Initial Assessment: Access Advance's VVC Royalty Rate Structure Is Fair and Reasonable

July 21, 2021

Prepared By:

Jorge L. Contreras
Presidential Scholar and Professor of Law
University of Utah S.J. Quinney College of Law
Salt Lake City, Utah

Michael A. Carrier
Distinguished Professor
Rutgers Law School
Camden, New Jersey

July 21, 2021

Paul Bawel
Senior VP, Business Development
Access Advance LLC
100 Cambridge Street, Suite 21400
Boston, MA 02114

Re: *Access Advance VVC Royalty Rate Evaluation*

Dear Mr. Bawel:

Each of us is a licensed attorney and law professor, collectively having more than 50 years of professional experience. We are experts in intellectual property, contract, and antitrust law. Our research focuses on, among other topics, the development of technical interoperability standards and the licensing of standards-essential patents ("SEPs"). Between us, we have published 7 books and more than 80 articles and book chapters on these topics; have been cited in judicial opinions and agency documents in North America, South America, Europe, and Asia; and have advised some of the world's largest standards organizations and corporations on these issues. Our full *curricula vitae* are attached to this letter. We submit this letter to you in our individual capacities as experts in the field of technical standardization law, and do not represent or speak on behalf of our respective academic institutions or any other bodies or groups with which we may be affiliated.

I. Scope of Opinion

You have requested our expert opinion regarding the proposed royalty rate structure and terms of the VVC ("Versatile Video Coding") patent pool (the "VVC Pool") proposed by Access Advance LLC ("Advance"). In particular, you have asked us to suggest a range of royalty rates for the proposed VVC Pool, based on whether and to what extent we believe the royalty rates charged by the VVC Pool may exceed those charged by the HEVC Advance ("HADV") Pool (*i.e.*, the patent pool for High Efficiency Video Coding SEPs administered by Access Advance[1]), while still enabling Pool Members (defined below) to comply with their obligations to the JVET (defined below) standards body (which operates under the Common Patent Policy of ISO/IEC/ITU-T) to license VVC SEPs "on a worldwide, non-discriminatory basis and on reasonable terms and conditions" (a "RAND"[2] basis) (to the extent a VVC Pool Member has such an obligation).[3]

Our opinion is limited to an application of the assumed facts set out below to the contractual RAND commitment contained in the ISO/IEC/ITU-T Common Patent Policy (defined below) based on our understanding of the common law of contracts as generally applicable in the United States. We do not express any opinion regarding the statutory or common law of any particular state of the United States, nor the law of any other country, although we have no reason to believe that the

---

[1] Access Advance was formerly known as "HEVC Advance." The name change was announced in August 2020.
[2] Courts also sometimes refer to this basis as a "FRAND" (fair, reasonable, and nondiscriminatory) basis. There is no material difference between the two terms.
[3] A discussion of whether RAND obligations extend to licensors in a patent pool or whether the RAND obligation may be satisfied through a RAND bilateral offer is not addressed here and is not within the scope of our analysis.

law of any jurisdiction conflicts with this analysis. We also express no opinion regarding antitrust or competition law, either in the United States or elsewhere.

II. Background and Assumptions

Our opinion is based on the following assumed facts which have been provided to us by (1) Analysis Group, Inc. in its written report dated June 21, 2021 titled "*Preliminary Economic Observations on the Value of the VVC Standard*" ("AGI Report"), and/or (2) your client (as identified throughout this opinion), Advance, both of which, with your acknowledgement, we rely upon without independent investigation or verification.

The VVC Standard

1. The VVC ("Versatile Video Coding") standard (also designated as ITU-T Recommendation H.266) was developed by the Joint Video Experts Team ("JVET"), a joint effort of ISO/IEC JTC1/SC29/WG11 ("MPEG") and the Video Coding Experts Group ("VCEG") of ITU-T SG16(Q6/16). ISO and ITU-T are based in Geneva, Switzerland.

2. The initial draft of the VVC standard was released in April 2018, and the standard reached Final Draft International Standard ("FDIS") stage in July 2020.

3. No known implementations of the VVC standard are currently released in the market.

4. A standardization effort known as MPEG-5 EVC began in January 2019 as a potential alternative to VVC.

Prior Standards: HEVC, AVC, and MPEG-2

5. VVC is a next–generation video coding standard that succeeds the High Efficiency Video Coding ("HEVC") (Rec. ITU-T H.265 | ISO/IEC 23008-2), Advanced Video Coding ("AVC") (Rec. ITU-T H.264 | ISO/IEC 14496-10), and Moving Pictures Expert Group-2 ("MPEG-2") (Rec. ITU-T H.262 | ISO/IEC 13818-2) standards. The AVC and HEVC standards were developed by a predecessor joint effort of MPEG and VCEG known as the Joint Video Team ("JVT") (for AVC) and the Joint Collaborative Team on Video Coding ("JCT-VC") (for HEVC).

6. HEVC approximately doubles the compression/bandwidth ratio at the same level of video quality[4] as compared with AVC, with the result, among other benefits, that a given level of video quality generally requires less than half the transmission bandwidth

[4] AGI Report, at 3-4 and n.11.

to a device and/or far less storage capacity within a given device. The same is true when comparing AVC to its predecessor MPEG-2.[5]

7. Similarly, VVC approximately doubles the compression/bandwidth ratio at the same level of video quality as HEVC, with the result, among other benefits, that a given level of video quality generally requires less than half the transmission bandwidth to a device and/or far less storage capacity within a given device. As compared with HEVC, VVC also offers significant improvements in resolution up to 16K, multi-view capabilities, screen content coding, and high dynamic resolution, among others.[6] There are no known technical deficiencies of VVC relative to its predecessor video standards.[7] VVC is expected to provide a basis for new products and services incorporating the advanced features that VVC provides which are not able to be efficiently incorporated with previous video codecs, such as omnidirectional (360º) imaging and virtual reality.[8]

The Common Patent Policy

8. JVT, JCT-VC, and JVET each operate under the Common Patent Policy of ISO/IEC/ITU-T dated Apr. 18, 2007 (the "Common Patent Policy").

9. Paragraph 1 of the Common Patent Policy requires that "any party participating in the work of ITU, ISO or IEC should draw the attention of the [Director] … to any known patent or to any known pending patent application, either their own or of other organizations".

10. Under Paragraph 3 of the Common Patent Policy, VVC Patent Holders (defined below) must file a written "Patent Statement and Licensing Declaration" Form with the appropriate body with respect to such VVC SEPs. Such Form must indicate whether such VVC Patent Holder is willing to negotiate licenses of VVC SEPs with other parties on a basis that is either free of charge or RAND. For purposes of this opinion, we focus only on VVC Patent Holders who have indicated their willingness to negotiate licenses of VVC SEPs on RAND terms.

Patent Pools and Other Joint Licensing Programs

11. Patent pools covering the MPEG-2 and AVC video compression standards (respectively, the "MPEG-2 Pool" and "AVC Pool") were organized by MPEG LA. These MPEG LA pools license the respective encoders and decoders (codecs) in

---

[5] *Id*. at 3-4 and n.10.
[6] *Id*. at 5-8.
[7] *Id*.
[8] *Id*. at 8-14.

substantially completed devices and charge a fee for each codec in such devices that may infringe one or more licensed patents.

12. At the time MPEG-2 became available (in or around 1995),[9] there were very few video devices, all of which were dedicated to playing video and did not have other primary functions. The rates initially set by MPEG LA in the 1997 timeframe for the MPEG-2 pool were $4.00 per unit, which decreased to $2.50 on January 1, 2002.[10]

13. When AVC became available (in or around 2003),[11] multifunction devices and applications such as smartphones and browsers were beginning to be introduced into the market, but the comparable value of functions, including video, in multifunction devices was unknown and the infrastructure to support these functions—e.g., protocols such as HTML to enable efficient internet transmission—either were in an early stage of development or would not exist for several more years.

14. Effective January 1, 2005, MPEG LA's AVC royalty rates were $0.00, $0.10, or $0.20 per codec, depending on annual volume, with annual caps (initially $3.5 million and currently $9.75 million) that have increased over time.[12]

15. At the time MPEG LA's AVC rate was set (approximately 2004), the use of video compression on mobile and internet devices was significantly less important than it is today, with video representing only about 5% of total internet bandwidth in 2004 versus about 80% in 2020, a rate that is still increasing.[13] The existing MPEG-2 royalty rate at the time of $2.50 per device was also a factor in establishing the AVC rate.

16. Video devices today often are multi-functional devices in which video is one of many primary functions.

17. Two patent pools currently offer licenses to patents determined to be essential to implement the HEVC standard. In addition, one joint licensing program offers licenses to HEVC patents that it describes as having been "granted or allowed," but it is not clear whether these patents have been independently evaluated as essential to the standard (*See* Velos Media website section on "Licensing."[14])

---

[9] *Id.* at 4 n.10.
[10] *Id.* at 3 n.8.
[11] *Id.* at 4.
[12] *Id.* at 3 n.8.
[13] See Cisco: Video to Consume 79% of Internet Traffic by 2020 | Multichannel News (nexttv.com), and Advance FRAND White Paper, pp.16-28.
[14] See http://velosmedia.com/licensing/ (viewed May 25, 2021).

The HADV Pool, administered by Advance[15]
Standard Rate = $0.267 to $1.60 (depending on application)
Best In-Compliance Rate = $0.20 to $1.20 (depending on application)
First units equal to $6250 in royalties per quarter = $0.00

The HEVC Pool, administered by MPEG-LA

First 100,000 units annually	$0.00
Units 100,001+ annually	$0.20 – per codec in any device, including Upgrades

The HEVC licensing program administered by Velos Media (the "VMED Program")
Rate structure not publicly available[16]

18. The royalty rates[17] charged by the HADV Pool to third party licensees were found by the court in *Dolby Intl. AB v. MAS Elektronik AG* (Düsseldorf Dist. Ct., May 7, 2020)[18] to comply with the RAND obligations imposed by the Common Patent Policy.

19. The Advance FRAND White Paper describes how the HADV Pool rate structure and terms were determined and how the HADV Pool rate structure[19] considers the value of HEVC to the products that incorporate a HEVC codec. The initial rates were set based on the assumption that the pool would include 40% of all HEVC SEPs.

The VVC Pool

20. VVC patent holders who believe their patents will be "required to implement" the VVC standard ("VVC SEPs") have filed written declarations with ISO and/or ITU-T

[15] PowerPoint Presentation (accessadvance.com) p.16. In almost all cases, the HADV Pool rates include a license to all HEVC codecs implemented in a device at the time of the sale of the device to an end user.
[16] One unverified online source estimates Velos Media HEVC rates to be in the range of $1.00 to $2.50 per device with no annual cap. Jan Ozer, *A Video Codec Licensing Update*, Jan. 13, 2019, www.streamingmedia.com/Articles/ReadArticle.aspx?ArticleID=129386.
[17] HEVC Advance Patent Pool: Royalty Rates Summary - Access Advance. This includes the rate structure of the HADV Pool, which provides for four product categories (Mobile Products, Connect Home and Other Devices, 4K UHD TVs, and Digital Media Storage) and three sets of royalty rates (Standard Rates, In-Compliance with Trademark Rates, and In-Compliance without Trademark Rates).
[18] There are, in fact, three cases that were decided by the Düsseldorf court simultaneously: the *Dolby* case, *Koninklijke Philips N.V. v. MAS Elektronik AG* (Düsseldorf Dist. Ct.), and *General Electric Video Compressions, LLC v. MAS Elektronik AG* (Düsseldorf Dist. Ct.). Based on an email exchange with Advance's German counsel dated June 2, 2021, we understand that the court in all three cases issued substantially the same judgment based on substantially the same findings.
[19] HEVC Advance Patent Pool: Royalty Rates Summary - Access Advance. The HEVC Pool rate structure includes four rate categories in which consumer products are included. Each rate category has a different rate based on (i) the type of device and/or (ii) the price of the device (depending on application).

indicating that they are willing to grant licenses under such VVC SEPs "to an unrestricted number of applicants on a worldwide, non-discriminatory basis and on reasonable terms and conditions" ("RAND")". Some of the declarations also condition their willingness on reciprocity by individual licensees, as permitted by the Common Patent Policy.

21. The VVC Pool License Administrator will be granted non-exclusive rights to license all VVC SEPs licensable by the holders of those VVC SEPs who join the VVC Pool (the "Pool Members").

22. Patents submitted to the VVC Pool will be assessed by an independent expert for essentiality to the VVC standard, and only patents that are assessed as essential, i.e., VVC SEPs, will be included in the VVC Pool.

23. The VVC Pool will offer to grant non-exclusive licenses of all (not a subset) of the pooled VVC SEPs to all parties wishing to take the Advance VVC license on a worldwide, non-discriminatory basis. [20]

24. It is assumed by Advance that the participation by VVC Patent Holders and the number of VVC SEPs in the VVC Pool will approximately track participation in the HADV Pool over time and reach at least 40% of all VVC SEPs[21].

III. Analysis

A. Scope and Basis for Comparison

You have requested that we propose a range of RAND royalty rates that may be charged by the VVC Pool to third party licensees.

We first consider the rates charged by MPEG LA for its HEVC pool. MPEG LA adopted virtually the same $0.20 rate for the HEVC Pool as for its earlier AVC Pool notwithstanding the substantial performance benefits of HEVC over AVC. We have no reason to believe that maintaining this $0.20 rate was necessary for the HEVC Pool rate to be RAND. In fact, it is likely that this rate was substantially below RAND levels. In *Microsoft v. Motorola*, the district court assessed the royalty rate for the AVC Pool to be "at the low end of the range for a RAND royalty," primarily because

---

[20] Given that, based on representations made by Advance, the VVC Pool intends to grant licenses to third parties on a nondiscriminatory basis that aligns with the terms of the Common Patent Policy, we do not analyze further the "nondiscrimination" prong of the Common Patent Policy as applied to the VVC Pool.

[21] We have been informed by Advance that the HEVCA pool launched in 2015 with approximately 5-10% of the HEVC stack and as of June 2021 licenses approximately 65% of the HEVC stack, which we understand from Advance is expected to continue to increase.

significant SEP holders failed to join the pool.[22] One media source argues that the AVC rate was "artificially low" due to the omission of certain key SEP holders.[23] It is clear that parties, including patent pools, may elect to set SEP royalty rates at levels that are below RAND, and even offer SEP licenses on a royalty-free basis. These are commercial decisions that do not necessarily affect the reasonableness of royalty rates offered by others.

We believe that the HADV Pool offers a more robust basis for assessing a RAND royalty rate for the VVC pool. The HADV Pool currently has over 30 licensors and over 200 licensees, both from a broad range of business models and industries. These numbers have grown steadily since the launch of the HADV Pool, and a number of companies that had joined the MPEG LA HEVC pool as licensors have since left the MPEG LA pool and joined as licensors in the HADV pool instead. The HADV Pool charges a different rate for each of four product categories based on the value of HEVC to products included in that category (see note 17 and accompanying text). The license terms and rates charged by the HADV Pool to third party licensees were found by the Düsseldorf court in the *Dolby, GE, and Philips* cases against *MAS Elektronik AG* (Düsseldorf Dist. Ct., May 7, 2020) to comply with each licensor's RAND obligation. Accordingly, we focus our analysis on the reasonableness of the proposed VVC Pool rates assuming a similar rate structure to that of the HADV Pool, but with rates increased above the HADV Pool rates.

Because the VVC standard is new, we are not able to consider directly comparable licenses for VVC SEPs. And because the technology is not yet on the market, we are not able to apply other approaches used for mature technologies, such as a direct assessment of the value of the technology to specific devices on the market.

B. Patent Pools

In considering appropriate royalty rates, patent pools present unique issues. Critically, the rates must be acceptable to both licensors and licensees. In particular, they must be high enough to fairly compensate the patent owners for their investments and encourage their continued participation in creating new technologies, and therefore to attract licensors owning patents essential to the practice of the standard. But at the same time, they must be low enough so that potential implementers are attracted to the pool. In addition, as explained in more detail below, as a general matter, because of the licensing efficiencies that they generate, the rates in patent pools tend to be lower than bilaterally negotiated rates.

---

[22] *Microsoft Corp. v. Motorola, Inc*., 2013 U.S. Dist. LEXIS 161762 (W.D. Wash., Nov. 12, 2013).
[23] IAM Media, *What Will TV Cost You? Putting a Price on HEVC Licenses*, IAM Magazine Issue 89 (May/June 2018), *available at* http://www.iam- media.com/Magazine/Issue/89/Features/What-will-TV-cost-you-Putting-a-price- on-HEVC-licences (viewed April 15, 2021).

C. Value-Based Pricing, Generally

The principal argument supporting an increase in the royalty rate from the HADV Pool to the proposed VVC Pool is that VVC offers substantial technical advantages, and therefore economic advantages, over HEVC in products that incorporate the technologies. In effect, the value of the technology embodied by the VVC standard is greater than the value of the technology embodied by the HEVC standard as discussed in Part I.

So-called "value-based pricing", in which a product's price is based on its economic value to the consumer, is well-known and accepted in the literature.[24] As defined by Hinterhuber, "a product's economic value is the price of the customer's best alternative—reference value—plus the value of whatever differentiates the offering from the alternative—differentiation value."[25] There are a variety of factors that can differentiate a product from its competitors, one of which is performance.[26] In the case of video codecs, we consider technical performance to be the principal factor differentiating one codec from another.[27] As noted by Hinterhuber, "Buyers are less sensitive to a product's price to the extent that a higher price signals better quality"[28] and "[t]he perceived fairness of the transaction is influenced by the price paid compared with internal reference prices."[29]

Assuming that the "reference price" for the video codecs under consideration is the RAND rate charged for the existing HADV Pool, and that the VVC standard offers substantial improvement in technical performance and efficiency over the HEVC standard, we are of the opinion that **it is both fair and reasonable to set rates for the VVC Pool that are above the rates for the HADV Pool**.

---

[24] *See, e.g.*, Stephan M. Liozu et al., *The conceptualization of value-based pricing in industrial firms*, 11 J. Revenue & Pricing Mgt. 12 ("Of the three main approaches to pricing in industrial markets – cost-based, competition-based and value-based – the last is considered superior by most marketing scholars and pricing practitioners" (citations omitted)); Andreas Hinterhuber, *Customer value-based pricing strategies: why companies resist*, 29 J. Bus. Strat. 41, 41 ("customer value-based pricing is increasingly recognised in the literature as superior to all other pricing strategies").

[25] Andreas Hinterhuber, *Towards value-based pricing—An integrative framework for decision making*, 33 Indus. Mktg. Mgt. 765, 769 (2004).

[26] *Id*. at 770 ("Products and services can create value for customers in a variety of different ways: reliability, performance, ease of use, longevity, life cycle costs, user and environmental safety, service (in terms of delivery reliability, delivery speed, and flexibility of deliveries), superior esthetics, prestige, and so on").

[27] We adopt this approach as technical performance is the best metric available for comparison at this early stage of VVC implementation. Other anticipated VVC improvements, such as new products that it may enable, may become factors capable of being measured as VVC implementation occurs over time.

[28] Hinterhuber, *Towards value-based pricing*, *supra* note 25, at 773.

[29] *Id*. at 772.

D. Legal Standards for RAND

A single common methodology to determine reasonable rates for SEP licenses does not exist. To our knowledge, the RAND commitment under the Common Patent Policy has been interpreted in some detail in *Microsoft v. Motorola*, both at the district court and Ninth Circuit. In *Microsoft*, the district court, in analyzing the royalty rate for Motorola's AVC SEPs, held that the rate must reflect "the importance of the SEPs to the standard and the importance of the standard and the SEPs to the products at issue."[30]

Likewise, in *Ericsson v. D-Link*,[31] which concerned patents essential to the IEEE Wi-Fi standards, the Federal Circuit explained that a reasonable royalty must be based on the "incremental value" added to the product by the patented features.[32] In particular, the court "h[e]ld that the royalty for SEPs should reflect the approximate value of that technological contribution, not the value of its widespread adoption due to standardization."[33]

Additional detail can be discerned from the 15-factor analysis for "reasonable royalty" patent damages set forth in *Georgia-Pacific Corp. v. United States Plywood Corp*.[34] Courts have not distilled a single set of factors from this framework relevant in the SEP context, and different courts weigh the factors differently. But, as discussed by the courts in *Microsoft* and *Ericsson*, some of the factors could be helpful in elaborating the reasonableness of royalties charged in the FRAND context. For example, *Georgia-Pacific* factor 9 addresses the advantages of the patented technology over older technologies, while factor 10 emphasizes the benefits offered by the patented technology beyond its value as a standard.

We believe the reasoning of the *Microsoft* and *Ericsson* decisions can be applied to evaluate the reasonableness of royalty levels for essential SEPs included in a patent pool.

E. Common Patent Policy

As described above, the VVC standard was developed by the JVET and VCEG. Given that there are no known actions by any participants during the VVC standard formation that would violate the Common Patent Policy, we will focus on whether "The Patent Holder is prepared to grant a license to an unrestricted number of applicants on a worldwide, non-discriminatory basis and on reasonable terms and conditions to make, use and sell implementations of the above document."[35]

---

[30] *Microsoft Corp. v. Motorola, Inc.*, 2013 WL 2111217, at *3 (W.D. Wash. Apr. 25, 2013); *see also id.* at *20 (noting significance of "determin[ing] each portfolio's importance to its respective standard as well as the importance to Microsoft's products").
[31] *Ericsson v. D-Link*, 773 F.3d 1201, 1231 (Fed. Cir. 2014).
[32] *Id.* at 1232.
[33] *Id.* at 1233.
[34] 318 F. Supp. 1116 (S.D.N.Y. 1970).
[35] Patent Statement and Licensing Declaration Form for ITU-T/ITU-R Recommendation | ISO/IEC Deliverable, at 2, https://www.itu.int/dms_pub/itu-t/oth/04/07/T04070006EC0001PDFE.pdf.

If a Patent Holder, as defined in the Policy, offers RAND licenses, including through a patent pool, to implementors, then we conclude that the Patent Holder has complied with its applicable obligation under the Common Patent Policy.

F. *Incremental Value*

As noted above, the *Ericsson* court explained that a RAND royalty must be based on the incremental value added by the patented features to the overall product.[36]

As discussed above and detailed in the accompanying economic analysis by Analysis Group, we understand that VVC provides a 2X increase in efficiency over HEVC.

We conclude, based on the foregoing that **an increase in functionality above prior technologies, in particular HEVC, should reasonably justify an increase in the VVC Pool royalty rate over the HEVC Pool royalty rate**.

G. Dolby v. MAS

Additional guidance on determining an appropriate VVC pool royalty rate is provided by the Düsseldorf court in *Dolby v. MAS*,[37] which analyzed the rates charged by the HADV Pool and several holders of patents essential to the HEVC standard.

As we understand it, the proposed VVC Pool will have several features that the *Dolby* court found to be RAND in the context of the HADV Pool. In particular, the court found that the pool's licensing transparency and inclusion of a large number of the patents in relation to the Pool's rates covering the standard, and the significant number of licenses (and licensees), weighed in favor of a finding that the pool's license terms and rates are RAND.[38]

The court also found that rate increases of up to 20% at the time of license renewal were RAND.[39] And it held that additional terms also were reasonable, such as a clause specifying a constant royalty rate that applies "not only in the event of patent numbers increasing but also [where] patents included are no longer valid."[40] In fact, the court found that "it does not seem unreasonable to also include a clause allowing for the amount of royalty to be increased in the event of . . . steady portfolio growth, because a limited opportunity to increase the royalty is only a reflection of the increasing value and acceptance of the portfolio."[41] The opinion supports the proposition that VVC

---

[36] *Ericsson*, at 1232.
[37] *Dolby Intl. AB v. MAS Elektronik AG* (Düsseldorf Dist. Ct., May 7, 2020).
[38] *Id.* at 51, 57.
[39] *Id.* at 57
[40] *Id.* at 58.
[41] *Id.*

rates can be higher than HADV rates and remain compliant with the RAND commitments of SEP holders.

H. Benchmarking Rate Increases

In determining whether the VVC Pool's rates would be RAND under the Common Patent Policy if they exceed the HADV Pool's rates, we first observe that numerous patent pools have reserved the right to increase their rates over time with little or no change to the underlying standard covered by the pooled patents. For example, in 1997 the MPEG-2 patent pool, which included patents subject to the then-current ISO RAND patent policy, indicated that it could increase its rates by up to 25% when renewing license agreements.[42] In reviewing the pool, the U.S. Department of Justice ("DOJ") did not consider this possibility to raise significant antitrust issues,[43] nor are we aware of any challenge to the RAND basis of the MPEG-2 pool's rate structure. Likewise, the Düsseldorf court in *Dolby* found that rate increases of up to 20% by the HADV Pool at the time of license renewal would not be unreasonable for purposes of compliance with the Common Patent Policy's RAND commitment.[44]

Beyond rate increases when the underlying technology does *not* change, we also considered rate increases when new generations of standards have substantially enhanced technical performance. In particular, we believe that the previous generation of video codec standards—HEVC—provides a baseline for determining an increased royalty range for the VVC Pool.[45]

Courts have considered an appropriate royalty range based on the rates charged by various SEP holders and pools for patents covering the widely litigated 2G, 3G, and 4G wireless telecommunications standards.[46] While the decisions of these courts have been based on the facts of each case and have used various methods, all have concluded that next generation standardized technologies are incrementally more valuable than the preceding generation of technologies, and thus that a material increase in rates is reasonable.

---

[42] Letter from Joel I. Klein to Garrard R. Beeney, Esq. (June 26, 1997), *available at* https://www.justice.gov/archive/atr/public/busreview/215742.htm#N_22_.
[43] *Id*.
[44] *Dolby,* at 57.
[45] See AGI Report, at 4 ("HEVC . . . improved upon AVC . . . by, among other things, improving the compression efficiency by roughly 50 percent, which, all else equal, enabled a roughly 50 percent reduction in storage and bandwidth requirements."); see also *id.* at 15 ("VVC and HEVC offer approximately a 50 percent improvement in compression efficiency over HEVC and AVC, respectively, and . . . these improvements lead to marketplace benefits, including higher prices and sales of products and services that embody the new video codec technology").
[46] We refer here to the ETSI wireless telecommunications standards because patent issues with respect to those standards have been litigated frequently and have given rise to numerous reported judicial decisions and agency actions. While the scope of this assignment did not accommodate a broader survey of pricing behavior in technology markets, it is common knowledge that, when released, the prices of next-generation technology products are generally above the prices of prior generations of products, whether they are smartphones, smart watches, vacuum cleaners, industrial equipment, or electric vehicles. Additional study of this phenomenon may be productive.

Table 1 below summarizes royalty rate increases imposed by SEP licensors between the 2G/3G generation of standards[47] and the 4G standard.[48] The rates shown for *Unwired Planet v. Huawei* (UK)[49] are those charged by Ericsson, the original holder of the patent portfolio that was partially assigned to, and asserted by, Unwired Planet. The rates shown for *TCL v. Ericsson*[50] represent the total "top-down" royalty for the applicable standard, as determined by the court. And the rates shown for Avanci are per-vehicle rates published on Avanci's web site.[51]

Table 1

	***Unwired Planet v. Huawei* (Ericsson's rates)[52]**	***TCL v. Ericsson* (total royalty stack)[53]**	***Avanci* (per-vehicle rate)**
2G/3G rate	0.67%	5%	$9
4G rate	0.80%	6%[54] - 10%	$15
4G rate % increase vs. 3G	20%	20% - 100%	67%

As Table 1 illustrates, the generational leap from 2G/3G to 4G resulted in rate increases between 20% and 100%, centered on increases in the 20% to 67% range. Though we do not know the precise performance increases from 2G/3G to 4G, it appears that performance enhancements and expanded applications support material rate increases. The courts that assessed these rates as RAND may have taken the performance and capability enhancements into account when making that determination, and the DOJ most likely recognized the successive performance increases represented by the evolution of the 2G, 3G, and 4G standards when assessing the proposed Avanci pool.

---

[47] We group the 2G and 3G standards together, as this appears to have been the practice in the industry.

[48] Because our analysis does not seek to determine a numerical rate for the VVC Pool or any particular patent(s) included therein, we do not consider the total number of patents declared essential with respect to each standard (the patent stack). Rather, we consider each standard as a separate "product" and compare its overall price (in terms of royalty level) with its performance/feature gains generation over generation. We believe this method avoids the vagaries of patent drafting and prosecution, in which an increasing number of patents can be issued on similar features of a single technology. Our concern is with the overall patent stack, viewed as a unitary whole covering the standard.

[49] *Unwired Planet Int'l Ltd. v. Huawei Techs.*, [2017] EWHC 711 (Pat), *aff'd*, [2018] EWCA Civ 2344 and [2020] UKSC 37.

[50] *TCL v. Ericsson*, 2017 WL 6611635 (C.D. Cal. Dec. 21, 2017), *rev'd on other grounds*, 943 F.3d 1360 (Fed. Cir. 2019).

[51] Avanci, Marketplace (Enabling the IoT), https://www.avanci.com/marketplace/ (last accessed Jun. 23, 2021).

[52] *Unwired Planet*, [2017] EWHC 711 (Pat) ¶ 475.

[53] *TCL*, 2017 WL 6611635, at *12-13.

[54] As reported by the court, Ericsson believed that the rate "would be as low as 6% (if not lower)". *TCL*, at *24.

IV. Conclusions

As the Department of Justice Antitrust Division recently explained in its business review letter concerning Avanci: "There is no single correct way to calculate a reasonable royalty in the [] RAND context."[55] The district court in *Microsoft* calculated a range of rates that complied with the Common Patent Policy's RAND obligation.[56] Similarly, in *Dolby*, the Düsseldorf district court explained that "FRAND does not entail a specific rate, but comprises an overall range/corridor."[57] Accordingly, we believe that there is a range of rates for the VVC Pool that would comply with a RAND commitment under the Common Patent Policy.

Given that the VVC standard is still at an early stage of deployment, our assessment of an appropriate RAND royalty range does not rely on many typical indicia of RAND, such as the precise number of patents included in the pool, products that have implemented the standard, or closely comparable licenses.[58] As a result, a central foundation of our analysis is the value-based pricing we discuss above. Our understanding is that VVC represents a generational leap in functionality and performance over the earlier HEVC and AVC standards. As Table 1 shows, wireless communication generational performance and application enhancements support rate increases between 20% and 100%, centered on a 20% to 67% range.

Given that, as noted above, the Düsseldorf court in *Dolby* and the DOJ in the MPEG-2 letter found that increases of pool rates by 20% and 25%, respectively, were unobjectionable even in the face of no technological advance, we believe that it is consistent with RAND (based additionally on Table 1) to apply a lower bound of a 25% royalty increase for rates in the VVC Pool.

To state the obvious, within the universe of potential RAND rates, the rate chosen by the VVC Pool does not need to be the lowest possible rate. For the upper bound, we believe 75%—a figure that sits comfortably within the range of rates in Table 1—is appropriate.

We view a rate increase of 75% as an effective upper bound. As discussed above, and for the reasons enumerated by the district court in *Microsoft*, the rates in patent pools tend to be lower than bilaterally negotiated rates. Until VVC implementations occur and the market matures, we are comfortable saying we believe a 75% increase will still provide a royalty rate for the pool that will be lower than the sum of bilaterally negotiated rates for the same set of patents. The existence of potential alternatives to VVC, including the MPEG-5 EVC standard (see Assumption 4, above), may discipline rates, even among rates that are RAND. In addition to those pricing at the low end of the RAND range, others could price below RAND levels, or even offer licenses that are royalty-

---

[55] Letter from Makan Delrahim to Mark H. Hamer, at 20 (July 28, 2020), *available at* https://www.justice.gov/atr/page/file/1298626/download.
[56] *Microsoft*, 2013 U.S. Dist. LEXIS 161762 at *15-16.
[57] *Dolby*, at 55.
[58] The court in *Microsoft* confronted similar issues in its analysis of the AVC pool, which was also formed at an early stage in the standard's deployment.

free.[59] A very high rate, particularly in the presence of competing standards and potential entrants, could affect adoption of the VVC standard, and thus affect licensor and licensee participation in the VVC Pool. We believe that this potential competition, together with lower pricing for patent pools, suggests an upper bound of a 75% increase of VVC rates over HADV's HEVC rates to be RAND for the VVC Pool.

In conclusion, **we are of the opinion, based on the facts and assumptions stated above, that the VVC Pool, if it includes at least 40% of the patents essential to the VVC Standard over the Pool's life, may charge rates that are between 25% and 75% higher than the HADV Pool and remain consistent with the RAND requirements of the Common Patent Policy**.

Please do not hesitate to let us know if you have any questions regarding this matter.

Jorge L. Contreras
Presidential Scholar and Professor of Law
University of Utah S.J. Quinney College of Law
Salt Lake City, Utah

Michael A. Carrier
Distinguished Professor
Rutgers Law School
Camden, New Jersey

[59] For example, the rate charged by the HEVC [HADV] Pool was 1.95 to 8 times higher than the rate charged by the competing HEVC [MPEG] pool, but the *Dolby* court still found the HEVC [HADV] Pool to be RAND. *Dolby*, at 52.

APPENDIX:

PRELIMINARY ECONOMIC OBSERVATIONS ON THE VALUE OF THE VVC STANDARD

John Jarosz, Shogo Hamasaki, Yuan Tian

(Analysis Group, Inc.)

July 21, 2021

TABLE OF CONTENTS

I. ASSIGNMENT

1. We were asked by Access Advance, LLC ("Access Advance" or "Advance") to provide a non-technical overview of the Versatile Video Coding ("VVC") standard and an early assessment of its potential marketplace (economic) value. We understand that Access Advance is in the process of starting a patent pool to license patents essential to the VVC standard and that Professors Jorge Contreras and Michael Carrier are providing an expert legal opinion on the pool members' compliance with their "fair, reasonable, and non-discriminatory" commitments.

2. Analysis Group, Inc. ("AGI") is an economic, strategy, finance, and healthcare consulting firm that has offices in Beijing, China; Boston, MA; Brussels, Belgium; Chicago, IL; Dallas, TX; Denver, CO; London, England; Los Angeles, CA; Menlo Park, CA; Montreal, Quebec; New York, NY; Paris, France; San Francisco, CA; and Washington, DC.

3. The three of us are economists who focus on issues involving the application of microeconomics, industrial organization, and game theory. Much of our work is in technology settings, and we are often asked to provide research and analysis in a variety of business, litigation, and regulatory settings, and have particular expertise in intellectual property ("IP") matters, having been engaged in numerous matters involving patents and standard-essential patents ("SEPs"), trademarks, copyrights, and trade secrets. John Jarosz is a Managing Principal of AGI and Director of the firm's Washington, D.C. office. He specializes in matters involving IP, commercial damages, licensing, and antitrust, and has provided testimony as an expert witness in over 300 matters. He holds a B.A. (Creighton University), an M.A. in Economics (University of Wisconsin), and a J.D. (University of Wisconsin). Shogo Hamasaki is a Vice President of AGI in the firm's Washington, D.C. office. He specializes in matters involving IP, antitrust, and contracts. He holds a B.A. (UC Berkeley) and a Ph.D. in Economics (UCLA). Yuan Tian is a Manager of AGI in the firm's Washington, D.C. office. He specializes in matters involving IP, antitrust, and contracts. He holds a B.A. (Carleton College) and a Ph.D. in Economics (University of Chicago).

4. The views expressed here are ours' and not those of our firm. Our views may change over time with new information, and our Analysis Group colleagues may not be in agreement with all, or even many, of our current views.

5. We understand that the VVC standard was finalized by the Joint Video Experts Team ("JVET") on July 6, 2020. We also understand that the development of VVC-compliant software and hardware components (*e.g.*, chipsets with VVC cores and graphic accelerators that can accept

VVC encoding and/or decoding functionality) are currently underway, and when they are developed, VVC is expected to be deployed in a wide variety of popular consumer and commercial products and services such as mobile devices, connected home devices, streaming services, and many others. We understand that VVC technology has not yet been incorporated in any material manner into commercial products and services, and that it will likely be several more months, and possibly years, until implementers can ramp up their deployment of VVC.

6. This paper provides a number of preliminary observations based on early information, all of which is prior to the commercialization of products that embody VVC. As a result, we may modify or supplement our observations based on our review and analysis of data and information that become available subsequent to the date of this paper.

II. BACKGROUND

A. Video Codecs

7. The term "codec" is a contraction of "code / decode" and consists of encoders and decoders. A video codec compresses video data (the "encoder" function) for transmission or storage, and then decompresses the received or stored data (the "decoder" function) for display and viewing.[1] Video codecs—sometimes both an encoder and a decoder, sometimes just an encoder or decoder—are currently used in a variety of devices and products, including mobile devices, TVs, set-top boxes ("STBs"), Blu-ray video players, cameras, video streaming devices and services, TV broadcasts, and videoconferencing equipment, among many others.[2]

8. Video codecs are crucial to the distribution of video content as uncompressed (or under-compressed) videos contain a large amount of data that may be either physically or economically

---

1 https://www.any-video-converter.com/mac-tutorial/video-codec.php (viewed July 12, 2021). https://www.haivision.com/blog/all/video-encoding-basics-what-is-a-video-codec/ (viewed July 12, 2021). "A video codec is a software or sometimes a piece of hardware that compresses and decompresses digital video. In other words, a codec processes raw digital video and stores it in a stream of bytes." *See, e.g.*, https://www.freemake.com/blog/video-codec/ (viewed July 12, 2021).

2 https://www.mediaentertainmentinfo.com/2013/10/4-concept-series-what-is-the-difference-between-hevc-h-265-and-h-264-mpeg-4-avc.html/ (viewed July 12, 2021). https://www.techspot.com/article/1131-hevc-h256-enconding-playback/ (viewed July 12, 2021). https://streaminglearningcenter.com/blogs/apple-embraces-hevc-what-this-means-for-the-codec-market.html (viewed July 12, 2021); http://web.archive.org/web/20191204145914/http://www.mediaentertainmentinfo.com/2013/10/4-concept-series-what-is-the-difference-between-hevc-h-265-and-h-264-mpeg-4-avc.html/ (viewed May 12, 2021).

impractical to transfer or store.[3] The compression (or coding efficiency) of a video codec[4] is particularly important as it directly affects the ability of device manufacturers and service providers to offer products and services that have higher resolution (the number of pixels in a video picture) in relation to prior generation products and services. In short, higher compression efficiency is associated with higher resolution, all else equal.[5]

B. Video Codec Standards

9. Over the years, international standard-setting organizations ("SSOs") have set technology standards for many video codecs to ensure compatibility across different implementers' products and services.[6] Compliant products provide substantial benefits to consumers by enabling high-resolution video content to be stored, transmitted, and displayed with, in relation to earlier generation products and services, lower bandwidth requirements and reduced storage costs.[7] These benefits are particularly important in today's video-heavy environment.

10. Prior-generations of video codec formats (sometimes described as standards) that have been developed and commercialized, and subsequently improved upon, include MPEG-2, H.264 (also called "advanced video coding" or "AVC"), and H.265 (also called "high efficiency video coding" or "HEVC").[8] Researchers have noted that "the primary goal of most digital video coding

---

3 https://www.haivision.com/blog/all/video-encoding-basics-what-is-a-video-codec/ (viewed July 12, 2021). Zhang, Ticao and Shiwen Mao, "An Overview of Emerging Video Coding Standards," *GetMobile*, 22(4), 2018, 13 – 20 ("Zhang and Mao (2018)"), at 13.

4 Compression / coding efficiency refers to "the ability to minimize the bit rate necessary for representation of video content to reach a given level of video quality." Ohm, Jens-Rainer, Gary Sullivan, Heiko Schwarz, Thiow Keng Tan, and Thomas Wiegand, "Comparison of the Coding Efficiency of Video Coding Standards—Including High Efficiency Video Coding (HEVC)," *IEEE Transactions on Circuits and Systems for Video Technology*, 22(12), 2012, 1669 – 84 ("Ohm et al. (2012)"), at 1669.

5 Sjoberg, Rickard, Jacob Strom, Lukasz Litwic, and Kenneth Andersson, 2020, "Versatile Video Coding Explained," *Ericsson Technology Review*, October 2020 ("Sjoberg et al. (2020)"), at 2-3.

6 https://www.vcodex.com/an-overview-of-h264-advanced-video-coding/ (viewed July 12, 2021). Zhang and Mao (2018), at 15 – 16.

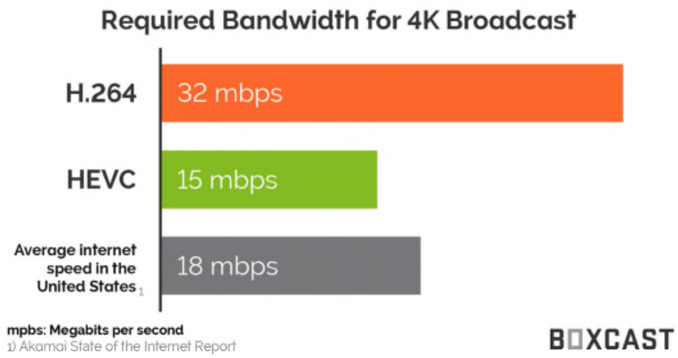
7 *See, e.g.*, https://www.jbistudios.com/blog/bit-rate-video-translation (viewed July 12, 2021), https://medium.com/advanced-computer-vision/h-264-vs-h-265-a-technical-comparison-when-will-h-265-dominate-the-market-26659303171a (viewed July 12, 2021), https://www.techspot.com/article/1131-hevc-h256-enconding-playback/page6.html (viewed July 12, 2021), https://www.boxcast.com/blog/hevc-h.265-vs.-h.264-avc-whats-the-difference (viewed July 12, 2021), and https://www.iam-media.com/litigation/what-will-tv-cost-you-putting-price-hevc-licences (viewed July 12, 2021).

8 Zhang and Mao (2018), Table 1 and Figure 8. MPEG-LA formed a patent pool for MPEG-2 SEPs around 1997. MPEG-LA's MPEG-2 pool charged a per unit royalty rate of $4.00 per unit for "MPEG-2 Decoders and Encoders" and $6.00 per unit for "Consumer Products" through January 1, 2002, and their rates decreased thereafter (*e.g.,* $2.50 per unit for MPEG-2 Decoders and Encoders and $2.00 per unit for Consumer Products

standards has been to optimize coding efficiency.”[9]

11. HEVC (first published in 2013) improved upon AVC (first published in 2003) by, among other things, improving the compression efficiency by roughly 50 percent, which, all else equal, enabled a roughly 50 percent reduction in storage and bandwidth requirements.[10] As shown in Figure 1, according to a 2018 article by BoxCast, the reduction in bandwidth enabled by HEVC made it practical to broadcast 4K video in the U.S.[11]

Figure 1: 4K Required Bandwidth by Video Codec vs. Internet Speed (2018)



through December 2015). *See* https://www.mpegla.com/wp-content/uploads/m2web.pdf (viewed July 12, 2021). *See also*, https://www.iam-media.com/litigation/what-will-tv-cost-you-putting-price-hevc-licences (viewed July 12, 2021). MPEG-LA also administers a patent pool for AVC SEPs. Effective January 1, 2005, MPEG-LA’s AVC royalty rates are $0.00, $0.10, or $0.20 per unit (a “unit” is defined as “decoder, encoder or product consisting of one decoder and one encoder”), depending on annual volume, with annual caps (increasing from $3.5 million per year for 2005 through 2006 to $9.75 million per year for 2017 through 2025). *See* https://www.mpegla.com/wp-content/uploads/avcweb.pdf (viewed July 12, 2021). *See* https://www.iam-media.com/litigation/what-will-tv-cost-you-putting-price-hevc-licences (viewed July 12, 2021).

9 Ohm, Jens-Rainer, Gary Sullivan, Heiko Schwarz, Thiow Keng Tan, and Thomas Wiegand, “Comparison of the Coding Efficiency of Video Coding Standards—Including High Efficiency Video Coding (HEVC),” *IEEE Transactions on Circuits and Systems for Video Technology*, 22(12), 2012, 1669 – 84 (“Ohm et al. (2012)”), at 1669.

10 Similarly, the AVC standard improved the compression efficiency by roughly 50 percent over the MPEG-2 standard (first published in 1995). Zhang and Mao (2018), Table 1 and Figure 9. At the time AVC became available, multifunction devices and applications such as smartphones and browsers, as well as protocols to enable efficient internet transmission, were in the very early stages of development; and at the time MPEG-2 became available in or around 1995, multi-function, high-resolution video devices had not yet been commercialized in any material way. *See, e.g.,* Zhang and Mao (2018), Table 1 and Figure 9.

11 BoxCast Team, “HEVC (H.265) Vs. AVC (H.264): What’s The Difference?”, September 20, 2018 (available at https://www.boxcast.com/blog/hevc-h.265-vs.-h.264-avc-whats-the-difference) (viewed July 12, 2021). *See also*, Harding, “What Are HEVC and AVC? H.265 and H.264 Video Codecs Explained,” December 23, 2020 (available at https://www.tomshardware.com/reference/h264-h265-hevc-codec-definition, viewed July 12, 2021: “HEVC compresses video in a more efficient manner than AVC but with the same level of image quality. H.264 isn’t efficient enough for 4K streaming, but with H.265 4K content is compressed to a size that allows for streaming over something like Netflix, assuming you have the recommended Internet speed. With H.265, the video data takes up less space or needs less transmission capacity than with H.264 but with the same level of quality.”).

C. VVC

12. H.266 (also called "Versatile Video Coding" or "VVC") is the next generation video codec format / standard. According to Ericsson, "[a]s the latest and most sophisticated video codec to date, VVC offers the highest compression efficiency of all video codecs."[12]

13. VVC (first published in 2020)[13] improves on the prior-generation HEVC (first published in 2013) by, among other things, improving the compression efficiency by roughly 50 percent, which, all else equal, enables a roughly 50 percent reduction in storage and bandwidth requirements.[14] By construction, moreover, the VVC standard improves compression efficiency by roughly 75 percent over the AVC standard.[15]

14. VVC is designed to address the increasing marketplace demand for high-resolution video delivered over the internet. Since the early 2000s, internet traffic has increased exponentially, from less than 2 exabytes per month in 2005 to more than 200 exabytes per month in 2019.[16] The increase in internet traffic to date has been driven, in large part, by consumer demand for (i) high-resolution video and (ii) streaming video, both of which require substantial internet bandwidth.[17] Recent industry estimates have found that video is now the number one source of information to learn more about products or services for more than 60 percent of people, more than 75 percent of all video views come from mobile devices, and U.S. residents spend more than 300 minutes per week watching video on mobile phones alone.[18] Accordingly, video's share of internet traffic has

---

12 Sjoberg et al. (2020), at 5.

13 We understand that the VVC standard was finalized by the Joint Video Experts Team (JVET) on July 6, 2020.

14 According to Fraunhofer, "compared to its predecessor H.265 / HEVC, VVC achieves about 50% bit-rate reduction at the same subjective video quality for a wide range of video content and applications." https://www.hhi.fraunhofer.de/en/departments/vca/technologies-and-solutions/h266-vvc/vvc-overview.html (viewed July 12, 2021). Other studies have noted that VVC achieves a bit-rate reduction of approximately 40 to 50 percent over HEVC. Sjoberg et al. (2020), at 5; https://www.fiercevideo.com/tech/qualcomm-draws-up-vvc-uses-outside-streaming-video (viewed July 12, 2021). VVC also offers new technologies to enhance support for immersive video, low-latency transmissions, and computer-generated images, among others. https://www.fiercevideo.com/tech/qualcomm-draws-up-vvc-uses-outside-streaming-video (viewed July 12, 2021); https://www.ericsson.com/en/patents/articles/versatile-video-coding-vvc-enabling-future-technology (viewed July 12, 2021).

15 1 - (50% x 50%) = 75%.

16 https://blogs.cisco.com/sp/the-history-and-future-of-internet-traffic (viewed July 12, 2021); Cisco, 2018, "Cisco Visual Networking Index: Forecast and Trends, 2017–2022," at Figure 1.

17 Innovations in video codec are particularly important for streaming video on mobile networks because bandwidth increases on mobile networks have lagged behind that of Wi-Fi and broadband networks. *See, e.g.,* Cisco Annual Internet Report (2018-2023) White Paper ("Cisco 2020") (available at https://www.cisco.com/c/en/us/solutions/collateral/executive-perspectives/annual-internet-report/white-paper-c11-741490.html) (viewed July 12, 2021).

18 https://techjury.net/blog/video-consumption-statistics/#gref (viewed July 12, 2021).

increased substantially over the years, from roughly 10 percent in 2005 to 80 percent in 2019, and consumption of high-resolution video, particularly with the rollout of the 5G mobile network, is expected to increase even more in the future.[19]

15. All else equal, more bandwidth (often measured in megabits per second or "Mbps") is needed to accommodate (i) increases in video resolution or (ii) increases in the quantity of streaming video. Similarly, all else equal, more storage space (often measured in gigabytes or "GB") and time are needed to download higher-resolution video. For example, according to a 2020 report by Cisco, streaming 4K video content currently requires 15 to 18 Mbps, compared with 5 to 7 Mbps for HD video and 2 Mbps for SD video; and downloading a typical HD movie currently takes approximately 20 minutes at 10 Mbps and 9 minutes at 25 Mbps.[20] The use of VVC would reduce these bandwidths (and therefore time-to-download) and storage requirements by roughly 50 percent (over HEVC) and 75 percent (over AVC).

16. As a result of its technical advances, VVC would, versus HEVC, make it practical to stream even higher-resolution video (*e.g.*, 8K), enable much faster streaming (reducing buffering) and downloading, and substantially reduce storage costs.[21]

17. In fact, video codec advances play a particularly important role in alleviating bandwidth congestion that can cause disruptions and reduce the quality of video and related products and services, including connected home and gaming devices that rely on having access to sufficient bandwidth at all times, but share limited bandwidth with many other devices at the same time on the same network.[22] The congestion can be particularly severe for home Wi-Fi and local internet service provider networks that have many household members / local end users connecting multiple devices at the same time and sharing a network with limited bandwidth.[23]

18. Bandwidth at various levels (including the internet backbone, the content providers'

---

[19] https://qz.com/742474/how-streaming-video-changed-the-shape-of-the-internet/ (viewed July 12, 2021); Cisco 2020, pp. 15-18.

[20] Cisco 2020, at PDF p. 15.

[21] Innovations in video codec technology are complementary to innovations that increase bandwidth and storage as they all work together to improve the quality and quantity of video consumption.

[22] *See, e.g.*, https://www.harmonicinc.com/insights/blog/managing-bandwidth-congestion-with-bitrate-reduction-for-ott-services (viewed July 12, 2021); https://qwilt.com/downloads/nscreenmedia-caching4scale.pdf (viewed July 12, 2021), at 7. *See also*, https://dvb.org/wp-content/uploads/2019/12/A145_Internet_TV_Content_Delivery_Study.pdf (viewed July 12, 2021), at 16-17.

[23] https://www.audienceproject.com/blog/key-insights/new-study-the-decline-of-the-computer-continues-while-newer-devices-are-on-the-rise/ (viewed July 12, 2021).

connection to the backbone, the content providers' distribution network, the ISPs' connection to local hubs, and the connection of the local hubs to the end user[24]) has increased over time, while data and storage costs have decreased over time. Innovations in video codec, internet bandwidth / data, and storage technologies are complementary in that they all work together to improve the quality and quantity of video consumption. By way of illustration, based on the data in Figure 1, innovations in both video codec (HEVC) and internet bandwidth (18 Mbps speed at reasonable cost) made it practical for consumers to view 4K video content. Without HEVC (or similar video codec technology), 18 Mbps alone would not have been sufficient for consumers to view 4K video content (and vice versa). The result has been exponential growth in consumer demand for additional bandwidth, data, and storage. More innovation has led to more consumption. More consumption has led to more innovation.

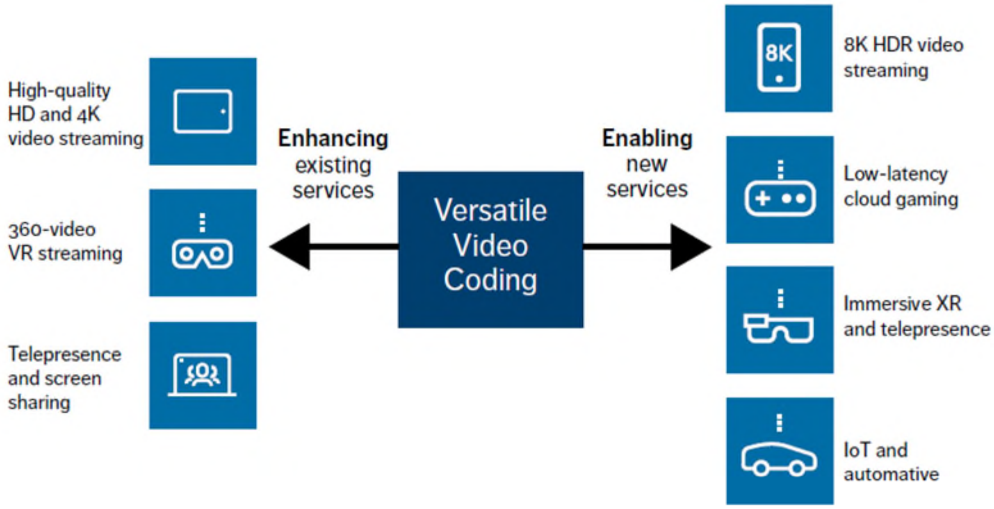
19. In the future, as the number of internet users, adoption of advanced video devices (*e.g.,* 4K / 8K TVs and streaming devices, connected home products), popularity of video-intensive events (*e.g.,* gaming, e-sports) and new applications for high-resolution video continue to grow, the pace of improvements in bandwidth speed alone are not sufficient to fulfill consumer demand; the efficient compression of video content via VVC (and future video codecs) is also required. Figure 2 illustrates a selected set of existing and new applications that VVC is expected to enhance or enable.[25]

---

[24] *See, e.g.,* https://dvb.org/wp-content/uploads/2019/12/A145_Internet_TV_Content_Delivery_Study.pdf (viewed July 12, 2021), at 16-17.

[25] Sjoberg et al. (2020), at 3.

Figure 2: Selected VVC Applications



20. The adoption of these advanced video products and services has a multiplier effect on internet traffic because each of the products / services requires substantial bandwidth to operate (*e.g.*, according to Cisco, "the bit rate for 4K video [..] is more than double the HD video bit rate and nine times more than SD video bit rate"[26]). Accordingly, industry articles have noted that the next wave of game-changing innovations in Internet-of-Things and artificial intelligence (*e.g.*, self-driving cars, robotics, drones, smart buildings / cities, and VR / AR) relies on efficient capturing, transmission, storage, and processing of high-resolution video.[27]

III. MARKETPLACE BENEFITS

A. Consumers and Producers

21. Given that VVC is new, actual / historical marketplace data on VVC-compliant products (*e.g.*, prices, revenues, quantities sold, etc.) are not yet available. Therefore, we rely on the technical improvements of VVC over previous generations of video codecs, including those improvements that are related to bandwidth and storage savings, and the new and improved products and services that can be enabled by VVC, as indicators of the potential economic benefits associated with the VVC technology. We also review and assess a number of marketplace benefits

---

26 Cisco 2020, p. 7. In regards to resolution, the "pixel size" is 1920 × 1080 pixels for HD videos, 3840 × 2160 pixels for 4K videos, and 7680 × 4320 pixels for 8K videos. *See*, *e.g.*, https://typito.com/blog/video-resolutions/ (viewed July 12, 2021); https://www.dacast.com/blog/bitrate-vs-resolution/ (viewed July 12, 2021).

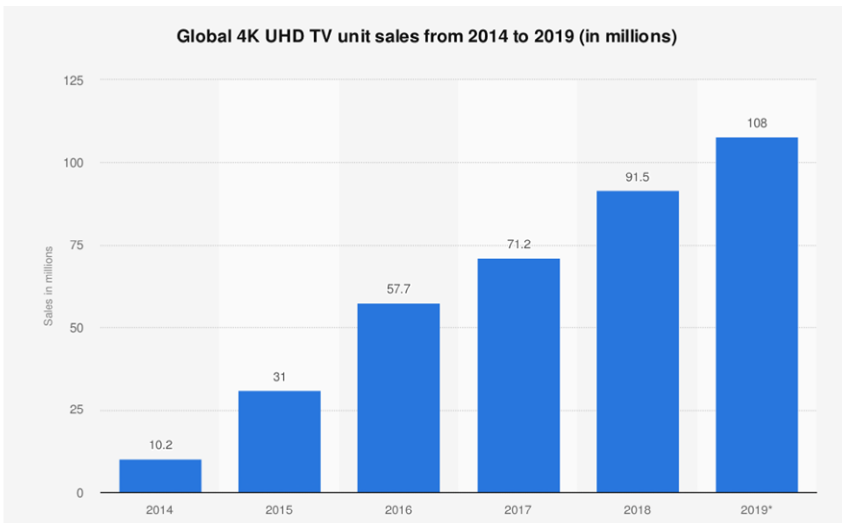
27 Qualcomm, 2016, "Making 5G NR a Reality," at 3, 24; Cisco, 2018, "Cisco Visual Networking Index: Forecast and Trends, 2017–2022," at Figures 10, 20, PDF p. 28.

that were associated with innovations in prior-generation video codec standards.

22. The marketplace benefits (for consumers and producers) of video codec technology are reflected in a number of metrics, including sales, prices and profit premiums, and cost savings, of new and improved products and services enabled by the technology.

23. Since the introduction of HEVC (in 2013), sales of 4K TVs, for example, have increased rapidly, as shown in Figure 3 below.[28] By 2019, 4K TVs accounted for more than 50 percent of global TV shipments.[29] 4K streaming services were launched shortly after the publication of the HEVC standard, with Netflix and Amazon both announcing in 2014 that they would support 4K video streaming.[30]

Figure 3: Global 4K TV Shipments[31]



24. 4K products often command a price premium over otherwise similar HD products. By way of illustration, Figure 4 reports the price premium associated with 4K products based on selected pairwise comparisons of 4K and HD TV prices in the U.S., as reported by Consumer Reports, within each brand and screen size. It shows that 4K models generally command substantial price premiums over HD models. In some instances, 4K models can command price premiums of over

28 https://www.statista.com/statistics/540680/global-4k-tv-unit-sales/ (viewed July 12, 2021).
29 https://www.statista.com/statistics/818419/world-tv-market-share-by-type/ (viewed July 12, 2021).
30 https://www.cnet.com/news/netflix-begins-4k-streams/ (viewed July 12, 2021); https://www.cnet.com/news/amazon-starts-4k-uhd-streams/ (viewed July 12, 2021).
31 https://www.statista.com/statistics/540680/global-4k-tv-unit-sales/ (viewed July 12, 2021).

50 percent relative to HD models. Figure 5 reports the price premium based on selected streaming devices. It shows that 4K streaming devices can command price premiums of 20 percent to 97 percent over HD streaming devices. Figure 6 shows Netflix's pricing plans as reported on its website.[32] It shows that Netflix's 4K streaming plan commands substantial price premium over its HD streaming plan. Similar premiums can be observed in many other 4K products and services.[33]

---

32 Analyzing the impact of other potential differences within each pair or complementarities among product features is beyond the scope of these illustrations.

33 *See, e.g.,* Access Advance White Paper, pages 37-39.

Figure 4: 4K TV Price Premiums[34]

	Screen Size (in.)	Brand								
		Hisense	Insignia	LG	RCA	Samsung	Sharp	TCL	Toshiba	Vizio
	[A]	[B]	[C]	[D]	[E]	[F]	[G]	[H]	[I]	[J]
[1]	32	-	-	-	-	233.3%	-	-	-	-
[2]	40	-	-	-	-	-	-	-	-	20.0%
[3]	43	38.9%	53.3%	20.2%	(15.0%)	-	-	7.0%	14.3%	-
[4]	50	-	25.0%	-	-	-	17.9%	-	-	-
[5]	All	38.9%	39.2%	20.2%	(15.0%)	233.3%	17.9%	7.0%	14.3%	20.0%

Figure 5: Price Premiums of Selected Streaming Devices

Manufacturer	Device	Price
Roku[35]	Roku Express (HD)	$24.99
	Roku Premiere (4K)	$33.99
	Price Premium	*36%*
Apple[36]	Apple TV HD (HD, 32GB)	$149.00
	Apple TV 4K (4K, 32GB)	$179.00
	Price Premium	*20%*
Google[37]	Chromecast (HD)	$35.00
	Chromecast Ultra (4K)	$69.00
	Price Premium	*97%*

34 Premiums calculated as ((average price for 4K/UHD TVs) / (average price for HD TVs)) – 1 when pairwise comparisons by brand and screen size are available. Data available at https://www.consumerreports.org/products/tvs/ratings-overview/ (viewed July 12, 2021), in which Element, Hitachi, Magnavox, Onn, Philips, Sanyo, Sony, and Westinghouse have no pairwise-comparable TVs in terms of screen size category. There were no pairwise-comparable TVs of screen sizes 24, 28, 39, 49, or 55 or more inches for any brands.

35 https://www.cloudwards.net/how-much-is-roku/ (viewed July 12, 2021).

36 https://www.apple.com/shop/buy-tv/apple-tv-hd/32gb (viewed July 12, 2021); https://www.apple.com/shop/buy-tv/apple-tv-4k (viewed July 12, 2021).

37 https://www.cordcuttersnews.com/chromecast-vs-chromecast-ultra/ (viewed July 12, 2021).

Figure 6: Netflix Streaming Plan Prices[38]

	Basic	Standard	Premium
Monthly price	$8.99	$13.99	$17.99
Video quality	Good	Better	Best
Resolution	480p	1080p	4K+HDR
Watch on your TV, computer, mobile phone and tablet	✓	✓	✓

HD (720p), Full HD (1080p), Ultra HD (4K) and HDR availability subject to your internet service and device capabilities. Not all content is available in all resolutions. See our Terms of Use for more details.

Only people who live with you may use your account. Watch on 4 different devices at the same time with Premium, 2 with Standard and 1 with Basic.

25. VVC is expected to facilitate sales of high-priced 8K TVs and streaming services.[39] Industry estimates have projected that global 8K TV shipments will increase from less than 1 million units in 2019 to more than 10 million units in 2023.[40] As of 2021, the "starting price" of 8K TVs is "around US$1,500" per unit, while the "starting price" of 4K TVs is "around US$300."[41]

26. VVC is also expected to facilitate sales of many other new and existing products and services. For example, Qualcomm has envisioned many more use cases for VVC other than streaming video, including cloud gaming, telemedicine, smart cities, autonomous vehicles, security applications, and video conferencing.[42] According to Ericsson, VVC will be "critically important in the coming years, enabling some of the most exciting technologies, from fully-

---

[38] https://www.netflix.com/signup/planform (viewed July 12, 2021).
[39] Cisco 2020, at p. 16.
[40] https://www.extremetech.com/extreme/312421-new-vvc-h-266-codec-is-a-step-towards-8k (viewed July 12, 2021).
[41] Deloitte Report, at 80. *See also*, https://www2.deloitte.com/us/en/insights/industry/technology/technology-media-and-telecom-predictions/2021/state-of-8k-tv-and-the-future-of-television-resolution.html (viewed July 14, 2021).
[42] https://www.fiercevideo.com/tech/qualcomm-draws-up-vvc-uses-outside-streaming-video (viewed July 12, 2021).

immersive VR games to self-driving cars"[43] and "the adoption of immersive consumer services using VR and AR is expected to lead to an even higher growth rate in the long term" for mobile data consumption.[44]

27. VVC can also lower the consumer costs of viewing or storing video content on the cloud and on their personal devices, which, in turn, can further increase consumer demand for products and service above. Consumers currently pay more for mobile and broadband internet services with higher bandwidth and data limits,[45] cloud storage services with higher storage,[46] and other products and services with higher bandwidth or storage capacities.[47] While these costs may not be linear, all else equal, consumers generally have to pay more to use more bandwidth or data.

28. For example, the incremental costs of doubling storage on Apple iPhones currently are $50 (64GB vs. 128 GB) or $100 (128GB vs. 256GB) on (otherwise identical) Apple iPhone 12 smartphones, and $100 (128GB vs. 256GB) or $200 (256GB vs. 512GB) on (otherwise identical) Apple iPhone 12 Pro smartphones.[48] Based on these data, all else equal, VVC would enable consumers to store double the video content without purchasing the higher capacity phone or store more video content at lower cost. All else equal, for an iPhone 12,[49] a $50 upgrade from 64GB to 128GB with VVC buys double the video storage versus HEVC,[50] and for an iPhone 12 Pro,[51] 512GB storage (the maximum storage offered) with VVC doubles the maximum amount of video content that can be stored compared to HEVC.[52] Consumers also can realize similar benefits on

---

43 https://www.ericsson.com/en/patents/articles/versatile-video-coding-vvc-enabling-future-technology (viewed July 12, 2021).

44 https://www.ericsson.com/4adc87/assets/local/mobility-report/documents/2020/november-2020-ericsson-mobility-report.pdf, at 14.

45 *See, e.g.,* https://www.t-mobile.com/cell-phone-plans (viewed July 12, 2021); https://www.xfinity.com/learn/internet-service/deals (viewed July 12, 2021).

46 *See, e.g.,* https://www.dropbox.com/individual/plans-comparison (viewed July 12, 2021).

47 *See, e.g.,* https://pocketnow.com/iphone-12-storage (viewed July 12, 2021).

48 *See, e.g.,* https://pocketnow.com/iphone-12-storage (viewed July 12, 2021). Similarly, the upgrade cost is $50 (128GB vs. 256GB) to double the storage on Samsung Galaxy S21 smartphones, and $130 (256GB vs. 512GB) to double the storage on Samsung Galaxy S21 Ultra smartphones. *See, e.g.,* https://www.bestbuy.com/site/compare?skus=6441105,6441103,6441102,6445573 (viewed July 12, 2021).

49 iPhone 12 is offered in 64GB, 128GB, and 256GB. https://www.apple.com/shop/buy-iphone/iphone-12 (viewed July 12, 2021).

50 To illustrate, if 10 additional units of video can be stored by increasing storage by 64GB using HEVC, then 20 additional units of video can be stored using VVC.

51 iPhone 12 Pro is offered in 128GB, 256GB, and 512GB. https://www.apple.com/shop/buy-iphone/iphone-12-pro (viewed July 12, 2021).

52 To illustrate, if 100 units of video can be stored with 512GB using HEVC, then 200 units of can be stored using VVC.

their mobile and broadband data subscriptions.[53]

B. Technology Developers

29. The next-generation products and services described above rely on innovations in the underlying technology for bandwidth enhancements (*e.g.*, "deep fiber"—"fiber infrastructure close to the end customers" and "MegaMIMO 2.0," which "uses multiple transmitters and receivers to relay data simultaneously"[54]), storage (*e.g.*, "flash-based storage system" and "non-volatile memory express"[55]), and video codecs. As noted above, the VVC standard is an important technological input into enabling those products and services to be commercially viable.

30. Technology developers incur substantial costs to research, develop, and standardize any new codec technology, including VVC. Developers of video codec technologies historically have monetized their contributions by, among other things, selling products and services that implement the new codec, or licensing their patents to implementers through bilateral license agreements or by joining a patent pool such as Access Advance's HEVC patent pool, or some combination of some or all of these. Each of these provides revenue and potential profits that repays the investment and provides business justification for future research. For example, licensing is an economically sensible option for technology developers because the prospect of royalties incentivizes technology developers to invest in making improvements to video codec technology. A royalty, along with a commercially viable licensing program (*e.g.*, patent pool licensing SEPs on FRAND terms), enables technology developers to appropriately share in the success of products and services launched in the marketplace, which entices developers to innovate. A running royalty entices developers to continue making improvements to the standard (*e.g.*, introducing new features and improvements that increase the number of licensed products leads to an increase in royalties), thereby further enhancing consumer and producer benefits, even after licensing their patents.

---

53 For example, T-Mobile charges $30 per month for 50GB of "premium" mobile data and $40 per month for 100GB of "premium" mobile data and Comcast charges approximately $30 per month for broadband with up to 100 Mbps download speed and approximately $60 per month for broadband with up to 400 Mbps download speed. https://www.t-mobile.com/cell-phone-plans (viewed July 12, 2021); https://www.t-mobile.com/cell-phone-plans (viewed July 12, 2021); https://www.xfinity.com/learn/internet-service/deals (viewed July 12, 2021).

54 *See, e.g.*, https://www.engadget.com/2017-01-07-six-new-technologies-that-will-provide-faster-better-internet-t.html (viewed July 12, 2021); https://www2.deloitte.com/content/dam/Deloitte/us/Documents/technology-media-telecommunications/us-tmt-5GReady-the-need-for-deep-fiber-pov.pdf (viewed July 12, 2021).

55 *See, e.g.*, https://www.computerweekly.com/feature/A-peek-into-the-future-of-storage (viewed July 12, 2021).

31. Access Advance is currently in the process of introducing a VVC patent pool that seeks to aggregate and license at least 40 percent of patents essential to the VVC standard.[56] Access Advance seeks to license those SEPs using running royalty rates and is in the process of setting those rates by using HEVC's royalty rates in the marketplace as a baseline and adding a premium that is in line with the benefits of VVC over HEVC. Both VVC and HEVC, as noted above, enable similar compression efficiency improvements over their prior-generation video codec standards. VVC and HEVC offer approximately a 50 percent improvement in compression efficiency over HEVC and AVC, respectively, and as described above, these improvements lead to marketplace benefits, including higher prices and sales of products and services that embody the new video codec technology. Accordingly, it is reasonable as a matter of economics for VVC to command a royalty premium over HEVC, and for VVC's royalty rate to be determined by using HEVC's royalty rate as a starting point.[57]

[56] Access Advance is currently working with approximately 60 patent owners to form the VVC Advance Patent Pool. https://accessadvance.com/licensing-programs/vvc-advance/ (viewed July 12, 2021).

[57] We understand that Professors Jorge Contreras and Michael Carrier are suggesting a range of royalty rates for Access Advance's proposed VVC pool, based on whether and to what extent they believe the royalty rates charged by its VVC pool may exceed those charged by Access Advance's HEVC pool, while still enabling pool members to comply with their obligations to license VVC SEPs "on a worldwide, non-discriminatory basis and on reasonable terms and conditions" (a "RAND" basis) (to the extent a VVC Pool Member has such an obligation).