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VP8 as RTCWEB Mandatory to Implement  
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Abstract

This document recommends that the RTCWEB working group choose the VP8 specification as a mandatory to implement video codec for RTCWEB implementations.

This document is not intended for publication as an RFC.

Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

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## 1. Introduction

As described in [I-D.ietf-rtcweb-overview], successful interoperable deployment of RTCWEB requires that implementations share a video codec. Not requiring a video codec will mean that this decision is left to processes outside the standards process, and risks the spectre of fragmented deployment.

This memo argues that VP8 should be that codec.

## 2. Requirements for an MTI codec

As outlined by the presentation given at the IETF meeting at IETF 84 in Vancouver, it is unclear what the hard requirements for a video codec are, but the items that it was suggested that proposals give information on were:

- o Image quality - comparative data was sought, but without defining a baseline
- o Performance - what resolutions / frame rates can be achieved in software on some common systems
- o Power consumption of hardware and/or software implementations
- o Hardware support
- o IPR status

This document lays out the available information in each category.

## 3. Specification status

VP8 is defined in [RFC6386], and its RTP payload is defined in [I-D.ietf-payload-vp8]. There are no profiles; all decoders are able to decode all valid media streams.

In the time since the original RFC publication, and indeed since the first publication of the VP8 bitstream format, there have been no changes to the decoder that broke bitstream compatibility.

### 3.1. VP8 standardization status

The VP8 codec has been proposed as a basis for standardization in MPEG, in response to its Call for Proposals for a royalty-free video codec. At its meeting in Vienna, Austria in July 2013, following the

presentation of subjective and objective quality evaluation results, and a focused discussion of possible IPR issues, MPEG passed a resolution calling for the creation of a new project (Video Coding for Browsers, or VCB), with the aim of producing a final DIS document (FDIS) by July 2014. (MPEG output document w13648).

At the meeting of the US National Body of MPEG in October 013, the USNB passed a resolution supporting this work, and expressing a preference for "options that maintain a native VP8 mode" - that is, no incompatible changes.

#### 4. Deployment status

The VP8 codec has been extensively deployed in production services:

- o Skype (now part of Microsoft) used the codec extensively in its video conferencing software.
- o Google Hangouts is now fully converted to using VP8 on the various PC platforms. This platform now offers free videoconferencing in HD quality to everyone.
- o Google Remote Desktop uses VP8.
- o Google Chromecast uses VP8, showing what can be achieved with hardware decoding support.
- o Both the Firefox and Chrome WebRTC implementations use VP8 exclusively.

#### 5. Image quality evaluations

##### 5.1. Objective evaluations

In tests carried out by Google on a set of ten sample video clips containing typical video-conference content, VP8 outperformed the x264 H.264 codec running the constrained baseline profile by on average 37.2%. That is, at the same quality, measured by PSNR, VP8 produced 37.2% fewer bits on average than H.264. VP8 outperformed H.264 on all ten of the test clips by between 19% and 64%. Both codecs were configured in one-pass mode using settings conducive to real-time operation, and the ten clips varied in size between 640x360 pixels and 1280x720 pixels.

The software and the clips are available via the WEBM project's GIT repository:

[http://git.chromium.org/gitweb/?p=webm/vpx\\_codec\\_comparison.git](http://git.chromium.org/gitweb/?p=webm/vpx_codec_comparison.git)

Note: Tests run by Ericsson have demonstrated that it is possible to reduce the VP8 performance to be very close to that of baseline by running in "fixed QP" mode - selecting a single QP value in order to achieve a given bitrate. We believe this VP8 mode is an unrealistic mode for production use, and not what we should be evaluating.

## 5.2. Subjective evaluations

As part of the process of submitting VP8 for evaluation in ISO/IEC JTC1 SC29 WG11 (MPEG), the VP8 codec has been subjected to subjective and objective quality evaluations; the input reports are in WG11 documents N13775 (Vienna, MPEG 105 meeting, subjective numbers for VP8 performed by Vittorio Baroncini), M29364 (Incheon, subjective comparison between VP8 and IVC) and M28182 (Geneva, MPEG 103 meeting), respectively.

These tests were performed at the laboratories of Vittorio Baroncini, who is also a chair of the Testing subgroup of MPEG, and has performed many of the subjective tests done as part of the HEVC effort.

Together with the tests presented in document M29364, we also asked Vittorio Baroncini to do a subjective evaluation of VP8 compared to the AVC Baseline; the results of this evaluation are given in a separate presentation.

In all these cases, VP8 performed adequately in subjective evaluations; the numbers can be interpreted as showing that VP8 in "realtime" mode performed better than the "anchors" on both tests, but due to the amount of discussion occurring in the meetings about whether the precise parameters chosen for the tests made it a "fair" comparison, we will not state flatly that VP8 performed better than the anchors (AVC Baseline and AVC High Profile, respectively), but we will state flatly that there is no evidence that the anchors performed significantly better than VP8.

## 6. Performance evaluation

### 6.1. Software

The current reference implementation is libvpx, developed in the WebM project.

The encoding speed in software depends on the quality setting. On a stock PC platform using an Intel Xeon CPU at 2.67 GHz, in a test

using extremely difficult 720p material and encoding at a target data rate of 2 Mbit/sec, VP8's encoding speed varied from 48.4 fps (at the setting used in WebRTC today) to 96.2 fps (at the fastest setting), using a single thread. This variation in encode speed is achieved by changing the configuration of VP8 encoding tools in a deterministic way to trade-off encoding speed with output quality.

On a stock PC platform using an Intel Xeon CPU with 8 cores at 2.27GHz, tests using difficult 720p material encoded at 2 Mbit/sec show that using a single thread VP8 can decode at 200.50 fps (in comparison H.264, baseline profile, achieves 107.95 fps), using four threads VP8 decodes at 519.96 fps (H.264 achieves 363.73 fps), and using sixteen threads VP8 decodes at 1,076.49 fps (H.264 achieves 807.11 fps).

## 6.2. Hardware support

NOTE: This section contains mostly information that was valid as of October 2012. It will be updated.

As of October 2012, Google has licensed VP8 hardware accelerators to over 50 chip manufacturers, and VP8 hardware IP cores have also been made available by Imagination Technologies, Verisilicon and Chips & Media. Furthermore, Google is aware of several 3rd party implementations of VP8 decoders and encoders from the world's leading semiconductor companies.

As of October 2012, more than a dozen chip manufacturers had announced chips with 1080p VP8 support, including Samsung (Exynos 5), NVIDIA (Tegra 3, Tegra 4), Marvell (Armada 1500), Broadcom (BCM28150), Texas Instruments (OMAP54xx), Freescale (i.MX 6), ST-Ericsson (NovaThor L9540), LG Electronics, Hisilicon (K3v2), Rockchip (RK2918, RK3066), Nufont (NS115), Ziilabs (ZMS40) and Allwinner (A10). Google estimates that a clear majority of leading mobile chipsets in 2013 will contain VP8 hardware support. (Nvidia Tegra4 info added after October 2012).

The encoder chip produced by Quanta has allowed OEMs to integrate hardware HD VP8 encoding into their video camera hardware; this chip is available now. More suppliers have such a chip coming.

The ChromeCast device, which is selling in significant numbers in the US, has VP8 hardware decode.

## 6.3. Hardware performance

Several of the aforementioned hardware implementations are based on the WebM video hardware designs described at

<http://www.webmproject.org/hardware/>. Performance figures include:

- o Decode of 1080p video at 30 fps at less than 100 MHz clock frequency
- o Decoding more than ten simultaneous SD video streams on a single chip
- o Less than 25 milliwatts of power for 1080p decoding
- o Encoding 1080p video at 30 fps at less than 220 MHz clock frequency
- o Less than 80 milliwatts of power for HD video encoding

Based on the Hantro G1 multiformat decoder implementation, the VP8 hardware decoder is 45% smaller in silicon area than the H.264 High Profile decoder. VP8 also requires 18% less DRAM bandwidth than H.264 as it does not use bidirectional inter prediction, allowing significant reductions in the overall decoding system power consumption.

## 7. IPR status

The IETF has a long tradition of preferring non-encumbered IPR whenever possible, and especially to avoid IPR where using the technology requires making agreements with and payments to third parties as part of the cost of doing business. Among the reasons for this tradition is that the requirement for IPR agreements severely distorts the competitive landscape, and especially that it seriously hampers people attempting to implement standards in open source, or other business models where counting the number of installations or users is difficult, expensive or simply impossible.

As of this moment (October 4, 2013), the following IPR disclosures are filed in the IETF IPR database:

- o <https://datatracker.ietf.org/ipr/1571/> - by Google, declaring that the technology is royalty-free.
- o <https://datatracker.ietf.org/ipr/2035/> - by Nokia, which does not declare a royalty-free license.

The licensing terms for Google's IPR are available at <http://www.webmproject.org/license/additional/>.

The Nokia IPR mentioned above includes IPR that has been asserted in

ongoing litigation in Germany (Nokia v. HTC, District Court in Mannheim, Germany. 7 O 201/12); on one of the patents, the court has ruled that the phones in question (which support VP8) are not infringing. As mentioned in <http://blog.webmproject.org/2013/08/good-news-from-germany.html?m=0>; the case is still ongoing.

The following companies have asserted that any IPR relevant to VP8 they might have is available for licensing by Google under a royalty free license; the licensing terms are available at <http://www.webm-ccl.org/vp8/agreement/>, as well as details on the licensors:

- o CIF Licensing LLC
- o France Telecom
- o Fraunhofer-Gesellschaft zur Foerderung der angewandten Forschung e.V.
- o Fujitsu Limited
- o Koninklijke Philips Electronics N.V.
- o LG Electronics Inc.
- o Mitsubishi Electric Corporation
- o MPEG LA, LLC
- o NTT DOCOMO, INC
- o Panasonic Corporation
- o Samsung Electronics Co., Ltd.
- o Siemens Corporation

The license can be executed on-line from the link given above.

## 8. IANA Considerations

This document makes no request of IANA.

Note to RFC Editor: this section may be removed if this document is ever published as an RFC.



## 9. Security Considerations

Codec definitions do not in themselves comprise security risks, as long as there is no means of embedding active content in their datastream. VP8 does not contain such active content.

Codec implementations have frequently been the cause of security concerns. The reference implementation of VP8 has been extensively tested by Google security experts, and is believed to be free from exploitable vulnerabilities. There is a continuous program in place to ensure that any vulnerabilities identified are repaired as quickly as possible.

## 10. Acknowledgements

Several members of the Google VP8 team contributed to this memo.

In addition, we wish to thank the people from the X264 mailing list who came forward with suggested improvements in the codec settings for the objective performance evaluations, Bo Burmann who re-ran the tests entirely independently of Google, Mohammed Raad and Lazar Bivolarski who prepared the materials for the subjective evaluation tests and Vittorio Baronici who performed them, and all the countless members of the RTCWEB working group who have debated extensively the matter of mandatory to implement video codecs.

## 11. References

### 11.1. Normative References

- [I-D.ietf-payload-vp8]  
Westin, P., Lundin, H., Glover, M., Uberti, J., and F. Galligan, "RTP Payload Format for VP8 Video", draft-ietf-payload-vp8-09 (work in progress), July 2013.
- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.
- [RFC6386] Bankoski, J., Koleszar, J., Quillio, L., Salonen, J., Wilkins, P., and Y. Xu, "VP8 Data Format and Decoding Guide", RFC 6386, November 2011.

### 11.2. Informative References

- [I-D.ietf-rtcweb-overview]  
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