QBR™

QBR PERFORMANCE
COMPARED TO ABR

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SUMMARY

QBR from MediaMelon improves the efficiency of existing adaptive bitrate video streaming methods, reducing the volume of data delivered while improving the quality of experience.

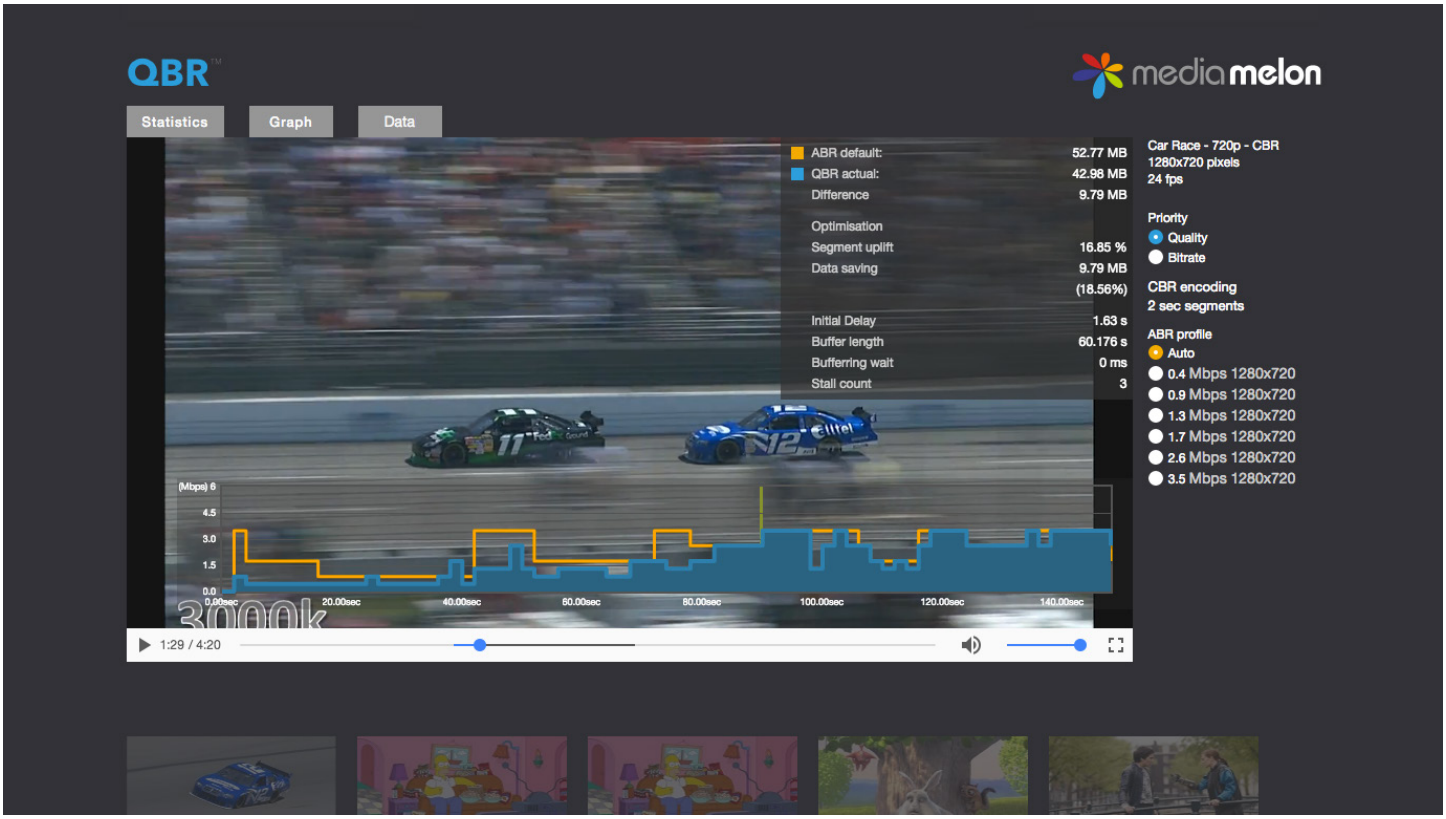
This is achieved by identifying segments with simple scenes that do not benefit from encoding at higher data rates and replacing them with encodings at a lower data rate. This efficiency gain can optionally be used to deliver higher data rate segments for more complex scenes, increasing perceived quality where it matters most, while still reducing delivery costs.

To demonstrate the benefits of QBR, MediaMelon provides an online test tool, which offers a selection of video clips and allows the performance of QBR to be compared to the same encoding delivered with conventional ABR.

The tool enables different modes that demonstrate QBR, with optimization options to prioritize either reduced bitrate or higher quality.

Compared to conventional ABR, the results show that the QBR approach can provide an average reduction in data delivered of 30-45%.

The reduction in data translates into significant cost savings in content distribution and infrastructure, while extending reach to users with constrained network connections, without reducing the perceived picture quality. Furthermore, perceived quality can be increased for more demanding scenes, without requiring more overall bandwidth.



TEST ENVIRONMENT

The online QBR demonstration offers a selection of video sequences encoded using conventional H.264/AVC digital video compression in short segments at a range of data rates, representative of a traditional adaptive bitrate delivery scenario.

The sequences can be played in a standard HTML5 web browser, in this case using the DASH IF Reference Player.

The player requests each segment at the appropriate bitrate for the prevailing network and playback conditions. The default behavior is determined by the DASH IF Reference Player implementation.

Where QBR is implemented in the player, it employs additional quality hint metadata requested together with the media manifest to determine which segments to request.

Various playback options are available:

Quality – This shows QBR optimized for higher quality.

Bitrate – This shows QBR optimized for reduced bitrate.

The playback profile can be set to **Auto**, in which case the player will play video based on the capacity of the available network connection. Alternatively, it can be capped at the data rate of any of the available bitrate profiles to simulate a constrained capacity network connection.

In each case, an on-screen graph shows in blue the data downloaded for the QBR playback, compared to the data that would have been downloaded using the standard ABR playback, as shown by the orange line.

The blue line will often be below the orange line, indicating where QBR requires a reduced volume of data to deliver perceptually equivalent results.

In some cases, the blue line will peak above the yellow line, showing where QBR has taken advantage of the increased efficiency to enable the delivery of a higher quality video segment than would have been possible with conventional ABR.

On screen statistics show the resulting saving in data and the proportion of segments that benefit from an uplift in bitrate to protect quality. Representative example data are summarized in the following results.

PROCEDURE

The performance was independently evaluated over the open internet using a standard broadband connection, with the server and client in different continents, representative of real-world conditions.

The video used was a 'Car Race' sequence that was 260 seconds in duration, comprising an edited sequence of shots combining slow and fast motion and different levels of detail, together with graphics. The video format was 1280×720 at 24 frames per second, assumed to have been acquired at 60 frames per second.

The video had been encoded using H.264/AVC at multiple bitrates in short segments of two seconds in duration. The bitrates available were declared in a manifest file that is requested by the player prior to playback. The six bitrates provided ranged from an average of 0.4 megabits per second to 3.6 megabits per second.

Playback was evaluated using the DASH IF Reference Player, firstly using **ABR Default**, then with **QBR Quality** enabled, and finally with **QBR Bitrate**, in each case in **Auto** mode..

Five test runs of the entire video sequence were performed for each mode to reduce the effects of transient network issues and the results were averaged.

The output of each test run was monitored visually and any anomalies were noted.

The performance data from each session were captured. These provide metrics for each video segment requested by the player.

For each segment, the QBR player reports the bitrate and segment size of the default segment that would have been requested for ABR and the bitrate and segment size of the requested segment using QBR.

The QBR player also reports the quality of the default segment that would have been requested for ABR and the quality of the segment requested using QBR. The basis of this is a Mean Opinion Score automatically calculated for each rendition of each segment as part of the QBR process, ranging from zero to 50, with higher numbers indicating higher quality. To provide an independent objective measure for this comparison, the total video data downloaded and the effective mean video bitrate were determined using the Network section of the Developer Tools in the Chrome browser.

Video data was determined by the sum of the file size of .mp4 video segments requested, as reported by the browser, measured in 1024×1024 bytes (MiB).

Video bitrate was calculated from the video data divided by the number of seconds of video, and measured in millions of bits per second (Mbps).

These numbers were validated using the `nettop` tool available in the OS X operating system that measures by process the actual traffic in bytes over the network interface.

RESULTS

The results summarized here are representative of what can be achieved using QBR in comparison to conventional ABR delivery.

Although the results obtained may vary according to the type of media and prevailing network conditions, the tests can be reproduced using the online tool, which allows anyone to judge the affect on video quality for themselves.

ABR provided good quality playback with no interruptions during each 4 minute 20 second run. Although compression artifacts were occasionally observed, the results were generally acceptable for a consumer service.

It was notable that even with a relatively stable downstream connection with observed download rates that exceeded the maximum bitrate encoding of the video, ABR did not simply ramp up to the highest available bitrate rendition and stay at that quality. There was some variation in bitrates selected that sometimes appeared rather arbitrary. This behavior may be attributable to transient changes in the end-to-end connectivity, which is characteristic of delivery over the open internet.

With QBR enabled, the start times were comparable to ABR and there were no interruptions to playback. The player reported substantial data savings in both Quality and Bitrate modes in comparison to the ABR reference implementation.

While reducing the overall volume of data requested, QBR also appeared to build up a bigger buffer, maintaining a cache of about a minute of video ahead, providing further protection against temporary interruptions in traffic.

The video quality provided by QBR in Quality mode was subjectively comparable to the ABR mode and only marginally inferior in Bitrate mode. The video quality is ultimately constrained by the maximum 3.6 megabit per second encoding.

By employing the quality hint metadata, QBR has visibility of the comparative complexity of video segments that have yet to be requested. It can therefore make more intelligent choices about which bitrate rendition to select for a given segment. This can be based not only on the current buffer level and observed download rate but also on the notional complexity of the next and succeeding segments.

The graphs of requested bitrate by segment demonstrate that QBR requested lower data rate renditions for many segments while occasionally requesting an equivalent or higher bitrate than would otherwise have been expected with ABR.

The segments requested at higher data rates appeared to correspond to sections of video that demonstrated high complexity in detail and motion. This had the effect of protecting these sections from artifacts that would have been apparent at lower data rates, resulting in an improved quality of experience.

The results of each mode are summarized in the following sections.

ABR – DEFAULT

The default scenario demonstrates the results of using ABR without any form of QBR.

The entire segment was requested for five consecutive runs under similar network conditions. In the example shown, it can be seen that the adaptive bitrate algorithm changes between the three higher bitrates available, with the mean just above the second highest available bitrate. There was some variation across runs but the mean bitrate delivered was just under 3 megabits per second.

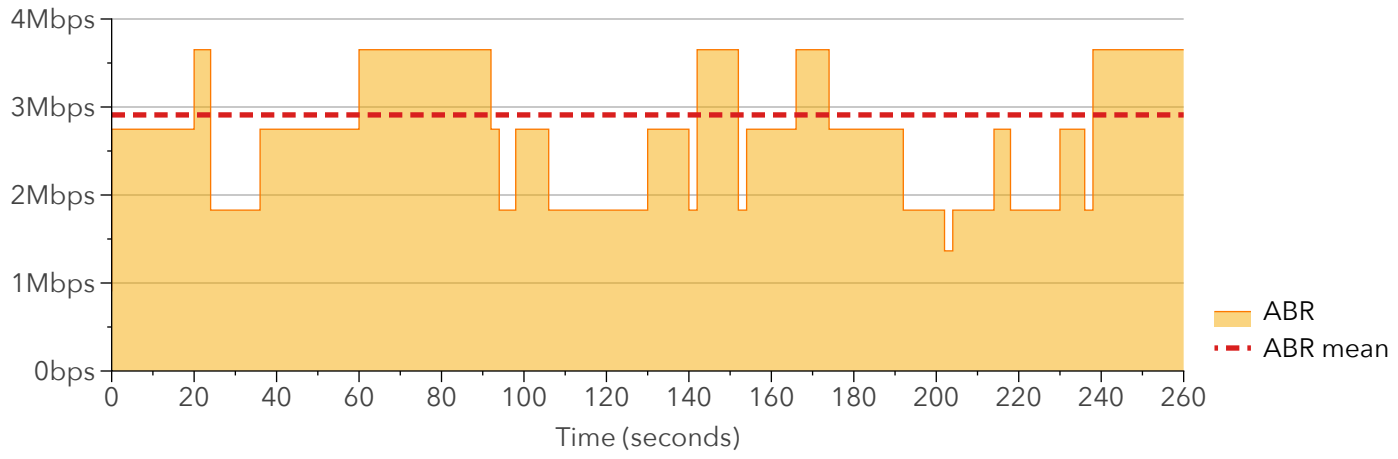
As there was adequate network capacity to deliver segments at the higher data rates, the ABR mechanism did not select the lower data rates.

The selection of different bitrate renditions is determined by factors including the state of the buffer at the time and the observed download rate. It does not take into account any characteristics of the individual video segments.

Notably, although there was sufficient capacity on the access and local network, there is still variation in the bitrates of the segments requested. This may be due to transient fluctuations in the observed download rate over the entire network.

Test	Video data MiB	Video Bitrate Mbps
1	**90.20**	**2.91**
2	91.20	2.94
3	96.60	3.12
4	87.90	2.84
5	97.30	3.14
Mean	**92.64**	**2.99**

Car Race - ABR
Segment bitrates requested



QBR – QUALITY

The increased quality scenario shows the optional benefit of QBR integrated in the server and client to increase the perceived video quality that can be delivered for a given bandwidth. This can be implemented on the client using plug-in software integrations with popular players. The client player is then able to use QBR metadata to identify where data rate savings can be used most effectively to request higher bitrate segments where it matters most for the viewer.

16% of segments were delivered at higher bitrates than the ABR default, indicating that QBR prioritized the protection of quality for complex scenes.

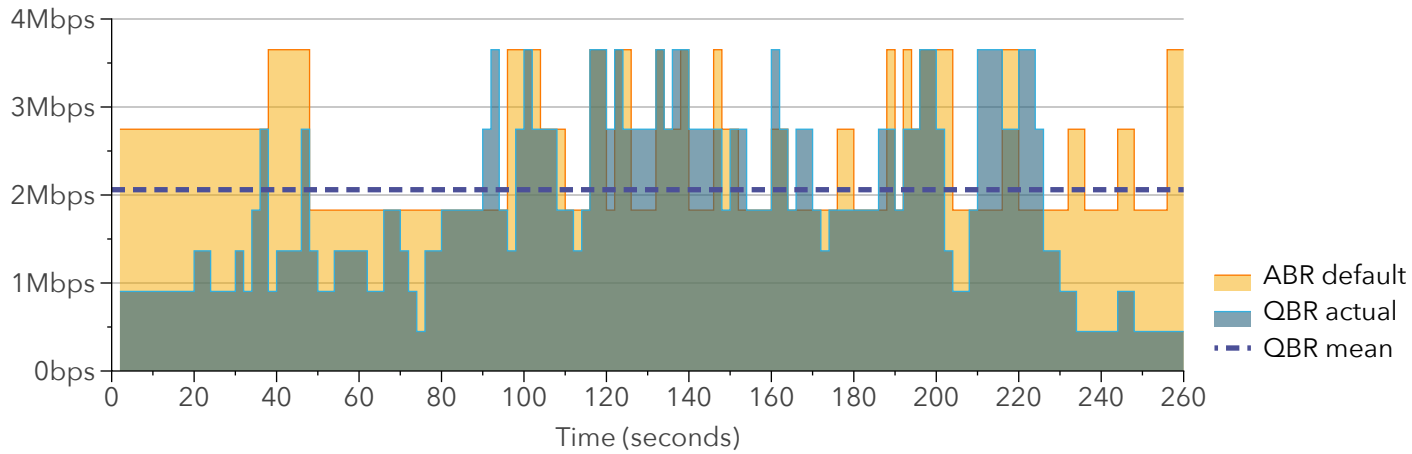
In QBR Quality mode, the player downloaded 63.86 MiB of video data, compared to 92.64 MiB with ABR, a saving of over 30%.

The result is a significant reduction in data delivered, with quality that is comparable, if not better to that delivered by ABR.

Test	Video data MiB	Video bitrate Mbps
1	**66.20**	**2.14**
2	65.60	2.12
3	62.10	2.00
4	61.10	1.97
5	64.30	2.07
Mean	**63.86**	**2.06**

QBR achieved an average data saving of over 30% and offered equivalent or better quality compared to ABR.

Car Race QBR - Quality mode
Segment bitrates requested



QBR – BITRATE

The reduced bitrate scenario shows the benefit of QBR integrated in the server and client. This can be implemented on the client using plug-in integrations with popular players. The client player is then able to use QBR metadata to identify where a reduced bitrate segment can be requested without affecting the perceived video quality.

The chart shows the bitrate segment that would have been selected with ABR by default, together with the actual bitrate segment selected using QBR.

For many segments, QBR selects a lower bitrate segment, where it determines the subjective visual quality is comparable.

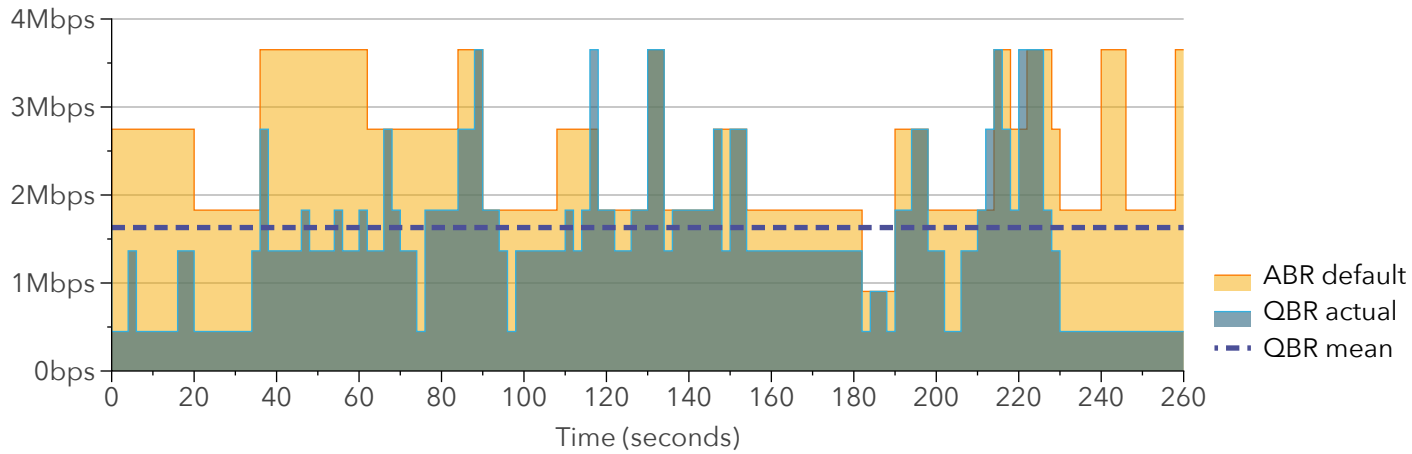
The result is a significant reduction in data rate, with a marginal reduction in quality.

With QBR, the player downloaded 50.64 MiB of video data, compared to 92.64 MiB with ABR, a saving of over 45%.

Test	Video data MiB	Video bitrate Mbps
1	**51.90**	**1.67**
2	50.40	1.63
3	49.30	1.59
4	50.70	1.64
5	50.90	1.64
Mean	**50.64**	**1.63**

QBR in Bitrate mode achieved an average data saving of over 45% compared to ABR.

Car Race QBR – Bitrate mode
Bitrate mode



CONCLUSIONS

QBR demonstrates tangible benefits for service providers, network operators, and viewers by optimizing traditional ABR methods to deliver improved efficiency.

QBR in Quality mode required 30% less data than ABR and provided subjectively comparable quality.

QBR required a 45% less data in Bitrate mode compared to conventional ABR.

Furthermore, while saving bandwidth, QBR was able to increase the bitrate delivered for 16% of segments, protecting quality where it mattered most.

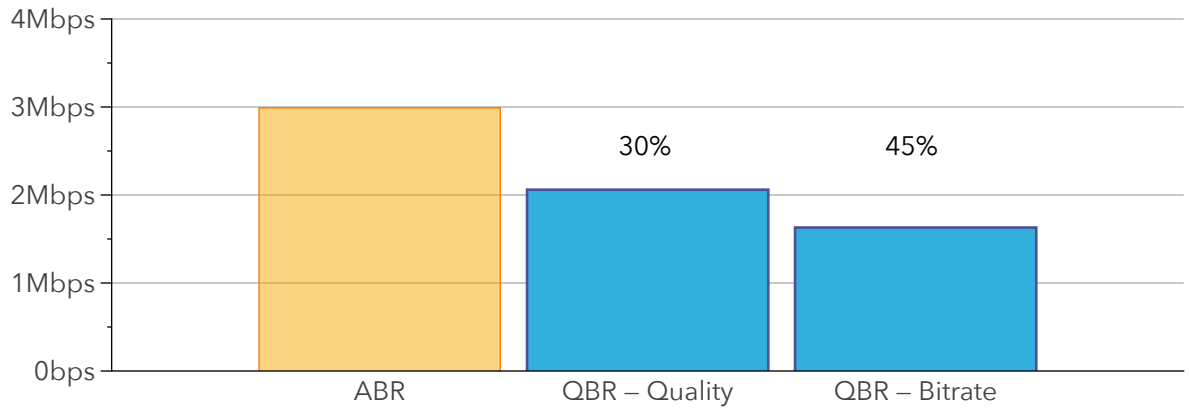
A reduction in the volume of data delivered translates directly into savings in distribution costs, which can either increase margin or allow more streams to be served for the same cost. Reducing the average data rate required to deliver video at equivalent quality increases the ability to serve users with constrained network connections.

This can be achieved without any changes to the way the video is compressed, simply by delivering it more intelligently using QBR.

Mode	Video data MiB	Video bitrate Mbps	Data saving
ABR	92.64	2.99	–
QBR – Quality	**63.86**	**2.06**	**30%**
QBR – Data	**50.64**	**1.63**	**45%**

QBR offers data savings of around 30%-45% compared to ABR and can protect the quality of complex scenes.

Car Race ABR QBR comparison
Average bitrate



Based on the average of 5 complete runs of the same 260 second sequence in each mode under similar network conditions.

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