DEPLOYING AV1 FOR LIVE BROADCAST, SPORTS, AND RTC STREAMING

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MEDIA & ENTERTAINMENT

Cloud, Network, Hyperscale & Supercomputing

5G & Comms Infrastructure

AI & Analytics Everywhere

Adaptable Intelligent Systems

Gaming, Simulation and Visualization

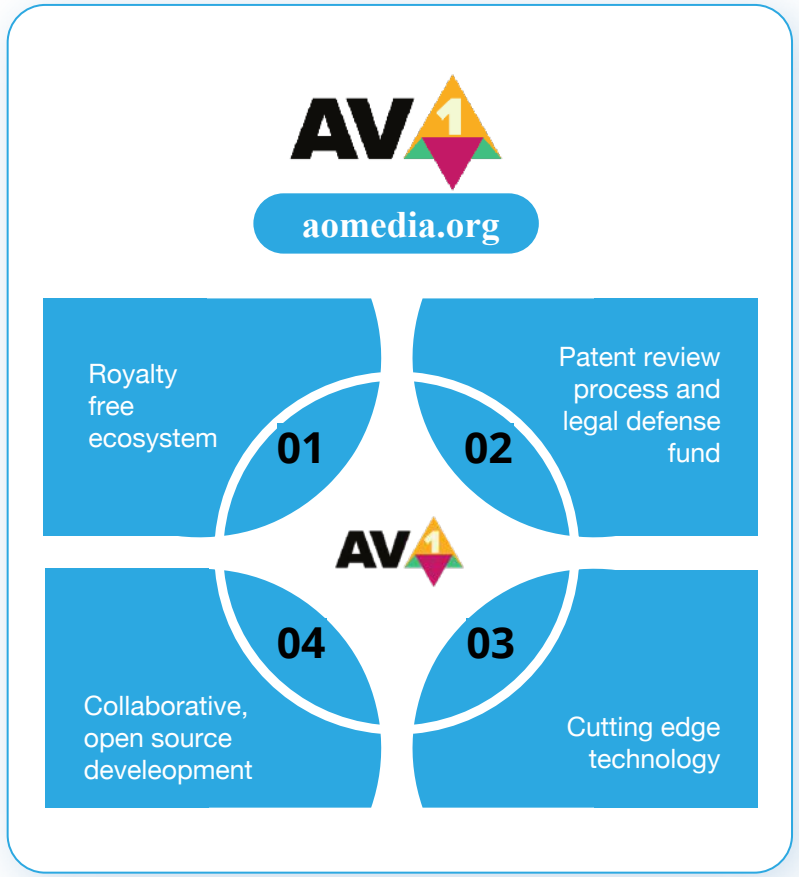
Smarter Client Devices & Edge

AT THE CENTER OF TODAY'S WORLD


AMD
+
Visionular

AOM/AV1 - The Journey & Mission

- AV1 is the first video codec from AOM
- **Zero** version of AV1: VP9 (libvpx)
- Tools proposed from:
  - VP10 (Google)
  - Daala (Mozilla)
  - Thor (Cisco)
  - 100+ new tools
- Finalized in June 2018



AOM/AV1 - SW & HW Decoder Ecosystem is Growing

HARDWARE

CPUs, GPUs, & SoCs

MEDIATEK
SAMSUNG
BROADCOM
AMD
Amlogic
intel
REALTEK
NVIDIA

Mobile Phones

oppo
SAMSUNG
vivo
LG Mobile
mi

TVs & Streaming Devices

SAMSUNG
Roku
ZTE
LG
Google
SONY
TCL
TOSHIBA
INSIGNIA

SOFTWARE

Open Source Decoders

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AOM Supported

dav1d

VideoLAN

FFmpeg

SVT-AV1

intel

NETFLIX

libgav1

chrome

Apps & Platforms

Windows 10

chrome

VLC media player

Firefox

FFMPEG

Microsoft Edge

Opera

AV1 Streaming Protocols & Formats

Common Media Application Format (CMAF)

https://aomediacodec.github.io/av1-isobmff/

CMAF AV1 track format specification

DASH

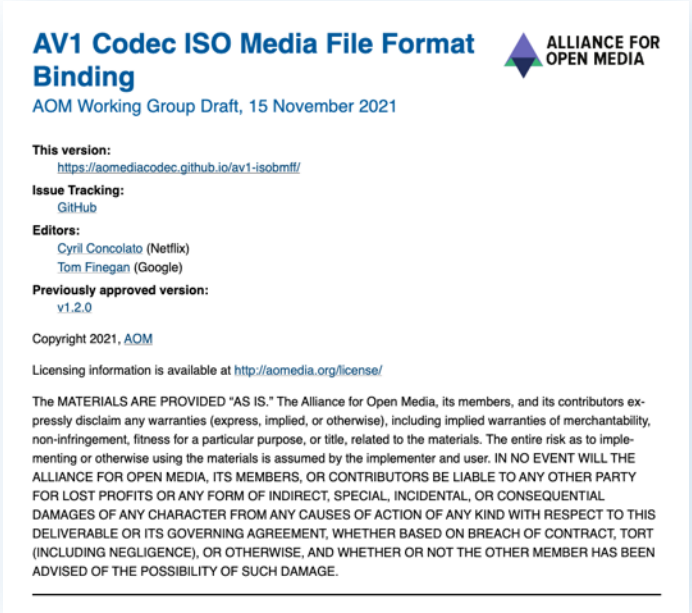
Segments may contain media data

Audio/video codec agnostic

http://wiki.webmproject.org/adaptive-streaming/instructions-to-playback-adaptive-webm-using-dash

AV1 DRM Support

CMAF/DASH DRM, e.g. Widevine DRM



AV1 Codec ISO Media File Format Binding

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AOM Working Group Draft, 15 November 2021

This version:
https://aomediacodec.github.io/av1-isobmff/

Issue Tracking:
GitHub

Editors:
Cyril Concolato (Netflix)
Tom Finegan (Google)

Previously approved version:
v1.2.0

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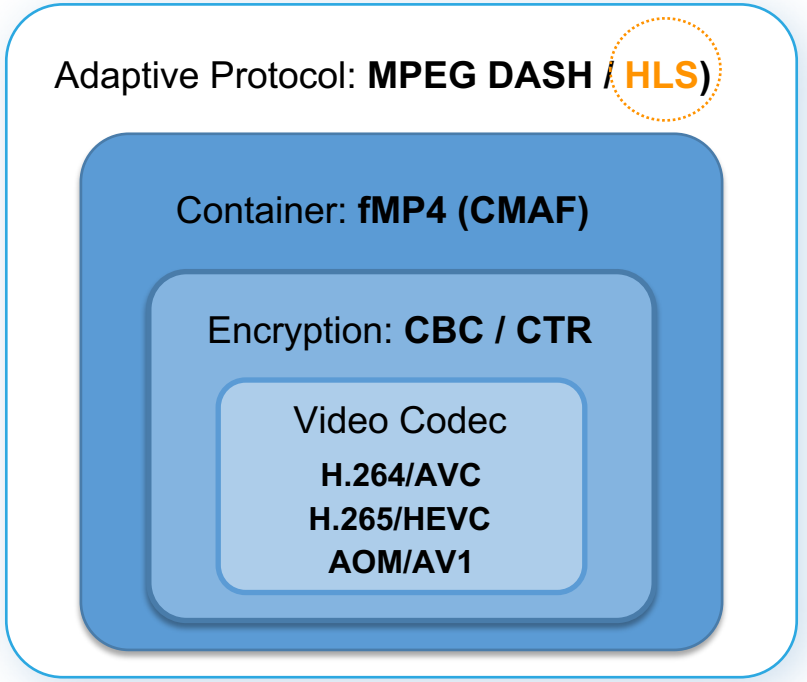


Input Format Support

1. Support for 10,12, and 16-bit color
2. Chroma subsampling 420, 422, and 444 are all supported

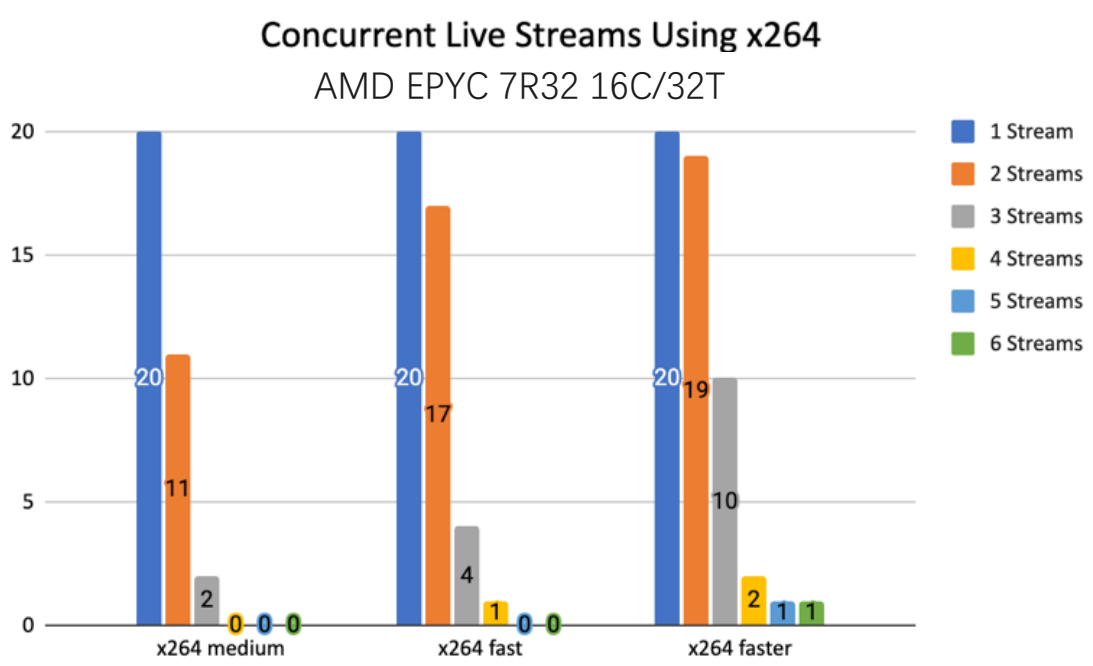
Metadata Handling

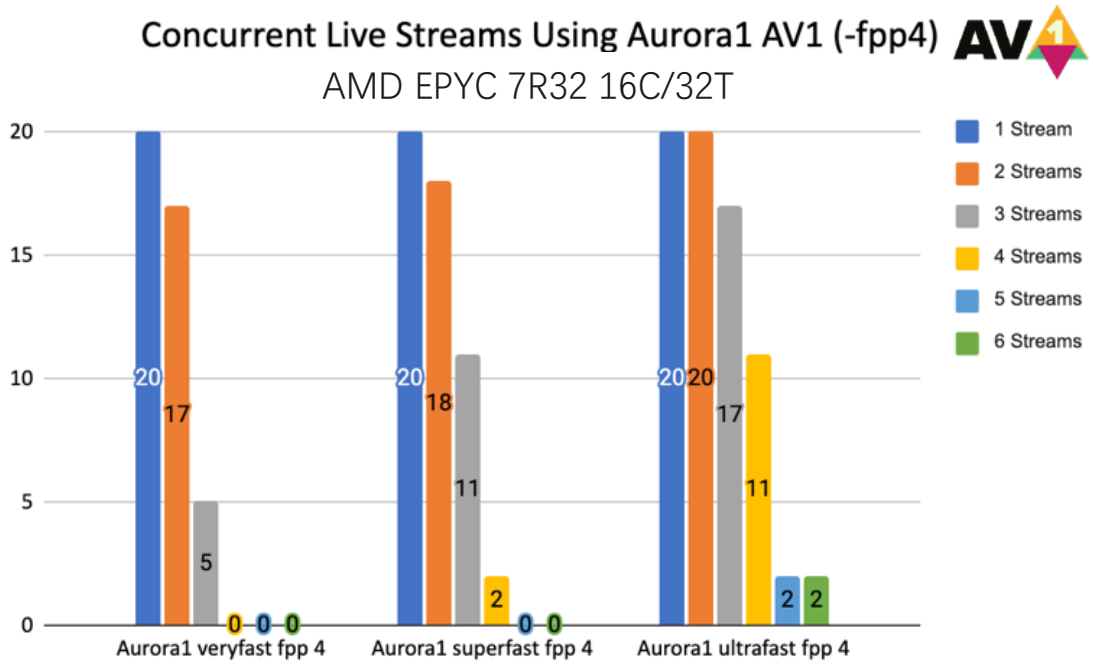
1. HDR10: OBUs for Max Content Light Level, Max Frame Average Light Level, and Mastering Display Color Volume.
2. HDR10+: T35
3. Flexibility for metadata insertion
   - Allows per-frame insertion, or keyframe only, or upon metadata change

Color Description

1. Can specify color primaries, transfer characteristics, and color conversion matrix coefficients
   - Specified in the sequence header (General sequence header OBU syntax)

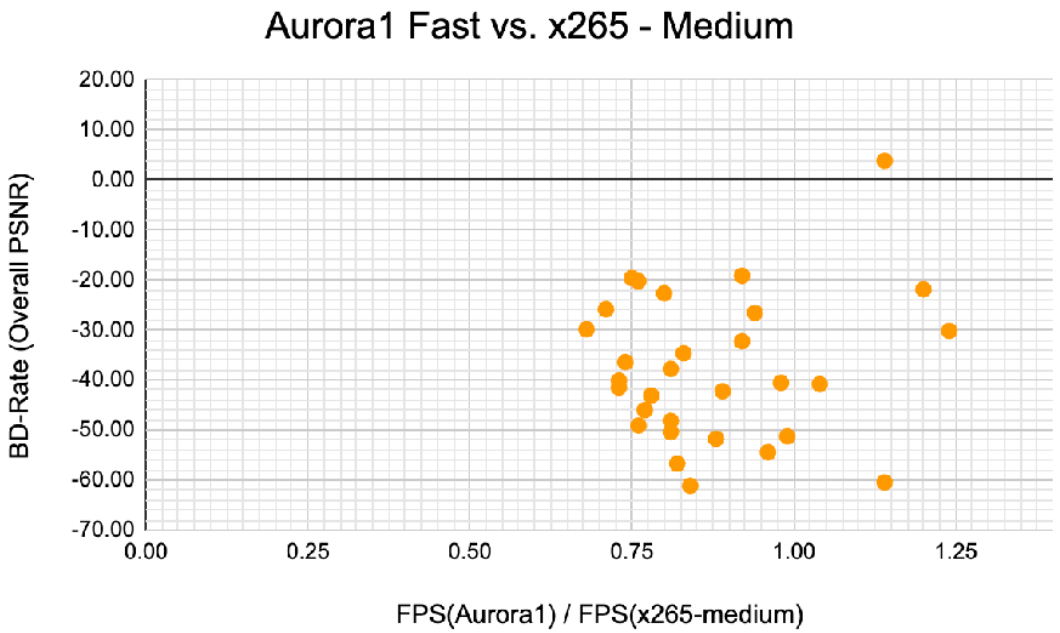
AV1 vs. H.264 - Aurora1 compared to x264





Aurora1 AV1 vs x264 BD-rate	Overall PSNR	PSNR-Y	SSIM-AVG	SSIM-Y	VMAF
x264 medium vs Aurora veryfast fpp4	-40.94	-42.54	-46.63	-46.85	-42.51
x264 medium vs Aurora superfast fpp4	-39.16	-41.22	-45.08	-45.74	-36.87
x264 medium vs Aurora ultrafast fpp4	-25.18	-28.34	-31.55	-32.49	-22.92

AV1 vs. HEVC - Aurora1 compared to x265

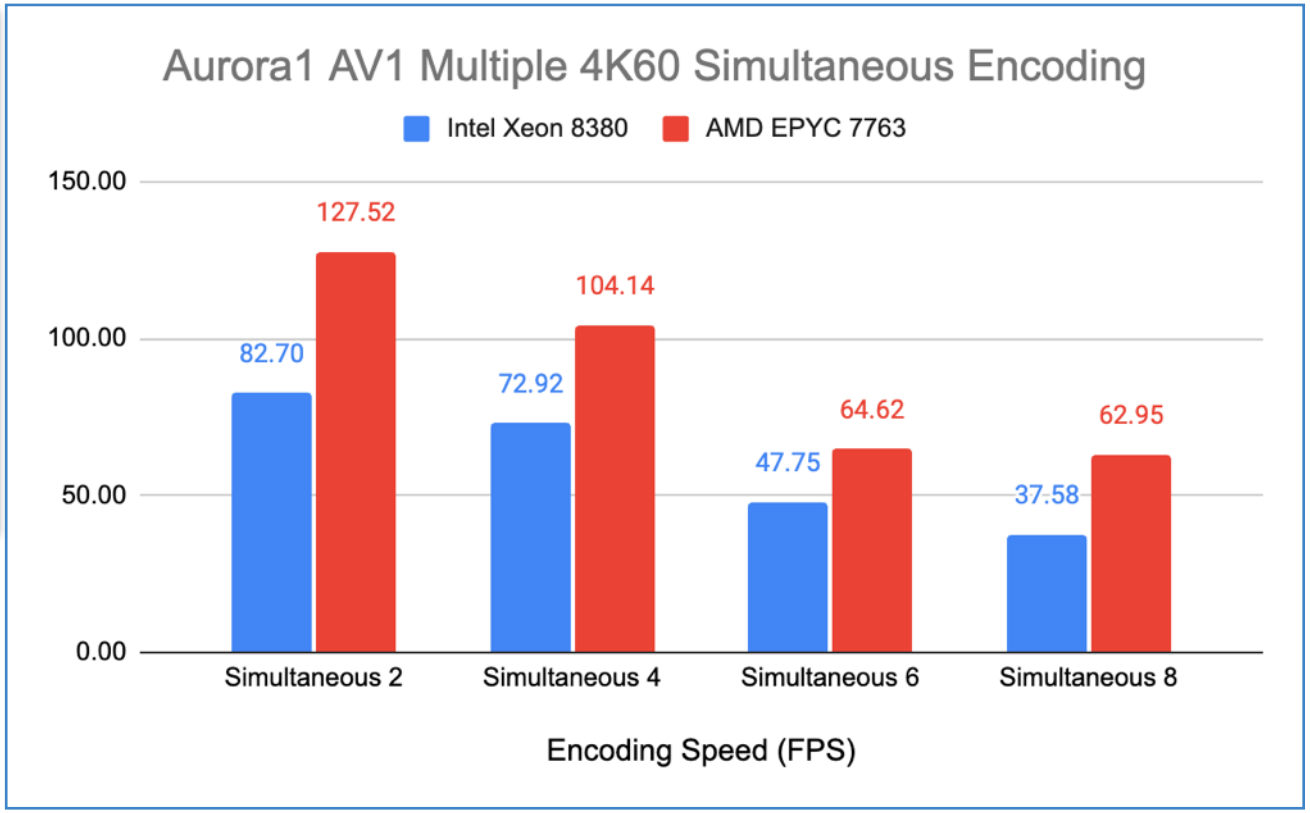


BD-rate (%)Overall PSNR	BD-rate (%)PSNR	BD-rate (%)SSIM	BD-rate (%)VMAF	FPS(Aurora1) / FPS(x265)
-37.69	-36.67	-38.18	-35.50	0.88

- Aurora1 Fast vs x265 medium: Over the AOM standard test set (object-1-fast, also a longer version for SIWG CTC) containing 30 videos of various resolutions - 16 1080p, 7 720p, and 7 360p, mainly 60fps, qualities, content types, and visual characteristics.
- Encoders operated on AMD Ryzen 9 3900X 12-Core Processor 12C24T.
- Aurora1 Fast on averages achieves a BD-rate gain of **37.69% in Overall PSNR**, **36.67% in Average PSNR**, **38.18% in SSIM**, and **35.50% in VMAF**, and meanwhile,
- Aurora1 Fast runs at 88% of the speed of x265-medium.

Aurora1 AV1 on EPYC 7763 & Intel 8380

Encoding Speed (FPS)	Simultaneous 2	Simultaneous 4	Simultaneous 6	Simultaneous 8
Intel Xeon 8380	82.70	72.92	47.75	37.58
AMD EPYC 7763	127.52	104.14	64.62	62.95
Speedup	54.20%	42.82%	35.34%	67.50%



Test Video	Resolution	Frame-Rate (fps)	Frames
crowd_run	3840x2160	50	500

Machine Learning For AV1 Encoding Optimization

100+ coding tools

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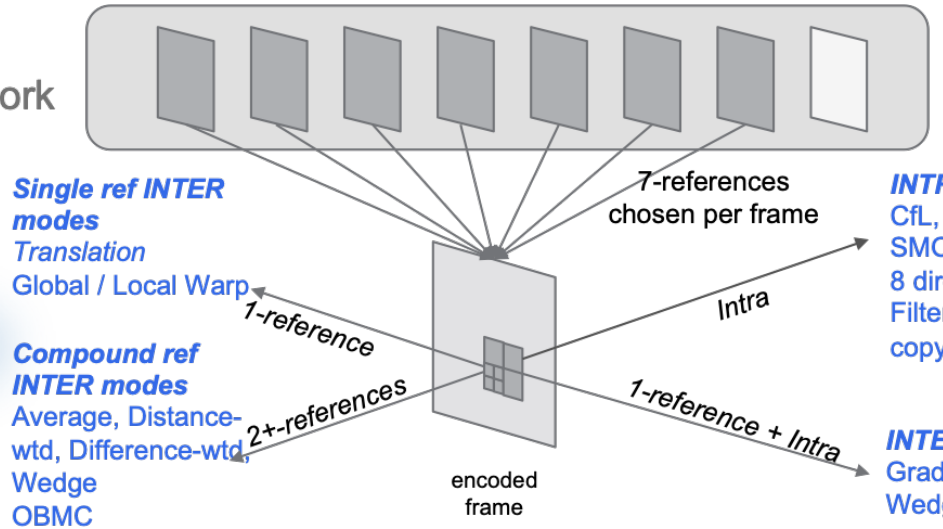
AOM Supported

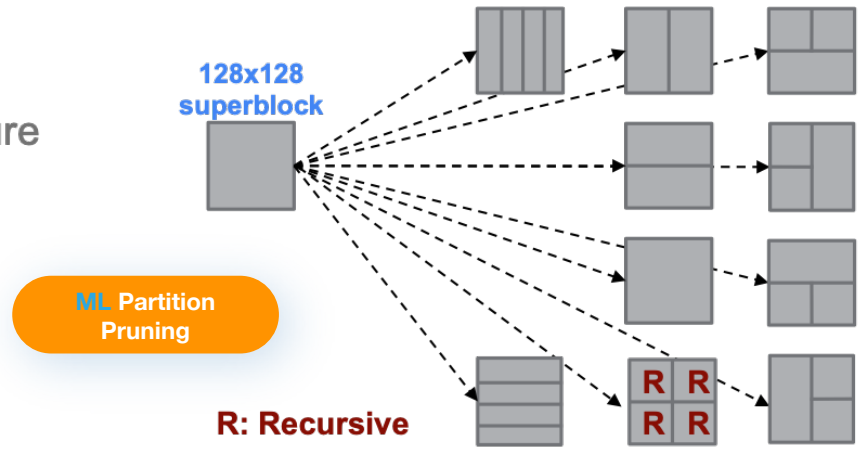
Prediction Framework



ML GOP Structure Selection

ML Mode Selection

Prediction Structure



ML Transform Size/Type Selection

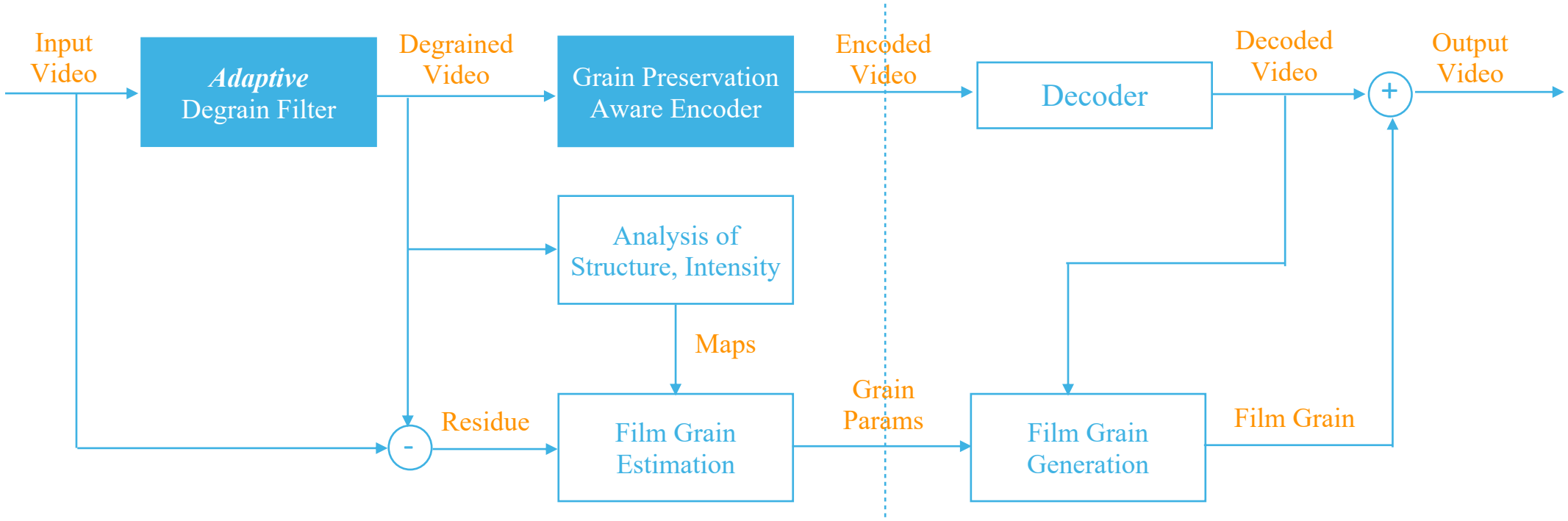
ML Partition Pruning

ML RD-Model Refinement

ML Restoration Filter Selection

Courtesy Dr. Debargha Mukherjee, Google Inc.

Aurora1 Film Grain – Synthesis + Grain Preservation



Temporal filter
Temporal Dependency Modeling (TPL)
Inter-/Intra prediction
Optimize_b
In-loop post-processing
Hierarchical GOP-structure

- Multi-frame smoothness detection
- Cascaded two-stage degraining
- Effective anti-banding encoding

ML for AV1 Film Grain - Aurora1 Dithering

AV1 Encoder Optimization - Decoder Complexity Aware

Case Study: VOD

- dav1d 0.7.1 FFmpeg
- Encoding a 1920x1080 60fps 30-sec long gaming video clip:
  - Target bitrate: 10Mbps
  - HW: Intel i5 cpu notebook
  - Player: Chrome as the player
  - Additional "bullet comments" special effects imposed, adding another layer of playback complexity.

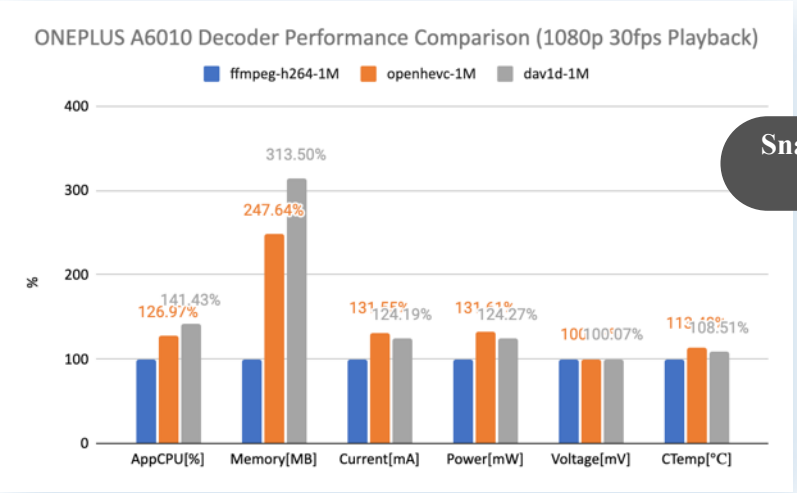
Overall PSNR	PSNR	SSIM	VMAF
4.84	4.96	5.21	-0.11

Encoder Algorithms	Decoding Speed (fps)	Decoding Speed vs.Source Frame Rate i.e. 60fps	Decoder Speedup (vs baseline)
BASE_CFG (baseline)	78	1.30x	-
Adaptive motion mode selection	88	1.46x	12.82%
Adaptive frame-level parallel setup	85	1.41x	8.97%
Adaptive loop filtering mode selection	89	1.48x	14.10%
Minimum partition size pruning	83	1.38x	6.41%
Adaptive GOP structure configuration	89	1.49x	14.10%
Overall	**134**	**2.24x**	**71.79%**

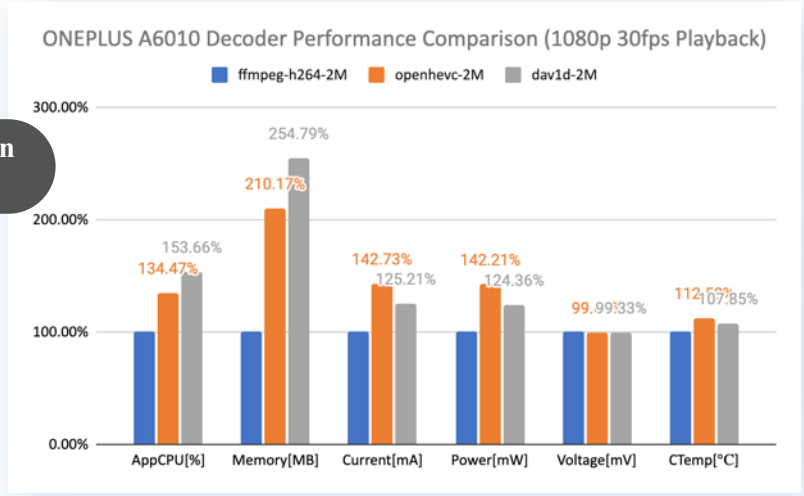
dav1d

VideoLAN

FFmpeg



Snapdragon 845



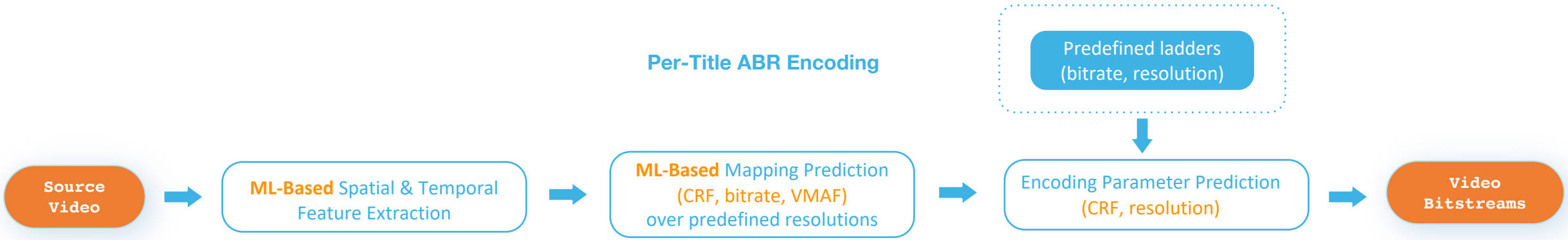
Aurora1 Multi-stream Output

- Aurora1 AV1 can deliver **Adaptive BitRate (ABR)** multi-bitstream encoding.
- **Single** AV1 encoder instance: Aurora1 is able to take one *single* source video input whereas output *multiple*, **GOP-aligned** encoded AV1 bitstreams of various (resolution, bitrate) renditions.
- Aurora1 AV1 is capable of fast **Per-Title** encoding leveraging the use of machine learning.

GOP-Aligned

Keyframe's position is synchronized across varying resolutions and bitrates settings.

- May output keyframe positions to a log file.
- May take an external log file to enforce keyframe positions.



Tools for RTC – Speed, Temporal Scalability, SCC

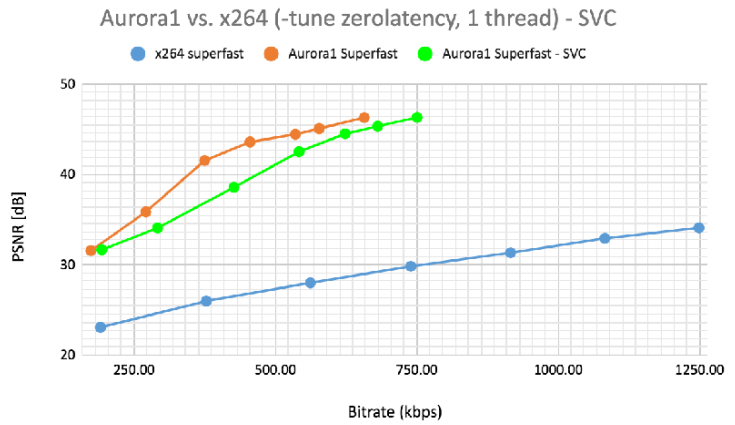
- **Source:** 1080p/30fps screen content
- **Test platform: AMD Ryzen 7**
- **CPU usage:** ~100% (configured with single thread)

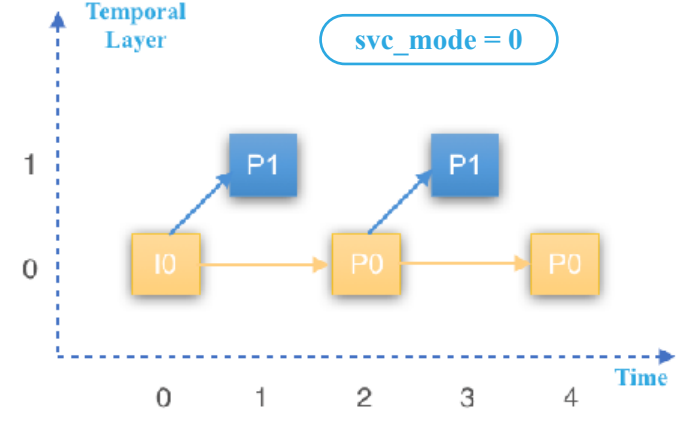
x264 commands

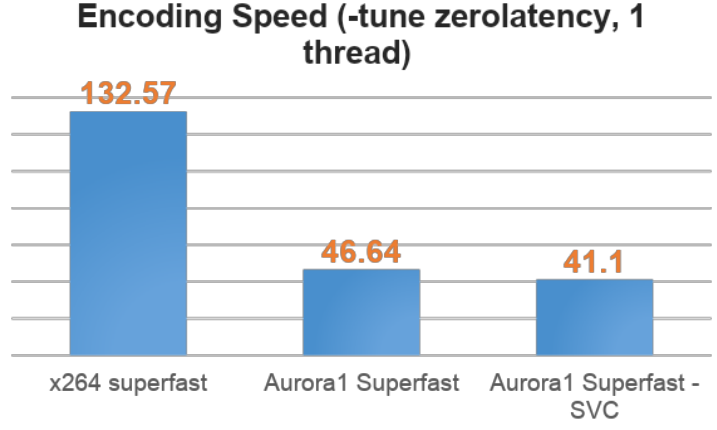
```
ffmpeg -threads 1 -r 30 -s 1920x1080 -c:v
libx264 -x264-params bframes=0 -tune
zerolatency -preset superfast -threads 1
```

***Aurora1* non-SVC**

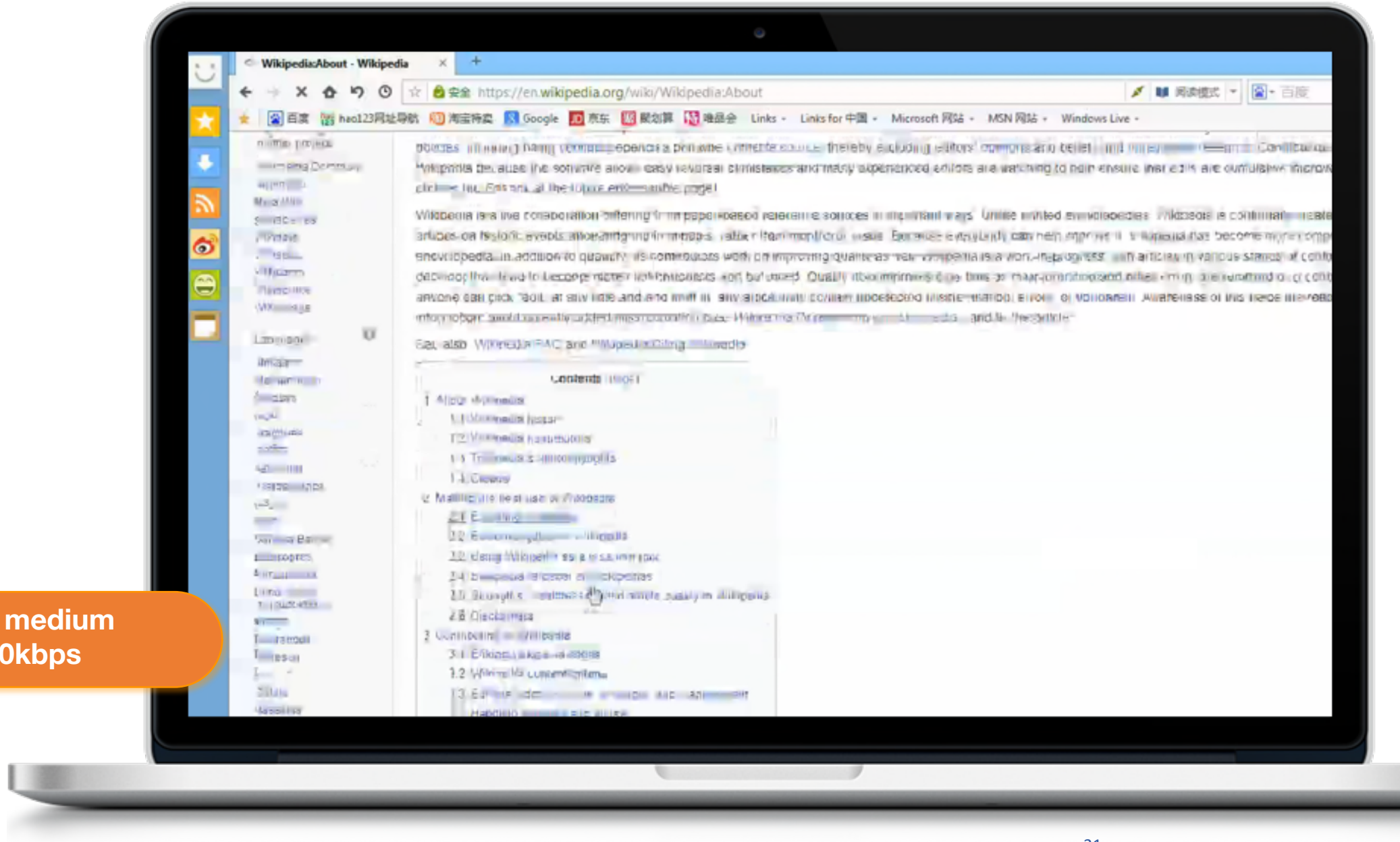
- BD-rate (PSNR): -81.25% BD-PSNR: 13.95dB
- Aurora1 runs at a speed of ~1/3 as that of x264





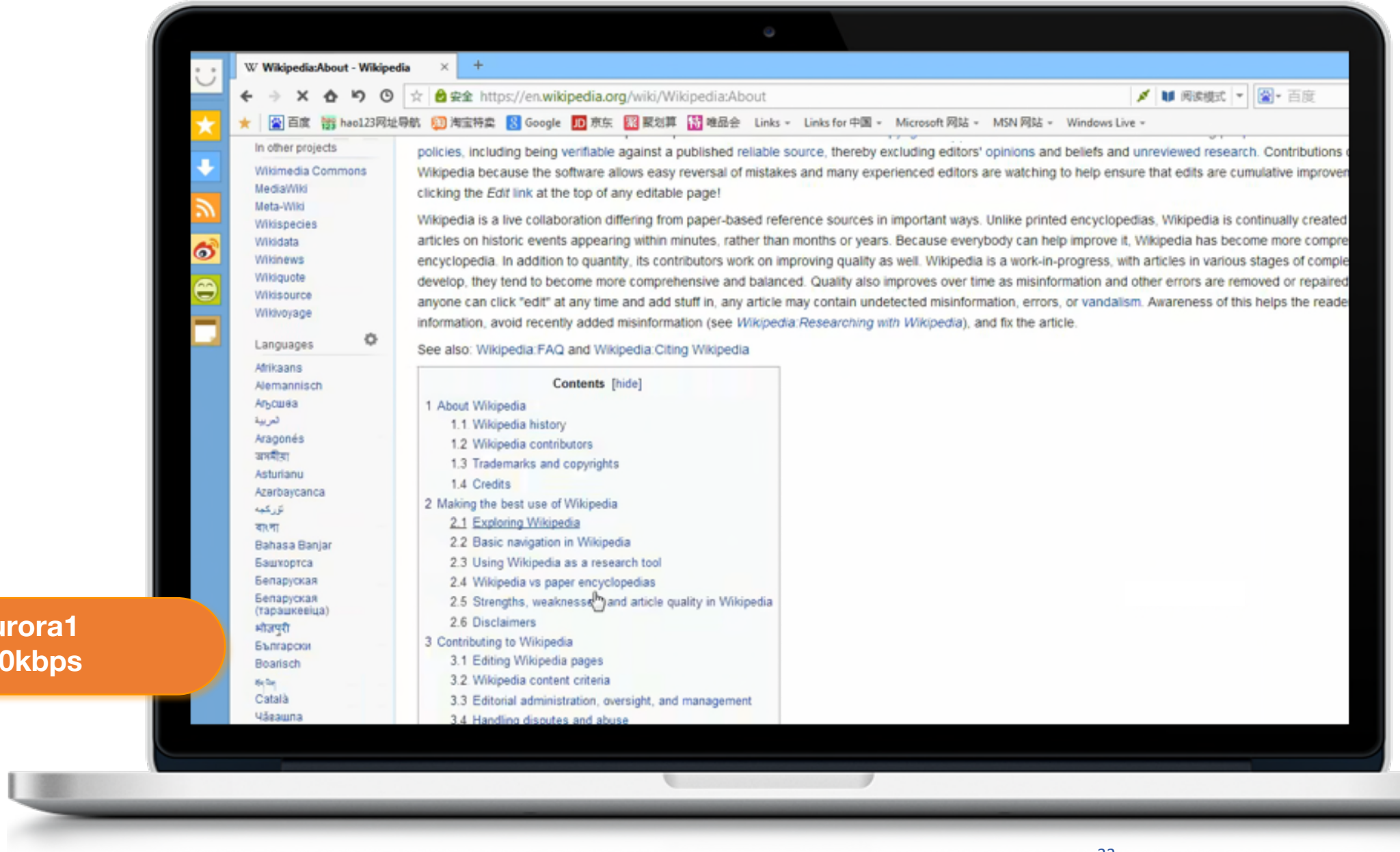


Screen Content Coding x264 example



x264 medium
800kbps

Screen Content Coding Aurora1 AV1 example



Aurora1
400kbps

THANK YOU!

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