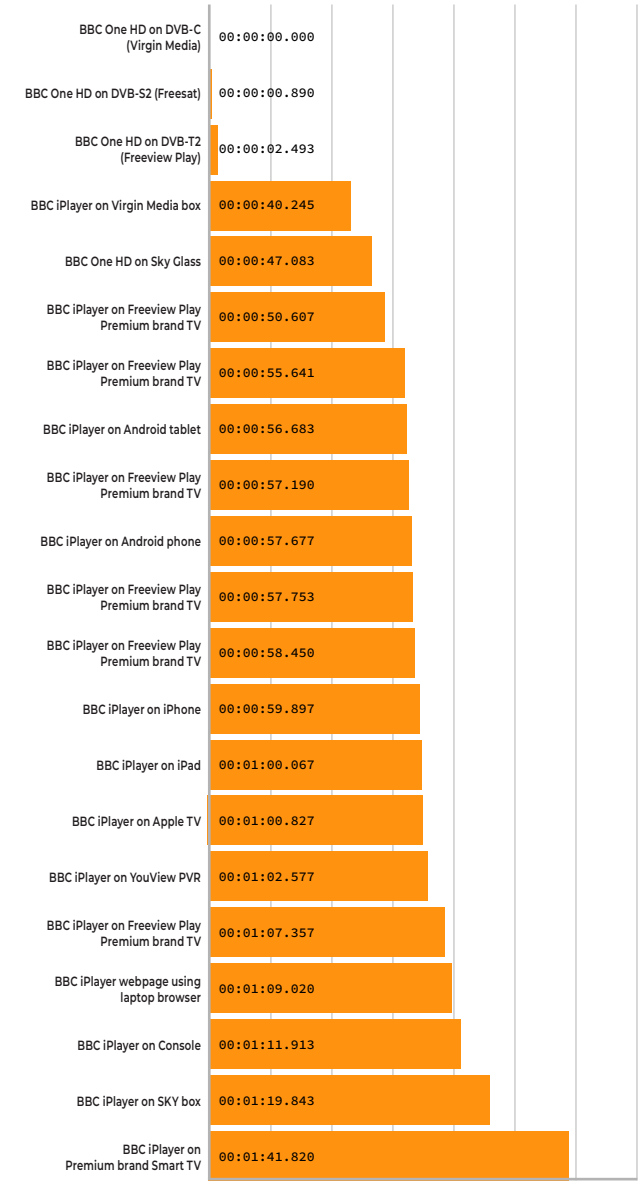


Figure 7 *Coronation of King Charles III 2023 BBC One (HD feed) test analysis*

The BBC iPlayer webpage using laptop browser and BBC iPlayer on Freeview Play Premium brand TVs also experienced substantial reductions in latency, with improvements of around 28 and 17-28 seconds respectively.

The BBC One HD on IP Stream platform – Sky Glass, improved by 23 seconds, while the BBC iPlayer on iPhone and iPad showed around 19-20 seconds of improvement.

Other platforms like Apple TV and YouView PVR improved by 18 to 22 seconds.

There was no observed improvement in latency on the Android phone and tablet this year compared with the performance recorded last year.

Overall, Wimbledon and the Olympics in 2024 saw noticeable reductions in latency across most platforms, with the greatest improvement seen on BBC iPlayer performance on Console and Premium brand Smart TV compared with last year.

Device Performance during Paralympics

During the Paralympics testing (Figure 8), the Channel 4 latency performance across various devices and platforms shows considerable variability.

Low Latency: Channel 4 HD on DVB-S2 offers the fastest experience with no delay, while Channel 4 HD on DVB-T2 follows closely with a latency of 2.11 seconds.

Moderate Latency: In comparison, the Channel 4 app on Console shows a significant delay of 23.7 seconds. Other platforms such as the Channel 4 app on Premium brand Smart TV and Channel 4 HD on Sky Glass have latencies of 25.69 seconds and 25.977 seconds, respectively. The Channel 4 webpage using a laptop browser adds a delay of 26.64 seconds, while the Channel 4 app on Android Phone has a latency of 27.153 seconds.

Higher Latency: Higher latencies are observed with the Channel 4 app on Android Tablet at 28.937 seconds, followed by the Channel 4 app on Apple TV at 30.583 seconds and the Channel 4 app on iPhone at 30.703 seconds. The Channel 4 app on iPad has a latency of 34.663 seconds, and the Channel 4 on IP Stream platform - Freely shows a delay of 35.112 seconds.

Lastly, the Channel 4 app on Freeview Play Premium brand TV exhibits the highest latency at 1 minute and 12.690 seconds, underscoring the notable differences in performance across these devices and platforms.

Channel 4 testing results – Paralympics (HD feed)

Average Channel 4 time behind broadcast: **30.3 seconds**

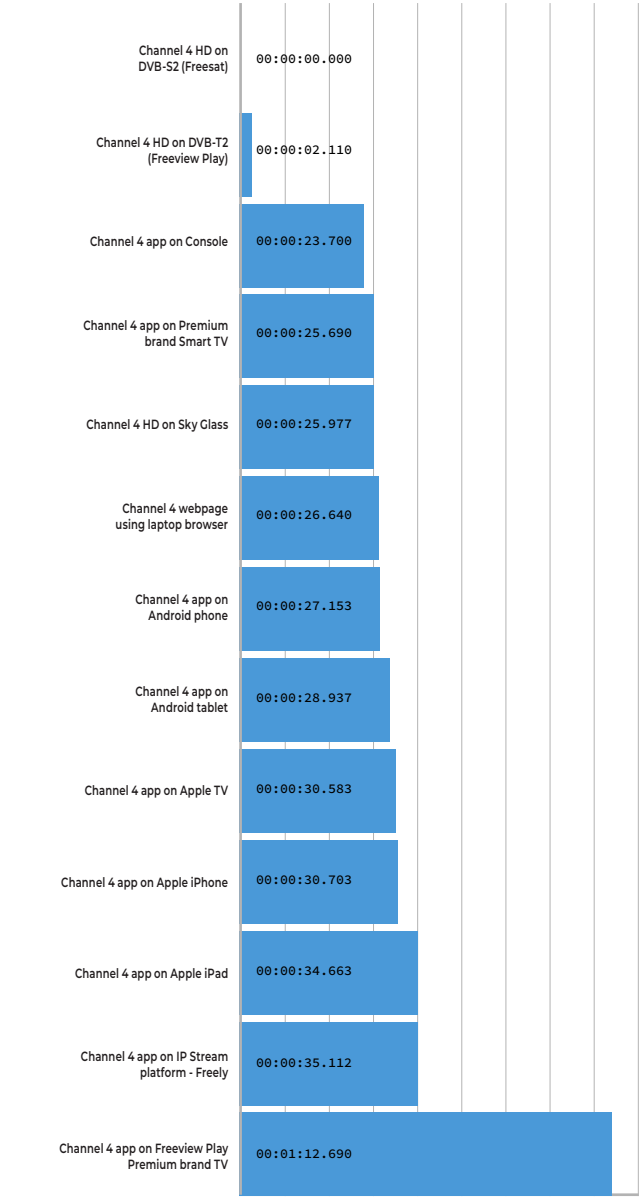


Figure 8 *Paralympics Channel 4 (HD feed) test analysis*

Key Findings and Recommendations

User experience

- Testing revealed several key strengths from a user experience standpoint, particularly around enhancing customer viewing experience. One Freeview Play Premium brand TV explicitly communicated that HDR was enabled when the UHD BBC iPlayer feed was selected. Other TVs may have presented the content in HDR however this was not notified to the viewer. The BBC One HD DVB-T2 service seamlessly prompted the viewer with the option to view the content in UHD. These features significantly elevate the user experience by proactively informing customers of the availability of premium content and providing clear confirmation when the higher-quality streams are initiated.

Content Delivery Comparisons

- The DVB-S2 & DVB-T2 broadcast delivery consistently outperformed in terms of latency, presenting content with a fixed delay. These platforms were ahead of both IP live channels and live application content across all tests.
- Subtitles appeared to be accurate for both content and timing across broadcast, live IP channel feeds as well as live streaming via application.

Device Issues

- On one device, enabling subtitles in the BBC iPlayer menu did not result in any subtitles being displayed.
- In the Channel 4 app one device didn't display any subtitles, despite setting them to enabled (a different device to BBC iPlayer testing).
- One device experienced a playback failure with a DRM error message "Service Unavailable - Channel 4 is currently unavailable. Please try again later. - 4200-DRM-FAILED" after approximately four minutes when using Channel 4 app.
- One device had a general issue that subtitles were disabled upon returning from standby mode on another device for live IP feed channels.

Inconsistencies in application

- One version of the Channel 4 app did not offer an option to enable/disable subtitles, affecting accessibility testing.
- Several devices with the particular Channel 4 version app did not offer the "Live TV" option in the app menu, preventing adequate testing for this investigation.

Streaming Performance

- Aside from the DRM error with Channel 4 app, there were no significant stream errors, such as buffering or glitching, during the testing phase.

Accessibility Features

Audio Description Availability

- Audio description wasn't available in Channel 4 app during testing (supposedly available during "live prime time sport", possibly evening content). Therefore, the testing for audio description in Channel 4 app during Paralympics was inconclusive, as it was not available during the testing window. Signed language shown in-picture during afternoon testing.
- No audio description or sign language options were available by design during the Olympics on selecting the live event coverage in BBC iPlayer when tested.

Subtitles Availability

- UHD Centre Court live feed for Wimbledon did not provide subtitles by design, however subtitles were available on the BBC One HD live stream in BBC iPlayer.
- Selecting the direct feed for the Olympics (what was shown on the BBC iPlayer home screen) did not allow subtitles to be presented by design. However, selecting the BBC One channel feed did allow subtitles to be switched on and off.

Further Testing

- Conduct additional tests to verify the availability of audio description and sign language during live events.
- Explore potential solutions to reduce latency, including trials with Low-Latency DASH technology by collaborating with interested parties.

Power Consumption Monitoring

- Power consumption tests were conducted on only two devices for viewing the content using DVB-T2 mode and via streaming. The data gathered showed interesting findings. Further investigation & collaboration would be recommended to determine how best to expand power consumption monitoring to include multiple devices for a comprehensive analysis as the industry transitions from broadcast to IP.

Device Performance Analysis

- Continue investigating discrepancies in subtitle functionality across different devices and versions of player applications.

Conclusions

The testing conducted revealed significant insights into the performance of various devices regarding accessibility features and streaming quality. While some devices exhibited issues with subtitles and DRM errors, the overall streaming experience was largely free from errors such as buffering or glitching.

Moving forward, a focus on enhancing accessibility features, monitoring power and bandwidth consumption, and reducing latency will be critical as we adapt to the increasing demand for high-quality streaming experiences.

Further investigations are necessary to ensure consistent and inclusive access to live events across different platforms and devices.

DTG Members can contact the DTG Testing team to understand the performance results of their specific device or platform.

For more information about DTG Testing services get in touch with the team.

THE CENTRE OF UK DIGITAL TV

dtg.org.uk

Copyright © 2024 Digital TV Group. All rights reserved.