New Codecs for 5G

Thierry Fautier (Harmonic)

Forewords

Forewords

VVC

EVC

LC-EVC

Audio subject skipped as easier to tackle

Video codec is an explosive topic, need time to soak into it

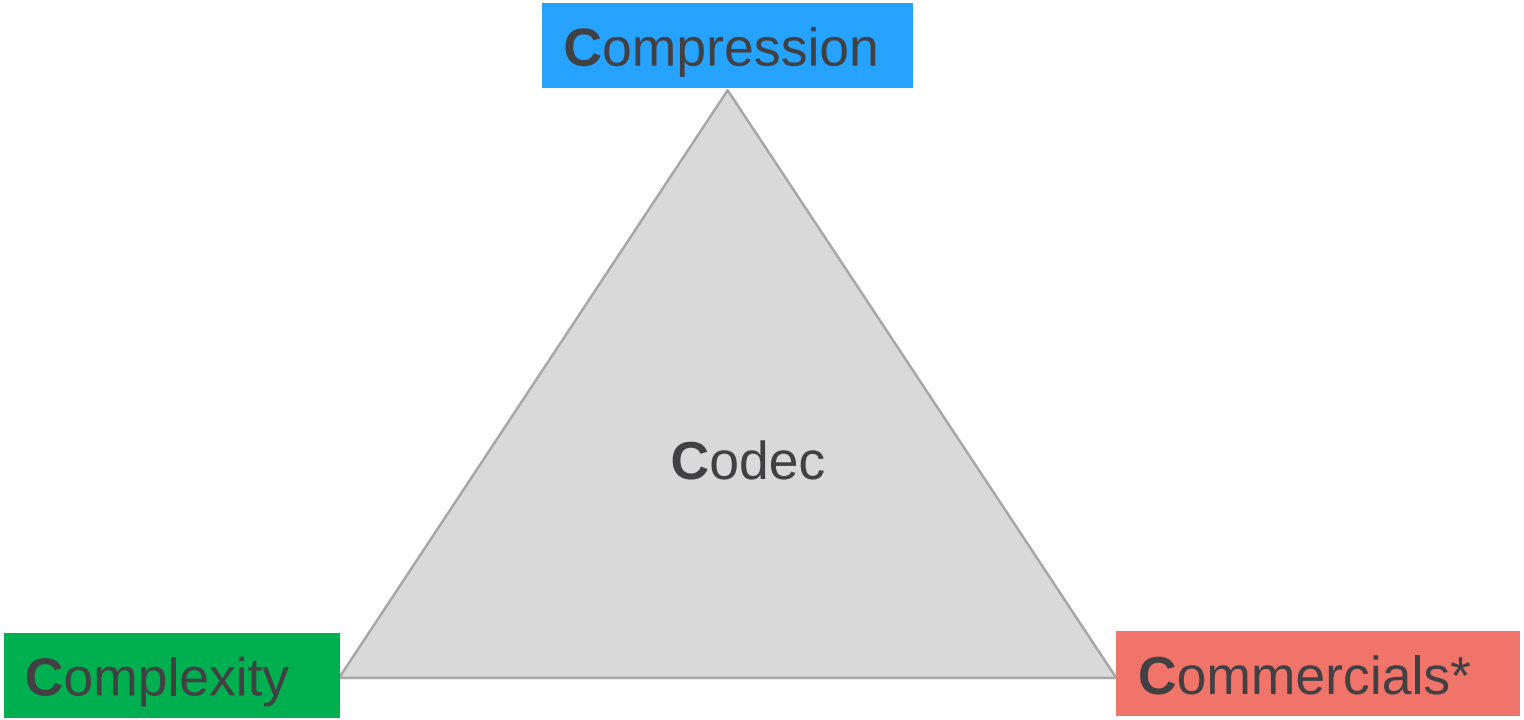
Presentation based on data

Codec can not be disassociated from the application

Information presented aimed at triggering discussions

Most thorough Mobile Video codec presentation done

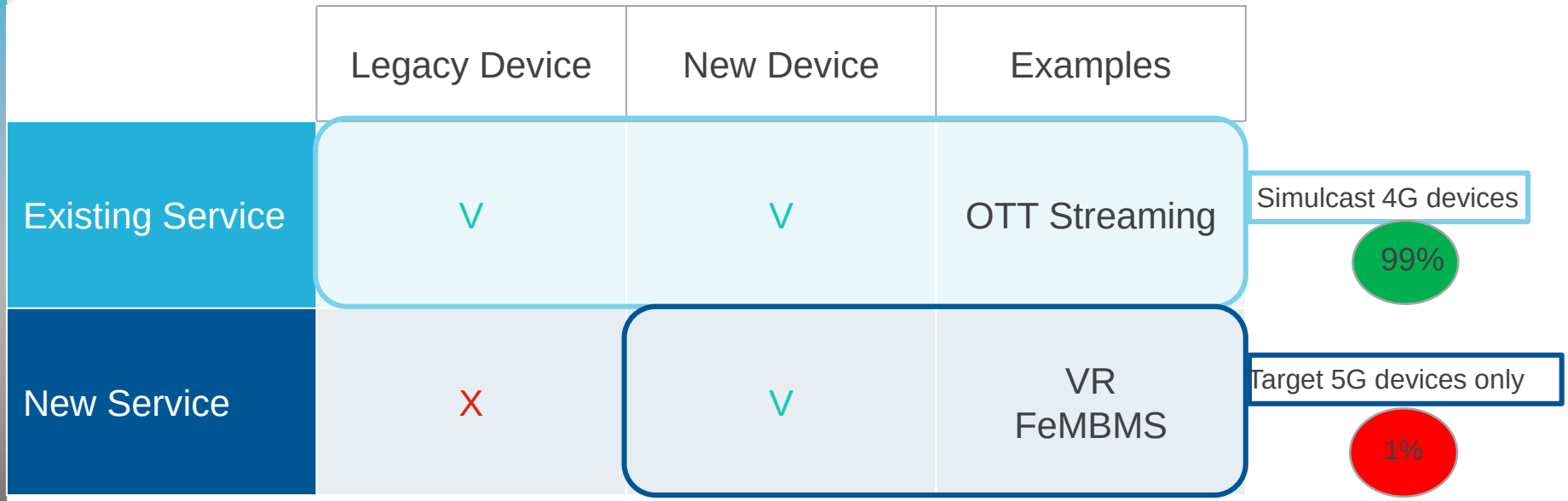
The 3 Cs of Codecs



Broadcast & Unicast have different dynamics

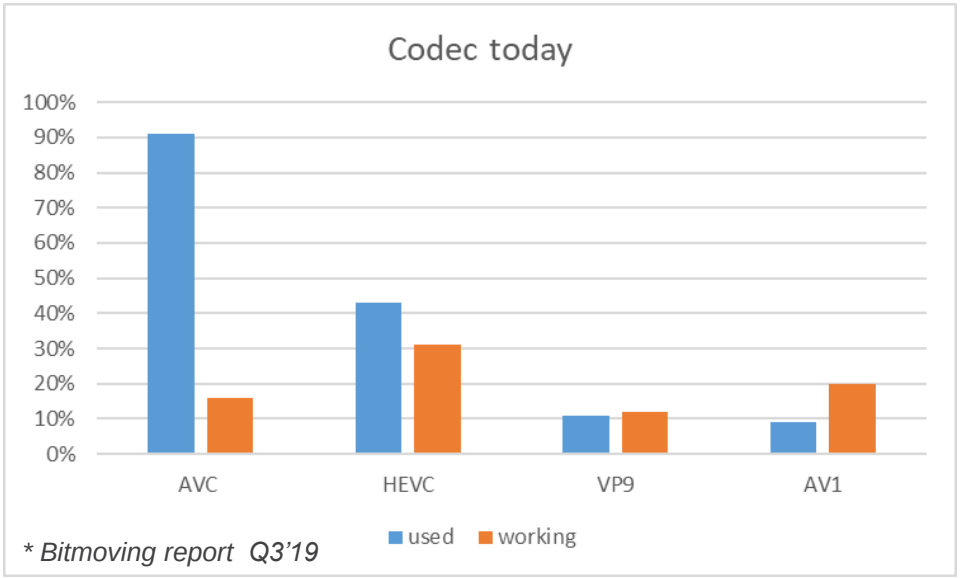
** Licensing*

New Codec Matrix



Next Gen codec impact highly depends on mix service /device

Where do we stand today?



H.264 MPEG-4/AVC	✓	✓	✓	✓	✓	✓
HEVC	✓	✗	✓	✗	✓	✓
VP9	✓	✓	✗	✓	✗	✓
AV1	✓	✓	✓	✓	✗	✓

AVC still dominates, HEVC heir, challenged on PC by AV1

Some Mobile Codecs Data Points

- Facts
  - Licensing: No streaming fees in HEVC from 3 PP (VELOS gives up streaming licenses, MC-IF sep'19 meeting)
  - Resolution:
    - In US Zero rating (unlimited video) is capped at 1.5M/s /SD AVC
    - On Mobile, SD/HD 50/50 today*
    - 360p judged "good quality" by 71% of users *
    - HW support : iOS (1080p), Android (1440p)+
    - Mobile consumption at max 1080p60 resolution for broadcast content today
    - 4K 15% of formats in 2020, 45% in 2025*
  - Bitrates: Higher bitrates only needed for XR (VR, AR, MR) (niche) & 4K (building up)
  - 8K: 8Kp60 HEVC can compress Sports down to 40M/s (IBC'19 public demos)
  - 4G: 4G NW can not support 1080p60 (8M/s AVC) at scale, economically*, so need either new codec or new NW
- If we want to transmit:
  - At scale 1080p60
  - New applications such as VR (15-25M/s)

  => Need 5G network, but

Do we need a new codec?

* source Openwave spring 19 +https://www.scientiamobile.com/growing-support-of-hevc-or-h-265-video-on-mobile-devices/

Popular Streaming Services

	Mobile	TV		Computer
Apple	HEVC	H.264 MPEG-4/AVC + HEVC	HEVC	H.264 MPEG-4/AVC + HEVC
Netflix	H.264 MPEG-4/AVC	H.264 MPEG-4/AVC	HEVC	H.264 MPEG-4/AVC
prime video	H.264 MPEG-4/AVC	H.264 MPEG-4/AVC	HEVC	H.264 MPEG-4/AVC
AT&T tv NOW	H.264 MPEG-4/AVC	H.264 MPEG-4/AVC		H.264 MPEG-4/AVC

AVC still dominates, HEVC only Apple

5G Devices Codec Support

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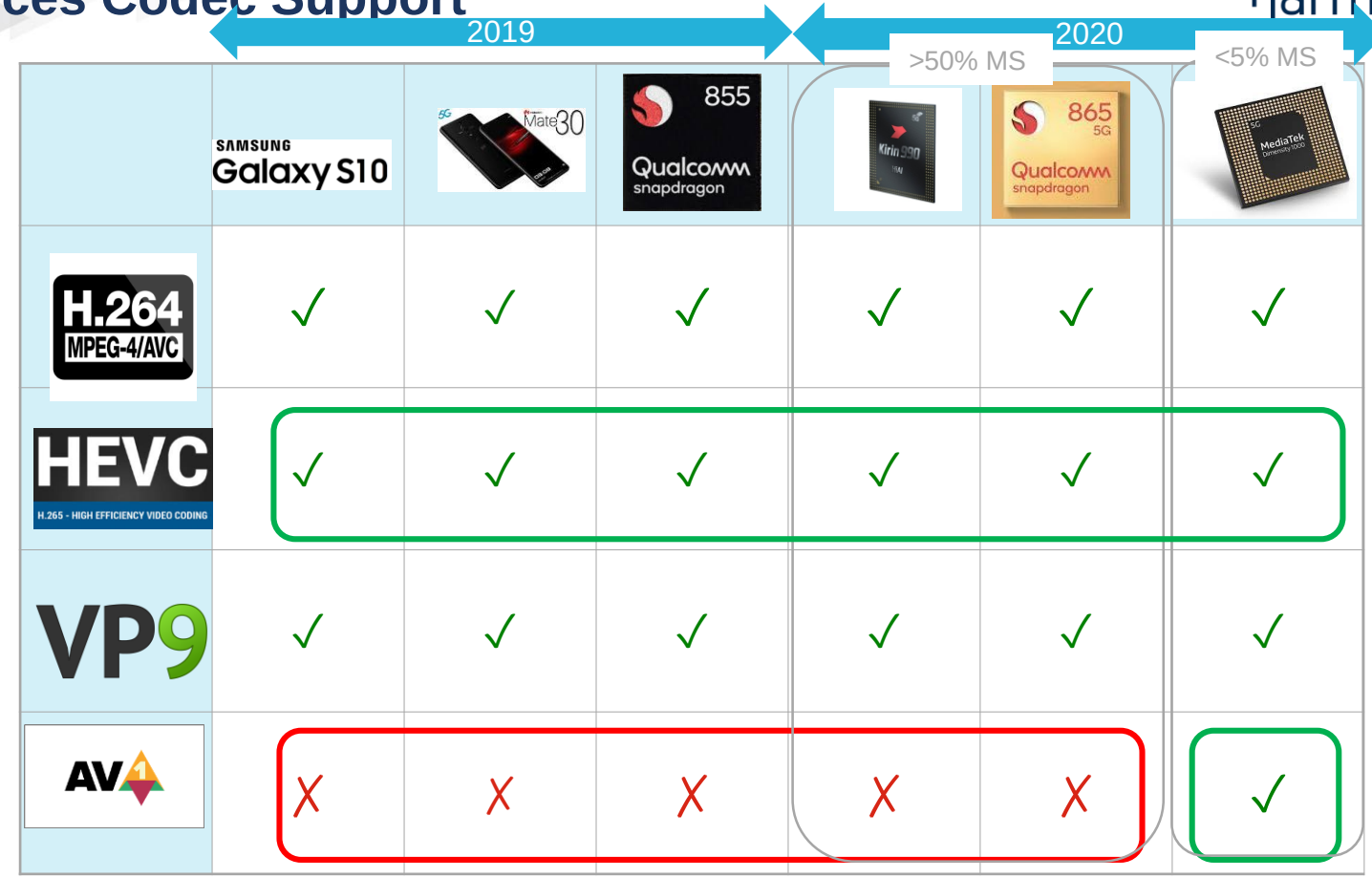
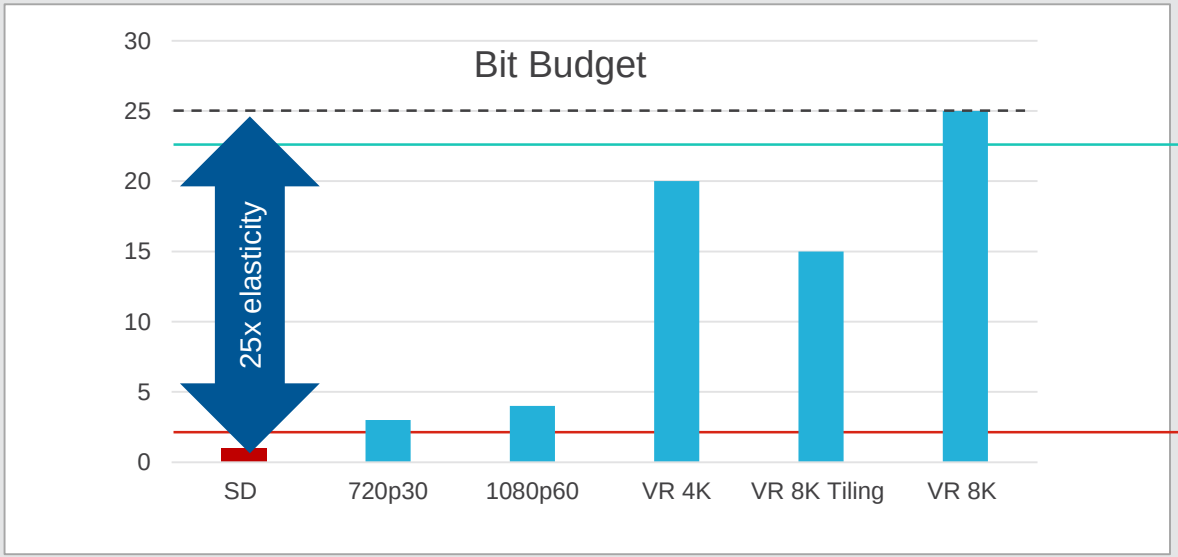


AVC/HEVC/VP9 dominate , AV1 just starting with niche player

Bit Budget for Mobile

5G link to exceed 100M/s /user at scale



HEVC

AVC

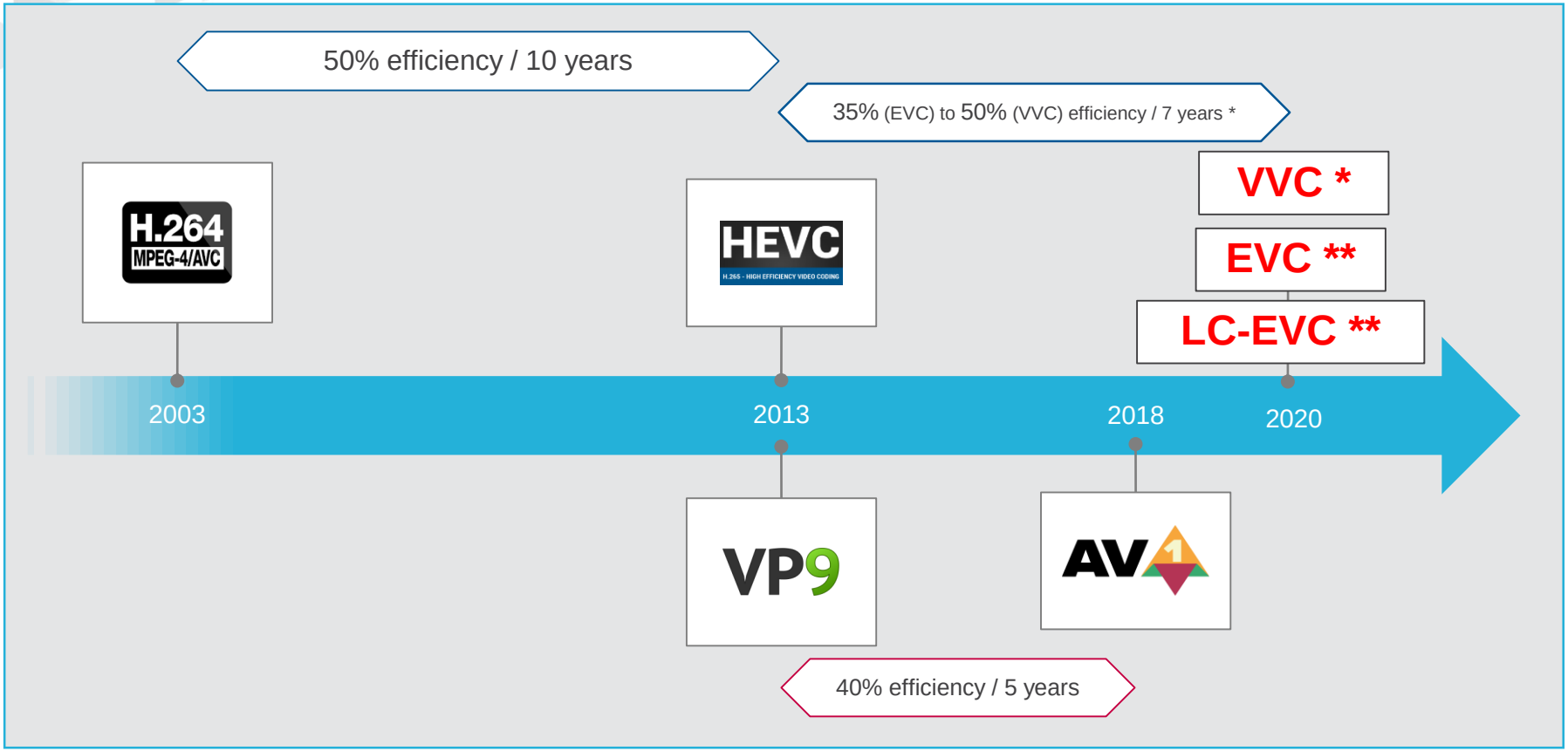
*US 4G DL ☺

My Airport test ☹

** Opensignal Q1'19*

5G technology needed if we keep HEVC codec

Codec Roadmap



*Pending – Joint MPEG/ITU-T standardization in progress

**Pending –MPEG standardization in progress

Video Codecs Standards Landscape

Standard	SDO	Release	Proponents	Silicon	Volume
AV1	AOM	July'18	Google, Amazon, Cisco, Intel, Microsoft, Mozilla and Netflix	Sep'19	'21
VVC	ITU/ISO	July'20	HHI, Qualcomm, Huawei, MediaTek, Samsung, Tencent, InterDigital, Nokia, Bytedance, Sharp, Broadcom, Ericsson	'22	'23
EVC	ISO	April'20	Samsung, Huawei, Qualcomm, Tencent and Divideon	'22	'23
LC-EVC	ISO	Oct'20	V-Nova	Now	'21

More than we can chew

Qualitative Codecs Overview

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Past | 2019 | 2020

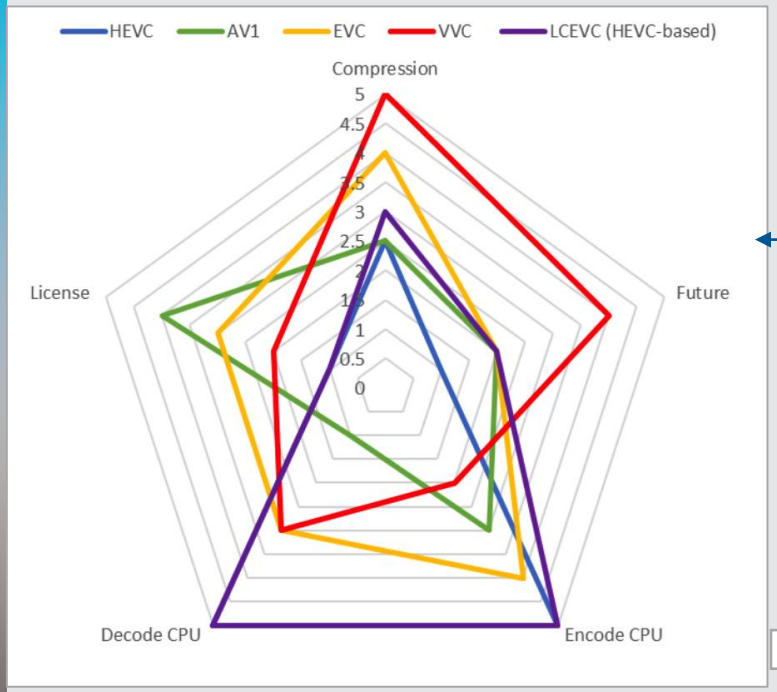
Technology	H.264 MPEG-4/AVC	HEVC High Effecieny Video Coding	VP9	AV1	EVC	VVC
Licensing	Decoder Stream based (low cap)	Decoder Stream based (high cap)	Royalty free	Royalty free*	Royalty controlled	Royalty under profile control**
Mobile Scope	Yes	Yes	Yes	Yes	Yes	Yes
Deployed	Massively	Limited	YouTube	Web	NA	NA
Deployed clients	> 20B	>2B	PC, cTV, Mobile	PC only	NA	NA

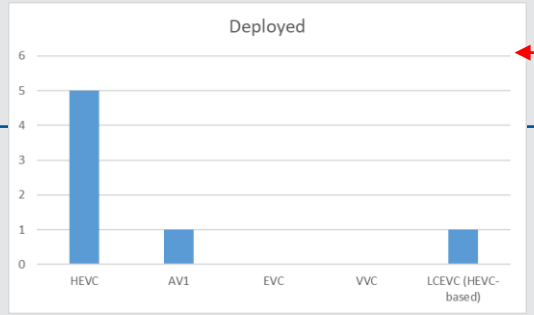
**Sysvel challenging*

***MC-IF*

EVC Support of Qualcomm, Huawei, Samsung (>50% MS) gives a strong position in Mobile

Quantitative Codecs Overview*





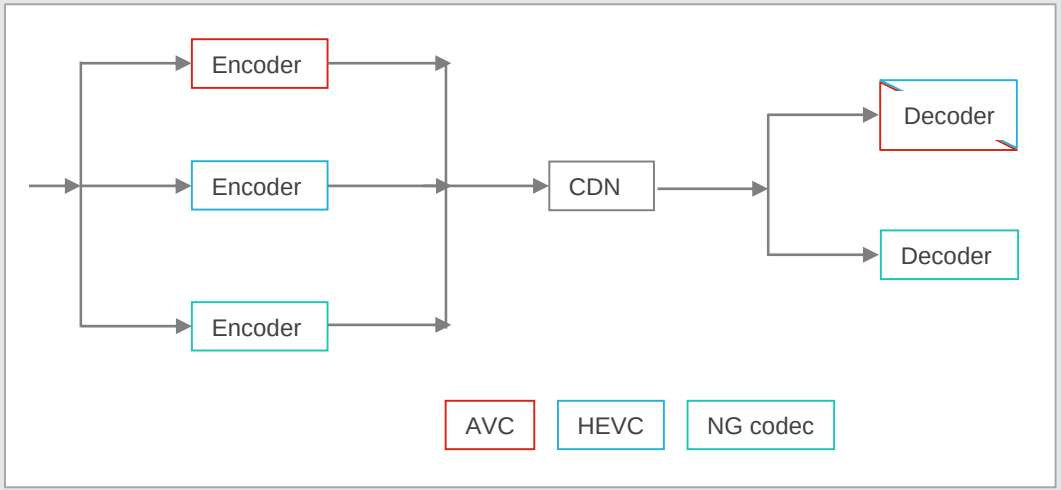
Feature	Weight
Deployed devices	4
Compression	4
Future	2
Encode CPU	1
Decode CPU	3
License	4

HEVC	AV1	EVC	VVC	LCEVC (HEVC)
62.2	44.4	50.0	52.2	48.9

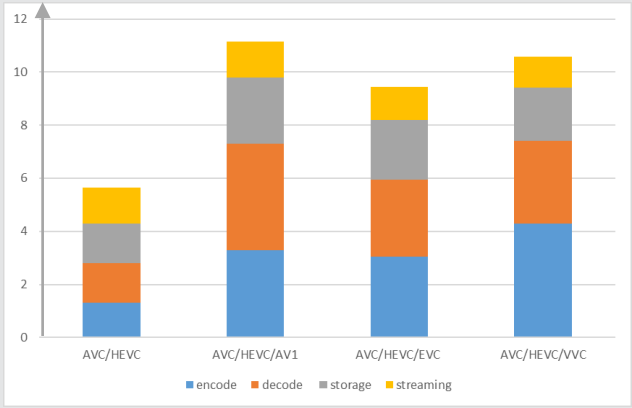
** Details available in Annex*

HEVC dominates (installed base effect)

Multi Codec World: HD Scenario*



Normalized cost



	Cost delta
AVC/HEVC	N/A
AVC/HEVC/AV1	98%
AVC/HEVC/EVC	68%
AVC/HEVC/VVC	88%

** LCEVC data not available*

Multi codec world has a 68-100% cost impact vs today

3GPP Requirement for 5G

- Until now in 3GPP: AVC mandatory, HEVC optional
- 5G Media Streaming
  - TS 26.511 defines the new codecs, Final version in H1’20.
  - Candidates:
    - AVC: legacy
    - HEVC: natural candidate as already deployed in ALL 5G terminals
    - AV1: no supporters (poor technical performance)
    - VVC: mainstream next gen codec (licensing unclear)
    - EVC: alternative option (licensing clearer)
    - LCEVC: could be considered if VVC can not fly

Codec selection beyond HEVC will take time, VVC favored

Conclusion for 5G Mobile

Next gen codec for 5G, beyond HEVC, only motivated by Immersive & 4K apps

HEVC does a decent job* for mainstream apps, legacy effect on 5G terminals

HEVC (‘20-’22), AV1 insignificant, EVC challenger in ‘23, VVC immersive ‘TDB

Multi codec world represents 68-98% cost increase vs today, biz model anyone?

Too early to decide, need more clarity on licensing terms

Next gen codec makes only sense to balance a 2x traffic increase and res increase

As opposed to HEVC situation, we now have (too) many options

** Withstanding licensing terms*

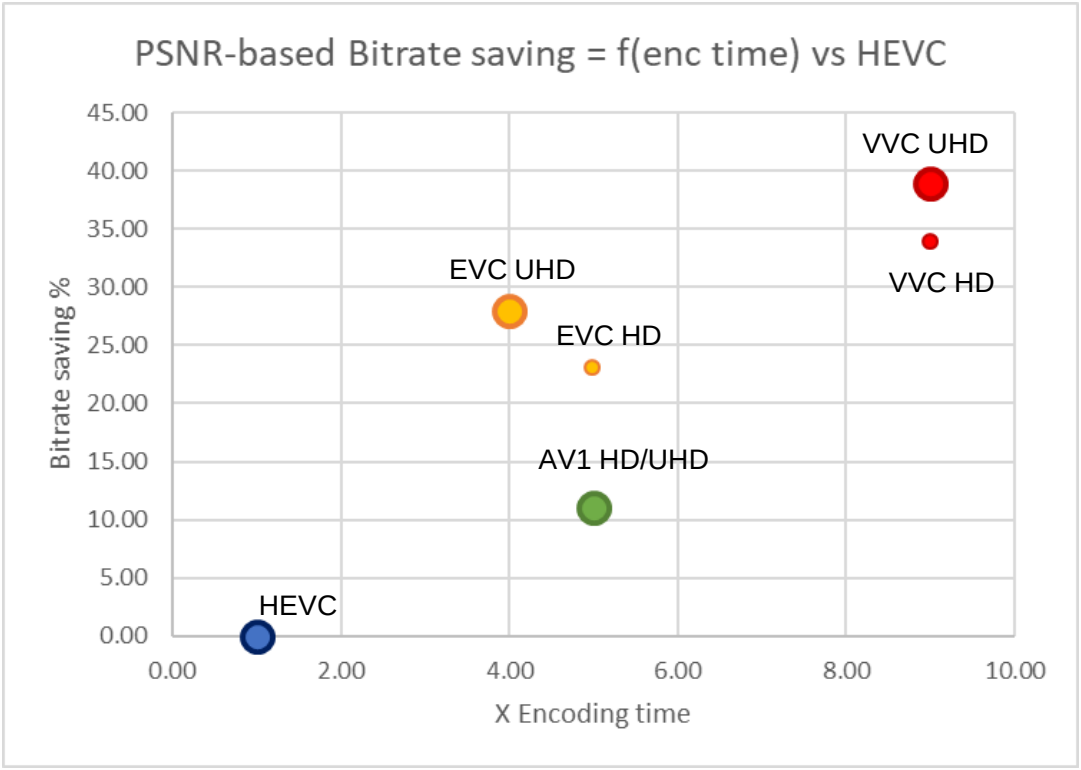
Thank You.

Tools and applications

Applications	HEVC	VVC	EVC (MP)	AV1
Targeting huge video formats (8K and above)	Possible, but not optimized for formats above 8K Max block size of 64x64 + max TF of 32x32	Yes. Max block size of 128x128 and max TF of 64x64	Yes. Max block size of 128x128 and max TF of 64x64	Yes. Max block size of 128x128 and max TF of 64x64
Screen content coding	Specific tools only in a specific extension and profile of HEVC	Yes. Specific tools in the spec: Intra Block Copy, Palette mode, Residual Coding for Skip TF, Block Diff Pulse Coding Modulation	Yes. Specific tools in the spec: Intra Block Copy	Yes. Specific tools in the spec: Intra Block Copy and Palette mode
Immersive applications	Extraction and merging of sub-pictures require stream header rewriting	Flexible block addressing for easier extraction and merging of sub-pictures + Padding	Extraction and merging of sub-pictures require stream header rewriting	Extraction and merging of sub-pictures require stream header rewriting
OTT streaming	Closed-GOP needed for segments	Open-GOP possible with Reference Picture Resampling	Closed-GOP needed for segments	Open-GOP possible with Reference Picture Resampling
Visio-conference	Spatial scalability only in a specific extension and profile of HEVC	Spatial scalability in the spec, using same resampling as Reference Picture Resampling	No spatial scalability	No spatial scalability

VVC best future proof codec

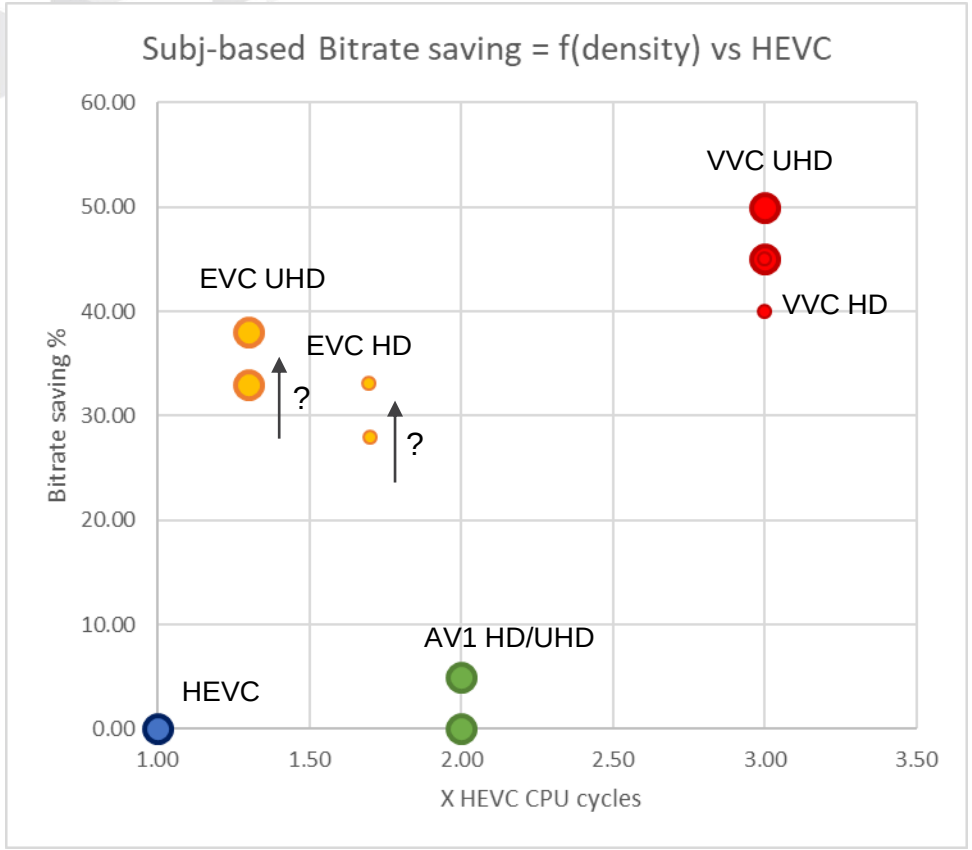
Compression performance vs HEVC (ref SW models) *



** Harmonic compilation from JVET, MPEG, InterDigital / Broadcast/OTT encoding configuration Q4'19)*

VVC and EVC strong candidates

Compression performance vs HEVC (optimized SWs)*

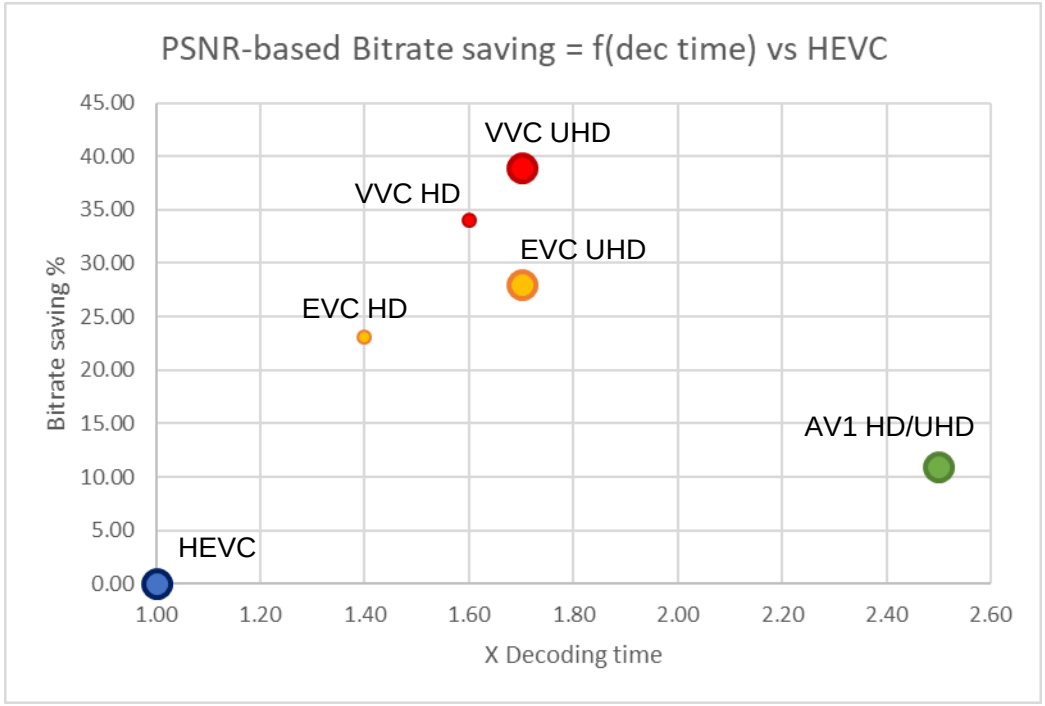


- Subjective gains above PSNR objective gains in a range of 5 to 10% for VVC
- To be qualified for EVC
- Seems to be on-par or slightly lower than PSNR objective gains for AV1 (bluriness observed)
- Density is based on current optimized SW version of AV1 and projected CPU cycles for VVC and EVC

** Projection from Harmonic / Broadcast/OTT encoding configuration*

EVC best encoder trade off candidate

Decoding complexity vs HEVC (ref SW models)



** Harmonic compilation from JVET, MPEG, InterDigital / Broadcast/OTT encoding configuration Q4'19)*

EVC & EVC best decoder trade off candidates

LCEVC compression performance

- LCEVC is not really a new codec, but more a pre/post processing pairing on top of existing or future codecs
- LCEVC (lower resolution HEVC encoding + post-processing) brings a bandwidth saving of ~35% over full resolution HEVC encoding (PSNR or VMAF-based)
- Needs some subjective evaluations to confirm these gains ▸ enhancement layers may bring temporal aliases on edges
- Encoding complexity is significantly reduced since a lower resolution is encoded (/2.7 measured on UHD/HD using x265)

No conclusion possible yet on LCEVC

Licensing

Licensing	HEVC	VVC	EVC (MP)	AV1	LCEVC (HEVC-based)
Nb of licensors	3 pools: MPEG-LA, HEVC Advanced, Velos + individual licensors	Not yet known but a lot of IP owners	To be defined (1 pool with the 5 companies which developed the standard?)	1 consortium (AOM) 1 pool (Sisvel)	1 company (V-Nova)
Terms	Known for 2 pools (MPEG-LA, HEVC Advanced) and higher than AVC Defined in one-to-one negotiations for Velos and individual licensors. No streaming fees for the 3 pools.	Not yet known. High risks to be spread into many licensors. MediaCoding-IF created to favor the creation of a licensable codec or to build licensable sub-profiles of the codec. VVC High-level Syntax is sub-profiling friendly.	Royalty-free for Baseline profile. To be clarified for Main profile. Commitments on timely publication of licensing terms (24 months after the completion of the standard). EVC High-level Syntax is sub-profiling friendly.	Royalty-free by known patent holders in AOM. Sisvel is working on terms for patent holders not in AOM	Not yet set, but committed to be very low for the LCEVC specific part. Though, it inherits from the licensing terms of the base layer codec.

EVC safer bet than VVC short term

Mobile Video Codecs

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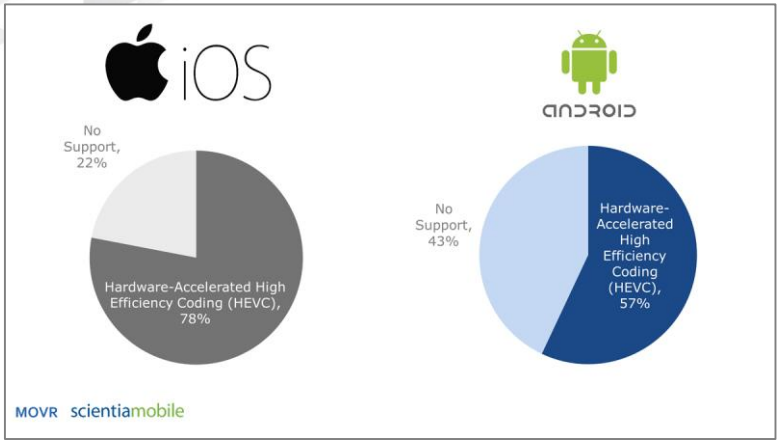
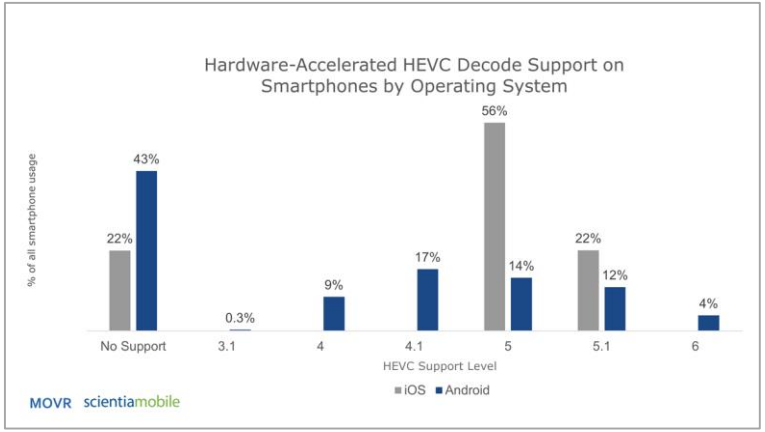
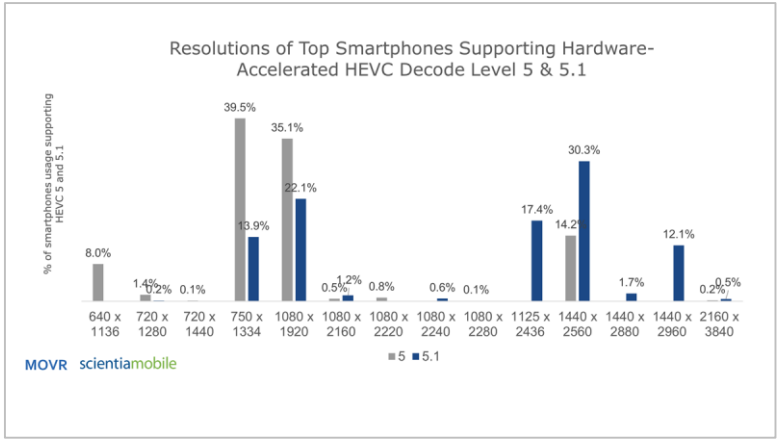
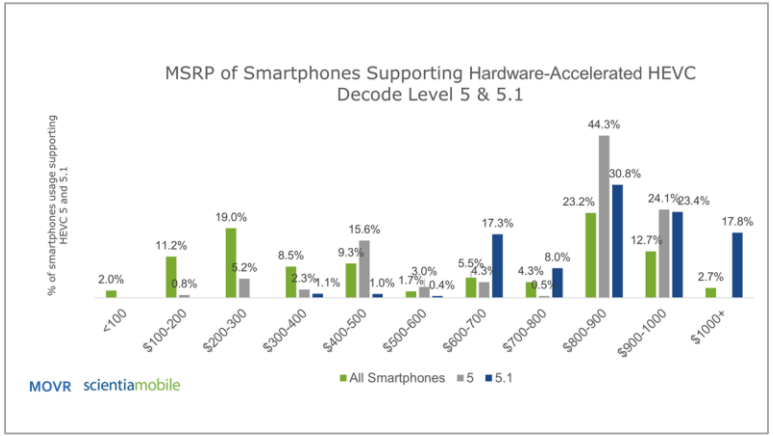
					iOS	
H.264 MPEG-4/AVC	✓	✓	✓	✓	✓	✓
HEVC H.265 - HIGH EFFICIENCY VIDEO CODING	✓	✗	✓	✗	✓	✓
VP9	✓	✓	✗	✓	✗	✓
AV1	✓	✓	✓	✓	✗	✓

HEVC Mobile Support



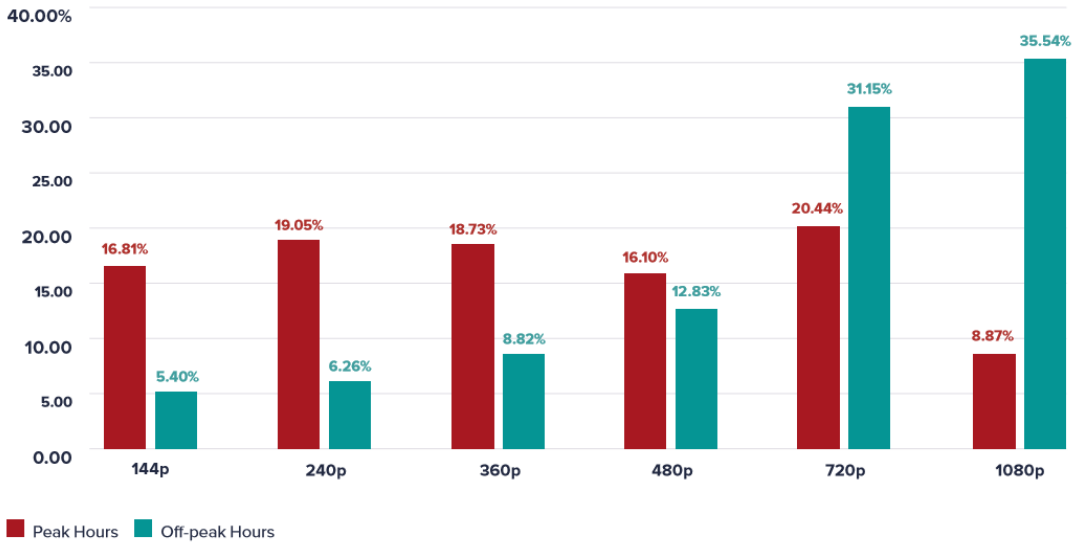






https://www.scientiamobile.com/growing-support-of-hevc-or-h-265-video-on-mobile-devices/

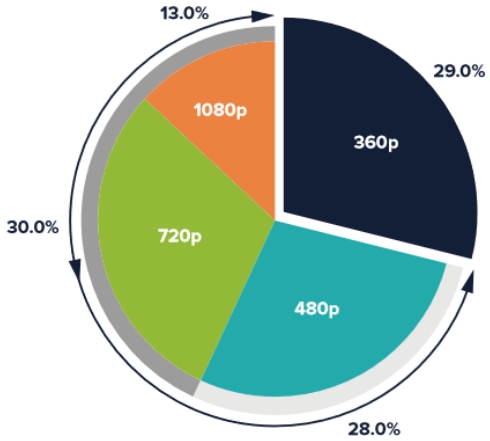
Traffic Pattern*



HD not possible at scale on 4G

* Tier-1 developed country, source Openwave spring'19

Perceived Quality



71% of videos were perceived at a higher quality

43% of the videos were perceived as HD / FHD

Figure 9
360p Blind Quality Test - Resolutions perceived by 100 participants for 300 360p videos
Source: Openwave Mobility Customer Data, 2018

SD judged “good enough”