UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

DYNAMIC DATA TECHNOLOGIES, LLC, ***Plaintiff,*** v. **LG ELECTRONICS INC. AND** **LG ELECTRONICS U.S.A., INC.,** ***Defendants.***	**Civil Action No. 2:18-cv-468-RWS** **JURY TRIAL DEMANDED**

FIRST AMENDED COMPLAINT FOR PATENT INFRINGEMENT

Dynamic Data Technologies, LLC ("Dynamic Data") brings this action and makes the following allegations of patent infringement relating to U.S. Patent Nos. 6,639,944 (the "'944 patent"); 6,760,376 (the "'376 patent"); 6,774,918 (the "'918 Patent"); 6,996,177 (the "'177 Patent"); 7,010,039 (the "'039 Patent"); 7,519,230 (the "'230 patent"); 7,542,041 (the "'041 patent"); 7,571,450 (the "'450 patent"); 7,750,979 (the "'979 patent"); 7,894,529 (the "'529 Patent"); 8,073,054 (the "'054 Patent"); 8,135,073 (the "'073 Patent"); 8,184,689 (the "'689 patent"); 8,189,105 (the "'105 Patent"); and 8,311,112 (the "'112 Patent") (collectively, the "patents-in-suit"). Defendants LG Electronics Inc. and LG Electronics U.S.A., Inc. (collectively, "LG" or "Defendant") infringe each of the patents-in-suit in violation of the patent laws of the United States of America, 35 U.S.C. § 1 *et seq*.

INTRODUCTION

1. Dynamic Data's portfolio of over 1,200 patent assets encompasses core technologies in the field of image and video processing. Dynamic Data's patents arose from the research and development efforts of Koninklijke Philips N.V. ("Philips"). Founded in 1891, for

well over a century, Philips pioneered ground-breaking technologies, including compact audio cassettes, magnetic resonance imaging (MRI) machines, and compact discs.

2. To facilitate the licensing of Philips' foundational technology, Dynamic Data is pursuing remedies for infringement of its patents in venues throughout the world. Contemporaneous to the filing of this Complaint and complaints against other companies selling the technologies claimed by Dynamic Data's patent portfolio, Dynamic Data has filed patent enforcement actions against Apple Retail Germany B.V. & Co. KG, Apple Distribution International, and Apple, Inc. in Düsseldorf, Germany.[1] In the People's Republic of China, Dynamic Data has filed patent enforcement actions against Advanced Micro Devices (China) Co., Ltd.,[2] Apple Electronic Products Trading (Beijing) Co., Ltd.,[3] and Microsoft (China) Co., Ltd.[4]

3. LG has cited the intellectual property assets in Dynamic Data's patent portfolio in 77 patents and published patent applications assigned to LG.[5]

DYNAMIC DATA'S LANDMARK INVENTIONS

4. The groundbreaking inventions in image and video processing taught in the patents-in-suit were pioneered by Philips. Video and image processing were at the heart of Philips' business for over fifty years. In 1891, Philips, then known as Philips & Company, was founded

[1] *See* In der Zivilsache Dynamic Data Technologies LLC gegen Apple Retail Germany B.V. & Co. KG u.a., AktNr: 010470-18.

[2] Asserting Patent No. ZL02817458.5.

[3] *See* Case Nos. (2019) Jing 73 Min Chu No. 235; (2019) Jing 73 Min Chu No. 234.

[4] *See* Case Nos. (2018) Su 01 Minchu 3500 ((2018)苏01民初3500号), (2018) Su 01 Minchu 3501 ((2018)苏01民初3501号), and (2018) Su 01 Minchu 3502 ((2018) 苏01民初3502号).

[5] *See e.g.*, U.S. Patent Nos. 8,170,108, 8,217,921, 8,264,968, 8,325,814, 8,363,732, 8,401,091, 8,411,744, 8,428,130, 8,432,972, 8,451,899, 8,457,201, 8,457,207, 8,472,519, 8,483,273, 8,532,178, 8,532,180, 8,532,181, 8,532,182, 8,532,183, 8,532,184, 8,548,053, 8,553,775, 8,559,505, 8,559,507, 8,559,508, 8,559,523, 8,565,303, 8,565,319, 8,571,113, 8,576,920, 8,611,419, 8,611,427, 8,619,872, 8,630,344, 8,634,475, 8,649,433, 8,660,179, 8,681,863, 8,711,932, 8,718,136, 8,724,700, 8,761,255, 8,767,827, 8,792,554, 8,902,983, and 8,902,984. These illustrative LG patents are assigned to LG Electronics, Inc.

in Eindhoven, Netherlands to manufacture carbon-filament lamps.[6] In the 1920s, Philips began to produce vacuum tubes and small radios, which would augur Philips' later entry into video and audio processing.

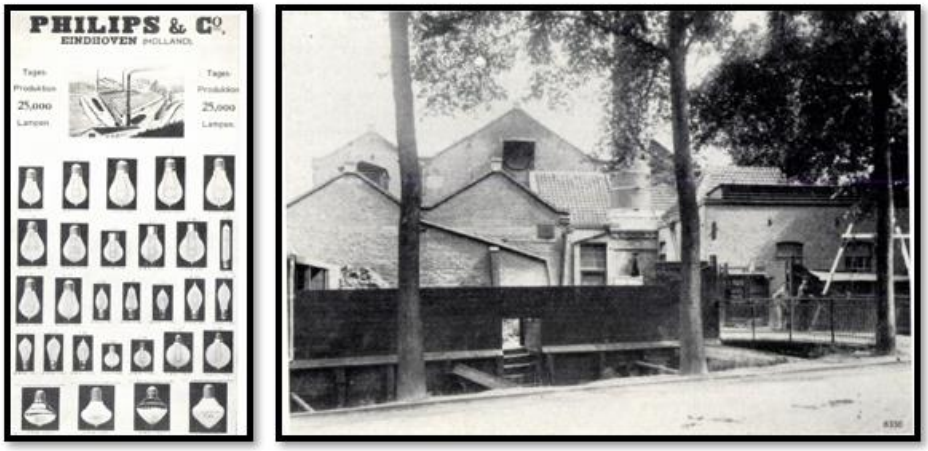
N.A. Halbertsma, *The Birth of a Lamp Factory In 1891*, PHILIPS TECHNICAL REVIEW, Vol. 23 at 230, 234 (1961).

5. In 1962, Philips introduced the first audio cassette tape.[7] A year later, Philips launched a small battery-powered audio tape recorder that used a cassette instead of a loose spool.[8] Philips C-cassette was later used as the first mass storage device for early personal computers in the 1970s and 1980s.

[6] Gerard O'Regan, A BRIEF HISTORY OF COMPUTING at 99 (2012).

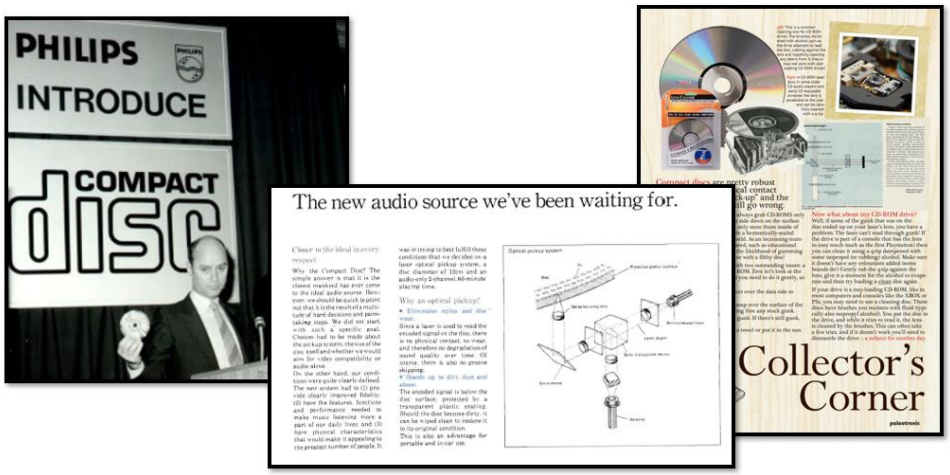
[7] Gerard O'Regan, PILLARS OF COMPUTING: A COMPENDIUM OF SELECT, PIVOTAL TECHNOLOGY FIRMS at 172 (2015) ("Philips invented the compact cassette for audio storage in 1962.")

[8] Anthony Pollard, GRAMOPHONE: THE FIRST 75 YEARS at 231 (1998).



THE ROTARIAN MAGAZINE, Vol. 101 No. 6 at 70 (December 1962) (advertisement showing Philips Norelco device which used cassettes for recording audio for transcription); Fred Chandler, *European Mfrs. Bid For Market Share*, BILLBOARD MAGAZINE AT P-6 (April 8, 1967) (image of the Philips EL 3300 battery-operated tape recorder which was released in 1963); Jan Syrjala, *Car Stereo: How Does The Music Sound?,* N.Y. TIMES at 2-M (September 25, 1966) (showing Philips's Norelco Cassette "the Philips device has two tiny reels inside it, with the tape traveling from one to the other").

6. In 1971, Philips demonstrated the world's first videocassette records (VCR). A year later, Philips launched the world's first home video cassette recorder, the N1500. In 1982, Philips teamed with Sony to launch the Compact Disc; this format evolved into the DVD and later Blu-ray, which Philips launched with Sony in 1997 and 2006 respectively.



Hans Peek, Jan Bergmans, Jos Van Haaren, Frank Toolenaar, and Sorin Stan, ORIGINS AND SUCCESSORS OF THE COMPACT DISC: CONTRIBUTIONS OF PHILIPS TO OPTICAL STORAGE at 15 (2009) (showing image of Joop Sinjou of Philips introducing the compact disc in March 1979); Advertisements for Philip's Compact Disc Products (1982).

7. In the late 1990s and early 2000s, Philips pioneered the development of technologies for encoding and decoding of video and audio content. At the time most of the technologies claimed by the patents in Dynamic Data's portfolio were invented, Philips' subsidiary primarily responsible for Philips' work in this field, Philips Semiconductor was the world's sixth largest semiconductor company.[9] The video encoding technologies developed by Philips Semiconductor enable video streaming on set-top boxes, smartphones, popular gaming consoles, Internet-connected computers, and numerous other types of media streaming devices.

8. Philips Semiconductor dedicated significant research and development resources to advancing the technology of video compression and transmission by reducing file sizes and decreasing the processing resources required to transmit the data.[10] Philips Semiconductor was among the first companies aggressively driving innovation in the field of video processing:

> The late 1980s and early 1990s saw the announcement of several complex, programmable VSPs. Important examples include chips from Matsushita, NTT, Philips [Semiconductors], and NEC. All of these processors were high-performance parallel processors architected from the ground up for real-time video signal processing. . . . The Philips VSP-1 and NEC processor were probably the most heavily used of these chips.[11]

9. Starting in the 1960s Philips pioneered the development of audio and video technologies that would establish itself as a leader in the field that would later develop into the audio and video encoding fields. Continuing Philips' pioneering history in these fields, the patents-in-suit disclose cutting-edge video compression and transmission technologies.

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[9] *Company News; Philips in $1 Billion Deal for VLSI Technology*, THE NEW YORK TIMES (May 4, 1999), *available at*: https://www.nytimes.com/1999/05/04/business/company-news-philips-in-1-billion-deal-for-vlsi-technology.html.

[10] HU, YU HEN, PROGRAMMABLE DIGITAL SIGNAL PROCESSORS: ARCHITECTURE, PROGRAMMING, AND APPLICATIONS, at 190 (Dec. 6, 2001) ("Philips Semiconductors developed early dedicated video chips for specialized video processors.").

[11] *Id.* at 191.

DYNAMIC DATA'S PATENT PORTFOLIO

10. Dynamic Data's patent portfolio includes over 1,200 patent assets, with over 470 issued patents granted by patent offices around the world. Dynamic Data owns numerous patents issued by the United States Patent and Trademark Office, including each of the patents-in-suit, The State Intellectual Property Office of the People's Republic of China,[12] the European Patent Office,[13] the German Patent and Trademark Office,[14] the Japan Patent Office,[15] and many other national patent offices.

11. Philips Semiconductor's pioneering work in the area of video processing and encoding has resulted in various inventions that are fundamental to today's video processing technologies. Dynamic Data is the owner by assignment of over 1,200 of these patent assets, which include over 470 patents issued by patent offices around the world.

12. Highlighting the importance of the patents-in-suit is the fact that the patents-in-suit have been cited by over 470 U.S. and international patents and patent applications by a wide variety of the largest companies operating in the field. For example, the patents-in-suit have been cited by companies such as:

- MediaTek Inc.[16]
- Samsung Electronics Co., Ltd.[17]
- Qualcomm Inc.[18]

[12] *See, e.g.*, CN100504925C; CN100438609C; CN1679052B; CN1333373C; CN1329870C; CN1303818C.

[13] *See, e.g.*, European Patent Nos. EP1032921B1; EP1650978B1; EP1213700B1; EP1520409B1.

[14] *See, e.g.*, German Patent Nos. DE60120762; DE50110537; DE60126151; DE60348978; DE602004049357.

[15] *See, e.g.*, Japanese Patent Nos. JP4583924B2; JP5059855B2; JP5153336B2; JP4637585B2.

[16] *See, e.g.*, U.S. Patent Nos. 7,397,973; 7,605,872; 8,179,984; 9,563,960; 9,917,988; and 9,641,861.

[17] *See, e.g.*, U.S. Patent Nos. 6,930,729; 7,911,537; 7,532,764; 8,605,790; and 8,095,887.

[18] *See, e.g.*, U.S. Patent Nos. 7,840,085; 8,649,437; 8,750,387; 8,918,533; 9,185,439; 9,209,934; 9,281,847; 9,319,448; 9,419,749; 9,843,844; 9,917,874; and 9,877,033.

- Google LLC[19]
- Intel Corporation[20]
- Broadcom Corporation[21]
- Microsoft Corporation[22]
- Sony Corporation[23]
- Fujitsu Ltd.[24]
- Panasonic Corporation[25]
- Matsushita Electric Industrial Company Limited[26]

THE PARTIES

DYNAMIC DATA TECHNOLOGIES, LLC

13. Dynamic Data Technologies, LLC ("Dynamic Data" or "Plaintiff") is a limited liability company organized under the laws of the State of Delaware.

14. In an effort to obtain compensation for Philips' pioneering work in the fields of video data encoding, decoding, and transmission, Dynamic Data acquired the patents-in-suit along with the several hundred additional issued United States and international Patents.

15. Dynamic Data pursues the reasonable royalties owed for LG's use of the inventions claimed in Dynamic Data's patent portfolio, which primarily arise from Philips' groundbreaking technology, both here in the United States and throughout the world.

LG

16. LG Electronics Inc. is a Korean corporation with a principal place of business at LG Twin Towers, 128 Yeoui-daero, Yeongdungpo-gu, Seoul, South Korea.

[19] *See, e.g.*, U.S. Patent No. 8,787,454 and U.S. Patent Appl. No. 10/003,793.
[20] *See, e.g.*, U.S. Patent Nos. 7,554,559; 7,362,377; and 8,462,164.
[21] *See, e.g.*, U.S. Patent Nos. 8,325,273 and 9,377,987.
[22] *See, e.g.*, U.S. Patent Nos. 7,453,939; 7,670,227; 7,408,986; 7,421,129; 7,558,320; and 7,929,599.
[23] *See, e.g.*, U.S. Patent Nos. 7,218,354 and 8,174,615.
[24] *See, e.g.*, U.S. Patent Nos. 7,092,032 and 8,290,308.
[25] *See, e.g.*, U.S. Patent Nos. 8,164,687 and 8,432,495.
[26] *See, e.g.*, U.S. Patent Nos. 7,362,378 and 7,423,961.

17. LG Electronics U.S.A., Inc. is a Delaware corporation with a regular and established place of business in the Eastern District of Texas at 21251-2155 Eagle Parkway, Fort Worth, Texas 76177. LG Electronics U.S.A., Inc. is registered to do business in the State of Texas and has been since at least April 3, 1984. LG Electronics U.S.A., Inc. may be served with process at its registered agent for service of process at United States Corporation Company, 211 E. 7th Street, Suite 620, Austin, Texas 78701.

18. LG Electronics U.S.A., Inc. is a wholly-owned subsidiary of LG Electronics Inc. LG Electronics Inc. and LG Electronics U.S.A., Inc. are collectively referred to herein as "LG."

JURISDICTION AND VENUE

19. This action arises under the patent laws of the United States, Title 35 of the United States Code. Accordingly, this Court has exclusive subject matter jurisdiction over this action under 28 U.S.C. §§ 1331 and 1338(a).

20. This Court has personal jurisdiction over LG in this action because LG has committed acts within the Eastern District of Texas giving rise to this action and has established minimum contacts with this forum such that the exercise of jurisdiction over LG would not offend traditional notions of fair play and substantial justice. Defendant LG, directly and/or through subsidiaries or intermediaries (including distributors, retailers, and others), has committed and continues to commit acts of infringement in this District by, among other things, offering to sell and selling products and/or services that infringe the patents-in-suit. Moreover, LG is registered to do business in the State of Texas, has offices and facilities in the State of Texas and the Eastern District of Texas, and actively directs its activities to customers located in the State of Texas and the Eastern District of Texas.

21. Venue is proper in this district under 28 U.S.C. §§ 1391(b)-(d) and 1400(b). Defendant LG is registered to do business in the State of Texas, has offices in the State of Texas,

has a regular and established place of business within the Eastern District of Texas, and upon information and belief, has transacted business in the Eastern District of Texas and has committed acts of direct and indirect infringement in the Eastern District of Texas.

THE ASSERTED PATENTS

U.S. PATENT NO. 6,639,944

22. U.S. Patent No. 6,639,944 entitled, *Sub-Pixel Accurate Motion Vector Estimation and Compensated Interpolation*, was filed on April 26, 2000, and claims priority to April 26, 1999. Dynamic Data is the owner by assignment of all right, title, and interest in the '944 Patent. A true and correct copy of the '944 Patent is attached hereto as Exhibit 1.

23. The '944 Patent discloses novel methods and systems for sub-pixel accurate motion vector estimation and motion-compensated interpolation or prediction.

24. The inventions disclosed in the '944 Patent enables higher accuracy motion estimation at a lower cost through improvements in motion vector estimation and motion-compensated interpolation.

25. The '944 Patent discloses a method of generating an intermediate image using sub-pixel accurate motion vectors having vector components that may have non-integer values, from first and second images having a given mutual temporal distance, the intermediate image being at a fractional distance from said first image, said fractional distance being a fraction of said given mutual temporal distance.

26. The '944 Patent discloses a method that includes deriving first and second vectors from said sub-pixel accurate motion vectors.

27. The '944 Patent discloses a method that includes generating an intermediate image by combining first positions in a first image shifted over first vectors and second positions in said second image shifted over second vectors.

28. The ‘944 Patent discloses a method that includes deriving first and second vectors from sub-pixel accurate motion vectors by multiplying the vector components of the sub-pixel accurate motion vectors by a fraction to obtain fractional vector components.

29. The ‘944 Patent discloses a method that includes deriving first and second vectors from sub-pixel accurate motion vectors by rounding the fractional vector components to obtain vector components of the first vectors, which have only integer vector components.

30. The ‘944 Patent discloses a method that includes deriving first and second vectors from sub-pixel accurate motion vectors by subtracting the first vector from the candidate vector to obtain the second vector, whereby the second vectors have vector components that, depending on the candidate vector and the fraction, may have non-integer values.

31. The ‘944 Patent Family has been cited by 23 patents and patent applications as relevant prior art. Specifically, patents and patent applicatios issued to the following companies have cited the ‘944 Patent Family as relevant prior art: Himax Media Solutions, Inc.; Cyberlink Corp.; and Marvell International Ltd.

U.S. PATENT NO. 6,760,376

32. U.S. Patent No. 6,760,376 entitled, *Motion Compensated Upconversion For Video Scan Rate Conversion*, was filed on November 6, 2000. The ‘376 Patent is subject to a 35 U.S.C. § 154(b) term extension of 697 days. Dynamic Data is the owner by assignment of all right, title, and interest in the ‘376 Patent. A true and correct copy of the ‘376 Patent is attached hereto as Exhibit 2.

33. The ‘376 Patent discloses novel methods and systems for motion compensated upconversion in a video image that uses motion compensation to generate an interpolated video field using motion vectors.

34. The inventions disclosed in the '376 Patent provide a sharp video image by comparing a calculated correlation value of pixels with a threshold value.

35. The '376 Patent discloses technologies that improve video image quality by selecting a motion compensated pixel that will provide a sharp video image by comparing a calculated correlation value of pixels with a threshold value.

36. The '376 Patent discloses a method of motion compensation for use in a video image upconversion unit of the type that uses motion compensation to generate an interpolated field using motion vectors.

37. The '376 Patent discloses a method of motion compensation that includes calculating a correlation value from the values of causal neighbor pixels of a generated field and from the values of corresponding neighbor pixels of a next field.

38. The '376 Patent discloses a method of motion compensation that includes comparing the correlation value with a threshold value.

39. The '376 Patent discloses a method of motion compensation that includes setting the value of a pixel to be created within the generated field to be equal to the value of a corresponding pixel of the next field if the correlation value is less than the threshold value.

40. The '376 Patent Family has been cited by several patents and patent applications as relevant prior art. Specifically, patents and patent applications issued to the following companies have cited the '376 Patent Family as relevant prior art: Samsung Electronics Co., Ltd.; Blip X Ltd.; Himax Technologies Limited; and Snell Ltd.

U.S. PATENT NO. 6,774,918

41. U.S. Patent No. 6,774,918 entitled, *Video Overlay Processor with Reduced Memory and Bus Performance Requirements*, was filed on June 28, 2000. The '918 Patent is subject to a

35 U.S.C. § 154(b) term extension of 591 days. Dynamic Data is the owner by assignment of all right, title, and interest in the '918 Patent. A true and correct copy of the '918 Patent is attached hereto as Exhibit 3.

42. The '918 Patent claims specific methods and systems for providing an overlay such as a cursor in an on-screen display in a consumer electronic device. On-screen display (OSD) data for generating an image on a display device are downloaded to an OSD unit on an integrated circuit.

43. The '918 Patent discloses downloading on-screen display (OSD) data for generating an image on a display device.

44. The '918 Patent further discloses downloading the on-screen display (OSD) data in segments separated by gaps.

45. The '918 Patent further discloses, during a gap in downloading the on-screen display data, downloading an amount of overlay data for generating an overlay on the image generated on a display device.

46. Further, the '918 Patent discloses that the overlay data downloaded during a gap comprises a portion of the overlay data.

47. The inventions disclosed in the '918 Patent improves the operation and efficiency of computer components because only a portion of the overlay data is downloaded during each burst gap, thus reducing the amount of memory needed to store the overlay data. The inventions disclosed in the '918 Patent further eliminate the requirement that on-chip memory be large enough to hold the data needed for an entire overlay. Instead, only one line or a part of one line of the overlay needs to be stored on-chip.

48. The ‘918 Patent claims a technical solution to a problem unique to video processing.

49. The ‘918 Patent Family has been cited by several United States patents and patent applications as relevant prior art. Specifically, patents and patent applications issued to Realtek Semiconductor Corp., Samsung Electronics Co., Ltd., and Thomson Licensing SA have all cited the ‘918 Patent Family as relevant prior art.

U.S. PATENT NO. 6,996,177

50. U.S. Patent No. 6,996,177 entitled, *Motion Estimation*, was filed on July 24, 2000, and claims priority to August 22, 1999. The ‘177 Patent is subject to a 35 U.S.C. § 154(b) term extension of 1,103 days. Dynamic Data is the owner by assignment of all right, title, and interest in the ‘177 Patent. A true and correct copy of the ‘177 Patent is attached hereto as Exhibit 4.

51. The ‘177 Patent claims specific methods and devices for motion estimation and motion-compensated picture signal processing.

52. The ‘177 Patent discloses a motion vector estimation method and device that carries out a block-based motion vector estimation process that involves comparing a plurality of candidate vectors to determine block-based motion vectors.

53. The ‘177 Patent discloses a motion vector estimation method and device that determines at least a most frequently occurring block-based motion vector.

54. The ‘177 Patent discloses a motion vector estimation method and device that carries out a global motion vector estimation process using at least the most frequently occurring block-based motion vector to obtain a global motion vector.

55. The ‘177 Patent discloses a motion vector estimation method and device that applies the global motion vector as a candidate vector to the block-based motion vector estimation process.

56. The inventions disclosed in the '177 Patent improve the operation of the computer components necessary to the performance of picture signal processing by reducing the load on the central processing unit.

57. The '177 Patent Family has been cited by 16 United States and international patents and patent applications as relevant prior art. Specifically, patents and patent applications issued to the following companies have cited the '177 Patent Family as relevant prior art:

- Qualcomm Incorporated
- LG Electronics
- Microsoft Corporation
- Samsung Electronics Co., Ltd.
- VIXS Systems Incorporated
- General Instrument Corporation

U.S. PATENT NO. 7,010,039

58. U.S. Patent No. 7,010,039 entitled, *Motion Estimator for Reduced Halos in MC Up-Conversion*, was filed on May 15, 2001, and claims priority to May 18, 2000. The '039 Patent is subject to a 35 U.S.C. § 154(b) term extension of 768 days. Dynamic Data is the owner by assignment of all right, title, and interest in the '039 Patent. A true and correct copy of the '039 Patent is attached hereto as Exhibit 5.

59. The '039 Patent claims specific methods and apparatuses detecting motion at a temporal intermediate position between previous and next images. The inventions disclosed in the '039 Patent solve a problem wherein an estimator estimating motion between two successive pictures from a video sequence cannot perform well in areas where covering or uncovering occurs.

60. The '039 Patent solves this problem by carrying out the optimization at the temporal position of the next image in covering areas and at the temporal position of the previous image in uncovering areas.

61. The ‘039 Patent discloses a method and apparatus for detecting motion at a temporal intermediate position between previous and next images.

62. The ‘039 Patent discloses the use of a criterion function for selecting and optimizing candidate vectors.

63. The ‘039 Patent further discloses a criterion function that depends on data from both previous and next images and in which the optimizing is carried out at the temporal intermediate position in non-covering and non-uncovering areas, characterized in that the optimizing is carried out at the temporal position of the next image in covering areas and at the temporal position of the previous image in uncovering areas.

64. The ‘039 Patent Family has been cited by 30 United States and international patents and patent applications as relevant prior art. Specifically, patents and patent applications issued to the following companies have cited the ‘039 Patent Family as relevant prior art:

- Qualcomm Incorporated
- Panasonic Corporation
- Samsung Electronics Co., Ltd.
- Matsushita Electric Industrial Co., Ltd.
- Sharp Kabushiki Kaisha
- Integrated Device Technology, Inc.
- Zoran Corporation

U.S. PATENT NO. 7,519,230

65. U.S. Patent No. 7,519,230 (the “‘230 Patent”) entitled, *Background Motion Vector Detection*, was filed on December 16, 2003, and claims priority to January 23, 2003. The ‘230 Patent is subject to a 35 U.S.C. § 154(b) term extension of 685 days. Dynamic Data is the owner of all right, title, and interest in the ‘230 Patent. A true and correct copy of the ‘230 Patent is attached hereto as Exhibit 6.

66. The ‘230 Patent claims specific methods and systems to select a background motion vector for a pixel in an occlusion region of an image.

67. The ‘230 Patent discloses systems and methods determine the correct motion vector in occlusion regions, thereby reducing or eliminating artifacts of motion compensated image rate converters, which are referred to as “halos” in the display of video images.

68. The ‘230 Patent claims a method of selecting a background motion vector for a pixel in an occlusion region of an image comprising computing a model-based motion vector for the pixel on basis of a motion model being determined on basis of a part of a motion vector field of the image.

69. The ‘230 Patent claims a method of selecting a background motion vector for a pixel in an occlusion region of an image comprising comparing the model-based motion vector with each of the motion vectors of the set of motion vectors.

70. The ‘230 Patent claims a method of selecting a background motion vector for a pixel in an occlusion region of an image comprising selecting a particular motion vector of the set of motion vectors on basis of the comparing and for assigning the particular motion vector as the background motion vector.

71. The ‘230 Patent Family has been cited by 28 United States and international patents and patent applications as relevant prior art. Specifically, patents and patent applications issued to the following companies have cited the ‘230 Patent Family as relevant prior art:

- Sony Corporation
- Fujitsu Ltd.
- Motorola Solutions Inc.
- Nokia Oyj
- Qualcomm Inc.
- Samsung Electronics Co., Ltd.
- Toshiba Corporation

U.S. PATENT NO. 7,542,041

72. U.S. Patent No. 7,542,041 (the "041 patent") entitled, *Runtime Configurable Virtual Video Pipeline*, was filed on April 2, 2004, and claims priority to April 3, 2003. The '041 Patent is subject to a 35 U.S.C. § 154(b) term extension of 288 days. Dynamic Data is the owner by assignment of all right, title, and interest in the '041 Patent. A true and correct copy of the '041 Patent is attached hereto as Exhibit 7.

73. The '041 Patent discloses novel systems for dynamically configuring a multi-pipe pipeline system.

74. The inventions disclosed in the '041 Patent enable a multiple-pipeline system that is dynamically configurable to effect various combinations of functions for each pipeline.

75. The inventions disclosed in the '041 Patent teach a multiple pipeline system that includes a pool of auxiliary function blocks that are provided as required to select pipelines.

76. In one embodiment of the '041 Patent, each pipeline of the multiple-pipeline system is configured to include a homogenous set of core functions. A pool of auxiliary functions is provided for selective insertion of auxiliary functions between core functions of select pipelines.

77. In one embodiment of the '041 Patent, each auxiliary function includes a multiplexer that allows it to be selectively coupled within each pipeline.

78. The '041 Patent discloses, in one embodiment, a processing system that includes a plurality of pipelines, with each pipeline of the plurality including a plurality of core pipeline elements that are configured to sequentially process data as it traverses the pipeline.

79. The '041 Patent discloses, in one embodiment, a processing system that includes a plurality of auxiliary elements, each auxiliary element of the plurality of auxiliary elements being configured to be selectively coupled to multiple pipelines of the plurality of pipelines.

80. The ‘041 Patent discloses, in one embodiment, a processing system wherein the auxiliary elements are responsive to external coupling-select signals.

81. The ‘041 Patent discloses, in one embodiment, a processing system wherein a plurality of auxiliary elements are within a selected pipeline of the multiple pipelines, between a pair of core pipeline elements of the plurality of core pipeline elements to process the data as it traverses between the pair of core elements.

82. The ‘041 Patent Family has been cited by several United States and international patents and patent applications as relevant prior art. Specifically, patents and patent applications issued to Microsoft Corporation, Xilinx Inc., Canon Inc., Intel Corporation, and Nokia Oyj have cited the ‘041 Patent Family as relevant prior art.

U.S. PATENT NO. 7,571,450

83. U.S. Patent No. 7,571,450 (the “‘450 Patent”) entitled, *System For And Method Of Displaying Information*, was filed on February 12, 2003, and claims priority to March 11, 2002. The ‘450 Patent is subject to a 35 U.S.C. § 154(b) term extension of 846 days. Dynamic Data is the owner by assignment of all right, title, and interest in the ‘450 Patent. A true and correct copy of the ‘450 Patent is attached hereto as Exhibit 8.

84. The ‘450 Patent discloses novel methods and systems for displaying information. The inventions disclosed in the ‘450 Patent enable methods and systems wherein a user does not need to make a new selection after being switched from one service to a second service.

85. The inventions disclosed in the ‘450 Patent permit a user of an information display system to have selections made on a first service also presented when the user switches to a second service without requiring the user to browse through the menus to define the type of information to be displayed a second time.

86. In one embodiment of the ‘450 Patent, the user selection being made on the basis of the provided options while the first service was selected is use to select the appropriate data elements of the stream of the second service.

87. The inventions disclosed in the ‘450 Patent enable various content sources to share similar information models.

88. The ‘450 Patent, in one embodiment, discloses a method of displaying information on a display device wherein receiving a transport stream comprises services, with the services having elementary streams of video and of data elements.

89. The ‘450 Patent, in one embodiment, discloses a method of displaying information on a display device wherein user actions of making a user selection of a type of information to be displayed on the device are received.

90. The ‘450 Patent, in one embodiment, discloses a method of displaying information on a display device wherein filtering to select a data element of a first one of the services on the basis of the user selection is performed.

91. The ‘450 Patent, in one embodiment, discloses a method of displaying information on a display device wherein rendering to calculate an output image to be displayed on the display device, on the basis of the first data element selected by the filer is performed.

92. The ‘450 Patent, in one embodiment, discloses a method of displaying information on a display device wherein switching from the first one of the services to a second one of the services, characterized in comprising a second step of filtering to select a second data-element of the second one of the services, on basis of the user selection is performed.

93. The ‘450 Patent, in one embodiment, discloses a method of displaying information on a display device wherein being switched from the first one of the services to the second one of

the services, with the data-element and the second data-element being mutually semantically related and a second step of rendering to calculate the output image to be displayed on the display device, on basis of the second data-element selected by the filter is performed.

94. The '450 Patent Family has been cited by several patents and patent applications as relevant prior art. Specifically, patents and patent applications issued to AT&T Intellectual Property I LP, Nokia Oyj, Samsung Electronics Co., Ltd., and ZTE Corporation have all cited the '450 Patent Family as relevant prior art.

U.S. PATENT NO. 7,750,979

95. U.S. Patent No. 7,750,979 (the "'979 Patent") entitled, *Pixel-Data Line Buffer Approach Having Variable Sampling Patterns*, was filed on October 26, 2001. The '979 Patent is subject to a 35 U.S.C. § 154(b) term extension of 2,749 days. Dynamic Data is the owner by assignment of all right, title, and interest in the '979 Patent. A true and correct copy of the '979 Patent is attached hereto as Exhibit 9.

96. The '979 Patent discloses novel methods and systems for motion compensation in video signal processing.

97. The '979 Patent discloses methods and systems that use line buffers that are decoupled and that can deliver a fixed number of pixels, as may be required by a video processing stage, using a sampling pattern that is defined as one among several selectable sampling windows.

98. The '979 Patent discloses a video processing circuit having an input stream of pixels corresponding to an array of video pixels.

99. The '979 Patent further discloses having a variable window size for sampling subsets of the array as a two-dimensional window that spans the pixels in the array.

100. The ‘979 Patent further discloses having a video processing stage that inputs pixels using a fixed number of pixels.

101. The ‘979 Patent further discloses a method for delivering the input stream of pixels to the video processing stage.

102. The ‘979 Patent further discloses a method comprising establishing a window size and a sampling-window size, such that the window size is a multiple of the sampling-window size and the sampling-window size defines the fixed number of pixels.

103. The ‘979 Patent further discloses a method comprising storing pixels from the input stream into a first set of line butters, the pixels stored in the first set of line butters including pixels for the established window size.

104. The ‘979 Patent further discloses a method comprising prefetching the stored pixels from the first set of line butters into a second set of line buffers, the second set of line buffers being sufficiently long to store at least the pixels corresponding to the established sampling-window size.

105. The ‘979 Patent further discloses a method comprising fetching the fixed number of pixels from the second set of line buffers for the video processing stage.

U.S. PATENT NO. 7,894,529

106. U.S. Patent No. 7,894,529 entitled, *Method And Device For Determining Motion Vectors*, was filed on June 1, 2006, and claims priority to June 3, 2005. The ‘529 Patent is subject to a 35 U.S.C. § 154(b) term extension of 1,301 days. Dynamic Data is the owner by assignment of all right, title, and interest in the ‘529 Patent. A true and correct copy of the ‘529 Patent is attached hereto as Exhibit 10.

107. The ‘529 Patent discloses novel methods and apparatuses for determining motion vectors that are each assigned to individual image regions.

108. The inventions disclosed in the ‘529 Patent enable an increase in the resolution of video and image signals during the motion estimation process.

109. The ‘529 Patent discloses a method for determining motion vectors which are assigned to individual image regions of an image.

110. The ‘529 Patent discloses a method wherein an image is subdivided into a number of image blocks, and a motion estimation technique is implemented to assign at least one motion vector to each of the image blocks where a modified motion vector is generated for at least a first image block.

111. The ‘529 Patent discloses a method that determines at least a second image block through which the motion vector assigned to the first image block at least partially passes.

112. The ‘529 Patent discloses a method that generates the modified motion vector as a function of a motion vector assigned to at least the second image block.

113. The ‘529 Patent discloses a method that assigns the modified motion vector as the motion vector to the first image block.

114. The ‘529 Patent Family has been cited by multiple patents and patent applications as relevant prior art. Specifically, patents and patent applications issued to Fujifilm Corp., and Samsung Electronics Co., Ltd. have cited the ‘529 Patent Family as relevant prior art.

U.S. PATENT NO. 8,073,054

115. U.S. Patent No. 8,073,054 entitled, *Unit For And Method Of Estimating A Current Motion Vector*, was filed on December 12, 2002, and claims priority to January 17, 2002. The ‘054 Patent is subject to a 35 U.S.C. § 154(b) term extension of 1,162 days. Dynamic Data is the owner by assignment of all right, title, and interest in the ‘054 Patent. A true and correct copy of the ‘054 Patent is attached hereto as Exhibit 11.

116. The ‘054 Patent discloses novel methods and apparatuses for estimating a current motion vector for a group of pixels of an image.

117. The inventions disclosed in the ‘054 Patent enable motion estimation with a relatively fast convergence in finding the appropriate motion vectors of the motion vector fields by adding a further candidate motion vector to the set of candidate motion vectors.

118. The ‘054 Patent discloses a motion estimation unit comprising a generating unit for generating a set of candidate motion vectors for the group of pixels, with the candidate motion vectors being extracted from a set of previously estimated motion vectors.

119. The ‘054 Patent discloses a motion estimation unit comprising a match error unit for calculating match errors of respective candidate motion vectors.

120. The ‘054 Patent discloses a motion estimation unit comprising a selector for selecting the current motion vector from the candidate motion vectors by comparing the match errors of the respective candidate motion vectors, characterized in that the motion estimation unit is arranged to add a further candidate motion vector to the set of candidate motion vectors by calculating the further candidate motion vector on the basis of a first motion vector and a second motion vector, both belonging to the set of previously estimated motion vectors.

121. The ‘054 Patent discloses a motion estimation unit that calculates the further candidate motion vector on the basis of the first motion vector and the second motion vector, with the first motion vector belonging to a first forward motion vector field and the second motion vector belonging to a second forward motion vector field, with the first forward motion vector field and the second forward motion vector field being different.

122. The ‘054 Patent discloses a motion estimation unit that arranges to calculate the further candidate motion vector by calculating a difference between the second motion vector and the first motion vector.

123. The ‘054 Patent Family has been cited by 14 patents and patent applications as relevant prior art. Specifically, patents and patent applications issued to the following companies have cited the ‘054 Patent Family as relevant prior art:

- Canon Inc.
- Huawei Technologies, Ltd.
- Imagination Technologies Ltd.
- MediaTek Inc.
- Panasonic Corp.
- Samsung Electronics Co., Ltd.
- Siemens Healthcare GmbH
- Tencent Technology (Shenzhen) Co., Ltd.

U.S. PATENT NO. 8,135,073

124. U.S. Patent No. 8,135,073 entitled, *Enhancing Video Images Depending on Prior Image Enhancements*, was filed on December 12, 2003, and claims priority to December 19, 2002. The ‘073 Patent is subject to a 35 U.S.C. § 154(b) term extension of 1,799 days. Dynamic Data is the owner by assignment of all right, title, and interest in the ‘073 Patent. A true and correct copy of the ‘073 Patent is attached hereto as Exhibit 12.

125. The ‘073 Patent discloses novel methods and systems for enhancing subsequent images of a video stream in which frames are encoded based on previous frames using prediction and motion estimation.

126. The inventions disclosed in the ‘073 Patent reduce the processing capacity required for providing video enhancements to video processing through re-mapping of previous frames for subsequent frames.

127. Accordingly, the technologies disclosed in the ‘073 Patent enable the provision of enhanced video pictures with minimal additional hardware costs for the components required to successfully process the video data.

128. The ‘073 Patent discloses a video decoder comprising an input for receiving a video stream containing encoded frame-based video information including an encoded first frame and an encoded second frame.

129. The ‘073 Patent discloses a video decoder comprising an input for receiving video information wherein the encoding of the second frame depends on the encoding of the first frame, the encoding of the second frame includes motion vectors indicating differences in positions between regions of the second frame and corresponding regions of the first frame, the motion vectors define correspondence between regions of the second frame and corresponding regions of the first frame.

130. The ‘073 Patent discloses a video decoder comprising a decoding unit for decoding the frames, wherein the decoding unit recovers the motion vectors for the second frame.

131. The ‘073 Patent discloses a video decoder comprising a processing component configured to determine a re-mapping strategy for video enhancement of the decoded first frame using a region-based analysis, re-map the first frame using the re-mapping strategy, and re-map one or more regions of the second frame depending on the re-mapping strategy for corresponding regions of the first frame.

132. The ‘073 Patent Family has been cited by 36 patents and patent applications as relevant prior art. Specifically, patents and patent applications issued to the following companies have cited the ‘073 Patent Family as relevant prior art:

- Canon Inc.
- Microsoft Corporation

- International Business Machines Corporation
- Qualcomm Inc.
- Digital Fountain Incorporated
- Samsung Electronics Co., Ltd.
- SK Planet Co. Ltd.

U.S. PATENT NO. 8,184,689

133. U.S. Patent No. 8,184,689 (the "'689 Patent") entitled, *Method Video Encoding And Decoding Preserving Cache Localities*, was filed on August 7, 2006, and claims priority to August 17, 2005. The '689 Patent is subject to a 35 U.S.C. § 154(b) term extension of 948 days. Dynamic Data is the owner by assignment of all right, title, and interest in the '689 Patent. A true and correct copy of the '689 Patent is attached hereto as Exhibit 13.

134. The '689 Patent discloses novel methods and apparatuses for encoding and decoding video data.

135. The inventions disclosed in the '689 Patent processing time and power consumption associated with encoding and decoding video stream data is reduced by reducing off-chip memory accesses through using simultaneous encoded/decoded images as a reference image for encoding/decoding at least one of the other simultaneously encoded/decoded images.

136. The '689 Patent discloses a method for encoding and decoding a video stream, including a plurality of images in a video processing apparatus having a processing unit coupled to a first memory, further comprising a second memory.

137. The '689 Patent discloses a method for encoding and decoding a video stream comprising providing a subset of image data stored in the second memory in the first memory.

138. The '689 Patent discloses a method for encoding and decoding a video stream comprising simultaneous encoding/decoding of more than one image of the video stream, by

accessing said subset, wherein the simultaneously encoding/decoding is performed by access sharing to at least one image.

139. The ‘689 Patent Family and its underlying patent application have been cited by several patents and patent applications as relevant prior art. Specifically, patents and patent applications issued to Fujitsu Ltd., Qualcomm Inc., Sony Corporation, Sun Patent Trust, and VIXS Systems Incorporated have all cited the ‘689 Patent Family as relevant prior art.

U.S. PATENT NO. 8,189,105

140. U.S. Patent No. 8,189,105 entitled, *Systems and Methods of Motion and Edge Adaptive Processing Including Motion Compensation Features,* was filed on October 17, 2007. The ‘105 Patent is subject to a 35 U.S.C. § 154(b) term extension of 1258 days. Dynamic Data is the owner by assignment of all right, title, and interest in the ’105 Patent. A true and correct copy of the ’105 Patent is attached hereto as Exhibit 14.

141. The ‘105 Patent discloses novel systems and methods for processing pixel information based on received motion and edge data.

142. The ‘105 Patent further discloses the use of a blending component (implemented by hardware, software, firmware, combinations thereof, etc.) that implements interpolating intensity of the pixel to equal to the first intensity estimate if motion reliability data is below a threshold.

143. The ‘105 Patent in one embodiment teaches using segmentation to average four contiguous pixels into one averaged pixel segment during motion detection.

144. The ’105 Patent Family has been cited by 46 patents and patent applications as relevant prior art. Specifically, patents and patent applications issued to the following companies have cited the ’105 Patent Family as relevant prior art:

- Flextronics Ap, LLC
- Qingdao Hisense Electronics Co., Ltd.
- Hon Hai Precision Industry Co., Ltd.
- Intel Corporation
- Sony Corporation
- Fujitsu Corporation
- Himax Media Solutions, Inc.
- Ati Technologies Ulc
- Sharp Kabushiki Kaisha
- Xerox Corporation

U.S. PATENT NO. 8,311,112

145. U.S. Patent No. 8,311,112 entitled, *System And Method For Video Compression Using Predictive Coding*, was filed on December 31, 2008. The '112 Patent is subject to a 35 U.S.C. § 154(b) term extension of 847 days. Dynamic Data is the owner by assignment of all right, title, and interest in the '112 Patent. A true and correct copy of the '112 Patent is attached hereto as Exhibit 15.

146. The '112 Patent discloses novel methods and systems for video compression.

147. The '112 Patent discloses novel technologies for video compression that perform predictive coding on a macroblock of a video frame such that a set of pixels of the macroblock is coded using some of the pixels from the same video frame as reference pixels and the rest of the macroblock is coded using reference pixels from at least one other video frame.

148. The '112 Patent discloses a system for video compression comprising an intra-frame coding unit configured to perform predictive coding on a set of pixels of a macroblock of pixels using a first group of reference pixels, the macroblock of pixels and the first group of reference pixels being from a video frame.

149. The '112 Patent discloses a system for video compression comprising an inter-frame coding unit configured to perform predictive coding on the rest of the macroblock of pixels

using a second group of reference pixels, the second group of reference pixels being from at least one other video frame.

150. The '112 Patent Family has been cited by 10 patents and patent applications as relevant prior art. Specifically, patents and patent applications issued to the following companies have cited the '112 Patent Family as relevant prior art:

- British Broadcasting Corporation
- Google LLC
- Megachips Corp.
- Olympus Corp.
- Samsung Electronics Co., Ltd.
- Sony Corporation
- Toshiba Corporation

COUNT I
INFRINGEMENT OF U.S. PATENT NO. 6,639,944

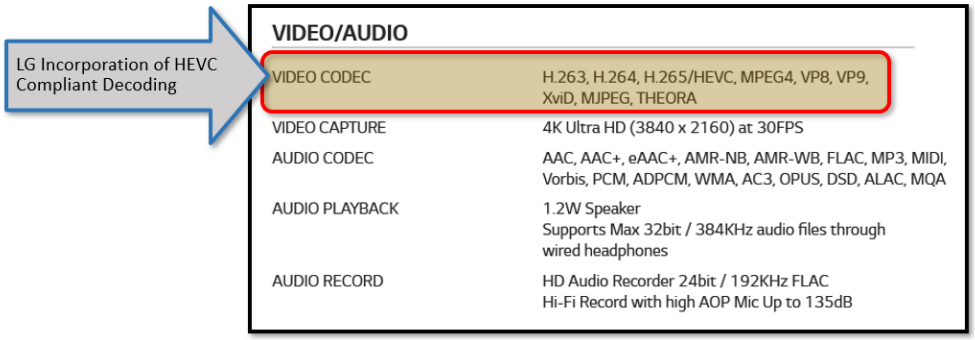
151. Dynamic Data references and incorporates by reference the preceding paragraphs of this Complaint as if fully set forth herein.

152. LG designs, makes, uses, sells, and/or offers for sale in the United States products and/or services for sub-pixel accurate motion vector estimation and motion-compensated interpolation or prediction.

153. LG designs, makes, sells, offers to sell, imports, and/or uses LG products that contain sub-pixel accurate motion vector functionality, including but not limited to LG products that contain and/or enable H.265 decode functionality, including: LG smart phones, LG OLED TVs, LG Super UHD 4K TVs, LG UHD 4K TVs, and LG digital signage products (collectively, the "LG '944 Products").

154. The accused LG '944 Products include the following LG smart phone models (which include functionality for decoding video content that is encoded in accord with the HEVC standard): LG US700, LG LMV405UA, LG Q610TA, LG K450, LG V350AWM, LG SP200, LG

Q710MS, LG 211BL, LG M154, LG X410TK, LG Q617QA, LG Q610MA, LG US701, LG M327, LG 255, LG H700, LG M430, LG L83BL, LG M257, LG X410ASR, LG Q710ULS, LG US601, LG M322, LG Q710ULM, LG Q710CS, LG V350ULM, LG X210ULMA, LG LM-X210ULMA-K8, LG LM-X210VPP, LG LMX220MA, LG Q710AL, LG US601 ACG, LG LMX210MA, LG LM-V405UA, and LG X212TAL.[27] The following excerpt from an exemplar specification of one of the accused LG smart phones identifies that it contains an HEVC decoder functionality.

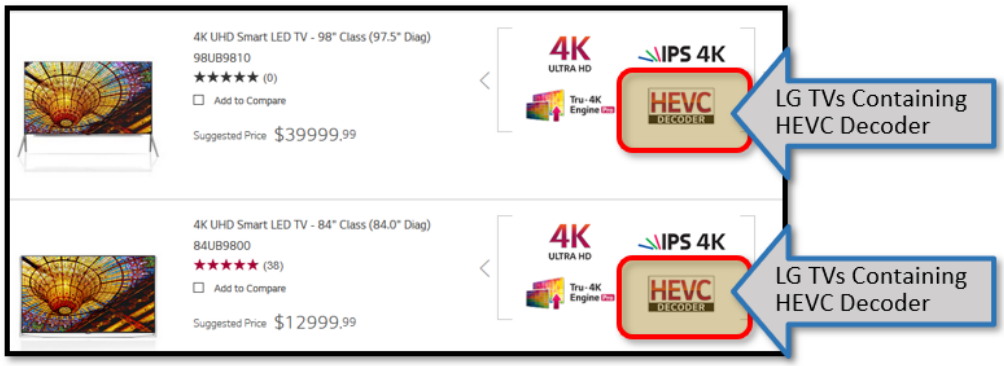


LG V30 SPECIFICATION SHEET at 1 (2017) (annotation added).

155. The accused LG '944 Products include the following LG television models: 60UF8500, 105UC9, 98UB9810, 84B9800, 40UB8000, 49UB8500, 55UB8500, 55UB8200, 65UB9200, 60UB8200, 98UB9800, 49UB8300, 55UB8300, 55UB9500, 65UB9500, 79UB9800, and 65UB9800.[28]

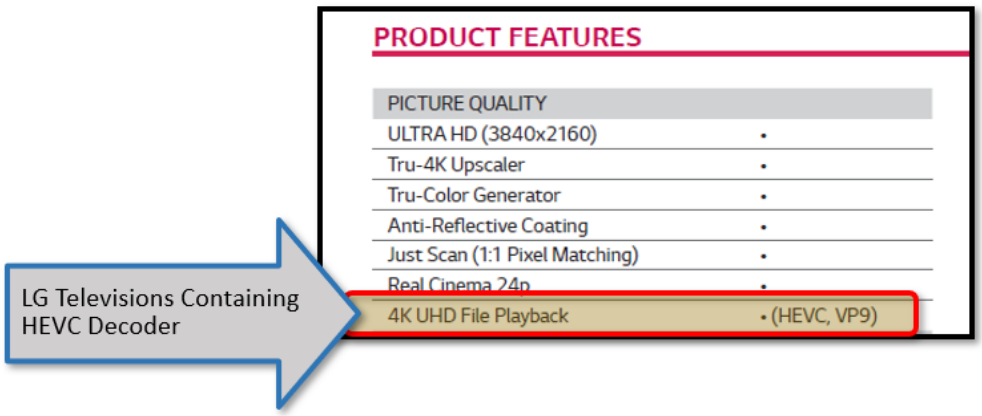
[27] *See e.g., LG Phones Website*, LG WEBSITE (last visited March 2019), *available at*: https://www.lg.com/us/cell-phones/all-cell-phones; LG G4 vs. Samsung Galaxy S6", GSMArena, June 19, 2015 (LG's G4 (2015), G5 (2015), and G6 (2017) phones support HEVC with UHD resolution [81], and the G5 and G6 support 10 bit video and 60 fps HFR).

[28] Tribbey, Chris, *CES 2017: LG Debuts ATSC 3.0-Enabled 4K TVs*, BROADCASTING AND CABLE, January 8, 2017.



LG Television Product Search, LG CONSUMER WEBSITE (last visited March 2018), *available at*: https://www.lg.com/us/search.lg?search=hevc (annotations added).

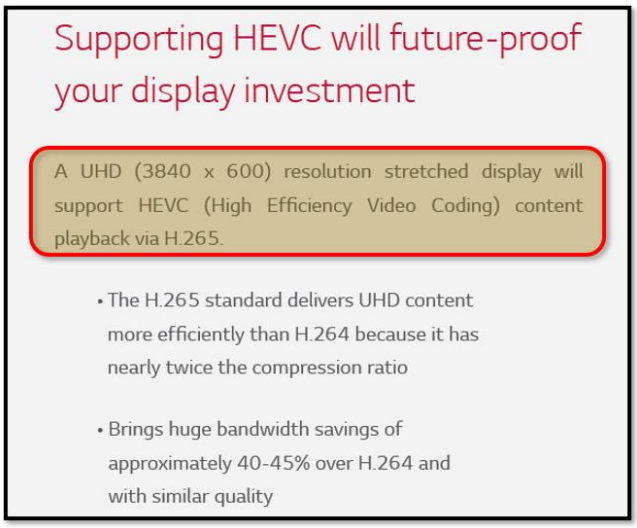
156. LG documentation identifies that the accused LG television products enable the playback of content that is encoded in the HEVC standard using an HEVC complaint decoder.



LG EG9600 4K UHD SMART CURVED OLET TV W/ WEBOS 2.0 & 3D SPECIFICATION at 1 (2015) (annotation added).

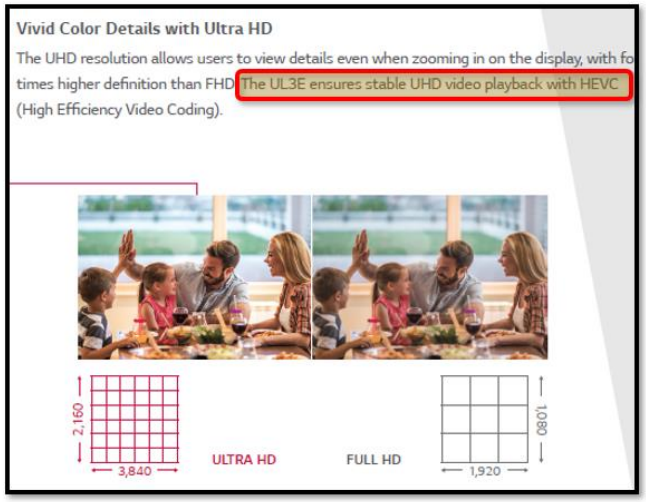
157. The accused LG '944 Products include the following LG digital signage products: UM3C, 75UH5C, 75UM3C, 60UL3E, 86UH5E-B, 55UH5B, 55VH7B, 55VM5B, 49VM5C, 55VX1D, 49UH5C, and 55UH5C.[29]

[29] *See e.g.*, *LG Business Solutions Digital Signage*, LG WEBSITE, *available at*: https://www.lg.com/us/business/commercial-display/displays-tvs/digital-signage/.



How to Stretch Customer Imagination with Digital Signage, LG BUSINESS SOLUTIONS DOCUMENTATION at 6 (2016) (annotation added).

158. The accused LG '944 Products are described in LG documentation as ensuring "stable UHD video playback with HEVC."



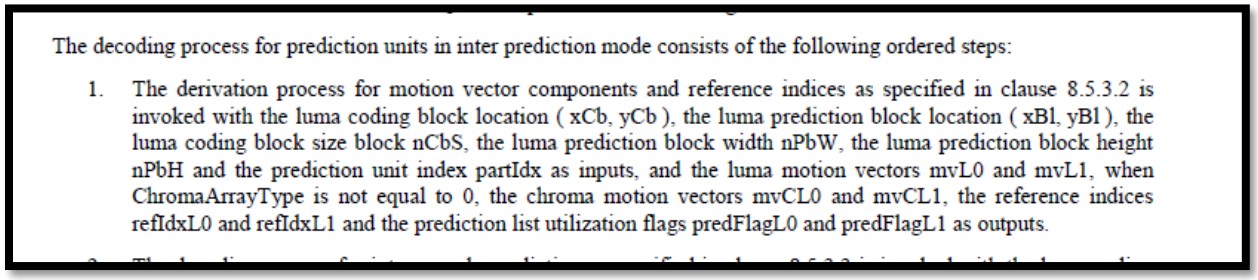
70UL3E 60UL3E Clear Color Expression of UHD Content Documentation, LG DOCUMENTATION at 2 (2018) (annotation added).

159. One or more LG subsidiaries and/or affiliates use the LG '944 Products in regular business operations.

160. The LG '944 Products perform a method of generating an intermediate image using sub-pixel accurate motion vectors having vector components that may have non-integer values,

from first and second images having a given mutual temporal distance, the intermediate image being at a fractional distance from said first image, said fractional distance being a fraction of said given mutual temporal distance.

161. The LG '944 Products comply with the HEVC standard, which requires determining motion vectors assigned to individual image regions of an image.



The decoding process for prediction units in inter prediction mode consists of the following ordered steps:

1. The derivation process for motion vector components and reference indices as specified in clause 8.5.3.2 is invoked with the luma coding block location (xCb, yCb), the luma prediction block location (xBl, yBl), the luma coding block size block nCbS, the luma prediction block width nPbW, the luma prediction block height nPbH and the prediction unit index partIdx as inputs, and the luma motion vectors mvL0 and mvL1, when ChromaArrayType is not equal to 0, the chroma motion vectors mvCL0 and mvCL1, the reference indices refIdxL0 and refIdxL1 and the prediction list utilization flags predFlagL0 and predFlagL1 as outputs.

High Efficiency Video Coding, SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 at § 8.5.3.1 (February 2018).

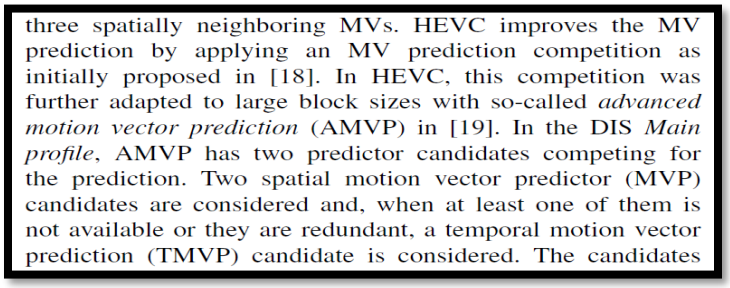
162. The LG '944 Products perform a method that includes deriving first and second vectors from said sub-pixel accurate motion vectors.

163. The LG '944 Products perform a method that includes generating an intermediate image by combining first positions in a first image shifted over first vectors and second positions in said second image shifted over second vectors.

> One way of achieving high video compression is to predict pixel values for a frame based on prior and succeeding pictures in the video. Like its predecessors, H.265 features the ability to predict pixel values between pictures, and in particular, to specify in which order pictures are coded and which pictures are predicted from which. The coding order is specified for Groups Of Pictures (GOP), where a number of pictures are grouped together and predicted from each other in a specified order. The pictures available to predict from, called reference pictures, are specified for every individual picture.

Johan Bartelmess, *Compression Efficiency of Different Picture Coding Structures in High Efficiency Video Coding (HEVC)*, UPTEC STS 16006 at 4 (March 2016) (emphasis added).

164. The LG '944 Products perform a method that includes deriving first and second vectors from sub-pixel accurate motion vectors by multiplying the vector components of the sub-pixel accurate motion vectors by a fraction to obtain fractional vector components.



three spatially neighboring MVs. HEVC improves the MV prediction by applying an MV prediction competition as initially proposed in [18]. In HEVC, this competition was further adapted to large block sizes with so-called *advanced motion vector prediction* (AMVP) in [19]. In the DIS *Main profile*, AMVP has two predictor candidates competing for the prediction. Two spatial motion vector predictor (MVP) candidates are considered and, when at least one of them is not available or they are redundant, a temporal motion vector prediction (TMVP) candidate is considered. The candidates

Philipp Helle, Simon Oudin, Benjamin Bross, Detlev Marpe, M. Oguz Bici, Kemal Ugur, Joel Jung, Gordon Clare, and Thomas Wiegand, *Block Merging for Quadtree-Based Partitioning in HEVC*, IEEE TRANS. CIR. AND SYS. FOR VIDEO TECHNOLOGY, Vol. *22* No. 12 (December 2012) ("AMVP has two predictor candidates competing for the prediction. Two spatial motion vector predictor (MVP) candidates are considered and, when at least one of them is not available or they are redundant, a temporal motion vector prediction (TMVP) candidate is considered.").

165. In AMVP, the motion vector selection process is composed of two steps wherein the candidate motion vectors are constructed into an index and then the motion vectors are compared. "In AMVP, the motion vector selection process is composed by two steps in encoder implementation. The first step is the motion vector candidate set construction process and the second step is the best motion vector selection step. In the first step, the motion vector candidate set is organized by selecting the motion vectors spatially and temporally." Gwo-Long Li, Chuen-Ching Wang, and Kuang-Hung Chiang, *An Efficient Motion Vector Prediction Method for Avoiding AMVP Data Dependency For HEVC*, 2014 IEEE INTERNATIONAL CONFERENCE ON ACOUSTIC, SPEECH AND SIGNAL PROCESSING (ICASSP) at 7412-13 (2014).

166. The LG '944 Products perform a method that includes deriving first and second vectors from sub-pixel accurate motion vectors by rounding the fractional vector components to obtain vector components of the first vectors, which have only integer vector components.

> Using a translational motion model, the position of the block in a previously decoded picture is indicated by a motion vector: Δx; Δy where Δx specifies the horizontal and Δy the vertical displacement relative to the position of the current block. The motion vectors: Δx; Δy could be of fractional sample accuracy to more accurately capture the movement of the underlying object. Interpolation is applied on the reference pictures to derive the prediction signal when the corresponding motion vector has fractional sample accuracy. The previously decoded picture is referred to as the reference picture and indicated by a reference index Δt to a reference picture list. These translational motion model parameters, i.e. motion vectors and reference indices, are further referred to as motion data.

Benjamin Bross, *Inter-Picture Prediction In HEVC*, IN HIGH EFFICIENCY VIDEO CODING (HEVC) (Vivienne Sze, Madhukar Budagavi, and Gary J. Sullivan (Editors)) at 114 (September 2014) (emphasis added).

167. The LG '944 Products perform a method that includes deriving first and second vectors from sub-pixel accurate motion vectors by subtracting the first vector from the candidate vector to obtain the second vector, whereby the second vectors have vector components that, depending on the candidate vector and the fraction, may have non-integer values.

168. The LG '944 Products contain functionality for motion compensation where two or more motion vectors can be applied. Further, one or two motion vectors can be applied to the image processing process. The application of the motion vectors leads to uni-predictive or bi-predictive coding, respectively, where bi-predictive coding uses an averaged result of two predictions to form the final prediction.

Summary

Recommendation ITU-T H.265 | International Standard ISO/IEC 23008-2 represents an evolution of the existing video coding Recommendations (ITU-T H.261, ITU-T H.262, ITU-T H.263 and ITU-T H.264) and was developed in response to the growing need for higher compression of moving pictures for various applications such as Internet streaming, communication, videoconferencing, digital storage media and television broadcasting. It is also designed to enable the use of the coded video representation in a flexible manner for a wide variety of network environments. The use of this Recommendation | International Standard allows motion video to be manipulated as a form of computer data and to be stored on various storage media, transmitted and received over existing and future networks and distributed on existing and future broadcasting channels.

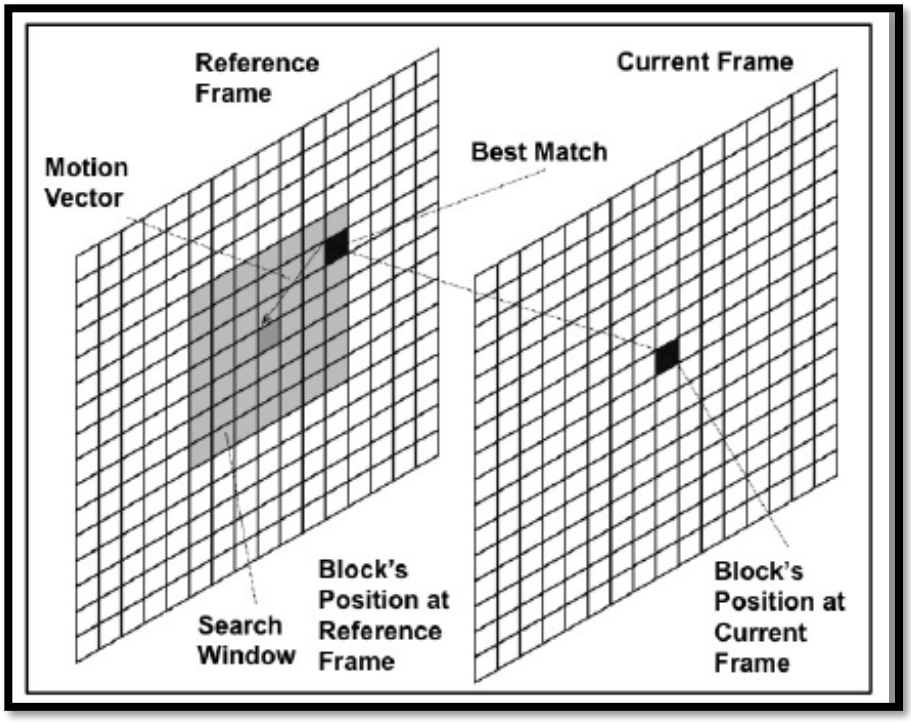
Series H: Audiovisual and Multimedia Systems- Infrastructure of Audiovisual Services – Coding of Moving Video, INTERNATIONAL TELECOMMUNICATIONS UNIONS - TU-T H.265, V.5 at I (February 2018).

169. The following excerpt from a book describes that the motion estimation is done through PU matching method and that the MV represents the displacement between the current PU in the current frame and the matching PU in the reference frame.

> Motion estimation compares the current prediction unit (PU) with the spatially neighboring PUs in the reference frames, and chooses the one with the least difference to the current PU. The displacement between the current PU and the matching PU in the reference frames is signaled using a motion vector.

Sung-Fang Tsai, *et al.*, *Encoder Hardware Architecture for HEVC*, High Efficiency Video Coding (HEVC) at 347 (September 2014) (emphasis added).

170. The following exemplary drawings reflect that the corresponding image segment of a reference picture is co-located with the current image segment of a current picture.



R.C. LINS, *et al.*, *A Faster Pixel-Decimation Method for Block Motion Estimation in H.264/AVC*, PUBLISHED IN TEND. MAT. APL. COMPUT., VOL. 15, NO. 1 at 120 (2014), *available at*: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S2179-84512014000100010.

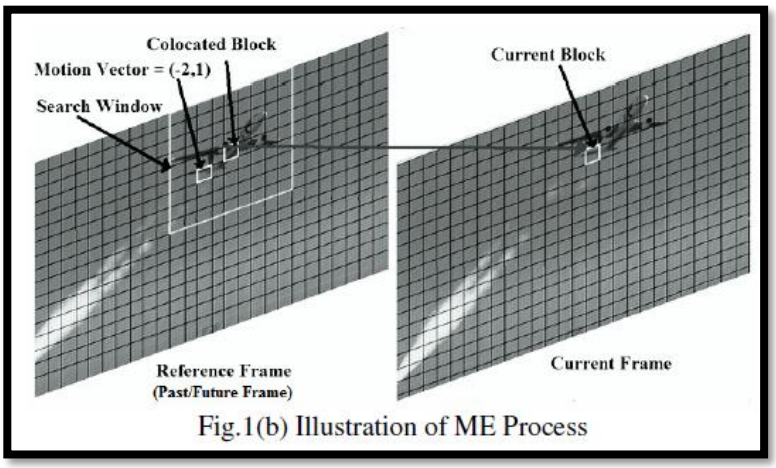


Fig.1(b) Illustration of ME Process

Purnachand Nalluri, *et al., Fast Motion Estimation Algorithm for HEVC Video Encoder*, published in 9TH CONFERENCE ON TELECOMMUNICATIONS, Vol. 1 at 1 (May 2013) (attached hereto as Exhibit_ZL 5), *available at*: https://www.it.pt/Publications/PaperConference/14332

171. For AMVP mode with motion estimation, the main goal of the motion estimation is to find the best matching block of each current PU and determine the real MV which represents the motion translation in the successive frame. The MV difference between the optimal AMVP candidate and the real MV derived from the motion estimation is encoded and transmitted together with other information, e.g., the optimal AMVP and reference frame indexes. The motion estimation is conducted in two stages, the integer motion estimation (IME) at integer pixel accuracy and the fractional motion estimation (FME) at subpixel accuracy. According to the "High Efficiency Video Coding (HEVC) Test Model 16 (HM 16) Improved Encoder Description Update 9" approved by JCT-VC, the best candidate MVP selected from the AMVP candidate list is used as an initial search center of the IME, which indicates that the search center of the IME is offset from the co-located block within the reference frame by the best candidate MVP.

172. Therefore, when the LG '944 Products processes the video data using AMVP mode based on the IME, the co-located block within the reference frame of the current PU corresponds to the selected image segment, and the best candidate MVP corresponds to the offset vector within

the reference frame from the co-located block of the current PU (i.e., the selected image segment) to the search center.

> To derive the motion vector(s) for each PU, a block matching algorithm is performed in the HM encoder. For AMVP, find the best candidate MV predictor for each ref_idx and ref_pic_list using xEstimateMvPredAMVP(), called from predInterSearch(). The default search range for the first search in the HM encoder is 96 integer pixels, however the CTC [3] uses a value of 64. A search window is defined according to the search range, relative to the **best candidate MV predictor**. Firstly an integer-pel search is performed, followed by a fractional-pel refinement search.

The Joint Collaborative Team on Video Coding (JCT-VC), *High Efficiency Video Coding (HEVC) Test Model 16 (HM 16) Improved Encoder Description Update 9*, ISO/IEC JTC1/SC29/WG11 N17047 at 43 (July 2017) (emphasis added), *available at*: https://mpeg.chiariglione.org/standards/mpeg-h/high-efficiency-video-coding/n17047-high-efficiency-video-coding-hevc-test-model-16.

173. By complying with the HEVC standard, the LG '944 Products necessarily infringe the '944 patent. The mandatory sections of the HEVC standard require the elements required by certain claims of the '944 patent, including but not limited to claim 2 of the '944 patent. *High Efficiency Video Coding*, SERIES H: AUDIOVISUAL AND Multimedia SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 (February 2018) (The following sections of the HEVC Standard are relevant to LG's infringement of the '944 patent: "8.3.2 Decoding process for reference picture set;" "8.5.4 Decoding process for the residual signal of coding units coded in inter prediction mode;" "8.6 Scaling, transformation and array construction process prior to deblocking filter process;" "8.5.2 Inter prediction process;" "8.5.3 Decoding process for prediction units in inter prediction mode;" and "8.7.2 Deblocking filter process;" "8.7.3 Sample adaptive offset process.").

174. The LG '944 Products perform a method that includes deriving first and second vectors from said sub-pixel accurate motion vectors.

175. The LG ‘944 Products perform a method that includes generating an intermediate image by combining first positions in a first image shifted over first vectors and second positions in said second image shifted over second vectors.

176. The LG ‘944 Products perform a method that includes deriving first and second vectors from sub-pixel accurate motion vectors by multiplying the vector components of the sub-pixel accurate motion vectors by a fraction to obtain fractional vector components.

177. The LG ‘944 Products perform a method that includes deriving first and second vectors from sub-pixel accurate motion vectors by rounding the fractional vector components to obtain vector components of the first vectors, which have only integer vector components.

178. The LG ‘944 Products perform a method that includes deriving first and second vectors from sub-pixel accurate motion vectors by subtracting the first vector from the candidate vector to obtain the second vector, whereby the second vectors have vector components that, depending on the candidate vector and the fraction, may have non-integer values.

179. The LG ’944 Products are available to businesses and individuals throughout the United States.

180. The LG ’944 Products are provided to businesses and individuals located in the Eastern District of Texas.

181. By making, using, testing, offering for sale, and/or selling products and services for sub-pixel accurate motion vector estimation and motion-compensated interpolation or prediction, including but not limited to the LG ’944 Products, LG has injured Dynamic Data and is liable to the Plaintiff for directly infringing one or more claims of the ‘944 patent, including at least claim 2 pursuant to 35 U.S.C. § 271(a).

182. LG also indirectly infringes the '944 patent by actively inducing infringement under 35 USC § 271(b).

183. LG has had knowledge of the '944 patent since at least service of this First Amended Complaint or shortly thereafter, and on information and belief, LG knew of the '944 patent and knew of its infringement, including by way of this lawsuit.

184. LG intended to induce patent infringement by third-party customers and users of the LG '944 Products and had knowledge that the inducing acts would cause infringement or was willfully blind to the possibility that its inducing acts would cause infringement. LG specifically intended and was aware that the normal and customary use of the accused products would infringe the '944 patent. LG performed the acts that constitute induced infringement, and would induce actual infringement, with knowledge of the '944 patent and with the knowledge that the induced acts would constitute infringement. For example, LG provides the LG '944 Products that have the capability of operating in a manner that infringe one or more of the claims of the '944 patent, including at least claim 2, and LG further provides documentation and training materials that cause customers and end users of the LG '944 Products to utilize the products in a manner that directly infringe one or more claims of the '944 patent.[30] By providing instruction and training to customers and end-users on how to use the LG '944 Products in a manner that directly infringes

[30] *See, e.g.*, *Large Ultra HD Signage: UM3C Series*, LG SPECIFICATION SHEET (2018); *Multiple Screen Split-Ultra HD Signage: Ultra HD UH5C Series*, LG SPECIFICATION SHEET (2016); *LG Help Library: Ultra HD 4K Upscaling – UHD TV Video*, LG Support Website (last visited March 2019), available at: https://www.lg.com/us/support/product-help/CT10000018-1432737109927-general-specifications; *98UB9800, 98UB9810, 105UC9,* OWNER'S MANUAL LED TV, *available at*: https://www.lg.com/us/support-product/lg-98UB9810 (last visited Nov. 2018); *40UB8000, 49UB8200, 55UB8200, 60UB8200, 49UB8300, 55UB8300, 65UB9200*, OWNER'S MANUAL LED TV, *available at*: https://www.lg.com/us/support-product/lg-55UB8200 (last visited Nov. 2018); *50UH5500, 50UH5530, 65UH5500,* OWNER'S MANUAL SAFETY AND REFERENCE LED TV, *available at*: https://www.lg.com/us/support-product/lg-50UH5530 (last visited Nov. 2018); *LM-V405AQ*, USER GUIDE (2018); *LM-V35OULM*, USER GUIDE (2018); *LG Stylo 4 LM-Q71OULM*, USER GUIDE (2018); *LG V30*, USER GUIDE (2018); *LM-X410AS*, USER GUIDE (2018).

one or more claims of the '944 patent, including at least claim 2, LG specifically intended to induce infringement of the '944 patent. LG engaged in such inducement to promote the sales of the LG '944 Products, e.g., through LG user manuals, product support, marketing materials, and training materials to actively induce the users of the accused products to infringe the '944 patent. Accordingly, LG has induced and continues to induce users of the accused products to use the accused products in their ordinary and customary way to infringe the '944 patent, knowing that such use constitutes infringement of the '944 patent.

185. The '944 patent is well-known within the industry as demonstrated by multiple citations to the '944 patent in published patents and patent applications assigned to technology companies and academic institutions.

186. LG is utilizing the technology claimed in the '944 patent without paying a reasonable royalty. LG is infringing the '944 patent in a manner best described as willful, wanton, malicious, in bad faith, deliberate, consciously wrongful, flagrant, or characteristic of a pirate.

187. To the extent applicable, the requirements of 35 U.S.C. § 287(a) have been met with respect to the '944 patent. As a result of LG's infringement of the '944 patent, Dynamic Data has suffered monetary damages, and seeks recovery in an amount adequate to compensate for LG's infringement, but in no event less than a reasonable royalty for the use made of the invention by LG together with interest and costs as fixed by the Court.

COUNT II
INFRINGEMENT OF U.S. PATENT NO. 6,760,376

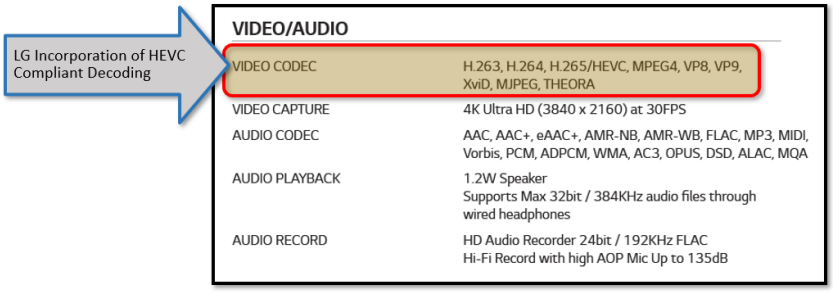
188. Dynamic Data references and incorporates by reference the preceding paragraphs of this Complaint as if fully set forth herein.

189. LG designs, makes, sells, offers to sell, imports, and/or uses LG products that contain sub-pixel accurate motion vector functionality, including but not limited to LG products

that contain and/or enable H.265 decode functionality, including: LG smart phones, LG OLED TVs, LG Super UHD 4K TVs, LG UHD 4K TVs, and LG digital signage products (collectively, the "LG '376 Products").

190. The LG '376 Products comprise an input for receiving encoded data and a decoder that is compliant with the H.265 standard.

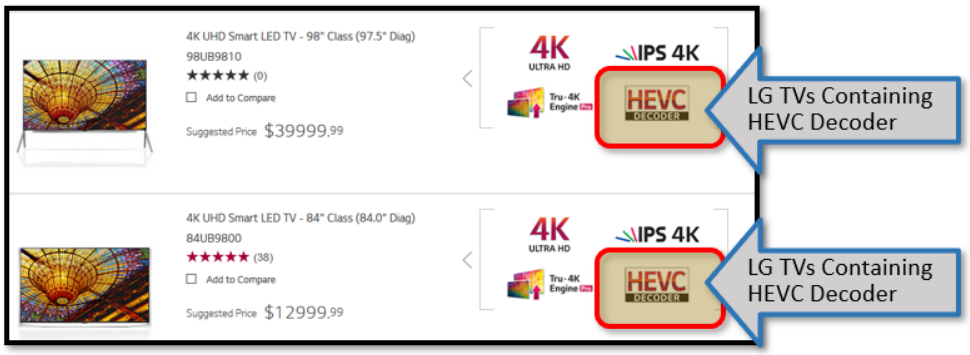
191. The accused LG '376 Products include the following LG smart phone models (which include functionality for decoding video content that is encoded in accord with the HEVC standard): LG US700, LG LMV405UA, LG Q610TA, LG K450, LG V350AWM, LG SP200, LG Q710MS, LG 211BL, LG M154, LG X410TK, LG Q617QA, LG Q610MA, LG US701, LG M327, LG 255, LG H700, LG M430, LG L83BL, LG M257, LG X410ASR, LG Q710ULS, LG US601, LG M322, LG Q710ULM, LG Q710CS, LG V350ULM, LG X210ULMA, LG LM-X210ULMA-K8, LG LM-X210VPP, LG LMX220MA, LG Q710AL, LG US601 ACG, LG LMX210MA, LG LM-V405UA, and LG X212TAL.[31] The following excerpt from an exemplar specification of one of the accused LG smart phones identifies that it contains an HEVC decoder functionality.



LG V30 SPECIFICATION SHEET at 1 (2017) (annotation added).

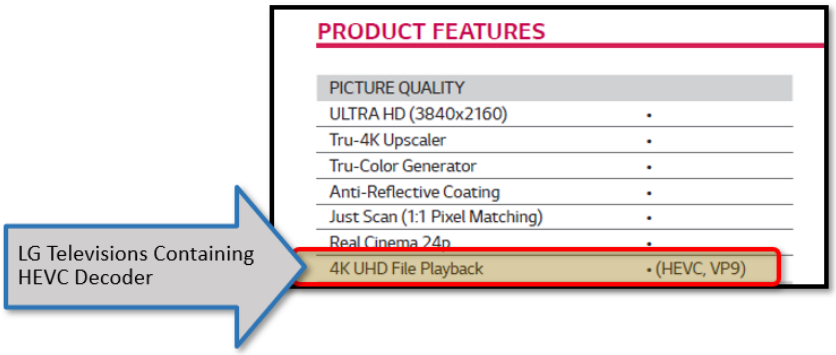
[31] *See e.g., LG Phones Website*, LG WEBSITE (last visited March 2019), *available at*: https://www.lg.com/us/cell-phones/all-cell-phones; LG G4 vs. Samsung Galaxy S6", GSMArena, June 19, 2015 (LG's G4 (2015), G5 (2015), and G6 (2017) phones support HEVC with UHD resolution [81], and the G5 and G6 support 10 bit video and 60 fps HFR).

192. The accused LG '376 Products include the following LG television models: 60UF8500, 105UC9, 98UB9810, 84B9800, 40UB8000, 49UB8500, 55UB8500, 55UB8200, 65UB9200, 60UB8200, 98UB9800, 49UB8300, 55UB8300, 55UB9500, 65UB9500, 79UB9800, and 65UB9800.[32]



LG Television Product Search, LG CONSUMER WEBSITE (last visited March 2018), *available at*: https://www.lg.com/us/search.lg?search=hevc (annotations added).

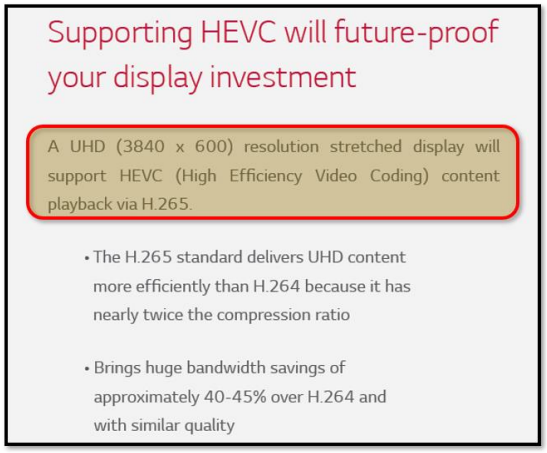
193. LG documentation identifies that the accused LG television products enable the playback of content that is encoded in the HEVC standard using an HEVC complaint decoder.



LG EG9600 4K UHD SMART CURVED OLET TV W/ WEBOS 2.0 & 3D SPECIFICATION at 1 (2015) (annotation added).

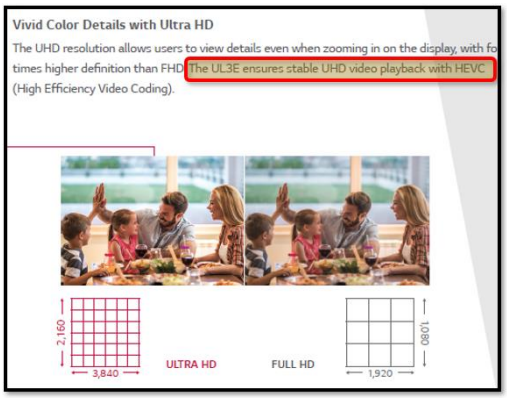
[32] Tribbey, Chris, *CES 2017: LG Debuts ATSC 3.0-Enabled 4K TVs*, BROADCASTING AND CABLE, January 8, 2017.

194. The accused LG '376 Products include the following LG digital signage products: UM3C, 75UH5C, 75UM3C, 60UL3E, 86UH5E-B, 55UH5B, 55VH7B, 55VM5B, 49VM5C, 55VX1D, 49UH5C, and 55UH5C.[33]



How to Stretch Customer Imagination With Digital Signage, LG BUSINESS SOLUTIONS DOCUMENTATION at 6 (2016).

195. The accused LG '376 Products are described in LG documentation as ensuring "stable UHD video playback with HEVC."



70UL3E 60UL3E Clear Color Expression of UHD Content Documentation, LG DOCUMENTATION at 2 (2018) (annotation added).

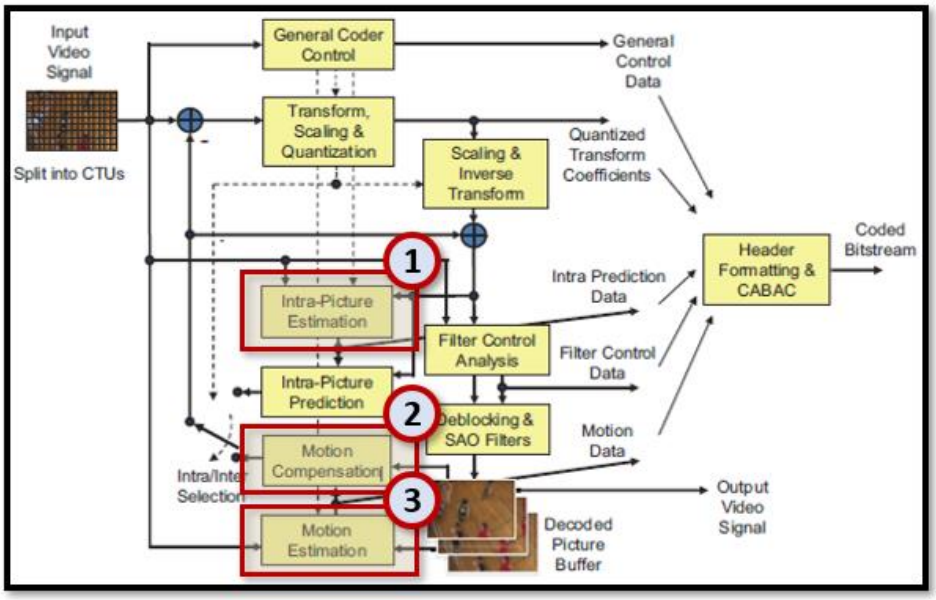
196. One or more LG subsidiaries and/or affiliates use the LG '376 Products in regular business operations.

[33] *See e.g.*, *LG Business Solutions Digital Signage*, LG WEBSITE, *available at*: https://www.lg.com/us/business/commercial-display/displays-tvs/digital-signage/.

197. One or more of the LG '376 Products include technology for motion compensated upconversion in a video image that uses motion compensation to generate an interpolated video field using motion vectors.

198. One or more of the LG '376 Products use upconversion units to generate an interpolated field using motion vectors to in the process of performing motion compensation.

199. The LG '376 Products use upconversion units within an image retrieved from memory. The frames are then processed using both motion compensation and motion estimation. The motion compensation functionality used by the LG '376 Products include quarter-sample precision for the motion vectors and 7-tap or 8-tap filters that are used for interpolation of fractional-sample positions.



Standardized Extensions of High Efficiency Video Coding (HEVC), IEEE JOURNAL OF SELECTED TOPICS IN SIGNAL PROCESSING, VOL. 7, NO. 6 at 1002 (December 2013) (emphasis added) (the annotations showing (1) intra-picture prediction, (2) motion compensation, and (3) motion estimation).

200. The LG '376 Products calculate a correlation value from the values of causal neighbor pixels of a generated field and from the values of corresponding neighbor pixels of a next field.

> It can be seen from Fig. 5.4b that only motion vectors from spatial neighboring blocks to the left and above the current block are considered as spatial MVP candidates. This can be explained by the fact that the blocks to the right and below the current block are not yet decoded and hence, their motion data is not available. Since the co-located picture is a reference picture which is already decoded, it is possible to also consider motion data from the block at the same position, from blocks to the right of the co-located block or from the blocks below**.** In HEVC, the block to the bottom right and at the center of the current block have been determined to be the most suitable to provide a good temporal motion vector predictor (TMVP).

Benjamin Bross, *et al., Inter-picture prediction in HEVC,* in HIGH EFFICIENCY VIDEO CODING (HEVC) at 119 (2014) (emphasis added).

201. The LG ’376 Products compare the correlation value with a threshold value.

> Motion estimation compares the current prediction unit (PU) with the spatially neighboring PUs in the reference frames, and chooses the one with the least difference to the current PU. The displacement between the current PU and the matching PU in the reference frames is signaled using a motion vector.

Sung-Fang Tsai, *et al., Encoder Hardware Architecture for HEVC*, HIGH EFFICIENCY VIDEO CODING (HEVC) at 347 (September 2014) (emphasis added).

202. The LG ’376 Products set the value of a pixel to be created within the generated field to be equal to the value of a corresponding pixel of the next field if the correlation value is less than the threshold value.

203. LG has directly infringed and continues to directly infringe the ‘376 patent by, among other things, making, using, offering for sale, and/or selling technology for motion compensated upconversion in a video image that uses motion compensation to generate an interpolated video field using motion vectors, including but not limited to the LG ’376 Products.

204. By complying with the HEVC standard, the LG products – such as the LG ‘376 Products – necessarily infringe the ‘376 patent. The mandatory sections of the HEVC standard require the elements required by certain claims of the ‘376 patent, including but not limited to claim 4 of the ‘376 patent. *High Efficiency Video Coding*, SERIES H: AUDIOVISUAL AND Multimedia SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 (February 2018) (The following sections of the HEVC Standard are relevant to

LG's infringement of the '376 patent: "8.3.2 Decoding process for reference picture set;" "8.5.4 Decoding process for the residual signal of coding units coded in inter prediction mode;" "8.6 Scaling, transformation and array construction process prior to deblocking filter process;" "8.5.2 Inter prediction process;" "8.5.3 Decoding process for prediction units in inter prediction mode;" and "8.7.2 Deblocking filter process;" "8.7.3 Sample adaptive offset process.").

205. The LG '376 Products perform a method of motion compensation for use in a video image upconversion unit of the type that uses motion compensation to generate an interpolated field using motion vectors.

206. The LG '376 Products perform a method of motion compensation that includes calculating a correlation value from the values of causal neighbor pixels of a generated field and from the values of corresponding neighbor pixels of a next field.

207. The LG '376 Products perform a method of motion compensation that includes comparing the correlation value with a threshold value.

208. The LG '376 Products perform a method of motion compensation that includes setting the value of a pixel to be created within the generated field to be equal to the value of a corresponding pixel of the next field if the correlation value is less than the threshold value.

209. The LG '376 Products are available to businesses and individuals throughout the United States.

210. The LG '376 Products are provided to businesses and individuals located in the Eastern District of Texas.

211. By making, using, testing, offering for sale, and/or selling products and services for motion compensated upconversion in a video image that uses motion compensation to generate an interpolated video field using motion vectors, including but not limited to the LG '376 Products,

LG has injured Dynamic Data and is liable to the Plaintiff for directly infringing one or more claims of the '376 patent, including at least claim 4 pursuant to 35 U.S.C. § 271(a).

212. LG has also indirectly infringed the '376 patent by actively inducing infringement under 35 USC § 271(b).

213. LG has had knowledge of the '376 patent since at least service of this First Amended Complaint or shortly thereafter, and on information and belief, LG knew of the '376 patent and knew of its infringement, including by way of this lawsuit.

214. One or more LG subsidiaries and/or affiliates use the LG '376 Products in regular business operations.

215. LG intended to induce patent infringement by third-party customers and users of the LG '376 Products and had knowledge that the inducing acts would cause infringement or was willfully blind to the possibility that its inducing acts would cause infringement. LG specifically intended and was aware that the normal and customary use of the accused products would infringe the '376 patent. LG performed the acts that constitute induced infringement, and would induce actual infringement, with knowledge of the '376 patent and with the knowledge that the induced acts would constitute infringement. For example, LG provides the LG '376 Products that have the capability of operating in a manner that infringe one or more of the claims of the '376 patent, including at least claim 4, and LG further provides documentation and training materials that cause customers and end users of the LG '376 Products to utilize the products in a manner that directly infringe one or more claims of the '376 patent.[34] By providing instruction and training to

[34] *See, e.g.*, *Large Ultra HD Signage: UM3C Series*, LG SPECIFICATION SHEET (2018); *Multiple Screen Split-Ultra HD Signage: Ultra HD UH5C Series*, LG SPECIFICATION SHEET (2016); *LG Help Library: Ultra HD 4K Upscaling – UHD TV Video*, LG Support Website (last visited March 2019), available at: https://www.lg.com/us/support/product-help/CT10000018-1432737109927-general-specifications; *98UB9800, 98UB9810, 105UC9*, OWNER'S MANUAL LED TV, *available at*: https://www.lg.com/us/support-product/lg-98UB9810 (last visited Nov.

customers and end-users on how to use the LG '376 Products in a manner that directly infringes one or more claims of the '376 patent, including at least claim 4, LG specifically intended to induce infringement of the '376 patent. LG engaged in such inducement to promote the sales of the LG '376 Products, e.g., through LG user manuals, product support, marketing materials, and training materials to actively induce the users of the accused products to infringe the '376 patent. Accordingly, LG has induced and continues to induce users of the accused products to use the accused products in their ordinary and customary way to infringe the '376 patent, knowing that such use constitutes infringement of the '376 patent.

216. The '376 patent is well-known within the industry as demonstrated by multiple citations to the '376 patent in published patents and patent applications assigned to technology companies and academic institutions. LG is utilizing the technology claimed in the '376 patent without paying a reasonable royalty. LG is infringing the '376 patent in a manner best described as willful, wanton, malicious, in bad faith, deliberate, consciously wrongful, flagrant, or characteristic of a pirate.

217. To the extent applicable, the requirements of 35 U.S.C. § 287(a) have been met with respect to the '376 patent. As a result of LG's infringement of the '376 patent, Dynamic Data has suffered monetary damages, and seeks recovery in an amount adequate to compensate for LG's infringement, but in no event less than a reasonable royalty for the use made of the invention by LG together with interest and costs as fixed by the Court.

2018); *40UB8000, 49UB8200, 55UB8200, 60UB8200, 49UB8300, 55UB8300, 65UB9200*, OWNER'S MANUAL LED TV, *available at*: https://www.lg.com/us/support-product/lg-55UB8200 (last visited Nov. 2018); *50UH5500, 50UH5530, 65UH5500*, OWNER'S MANUAL SAFETY AND REFERENCE LED TV, *available at*: https://www.lg.com/us/support-product/lg-50UH5530 (last visited Nov. 2018); *LM-V405AQ*, USER GUIDE (2018); *LM-V35OULM*, USER GUIDE (2018); *LG Stylo 4 LM-Q71OULM*, USER GUIDE (2018); *LG V30*, USER GUIDE (2018); *LM-X410AS*, USER GUIDE (2018).

COUNT III
INFRINGEMENT OF U.S. PATENT NO. 6,774,918

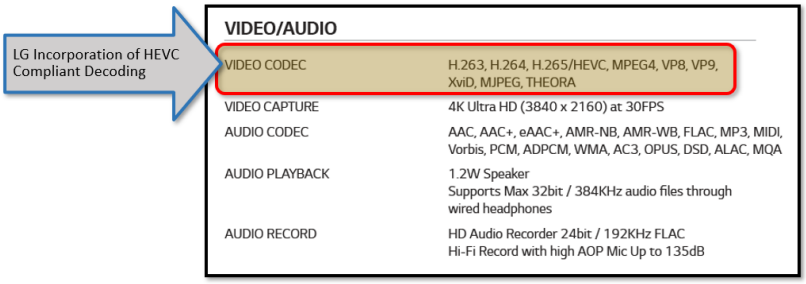
218. Dynamic Data references and incorporates by reference the preceding paragraphs of this Complaint as if fully set forth herein.

219. LG designs, makes, uses, sells, and/or offers for sale in the United States products and/or services for image processing.

220. LG designs, makes, sells, offers to sell, imports, and/or uses LG products that contain sub-pixel accurate motion vector functionality, including but not limited to LG products that contain and/or enable H.265 decode functionality, including: LG smart phones, LG OLED TVs, LG Super UHD 4K TVs, LG UHD 4K TVs, and LG digital signage products (collectively, the "LG '918 Products").

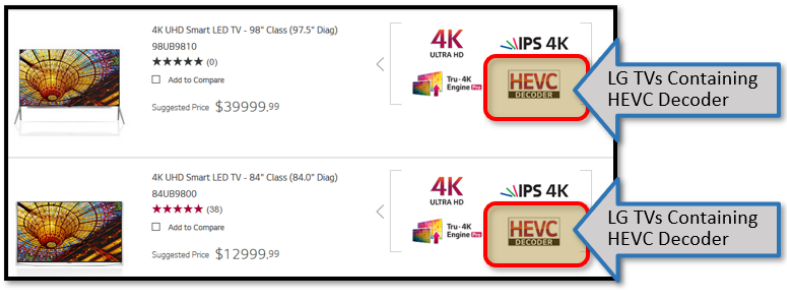
221. The accused LG '918 Products include the following LG smart phone models (which include functionality for decoding video content that is encoded in accord with the HEVC standard): LG US700, LG LMV405UA, LG Q610TA, LG K450, LG V350AWM, LG SP200, LG Q710MS, LG 211BL, LG M154, LG X410TK, LG Q617QA, LG Q610MA, LG US701, LG M327, LG 255, LG H700, LG M430, LG L83BL, LG M257, LG X410ASR, LG Q710ULS, LG US601, LG M322, LG Q710ULM, LG Q710CS, LG V350ULM, LG X210ULMA, LG LM-X210ULMA-K8, LG LM-X210VPP, LG LMX220MA, LG Q710AL, LG US601 ACG, LG LMX210MA, LG LM-V405UA, and LG X212TAL.[35] The following excerpt from an exemplar specification of one of the accused LG smart phones identifies that it contains an HEVC decoder functionality.

[35] *See e.g., LG Phones Website*, LG WEBSITE (last visited March 2019), *available at*: https://www.lg.com/us/cell-phones/all-cell-phones; LG G4 vs. Samsung Galaxy S6", GSMArena, June 19, 2015 (LG's G4 (2015), G5 (2015), and G6 (2017) phones support HEVC with UHD resolution [81], and the G5 and G6 support 10 bit video and 60 fps HFR).



LG V30 SPECIFICATION SHEET at 1 (2017) (annotation added).

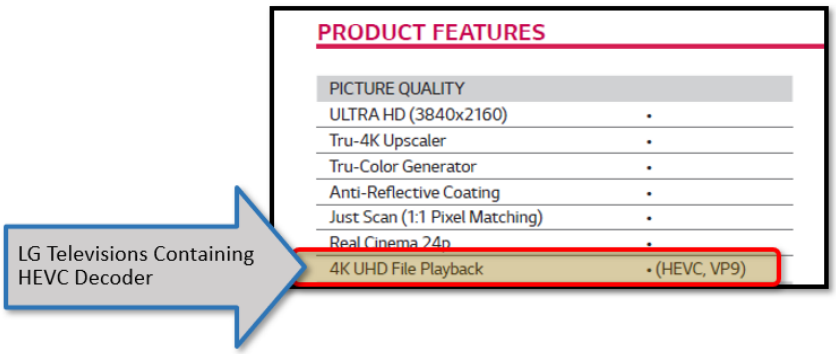
222. The accused LG '918 Products include the following LG television models: 60UF8500, 105UC9, 98UB9810, 84B9800, 40UB8000, 49UB8500, 55UB8500, 55UB8200, 65UB9200, 60UB8200, 98UB9800, 49UB8300, 55UB8300, 55UB9500, 65UB9500, 79UB9800, and 65UB9800.[36]



LG Television Product Search, LG CONSUMER WEBSITE (last visited March 2018), *available at*: https://www.lg.com/us/search.lg?search=hevc (annotations added).

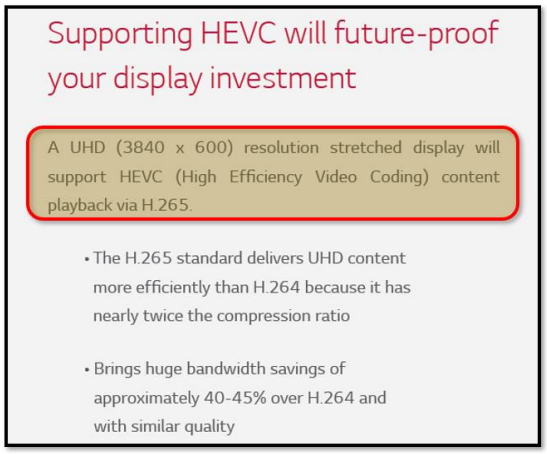
223. LG documentation identifies that the accused LG television products enable the playback of content that is encoded in the HEVC standard using an HEVC complaint decoder.

[36] Tribbey, Chris, *CES 2017: LG Debuts ATSC 3.0-Enabled 4K TVs*, BROADCASTING AND CABLE, January 8, 2017.



LG EG9600 4K UHD SMART CURVED OLET TV W/ WEBOS 2.0 & 3D SPECIFICATION at 1 (2015) (annotation added).

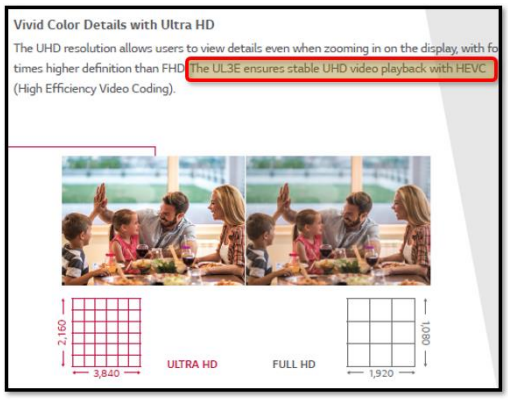
224. The accused LG '918 Products include the following LG digital signage products: UM3C, 75UH5C, 75UM3C, 60UL3E, 86UH5E-B, 55UH5B, 55VH7B, 55VM5B, 49VM5C, 55VX1D, 49UH5C, and 55UH5C.[37]



How to Stretch Customer Imagination With Digital Signage, LG BUSINESS SOLUTIONS DOCUMENTATION at 6 (2016).

225. The accused LG '918 Products are described in LG documentation as ensuring "stable UHD video playback with HEVC."

[37] *See e.g., LG Business Solutions Digital Signage*, LG WEBSITE, *available at*: https://www.lg.com/us/business/commercial-display/displays-tvs/digital-signage/.



70UL3E 60UL3E Clear Color Expression of UHD Content Documentation, LG DOCUMENTATION at 2 (2018) (annotation added).

226. The LG '918 Products contain functionality for downloading on-screen display (OSD) data for generating an image on a display device. Specifically, the LG '918 Products have an input for receiving frame-based encoded video information. The LG '918 Products receive frame-based encoded video information in the form of video data that is encoded in the High Efficiency Video Coding (HEVC/H.265) format set by the ITU-T Video Coding Experts Group.

227. By complying with the HEVC standard, the LG devices – such as the LG '918 Products – necessarily infringe the '918 patent. Mandatory sections of the HEVC standard require the elements required by certain claims of the '918 patent, including but not limited to claim 18. High Efficiency Video Coding, Series H: Audiovisual And Multimedia Systems: Infrastructure Of Audiovisual Services – Coding Of Moving Video Rec. ITU-T H.265 (February 2018). The following sections of the HEVC Standard are relevant to LG's infringement of the '918 patent: "5.3 Logical operators;" "5.10 Variables, syntax elements and tables;" "5.11 Text description of logical operations;" "7.2 Specification of syntax functions and descriptors;" "7.3.1 NAL unit syntax;" "7.3.2 Raw byte sequence payloads, trailing bits and byte alignment syntax;" "7.3.5 Supplemental enhancement information message syntax;" "7.4.2 NAL unit semantics;" and "7.4.6 Supplemental enhancement information message semantics."

228. The LG '918 Products receive a bitstream in which the data is segmented into Network Abstraction Layer ("NAL") Units. NAL Units are segments of data that can include video data and overlay data (such as captions and overlay images). The LG '918 Products support the receipt of VCL and non-VCL NAL units. The VCL NAL units contain the data that represents the values of the samples in the video pictures, and the non-VCL NAL units contain any associated additional information such as parameter sets or overlay data.

> HEVC uses a NAL unit based bitstream structure. A coded bitstream is partitioned into NAL units which, when conveyed over lossy packet networks, should be smaller than the maximum transfer unit (MTU) size. Each NAL unit consists of a NAL unit header followed by the NAL unit payload. There are two conceptual classes of NAL units. Video coding layer (VCL) NAL units containing coded sample data, e.g., coded slice NAL units, whereas non-VCL NAL units that contain metadata typically belonging to more than one coded picture, or where the association with a single coded picture would be meaningless, such as parameter set NAL units, or where the information is not needed by the decoding process, such as SEI NAL units.

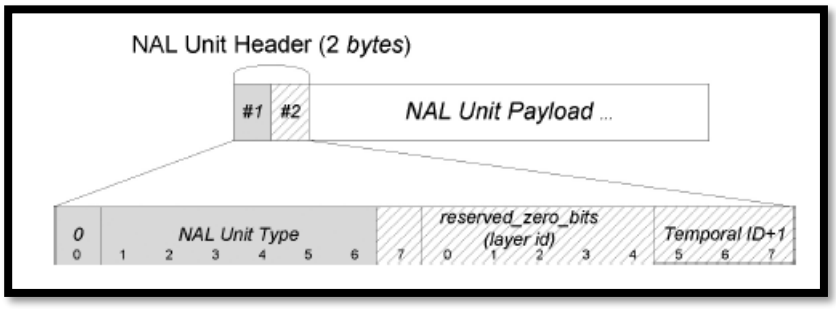
Rickard Sjöberg, et al., *Overview of HEVC High-Level Syntax and Reference Picture Management*, IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, Vol. 22, No. 12 at 1859 (December 2012) (emphasis added).

229. The VCL NAL Units contain segments of data which are used to generate an image (*e.g.*, HEVC image) on a display device. Each VCL NAL Unit comprises a discrete number of bites which make up a segment. The following excerpt from the HEVC specification describes the NAL unit as being a segment with a "demarcation" setting forth where the segment ends and begins:

> NumBytesInNalUnit specifies the size of the NAL unit in bytes. This value is required for decoding of the NAL unit. Some form of demarcation of NAL unit boundaries is necessary to enable inference of NumBytesInNalUnit. One such demarcation method is specified in Annex B for the byte stream format. Other methods of demarcation may be specified outside of this Specification.

High Efficiency Video Coding, SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 at § 7.4.2.1 (February 2018) (emphasis added).

230. VCL NAL Units comprise discrete video data that ends. It is between the receipt of VCL NAL Units that the overlay data (Non-VCL NAL Unit) data is received by the LG '918 Products.



Thomas Schierl, Miska M. Hannuksela, Ye-Kui Wang, and Stephan Wenger, System Layer Integration of High Efficiency Video Coding, *IEEE TRANS. CIR. AND SYS. FOR VIDEO TECHNOLOGY, VOL.* 22, NO. 12 at 1875 (December 2012).

231. The HEVC bitstream structure is comprised of discreet data. In the gaps between the receipt by the LG '918 Products of VCL NAL Units, Non-VCL NAL Units are received by the LG '918 Products' decoder.

> An HEVC bitstream consists of a number of access units, each including coded data associated with a picture that has a distinct capturing or presentation time. Each access unit is divided into NAL units, including one or more VCL NAL units (i.e., coded slice NAL units) and zero or more non-VCL NAL units, e.g., parameter set NAL units or supplemental enhancement information (SEI) NAL units. Each NAL unit includes an NAL unit header and an NAL unit payload. Information in the NAL unit header can be (conveniently) accessed by media gateways, also known as media aware network elements (MANEs), for intelligent, media aware operations on the stream, such as stream adaptation.

Thomas Schierl, Miska M. Hannuksela, Ye-Kui Wang, and Stephan Wenger, System Layer Integration of High Efficiency Video Coding, *IEEE TRANS. CIR. AND SYS. FOR VIDEO TECHNOLOGY, VOL.* 22, NO. 12 at 1873 (December 2012).

232. Non-VCL NAL unit types include data such as supplemental enhancement information that is used to create overlays for display on the device.

Table 2.2 The 32 HEVC non-VCL NAL unit types

Non-VCL NAL unit types			
Parameter sets	32	VPS_NUT	Video parameter set
	33	SPS_NUT	Sequence parameter set
	34	PPS_NUT	Picture parameter set
Delimiters	35	AUD_NUT	Access unit delimiter
	36	EOS_NUT	End of sequence
	37	EOB_NUT	End of bitstream
Filler data	38	FD_NUT	Filler data
Supplemental enhancement information (SEI)	39	PREFIX_SEI_NUT	
	40	SUFFIX_SEI_NUT	
Reserved	41–47	RSV	
Unspecified	48–63	UNSPEC	

Gary J. Sullivan, et al., HIGH EFFICIENCY VIDEO CODING (HEVC) at 29 (September 2014).

233. Non-VCL NAL Units include supplemental enhancement information ("SEI") messages. The SEI data that is received contains overlay information that can be combined with the image data that has already been received.

sei_message( ) {	Descriptor
payloadType = 0	
while(next_bits(8) == 0xFF) {	
ff_byte /* equal to 0xFF */	f(8)
payloadType += 255	
}	
last_payload_type_byte	u(8)
payloadType += last_payload_type_byte	
payloadSize = 0	
while(next_bits(8) == 0xFF) {	
ff_byte /* equal to 0xFF */	f(8)
payloadSize += 255	
}	
last_payload_size_byte	u(8)
payloadSize += last_payload_size_byte	
sei_payload(payloadType, payloadSize)	
}	

High Efficiency Video Coding, Series H: Audiovisual And Multimedia Systems: Infrastructure Of Audiovisual Services – Coding Of Moving Video Rec. ITU-T H.265 at § 7.3.5 (February 2018).

234. The LG '918 Products combine the VCL NAL Unit and Non-VCL NAL Unit information to create images that contain overlay information.

> The NAL units are decoded by the decoder to produce the decoded pictures that are output from the decoder. Both the encoder and decoder store pictures in a decoded picture buffer (DPB). This buffer is mainly used for storing pictures so that previously coded pictures can be used to generate prediction signals to use when coding other pictures. These stored pictures are called reference pictures. . . . There are two classes of NAL units in HEVC—video coding layer (VCL) NAL units and non-VCL NAL units. Each VCL NAL unit carries one slice segment of coded picture data while the non-VCL NAL units contain control information that

> typically relates to multiple coded pictures. One coded picture, together with the non-VCL NAL units that are associated with the coded picture, is called an HEVC access unit.

Gary J. Sullivan, et al., HIGH EFFICIENCY VIDEO CODING (HEVC) at 14-15 (September 2014) (emphasis added).

235. One or more LG subsidiaries and/or affiliates use the LG '918 Products in regular business operations.

236. The LG '918 Products are available to businesses and individuals throughout the United States.

237. The LG '918 Products are provided to businesses and individuals located in the Eastern District of Texas.

238. By making, using, testing, offering for sale, and/or selling products and services, including but not limited to the LG '918 Products, LG has injured Dynamic Data and is liable for directly infringing one or more claims of the '918 patent, including at least claim 18, pursuant to 35 U.S.C. § 271(a).

239. LG also indirectly infringes the '918 patent by actively inducing infringement under 35 U.S.C. § 271(b).

240. LG has had knowledge of the '918 patent since at least service of the Original Complaint in this case or shortly thereafter, and on information and belief, LG knew of the '918 patent and knew of its infringement, including by way of this lawsuit.

241. LG intended to induce patent infringement by third-party customers and users of the LG '918 Products and had knowledge that the inducing acts would cause infringement or was willfully blind to the possibility that its inducing acts would cause infringement. LG specifically intended and was aware that the normal and customary use of the accused products would infringe the '918 patent. LG performed the acts that constitute induced infringement, and would induce

actual infringement, with knowledge of the '918 patent and with the knowledge that the induced acts would constitute infringement. For example, LG provides the LG '918 Products that have the capability of operating in a manner that infringe one or more of the claims of the '918 patent, including at least claim 18, and LG further provides documentation and training materials that cause customers and end users of the LG '918 Products to utilize the products in a manner that directly infringe one or more claims of the '918 patent.[38] By providing instruction and training to customers and end-users on how to use the LG '918 Products in a manner that directly infringes one or more claims of the '918 patent, including at least claim 18, LG specifically intended to induce infringement of the '918 patent. LG engaged in such inducement to promote the sales of the LG '918 Products, e.g., through LG user manuals, product support, marketing materials, and training materials to actively induce the users of the accused products to infringe the '918 patent. Accordingly, LG has induced and continues to induce users of the accused products to use the accused products in their ordinary and customary way to infringe the '918 patent, knowing that such use constitutes infringement of the '918 patent.

242. The '918 patent is well-known within the industry as demonstrated by multiple citations to the '918 patent in published patents and patent applications assigned to technology companies and academic institutions. LG is utilizing the technology claimed in the '918 patent

[38] *See, e.g.*, *Large Ultra HD Signage: UM3C Series*, LG SPECIFICATION SHEET (2018); *Multiple Screen Split-Ultra HD Signage: Ultra HD UH5C Series*, LG SPECIFICATION SHEET (2016); *LG Help Library: Ultra HD 4K Upscaling – UHD TV Video*, LG Support Website (last visited March 2019), *available at*: https://www.lg.com/us/support/product-help/CT10000018-1432737109927-general-specifications; *98UB9800, 98UB9810, 105UC9*, OWNER'S MANUAL LED TV, *available at*: https://www.lg.com/us/support-product/lg-98UB9810 (last visited Nov. 2018); *40UB8000, 49UB8200, 55UB8200, 60UB8200, 49UB8300, 55UB8300, 65UB9200*, OWNER'S MANUAL LED TV, *available at*: https://www.lg.com/us/support-product/lg-55UB8200 (last visited Nov. 2018); *50UH5500, 50UH5530, 65UH5500*, OWNER'S MANUAL SAFETY AND REFERENCE LED TV, *available at*: https://www.lg.com/us/support-product/lg-50UH5530 (last visited Nov. 2018); *LM-V405AQ*, USER GUIDE (2018); *LM-V35OULM*, USER GUIDE (2018); *LG Stylo 4 LM-Q71OULM*, USER GUIDE (2018); *LG V30*, USER GUIDE (2018); *LM-X410AS*, USER GUIDE (2018).

without paying a reasonable royalty. LG is infringing the '918 patent in a manner best described as willful, wanton, malicious, in bad faith, deliberate, consciously wrongful, flagrant, or characteristic of a pirate.

243. To the extent applicable, the requirements of 35 U.S.C. § 287(a) have been met with respect to the '918 patent.

244. As a result of LG's infringement of the '918 patent, Dynamic Data has suffered monetary damages, and seeks recovery in an amount adequate to compensate for LG's infringement, but in no event less than a reasonable royalty for the use made of the invention by LG together with interest and costs as fixed by the Court.

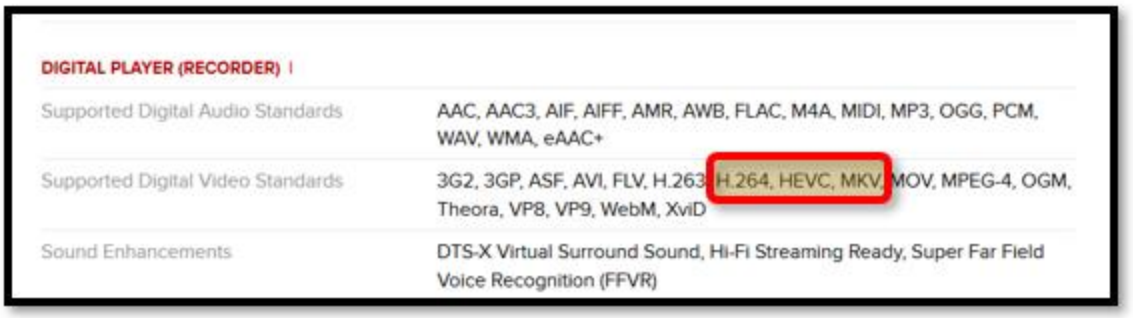
COUNT IV
INFRINGEMENT OF U.S. PATENT NO. 6,996,177

245. Dynamic Data references and incorporates by reference the preceding paragraphs of this Complaint as if fully set forth herein.

246. LG designs, makes, uses, sells, and/or offers for sale in the United States products and/or services for motion estimation.

247. LG designs, makes, sells, offers to sell, imports, and/or uses LG products that contain and/or enable H.265 encoding functionality, including the following products: LG V35 ThinQ, LG V40 ThinQ, and LG G7 ThinQ (collectively, the "LG '177 Products").[39]

[39] *LG G7 ThinQ Update Brings 4K @ 60fps Video Recording*, XDA DEVELOPERS WEBSITE (June 26, 2018), *available at*: https://www.xda-developers.com/lg-g7-thinq-update-4k-60fps/ ("Recording 4K video at 60fps has become a highly requested feature and the South Korean LG G7 ThinQ just received this feature with its latest OTA update.").



DIGITAL PLAYER (RECORDER)	
Supported Digital Audio Standards	AAC, AAC3, AIF, AIFF, AMR, AWB, FLAC, M4A, MIDI, MP3, OGG, PCM, WAV, WMA, eAAC+
Supported Digital Video Standards	3G2, 3GP, ASF, AVI, FLV, H.263, H.264, HEVC, MKV, MOV, MPEG-4, OGM, Theora, VP8, VP9, WebM, XviD
Sound Enhancements	DTS-X Virtual Surround Sound, Hi-Fi Streaming Ready, Super Far Field Voice Recognition (FFVR)

LG V35 ThinQ Specifications, CNET WEBSITE, *available at*: https://www.cnet.com/products/lg-v35-thinq/specs/ (annotation added).

248. One or more LG subsidiaries and/or affiliates use the LG '177 Products in regular business operations.

249. One or more of the LG '177 Products include technology for motion estimation and motion-compensated picture signal processing.

250. The LG '177 Products use a block-based motion vector estimation process that compares a plurality of candidate vectors to the determine block-based motion vectors.

251. The LG '177 Products contain a video encoder that selects an image segment of a second video image corresponding to an image segment of a first video image. The image segment has an image segment center.

252. Documentation from LG provides additional evidence that the LG '177 products contain H.265 encoding.

253. The LG '177 Products use a Prediction Unit matching method wherein the motion vector represents the displacement between the current Prediction Unit in the current frame and the matching Prediction Unit in the reference frame.

> Motion estimation compares the current prediction unit (PU) with the spatially neighboring PUs in the reference frames, and chooses the one with the least difference to the current PU. The displacement between the current PU and the matching PU in the reference frames is signaled using a motion vector.

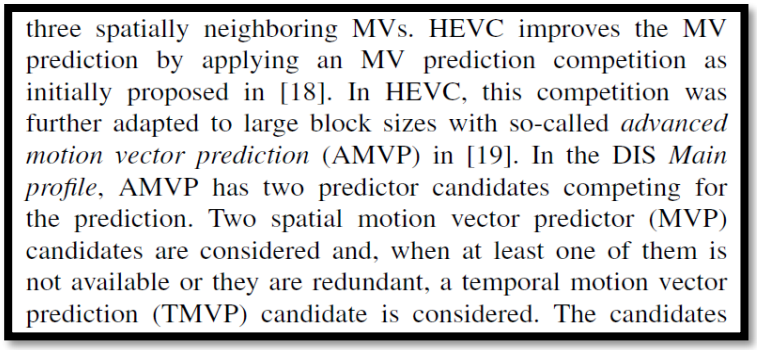
Sung-Fang Tsai, *et al.*, *Encoder Hardware Architecture for HEVC*, HIGH EFFICIENCY VIDEO CODING (HEVC) at 347 (September 2014) (emphasis added).

254. By complying with the HEVC standard, the LG devices – such as the LG '177 Products – necessarily infringe the '177 patent. Mandatory sections of the HEVC standard require the elements required by certain claims of the '177 patent, including but not limited to claim 1. *High Efficiency Video Coding*, SERIES H: AUDIOVISUAL AND Multimedia SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 (February 2018). The following sections of the HEVC Standard are relevant to LG's infringement of the '177 patent: "7.3.4 Scaling list data syntax;" 7.3.6.1 General slice segment header syntax;" "7.3.6.3 Weighted prediction parameters syntax;" "7.3.8.14 Delta QP syntax;" "7.4.4 Profile, tier and level semantics;" and "7.4.7.3 Weighted prediction parameters semantics."

255. One or more of the LG '177 Products include technology for motion estimation and motion-compensated picture signal processing.

256. One or more of the LG '177 Products include technology for estimating a current motion vector for a group of pixels of an image.

257. The LG '177 Products carry out a block-based motion vector estimation process that involves comparing a plurality of candidate vectors to determine block-based motion vectors. The LG '177 Products generate two predictor candidate motion vectors (a spatial motion vector and temporal motion vector). The first predictor candidate motion vector is drawn from a list of spatial motion vector candidates.



three spatially neighboring MVs. HEVC improves the MV prediction by applying an MV prediction competition as initially proposed in [18]. In HEVC, this competition was further adapted to large block sizes with so-called *advanced motion vector prediction* (AMVP) in [19]. In the DIS *Main profile*, AMVP has two predictor candidates competing for the prediction. Two spatial motion vector predictor (MVP) candidates are considered and, when at least one of them is not available or they are redundant, a temporal motion vector prediction (TMVP) candidate is considered. The candidates

Philipp Helle, Simon Oudin, Benjamin Bross, Detlev Marpe, M. Oguz Bici, Kemal Ugur, Joel Jung, Gordon Clare, and Thomas Wiegand, *Block Merging for Quadtree-Based Partitioning in HEVC, IEEE TRANS. CIR. AND SYS. FOR VIDEO TECHNOLOGY, Vol. 22* No. 12 (December 2012) ("AMVP has two predictor candidates competing for the prediction. Two spatial motion vector predictor (MVP) candidates are considered and, when at least one of them is not available or they are redundant, a temporal motion vector prediction (TMVP) candidate is considered.").

258. The LG '177 Products utilize a motion vector selection process wherein the candidate motion vectors are constructed into an index and then the motion vectors are compared. "In AMVP, the motion vector selection process is composed by two steps in encoder implementation. The first step is the motion vector candidate set construction process and the second step is the best motion vector selection step. In the first step, the motion vector candidate set is organized by selecting the motion vectors spatially and temporally." Gwo-Long Li, Chuen-Ching Wang, and Kuang-Hung Chiang, *An Efficient Motion Vector Prediction Method for Avoiding AMVP Data Dependency For HEVC*, 2014 IEEE INTERNATIONAL CONFERENCE ON ACOUSTIC, SPEECH AND SIGNAL PROCESSING (ICASSP) at 13 (2014).

259. One or more LG subsidiaries and/or affiliates use the LG '177 Products in regular business operations.

260. The LG '177 Products are available to businesses and individuals throughout the United States.

261. The LG '177 Products are provided to businesses and individuals located in the Eastern District of Texas.

262. The HEVC Standard provides details regarding what would be required for a compliant HEVC encoder—e.g., the standard uses terms such as "encoding," "coding," "compressing," and other similar terms to describe the encoding process.

263. The LG '177 Products use a block-based motion vector estimation process that compares a plurality of candidate vectors to determine block-based motion vectors. The LG '177 Products contain a video encoder that selects an image segment of a second video image corresponding to an image segment of a first video image.

264. The LG '177 Products determine at least a most frequently occurring block-based motion vector. The LG '177 Products contain functionality wherein the motion vector prediction performed includes the ability to transmit in the bitstream the candidate index of motion vectors. Documentation of the encoding process states that the encoder will "pick up the MV [motion vector] to use as an estimator using the index sent by the encoder in the bitstream."

Inter prediction

For motion vector prediction HEVC has two reference lists: L0 and L1. They can hold 16 references each, but the maximum total number of unique pictures is 8. Multiple instances of the same ref frame can be stored with different weights. HEVC motion estimation is much more complex than in AVC. It uses list indexing. There are two main prediction modes: Merge and Advanced MV. Each PU can use one of those methods and can have forward (a MV) or bi-directional prediction (2 MV). In Advanced MV mode a list of candidates MV is created (spatial and temporal candidates picked with a complex, probabilistic logic), when the list is created only the best candidate index is transmitted in the bitstream plus the MV delta (the difference between the real MV and the prediction). On the other side, the decoder will build and update continuously the same candidate list using the exact same rules used by the encoder and will pick-up the MV to use as estimator using the index sent by the encoder in the bitstream. The merge mode is similar, the main difference is that the candidates' list is calculated from neighboring MV and is not added to a delta MV. It is the equivalent of "skip" mode in AVC.

Fabio Sonnati, *H265 – Part I: Technical Overview*, VIDEO ENCODING & STREAMING TECHNOLOGIES WEBSITE (June 20, 2014) (emphasis added).

265. Any implementation of the HEVC standard would infringe the '177 patent as every possible implementation of the standard requires: compliant devices to carry out a global motion vector estimation process using the most frequently occurring block-based motion vectors. This process of vector candidate selection allows the LG '177 Products to obtain a global motion vector.

Specifically, the HEVC standard generates a set of candidate motion vectors for the group of pixels, with the candidate motion vectors being extracted from a set of previously estimated motion vectors. After the candidate motion vectors are generated, if there are two spatial motion vectors that are identical, that is determined to be the most frequently occurring block-based motion vector and the frequently occurring spatial motion vector and temporal motion vector candidate are used to generate the global motion vector. "In HEVC, this competition was further adapted to large block sizes with so-called advanced motion vector prediction (AMVP). In the DIS Main profile, AMVP has two predictor candidates competing for the prediction. Two spatial motion vector predictor (MVP) candidates are considered and, when at least one of them is not available or they are redundant, a temporal motion vector prediction (TMVP) candidate is considered." Kemal Ugur, Joel Jung, Gordon Clare, and Thomas Wiegand, *Block Merging for Quadtree-Based Partitioning in HEVC, IEEE TRANS. CIR. AND SYS. FOR VIDEO TECHNOLOGY, Vol. 22* No. 12 (December 2012).

266. The LG '177 Products apply a global motion vector as a candidate vector to the block-based motion vector estimation process. Specially, the LG '177 Products calculate the global motion vector by calculating a difference between the second motion vector and the first motion vector. The further candidate motion vector is calculated at the end of the process diagram below (as shown in the below figure) and applied to the block-based motion vector estimation process.

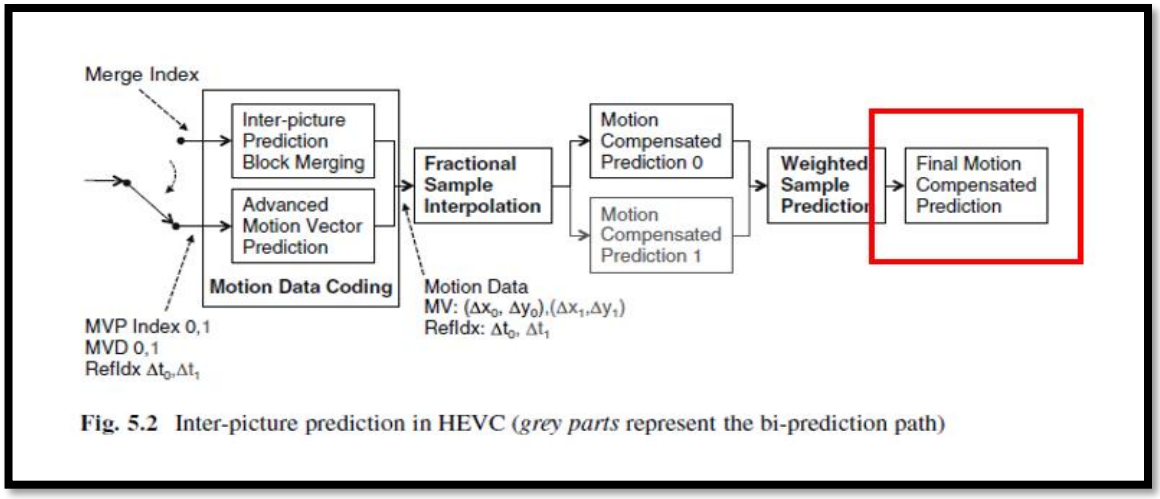


Fig. 5.2 Inter-picture prediction in HEVC (*grey parts* represent the bi-prediction path)

Gary J. Sullivan, *et al*., HEVC, HIGH EFFICIENCY VIDEO CODING (HEVC) at 115 (September 2014) (emphasis added).

267. Further, the LG '177 Products enable AMVP wherein several of the most probable candidate vectors based on data from adjacent prediction blocks are used to create a global estimation vector and that vector is applied to the block-based motion estimation functionality.

> Motion vector signaling: Advanced motion vector prediction (AMVP) is used, including derivation of several most probable candidates based on data from adjacent PBs and the reference picture. A "merge" mode for MV coding can be also used, allowing the inheritance of MVs from neighboring PBs. Moreover, compared to H.264/MPEG-4 AVC, improved "skipped" and "direct" motion inference are also specified.

Gary J. Sullivan, *et al*., *Overview of the High Efficiency Video Coding (HEVC) Standard*, PRE-PUBLICATION DRAFT, TO APPEAR IN IEEE TRANS. ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY at 3 (December 2012) (emphasis added).

268. LG has directly infringed and continues to directly infringe the '177 patent by, among other things, making, using, offering for sale, and/or selling products and services for motion estimation and motion-compensated picture signal processing.

269. The LG '177 Products comprise methods and devices for motion estimation and motion-compensated picture signal processing.

270. The LG ‘177 Products incorporate a motion vector estimation method and device that carries out a block-based motion vector estimation process that involves comparing a plurality of candidate vectors to determine block-based motion vectors.

271. The LG ‘177 Products determine at least a most frequently occurring block-based motion vector.

272. The LG ‘177 Products carry out a global motion vector estimation process using at least the most frequently occurring block-based motion vector to obtain a global motion vector.

273. The LG ‘177 Products applies the global motion vector as a candidate vector to the block-based motion vector estimation process.

274. By making, using, testing, offering for sale, and/or selling products and services, including but not limited to the LG ‘177 Products, LG has injured Dynamic Data and is liable for directly infringing one or more claims of the ‘177 patent, including at least claim 1, pursuant to 35 U.S.C. § 271(a).

275. LG also indirectly infringes the ‘177 patent by actively inducing infringement under 35 U.S.C. § 271(b).

276. LG has had knowledge of the ‘177 patent since at least service of the Original Complaint in this case or shortly thereafter, and on information and belief, LG knew of the ‘177 patent and knew of its infringement, including by way of this lawsuit.

277. Alternatively, LG has had knowledge of the ‘177 patent since at least March 29, 2010, when Korean Patent No. KR100949980B1, which is owned by LG and cites the ‘177 patent family as relevant prior art, was issued. Alternatively, LG has had knowledge of the ‘177 patent since at least July 1, 2015, when European Patent No. EP2030450B1, which is owned by LG and cites the ‘177 patent family as relevant prior art, was issued.

278. LG intended to induce patent infringement by third-party customers and users of the LG '177 Products and had knowledge that the inducing acts would cause infringement or was willfully blind to the possibility that its inducing acts would cause infringement. LG specifically intended and was aware that the normal and customary use of the accused products would infringe the '177 patent. LG performed the acts that constitute induced infringement, and would induce actual infringement, with knowledge of the '177 patent and with the knowledge that the induced acts would constitute infringement. For example, LG provides the LG '177 Products that have the capability of operating in a manner that infringe one or more of the claims of the '177 patent, including at least claim 1, and LG further provides documentation and training materials that cause customers and end users of the LG '177 Products to utilize the products in a manner that directly infringe one or more claims of the '177 patent.[40] By providing instruction and training to customers and end-users on how to use the LG '177 Products in a manner that directly infringes one or more claims of the '177 patent, including at least claim 1, LG specifically intended to induce infringement of the '177 patent. LG engaged in such inducement to promote the sales of the LG '177 Products, e.g., through LG user manuals, product support, marketing materials, and training materials to actively induce the users of the accused products to infringe the '177 patent. Accordingly, LG has induced and continues to induce users of the accused products to use the accused products in their ordinary and customary way to infringe the '177 patent, knowing that such use constitutes infringement of the '177 patent.

[40] *See, e.g.*, *LG V35 ThinQ*, LG USER GUIDE (2018); *LG V40 ThinQ*, USER GUIDE (2018); LG G7 THINQ, USER GUIDE (2018); *LG V40 ThinQ Camera: The New 5 Camera Phone*, LG WEBSITE (last visited March 2019), *available at*: https://www.lg.com/us/mobile-phones/v40-thinq/camera; *LG at CES 2019-LG ThinQ*, LG GLOBAL YOUTUBE CHANNEL (January 12, 2019), *available at*: https://www.youtube.com/watch?v=4QXpEr1EsjA; *LG Help Library: LG G7 ThinQ – Camera Overview and Settings*, LG SUPPORT WEBSITE (last visited March 2019), *available at*: https://www.lg.com/us/support/product-help/CT10000027-20150726477193-settings-features.

279. The '177 patent is well-known within the industry as demonstrated by multiple citations to the '177 patent in published patents and patent applications assigned to technology companies and academic institutions. LG is utilizing the technology claimed in the '177 patent without paying a reasonable royalty. LG is infringing the '177 patent in a manner best described as willful, wanton, malicious, in bad faith, deliberate, consciously wrongful, flagrant, or characteristic of a pirate.

280. To the extent applicable, the requirements of 35 U.S.C. § 287(a) have been met with respect to the '177 patent.

281. As a result of LG's infringement of the '177 patent, Dynamic Data has suffered monetary damages, and seeks recovery in an amount adequate to compensate for LG's infringement, but in no event less than a reasonable royalty for the use made of the invention by LG together with interest and costs as fixed by the Court.

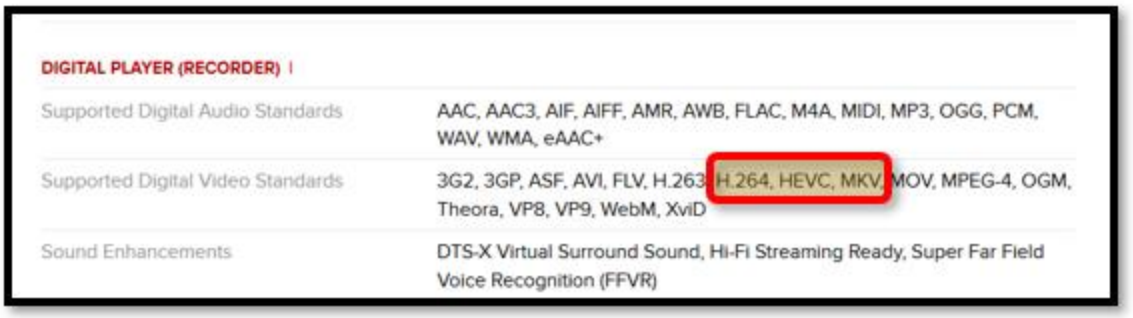
COUNT V
INFRINGEMENT OF U.S. PATENT NO. 7,010,039

282. Dynamic Data references and incorporates by reference the preceding paragraphs of this Complaint as if fully set forth herein.

283. LG designs, makes, uses, sells, and/or offers for sale in the United States products and/or services for detecting motion.

284. LG designs, makes, sells, offers to sell, imports, and/or uses LG products that contain and/or enable H.265 encoding functionality, including the following products: LG V35 ThinQ, LG V40 ThinQ, and LG G7 ThinQ (collectively, the "LG '039 Products").[41]

[41] *LG G7 ThinQ Update Brings 4K @ 60fps Video Recording*, XDA DEVELOPERS WEBSITE (June 26, 2018), *available at*: https://www.xda-developers.com/lg-g7-thinq-update-4k-60fps/ ("Recording 4K video at 60fps has become a highly requested feature and the South Korean LG G7 ThinQ just received this feature with its latest OTA update.").



DIGITAL PLAYER (RECORDER)	
Supported Digital Audio Standards	AAC, AAC3, AIF, AIFF, AMR, AWB, FLAC, M4A, MIDI, MP3, OGG, PCM, WAV, WMA, eAAC+
Supported Digital Video Standards	3G2, 3GP, ASF, AVI, FLV, H.263, H.264, HEVC, MKV, MOV, MPEG-4, OGM, Theora, VP8, VP9, WebM, XviD
Sound Enhancements	DTS-X Virtual Surround Sound, Hi-Fi Streaming Ready, Super Far Field Voice Recognition (FFVR)

LG V35 ThinQ Specifications, CNET WEBSITE, *available at*: https://www.cnet.com/products/lg-v35-thinq/specs/ (annotation added).

285. One or more LG subsidiaries and/or affiliates use the LG '039 Products in regular business operations.

286. The LG '039 Products contain functionality wherein a criterion function for candidate vectors is optimized. The criterion function depends on data obtained from the previous and next images in the video data stream. The optimizing is carried out at a temporal intermediate position in non-covered and covered areas. The following excerpts explain how HEVC is a form of encoding video information using a temporal intermediate position between previous and next images.

> One way of achieving high video compression is to predict pixel values for a frame based on prior and succeeding pictures in the video. Like its predecessors, H.265 features the ability to predict pixel values between pictures, and in particular, to specify in which order pictures are coded and which pictures are predicted from which. The coding order is specified for Groups Of Pictures (GOP), where a number of pictures are grouped together and predicted from each other in a specified order. The pictures available to predict from, called reference pictures, are specified for every individual picture.

Johan Bartelmess. *Compression Efficiency of Different Picture Coding Structures in High Efficiency Video Coding (HEVC),* UPTEC STS 16006 at 4 (March 2016).

> HEVC features both low- and high-level methods for dependency removal which can be used to leverage multi-core processors [13]. Only the three high-level mechanisms slices, tiles and WPP are of interest for this work. It is important to note that all of them subdivide individual video frames based on CTUs which are HEVC's basic processing unit. CTUs have a maximum size of 64×64 luma pixels and are recursively split into square-shaped Coding Units (CUs), which contain Prediction Units (PUs) and Transform Units (TUs) [14].

Stefan Radicke, *et al*., *Many-Core HEVC Encoding Based on Wavefront Parallel Processing and GPU -accelerated Motion Estimation*, E-BUSINESS AND TELECOMMUNICATIONS: 11TH INTERNATIONAL JOINT CONFERENCE at 296 (2015) ("HEVC feature both low- and high-level methods for dependency removal which can be used to leverage multi-core processors. . . It is important to note that all of them subdivide individual video frames based on CTUs which are HEVC' basic processing unit.").

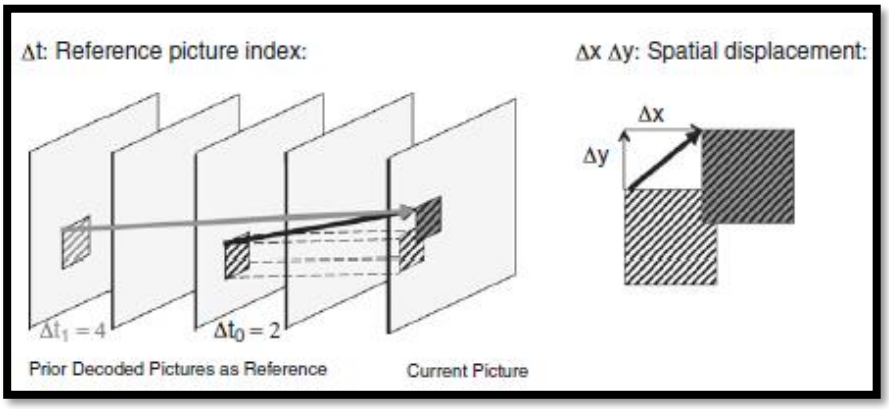
287. The LG '039 Products receive encoded video data that is encoded using inter-frame coding. The encoded video stream received by the LG '039 Products are coded using its predecessor frame and subsequent frame. Inter-prediction used in the encoded video data received by the LG '039 Products allows a transform block to span across multiple prediction blocks for inter-picture predicted coding units to maximize the potential coding efficiency benefits of the quadtree-structured transform block partitioning.

> The basic source-coding algorithm is a hybrid of interpicture prediction to exploit ***temporal statistical dependences,*** intrapicture prediction to exploit spatial statistical dependences, and transform coding of the prediction residual signals to further exploit spatial statistical dependences.

G. J. Sullivan, J.-R. Ohm, W.-J. Han, and T. Wiegand, *Overview of the High Efficiency Video Coding (HEVC) standard*, IEEE TRANS. CIRCUITS SYST. VIDEO TECHNOL., vol. 22, no. 12, p. 1654 (December 2012) (emphasis added).

288. The encoded video stream received by the LG '039 Products are encoded using inter-picture prediction that makes use of the temporal correlation between pictures to derive a motion-compensated prediction (MCP) for a block of image samples. For this block-based motion compensated prediction, a video picture is divided into rectangular blocks. Assuming homogeneous motion inside one block, and that moving objects are larger than one block, for each block, a corresponding block in a previously decoded picture can be found that serves as a

predictor. The general concept of inter-frame-based encoding using motion-compensated prediction based on a translational motion model is illustrated below.



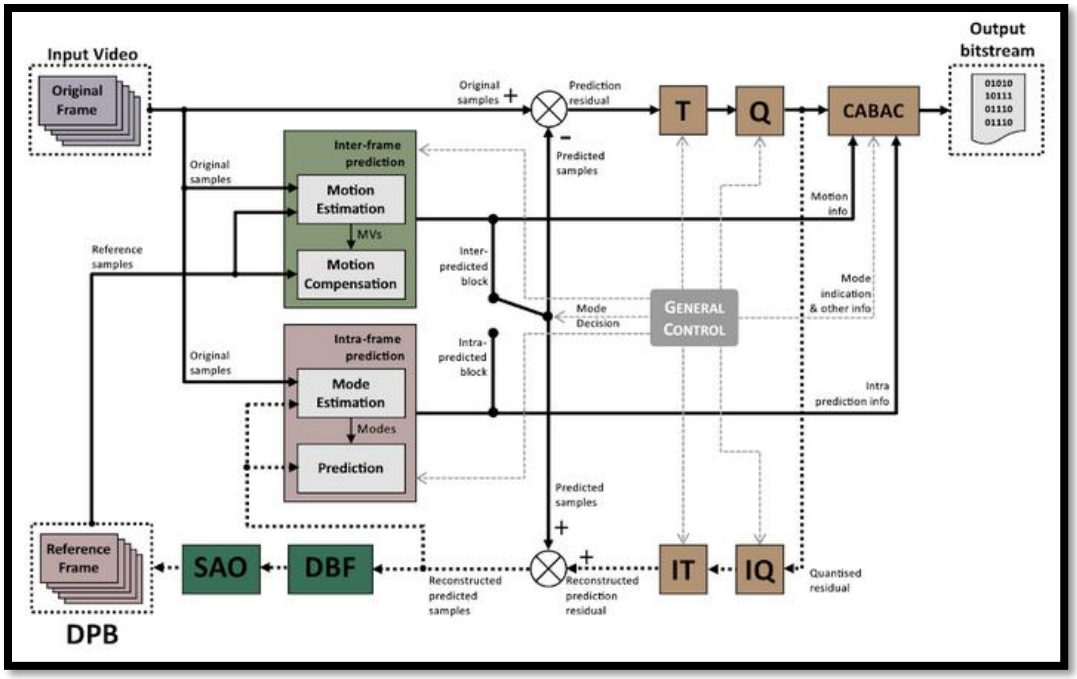
Benjamin Bross, *Inter-Picture Prediction In HEVC*, HIGH EFFICIENCY VIDEO CODING (HEVC) at 114 (September 2014).

289. The following excerpt from an article describing the architecture of the encoded video stream received by the LG '039 Products describes the functionality wherein the second encoded frame of the video data is dependent on the encoding of a first frame. "HEVC inter prediction uses motion vectors pointing to one reference frame . . . or two reference frames (bi-prediction) to predict a block of pixels."

> HEVC inter prediction uses motion vectors pointing to one reference frame (uni-prediction) or two reference frames (bi-prediction) to predict a block of pixels. The size of the predicted block, called Prediction Unit (PU), is determined by the Coding Unit (CU) size and its partitioning mode. For example, a 32×32 CU with 2N×N partitioning is split into two PUs of size 32×16, or a 16×16 CU with nL×2N partitioning is split into 4×16 and 12×16 PUs.

Mehul Tikekar, *et al., Decoder Hardware Architecture for HEVC*, HIGH EFFICIENCY VIDEO CODING (HEVC) (September 2014).

290. The following diagram shows how the LG '039 Products receive video data encoded using inter-frame prediction. Specifically, interframe prediction generates a motion vector based on the motion estimation across frames.



Guilherme Corrêa, *et al.*, COMPLEXITY-AWARE HIGH EFFICIENCY VIDEO CODING at 16 (2015).

291. The LG '039 Products receive encoded video data wherein the second frame includes a region encoding a motion vector difference in position between the region corresponding to the second frame indicating the first frame, the motion vector defines a region between the frame and the second frame corresponding to the first region the correspondence relationship. Specifically, the encoded video data received by the LG '039 Products use a translational motion model wherein the position of the block in a previously decoded picture is indicated by a motion vector: Δx; Δy where Δx specifies the horizontal and Δy the vertical displacement relative to the position of the current block. The motion vectors: Δx; Δy are of fractional sample accuracy to more accurately capture the movement of the underlying object. Interpolation is applied on the reference pictures to derive the prediction signal when the corresponding motion vector has fractional sample accuracy. The previously decoded picture is referred to as the reference picture and indicated by a reference index Δt to a reference picture list.

These translational motion model parameters, *i.e.*, motion vectors and reference indices, are further referred to as motion data.

292. The LG '039 Products optimize the selection of candidate vectors by calculation a temporal position of the next image in covering areas and at the temporal position of the previous image in uncovering areas. Specifically, the encoding process for video data received by the LG '039 Products use inter-picture prediction wherein motion data comprises the selection of a reference frame and motion vectors to be applied in predicting the samples of each block.

293. The "Overview of Design Characteristics" in the HEVC specification describes the use of "motion vectors for block-based inter prediction to exploit temporal statistical dependencies between frames."

compression. Encoding algorithms (not specified in this Recommendation | International Standard) may select between inter and intra coding for block-shaped regions of each picture. Inter coding uses motion vectors for block-based inter prediction to exploit temporal statistical dependencies between different pictures. Intra coding uses various spatial prediction modes to exploit spatial statistical dependencies in the source signal for a single picture. Motion vectors and intra prediction modes may be specified for a variety of block sizes in the picture. The prediction residual may then be further compressed using a transform to remove spatial correlation inside the transform block before it is quantized, producing a possibly irreversible process that typically discards less important visual information while forming a close approximation to the source samples. Finally, the motion vectors or intra prediction modes may also be further compressed using a variety of prediction mechanisms, and, after prediction, are combined with the quantized transform coefficient information and encoded using arithmetic coding.

High Efficiency Video Coding, Series H: Audiovisual And Multimedia Systems: Infrastructure Of Audiovisual Services – Coding Of Moving Video Rec. ITU-T H.265 at § 0.7 (April 2015) (annotation added).

294. By complying with the HEVC standard, the LG devices – such as the LG '039 Products – necessarily infringe the '039 patent. Mandatory sections of the HEVC standard require the elements required by certain claims of the '039 patent, including but not limited to claim 13. *High Efficiency Video Coding*, SERIES H: AUDIOVISUAL AND Multimedia SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 (February 2018). The following sections of the HEVC Standard are relevant to LG's infringement

of the '039 patent: "5.3 Logical operators;" "5.10 Variables, syntax elements and tables;" "5.11 Text description of logical operations;" "7.2 Specification of syntax functions and descriptors;" "7.3.1 NAL unit syntax;" "7.3.2 Raw byte sequence payloads, trailing bits and byte alignment syntax;" "7.3.5 Supplemental enhancement information message syntax;" "7.4.2 NAL unit semantics;" and "7.4.6 Supplemental enhancement information message semantics."

295. The LG '039 Products are available to businesses and individuals throughout the United States.

296. The LG '039 Products are provided to businesses and individuals located in the Eastern District of Texas.

297. LG has directly infringed and continues to directly infringe the '039 patent by, among other things, making, using, offering for sale, and/or selling technology for detecting motion, including but not limited to the LG '039 Products.

298. The LG '039 Products detect motion at a temporal intermediate position between previous and next images.

299. The LG '039 Products carry out the optimization at the temporal position of the next image in covering areas and at the temporal position of the previous image in uncovering areas.

300. The LG '039 Products detect motion at a temporal intermediate position between previous and next images.

301. The LG '039 Products utilize a criterion function for candidate vectors that is optimized.

302. The LG '039 Products utilize a criterion function that depends on data from both previous and next images and in which the optimizing is carried out at the temporal intermediate

position in non-covering and non-uncovering areas, characterized in that the optimizing is carried out at the temporal position of the next image in covering areas and at the temporal position of the previous image in uncovering areas.

303. By making, using, testing, offering for sale, and/or selling products and services, including but not limited to the LG '039 Products, LG has injured Dynamic Data and is liable for directly infringing one or more claims of the '039 patent, including at least claim 13, pursuant to 35 U.S.C. § 271(a).

304. LG also indirectly infringes the '039 patent by actively inducing infringement under 35 U.S.C. § 271(b).

305. LG has had knowledge of the '039 patent since at least service of the Original Complaint in this case or shortly thereafter, and on information and belief, LG knew of the '039 patent and knew of its infringement, including by way of this lawsuit.

306. LG intended to induce patent infringement by third-party customers and users of the LG '039 Products and had knowledge that the inducing acts would cause infringement or was willfully blind to the possibility that its inducing acts would cause infringement. LG specifically intended and was aware that the normal and customary use of the accused products would infringe the '039 patent. LG performed the acts that constitute induced infringement, and would induce actual infringement, with knowledge of the '039 patent and with the knowledge that the induced acts would constitute infringement. For example, LG provides the LG '039 Products that have the capability of operating in a manner that infringe one or more of the claims of the '039 patent, including at least claim 13, and LG further provides documentation and training materials that cause customers and end users of the LG '039 Products to utilize the products in a manner that

directly infringe one or more claims of the '039 patent.[42] By providing instruction and training to customers and end-users on how to use the LG '039 Products in a manner that directly infringes one or more claims of the '039 patent, including at least claim 13, LG specifically intended to induce infringement of the '039 patent. LG engaged in such inducement to promote the sales of the LG '039 Products, e.g., through LG user manuals, product support, marketing materials, and training materials to actively induce the users of the accused products to infringe the '039 patent. Accordingly, LG has induced and continues to induce users of the accused products to use the accused products in their ordinary and customary way to infringe the '039 patent, knowing that such use constitutes infringement of the '039 patent.

307. To the extent applicable, the requirements of 35 U.S.C. § 287(a) have been met with respect to the '039 patent.

308. As a result of LG's infringement of the '039 patent, Dynamic Data has suffered monetary damages, and seeks recovery in an amount adequate to compensate for LG's infringement, but in no event less than a reasonable royalty for the use made of the invention by LG together with interest and costs as fixed by the Court.

COUNT VI
INFRINGEMENT OF U.S. PATENT NO. 7,519,230

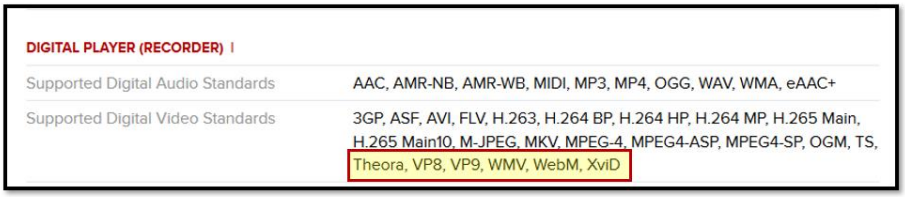
309. Dynamic Data references and incorporates by reference the preceding paragraphs of this Complaint as if fully set forth herein.

[42] *See, e.g.*, *LG V35 ThinQ*, LG USER GUIDE (2018); *LG V40 ThinQ*, USER GUIDE (2018); LG G7 THINQ, USER GUIDE (2018); *LG V40 ThinQ Camera: The New 5 Camera Phone*, LG WEBSITE (last visited March 2019), available at: https://www.lg.com/us/mobile-phones/v40-thinq/camera; *LG at CES 2019-LG ThinQ*, LG GLOBAL YOUTUBE CHANNEL (January 12, 2019), available at: https://www.youtube.com/watch?v=4QXpEr1EsjA; *LG Help Library: LG G7 ThinQ – Camera Overview and Settings*, LG SUPPORT WEBSITE (last visited March 2019), available at: https://www.lg.com/us/support/product-help/CT10000027-20150726477193-settings-features.

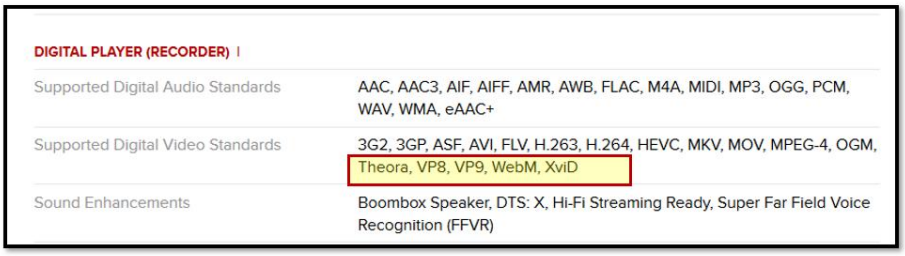
310. LG designs, makes, uses, sells, and/or offers for sale in the United States products and/or services for selecting a background motion vector for a pixel in an occlusion region of an image.

311. LG designs, makes, sells, offers to sell, imports, and/or uses LG products that contain VP9 encoding functionality, including but not limited to the following LG products: LG V40 ThinQ, LG G7 ThinQ, LG V35 ThinQ, LG G6, and LG V30 (collectively, the "LG '230 Products").

312. The LG '230 Products perform video processing compliant with the VP9 standard. By complying with the VP9 standard, the LG '230 Products - necessarily infringe the '230 patent. Mandatory sections of the VP9 standard require the elements required by certain claims of the '230 patent. *See* VP9 BITSTEAM & DECODING PROCESS SPECIFICATION VERSION 0.6 (March 31, 2016). The following sections of the VP9 Standard are relevant to LG's infringement of the '230 patent: "5.13 Motion vector prediction;" "5.15 Segmentation Map;" "6.2.11 Segmentation Params Syntax;" "6.4.7 Intra Segment id Syntax;" "6.4.9 Segmentation Feature Active Syntax;" "7.2.10 Segmentation Params Syntax;" and "7.4.6 Intra and Inter Segment id Semantics."



DIGITAL PLAYER (RECORDER)	
Supported Digital Audio Standards	AAC, AMR-NB, AMR-WB, MIDI, MP3, MP4, OGG, WAV, WMA, eAAC+
Supported Digital Video Standards	3GP, ASF, AVI, FLV, H.263, H.264 BP, H.264 HP, H.264 MP, H.265 Main, H.265 Main10, M-JPEG, MKV, MPEG-4, MPEG4-ASP, MPEG4-SP, OGM, TS, Theora, VP8, VP9, WMV, WebM, XviD



DIGITAL PLAYER (RECORDER)	
Supported Digital Audio Standards	AAC, AAC3, AIF, AIFF, AMR, AWB, FLAC, M4A, MIDI, MP3, OGG, PCM, WAV, WMA, eAAC+
Supported Digital Video Standards	3G2, 3GP, ASF, AVI, FLV, H.263, H.264, HEVC, MKV, MOV, MPEG-4, OGM, Theora, VP8, VP9, WebM, XviD
Sound Enhancements	Boombox Speaker, DTS: X, Hi-Fi Streaming Ready, Super Far Field Voice Recognition (FFVR)

LG G6 Specifications, CNET.COM WEBSITE (last visited March 2019), *available at*: https://www.cnet.com/products/lg-g6/specs/ (emphasis added); *LG V40 ThinQ Specifications*, CNET.COM WEBSITE (last visited March 2019), https://www.cnet.com/products/lg-v40-thinq/specs/ (emphasis added).

313. One or more LG subsidiaries and/or affiliates use the LG '230 Products in regular business operations.

314. One or more of the LG '230 Products include technology for selecting a background motion vector for a pixel in an occlusion region of an image.

315. One or more of the LG '230 Products use a processor to compute a model-based motion vector for the pixel on the basis of a motion model being determined on the basis of a part of a motion vector field of an image.

316. One or more of the LG '230 Products use a processor to compare the model-based motion vector with each of the motion vectors of the set of motion vectors.

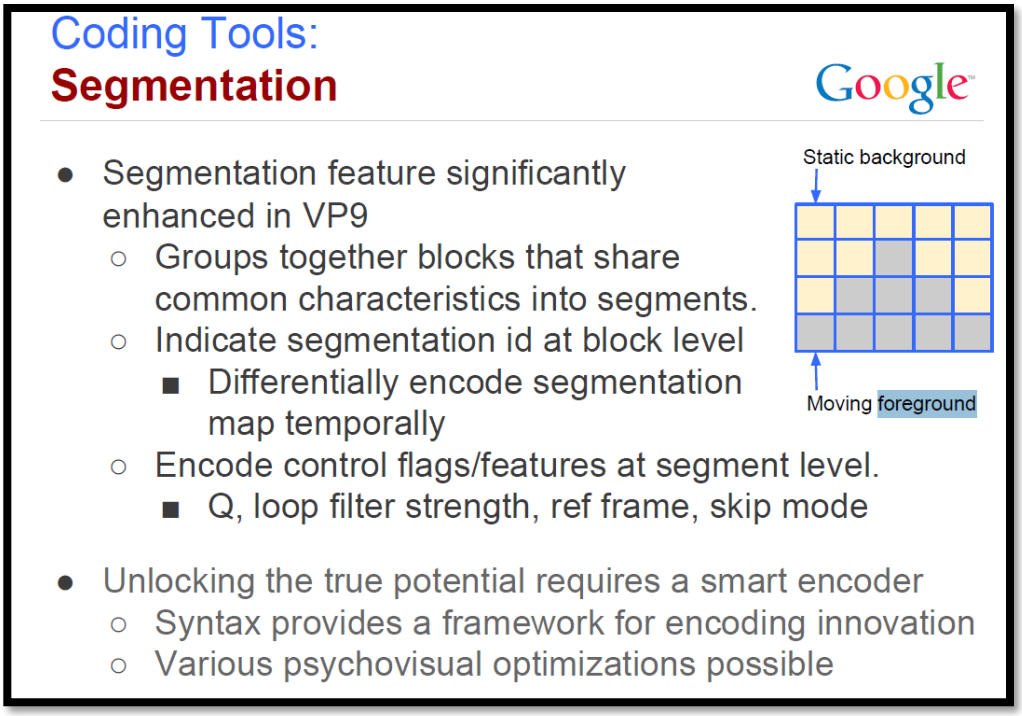
317. One or more of the LG '230 Products use a processor to select a particular motion vector of the set of motion vectors on the basis of the comparing and for assigning the particular motion vector as the background motion vector.

318. The LG '230 Products enable the use of segmentation where it is used to "identify background and foreground areas in encoded video content."

> In the reference implementation, segmentation is currently used to identify background and foreground areas in encoded video content. The (static) background is then coded at a higher quality compared to the rest of the frame in certain reference frames (such as the alt-ref frame) that provides prediction that persists over a number of frames. In contrast, for the frames between these persistent reference frames, the background is given fewer bits by, for example, restricting the set of available reference buffers, using only the ZERO_MV coding mode, or skipping the residual coefficient block. The result is that more bits are available to code the foreground-portion of the scene, while still preserving very good perceptual quality on the static background. Other use cases involving spatial and temporal masking for perceptual quality improvement are conceivable.

A VP9 Bitstream Overview, NETWORK WORKING GROUP § 2.8 (February 18, 2013).

319. LG has directly infringed and continues to directly infringe the '230 patent by, among other things, making, using, offering for sale, and/or selling technology for selecting a background motion vector for a pixel in an occlusion region of an image, including but not limited to the LG '230 Products.



Debargha Mukherjee, A TECHNICAL OVERVIEW OF VP9: THE LATEST ROYALTY FREE VIDEO CODEC FROM GOOGLE (2016).

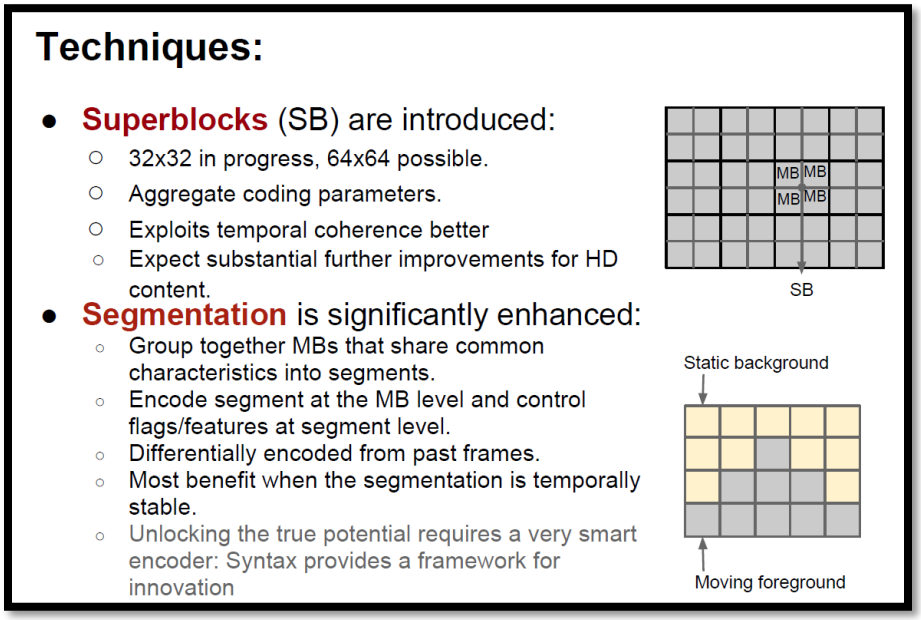
320. By making, using, testing, offering for sale, and/or selling products and services, including but not limited to the LG '230 Products, LG has injured Dynamic Data and is liable for directly infringing one or more claims of the '230 patent, including at least claim 6, pursuant to 35 U.S.C. § 271(a).

321. One or more of the LG '230 Products include technology for selecting a background motion vector for a pixel in an occlusion region of an image.

322. The LG '230 Products encode macroblocks into segments (regions) on a block by block basis to create segmentation maps that code the shape information.

323. The LG '230 Products use segments that are background (static) regions of inter blocks which contain blocks that are encoded from a fixed reference (previous) frame. The coded pixel information for a block contains the residual between the previous frame and the current

frame, which can be zero (skip), using the coded pixel information of a previous frame block corresponding to a current frame block (only a motion vector pointing to the reference frame).



Adrian Grange, OVERVIEW OF VP-NEXT: A NEXT GENERATION OPEN VIDEO CODEC at 12 (2012).

324. The LG '230 Products are available to businesses and individuals throughout the United States.

325. The LG '230 Products encode video content using VP9 coding which uses segmentation to group together blocks with common characteristics, including static background and moving foreground (object) region.

326. The LG '230 Products use VP9 segmentation to divide the inputted video into a stationary background and the object region on a block by block basis to create segmentation maps. For INTER blocks, VP9 uses the calculation of motion vectors temporally between frames to find a difference (residual) between blocks in a given frame (next frame) and a reference frame.

327. The LG '230 Products are provided to businesses and individuals located in the Eastern District of Texas.

328. LG also indirectly infringes the '230 patent by actively inducing infringement under 35 U.S.C. § 271(b).

329. LG has had knowledge of the '230 patent since at least service of the Original Complaint in this case or shortly thereafter, and on information and belief, LG knew of the '230 patent and knew of its infringement, including by way of this lawsuit.

330. LG intended to induce patent infringement by third-party customers and users of the LG '230 Products and had knowledge that the inducing acts would cause infringement or was willfully blind to the possibility that its inducing acts would cause infringement. LG specifically intended and was aware that the normal and customary use of the accused products would infringe the '230 patent. LG performed the acts that constitute induced infringement, and would induce actual infringement, with knowledge of the '230 patent and with the knowledge that the induced acts would constitute infringement. For example, LG provides the LG '230 Products that have the capability of operating in a manner that infringe one or more of the claims of the '230 patent, including at least claim 6, and LG further provides documentation and training materials that cause customers and end users of the LG '230 Products to utilize the products in a manner that directly infringe one or more claims of the '230 patent.[43] By providing instruction and training to customers and end-users on how to use the LG '230 Products in a manner that directly infringes one or more claims of the '230 patent, including at least claim 6, LG specifically intended to induce infringement of the '230 patent. LG engaged in such inducement to promote the sales of the LG '230 Products, e.g., through LG user manuals, product support, marketing materials, and training materials to actively induce the users of the accused products to infringe the '230 patent.

[43] *See, e.g.*, *LG V30*, USER GUIDE (2018); *LG V40*, USER GUIDE (2018); *LG G6, User Guide* (2017); *LG G7 ThinQ*, USER GUIDE (2017); *LG V35 ThinQ*, USER GUIDE (2018); *Getting to Know the LG V40*, LG SUPPORT WEBSITE (last visited March 2019), available at: https://www.lg.com/us/support/product-help/CT10000025-20150874484454-features.

Accordingly, LG has induced and continues to induce users of the accused products to use the accused products in their ordinary and customary way to infringe the '230 patent, knowing that such use constitutes infringement of the '230 patent.

331. The '230 patent is well-known within the industry as demonstrated by multiple citations to the '230 patent in published patents and patent applications assigned to technology companies and academic institutions. LG is utilizing the technology claimed in the '230 patent without paying a reasonable royalty. LG is infringing the '230 patent in a manner best described as willful, wanton, malicious, in bad faith, deliberate, consciously wrongful, flagrant, or characteristic of a pirate.

332. To the extent applicable, the requirements of 35 U.S.C. § 287(a) have been met with respect to the '230 patent.

333. As a result of LG's infringement of the '230 patent, Dynamic Data has suffered monetary damages, and seeks recovery in an amount adequate to compensate for LG's infringement, but in no event less than a reasonable royalty for the use made of the invention by LG together with interest and costs as fixed by the Court.

COUNT VII
INFRINGEMENT OF U.S. PATENT NO. 7,542,041

334. Dynamic Data references and incorporates by reference the preceding paragraphs of this Complaint as if fully set forth herein.

335. LG designs, makes, uses, sells, and/or offers for sale in the United States products and/or services for dynamically configuring a multi-pipe pipeline system.

336. LG designs, makes, sells, offers to sell, imports, and/or uses products that comprise a processing system with a plurality of pipelines. The LG products include the following models

that contain an Adreno GPU configured to sequentially process data in a pipeline: LG G7 ThinQ, LG V40 ThinQ, LG V35 ThinQ, LG V30, LG G6, LG G5, and LG V20 (collectively, the "LG '041 Products").

337. The LG '041 Products contain a controller that is configured to enable a modification, responsive to external coupling-select signals, of one or more pipelines. Specifically, the LG '041 Products include an 800 Series Qualcomm Snapdragon Chip. For each of the accused LG '041 Products the video processing chip is identified: LG G7 ThinQ (Snapdragon 845),[44] LG V40 ThinQ (Snapdragon 845),[45] LG V35 ThinQ (Snapdragon 845),[46] LG V30 (Snapdragon 835),[47] LG G6 (Snapdragon 812),[48] LG G5 (Snapdragon 820),[49] and LG V20 (Snapdragon 820).[50]

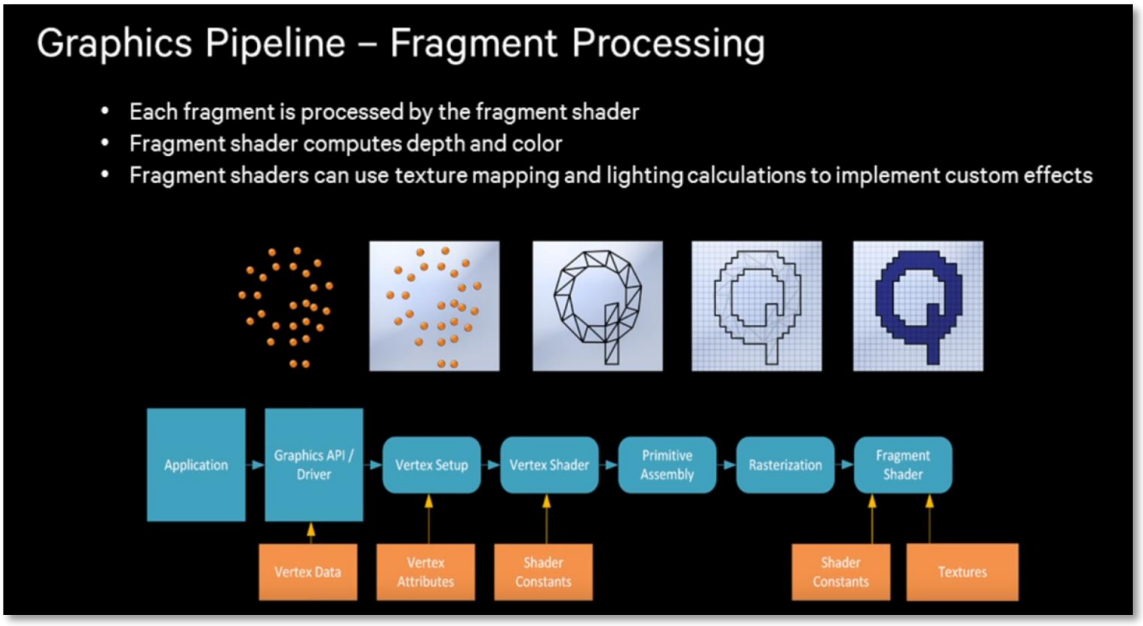
338. The LG '041 Products include a Snapdragon 800 Series processor that contains an Adreno graphics processing unit that is configured with a data processing pipeline system. The pipelines in the LG '041 Products comprise complex pipelines with complex core pipeline elements including shaders and other data needed to render geometry. There are 2 types of pipelines in the LG '041 Products: graphics and compute. Both pipelines in the LG '041 Products

[44] *LG G7 ThinQ Specifications*, LG WEBSITE, *available at*: https://www.lg.com/us/cell-phones/lg-G710ULM-LRA-g7-thinq.
[45] *LG V40 ThinQ Specifications*, LG WEBSITE, *available at*: https://www.lg.com/us/mobile-phones/v40-thinq/specs.
[46] *LG V35 ThinQ Specifications*, LG Website, *available at*: https://www.lg.com/us/cell-phones/lg-V350AWM-v35-thinq-att.
[47] *LG V30+ Specifications*, LG WEBSITE, *available at*: https://www.lg.com/us/cell-phones/lg-LS998U-lg-v30-plus.
[48] *LG G6 Specifications*, LG WEBSITE, *available at*: https://www.lg.com/levant_en/mobile-phones/lg-G6-platinum.
[49] *LG G5 Specifications*, LG WEBSITE, *available at*: https://www.lg.com/us/cell-phones/lg-RS988-Titan-g5-unlocked.
[50] *LG V20 Specifications*, LG WEBSITE, *available at*: https://www.lg.com/us/cell-phones/lg-VS995-Titan-v20.

function similarly, with the differences involving the type of state data and shaders needed for the different processing.

339. One or more LG subsidiaries and/or affiliates use the LG '041 Products in regular business operations.

340. The LG '041 Products include a plurality of core pipeline elements that are configured to sequentially process data as it traverses the pipeline. The below excerpt from a presentation regarding the infringing instrumentality identifies several of these core pipeline elements.



Adreno Hardware Tutorial 1: Graphics Pipeline Overview, QUALCOMM DEVELOPER NETWORK YOUTUBE CHANNEL (May 28, 2015), *available at*: https://www.youtube.com/watch?time_continue=559&v=ynm0_EFYVhc

341. The LG '041 Products enable pipelines to process data in parallel and to share a common cache element.

> As mentioned in the previous section, building pipelines in parallel is a useful technique to utilize the multiple cores on the device and speed up the CPU intensive activity.
>
> Each thread can build up a separate cache which Vulkan treats as thread safe. After all pipelines are created, you can then merge the caches using vkMergePipelineCaches to create a single pipeline cache which can then be saved and used on subsequent runs.

Qualcomm Adreno Vulkan Developer Guide, QUALCOMM ADRENO DOCUMENTATION 80-NB295-7A at 34 (August 8, 2017) (emphasis added).

342. The LG '041 Products include technology for dynamically configuring a multi-pipe pipeline system.

> This architecture is called a US. Operations related to the vertex shader, geometry shader, pixel shader, tessellation, and computation on graphics pipelines are performed. The US consists of dynamic scheduling and load balancing systems, which allocate computing units flexibly on the basis of the amount of work to be handled. In the graphics processing operation, texture mapping and filtering operations are performed by the TMU, which works with pixel and shader units.

Juwon Yun, et. al., *A Novel Performance Prediction Model for Mobile GPUs*, IEEE ACCESS VOL. 6 at 16236-37 (March 15, 2018) (emphasis added).

343. The LG '041 Products enable multiple pipelines to be coupled through a core pipelines element. The LG '041 Products enable the creation of derivative pipelines that process the data as it traverses between the pair of core elements.

> **4.10.3 Derivative pipelines**
>
> Using derivative pipelines is an excellent idea, particularly when you encounter similar pipelines sharing shaders. The key advantage is that the cost to create a child pipeline that is similar to a parent pipeline is less than the cost to create the child pipeline without knowledge of a parent pipeline. This is primarily due to not needed to recompile the shaders. Also during run time, switching from/to derivative pipelines is quicker. Vulkan doesn't specify how much in common the pipelines need to have, but using the same shaders is a good prerequisite for derivation.
>
> First make sure the parent pipeline is created with the VK_PIPELINE_CREATE_ALLOW_DERIVATIVES_BIT. When calling vkCreateGraphicsPipelines to create the child pipeline, use either the basePipelineHandle parameter or the basePipelineIndex provided you are also passing in parent pipeline.
>
> It is probably best not to use the VK_PIPELINE_CREATE_DERIVATIVES_BIT unless you are creating a parent pipeline, because there is some overhead with using it.

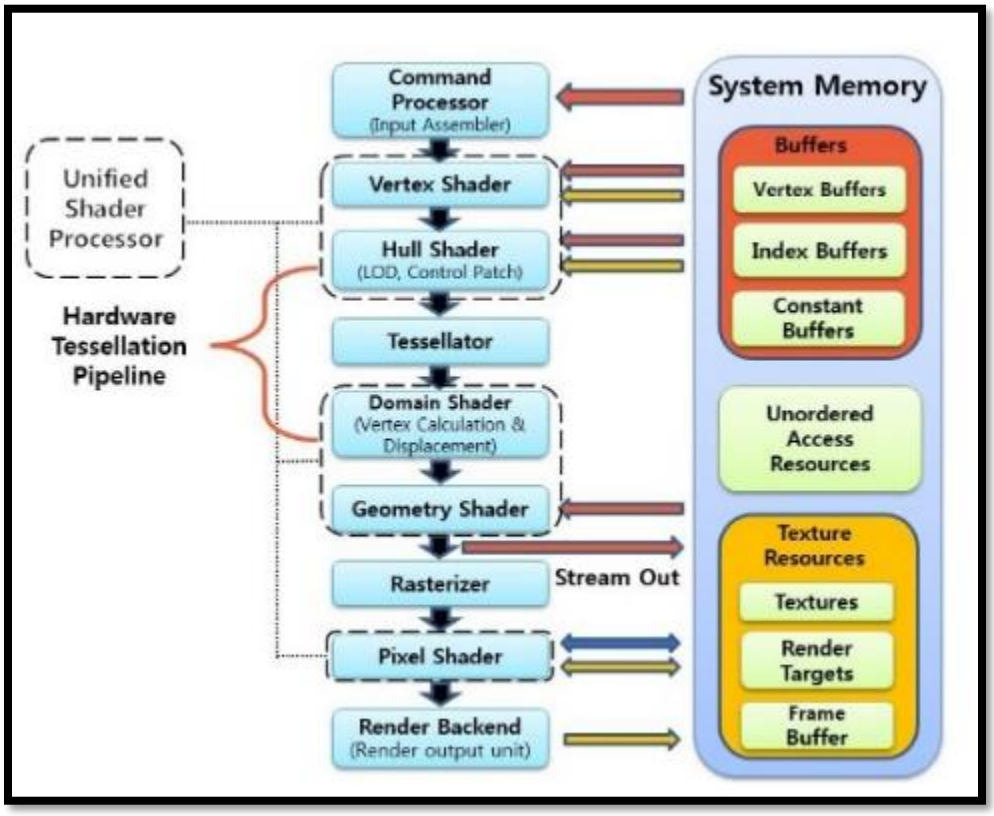
Qualcomm Adreno Vulkan Developer Guide, QUALCOMM ADRENO DOCUMENTATION 80-NB295-7A at 34 (August 8, 2017) (emphasis added).

344. The LG '041 Products contain a plurality of pipelines, each pipeline of the plurality of pipelines including a plurality of core pipeline elements that are configured to sequentially process data as it traverses the pipeline. The below excerpt describes the use of an in-order queue to manage the placement of data into a pipeline.

> The Adreno OpenCL platform has support for out-of-order command queues. However, there is a greater overhead due to the dependency management required for implementing out-of-order command queues. The Adreno software pipelines commands sent to an in-order queue. Therefore, it is good practice to use in-order command queues rather than out-of-order command queues.

Qualcomm Snapdragon OpenCL General Programming and Optimization, QUALCOMM ADRENO DOCUMENTATION 80-NB295-11A at 30 (November 3, 2017).

345. The following excerpt from an analysis of the processing unit contained in the LG '041 Products identifies that the pipelines (shown in blue) process data in a sequential manner.



Juwon Yun, et. al., *A Novel Performance Prediction Model for Mobile GPUs*, IEEE ACCESS VOL. 6 at 16236-37 (March 15, 2018).

346. The LG '041 Products enable a plurality of auxiliary elements to be selectively coupled in response to external coupling-select signals. Further, the LG '041 Products enable "Transform feedback" to check the data as it is passed through the pipelines.

> Use transform feedback to transfer the data out of the rendering pipeline back to the process, if it is suspected that some of the calculations may be executing incorrectly. Transform feedback allows for checking that the data is passed correctly through the whole rendering pipeline, except for the fragment shader stage. This becomes especially important when starting to use geometry and/or tessellation control/evaluation shaders.

Qualcomm Adreno OpenGL ES Developer Guide, QUALCOMM ADRENO DOCUMENTATION 80-NU141-1B at 42 (May 1, 2015) (emphasis added).

347. The Adreno GPUs in the LG '041 Products support the Unified Shader Model, which allows for use of a consistent instruction set across all shader types (vertex and fragment shaders). In hardware terms, Adreno GPUs have computational units, e.g., ALUs, that support both fragment and vertex shaders. Adreno GPUs use a shared resource architecture that allows the same ALU and fetch resources to be shared by the vertex shaders, pixel or fragment shaders, and general-purpose processing. The shader processing is done within the unified shader architecture, as shown in the below excerpted document.

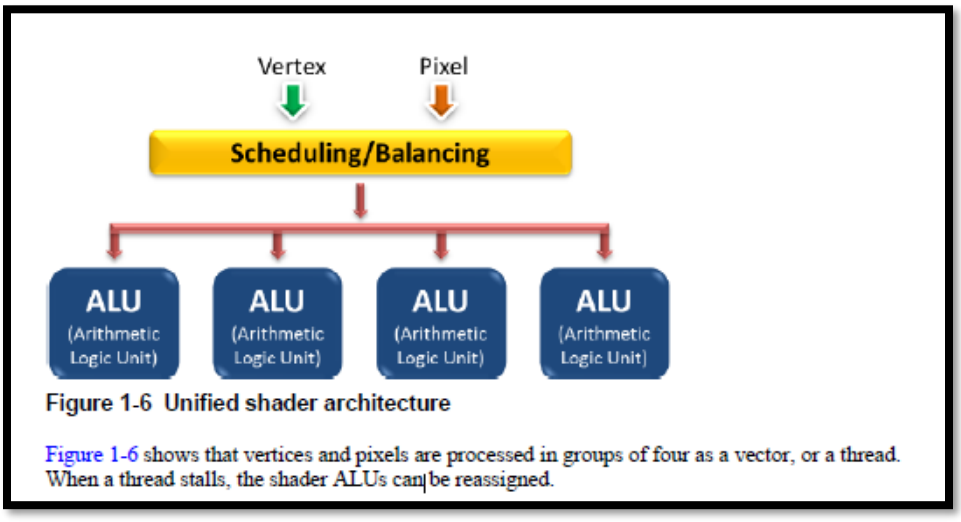


Figure 1-6 Unified shader architecture

Figure 1-6 shows that vertices and pixels are processed in groups of four as a vector, or a thread. When a thread stalls, the shader ALUs can be reassigned.

Qualcomm Adreno OpenGL ES Developer Guide, QUALCOMM ADRENO DOCUMENTATION 80-NU141-1B at 16 (May 1, 2015).

348. The LG ‘041 Products are provided to businesses and individuals located in the United States.

349. The LG ‘041 Products are provided to businesses and individuals located in the Eastern District of Texas.

350. By making, using, testing, offering for sale, and/or selling products and services for dynamically configuring a multi-pipe pipeline system, including but not limited to the LG ‘041 Products, LG has injured Dynamic Data and is liable to the Plaintiff for directly infringing one or more claims of the ‘041 patent, including at least claim 1 pursuant to 35 U.S.C. § 271(a).

351. LG also indirectly infringes the ‘041 patent by actively inducing infringement under 35 USC § 271(b).

352. LG has had knowledge of the ‘041 patent since at least service of the Original Complaint in this case or shortly thereafter, and on information and belief, LG knew of the ‘041 patent and knew of its infringement, including by way of this lawsuit.

353. LG intended to induce patent infringement by third-party customers and users of the LG ‘041 Products and had knowledge that the inducing acts would cause infringement or was willfully blind to the possibility that its inducing acts would cause infringement. LG specifically intended and was aware that the normal and customary use of the accused products would infringe the ‘041 patent. LG performed the acts that constitute induced infringement, and would induce actual infringement, with knowledge of the ‘041 patent and with the knowledge that the induced acts would constitute infringement. For example, LG provides the LG ‘041 Products that have the capability of operating in a manner that infringe one or more of the claims of the ‘041 patent, including at least claim 1, and LG further provides documentation and training materials that cause customers and end users of the LG ‘041 Products to utilize the products in a manner that directly

infringe one or more claims of the '041 patent.[51] By providing instruction and training to customers and end-users on how to use the LG '041 Products in a manner that directly infringes one or more claims of the '041 patent, including at least claim 1, LG specifically intended to induce infringement of the '041 patent. LG engaged in such inducement to promote the sales of the LG '041 Products, e.g., through LG user manuals, product support, marketing materials, and training materials to actively induce the users of the accused products to infringe the '041 patent. Accordingly, LG has induced and continues to induce users of the accused products to use the accused products in their ordinary and customary way to infringe the '041 patent, knowing that such use constitutes infringement of the '041 patent.

354. The '041 patent is well-known within the industry as demonstrated by multiple citations to the '041 patent in published patents and patent applications assigned to technology companies and academic institutions. LG is utilizing the technology claimed in the '041 patent without paying a reasonable royalty. LG is infringing the '041 patent in a manner best described as willful, wanton, malicious, in bad faith, deliberate, consciously wrongful, flagrant, or characteristic of a pirate.

355. To the extent applicable, the requirements of 35 U.S.C. § 287(a) have been met with respect to the '041 patent.

356. As a result of LG's infringement of the '041 patent, Dynamic Data has suffered monetary damages, and seeks recovery in an amount adequate to compensate for LG's infringement, but in no event less than a reasonable royalty for the use made of the invention by LG together with interest and costs as fixed by the Court.

[51] *See, e.g.*, *LM-V405AQ*, USER GUIDE (2018); *LM-V35OULM*, USER GUIDE (2018); *LG V30*, USER GUIDE (2018); *See, e.g.*, *LG V35 ThinQ*, LG USER GUIDE (2018); *LG V40 ThinQ*, USER GUIDE (2018); LG G7 THINQ, USER GUIDE (2018); LG GLOBAL YOUTUBE CHANNEL (January 12, 2019), available at: https://www.youtube.com/watch?v=4QXpEr1EsjA.

COUNT VIII
INFRINGEMENT OF U.S. PATENT NO. 7,571,450

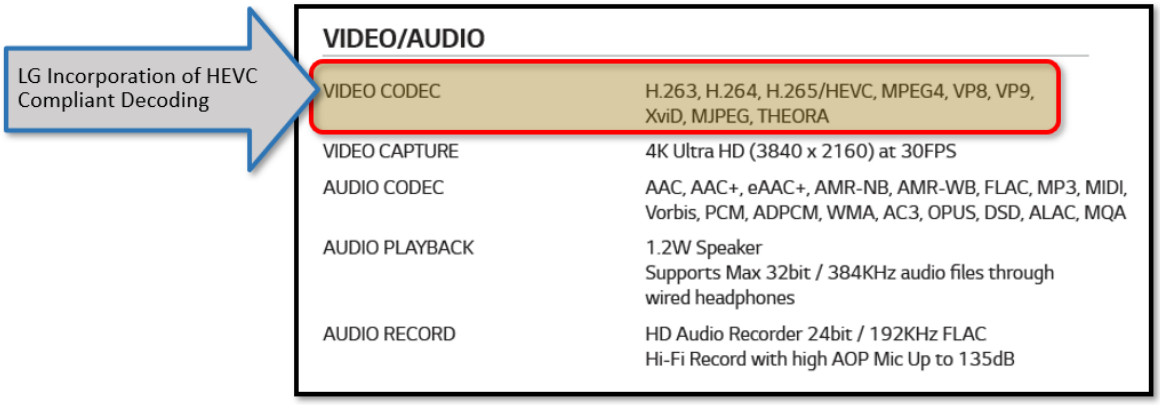
357. Dynamic Data references and incorporates by reference the preceding paragraphs of this Complaint as if fully set forth herein.

358. LG designs, makes, uses, sells, and/or offers for sale in the United States products and/or services for displaying information.

359. LG designs, makes, sells, offers to sell, imports, and/or uses LG devices that contain H.265 decoding functionality, including but not limited to: LG smart phones, LG OLED TVs, LG Super UHD 4K TVs, LG UHD 4K TVs, and LG digital signage products (collectively, the "LG '450 Products").

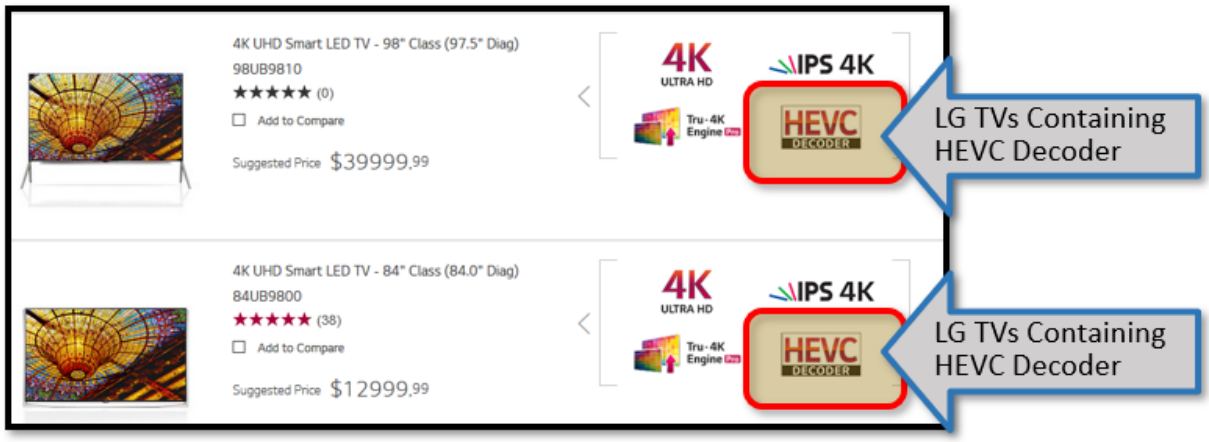
360. The accused LG '450 Products include the following LG smart phone models (which include functionality for decoding video content that is encoded in accord with the HEVC standard): LG US700, LG LMV405UA, LG Q610TA, LG K450, LG V350AWM, LG SP200, LG Q710MS, LG 211BL, LG M154, LG X410TK, LG Q617QA, LG Q610MA, LG US701, LG M327, LG 255, LG H700, LG M430, LG L83BL, LG M257, LG X410ASR, LG Q710ULS, LG US601, LG M322, LG Q710ULM, LG Q710CS, LG V350ULM, LG X210ULMA, LG LM-X210ULMA-K8, LG LM-X210VPP, LG LMX220MA, LG Q710AL, LG US601 ACG, LG LMX210MA, LG LM-V405UA, and LG X212TAL.[52] The following excerpt from an exemplar specification of one of the accused LG smart phones identifies that it contains an HEVC decoder functionality.

[52] *See e.g., LG Phones Website*, LG WEBSITE (last visited March 2019), *available at*: https://www.lg.com/us/cell-phones/all-cell-phones; LG G4 vs. Samsung Galaxy S6", GSMArena, June 19, 2015 (LG's G4 (2015), G5 (2015), and G6 (2017) phones support HEVC with UHD resolution [81], and the G5 and G6 support 10 bit video and 60 fps HFR).



LG V30 SPECIFICATION SHEET at 1 (2017) (annotation added).

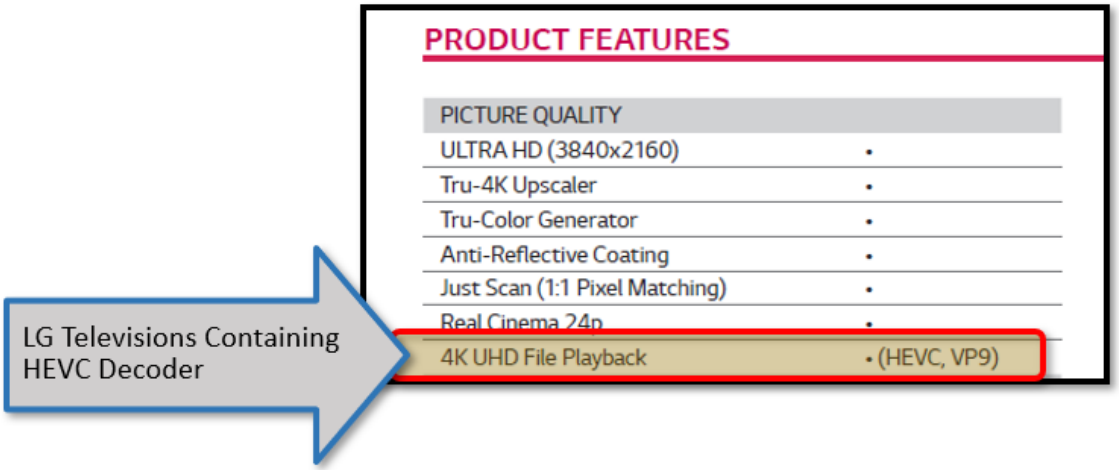
361. The accused LG '450 Products include the following LG television models: 60UF8500, 105UC9, 98UB9810, 84B9800, 40UB8000, 49UB8500, 55UB8500, 55UB8200, 65UB9200, 60UB8200, 98UB9800, 49UB8300, 55UB8300, 55UB9500, 65UB9500, 79UB9800, and 65UB9800.[53]



LG Television Product Search, LG CONSUMER WEBSITE (last visited March 2018), *available at*: https://www.lg.com/us/search.lg?search=hevc (annotations added).

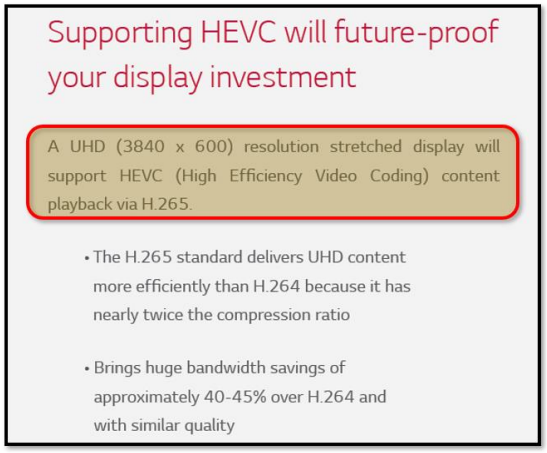
362. LG documentation identifies that the accused LG television products enable the playback of content that is encoded in the HEVC standard using an HEVC complaint decoder.

[53] Tribbey, Chris, *CES 2017: LG Debuts ATSC 3.0-Enabled 4K TVs*, BROADCASTING AND CABLE, January 8, 2017.



LG EG9600 4K UHD SMART CURVED OLET TV W/ WEBOS 2.0 & 3D SPECIFICATION at 1 (2015) (annotation added).

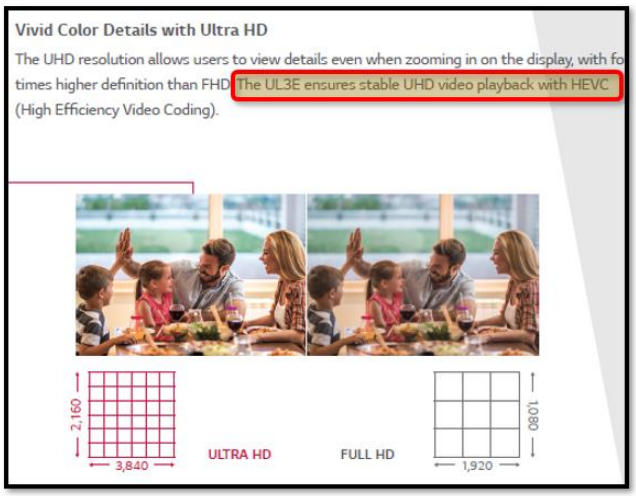
363. The accused LG '450 Products include the following LG digital signage products: UM3C, 75UH5C, 75UM3C, 60UL3E, 86UH5E-B, 55UH5B, 55VH7B, 55VM5B, 49VM5C, 55VX1D, 49UH5C, and 55UH5C.[54]



How to Stretch Customer Imagination with Digital Signage, LG BUSINESS SOLUTIONS DOCUMENTATION at 6 (2016).

364. The accused LG '450 Products are described in LG documentation as ensuring "stable UHD video playback with HEVC."

[54] *See e.g.*, *LG Business Solutions Digital Signage*, LG WEBSITE, *available at*: https://www.lg.com/us/business/commercial-display/displays-tvs/digital-signage/.



70UL3E 60UL3E Clear Color Expression of UHD Content Documentation, LG DOCUMENTATION at 2 (2018) (annotation added).

365. By complying with the HEVC standard, the LG devices – such as the LG '450 Products – necessarily infringe the '450 patent. Mandatory sections of the HEVC standard require the elements required by certain claims of the '450 patent, including but not limited to claim 8. *High Efficiency Video Coding*, SERIES H: AUDIOVISUAL AND Multimedia SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 (February 2018). The following sections of the HEVC Standard are relevant to LG's infringement of the '450 patent: "5.3 Logical operators;" "5.10 Variables, syntax elements and tables;" "5.11 Text description of logical operations;" "7.2 Specification of syntax functions and descriptors;" "7.3.1 NAL unit syntax;" "7.3.2 Raw byte sequence payloads, trailing bits and byte alignment syntax;" "7.3.5 Supplemental enhancement information message syntax;" "7.4.2 NAL unit semantics;" and "7.4.6 Supplemental enhancement information message semantics."

366. The LG '450 Products receive data that is segmented into Network Abstraction Layer ("NAL") Units. NAL Units are segments of data that can include video data and overlay data (such as captions and overlay images). The LG '450 Products support the receipt of VCL and non-VCL NAL units. The VCL NAL units contain the data that represents the values of the

samples in the video pictures, and the non-VCL NAL units contain any associated additional information such as parameter sets or overlay data.

> HEVC uses a NAL unit based bitstream structure. A coded bitstream is partitioned into NAL units which, when conveyed over lossy packet networks, should be smaller than the maximum transfer unit (MTU) size. Each NAL unit consists of a NAL unit header followed by the NAL unit payload. There are two conceptual classes of NAL units. Video coding layer (VCL) NAL units containing coded sample data, e.g., coded slice NAL units, whereas non-VCL NAL units that contain metadata typically belonging to more than one coded picture, or where the association with a single coded picture would be meaningless, such as parameter set NAL units, or where the information is not needed by the decoding process, such as SEI NAL units.

Rickard Sjöberg et al, *Overview of HEVC High-Level Syntax and Reference Picture Management,* IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, Vol. 22, No. 12 at 1859 (December 2012) (emphasis added).

367. The LG '450 Products process data in the form of VCL NAL Units that contain segments of data which are used to generate an image (e.g., HEVC image) on a display device. Each VCL NAL Unit comprises a discrete number of bites which make up a segment. The following excerpt from the HEVC specification describes a NAL unit as being a segment with a "demarcation" setting forth where the segment ends and begins.

> NumBytesInNalUnit specifies the size of the NAL unit in bytes. This value is required for decoding of the NAL unit. Some form of demarcation of NAL unit boundaries is necessary to enable inference of NumBytesInNalUnit. One such demarcation method is specified in Annex B for the byte stream format. Other methods of demarcation may be specified outside of this Specification.

High Efficiency Video Coding, SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 at § 7.4.2.1 (February 2018) (emphasis added).

368. The LG '450 Products receive VCL NAL units that contain the data that represents the values of the samples in the video pictures, and non-VCL NAL units that contain associated additional information such as parameter sets or overlay data.

> HEVC uses a NAL unit based bitstream structure. A coded bitstream is partitioned into NAL units which, when conveyed over lossy packet networks, should be smaller than the maximum transfer unit (MTU) size. Each NAL unit consists of a NAL unit header followed by the NAL unit payload. There are two conceptual classes of NAL units. Video coding layer (VCL) NAL units containing coded

> sample data, e.g., coded slice NAL units, whereas non-VCL NAL units that contain metadata typically belonging to more than one coded picture, or where the association with a single coded picture would be meaningless, such as parameter set NAL units, or where the information is not needed by the decoding process, such as SEI NAL units.

Rickard Sjöberg et al, *Overview of HEVC High-Level Syntax and Reference Picture Management*, IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, Vol. 22, No. 12 at 1859 (December 2012) (emphasis added).

369. The LG'450 Products perform filtering, wherein the filtering enables a user to select a data element based on the user's selection. Specifically, a user can select the display of Non-VCL NAL Unit data which can include closed captions or other overlay information that is selected based on the user interaction. The data that is selected by the user is parsed by the system and filtered. The Non-VCL NAL Units include supplemental enhancement information ("SEI") messages. The SEI data that is received contains overlay information that can be combined with the image data that has already been received.

sei_message( ) {	Descriptor
payloadType = 0	
while(next_bits(8) == 0xFF) {	
ff_byte /* equal to 0xFF */	f(8)
payloadType += 255	
}	
last_payload_type_byte	u(8)
payloadType += last_payload_type_byte	
payloadSize = 0	
while(next_bits(8) == 0xFF) {	
ff_byte /* equal to 0xFF */	f(8)
payloadSize += 255	
}	
last_payload_size_byte	u(8)
payloadSize += last_payload_size_byte	
sei_payload(payloadType, payloadSize)	
}	

High Efficiency Video Coding, SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 at § 7.3.5 (February 2018).

370. The LG '450 Products perform rendering of an output image to be displayed on a display device on the basis of the first data-element selected by the filter. The overlay data is used

to render overlays of the display data. The amount of overlay data that is downloaded in the form of Non-VCL data comprises a portion of the overlay that is displayed.

371. LG has directly infringed and continues to directly infringe the '450 Patent by, among other things, making, using, offering for sale, and/or selling technology for displaying information, including but not limited to the LG '450 Products.

372. One or more of the LG '450 Products enable methods and systems wherein a user does not need to make a new selection after being switched from one service to a second service.

373. One or more of the LG '450 Products perform a method of displaying information on a display device wherein receiving a transport stream comprises services, with the services having elementary streams of video and of data elements.

374. One or more of the LG '450 Products perform a method of displaying information on a display device wherein user actions of making a user selection of a type of information to be displayed on the device are received.

375. One or more of the LG '450 Products perform a method of displaying information on a display device wherein filtering to select a data element of a first one of the services on the basis of the user selection is performed.

376. One or more of the LG '450 Products perform a method of displaying information on a display device wherein rendering to calculate an output image to be displayed on the display device, on the basis of the first data element selected by the filer is performed.

377. One or more of the LG '450 Products perform a method of displaying information on a display device wherein switching from the first one of the services to a second one of the services, characterized in comprising a second step of filtering to select a second data-element of the second one of the services, on the basis of the user selection is performed.

378. One or more of the LG ‘450 Products perform a method of displaying information on a display device wherein being switched from the first one of the services to the second one of the services, with the data-element and the second data-element being mutually semantically related and a second step of rendering to calculate the output image to be displayed on the display device, on the basis of the second data-element selected by the filter is performed.

379. The LG ‘450 Products are available to businesses and individuals throughout the United States.

380. The LG ‘450 Products are provided to businesses and individuals located in the Eastern District of Texas.

381. By making, using, testing, offering for sale, and/or selling products and services for displaying information, including but not limited to the LG ‘450 Products, LG has injured Dynamic Data and is liable to the Plaintiff for directly infringing one or more claims of the ‘450 patent, including at least claim 8 pursuant to 35 U.S.C. § 271(a).

382. LG also indirectly infringes the ‘450 patent by actively inducing infringement under 35 U.S.C. § 271(b).

383. LG has had knowledge of the ‘450 patent since at least service of the Original Complaint in this case or shortly thereafter, and on information and belief, LG knew of the ‘450 patent and knew of its infringement, including by way of this lawsuit.

384. LG intended to induce patent infringement by third-party customers and users of the LG ‘450 Products and had knowledge that the inducing acts would cause infringement or was willfully blind to the possibility that its inducing acts would cause infringement. LG specifically intended and was aware that the normal and customary use of the accused products would infringe the ‘450 patent. LG performed the acts that constitute induced infringement, and would induce

actual infringement, with knowledge of the '450 patent and with the knowledge that the induced acts would constitute infringement. For example, LG provides the LG '450 Products that have the capability of operating in a manner that infringe one or more of the claims of the '450 patent, including at least claim 8, and LG further provides documentation and training materials that cause customers and end users of the LG '450 Products to utilize the products in a manner that directly infringe one or more claims of the '450 patent.[55] By providing instruction and training to customers and end-users on how to use the LG '450 Products in a manner that directly infringes one or more claims of the '450 patent, including at least claim 8, LG specifically intended to induce infringement of the '450 patent. LG engaged in such inducement to promote the sales of the LG '450 Products, e.g., through LG user manuals, product support, marketing materials, and training materials to actively induce the users of the accused products to infringe the '450 patent. Accordingly, LG has induced and continues to induce users of the accused products to use the accused products in their ordinary and customary way to infringe the '450 patent, knowing that such use constitutes infringement of the '450 patent.

385. The '450 patent is well-known within the industry as demonstrated by multiple citations to the '450 patent in published patents and patent applications assigned to technology companies and academic institutions. LG is utilizing the technology claimed in the '450 patent

[55] *See, e.g.*, *Large Ultra HD Signage: UM3C Series*, LG SPECIFICATION SHEET (2018); *Multiple Screen Split-Ultra HD Signage: Ultra HD UH5C Series*, LG SPECIFICATION SHEET (2016); *LG Help Library: Ultra HD 4K Upscaling – UHD TV Video*, LG Support Website (last visited March 2019), *available at*: https://www.lg.com/us/support/product-help/CT10000018-1432737109927-general-specifications; *98UB9800, 98UB9810, 105UC9,* OWNER'S MANUAL LED TV, *available at*: https://www.lg.com/us/support-product/lg-98UB9810 (last visited Nov. 2018); *40UB8000, 49UB8200, 55UB8200, 60UB8200, 49UB8300, 55UB8300, 65UB9200*, OWNER'S MANUAL LED TV, *available at*: https://www.lg.com/us/support-product/lg-55UB8200 (last visited Nov. 2018); *50UH5500, 50UH5530, 65UH5500,* OWNER'S MANUAL SAFETY AND REFERENCE LED TV, *available at*: https://www.lg.com/us/support-product/lg-50UH5530 (last visited Nov. 2018); *LM-V405AQ*, USER GUIDE (2018); *LM-V35OULM*, USER GUIDE (2018); *LG Stylo 4 LM-Q71OULM*, USER GUIDE (2018); *LG V30*, USER GUIDE (2018); *LM-X410AS*, USER GUIDE (2018).

without paying a reasonable royalty. LG is infringing the '450 patent in a manner best described as willful, wanton, malicious, in bad faith, deliberate, consciously wrongful, flagrant, or characteristic of a pirate.

386. To the extent applicable, the requirements of 35 U.S.C. § 287(a) have been met with respect to the '450 patent.

387. As a result of LG's infringement of the '450 patent, Dynamic Data has suffered monetary damages, and seeks recovery in an amount adequate to compensate for LG's infringement, but in no event less than a reasonable royalty for the use made of the invention by LG together with interest and costs as fixed by the Court.

COUNT IX
INFRINGEMENT OF U.S. PATENT NO. 7,750,979

388. Dynamic Data references and incorporates by reference the preceding paragraphs of this Complaint as if fully set forth herein.

389. LG designs, makes, uses, sells, and/or offers for sale in the United States products and/or services for motion compensation in video signal processing.

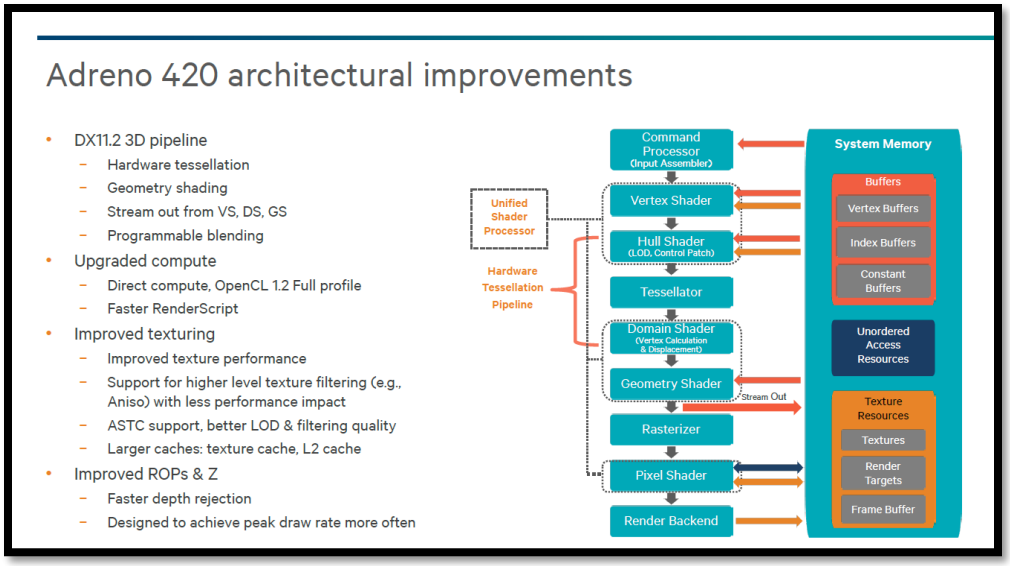
390. LG designs, makes, sells, offers to sell, imports, and/or uses LG products including the following device models: LG G7 ThinQ, LG V40 ThinQ, LG V35 ThinQ, LG V30, LG G6, LG G5, and LG V20 (collectively, the "LG '979 Products").

391. The LG '979 Products include a video processing circuit having an input stream of pixels corresponding to an array of video pixels. Specifically, the LG '979 Products include an 800 Series Qualcomm Snapdragon system on chip ("SoC") which contains an Adreno graphics processing unit ("GPU"). For each of the accused LG '979 Products the following Qualcomm

Snapdragon video processing chip is identified: LG G7 ThinQ (Snapdragon 845),[56] LG V40 ThinQ (Snapdragon 845),[57] LG V35 ThinQ (Snapdragon 845),[58] LG V30 (Snapdragon 835),[59] LG G6 (Snapdragon 812),[60] LG G5 (Snapdragon 820),[61] and LG V20 (Snapdragon 820).[62]

392. The LG '979 Products contain an infringing video processing circuit having an input stream of pixels corresponding to an array of video pixels. The following excerpt from a presentation regarding the graphics processing unit in the LG '979 Products identifies that the products contain functionality for processing a stream of pixels that are received from the system memory and then processed and sent to a frame buffer.

[56] *LG G7 ThinQ Specifications*, LG WEBSITE, *available at*: https://www.lg.com/us/cell-phones/lg-G710ULM-LRA-g7-thinq.
[57] *LG V40 ThinQ Specifications*, LG WEBSITE, *available at*: https://www.lg.com/us/mobile-phones/v40-thinq/specs.
[58] *LG V35 ThinQ Specifications*, LG WEBSITE, *available at*: https://www.lg.com/us/cell-phones/lg-V350AWM-v35-thinq-att.
[59] *LG V30+ Specifications*, LG WEBSITE, *available at*: https://www.lg.com/us/cell-phones/lg-LS998U-lg-v30-plus.
[60] *LG G6 Specifications*, LG WEBSITE, *available at*: https://www.lg.com/levant_en/mobile-phones/lg-G6-platinum.
[61] *LG G5 Specifications*, LG WEBSITE, *available at*: https://www.lg.com/us/cell-phones/lg-RS988-Titan-g5-unlocked.
[62] *LG V20 Specifications*, LG WEBSITE, *available at*: https://www.lg.com/us/cell-phones/lg-VS995-Titan-v20.

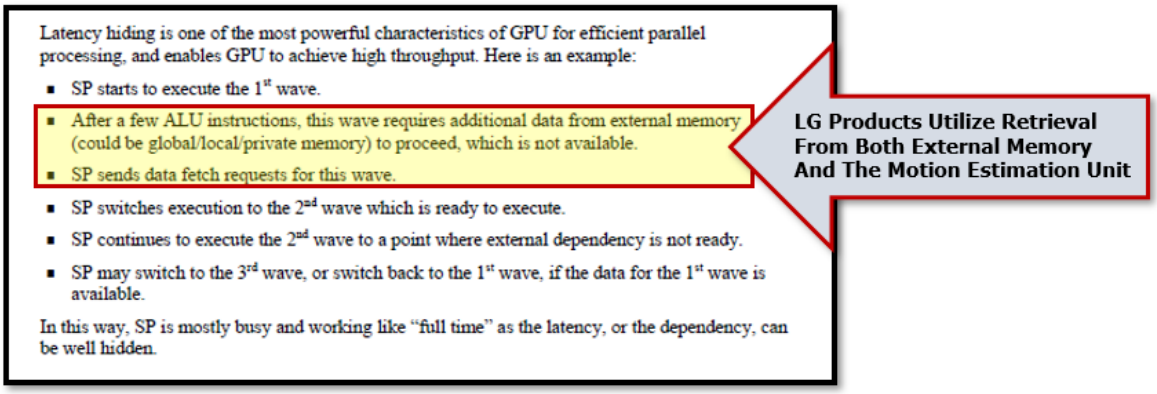


Manish Sirdeshmukh and Todd LeMoine, *Qualcomm Snapdragon Processors: A Super Gaming Platform*, UPLINQ 2014 PRESENTATION at 14 (2014).

393. The LG '979 Products enable a video processing stage that receives input pixels wherein the pixels are of a fixed number. "An image object is used to store a one-, two-, or three-dimensional texture, frame buffer, or an image data, and the layout of data inside the image object is opaque. In practice, the content in the object does not have to be associated with an actual image data. Any data can be stored as image object to utilize the hardware texture engine and its L1 cache in Adreno."[63]

394. The LG '979 Products enable the retrieval of pixel input data from memory. The below excerpt from documentation relating to the LG '979 Product GPU identifies that pixel data is retrieved from "global, local, and private memory."

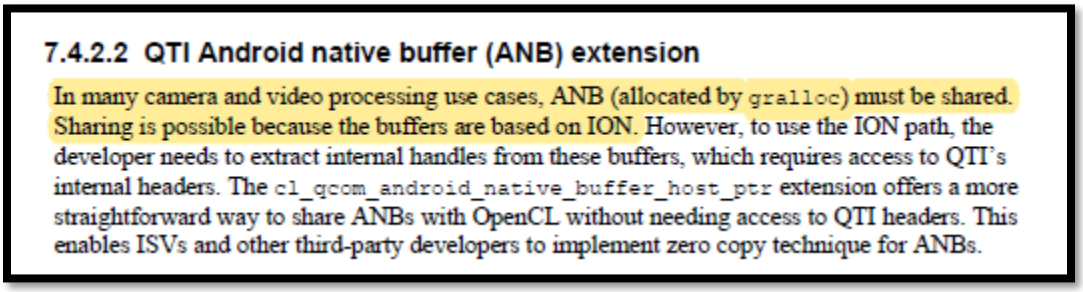
[63] *Qualcomm Snapdragon Mobile Platform OpenCL General Programming Optimization*, QUALCOMM DOCUMENT 80-NB295-11 A at 40 (November 3, 2017).



Qualcomm Snapdragon OpenCL General Programming and Optimization, QUALCOMM SNAPDRAGON DOCUMENTATION at 16 (November 3, 2017) (annotations added) (describing the use of latency hiding wherein data for video encoding is taken from both external memory and the motion estimation unit (on chip)).

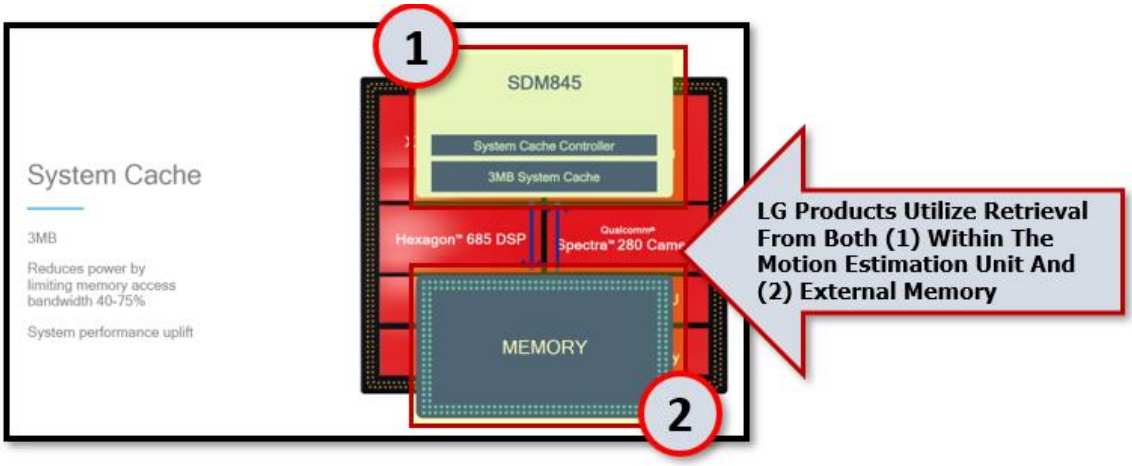
395. The LG'979 Products perform the step of establishing a window size and a sampling-window size, such that the window size is a multiple of the sampling window size and the sampling-window size defines the number of pixels.

396. The LG '979 Products enable the writing of pixel data to buffers that can be shared. "In many camera and video processing use cases, ANB [] must be shared."



Qualcomm *Snapdragon OpenCL General Programming and Optimization*, QUALCOMM SNAPDRAGON DOCUMENTATION at 45 (November 3, 2017) (annotations added).

397. The LG '979 Products comprise a video processing unit. The below image identifies an exemplar of the image processing component in the LG '979 Products.



Andrei Frumusanu, *Qualcomm Announces Snapdragon 845 Mobile Platform: Tocks Next-Gen CPU Cores, GPU, AI, & More*, ANANDTECH WEBSITE (December 6, 2017).

398. The LG '979 Products perform the step of storing pixels from the input stream into a first set of line buffers. The pixels that are stored in the first set of line buffers include pixels for the established window size. The LG '979 Products support the use of buffer objects and image objects which are stored in a line buffer. Documentation relating to the LG '979 Products states that, "Image objects" allows access to a "pixel size boundary."

For example, assume an image is of type `CLK_NORMALIZED_COORDS_TRUE` and `CL_UNORM_INT16`, i.e., image date is 2-byte unsigned short. Function call `read_imagef` will do the following:

- Reads pixels from image object (which is then cached in L1 cache).
- Interpolates neighboring pixels in hardware.
- Converts and normalizes it to the range of [0, 1]

This is convenient for bilinear or trilinear interpolation operations.

Sometimes a buffer object may be a better choice:

- More flexible data access:
  - Image object only allows access at the pixel size boundary, for example, 128-bit for RGBA and 32-bit/channel image object.
  - For buffer object, Adreno supports byte addressable access. For example, 128-bit data could be loaded from any byte address in a buffer object, if it is not out of the buffer boundary.

Qualcomm Snapdragon Mobile Platform OpenCL General Programming Optimization, QUALCOMM DOCUMENT 80-NB295-11 A at 41 (November 3, 2017).

399. The LG ‘979 Products perform the step of prefetching the stored pixels from the first set of line buffers into a second set of line buffers. The second set of line buffers being sufficiently long to a store at least the pixels corresponding to the established sampling-window size. “For example, consider a window-based motion estimation using object matching for certain video processing. Suppose each work item processes a small region of 8x8 pixels within a search window of 16x16 pixels, leading to a lot of data overlap between neighboring work items. Local memory cancan be a good fit to store the pixels in this case to reduce the redundant fetch.”[64]

400. As shown in the below image, the processor incorporated into the LG ‘979 Products contains an L3 Cache, DDR memory, and an Adreno GPU.

[64] *Qualcomm Snapdragon Mobile Platform OpenCL General Programming Optimization*, QUALCOMM DOCUMENT 80-NB295-11 A at 37 (November 3, 2017) (emphasis added).

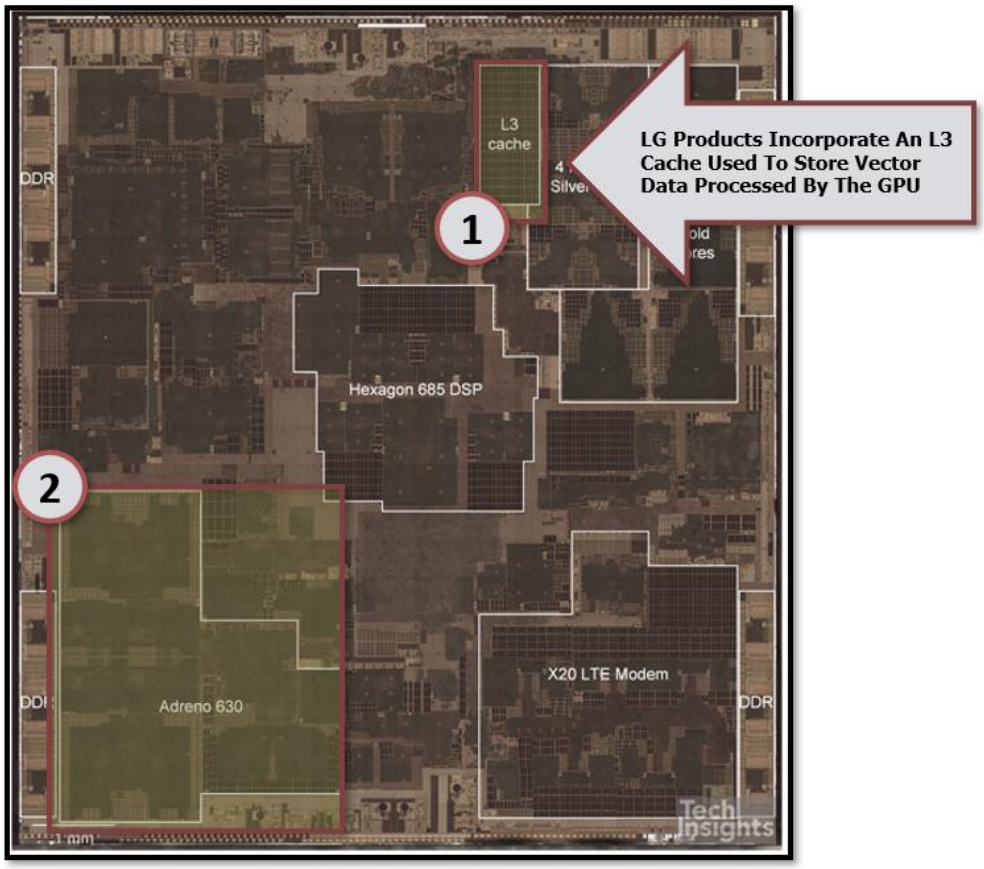
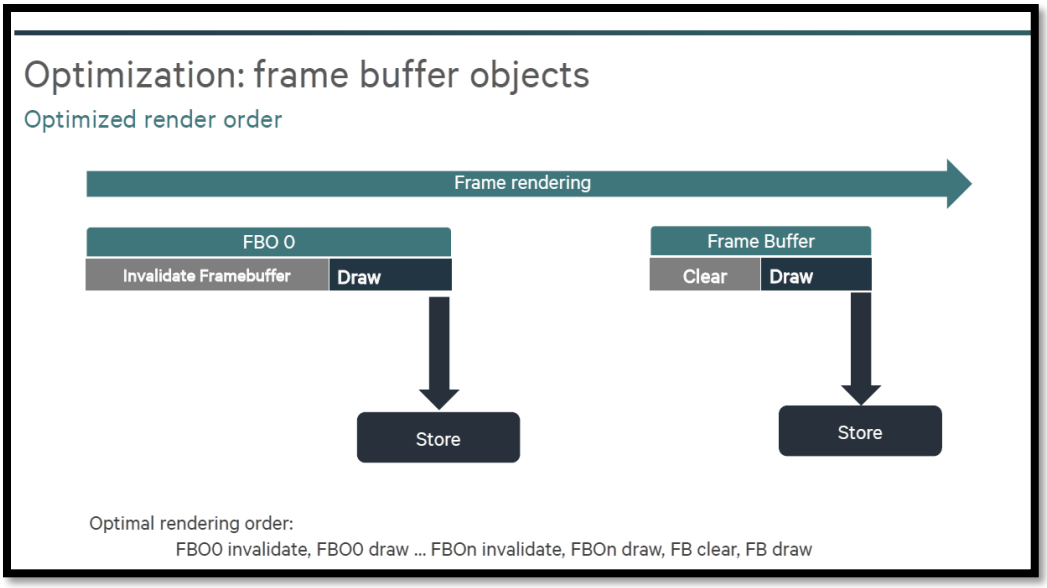


IMAGE OF SNAPDRAGON 845 PROCESSOR INCORPORATED INTO THE LG'979 PRODUCTS: DETAILED PRODUCT ANALYSIS OF THE SNAPDRAGON 845 (2018) (annotation added) (showing at annotation "1" the L3 Cache where image vector data is stored and at annotation "2" the Adreno 630 GPU).

401. The LG '979 Products perform the step of fetching a fixed number of pixels from the second set of line buffers. The below excerpt from a presentation regarding frame buffer objects and the optimized render order shows that a fixed number of pixels are stored and retrieved from a second set of line buffers.



Manish Sirdeshmukh and Todd LeMoine, *Qualcomm Snapdragon Processors: A Super Gaming Platform*, UPLINQ 2014 PRESENTATION at 19 (2014).

402. Documentation regarding the graphics processing units in the LG '979 Products states, "Adreno 4xx uses a shared resource architecture that allows the same ALU and fetch resources to be shared by the vertex shaders, pixel or fragment shaders, and general-purpose processing. The shader processing is done within the unified shader architecture."[65]

403. One or more LG subsidiaries and/or affiliates use the LG '979 Products in regular business operations.

404. One or more of the LG '979 Products include technology for motion compensation in video signal processing.

405. LG has directly infringed and continues to directly infringe the '979 patent by, among other things, making, using, offering for sale, and/or selling technology for motion compensation in video signal processing, including but not limited to the LG '979 Products.

[65] *Qualcomm Adreno OpenGL ES Developer Guide*, QUALCOMM DOCUMENTATION 80-NU141-1-B at 15 (May 1, 2015) (emphasis added).

406. The LG ‘979 Products have an input stream of pixels corresponding to an array of video pixels, having a variable window size for sampling subsets of the array as a two-dimensional window that spans the pixels in the array.

407. The LG ‘979 Products establish a window size and a sampling-window size, such that the window size is a multiple of the sampling-window size and the sampling-window size defines the fixed number of pixels.

408. The LG ‘979 Products prefetch the stored pixels from the first set of line buffers into a second set of line buffers, the second set of line buffers being sufficiently long to store at least the pixels corresponding to the established sampling-window size.

409. The LG ‘979 Products are available to businesses and individuals throughout the United States.

410. The LG ‘979 Products are provided to businesses and individuals located in the Eastern District of Texas.

411. By making, using, testing, offering for sale, and/or selling products and services for motion compensation in video signal processing, including but not limited to the LG ‘979 Products, LG has injured Dynamic Data and is liable to the Plaintiff for directly infringing one or more claims of the ‘979 patent, including at least claim 1 pursuant to 35 U.S.C. § 271(a).

412. LG also indirectly infringes the ‘979 patent by actively inducing infringement under 35 USC § 271(b).

413. LG has had knowledge of the ‘979 patent since at least service of the Original Complaint in this case or shortly thereafter, and on information and belief, LG knew of the ‘979 patent and knew of its infringement, including by way of this lawsuit.

414. LG intended to induce patent infringement by third-party customers and users of the LG '979 Products and had knowledge that the inducing acts would cause infringement or was willfully blind to the possibility that its inducing acts would cause infringement. LG specifically intended and was aware that the normal and customary use of the accused products would infringe the '979 patent. LG performed the acts that constitute induced infringement, and would induce actual infringement, with knowledge of the '979 patent and with the knowledge that the induced acts would constitute infringement. For example, LG provides the LG '979 Products that have the capability of operating in a manner that infringe one or more of the claims of the '979 patent, including at least claim 1, and LG further provides documentation and training materials that cause customers and end users of the LG '979 Products to utilize the products in a manner that directly infringe one or more claims of the '979 patent.[66] By providing instruction and training to customers and end-users on how to use the LG '979 Products in a manner that directly infringes one or more claims of the '979 patent, including at least claim 1, LG specifically intended to induce infringement of the '979 patent. LG engaged in such inducement to promote the sales of the LG '979 Products, e.g., through LG user manuals, product support, marketing materials, and training materials to actively induce the users of the accused products to infringe the '979 patent. Accordingly, LG has induced and continues to induce users of the accused products to use the accused products in their ordinary and customary way to infringe the '979 patent, knowing that such use constitutes infringement of the '979 patent.

415. To the extent applicable, the requirements of 35 U.S.C. § 287(a) have been met with respect to the '979 patent.

[66] *See, e.g.*, *LM-V405AQ*, USER GUIDE (2018); *LM-V35OULM*, USER GUIDE (2018); *LG V30*, USER GUIDE (2018); *See, e.g.*, *LG V35 ThinQ*, LG USER GUIDE (2018); *LG V40 ThinQ*, USER GUIDE (2018); LG G7 THINQ, USER GUIDE (2018); LG GLOBAL YOUTUBE CHANNEL (January 12, 2019), available at: https://www.youtube.com/watch?v=4QXpEr1EsjA.

416. As a result of LG's infringement of the '979 patent, Dynamic Data has suffered monetary damages, and seeks recovery in an amount adequate to compensate for LG's infringement, but in no event less than a reasonable royalty for the use made of the invention by LG together with interest and costs as fixed by the Court.

COUNT X
INFRINGEMENT OF U.S. PATENT NO. 7,894,529

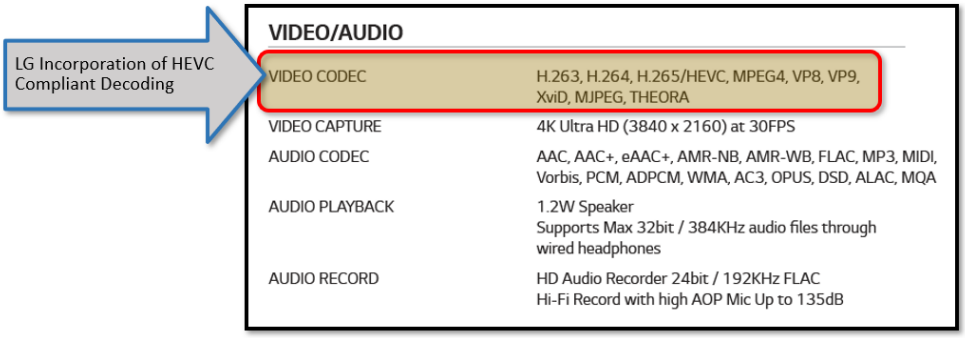
417. Dynamic Data references and incorporates by reference the preceding paragraphs of this Complaint as if fully set forth herein.

418. LG designs, makes, uses, sells, and/or offers for sale in the United States products and/or services for determining motion vectors that are each assigned to individual image regions.

419. LG designs, makes, sells, offers to sell, imports, and/or uses LG products that contain sub-pixel accurate motion vector functionality, including but not limited to LG products that contain and/or enable H.265 decode functionality, including: LG smart phones, LG OLED TVs, LG Super UHD 4K TVs, LG UHD 4K TVs, and LG digital signage products (collectively, the "LG '529 Products").

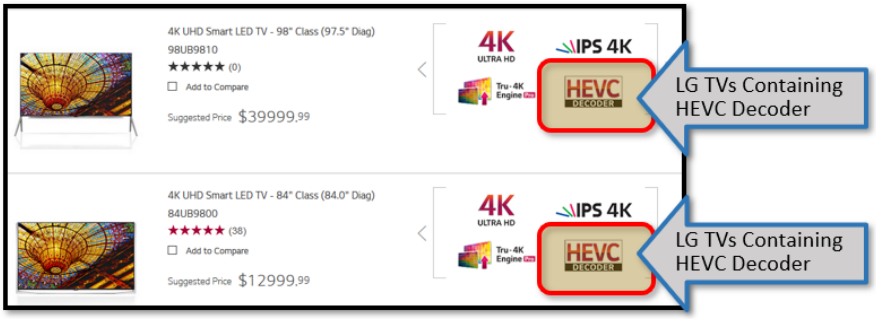
420. The accused LG '529 Products include the following LG smart phone models (which include functionality for decoding video content that is encoded in accord with the HEVC standard): LG US700, LG LMV405UA, LG Q610TA, LG K450, LG V350AWM, LG SP200, LG Q710MS, LG 211BL, LG M154, LG X410TK, LG Q617QA, LG Q610MA, LG US701, LG M327, LG 255, LG H700, LG M430, LG L83BL, LG M257, LG X410ASR, LG Q710ULS, LG US601, LG M322, LG Q710ULM, LG Q710CS, LG V350ULM, LG X210ULMA, LG LM-X210ULMA-K8, LG LM-X210VPP, LG LMX220MA, LG Q710AL, LG US601 ACG, LG

LMX210MA, LG LM-V405UA, and LG X212TAL.[67] The following excerpt from an exemplar specification of one of the accused LG smart phones identifies that it contains an HEVC decoder functionality.



LG V30 SPECIFICATION SHEET at 1 (2017) (annotation added).

421. The accused LG '529 Products include the following LG television models: 60UF8500, 105UC9, 98UB9810, 84B9800, 40UB8000, 49UB8500, 55UB8500, 55UB8200, 65UB9200, 60UB8200, 98UB9800, 49UB8300, 55UB8300, 55UB9500, 65UB9500, 79UB9800, and 65UB9800.[68]

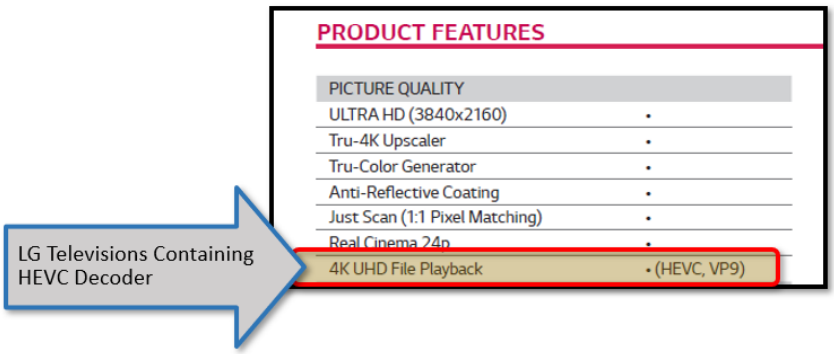


LG Television Product Search, LG CONSUMER WEBSITE (last visited March 2018), *available at*: https://www.lg.com/us/search.lg?search=hevc (annotations added).

[67] *See e.g.*, *LG Phones Website*, LG WEBSITE (last visited March 2019), *available at*: https://www.lg.com/us/cell-phones/all-cell-phones; LG G4 vs. Samsung Galaxy S6", GSMArena, June 19, 2015 (LG's G4 (2015), G5 (2015), and G6 (2017) phones support HEVC with UHD resolution [81], and the G5 and G6 support 10 bit video and 60 fps HFR).

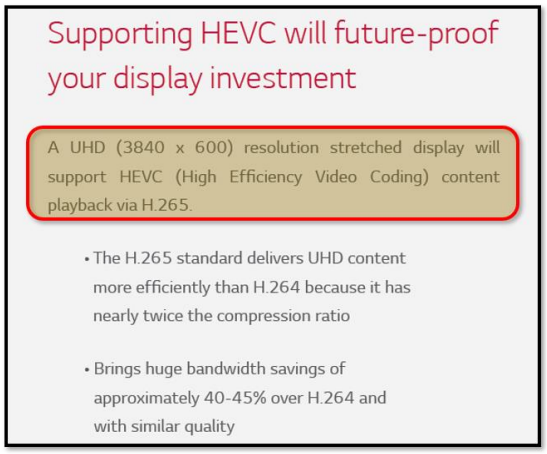
[68] Tribbey, Chris, *CES 2017: LG Debuts ATSC 3.0-Enabled 4K TVs*, BROADCASTING AND CABLE, January 8, 2017.

422. LG documentation identifies that the accused LG television products enable the playback of content that is encoded in the HEVC standard using an HEVC complaint decoder.



LG EG9600 4K UHD SMART CURVED OLET TV W/ WEBOS 2.0 & 3D SPECIFICATION at 1 (2015) (annotation added).

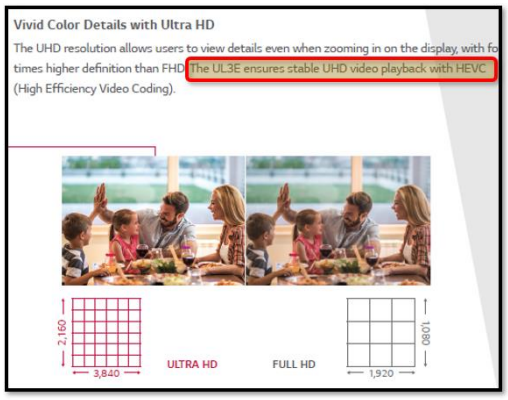
423. The accused LG '529 Products include the following LG digital signage products: UM3C, 75UH5C, 75UM3C, 60UL3E, 86UH5E-B, 55UH5B, 55VH7B, 55VM5B, 49VM5C, 55VX1D, 49UH5C, and 55UH5C.[69]



How to Stretch Customer Imagination With Digital Signage, LG BUSINESS SOLUTIONS DOCUMENTATION at 6 (2016).

424. The accused LG '529 Products are described in LG documentation as ensuring "stable UHD video playback with HEVC."

[69] *See e.g.*, *LG Business Solutions Digital Signage*, LG WEBSITE, *available at*: https://www.lg.com/us/business/commercial-display/displays-tvs/digital-signage/.



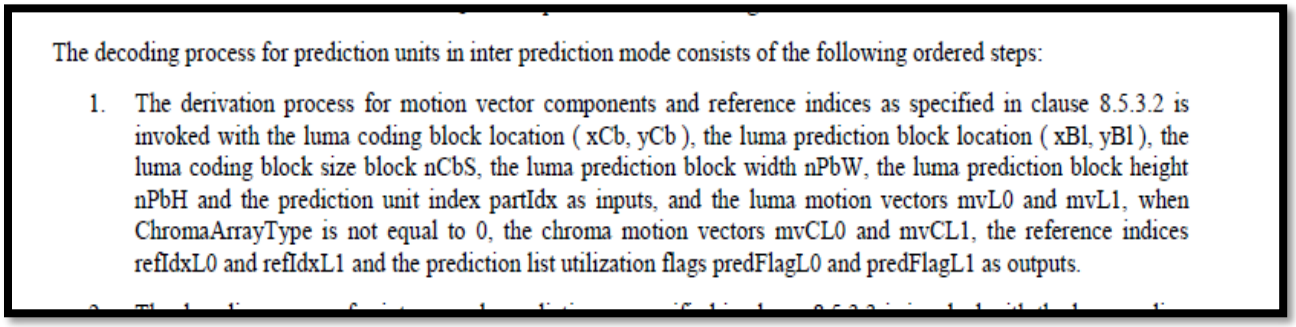
70UL3E 60UL3E Clear Color Expression of UHD Content Documentation, LG DOCUMENTATION at 2 (2018) (annotation added).

425. The LG '529 Products incorporate a decoding unit for decoding the frame of the received video data. The decoding utilizes a second frame recovery unit that is a decoding motion vector. Specifically, the encoding and decoding process for video data received by the LG '529 Products use inter-picture prediction wherein motion data comprises the selection of a reference frame and motion vectors to be applied in predicting the samples of each block.

426. By complying with the HEVC standard, the LG devices – such as the LG '529 Products – necessarily infringe the '529 patent. Mandatory sections of the HEVC standard require the elements required by certain claims of the '529 patent, including but not limited to claim 1. *High Efficiency Video Coding*, SERIES H: AUDIOVISUAL AND Multimedia SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 (February 2018). The following sections of the HEVC Standard are relevant to LG's infringement of the '529 patent: "3.110 Prediction Unit Definition;" "6.3.2 Block and quadtree structures;" "6.3.3 Spatial or component-wise partitioning;" "6.4.2 Derivation process for prediction block availability;" "7.3.8.5 Coding unit syntax;" "7.3.8.6 Prediction unit syntax;" "8.3.2 Decoding process for reference picture set;" "8.5.4 Decoding process for the residual signal of coding units coded in inter prediction mode;" "8.6 Scaling, transformation and array construction process prior

to deblocking filter process;" "8.5.2 Inter prediction process;" "8.5.3 Decoding process for prediction units in inter prediction mode;" and "8.7.2 Deblocking filter process."

427. The LG '529 Products comply with the HEVC standard, which requires determining motion vectors assigned to individual image regions of an image.



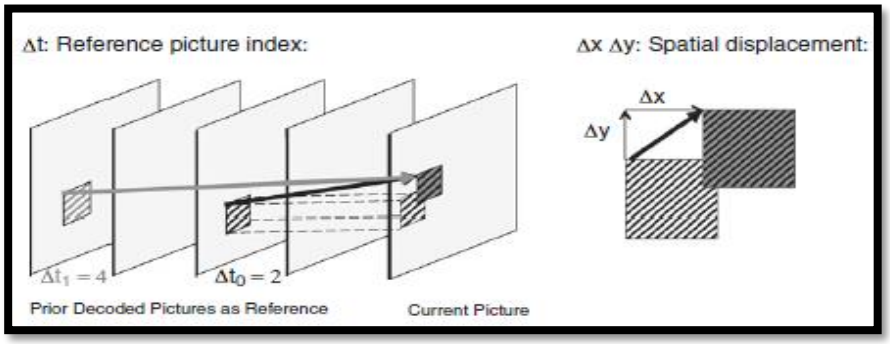
The decoding process for prediction units in inter prediction mode consists of the following ordered steps:

1. The derivation process for motion vector components and reference indices as specified in clause 8.5.3.2 is invoked with the luma coding block location (xCb, yCb), the luma prediction block location (xBl, yBl), the luma coding block size block nCbS, the luma prediction block width nPbW, the luma prediction block height nPbH and the prediction unit index partIdx as inputs, and the luma motion vectors mvL0 and mvL1, when ChromaArrayType is not equal to 0, the chroma motion vectors mvCL0 and mvCL1, the reference indices refIdxL0 and refIdxL1 and the prediction list utilization flags predFlagL0 and predFlagL1 as outputs.

High Efficiency Video Coding, Series H: Audiovisual And Multimedia Systems: Infrastructure Of Audiovisual Services – Coding Of Moving Video Rec. ITU-T H.265 at § 8.5.3.1 (February 2018).

428. LG has directly infringed and continues to directly infringe the '529 patent by, among other things, making, using, offering for sale, and/or selling technology for implementing a motion estimation technique that assigns at least one motion vector to each of the image blocks and generating a modification motion vector for at least the first image block.

429. The encoded video stream received by the LG '529 Products is encoded using inter-picture prediction that makes use of the temporal correlation between pictures to derive a motion-compensated prediction (MCP) for a block of image samples. For this block-based motion compensated prediction, a video picture is divided into rectangular blocks. Assuming homogeneous motion inside one block, and that moving objects are larger than one block, for each block, a corresponding block in a previously decoded picture can be found that serves as a predictor. The general concept of inter-frame-based encoding using motion-compensated prediction based on a translational motion model is illustrated below.



Benjamin Bross, *Inter-Picture Prediction In HEVC*, HIGH EFFICIENCY VIDEO CODING (HEVC) at 114 (September 2014).

430. The LG '529 Products perform the step of selecting a second image block where the motion vector that is assigned to the first image block passes. Specifically, the LG '529 Products, in the use of inter-picture prediction, look at two or more blocks in different frames wherein the vector passes through both the first and second image block. The following excerpts from documentation relating the video estimation technique used by the LG '529 Products explains how HEVC uses motion estimation to determine a temporal intermediate position between two images wherein two image blocks are selected that have a motion vector passing in both the first and second image block.

> One way of achieving high video compression is to predict pixel values for a frame based on prior and succeeding pictures in the video. Like its predecessors, H.265 features the ability to predict pixel values between pictures, and in particular, to specify in which order pictures are coded and which pictures are predicted from which. The coding order is specified for Groups Of Pictures (GOP), where a number of pictures are grouped together and predicted from each other in a specified order. The pictures available to predict from, called reference pictures, are specified for every individual picture.

Johan Bartelmess, *Compression Efficiency of Different Picture Coding Structures in High Efficiency Video Coding (HEVC)*, UPTEC STS 16006 at 4 (March 2016) (emphasis added).

431. The LG '529 Products receive encoded video data that is encoded using inter-frame coding. Specifically, the encoded video stream received by the LG '529 Products is coded using its predecessor frame. Inter-prediction used in the encoded video data received by the LG '529

Products allows a transform block to span across multiple prediction blocks for inter-picture predicted coding units to maximize the potential coding efficiency benefits of the quadtree-structured transform block partitioning.

> The basic source-coding algorithm is a hybrid of interpicture prediction to exploit temporal statistical dependences, intrapicture prediction to exploit spatial statistical dependences, and transform coding of the prediction residual signals to further exploit spatial statistical dependences.

G. J. Sullivan, J.-R. Ohm, W.-J. Han, and T. Wiegand, *Overview of the High Efficiency Video Coding (HEVC) standard*, IEEE TRANS. CIRCUITS SYST. VIDEO TECHNOL., Vol. 22, No. 12, p. 1654 (December 2012) (emphasis added).

432. The following excerpt from an article describing the architecture of the video stream received by the LG '529 Products describes the functionality wherein the second encoded frame of the video data is dependent on the encoding of a first frame. "HEVC inter prediction uses motion vectors pointing to one reference frame . . . to predict a block of pixels."

> HEVC inter prediction uses motion vectors pointing to one reference frame (uni-prediction) or two reference frames (bi-prediction) to predict a block of pixels. The size of the predicted block, called Prediction Unit (PU), is determined by the Coding Unit (CU) size and its partitioning mode. For example, a 32×32 CU with 2N×N partitioning is split into two PUs of size 32×16, or a 16×16 CU with nL×2N partitioning is split into 4×16 and 12×16 PUs.

Mehul Tikekar, *et al.*, *Decoder Hardware Architecture for HEVC*, HIGH EFFICIENCY VIDEO CODING (HEVC) (September 2014).

433. Any implementation of the HEVC standard infringes the '529 patent as every possible implementation of the standard requires: determining at least a second image block through which the motion vector assigned to the first image block at least partially passes; generating the modified motion vector as a function of a motion vector assigned to at least the second image block; and assigning the modified motion vector as the motion vector to the first image block. Further, the functionality of the motion estimation process in HEVC uses "motion vector[s]: A two-dimensional vector used for *inter prediction* that provides an offset from the

coordinates in the decoded picture to the coordinates in a reference picture," as defined in definition 3.83 of the *ITU-T H.265 Series H: Audiovisual and Multimedia Systems* (2018) (emphasis added); *see also, e.g.,* Gary J. Sullivan, Jens-Rainer Ohm, Woo-Jin Han, and Thomas Wiegand, *Overview of the High Efficiency Video Coding (HEVC) Standard,* published in IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, Vol. 22, No. 12 at 1650 (December 2012) ("The encoder and decoder generate identical inter picture prediction signals by applying motion compensation (MC) using the MV and mode decision data.").

434. The motion estimation done by the LG '529 Products is done through a PU matching method where the motion vector represents the displacement between the current PU in the current frame and the matching PU in the reference frame.

> Motion estimation compares the current prediction unit (PU) with the spatially neighboring PUs in the reference frames, and chooses the one with the least difference to the current PU. The displacement between the current PU and the matching PU in the reference frames is signaled using a motion vector.

Sung-Fang Tsai, *et al., Encoder Hardware Architecture for HEVC,* HIGH EFFICIENCY VIDEO CODING (HEVC) at 347 (September 2014) (emphasis added).

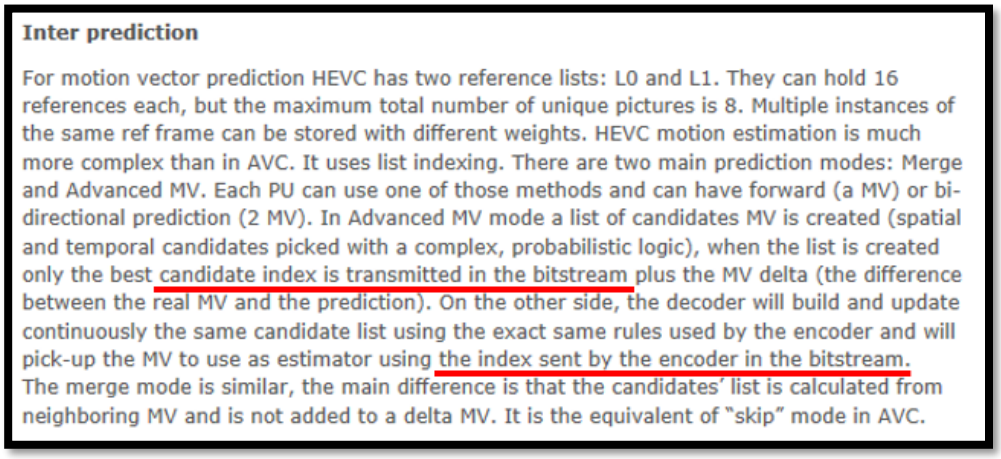
435. The LG '529 Products perform the step of assigning the modified motion vector as the motion vector to the first image block. Specifically, the LG '529 Products, through the use of AMVP and Merge Mode, select the modified motion vector and assign it to a first block. The displacement between the current prediction unit and the matching prediction unit in the second image (reference image) is signaled using a motion vector. Further, the LG '529 Products take the modified motion vector "computed from corresponding regions of previously decoded pictures" and transmit the residual.

> A block-wise prediction residual is computed from corresponding regions of previously decoded pictures (inter-picture motion compensated prediction) or neighboring previously decoded samples from the same picture (intra-picture spatial prediction). The residual is then processed by a block transform, and the

> transform coefficients are quantized and entropy coded. Side information data such as motion vectors and mode switching parameters are also encoded and transmitted.

Standardized Extensions of High Efficiency Video Coding (HEVC), IEEE JOURNAL OF SELECTED TOPICS IN SIGNAL PROCESSING, Vol. 7, No. 6 at 1002 (December 2013) (emphasis added).

436. The LG '529 Products transmit into the bitstream the candidate index of motion vectors. HEVC documentation states that the coding process will "pick up the MV [motion vector] to use as an estimator using the index sent by the encoder in the bitstream."



Inter prediction

For motion vector prediction HEVC has two reference lists: L0 and L1. They can hold 16 references each, but the maximum total number of unique pictures is 8. Multiple instances of the same ref frame can be stored with different weights. HEVC motion estimation is much more complex than in AVC. It uses list indexing. There are two main prediction modes: Merge and Advanced MV. Each PU can use one of those methods and can have forward (a MV) or bi-directional prediction (2 MV). In Advanced MV mode a list of candidates MV is created (spatial and temporal candidates picked with a complex, probabilistic logic), when the list is created only the best candidate index is transmitted in the bitstream plus the MV delta (the difference between the real MV and the prediction). On the other side, the decoder will build and update continuously the same candidate list using the exact same rules used by the encoder and will pick-up the MV to use as estimator using the index sent by the encoder in the bitstream. The merge mode is similar, the main difference is that the candidates' list is calculated from neighboring MV and is not added to a delta MV. It is the equivalent of "skip" mode in AVC.

Fabio Sonnati, *H265 – Part I: Technical Overview*, VIDEO ENCODING & STREAMING TECHNOLOGIES WEBSITE (June 20, 2014) (emphasis added).

437. One or more LG subsidiaries and/or affiliates use the LG '529 Products in regular business operations.

438. LG has directly infringed and continues to directly infringe the '529 Patent by, among other things, making, using, offering for sale, and/or selling technology for determining motion vectors that are each assigned to individual image regions, including but not limited to the LG '529 Products.

439. One or more of the LG '529 Products include technology for determining motion vectors that are each assigned to individual image regions.

440. One or more of the LG '529 Products enable an increase in the resolution of video and image signals during the motion estimation process.

441. One or more of the LG ‘529 Products perform a method for determining motion vectors which are assigned to individual image regions of an image.

442. One or more of the LG ‘529 Products perform a method wherein an image is subdivided into a number of image blocks, and a motion estimation technique is implemented to assign at least one motion vector to each of the image blocks where a modified motion vector is generated for at least a first image block.

443. One or more of the LG ‘529 Products perform a method that determines at least a second image block through which the motion vector assigned to the first image block at least partially passes.

444. One or more of the LG ‘529 Products perform a method that generates the modified motion vector as a function of a motion vector assigned to at least the second image block.

445. One or more of the LG ‘529 Products perform a method that assigns the modified motion vector as the motion vector to the first image block.

446. The LG ‘529 Products are available to businesses and individuals throughout the United States.

447. The LG ‘529 Products are provided to businesses and individuals located in the Eastern District of Texas.

448. By making, using, testing, offering for sale, and/or selling products and services for interpolating a pixel during the interlacing of a video signal, including but not limited to the LG ‘529 Products, LG has injured Dynamic Data and is liable to the Plaintiff for directly infringing one or more claims of the ‘529 patent, including at least claim 1 pursuant to 35 U.S.C. § 271(a).

449. LG also indirectly infringes the ‘529 patent by actively inducing infringement under 35 U.S.C. § 271(b).

450. LG has had knowledge of the '529 patent since at least service of the Original Complaint in this case or shortly thereafter, and on information and belief, LG knew of the '529 patent and knew of its infringement, including by way of this lawsuit.

451. LG intended to induce patent infringement by third-party customers and users of the LG '529 Products and had knowledge that the inducing acts would cause infringement or was willfully blind to the possibility that its inducing acts would cause infringement. LG specifically intended and was aware that the normal and customary use of the accused products would infringe the '529 patent. LG performed the acts that constitute induced infringement, and would induce actual infringement, with knowledge of the '529 patent and with the knowledge that the induced acts would constitute infringement. For example, LG provides the LG '529 Products that have the capability of operating in a manner that infringe one or more of the claims of the '529 patent, including at least claim 1, and LG further provides documentation and training materials that cause customers and end users of the LG '529 Products to utilize the products in a manner that directly infringe one or more claims of the '529 patent.[70] By providing instruction and training to customers and end-users on how to use the LG '529 Products in a manner that directly infringes one or more claims of the '529 patent, including at least claim 1, LG specifically intended to induce infringement of the '529 patent. LG engaged in such inducement to promote the sales of the LG

[70] *See, e.g.*, *Large Ultra HD Signage: UM3C Series*, LG SPECIFICATION SHEET (2018); *Multiple Screen Split-Ultra HD Signage: Ultra HD UH5C Series*, LG SPECIFICATION SHEET (2016); *LG Help Library: Ultra HD 4K Upscaling – UHD TV Video*, LG Support Website (last visited March 2019), *available at*: https://www.lg.com/us/support/product-help/CT10000018-1432737109927-general-specifications; *98UB9800, 98UB9810, 105UC9,* OWNER'S MANUAL LED TV, *available at*: https://www.lg.com/us/support-product/lg-98UB9810 (last visited Nov. 2018); *40UB8000, 49UB8200, 55UB8200, 60UB8200, 49UB8300, 55UB8300, 65UB9200*, OWNER'S MANUAL LED TV, *available at*: https://www.lg.com/us/support-product/lg-55UB8200 (last visited Nov. 2018); *50UH5500, 50UH5530, 65UH5500,* OWNER'S MANUAL SAFETY AND REFERENCE LED TV, *available at*: https://www.lg.com/us/support-product/lg-50UH5530 (last visited Nov. 2018); *LM-V405AQ,* USER GUIDE (2018); *LM-V35OULM*, USER GUIDE (2018); *LG Stylo 4 LM-Q71OULM,* USER GUIDE (2018); *LG V30,* USER GUIDE (2018); *LM-X410AS,* USER GUIDE (2018).

‘529 Products, e.g., through LG user manuals, product support, marketing materials, and training materials to actively induce the users of the accused products to infringe the ‘529 patent. Accordingly, LG has induced and continues to induce users of the accused products to use the accused products in their ordinary and customary way to infringe the ‘529 patent, knowing that such use constitutes infringement of the ‘529 patent.

452. The ‘529 patent is well-known within the industry as demonstrated by multiple citations to the ‘529 patent in published patents and patent applications assigned to technology companies and academic institutions. LG is utilizing the technology claimed in the ‘529 patent without paying a reasonable royalty. LG is infringing the ‘529 patent in a manner best described as willful, wanton, malicious, in bad faith, deliberate, consciously wrongful, flagrant, or characteristic of a pirate.

453. To the extent applicable, the requirements of 35 U.S.C. § 287(a) have been met with respect to the ‘529 patent.

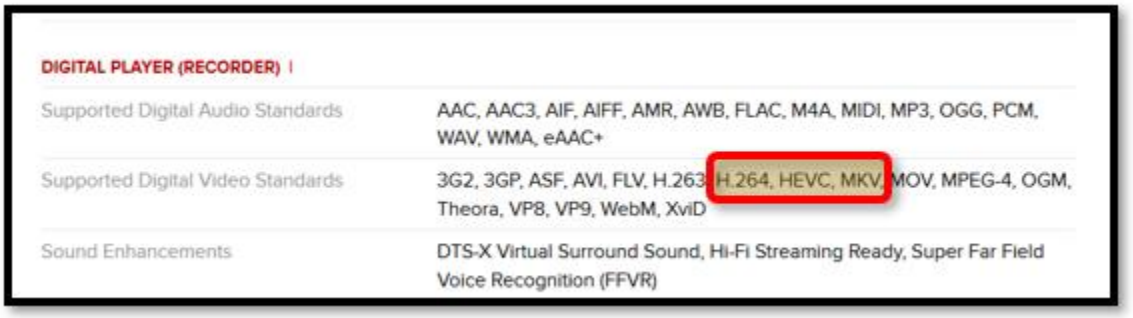
454. As a result of LG’s infringement of the ‘529 patent, Dynamic Data has suffered monetary damages, and seeks recovery in an amount adequate to compensate for LG’s infringement, but in no event less than a reasonable royalty for the use made of the invention by LG together with interest and costs as fixed by the Court.

COUNT XI
INFRINGEMENT OF U.S. PATENT NO. 8,073,054

455. Dynamic Data references and incorporates by reference the preceding paragraphs of this Complaint as if fully set forth herein.

456. LG designs, makes, uses, sells, and/or offers for sale in the United States products and/or services for estimating a current motion vector for a group of pixels of an image.

457. LG designs, makes, sells, offers to sell, imports, and/or uses LG products that contain and/or enable H.265 encoding functionality, including the following products: LG V35 ThinQ, LG V40 ThinQ, and LG G7 ThinQ (collectively, the "LG '054 Products").[71]



LG V35 ThinQ Specifications, CNET WEBSITE, *available at*: https://www.cnet.com/products/lg-v35-thinq/specs/ (annotation added).

458. One or more LG subsidiaries and/or affiliates use the LG '054 Products in regular business operations.

459. LG documentation cited in the proceeding paragraphs shows that the LG '054 Products perform a motion vector estimation method. Specifically, the LG '054 Products perform the method of encoding video content using High Efficiency Video Coding ("HEVC").

460. The LG '054 Products contain a processor for decoding the received encoded frame-based encoded video data. Further, the LG '054 Products apply a remapping policy to the first frame of decoded video data using a region-based luma analysis. As part of the decoding process performed by LG '054 Products, a reference picture (first frame) is decoded and two in-loop filters (deblocking and a sample adaptive offset) are applied to the reference picture.

[71] *LG G7 ThinQ Update Brings 4K @ 60fps Video Recording*, XDA DEVELOPERS WEBSITE (June 26, 2018), available at: https://www.xda-developers.com/lg-g7-thinq-update-4k-60fps/ ("Recording 4K video at 60fps has become a highly requested feature and the South Korean LG G7 ThinQ just received this feature with its latest OTA update.").

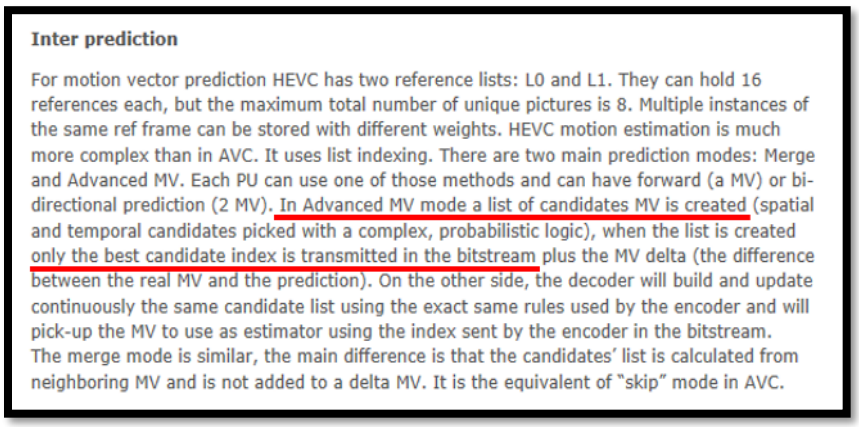
461. The LG ‘054 Products contain a video encoder that selects an image segment of a second video image corresponding to an image segment of a first video image. The image segment has an image segment center.

462. One or more of the LG ‘054 Products include technology for estimating a current motion vector for a group of pixels of an image

463. LG has directly infringed and continues to directly infringe the ‘054 patent by, among other things, making, using, offering for sale, and/or selling technology for estimating a current motion vector for a group of pixels of an image, including but not limited to the LG ‘054 Products.

464. By complying with the HEVC standard, LG’s devices – such as the LG ‘054 Products – necessarily infringe the ‘054 patent. Mandatory sections of the HEVC standard require the elements required by certain claims of the ‘054 patent, including but not limited to claim 1. High Efficiency Video Coding, Series H: Audiovisual And Multimedia Systems: Infrastructure Of Audiovisual Services – Coding Of Moving Video Rec. ITU-T H.265 (February 2018) (The following sections of the HEVC Standard are relevant to LG’s infringement of the ‘054 patent: “7.3.4 Scaling list data syntax;” 7.3.6.1 General slice segment header syntax;” “7.3.6.3 Weighted prediction parameters syntax;” “7.3.8.14 Delta QP syntax;” “7.4.4 Profile, tier and level semantics;” and “7.4.7.3 Weighted prediction parameters semantics.”

465. The LG ‘054 Products comprise functionality for generating a set of candidate motion vectors for a grouping of pixels (prediction unit). The HEVC standard generates a set of candidate motion vectors for the group of pixels, with the candidate motion vectors being extracted from a set of previously estimated motion vectors. After the candidate motion vectors are generated, only the best candidate index is transmitted.



Inter prediction

For motion vector prediction HEVC has two reference lists: L0 and L1. They can hold 16 references each, but the maximum total number of unique pictures is 8. Multiple instances of the same ref frame can be stored with different weights. HEVC motion estimation is much more complex than in AVC. It uses list indexing. There are two main prediction modes: Merge and Advanced MV. Each PU can use one of those methods and can have forward (a MV) or bi-directional prediction (2 MV). In Advanced MV mode a list of candidates MV is created (spatial and temporal candidates picked with a complex, probabilistic logic), when the list is created only the best candidate index is transmitted in the bitstream plus the MV delta (the difference between the real MV and the prediction). On the other side, the decoder will build and update continuously the same candidate list using the exact same rules used by the encoder and will pick-up the MV to use as estimator using the index sent by the encoder in the bitstream. The merge mode is similar, the main difference is that the candidates' list is calculated from neighboring MV and is not added to a delta MV. It is the equivalent of "skip" mode in AVC.

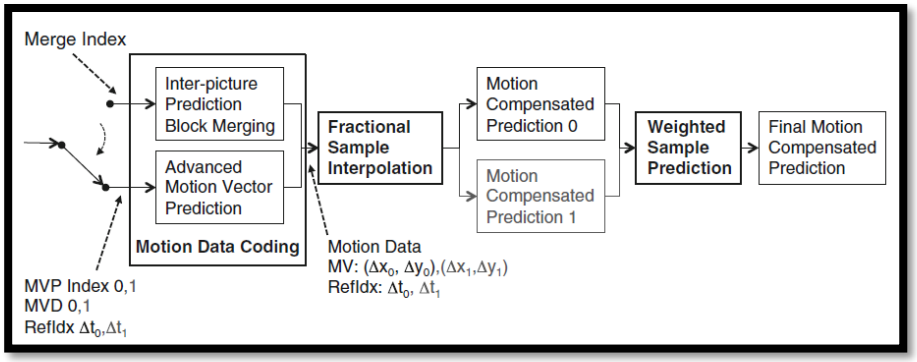
Fabio Sonnati, *H265 – Part I: Technical Overview*, VIDEO ENCODING & STREAMING TECHNOLOGIES WEBSITE (June 20, 2014) (emphasis added).

466. One or more of the LG '054 Products enable motion estimation with a relatively fast convergence in finding the appropriate motion vectors of the motion vector fields by adding a further candidate motion vector to the set of candidate motion vectors.

> HEVC introduces a so-called merge mode, which sets all motion parameters of an inter picture predicted block equal to the parameters of a merge candidate [6]. The merge mode and the motion vector prediction process optionally allow a picture to reuse motion vectors of prior pictures for motion vector coding,

Frank Bossen, *et al*., *HEVC Complexity and Implementation Analysis*, IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY VOL. 22 NO. 12 at 1686 (December (2012).

467. The following block diagram illustrates the form of encoded video data received by the LG '054 Products. Specifically, the encoded video data received by the LG '054 Products is encoded using inter-picture prediction where the motion data of a block is correlated with neighboring blocks. To exploit this correlation, motion data is not directly coded in the bitstream, but predictively coded based on neighboring motion data. Further, the LG '054 Products receive data that is encoded using advanced motion vector prediction where the best predictor for each motion block is signaled to the decoder. In addition, inter-prediction block merging derives all motion data of a block from the neighboring blocks.



Benjamin Bross, *et al*., *Inter-Picture Prediction in HEVC,* In HIGH EFFICIENCY VIDEO CODING (HEVC) at 115 (2014).

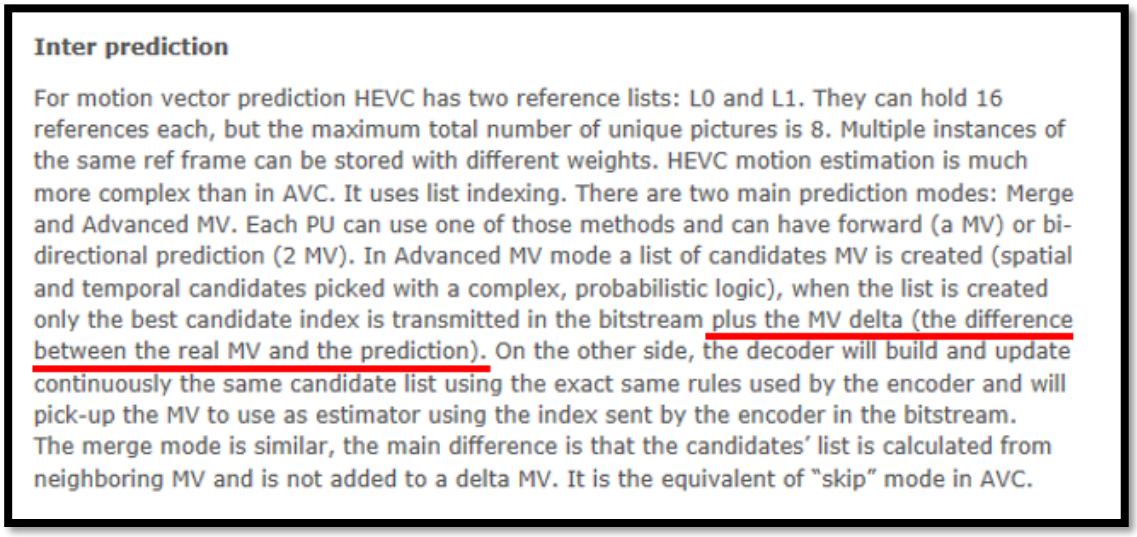
468. The LG '054 Products carry out a block-based motion vector estimation process that involves comparing a plurality of candidate vectors to determine block-based motion vectors. The LG '054 Products generate two predictor candidate motion vectors (a spatial motion vector and temporal motion vector). The first predictor candidate motion vector is drawn from a list of spatial motion vector candidates.

> three spatially neighboring MVs. HEVC improves the MV prediction by applying an MV prediction competition as initially proposed in [18]. In HEVC, this competition was further adapted to large block sizes with so-called *advanced motion vector prediction* (AMVP) in [19]. In the DIS *Main profile*, AMVP has two predictor candidates competing for the prediction. Two spatial motion vector predictor (MVP) candidates are considered and, when at least one of them is not available or they are redundant, a temporal motion vector prediction (TMVP) candidate is considered. The candidates

Philipp Helle, Simon Oudin, Benjamin Bross, Detlev Marpe, M. Oguz Bici, Kemal Ugur, Joel Jung, Gordon Clare, and Thomas Wiegand, *Block Merging for Quadtree-Based Partitioning in HEVC, IEEE TRANS. CIR. AND SYS. FOR VIDEO TECHNOLOGY, Vol. 22* No. 12 (December 2012) ("AMVP has two predictor candidates competing for the prediction. Two spatial motion vector predictor (MVP) candidates are considered and, when at least one of them is not available or they are redundant, a temporal motion vector prediction (TMVP) candidate is considered.").

469. One or more of the LG '054 Products include a motion estimation unit comprising a generating unit for generating a set of candidate motion vectors for the group of pixels, with the candidate motion vectors being extracted from a set of previously estimated motion vectors.

470. The LG '054 Products contain functionality for generating match errors of the respective candidate motion vectors. The HEVC standard calculates match errors of respective candidate motion vectors. The match errors are referred to as the MV delta. The MV delta is the difference between the real MV and the candidate prediction.



Inter prediction

For motion vector prediction HEVC has two reference lists: L0 and L1. They can hold 16 references each, but the maximum total number of unique pictures is 8. Multiple instances of the same ref frame can be stored with different weights. HEVC motion estimation is much more complex than in AVC. It uses list indexing. There are two main prediction modes: Merge and Advanced MV. Each PU can use one of those methods and can have forward (a MV) or bi-directional prediction (2 MV). In Advanced MV mode a list of candidates MV is created (spatial and temporal candidates picked with a complex, probabilistic logic), when the list is created only the best candidate index is transmitted in the bitstream plus the MV delta (the difference between the real MV and the prediction). On the other side, the decoder will build and update continuously the same candidate list using the exact same rules used by the encoder and will pick-up the MV to use as estimator using the index sent by the encoder in the bitstream. The merge mode is similar, the main difference is that the candidates' list is calculated from neighboring MV and is not added to a delta MV. It is the equivalent of "skip" mode in AVC.

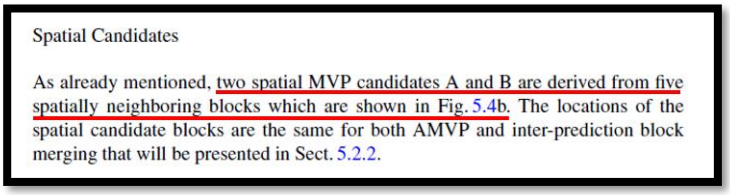
Fabio Sonnati, *H265 – Part I: Technical Overview*, VIDEO ENCODING & STREAMING TECHNOLOGIES WEBSITE (June 20, 2014) (emphasis added).

471. Any implementation of the HEVC standard would infringe the '054 patent as every implementation of the standard requires the elements in one or more claims of the '054 patent, including but not limited to claim 1, by way of example: a match error unit for calculating match errors of respective candidate motion vectors and calculating the further candidate motion vector by calculating a difference between the second motion vector and the first motion vector.

472. One or more of the LG '054 Products include a motion estimation unit comprising a selector for selecting the current motion vector from the candidate motion vectors by comparing the match errors of the respective candidate motion vectors, characterized in that the motion estimation unit is arranged to add a further candidate motion vector to the set of candidate motion

vectors by calculating the further candidate motion vector on the basis of a first motion vector and a second motion vector, both belonging to the set of previously estimated motion vectors.

473. The LG '054 Products select the current motion vector from the candidate motion vectors by comparing the match errors of the respective candidate motion vectors, characterized in that the motion estimation unit is arranged to add a further candidate motion vector to the set of candidate motion vectors by calculating the further candidate motion vector on the basis of a first motion vector and a second motion vector, both belonging to the set of previously estimated motion vectors. The first motion vector is labeled 'A' and the second motion vector is labeled 'B.'

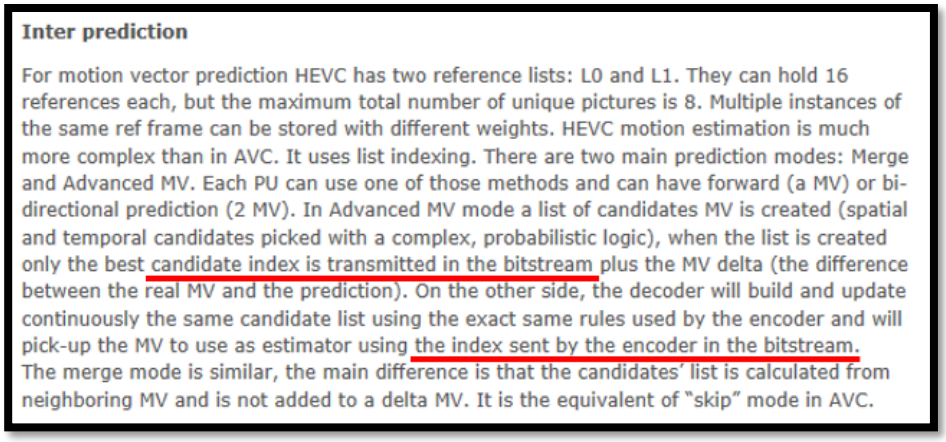


Spatial Candidates

As already mentioned, two spatial MVP candidates A and B are derived from five spatially neighboring blocks which are shown in Fig. 5.4b. The locations of the spatial candidate blocks are the same for both AMVP and inter-prediction block merging that will be presented in Sect. 5.2.2.

Gary Sullivan, *et al*., HIGH EFFICIENCY VIDEO CODING (HEVC) ALGORITHMS AND ARCHITECTURES at 117 (2014) (emphasis added).

474. Further, the LG '054 Products perform motion vector "competition / weighted sample prediction" by comparing the match errors of the candidate motion vectors. The match errors generated by the LG '054 Products comprise the difference value between the second motion vector and the first motion vector. Documentation of the encoding process states that the encoder will "pick up the MV [motion vector] to use as an estimator using the index sent by the encoder in the bitstream."



Inter prediction

For motion vector prediction HEVC has two reference lists: L0 and L1. They can hold 16 references each, but the maximum total number of unique pictures is 8. Multiple instances of the same ref frame can be stored with different weights. HEVC motion estimation is much more complex than in AVC. It uses list indexing. There are two main prediction modes: Merge and Advanced MV. Each PU can use one of those methods and can have forward (a MV) or bi-directional prediction (2 MV). In Advanced MV mode a list of candidates MV is created (spatial and temporal candidates picked with a complex, probabilistic logic), when the list is created only the best candidate index is transmitted in the bitstream plus the MV delta (the difference between the real MV and the prediction). On the other side, the decoder will build and update continuously the same candidate list using the exact same rules used by the encoder and will pick-up the MV to use as estimator using the index sent by the encoder in the bitstream. The merge mode is similar, the main difference is that the candidates' list is calculated from neighboring MV and is not added to a delta MV. It is the equivalent of "skip" mode in AVC.

Fabio Sonnati, *H.265 – Part I: Technical Overview*, VIDEO ENCODING & STREAMING TECHNOLOGIES WEBSITE (June 20, 2014) (emphasis added).

475. The LG '054 Products calculate the square of the difference between two corresponding pixels of the spatial position of the candidate block where the motion vector is located and the spatial position where the reference motion vector is located. As a result, this value is used to assess the similarity, or the matching degree, of a candidate block. Thus, in order to obtain the best matching vector, the LG '054 Products apply a penalty value to every candidate block with a different motion vector (*MVx, MVy*) within the search window defined by the search range in the reference frame. Finally, a candidate block with the minimum penalty value will be denoted as the best matching block and used to calculate the best motion vector from the candidate motion vectors. The below excerpt from an article discussing the selection of a best motion vector describes that the selection of a motion vector is based on the position of the motion vector.

The entire ME process is made up of three coarse-to-fine procedures, namely, MV prediction, integer-pixel ME and fractional-pixel ME. First, MV prediction predicts the start search position for the following motion search by utilizing the neighboring motion information. In HEVC, Advanced Motion Vector Prediction (AMVP), a new and effective technology that predicts the starting search position by referencing the motion vector (MV) information of spatial and temporal motion vector candidates, is adopted, which derives several most probable candidates based on data from adjacent PBs and the reference picture. The displacement between the starting search position and the current coding PU is called a predictive motion vector (PMV). HEVC also introduces a merge mode to derive the motion information from spatially or temporally neighboring blocks [1].

Yongfei Zhang, Chao Zhang, and Rui Fan, *Fast Motion Estimation in HEVC Inter Coding: An Overview of Recent Advances*, PROCEEDINGS, APSIPA ANNUAL SUMMIT AND CONFERENCE 2018 at 1 (November 2018) (emphasis added).

476. One or more of the LG '054 Products include a motion estimation unit that calculates the further candidate motion vector on the basis of the first motion vector and the second motion vector, with the first motion vector belonging to a first forward motion vector field and the second motion vector belonging to a second forward motion vector field, with the first forward motion vector field and the second forward motion vector field being different. Specifically, the HEVC standard arranges to calculate the further candidate motion vector by calculating a difference between the second motion vector and the first motion vector. The further candidate motion vector is calculated at the end of the process (see the red box in the below diagram).

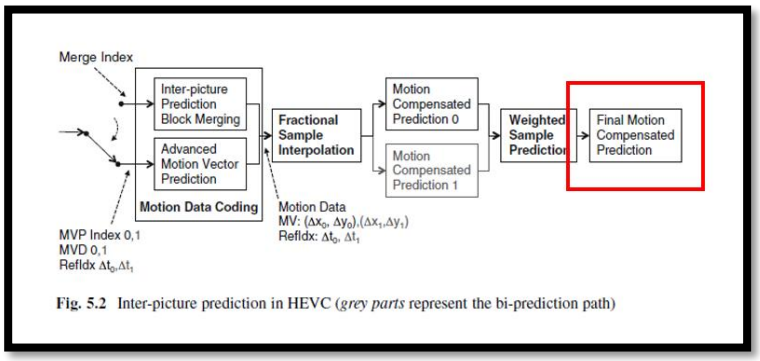


Fig. 5.2 Inter-picture prediction in HEVC (*grey parts* represent the bi-prediction path)

Gary J. Sullivan, *et al*., HEVC, HIGH EFFICIENCY VIDEO CODING (HEVC) at 115 (September 2014) (emphasis added).

477. One or more of the LG ‘054 Products include a motion estimation unit that arranges to calculate the further candidate motion vector by calculating a difference between the second motion vector and the first motion vector.

478. The LG ‘054 Products are available to businesses and individuals throughout the United States.

479. The LG ‘054 Products are provided to businesses and individuals located in the Eastern District of Texas.

480. By making, using, testing, offering for sale, and/or selling products and services for estimating a current motion vector for a group of pixels of an image, including but not limited to the LG ‘054 Products, LG has injured Dynamic Data and is liable to the Plaintiff for directly infringing one or more claims of the ‘054 patent, including at least claim 1 pursuant to 35 U.S.C. § 271(a).

481. LG also indirectly infringes the ‘054 patent by actively inducing infringement under 35 U.S.C. § 271(b).

482. LG has had knowledge of the ‘054 patent since at least service of the Original Complaint in this case or shortly thereafter, and on information and belief, LG knew of the ‘054 patent and knew of its infringement, including by way of this lawsuit.

483. LG intended to induce patent infringement by third-party customers and users of the LG ‘054 Products and had knowledge that the inducing acts would cause infringement or was willfully blind to the possibility that its inducing acts would cause infringement. LG specifically intended and was aware that the normal and customary use of the accused products would infringe the ‘054 patent. LG performed the acts that constitute induced infringement, and would induce actual infringement, with knowledge of the ‘054 patent and with the knowledge that the induced

acts would constitute infringement. For example, LG provides the LG '054 Products that have the capability of operating in a manner that infringe one or more of the claims of the '054 patent, including at least claim 1, and LG further provides documentation and training materials that cause customers and end users of the LG '054 Products to utilize the products in a manner that directly infringe one or more claims of the '054 patent.[72] By providing instruction and training to customers and end-users on how to use the LG '054 Products in a manner that directly infringes one or more claims of the '054 patent, including at least claim 1, LG specifically intended to induce infringement of the '054 patent. LG engaged in such inducement to promote the sales of the LG '054 Products, e.g., through LG user manuals, product support, marketing materials, and training materials to actively induce the users of the accused products to infringe the '054 patent. Accordingly, LG has induced and continues to induce users of the accused products to use the accused products in their ordinary and customary way to infringe the '054 patent, knowing that such use constitutes infringement of the '054 patent.

484. The '054 patent is well-known within the industry as demonstrated by multiple citations to the '054 patent in published patents and patent applications assigned to technology companies and academic institutions. LG is utilizing the technology claimed in the '054 patent without paying a reasonable royalty. LG is infringing the '054 patent in a manner best described as willful, wanton, malicious, in bad faith, deliberate, consciously wrongful, flagrant, or characteristic of a pirate.

[72] *See, e.g.*, *LG V35 ThinQ*, LG USER GUIDE (2018); *LG V40 ThinQ*, USER GUIDE (2018); LG G7 THINQ, USER GUIDE (2018); *LG V40 ThinQ Camera: The New 5 Camera Phone*, LG WEBSITE (last visited March 2019), available at: https://www.lg.com/us/mobile-phones/v40-thinq/camera; *LG at CES 2019-LG ThinQ*, LG GLOBAL YOUTUBE CHANNEL (January 12, 2019), available at: https://www.youtube.com/watch?v=4QXpEr1EsjA; *LG Help Library: LG G7 ThinQ – Camera Overview and Settings*, LG SUPPORT WEBSITE (last visited March 2019), available at: https://www.lg.com/us/support/product-help/CT10000027-20150726477193-settings-features.

485. To the extent applicable, the requirements of 35 U.S.C. § 287(a) have been met with respect to the '054 patent.

486. As a result of LG's infringement of the '054 patent, Dynamic Data has suffered monetary damages, and seeks recovery in an amount adequate to compensate for LG's infringement, but in no event less than a reasonable royalty for the use made of the invention by LG together with interest and costs as fixed by the Court.

COUNT XII
INFRINGEMENT OF U.S. PATENT NO. 8,135,073

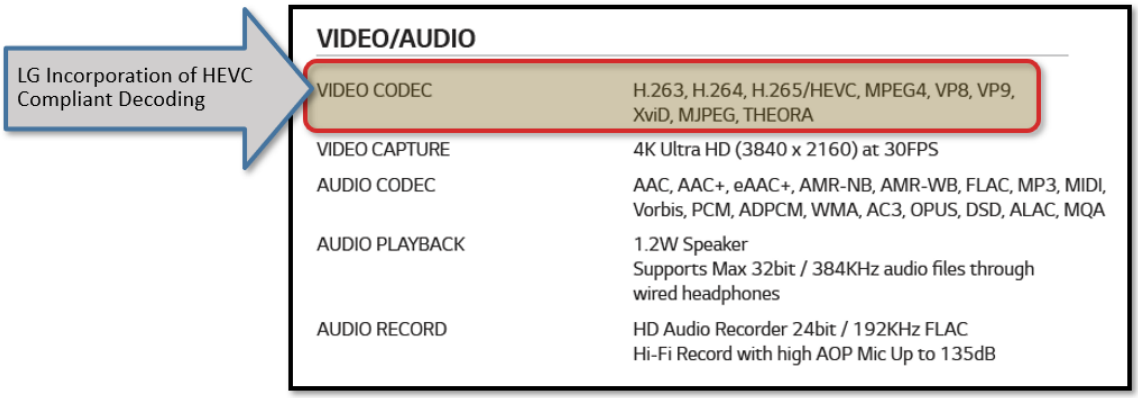
487. Dynamic Data references and incorporates by reference the preceding paragraphs of this Complaint as if fully set forth herein.

488. LG designs, makes, uses, sells, and/or offers for sale in the United States products and/or services for enhancing subsequent images of a video stream in which frames are encoded based on previous frames using prediction and motion estimation.

489. LG designs, makes, sells, offers to sell, imports, and/or uses LG products that contain sub-pixel accurate motion vector functionality, including but not limited to LG products that contain and/or enable H.265 decode functionality, including: LG smart phones, LG OLED TVs, LG Super UHD 4K TVs, LG UHD 4K TVs, and LG digital signage products (collectively, the "LG '073 Products").

490. The accused LG '073 Products include the following LG smart phone models (which include functionality for decoding video content that is encoded in accord with the HEVC standard): LG US700, LG LMV405UA, LG Q610TA, LG K450, LG V350AWM, LG SP200, LG Q710MS, LG 211BL, LG M154, LG X410TK, LG Q617QA, LG Q610MA, LG US701, LG M327, LG 255, LG H700, LG M430, LG L83BL, LG M257, LG X410ASR, LG Q710ULS, LG US601, LG M322, LG Q710ULM, LG Q710CS, LG V350ULM, LG X210ULMA, LG LM-

X210ULMA-K8, LG LM-X210VPP, LG LMX220MA, LG Q710AL, LG US601 ACG, LG LMX210MA, LG LM-V405UA, and LG X212TAL.[73] The following excerpt from an exemplar specification of one of the accused LG smart phones identifies that it contains an HEVC decoder functionality.

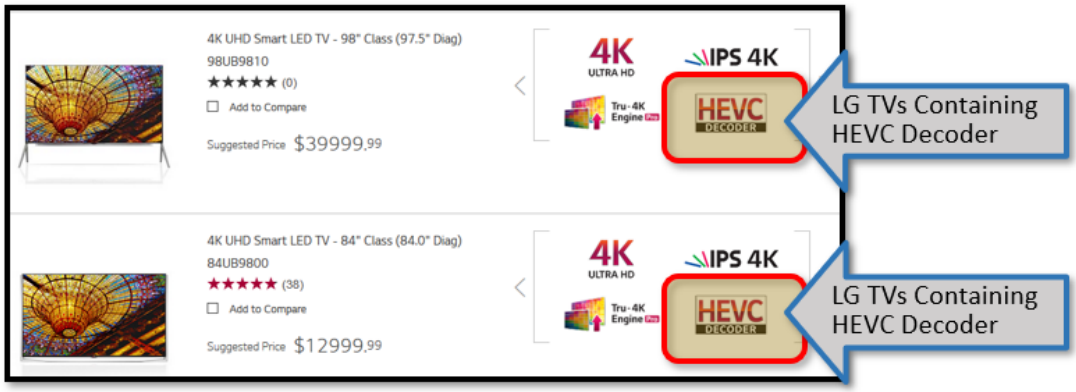


LG V30 SPECIFICATION SHEET at 1 (2017) (annotation added).

491. The accused LG '073 Products include the following LG television models: 60UF8500, 105UC9, 98UB9810, 84B9800, 40UB8000, 49UB8500, 55UB8500, 55UB8200, 65UB9200, 60UB8200, 98UB9800, 49UB8300, 55UB8300, 55UB9500, 65UB9500, 79UB9800, and 65UB9800.[74]

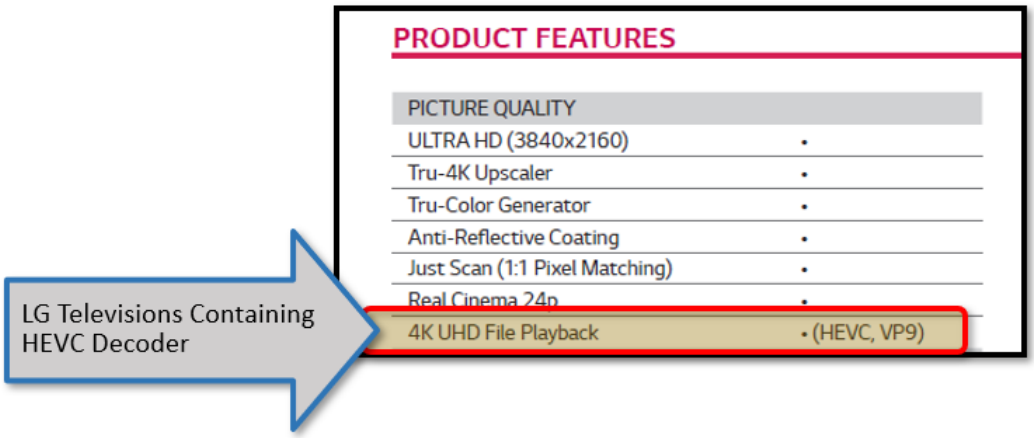
[73] *See e.g.*, *LG Phones Website*, LG WEBSITE (last visited March 2019), *available at*: https://www.lg.com/us/cell-phones/all-cell-phones; LG G4 vs. Samsung Galaxy S6", GSMArena, June 19, 2015 (LG's G4 (2015), G5 (2015), and G6 (2017) phones support HEVC with UHD resolution [81], and the G5 and G6 support 10 bit video and 60 fps HFR).

[74] Tribbey, Chris, *CES 2017: LG Debuts ATSC 3.0-Enabled 4K TVs*, BROADCASTING AND CABLE, January 8, 2017.



LG Television Product Search, LG CONSUMER WEBSITE (last visited March 2018), *available at*: https://www.lg.com/us/search.lg?search=hevc (annotations added).

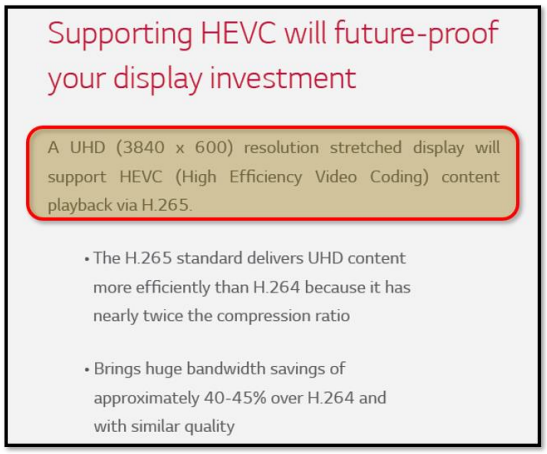
492. LG documentation identifies that the accused LG television products enable the playback of content that is encoded in the HEVC standard using an HEVC complaint decoder.



LG EG9600 4K UHD SMART CURVED OLET TV W/ WEBOS 2.0 & 3D SPECIFICATION at 1 (2015) (annotation added).

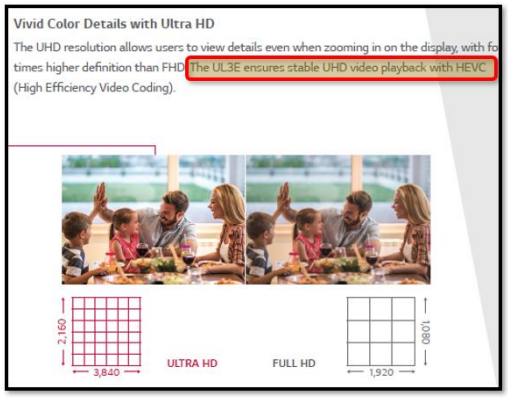
493. The accused LG '073 Products include the following LG digital signage products: UM3C, 75UH5C, 75UM3C, 60UL3E, 86UH5E-B, 55UH5B, 55VH7B, 55VM5B, 49VM5C, 55VX1D, 49UH5C, and 55UH5C.[75]

[75] *See e.g.*, *LG Business Solutions Digital Signage*, LG WEBSITE, *available at*: https://www.lg.com/us/business/commercial-display/displays-tvs/digital-signage/.



How to Stretch Customer Imagination with Digital Signage, LG BUSINESS SOLUTIONS DOCUMENTATION at 6 (2016).

494. The accused LG '073 Products are described in LG documentation as ensuring "stable UHD video playback with HEVC."



70UL3E 60UL3E Clear Color Expression of UHD Content Documentation, LG DOCUMENTATION at 2 (2018) (annotation added).

495. The LG '073 Products contain a processor for decoding the received encoded frame-based encoded video data. Further, the LG '073 Products apply a remapping policy to the first frame of decoded video data using a region-based luma analysis. As part of the decoding process performed by LG '073 Products, a reference picture (first frame) is decoded and two in-loop filters (deblocking and a sample adaptive offset) are applied to the reference picture.

496. The LG ‘073 Products comprise a video decoder for decoding video images. Specifically, the LG ‘073 Products contain functionality for video decoding through H.265/High Efficiency Video Coding (“HEVC”) decoding.

497. The LG ‘073 Products contain a processor for decoding the received encoded frame-based encoded video data. Further, the LG ‘073 Products apply a remapping policy to the first frame of decoded video data using a region-based luma analysis. As part of the decoding process performed by LG ‘073 Products, a reference picture (first frame) is decoded and two in-loop filters (deblocking and a sample adaptive offset) are applied to the reference picture.

498. The LG ‘073 Products have an input for receiving frame-based encoded video information. Specifically, the LG ‘073 Products receive frame-based encoded video information in the form of video data that is encoded in the High

499. The LG ‘073 Products include inputs for receiving and decoding HEVC video data

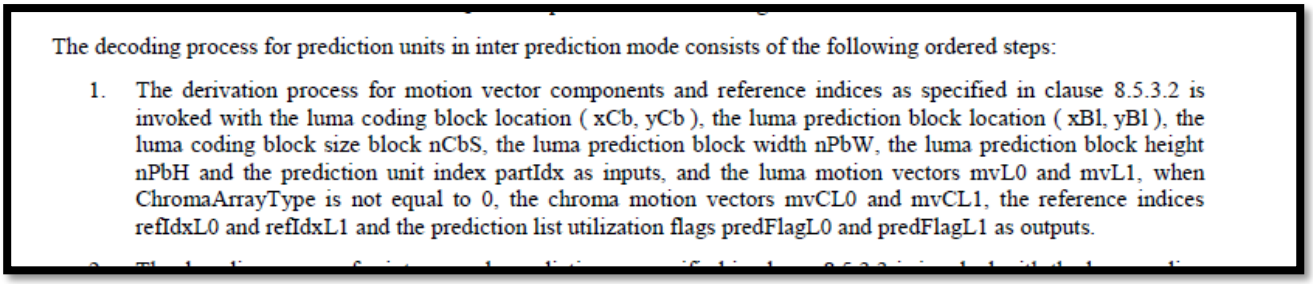
500. The LG ‘073 Products incorporate a decoding unit for decoding the frame of the received video data. The encoding and decoding process for video data received by the LG ‘073 Products use inter-picture prediction wherein motion data comprises the selection of a reference frame and motion vectors to be applied in predicting the samples of each block.

501. One or more of the LG ‘073 Products include technology for enhancing subsequent images of a video stream in which frames are encoded based on previous frames using prediction and motion estimation.

502. By complying with the HEVC standard, the LG devices – such as the LG ‘073 Products – necessarily infringe the ‘073 patent. The mandatory sections of the HEVC standard require the elements required by certain claims of the ‘073 patent, including but not limited to claim 14 of the ‘073 patent. *High Efficiency Video Coding*, SERIES H: AUDIOVISUAL AND

Multimedia SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 (February 2018) (The following sections of the HEVC Standard are relevant to LG's infringement of the '073 patent: "8.3.2 Decoding process for reference picture set;" "8.5.4 Decoding process for the residual signal of coding units coded in inter prediction mode;" "8.6 Scaling, transformation and array construction process prior to deblocking filter process;" "8.5.2 Inter prediction process;" "8.5.3 Decoding process for prediction units in inter prediction mode;" and "8.7.2 Deblocking filter process;" "8.7.3 Sample adaptive offset process.").

503. The LG '073 Products comply with the HEVC standard, which requires that motion vectors are recovered from the second frame in the video stream.



The decoding process for prediction units in inter prediction mode consists of the following ordered steps:

1. The derivation process for motion vector components and reference indices as specified in clause 8.5.3.2 is invoked with the luma coding block location (xCb, yCb), the luma prediction block location (xBl, yBl), the luma coding block size block nCbS, the luma prediction block width nPbW, the luma prediction block height nPbH and the prediction unit index partIdx as inputs, and the luma motion vectors mvL0 and mvL1, when ChromaArrayType is not equal to 0, the chroma motion vectors mvCL0 and mvCL1, the reference indices refIdxL0 and refIdxL1 and the prediction list utilization flags predFlagL0 and predFlagL1 as outputs.

High Efficiency Video Coding, SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 at § 8.5.3.1 (February 2018).

504. LG has directly infringed and continues to directly infringe the '073 patent by, among other things, making, using, offering for sale, and/or selling technology for enhancing subsequent images of a video stream in which frames are encoded based on previous frames using prediction and motion estimation, including but not limited to the LG '073 Products. The following excerpt explains how HEVC is a form of frame-based encoded video information.

> One way of achieving high video compression is to predict pixel values for a frame based on prior and succeeding pictures in the video. Like its predecessors, H.265 features the ability to predict pixel values between pictures, and in particular, to specify in which order pictures are coded and which pictures are predicted from which. The coding order is specified for Groups Of Pictures (GOP), where a number of pictures are grouped together and predicted from each other in a

> specified order. The pictures available to predict from, called reference pictures, are specified for every individual picture.

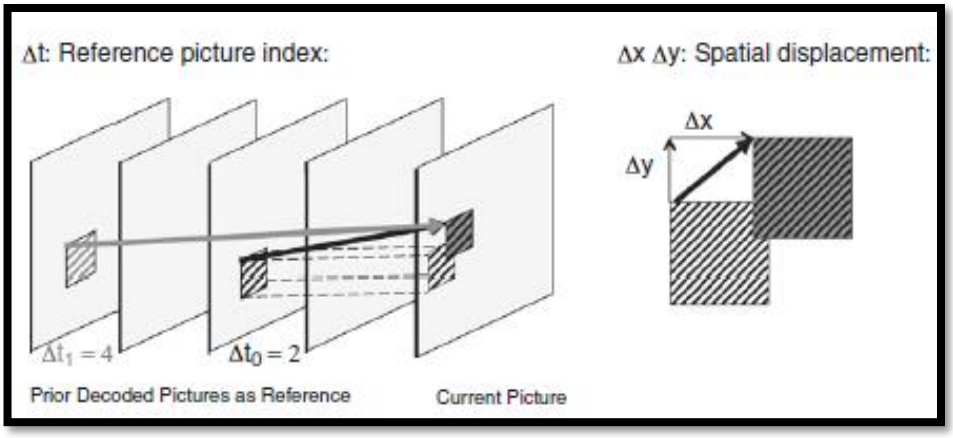
Johan Bartelmess. *Compression Efficiency of Different Picture Coding Structures in High Efficiency Video Coding (HEVC),* UPTEC STS 16006 at 4 (March 2016) (emphasis added).

505. The LG '073 Products receive encoded video data that is encoded using inter-frame coding. Specifically, the encoded video stream received by the LG '073 Products is coded using its predecessor frame. Inter-prediction used in the encoded video data received by the LG '073 Products allows a transform block to span across multiple prediction blocks for inter-picture predicted coding units to maximize the potential coding efficiency benefits of the quadtree-structured transform block partitioning.

> The basic source-coding algorithm is a hybrid of interpicture prediction to exploit temporal statistical dependences, intrapicture prediction to exploit spatial statistical dependences, and transform coding of the prediction residual signals to further exploit spatial statistical dependences.

G. J. Sullivan, J.-R. Ohm, W.-J. Han, and T. Wiegand, *Overview of the High Efficiency Video Coding (HEVC) standard*, IEEE TRANS. CIRCUITS SYST. VIDEO TECHNOL., vol. 22, no. 12, p. 1654 (December 2012) (emphasis added).

506. The encoded video stream received by the LG '073 Products is encoded using inter-picture prediction that makes use of the temporal correlation between pictures to derive a motion-compensated prediction (MCP) for a block of image samples. For this block-based motion compensated prediction, a video picture is divided into rectangular blocks. Assuming homogeneous motion inside one block, and that moving objects are larger than one block, for each block, a corresponding block in a previously decoded picture can be found that serves as a predictor. The general concept of inter-frame-based encoding using motion-compensated prediction based on a translational motion model is illustrated below.



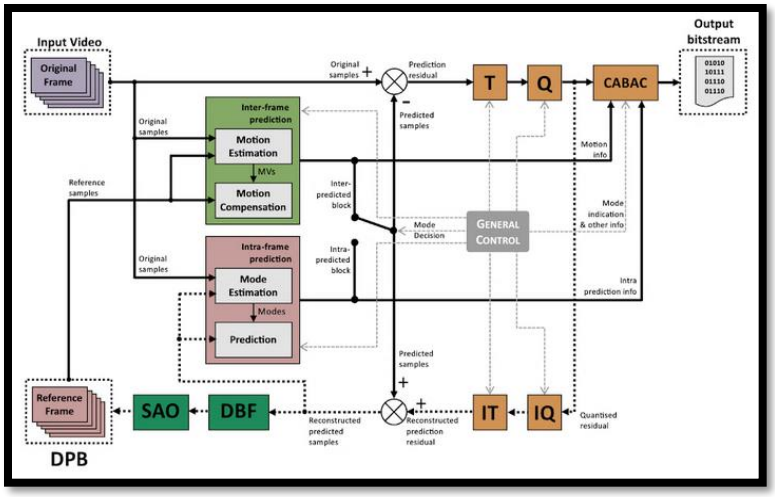
Benjamin Bross, *Inter-Picture Prediction In HEVC*, HIGH EFFICIENCY VIDEO CODING (HEVC) at 114 (September 2014).

507. The following excerpt from an article describing the architecture of the encoded video stream received by the LG '073 Products describes the functionality wherein the second encoded frame of the video data is dependent on the encoding of a first frame. "HEVC inter prediction uses motion vectors pointing to one reference frame . . . to predict a block of pixels."

> HEVC inter prediction uses motion vectors pointing to one reference frame (uni-prediction) or two reference frames (bi-prediction) to predict a block of pixels. The size of the predicted block, called Prediction Unit (PU), is determined by the Coding Unit (CU) size and its partitioning mode. For example, a 32×32 CU with 2N×N partitioning is split into two PUs of size 32×16, or a 16×16 CU with nL×2N partitioning is split into 4×16 and 12×16 PUs.

Mehul Tikekar, *et al.*, *Decoder Hardware Architecture for HEVC*, HIGH EFFICIENCY VIDEO CODING (HEVC) (September 2014).

508. The following diagram shows how the LG '073 Products receive video data encoded using inter-frame prediction. Specifically, interframe prediction generates a motion vector based on the motion estimation across a first and second frame.



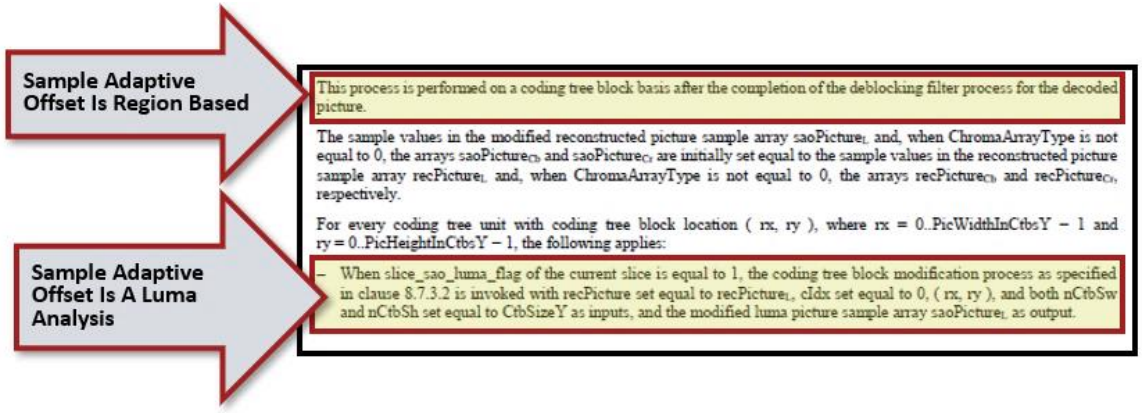
Guilherme Corrêa, *et al.*, COMPLEXITY-AWARE HIGH EFFICIENCY VIDEO CODING at 16 (2015).

509. One or more of the LG '073 Products reduce the processing capacity required for providing video enhancements to video processing through re-mapping of previous frames for subsequent frames.

510. Any implementation of the HEVC standard would infringe the '073 patent as every possible implementation of the standard requires: receiving a video stream containing encoded frame based video information (including both an encoded first frame and an encoded second frame); the encoded second frame that is received depends on the encoding of the first frame, the encoding of the second frame includes motion vectors indicating differences in positions between regions of the second frame and corresponding regions of the first frame; the motion vectors define correspondence between regions of the second frame and corresponding regions of the first frame; decoding the video stream by recovering the motion vectors in the second stream; and determining a re-mapping strategy for the video enhancement of the decoded first frame using a region-based analysis where the first frame is remapped using a remapping strategy and at least one region of the second frame is remapped depending on the re-mapping strategy for corresponding regions of the first frame.

511. The LG '073 Products' use of sample adaptive offset is a region-based luma analysis that is applied to the decoded first frame (reference picture). "The SAO reduces sample distortion by first classifying the samples in the region into multiple categories with as selected classifier and adding a specific offset to each sample depending on its category. The classifier index and the offsets for each region are signaled in the bitstream." Andrey Norkin, Chih-Ming Fu, Yu-Wen Huang, and Shawmin Lei, *In-Loop Filters In HEVC*, IN HIGH EFFICIENCY VIDEO CODING (HEVC) at 185 (September 2014) (emphasis added).

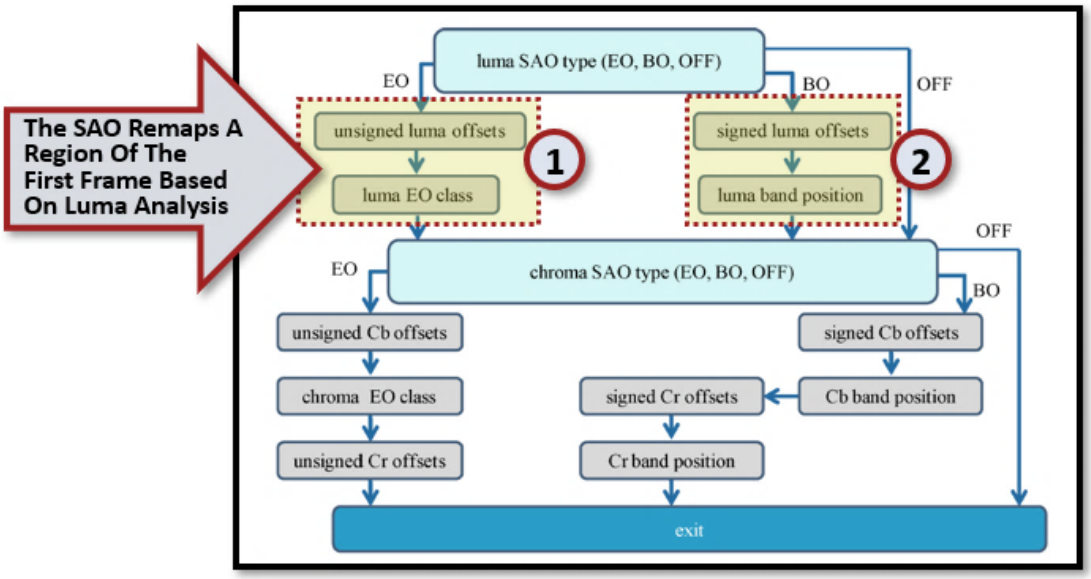
512. Further, the HEVC documentation requires that the application of a sample adaptive offset be region based (*e.g.*, applied to a coding block) ("This process is performed on a coding block basis after the completion for the deblocking filter process for the decoded picture").



High Efficiency Video Coding, SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 at § 8.7.3.1 (April 2015) (annotations added).

513. The LG '073 Products contain functionality wherein a decoder applies sample adaptive offset to a decoded reference frame (first frame). Further, the LG '073 Products apply the sample adaptive offset functions to remap a portion of the region based on luminance values (luma). "SAO can be applied to not only luma but also chroma." Chih-Ming Fu, *et al.*, *Sample Adaptive Offset in the HEVC Standard*, IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, VOL. 22, NO. 12 at 1765 (December 2012).

514. The LG '073 Products apply the sample adaptive offset to a coding tree unit (region in the first frame), a luminance analysis is performed using two luminance analysis techniques: Edge Offset ("EO") and Band Offset ("BO"). Edge Offset "uses four 1-D directional patterns for sample classification: horizontal, vertical, 135° diagonal, and 45° diagonal." Chih-Ming Fu, *et al.*, Sample Adaptive Offset in the HEVC Standard, IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, VOL. 22, NO. 12 AT 1757 (December 2012). Band Offset "implies one offset is added to all samples of the same band. The sample value range is equally divided into 32 bands." *Id.* at 1757. The below diagram shows that the LG '073 Products use different sample adaptive offsets in a region of the first frame in conducting a luminance analysis.



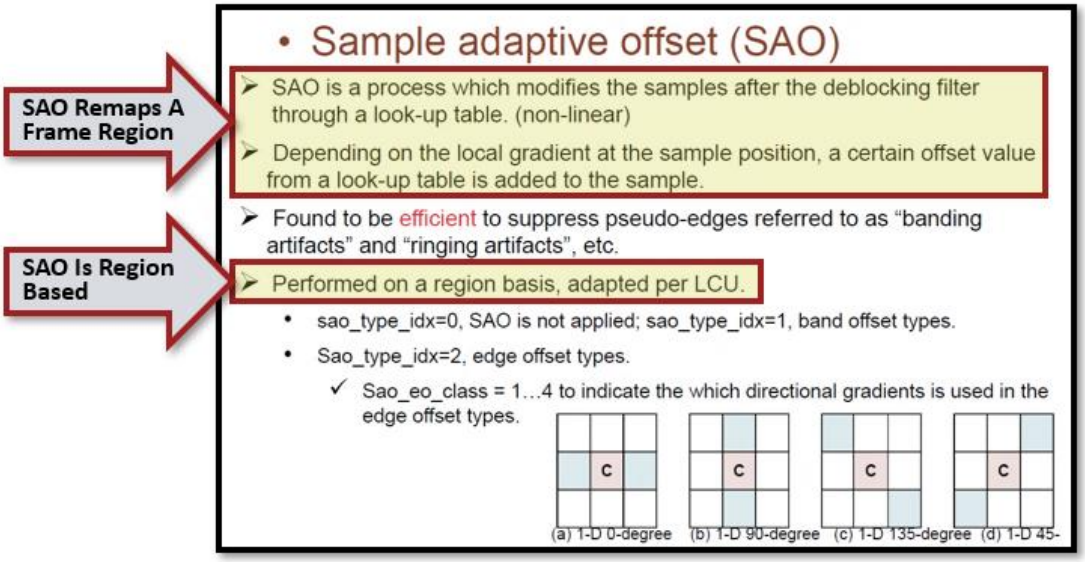
Chih-Ming Fu, *et al.*, *Sample Adaptive Offset in the HEVC Standard*, IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, VOL. 22, NO. 12 AT 1759 (December 2012) (annotations added showing (1) edge offset and (2) band offset luma analysis).

515. Further, HEVC documentation makes clear that the application of the standard adaptive offset remapping policy is based on a luminance analysis. The below shows that slices of a region have a standard adaptive offset applied based on a "luma flag."

if(sample_adaptive_offset_enabled_flag) {	
slice_sao_luma_flag	u(1)
if(ChromaArrayType != 0)	
slice_sao_chroma_flag	u(1)

High Efficiency Video Coding, SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 at § F.7.3.6.1 (April 2015) ("sample_adaptive_offset_enabled_flag equal to 1 specifies that the sample adaptive offset process is applied to the reconstructed picture after the deblocking filter process.").

516. Commentary on the use of sample adaptive offset functionality in decoding HEVC video further confirms that the use of Sample Adaptive Offset (such as that implemented by the LG '073 Products) is region based and remaps pixel values in a region of a frame by modifying pixels based on an offset value. "[A]fter the deblocking filter through a look-up table . . . [and applying] a certain offset value from a look-up-table is added to the sample."[76]



Oscar C. Au, HIGH EFFICIENCY VIDEO CODING (HEVC) PRESENTATION at 43 (October 2013) (annotations added).

[76] Oscar C. Au, HIGH EFFICIENCY VIDEO CODING (HEVC) PRESENTATION at 43 (October 2013).

517. When the LG '073 Products decode a second frame, the application of the remapping policy (sample adaptive offset) will be determined based on the application of sample adaptive offset to the first frame (reference picture). Thus, the application of the remapping policy (sample adaptive offset) to the first frame has the effect of increasing the quality of the reference picture such that the second frame might no longer require the application of sample adaptive offset (remapping policy).[77]

> The second in-loop filter, SAO, is applied to the output of the deblocking filter and further improves the quality of the decoded picture by attenuating ringing artifacts and changes in sample intensity of some areas of a picture. The most important advantage of the in-loop filters is improved subjective quality of reconstructed pictures. In addition, using the filters in the decoding loop also increases the quality of the reference pictures and hence also the compression efficiency.

Andrey Norkin, Chih-Ming Fu, Yu-Wen Huang, and Shawmin Lei, *In-Loop Filters In HEVC*, IN HIGH EFFICIENCY VIDEO CODING (HEVC) (Vivienne Sze, Madhukar Budagavi, and Gary J. Sullivan (Editors)) at 171 (September 2014) (annotations added).

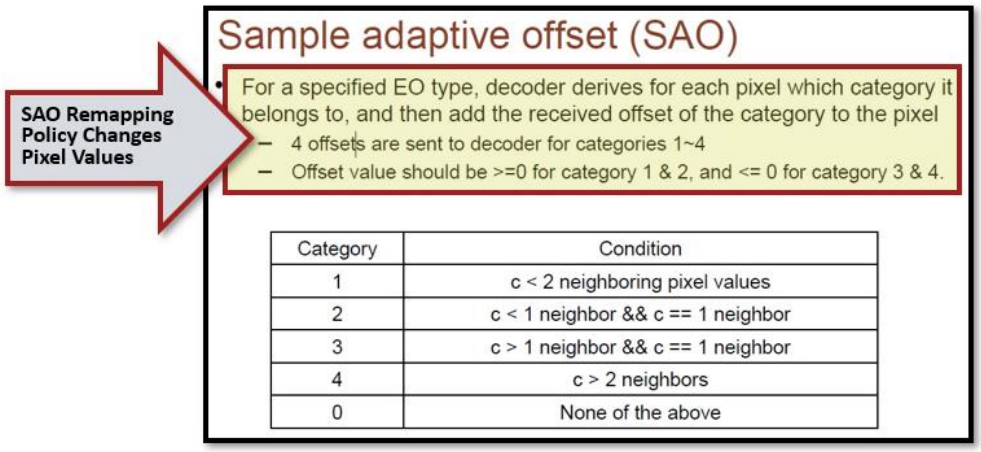
518. Sample adaptive offset as implemented by the LG '073 Products is a policy that remaps the values of pixels. If sample adaptive offset is applied to a reference frame, regions in a second frame might not require the application of the remapping policy as the reference frame that was used to generate the second frame was of a better quality.

> SAO classifies each pixel into one of four bands or one of four edge types and adds an offset to it. For band offsets, the band of each pixel depends on its value and the position of the four bands. For edge offsets, the edge of each pixel depends on the whether its value is larger or smaller than two of its neighbors. The selection between band offsets and edge offsets, position of bands, choice of neighbors for edge offsets, and values of the offsets are signaled at the CTU level for luma and chroma separately.

Mehul Tikekar, *et al., Decoder Hardware Architecture for HEVC*, HIGH EFFICIENCY VIDEO CODING (HEVC) at 335 (September 2014).

[77] Andrey Norkin, Chih-Ming Fu, Yu-Wen Huang, and Shawmin Lei, *In-Loop Filters In HEVC*, IN HIGH EFFICIENCY VIDEO CODING (HEVC) at 171 (September 2014) ("HEVC defines two in-loop filters, deblocking and sample adaptive offset (SAO), which significantly improve the subjective quality of decoded video sequences as well as compression efficiency by increasing the quality of the reconstructed/ reference pictures.").

519. The following excerpt from a presentation describing HEVC decoding provides details on how the application of sample adaptive offset remaps pixel values by adding an offset to the pixel value based on a luma analysis.



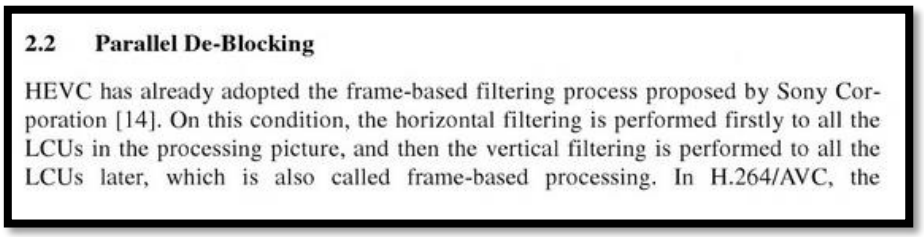
Oscar C. Au, HIGH EFFICIENCY VIDEO CODING (HEVC) PRESENTATION at 44 (October 2013) (annotation added).

520. The LG '073 Products receive encoded video data wherein the second frame includes a region encoding a motion vector difference in position between the region corresponding to the second frame indicating the first frame, the motion vector defines a region between the frame and the second frame corresponding to the first region the correspondence relationship. Specifically, the encoded video data received by the LG '073 Products use a translational motion model wherein the position of the block in a previously decoded picture is indicated by a motion vector: Δx; Δy where Δx specifies the horizontal and Δy the vertical displacement relative to the position of the current block. The motion vectors: Δx and Δy are of fractional sample accuracy to more accurately capture the movement of the underlying object. Interpolation is applied on the reference pictures to derive the prediction signal when the corresponding motion vector has fractional sample accuracy. The previously decoded picture is referred to as the reference picture and indicated by a reference index Δt to a reference picture list.

These translational motion model parameters, *i.e.*, motion vectors and reference indices, are further referred to as motion data.

521. One or more of the LG '073 Products enable the provision of enhanced video pictures with minimal additional hardware costs for the components required to successfully process the video data.

522. One or more of the LG '073 Products include an input for receiving a video stream containing encoded frame-based video information including an encoded first frame and an encoded second frame.



2.2 Parallel De-Blocking

HEVC has already adopted the frame-based filtering process proposed by Sony Corporation [14]. On this condition, the horizontal filtering is performed firstly to all the LCUs in the processing picture, and then the vertical filtering is performed to all the LCUs later, which is also called frame-based processing. In H.264/AVC, the

Ming-Ting Sun, *et al.*, *Advances in Multimedia Information Processing*, PCM 2012: 13TH PACIFIC-RIM CONFERENCE ON MULTIMEDIA PROCEEDINGS VOLUME 7674 at 274 (December 4-6, 2012) ("HEVC has already adopted the frame-based filtering process proposed by Sony Corporation.").

523. One or more of the LG '073 Products include a video decoder comprising an input for receiving video information wherein the encoding of the second frame depends on the encoding of the first frame, the encoding of the second frame includes motion vectors indicating differences in positions between regions of the second frame and corresponding regions of the first frame, the motion vectors define correspondence between regions of the second frame and corresponding regions of the first frame. The Overview of Design Characteristics in the HEVC Standard describes the use of "motion vectors for block-based inter prediction to exploit temporal statistical dependencies between frames."

compression. Encoding algorithms (not specified in this Recommendation | International Standard) may select between inter and intra coding for block-shaped regions of each picture. Inter coding uses motion vectors for block-based inter prediction to exploit temporal statistical dependencies between different pictures. Intra coding uses various spatial prediction modes to exploit spatial statistical dependencies in the source signal for a single picture. Motion vectors and intra prediction modes may be specified for a variety of block sizes in the picture. The prediction residual may then be further compressed using a transform to remove spatial correlation inside the transform block before it is quantized, producing a possibly irreversible process that typically discards less important visual information while forming a close approximation to the source samples. Finally, the motion vectors or intra prediction modes may also be further compressed using a variety of prediction mechanisms, and, after prediction, are combined with the quantized transform coefficient information and encoded using arithmetic coding.

High Efficiency Video Coding, SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 at § 0.7 (April 2015) (annotation added).

524. One or more of the LG '073 Products include a video decoder comprising a decoding unit for decoding the frames, wherein the decoding unit recovers the motion vectors for the second frame. Further, HEVC documentation shows that "motion vectors are used during the decoding process for prediction units in inter prediction mode."

The Decoder Uses Motion Vectors Based On Inter Prediction

The decoding process for prediction units in inter prediction mode consists of the following ordered steps:

1. The derivation process for motion vector components and reference indices as specified in clause 8.5.3.2 is invoked with the luma coding block location (xCb, yCb), the luma prediction block location (xBl, yBl), the luma coding block size block nCbS, the luma prediction block width nPbW, the luma prediction block height nPbH and the prediction unit index partIdx as inputs, and the luma motion vectors mvL0 and mvL1, when ChromaArrayType is not equal to 0, the chroma motion vectors mvCL0 and mvCL1, the reference indices refIdxL0 and refIdxL1 and the prediction list utilization flags predFlagL0 and predFlagL1 as outputs.
2. The decoding process for inter sample prediction as specified in clause 8.5.3.3 is invoked with the luma coding block location (xCb, yCb), the luma prediction block location (xBl, yBl), the luma coding block size block nCbS, the luma prediction block width nPbW, the luma prediction block height nPbH, the luma motion vectors mvL0 and mvL1, when ChromaArrayType is not equal to 0, the chroma motion vectors mvCL0 and mvCL1, the reference indices refIdxL0 and refIdxL1, and the prediction list utilization flags predFlagL0 and predFlagL1 as inputs, and the inter prediction samples (predSamples) that are an $(nCbS_L)x(nCbS_L)$ array $predSamples_L$ of prediction luma samples and, when ChromaArrayType is not equal to 0, two $(nCbSw_C)x(nCbSh_C)$ arrays $predSamples_{Cr}$ and $predSamples_{Cr}$ of prediction chroma samples, one for each of the chroma components Cb and Cr, as outputs.

High Efficiency Video Coding, SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 at § 8.5.3.1 (April 2015) (annotation added).

525. One or more of the LG '073 Products include a video decoder comprising a processing component configured to determine a re-mapping strategy for video enhancement of the decoded first frame using a region-based analysis, re-map the first frame using the re-mapping

strategy, and re-map one or more regions of the second frame depending on the re-mapping strategy for corresponding regions of the first frame.

526. One or more LG subsidiaries and/or affiliates use the LG '073 Products in regular business operations.

527. The LG '073 Products are available to businesses and individuals throughout the United States.

528. The LG '073 Products are provided to businesses and individuals located in the Eastern District of Texas.

529. By making, using, testing, offering for sale, and/or selling products and services for enhancing subsequent images of a video stream in which frames are encoded based on previous frames using prediction and motion estimation, including but not limited to the LG '073 Products, LG has injured Dynamic Data and is liable to the Plaintiff for directly infringing one or more claims of the '073 patent, including at least claim 14 pursuant to 35 U.S.C. § 271(a).

530. LG also indirectly infringes the '073 patent by actively inducing infringement under 35 U.S.C. § 271(b).

531. LG has had knowledge of the '073 patent since at least service of this Original Complaint in this case or shortly thereafter, and on information and belief, LG knew of the '073 patent and knew of its infringement, including by way of this lawsuit.

532. LG intended to induce patent infringement by third-party customers and users of the LG '073 Products and had knowledge that the inducing acts would cause infringement or was willfully blind to the possibility that its inducing acts would cause infringement. LG specifically intended and was aware that the normal and customary use of the accused products would infringe the '073 patent. LG performed the acts that constitute induced infringement, and would induce

actual infringement, with knowledge of the '073 patent and with the knowledge that the induced acts would constitute infringement. For example, LG provides the LG '073 Products that have the capability of operating in a manner that infringe one or more of the claims of the '073 patent, including at least claim 14, and LG further provides documentation and training materials that cause customers and end users of the LG '073 Products to utilize the products in a manner that directly infringe one or more claims of the '073 patent.[78] By providing instruction and training to customers and end-users on how to use the LG '073 Products in a manner that directly infringes one or more claims of the '073 patent, including at least claim 14, LG specifically intended to induce infringement of the '073 patent. LG engaged in such inducement to promote the sales of the LG '073 Products, e.g., through LG user manuals, product support, marketing materials, and training materials to actively induce the users of the accused products to infringe the '073 patent. Accordingly, LG has induced and continues to induce users of the accused products to use the accused products in their ordinary and customary way to infringe the '073 patent, knowing that such use constitutes infringement of the '073 patent.

533. The '073 patent is well-known within the industry as demonstrated by multiple citations to the '073 patent in published patents and patent applications assigned to technology companies and academic institutions. LG is utilizing the technology claimed in the '073 patent

[78] *See, e.g.*, *Large Ultra HD Signage: UM3C Series*, LG SPECIFICATION SHEET (2018); *Multiple Screen Split-Ultra HD Signage: Ultra HD UH5C Series*, LG SPECIFICATION SHEET (2016); *LG Help Library: Ultra HD 4K Upscaling – UHD TV Video*, LG Support Website (last visited March 2019), *available at*: https://www.lg.com/us/support/product-help/CT10000018-1432737109927-general-specifications; *98UB9800, 98UB9810, 105UC9*, OWNER'S MANUAL LED TV, *available at*: https://www.lg.com/us/support-product/lg-98UB9810 (last visited Nov. 2018); *40UB8000, 49UB8200, 55UB8200, 60UB8200, 49UB8300, 55UB8300, 65UB9200*, OWNER'S MANUAL LED TV, *available at*: https://www.lg.com/us/support-product/lg-55UB8200 (last visited Nov. 2018); *50UH5500, 50UH5530, 65UH5500*, OWNER'S MANUAL SAFETY AND REFERENCE LED TV, *available at*: https://www.lg.com/us/support-product/lg-50UH5530 (last visited Nov. 2018); *LM-V405AQ*, USER GUIDE (2018); *LM-V35OULM*, USER GUIDE (2018); *LG Stylo 4 LM-Q71OULM*, USER GUIDE (2018); *LG V30*, USER GUIDE (2018); *LM-X410AS*, USER GUIDE (2018).

without paying a reasonable royalty. LG is infringing the '073 patent in a manner best described as willful, wanton, malicious, in bad faith, deliberate, consciously wrongful, flagrant, or characteristic of a pirate.

534. To the extent applicable, the requirements of 35 U.S.C. § 287(a) have been met with respect to the '073 patent.

535. As a result of LG's infringement of the '073 patent, Dynamic Data has suffered monetary damages, and seeks recovery in an amount adequate to compensate for LG's infringement, but in no event less than a reasonable royalty for the use made of the invention by LG together with interest and costs as fixed by the Court.

COUNT XIII
INFRINGEMENT OF U.S. PATENT NO. 8,184,689

536. Dynamic Data references and incorporates by reference the preceding paragraphs of this Complaint as if fully set forth herein.

537. LG designs, makes, uses, sells, and/or offers for sale in the United States products and/or services for encoding and decoding video data.

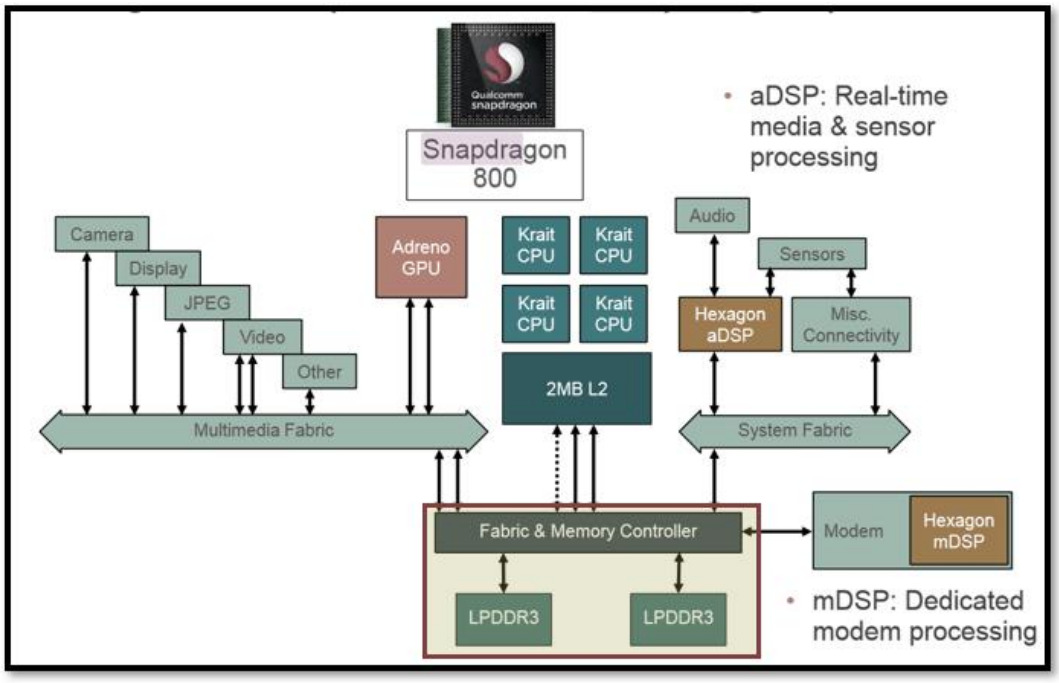
538. LG designs, makes, sells, offers to sell, imports, and/or uses LG products that enable encoding and decoding of video content including LG smart phone models: LG G7 ThinQ, LG V40 ThinQ, LG V35 ThinQ, LG V30, LG G6, LG G5, and LG V20 (collectively, the "LG '689 Products").

539. The LG '689 Products contain functionality for encoding and decoding a video stream using a video processing unit coupled to a first and second memory. Specifically, the LG '689 Products include an 800 Series Qualcomm Snapdragon Chip. For each of the accused LG

'689 Products the video processing chip is identified: LG G7 ThinQ (Snapdragon 845),[79] LG V40 ThinQ (Snapdragon 845),[80] LG V35 ThinQ (Snapdragon 845),[81] LG V30 (Snapdragon 835),[82] LG G6 (Snapdragon 812),[83] LG G5 (Snapdragon 820),[84] and LG V20 (Snapdragon 820).[85]

540. The LG '689 Products include a Hexagon Digital Signal Processor ("DSP"). The below figure shows a block diagram of the Snapdragon 800 series system-on-chip ("SoC") which is contained in the LG '689 Products. The SoC in the LG '689 Products contains dedicated subsystems for camera, display, video, audio/ voice, sensors, graphics, cellular modem, and Wi-Fi. Each subsystem on the LG '689 Products contains dedicated hardware, and special purpose processing engines and customized software. The following diagram identifies that the LG '689 Products contain an "aDSP" for "[r]eal-time media & sensor processing" and a "mDSP" for "[d]edicated modem processing."

[79] *LG G7 ThinQ Specifications*, LG WEBSITE, *available at*: https://www.lg.com/us/cell-phones/lg-G710ULM-LRA-g7-thinq.
[80] *LG V40 ThinQ Specifications*, LG WEBSITE, *available at*: https://www.lg.com/us/mobile-phones/v40-thinq/specs.
[81] *LG V35 ThinQ Specifications*, LG WEBSITE, *available at*: https://www.lg.com/us/cell-phones/lg-V350AWM-v35-thinq-att.
[82] *LG V30+ Specifications*, LG WEBSITE, *available at*: https://www.lg.com/us/cell-phones/lg-LS998U-lg-v30-plus.
[83] *LG G6 Specifications*, LG WEBSITE, *available at*: https://www.lg.com/levant_en/mobile-phones/lg-G6-platinum.
[84] *LG G5 Specifications*, LG WEBSITE, *available at*: https://www.lg.com/us/cell-phones/lg-RS988-Titan-g5-unlocked.
[85] *LG V20 Specifications*, LG WEBSITE, *available at*: https://www.lg.com/us/cell-phones/lg-VS995-Titan-v20.

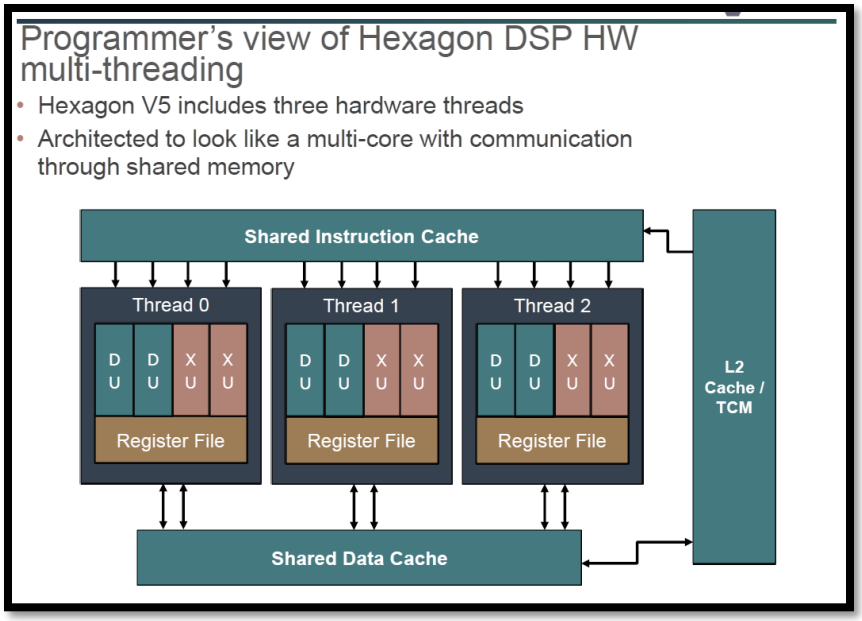


Lucian Codrescu, Qualcomm Hexagon DSP: An Architecture Optimized for Mobile Multimedia and Communications, QUALCOMM PRESENTATION at 2 (2013) (the yellow highlighted box shows the aDSP and mDSP modules described above).

541. The Hexagon DSP in the LG '689 Products is a multithreaded very long instruction word ("VLIW") DSP. As illustrated in the following diagram, the DSP in the LG '689 Products features a unified byte-addressable memory. This memory has a single 32-bit virtual address space that holds both instructions and data. The DSP operates in little-endian mode.

542. The LG '689 Products contain a full-featured memory management unit ("MMU") that translates virtual to physical addresses.

543. The LG '689 Products contain a DSP instruction unit that is coupled to a first and second memory (L2 Cache and Shared Data Cache).



Lucian Codrescu, Qualcomm Hexagon DSP: An Architecture Optimized for Mobile Multimedia and Communications, QUALCOMM PRESENTATION at 11 (2013) (depicting the L2 Cache and Shared Data Cache of the DSP in the LG '689 Products).

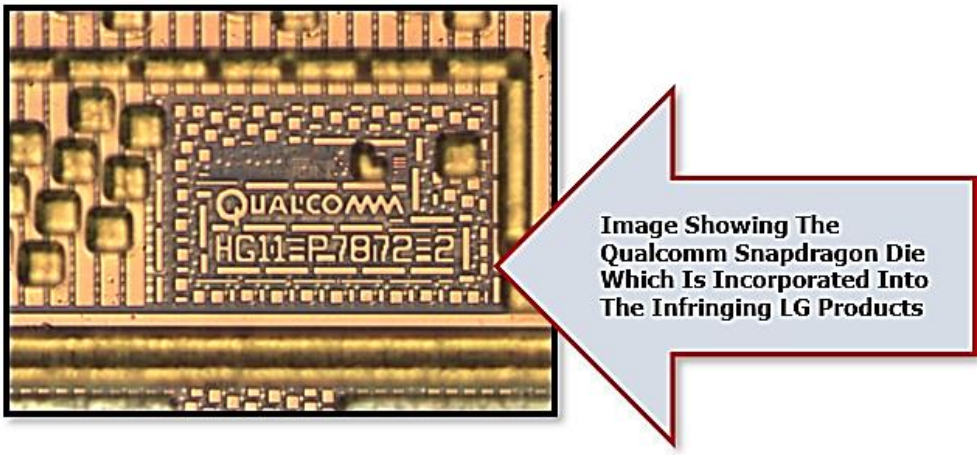
544. The LG '689 Products contain a digital signal processor that enables the encoding and decoding of video data. "The Hexagon instruction set architecture (ISA) contains numerous special-purpose instructions designed to accelerate key multimedia kernels. Multimedia algorithms with special instruction support include: variable-length encode/decode, such as context-adaptive binary-arithmetic coding processing in H.264 video; features from accelerated segment test (FAST) corner detection image processing; FFT algorithms; sliding-window filters; linear-feedback shift."[86]

545. The LG '689 Products contain a DSP which contains a data cache, L2 cache, and a connection of the main memory. "In the Snapdragon 800 implementation, the DSP runs up to 800 MHz. The instruction cache is 16 Kbytes, the data cache is 32 Kbytes, and the level-2 (L2) cache

[86] Lucian Codrescu et. al., *Hexagon DSP: An Architecture Optimized For Mobile Multimedia and Communications,* IEEE MICRO, VOL. 34, NO. 2, at 36-37 (March/April 2014) (emphasis added).

is 256 Kbytes. Connection to main memory is provided over a 64-bit system bus that runs at 240MHz."[87]

546. The LG '689 Products use motion estimation and motion compensation in the encoding and decoding of video data. The below image identifies an exemplar of the image processing component in the LG '689 Products – a Qualcomm 800 Series SoC.



QUALCOMM SNAPDRAGON 845 DIE MARKS (2017) (The Snapdragon processor incorporated in the LG Products is a software-based machine-learning solutions based on an SDKs, distributing workload to the CPU, GPU, or DSP based on requirements such and the infringing encoding/decoding process.).

547. The central processing unit ("CPU") and DSP contained in the LG '689 Products communicate with each other via FastRPC, a proprietary remote procedure call ("RPC") mechanism used to enable remote function calls between the CPU and DSP.

548. The LG '689 Products contain a processing unit that is coupled to a first and second memory. "The aDSP is part of the SoC package. Therefore, various processor units (in this case, the aDSP and CPU) have access to the same hardware memory unit (such as DDR3). For better memory control, there are multiple logical divisions of the memory. Each processing unit has

[87] *Id.*, at 40.

exclusive and shared access to various memory areas. Memory protection units (MPUs) implement the access control."[88]

549. The LG '689 Products contain functionality for providing a subset of image data stored in the second memory in the first memory.

> Data level parallelism means that the processor can take one piece of data and distribute it across different parallel computing nodes. Hexagon has four nodes, or execution units . . . Here, a shift is performed on a 64-bit piece of data, Rss, and the result is stored in Rdd. Instead of shifting the entire double word left, we want to shift four half-words each. Hexagon can do this in parallel.

MPSS Debug Manual, QUALCOMM DOCUMENTATION 80-NF515-10K at 9 (June 15, 2017) (emphasis added).

550. The LG '689 Products include a system memory management unit ("SMMU"). The LG '689 Product SMMU optimizes the need to allocate small chunks of memory when larger chunks are not available. Further, the SMMU layer enables actual non-continuous memory chunks to be presented in a continuous view to each processing unit.

551. The LG '689 Products store video data during the decoding process on memory structures including the CPU Cache, L3 Cache, L2 Cache, L1 Cache, and Off Chip Ram. The following image identifies an exemplar of the video processing structure in the LG '689 Products and the memory structures where memory image data during the encoding and decoding process can be stored.

[88] *Qualcomm FastRPC User Guide*, QUALCOMM DOCUMENTATION 80-N7039-2 at 11 (March 31, 2017).

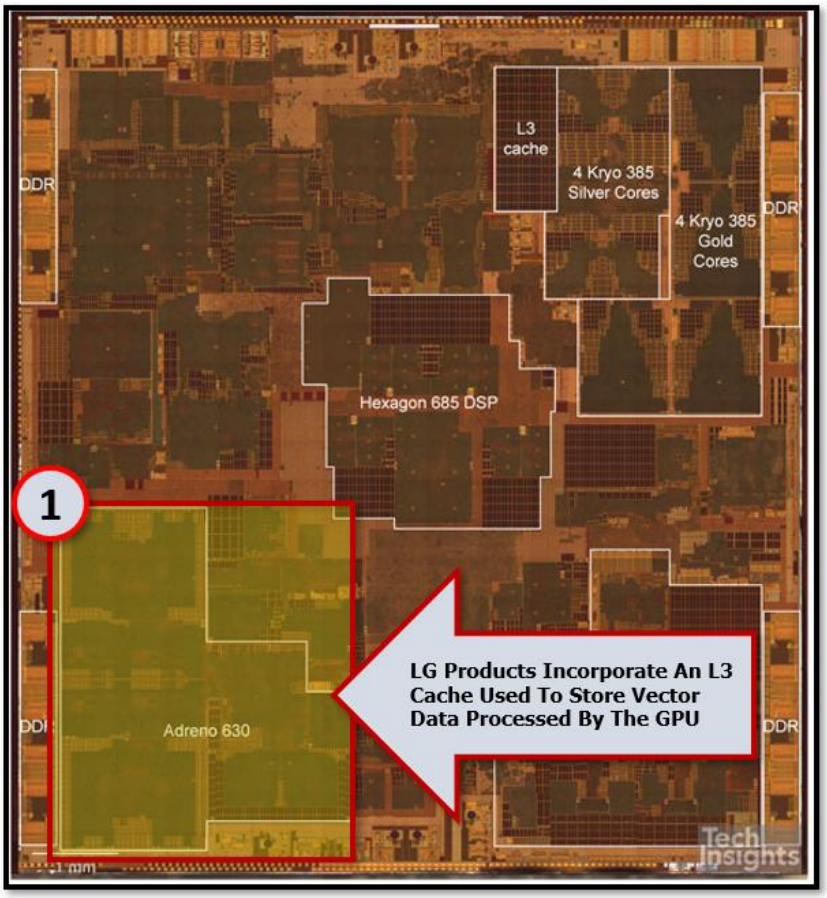


IMAGE OF AN LG '689 PRODUCT PROCESSOR: DETAILED PRODUCT ANALYSIS (2018) (annotations added) (showing at "1" the Adreno 630 GPU).

552. The LG '689 Products during the encoding and decoding process can write image data to the L2 Cache, L1 Cache, and System Memory. As an illustrative example, documentation regarding the processor in the LG '689 Products shows that through the use of "latency hiding" data for video encoding is retrieved from both external memory and on chip memory.

553. The LG '689 Products contain a DSP that exploits thread level parallelism. The hardware threads appear independent, but they share the L1 Instruction Cache, the L1 data Cache, and the L2 Unified Cache as shown in the below diagram.

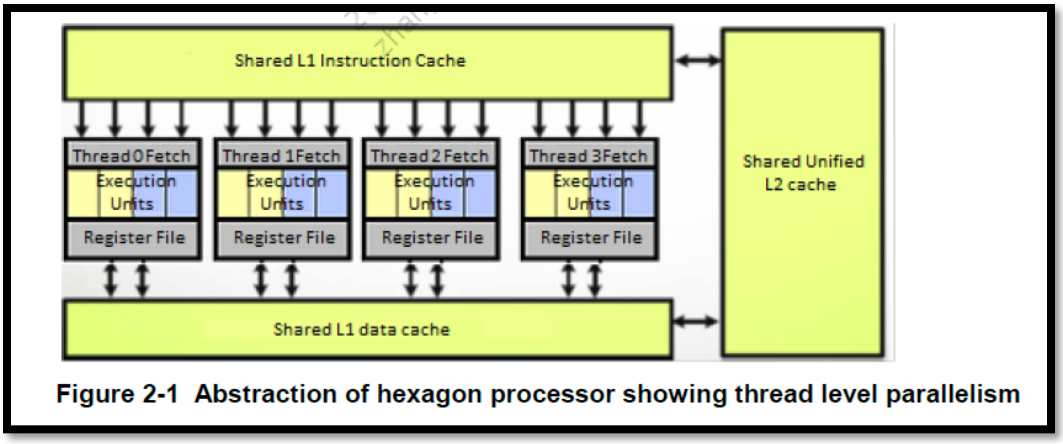
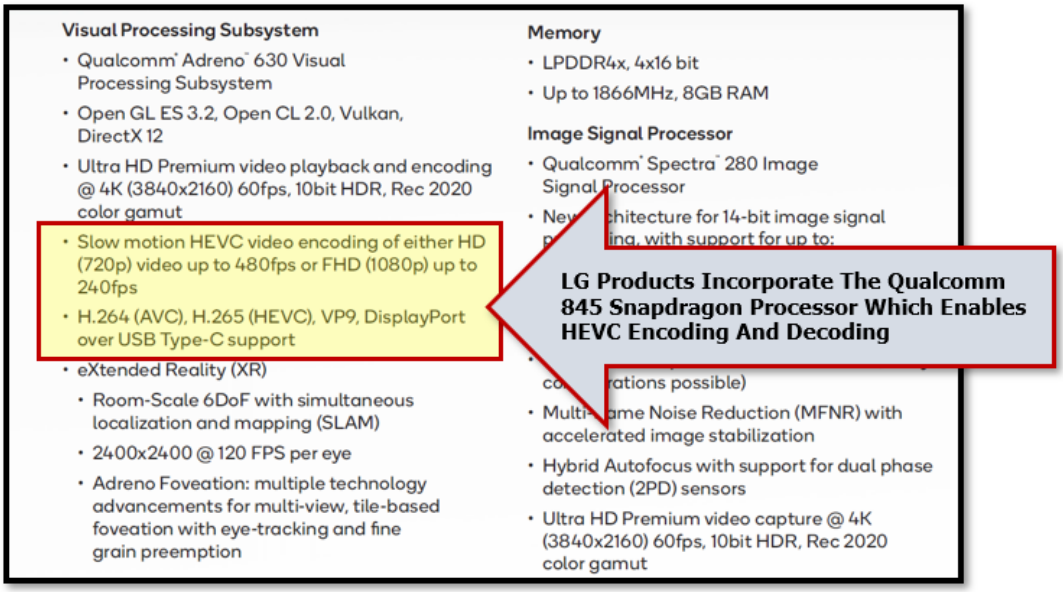


Figure 2-1 Abstraction of hexagon processor showing thread level parallelism

MPSS Debug Manual, QUALCOMM DOCUMENTATION 80-NF515-10K at 9 (June 15, 2017).

554. The LG '689 Products contain a processor stack frame. The processor stack is used to store stack frames, which are data structures that store state information on active subroutines of a program.

555. The LG '689 Products contain functionality for simultaneously encoding and decoding a video stream.



Qualcomm Snapdragon 845 Mobile Platform, QUALCOMM DATASHEET at 2 (2018) ("Higher quality video capture with Motion Compensated Temporal Filtering (MCTF)").

556. The LG ‘689 Products contain functionality for encoding and decoding a video stream by accessing a subset of image data stored in memory.

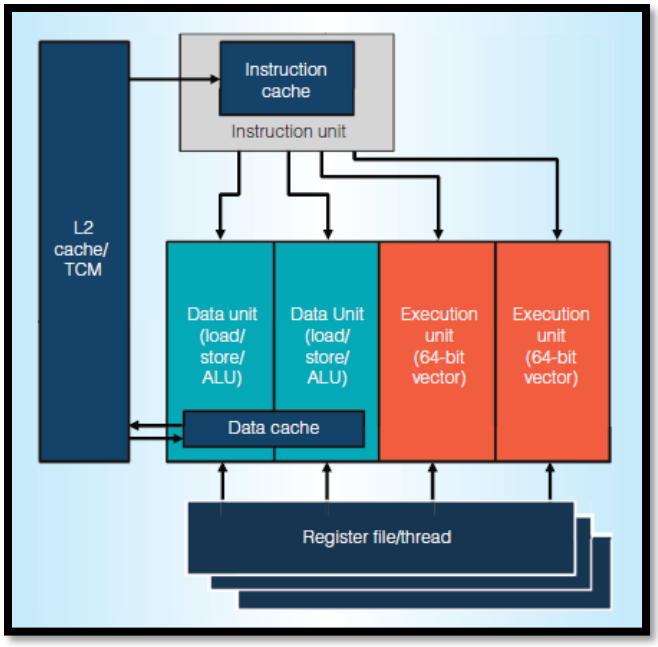
> Relying on its in-house DSP to spur new smartphone features, Qualcomm has improved the capabilities of its Hexagon architecture and is making it easier than ever for programmers to tap into. At today’s Hot Chips conference, the company disclosed improvements such as floating-point support and dynamic multithreading that it implemented in the Hexagon v5 generation, which recently began shipping in the Snapdragon 800 processor. These improvements expand the DSP’s range of applications to include image and video processing as well as computer vision and sensor analysis.

Linley Gwennap, *Qualcomm Extends Hexagon DSP: Hexagon v5 Adds Floating-Point Math, Dynamic Multithreading*, LINLEY GROUP MICROPROCESSOR REPORT at 1 (August 2013).

557. The LG ‘689 Products contain functionality for simultaneously encoding and decoding video data by access sharing one or more images stored in memory.

558. The LG ‘689 Products include multiple execution units and data units that can execute instructions in parallel. The instruction level parallelism in the LG ‘689 Products “allows multiple instructions to be executed concurrently. The processor has four Execution Units which are used in the instruction pipeline.”[89] The following diagram shows the shared “data cache” and “L2 Cache” that are coupled to the instruction unit in the LG ‘689 Products.

[89] *MPSS Debug Manual*, QUALCOMM DOCUMENTATION 80-NF515-10K at 9 (June 15, 2017).



Lucian Codrescu, et. al., *Hexagon DSP: An Architecture Optimized for Mobile Multimedia and Communications,* IEEE MICRO, VOL. 34, NO. 2, at 36 (Mar.-Apr. 2014).

559. One or more LG subsidiaries and/or affiliates use the LG '689 Products in regular business operations.

560. LG has directly infringed and continues to directly infringe the '689 patent by, among other things, making, using, offering for sale, and/or selling technology for encoding and decoding video data, including but not limited to the LG '689 Products.

561. The LG '689 Products are available to businesses and individuals throughout the United States.

562. The LG '689 Products are provided to businesses and individuals located in the Eastern District of Texas.

563. By making, using, testing, offering for sale, and/or selling products and services for encoding and decoding video data, including but not limited to the LG '689 Products, LG has injured Dynamic Data and is liable to the Plaintiff for directly infringing one or more claims of the '689 patent, including at least claim 1 pursuant to 35 U.S.C. § 271(a).

564. LG also indirectly infringes the '689 patent by actively inducing infringement under 35 USC § 271(b).

565. LG has had knowledge of the '689 patent since at least service of the Original Complaint in this case or shortly thereafter, and on information and belief, LG knew of the '689 patent and knew of its infringement, including by way of this lawsuit.

566. LG intended to induce patent infringement by third-party customers and users of the LG '689 Products and had knowledge that the inducing acts would cause infringement or was willfully blind to the possibility that its inducing acts would cause infringement. LG specifically intended and was aware that the normal and customary use of the accused products would infringe the '689 patent. LG performed the acts that constitute induced infringement, and would induce actual infringement, with knowledge of the '689 patent and with the knowledge that the induced acts would constitute infringement. For example, LG provides the LG '689 Products that have the capability of operating in a manner that infringe one or more of the claims of the '689 patent, including at least claim 1, and LG further provides documentation and training materials that cause customers and end users of the LG '689 Products to utilize the products in a manner that directly infringe one or more claims of the '689 patent.[90] By providing instruction and training to customers and end-users on how to use the LG '689 Products in a manner that directly infringes one or more claims of the '689 patent, including at least claim 1, LG specifically intended to induce infringement of the '689 patent. LG engaged in such inducement to promote the sales of the LG '689 Products, e.g., through LG user manuals, product support, marketing materials, and training materials to actively induce the users of the accused products to infringe the '689 patent.

[90] *See, e.g.*, *LM-V405AQ*, USER GUIDE (2018); *LM-V35OULM*, USER GUIDE (2018); *LG V30*, USER GUIDE (2018); *See, e.g.*, *LG V35 ThinQ*, LG USER GUIDE (2018); *LG V40 ThinQ*, USER GUIDE (2018); LG G7 THINQ, USER GUIDE (2018); LG GLOBAL YOUTUBE CHANNEL (January 12, 2019), available at: https://www.youtube.com/watch?v=4QXpEr1EsjA.

Accordingly, LG has induced and continues to induce users of the accused products to use the accused products in their ordinary and customary way to infringe the '689 patent, knowing that such use constitutes infringement of the '689 patent.

567. The '689 patent is well-known within the industry as demonstrated by multiple citations to the '689 patent in published patents and patent applications assigned to technology companies and academic institutions. LG is utilizing the technology claimed in the '689 patent without paying a reasonable royalty. LG is infringing the '689 patent in a manner best described as willful, wanton, malicious, in bad faith, deliberate, consciously wrongful, flagrant, or characteristic of a pirate.

568. To the extent applicable, the requirements of 35 U.S.C. § 287(a) have been met with respect to the '689 patent.

569. As a result of LG's infringement of the '689 patent, Dynamic Data has suffered monetary damages, and seeks recovery in an amount adequate to compensate for LG's infringement, but in no event less than a reasonable royalty for the use made of the invention by LG together with interest and costs as fixed by the Court.

COUNT XIV
INFRINGEMENT OF U.S. PATENT NO. 8,189,105

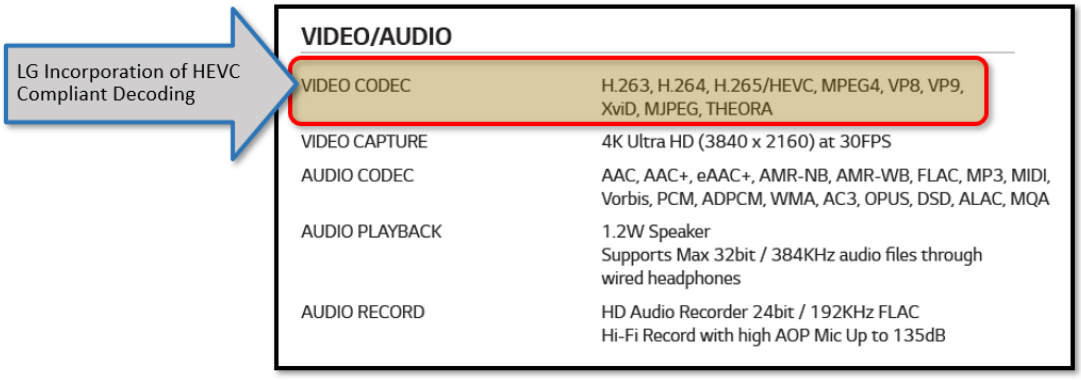
570. Dynamic Data references and incorporates by reference the preceding paragraphs of this Complaint as if fully set forth herein.

571. LG designs, makes, uses, sells, and/or offers for sale in the United States products and/or services for processing pixel information based on received motion and edge data.

572. LG designs, makes, sells, offers to sell, imports, and/or uses LG products that contain sub-pixel accurate motion vector functionality, including but not limited to LG products that contain and/or enable H.265 decode functionality, including: LG smart phones, LG OLED

TVs, LG Super UHD 4K TVs, LG UHD 4K TVs, and LG digital signage products (collectively, the "LG '105 Products").

573. The accused LG '105 Products include the following LG smart phone models (which include functionality for decoding video content that is encoded in accord with the HEVC standard): LG US700, LG LMV405UA, LG Q610TA, LG K450, LG V350AWM, LG SP200, LG Q710MS, LG 211BL, LG M154, LG X410TK, LG Q617QA, LG Q610MA, LG US701, LG M327, LG 255, LG H700, LG M430, LG L83BL, LG M257, LG X410ASR, LG Q710ULS, LG US601, LG M322, LG Q710ULM, LG Q710CS, LG V350ULM, LG X210ULMA, LG LM-X210ULMA-K8, LG LM-X210VPP, LG LMX220MA, LG Q710AL, LG US601 ACG, LG LMX210MA, LG LM-V405UA, and LG X212TAL.[91] The following excerpt from an exemplar specification of one of the accused LG smart phones identifies that it contains an HEVC decoder functionality.

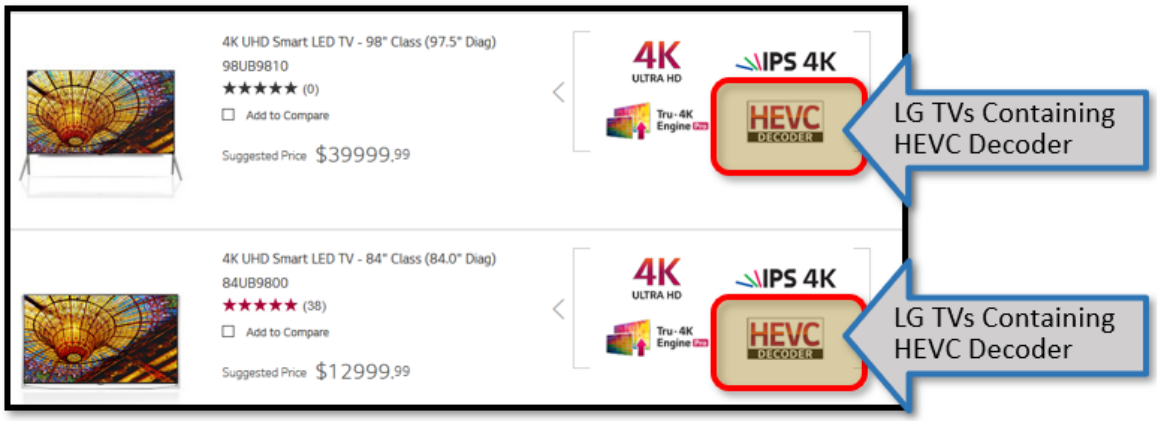


LG V30 SPECIFICATION SHEET at 1 (2017) (annotation added).

574. The accused LG '105 Products include the following LG television models: 60UF8500, 105UC9, 98UB9810, 84B9800, 40UB8000, 49UB8500, 55UB8500, 55UB8200,

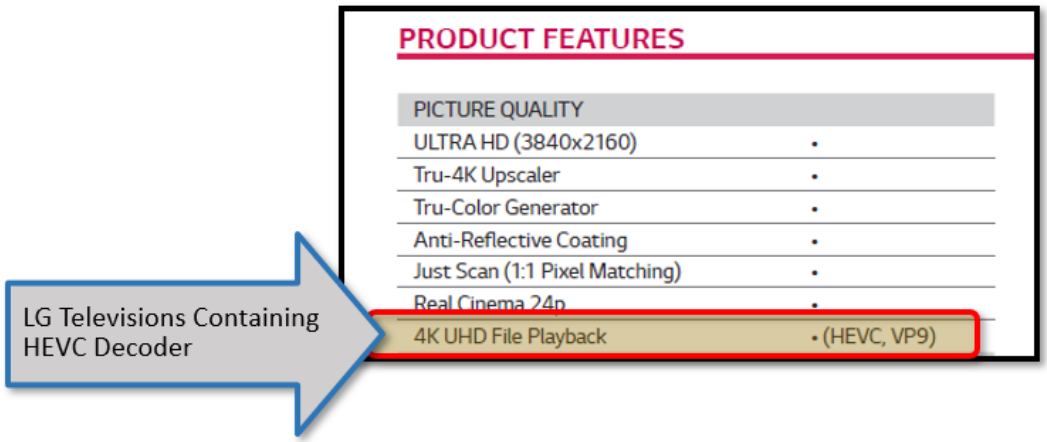
[91] *See e.g., LG Phones Website*, LG WEBSITE (last visited March 2019), *available at*: https://www.lg.com/us/cell-phones/all-cell-phones; LG G4 vs. Samsung Galaxy S6", GSMArena, June 19, 2015 (LG's G4 (2015), G5 (2015), and G6 (2017) phones support HEVC with UHD resolution [81], and the G5 and G6 support 10 bit video and 60 fps HFR).

65UB9200, 60UB8200, 98UB9800, 49UB8300, 55UB8300, 55UB9500, 65UB9500, 79UB9800, and 65UB9800.[92]



LG Television Product Search, LG CONSUMER WEBSITE (last visited March 2018), *available at*: https://www.lg.com/us/search.lg?search=hevc (annotations added).

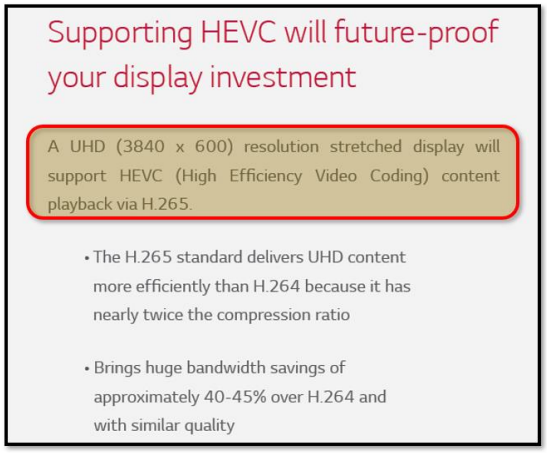
575. LG documentation identifies that the accused LG television products enable the playback of content that is encoded in the HEVC standard using an HEVC complaint decoder.



LG EG9600 4K UHD SMART CURVED OLET TV W/ WEBOS 2.0 & 3D SPECIFICATION at 1 (2015) (annotation added).

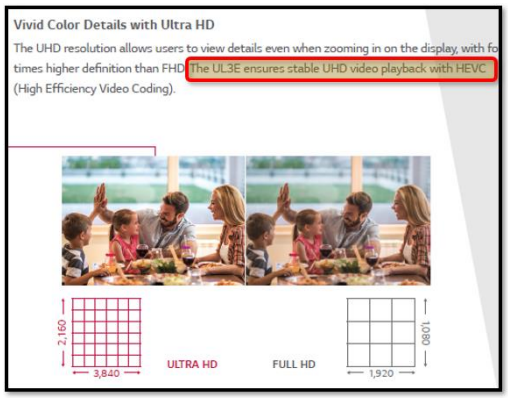
[92] Tribbey, Chris, *CES 2017: LG Debuts ATSC 3.0-Enabled 4K TVs*, BROADCASTING AND CABLE, January 8, 2017.

576. The accused LG '105 Products include the following LG digital signage products: UM3C, 75UH5C, 75UM3C, 60UL3E, 86UH5E-B, 55UH5B, 55VH7B, 55VM5B, 49VM5C, 55VX1D, 49UH5C, and 55UH5C.[93]



How to Stretch Customer Imagination with Digital Signage, LG BUSINESS SOLUTIONS DOCUMENTATION at 6 (2016).

577. The accused LG '105 Products are described in LG documentation as ensuring "stable UHD video playback with HEVC."



70UL3E 60UL3E Clear Color Expression of UHD Content Documentation, LG DOCUMENTATION at 2 (2018) (annotation added).

578. One or more LG subsidiaries and/or affiliates use the LG '105 Products in regular business operations.

[93] *See e.g.*, *LG Business Solutions Digital Signage*, LG WEBSITE, *available at*: https://www.lg.com/us/business/commercial-display/displays-tvs/digital-signage/.

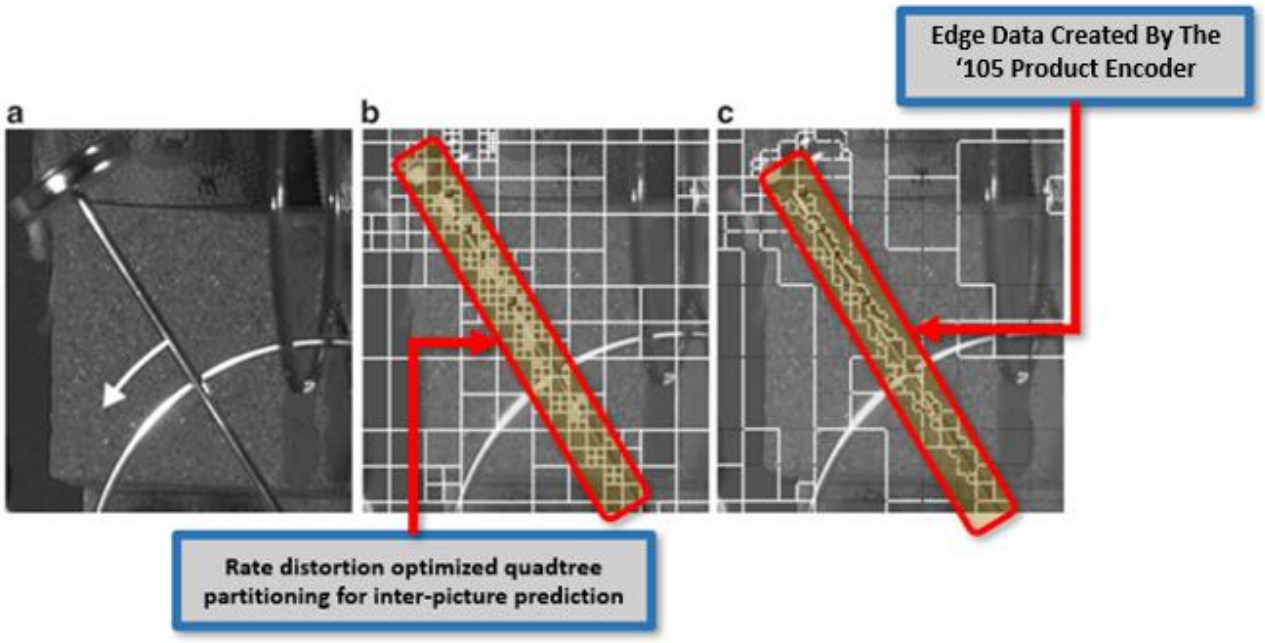
579. By complying with the HEVC standard, the LG devices – such as the LG '105 Products – necessarily infringe the '105 patent. The mandatory sections of the HEVC standard require the elements required by certain claims of the '105 patent, including but not limited to claim 1 of the '105 patent. *High Efficiency Video Coding*, SERIES H: AUDIOVISUAL AND Multimedia SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 (February 2018) (The following sections of the HEVC Standard are relevant to LG's infringement of the '105 patent: "8.3.2 Decoding process for reference picture set;" "8.5.4 Decoding process for the residual signal of coding units coded in inter prediction mode;" "8.6 Scaling, transformation and array construction process prior to deblocking filter process;" "8.5.2 Inter prediction process;" "8.5.3 Decoding process for prediction units in inter prediction mode;" and "8.7.2 Deblocking filter process;" "8.7.3 Sample adaptive offset process.").

580. The LG '105 Products comply with the HEVC standard, which requires processing edge data from edge-adaptive interpolation processing.

581. The LG '105 Products use two types of prediction methods for processing pixel information when encoding and decoding video data in HEVC format: inter prediction and intra prediction. Inter prediction utilizes motion vectors for block-based inter prediction to exploit temporal statistical dependencies between different pictures. Intra prediction uses various spatial prediction modes to exploit spatial statistical dependencies in the source signal for a single picture. The HEVC Specification (*e.g., High Efficiency Video Coding*, SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 (February 2018) sets forth the standard that is followed by HEVC compliant devices such as the LG '105 Products, and is relevant to both decoding and encoding that are performed pursuant to the HEVC standard. For instance, the LG '105 Products perform a

method for encoding a video signal comprised of pixels using motion vectors when performing encoding of H.265/HEVC video data.

582. During the encoding process, the LG '105 products process pixel information based on edge data. The edge data is generated by the LG '105 products using merge mode estimation. Specifically, the LG '105 Products generate merge estimation regions which identify edge information within a video frame. The merge estimation regions are comprised of prediction units ("PU") that contain luma values. For example, in the below diagram PUs are shown. The encoding process then identifies along the edges of each prediction unit a merge estimation region ("MER"). The MER regions thus identify the edges and the PU contains the intensity estimate for the pixels.



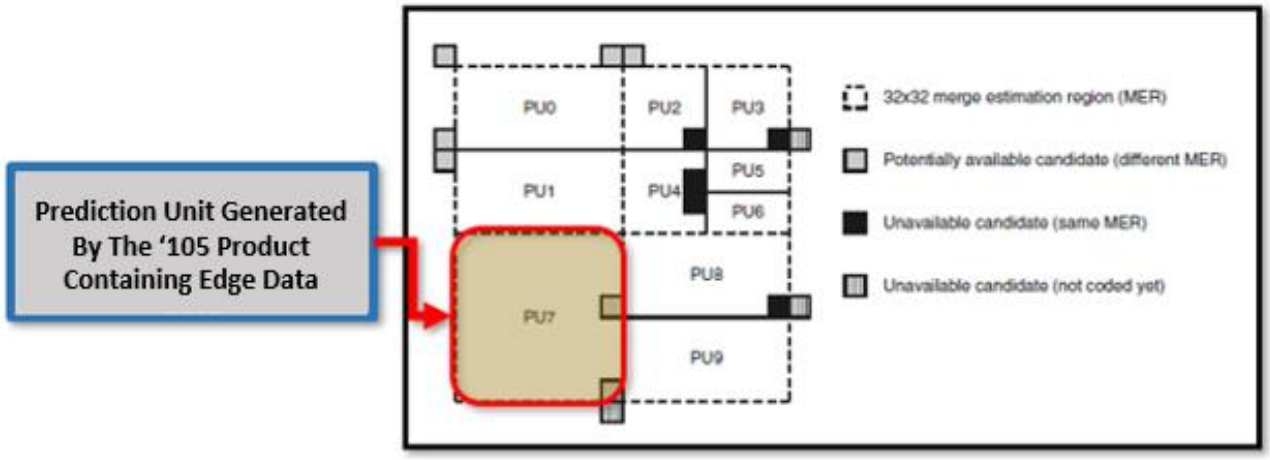
Benjamin Bross, et al., *Inter-Picture Prediction in HEVC*, HIGH EFFICIENCY VIDEO CODING (HEVC) at 114 (September 2014) (annotations added).

583. The LG '105 Products in the process of encoding video content in HEVC format generate merge estimation regions generate edge data that include luma location and luma values which include a first intensity estimate. The HEVC standards describes this process as leading to the generation of luma motion vector mvL0 and mvL1.

> [T]he derivation process for luma motion vectors for merge mode as specified in clause I.8.5.3.2.7 is invoked with the luma location (xCb, yCb), the luma location (xPb, yPb), the variables nCbS, nPbW, nPbH, and the partition index partIdx as inputs, and the output being the luma motion vectors mvL0, mvL1, the reference indices refIdxL0, refIdxL1, the prediction list utilization flags predFlagL0 and predFlagL1, the flag ivMcFlag, the flag vspMcFlag, and the flag subPbMotionFlag.

High Efficiency Video Coding, SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 at § I.8.5.3.2.1 (February 2018) (emphasis added).

584. The LG '105 Products perform the step of processing edge data from an edge adaptive interpolation process wherein the edge data includes a first intensity estimate of the pixel. Specifically, the LG '105 Products implement HEVC encoding which utilizes Parallel Merge Mode and Merge Estimation Regions (MER's) within the interpolation process to determine pixel edges. Parallel Merge Mode Estimation identifies the edge data within a prediction unit. The below diagram shows how video data is portioned into 10 prediction units and edge data is calculated and passed to the encoder.



Benjamin Bross, et al., *Inter-Picture Prediction in HEVC*, HIGH EFFICIENCY VIDEO CODING (HEVC) at 127 (September 2014) (annotations added).

585. The merge estimation processes implemented by the LG '105 Products is "adaptive." The below excerpt from documentation regarding the HEVC encoding process describes that the "merge estimation level is adaptive."

> In order to enable an encoder to trade-off parallelism and coding efficiency, the parallel merge estimation level is adaptive and signaled as `log2_parallel_merge_level_minus2` in the picture parameter set. The following MER sizes are allowed: 4×4 (no parallel merge estimation possible), 8×8, 16×16, 32×32 and 64×64. A higher degree of parallelization, enabled by a larger MER, excludes more potential candidates from the merge candidate list.

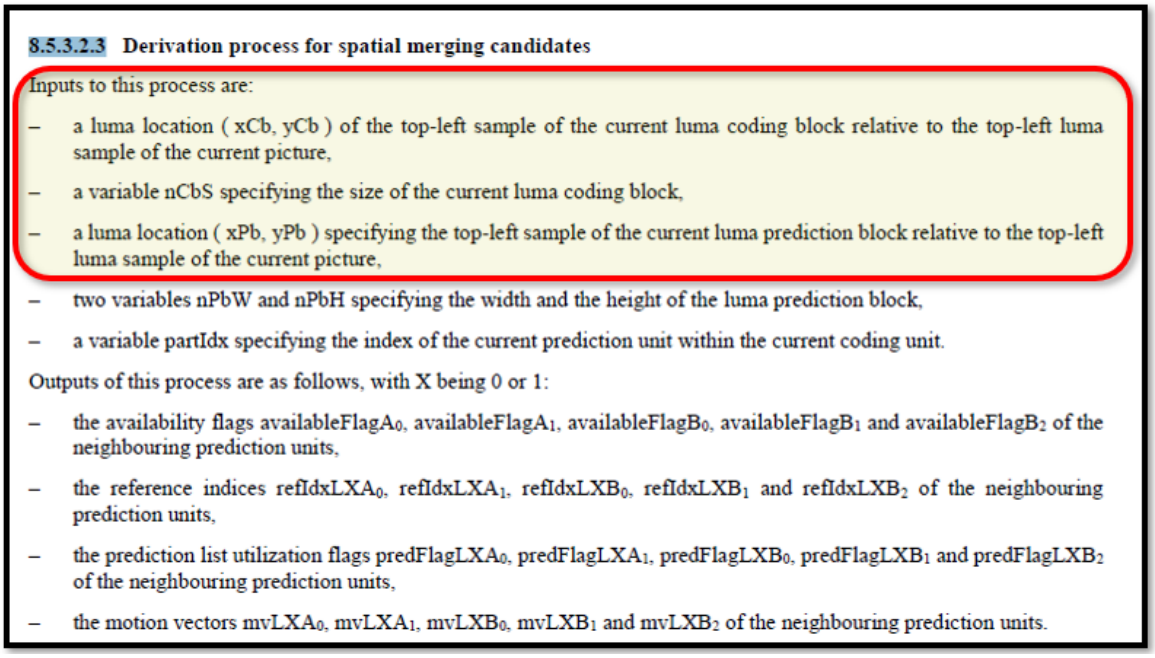
Benjamin Bross, et al., *Inter-Picture Prediction in HEVC*, HIGH EFFICIENCY VIDEO CODING (HEVC) at 128 (September 2014) (emphasis added).

586. The edge data that is processed from the edge adaptive interpolation process includes intensity estimates for pixels such as pixels in the merge estimation region. The intensity estimate or brightness estimate is referred to as "luma" in the encoding functionality implemented by the LG '105 Products.

> For representing color video signals, HEVC typically uses a tristimulus YCbCr color space with 4:2:0 sampling (although extension to other sampling formats is straightforward, and is planned to be defined in a subsequent version). This separates a color representation into three components called Y, Cb, and Cr. The Y component is also called luma, and represents brightness. The two chroma components Cb and Cr represent the extent to which the color deviates from gray toward blue and red, respectively. Because the human visual system is more

Gary J. Sullivan, Jens-Rainer Ohm, Woo-Jin Han, and Thomas Wiegand, Fellow, IEEE, *Overview of the High Efficiency Video Coding (HEVC) Standard*, published in IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, Vol. 22, No. 12 at 1654 (December 2012) (emphasis added).

587. The motion estimation region ("MER") is an adaptive interpolation process in which the edges of images are calculated and include the intensity estimates of pixels by way of a luma value. The below excerpt from the HEVC specification describes how during the generation of merge estimation regions edge data includes luminosity values (intensity estimates) for pixels within a region.



8.5.3.2.3 Derivation process for spatial merging candidates

Inputs to this process are:

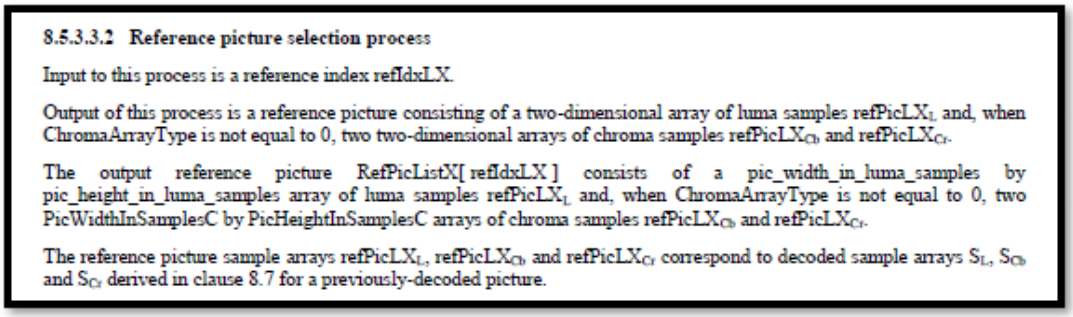
- a luma location (xCb, yCb) of the top-left sample of the current luma coding block relative to the top-left luma sample of the current picture,
- a variable nCbS specifying the size of the current luma coding block,
- a luma location (xPb, yPb) specifying the top-left sample of the current luma prediction block relative to the top-left luma sample of the current picture,
- two variables nPbW and nPbH specifying the width and the height of the luma prediction block,
- a variable partIdx specifying the index of the current prediction unit within the current coding unit.

Outputs of this process are as follows, with X being 0 or 1:

- the availability flags availableFlagA_0, availableFlagA_1, availableFlagB_0, availableFlagB_1 and availableFlagB_2 of the neighbouring prediction units,
- the reference indices refIdxLXA_0, refIdxLXA_1, refIdxLXB_0, refIdxLXB_1 and refIdxLXB_2 of the neighbouring prediction units,
- the prediction list utilization flags predFlagLXA_0, predFlagLXA_1, predFlagLXB_0, predFlagLXB_1 and predFlagLXB_2 of the neighbouring prediction units,
- the motion vectors mvLXA_0, mvLXA_1, mvLXB_0, mvLXB_1 and mvLXB_2 of the neighbouring prediction units.

High Efficiency Video Coding, Series H: Audiovisual And Multimedia Systems: Infrastructure Of Audiovisual Services – Coding Of Moving Video Rec. ITU-T H.265 at § I.8.5.2.3 (February 2018) (emphasis added).

588. The LG '105 Products process motion data associated with motion compensation. The motion data processed by the LG '105 Products include a first estimated motion vector of pixels within a reference frame prior to the current frame and a second estimated motion vector within the reference field after the current field. Specifically, the LG '105 Products generate motion data in the form of a bi-directional prediction unit (PU) which has two motion vectors (referencing a prior frame and a subsequent frame in the sequence). The two motion vectors are combined to make a "bi-predictive merge candidate." One of the motion vectors is obtained from "reference picture list0" and the other motion vector is obtained from "reference picture list1."



8.5.3.3.2 Reference picture selection process

Input to this process is a reference index refIdxLX.

Output of this process is a reference picture consisting of a two-dimensional array of luma samples $refPicLX_L$ and, when ChromaArrayType is not equal to 0, two two-dimensional arrays of chroma samples $refPicLX_{Cb}$ and $refPicLX_{Cr}$.

The output reference picture RefPicListX[refIdxLX] consists of a pic_width_in_luma_samples by pic_height_in_luma_samples array of luma samples $refPicLX_L$ and, when ChromaArrayType is not equal to 0, two PicWidthInSamplesC by PicHeightInSamplesC arrays of chroma samples $refPicLX_{Cb}$ and $refPicLX_{Cr}$.

The reference picture sample arrays $refPicLX_L$, $refPicLX_{Cb}$ and $refPicLX_{Cr}$ correspond to decoded sample arrays S_L, S_{Cb} and S_{Cr} derived in clause 8.7 for a previously-decoded picture.

High Efficiency Video Coding, SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 at § I.8.5.3.3 (February 2018).

589. The reference pictures that are used to generate a motion vector comprise both the forward and prior reference pictures which are referred to in the HEVC encoding process implemented by the LG '105 Products as "refPicLXcb" and "refPicLXcr." The following excerpt describing the implementation of the encoding process in the LG '105 Products which use bi-predictive slices.

> Since a merge candidate comprises all motion data and the TMVP is only one motion vector, the derivation of the whole motion data only depends on the slice type. For bi-predictive slices, a TMVP is derived for each reference picture list. Depending on the availability of the TMVP for each list, the prediction type is set to bi-prediction or to the list for which the TMVP is available. All associated reference picture indices are set equal to zero. Consequently for uni-predictive slices, only the TMVP for list 0 is derived together with the reference picture index equal to zero.

Benjamin Bross, et al., *Inter-Picture Prediction in HEVC*, HIGH EFFICIENCY VIDEO CODING (HEVC) at 123 (September 2014) (emphasis added) (describing the use of bi-prediction in which motion data is derived from the forward and prior reference pictures in generating temporal arrays/vectors).

590. The LG '105 Products' interpolation process contains bi-prediction functionality that computes a first estimated motion prediction and a second estimated motion prediction. The below excerpt from documentation of the encoding method used by the LG '105 products describes that the encoding process includes functionality for generating a second intensity estimate for the pixel data and the edge data determined according to motion. In bi-prediction, the second estimate is defined as Δx_1, Δy_1, Δt_1.

In case of bi-prediction, two sets of motion data ($\Delta x_0, \Delta y_0, \Delta t_0$ and $\Delta x_1, \Delta y_1, \Delta t_1$) are used to generate two MCPs (possibly from different pictures), which are then combined to get the final MCP. Per default, this is done by averaging but in case of weighted prediction, different weights can be applied to each MCP, e.g. to compensate for scene fade outs. The reference pictures that can be used in bi-prediction are stored in two separate lists, namely list 0 and list 1. In order to limit the memory bandwidth in slices allowing bi-prediction, the HEVC standard restricts PUs with 4×8 and 8×4 luma prediction blocks to use uni-prediction only. Motion data is derived at the encoder using a motion estimation process. Motion

Benjamin Bross, et al., *Inter-Picture Prediction in HEVC*, HIGH EFFICIENCY VIDEO CODING (HEVC) at 114 (September 2014) (emphasis added).

591. In AMVP the system generates a temporal intermediate candidate based on bi-directional motion data. The "inter_pred_idc [x0] [y0] specifies whether list0, list1, or bi-prediction is used for the current prediction unit" according to the below referenced table. "The array indices x0, y0 specify the location (x0, y0) of the top-left luma sample of the considered prediction block relative to the top-left luma sample of the picture."

Table 7-11 – Name association to inter prediction mode

inter_pred_idc	Name of inter_pred_idc	
	(nPbW + nPbH) != 12	(nPbW + nPbH) == 12
0	PRED_L0	PRED_L0
1	PRED_L1	PRED_L1
2	PRED_BI	na

High Efficiency Video Coding, SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 at § 7.4.9.6 (February 2018).

592. The LG '105 Products generate a second intensity estimate based on the edge data and the motion data. The edge data is combined with the temporal intermediate candidate to generate the temporal candidate. The prediction unit based on the first and second motion vector (motion data) is then combined with the edge data to generate a second intensity estimate. Once the reference picture for obtaining the co-located PU is selected then the position of the co-located

Pu will be selected among two candidate positions. A second intensity estimate is generated by using the bi-directional motion vectors and the edge data. The below excerpt from the HEVC specification describes that for a luma motion vector prediction the generation of a second intensity estimate is based on the motion data and the edge data. The edge data here is comprised by the luma location and luma prediction block information. Further, the luma motion vectors mvLO and mvL1 are combined with the edge data including luma location xCB yCB xBL and yBl to generate a second intensity estimate.

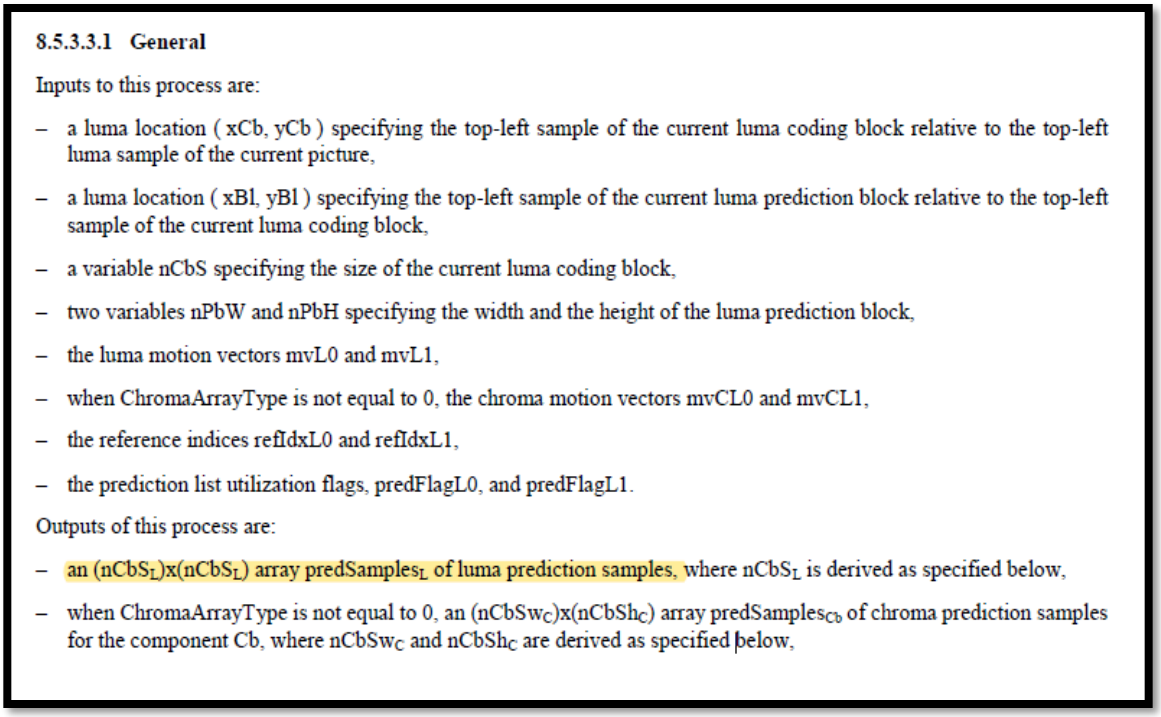
8.5.3.2.6 Derivation process for luma motion vector prediction

Inputs to this process are:

- a luma location (xCb, yCb) of the top-left sample of the current luma coding block relative to the top-left luma sample of the current picture,
- a variable nCbS specifying the size of the current luma coding block,
- a luma location (xPb, yPb) specifying the top-left sample of the current luma prediction block relative to the top-left luma sample of the current picture,
- two variables nPbW and nPbH specifying the width and the height of the luma prediction block,
- the reference index of the current prediction unit partition refIdxLX, with X being 0 or 1,
- a variable partIdx specifying the index of the current prediction unit within the current coding unit.

Output of this process is the prediction mvpLX of the motion vector mvLX, with X being 0 or 1.

High Efficiency Video Coding, SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 at § 8.5.3.2.6 (February 2018) (emphasis added).



8.5.3.3.1 General

Inputs to this process are:

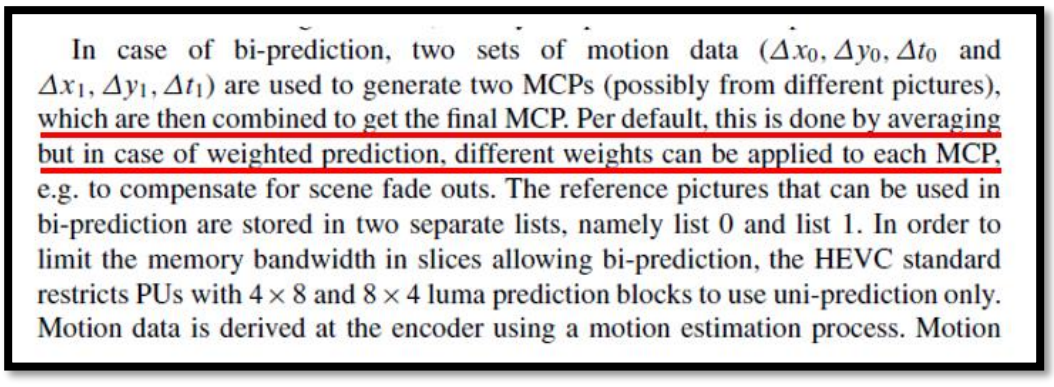
- a luma location (xCb, yCb) specifying the top-left sample of the current luma coding block relative to the top-left luma sample of the current picture,
- a luma location (xBl, yBl) specifying the top-left sample of the current luma prediction block relative to the top-left sample of the current luma coding block,
- a variable nCbS specifying the size of the current luma coding block,
- two variables nPbW and nPbH specifying the width and the height of the luma prediction block,
- the luma motion vectors mvL0 and mvL1,
- when ChromaArrayType is not equal to 0, the chroma motion vectors mvCL0 and mvCL1,
- the reference indices refIdxL0 and refIdxL1,
- the prediction list utilization flags, predFlagL0, and predFlagL1.

Outputs of this process are:

- an $(nCbS_L)x(nCbS_L)$ array $predSamples_L$ of luma prediction samples, where $nCbS_L$ is derived as specified below,
- when ChromaArrayType is not equal to 0, an $(nCbSw_C)x(nCbSh_C)$ array $predSamples_{Cb}$ of chroma prediction samples for the component Cb, where $nCbSw_C$ and $nCbSh_C$ are derived as specified below,

High Efficiency Video Coding, SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 at § 8.5.3.3.1 (February 2018) (emphasis added).

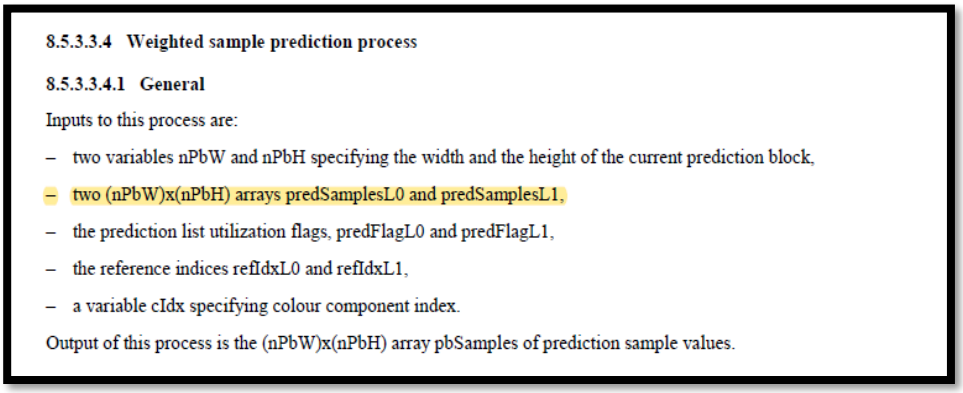
593. The LG '105 Products perform a mixing process in which the final edge/motion data of a pixel is calculated based on a first intensity estimate, second intensity estimate, and motion reliability data. Specifically, the LG '105 Products encode pixel data using bi-prediction wherein use two types of mixing functions: average mixing and weighted mixing.



In case of bi-prediction, two sets of motion data ($\Delta x_0, \Delta y_0, \Delta t_0$ and $\Delta x_1, \Delta y_1, \Delta t_1$) are used to generate two MCPs (possibly from different pictures), which are then combined to get the final MCP. Per default, this is done by averaging but in case of weighted prediction, different weights can be applied to each MCP, e.g. to compensate for scene fade outs. The reference pictures that can be used in bi-prediction are stored in two separate lists, namely list 0 and list 1. In order to limit the memory bandwidth in slices allowing bi-prediction, the HEVC standard restricts PUs with 4×8 and 8×4 luma prediction blocks to use uni-prediction only. Motion data is derived at the encoder using a motion estimation process. Motion

Benjamin Bross, et al., *Inter-Picture Prediction in HEVC*, HIGH EFFICIENCY VIDEO CODING (HEVC) at 123 (September 2014) (emphasis added).

594. The HEVC standard includes functionality to perform a mixing process. In MERGE mode, an up-to five-entry MERGE candidate list is first constructed with four (MV, Refldx) pairs from spatial neighbor blocks and one (MV, Refldx) pair from temporal bottom-right or collocated neighbor block, where Refldx is the index of the reference picture that the MV pointed to. After that, the encoder decides to use which candidate (MV, Refldx) pair to encode current block and then encode the candidate index into bitstream. In MERGE mode, the selected (MV, Refldx) pair is directly used to encode current block, and no MVD information needs to be coded. The number of merge candidates could be configured at encoder, with up to five merge candidates."



8.5.3.3.4 Weighted sample prediction process

8.5.3.3.4.1 General

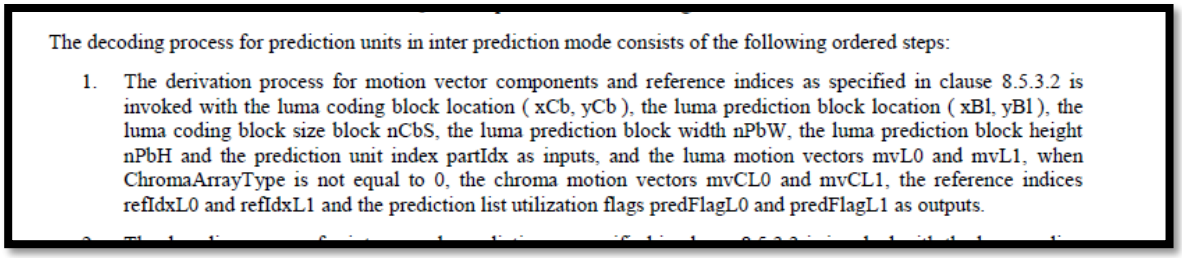
Inputs to this process are:

- two variables nPbW and nPbH specifying the width and the height of the current prediction block,
- two (nPbW)x(nPbH) arrays predSamplesL0 and predSamplesL1,
- the prediction list utilization flags, predFlagL0 and predFlagL1,
- the reference indices refIdxL0 and refIdxL1,
- a variable cIdx specifying colour component index.

Output of this process is the (nPbW)x(nPbH) array pbSamples of prediction sample values.

HIGH EFFICIENCY VIDEO CODING, SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 at § 8.5.3.3.4.1 (February 2018) (emphasis added).

595. The variables predFlagL0 and predFlagL1 are reliability values that are generated by the decoding process. The predFlagL0 and L1 values are prediction utilization values that are used to generate prediction utilization and reliability of the vectors.



The decoding process for prediction units in inter prediction mode consists of the following ordered steps:

1. The derivation process for motion vector components and reference indices as specified in clause 8.5.3.2 is invoked with the luma coding block location (xCb, yCb), the luma prediction block location (xBl, yBl), the luma coding block size block nCbS, the luma prediction block width nPbW, the luma prediction block height nPbH and the prediction unit index partIdx as inputs, and the luma motion vectors mvL0 and mvL1, when ChromaArrayType is not equal to 0, the chroma motion vectors mvCL0 and mvCL1, the reference indices refIdxL0 and refIdxL1 and the prediction list utilization flags predFlagL0 and predFlagL1 as outputs.

High Efficiency Video Coding, SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 at § 8.5.3.1 (February 2018).

596. Any implementation of the HEVC standard would infringe the '105 patent as every possible implementation of the standard requires: processing edge data from edge-adaptive interpolation processing, including a first intensity estimate for the pixel as well as data pertaining to one or more pixels that neighbor the pixel; processing motion data associated with motion compensation processing, wherein the motion data includes a first estimated motion vector for a pixel in a reference field prior to the present field and a second estimated motion vector for a pixel in a reference field subsequent to the present field; determining a second intensity estimate for the pixel as a function of the edge data and the motion data; and performing a blending process wherein final edge/motion data of the pixel is calculated as a function of the first intensity estimate, the second intensity estimate, and motion reliability data characterizing reliability of the motion data.

597. The LG '105 Products are available to businesses and individuals throughout the United States.

598. The LG '105 Products are provided to businesses and individuals located in the Eastern District of Texas.

599. By making, using, testing, offering for sale, and/or selling products and services for enhancing subsequent images of a video stream in which frames are encoded based on previous frames using prediction and motion estimation, including but not limited to the LG '105 Products,

LG has injured Dynamic Data and is liable to the Plaintiff for directly infringing one or more claims of the '105 patent, including at least claim 1 pursuant to 35 U.S.C. § 271(a).

600. LG also indirectly infringes the '105 patent by actively inducing infringement under 35 U.S.C. § 271(b).

601. LG has had knowledge of the '105 patent since at least service of this First Amended Complaint or shortly thereafter, and on information and belief, LG knew of the '105 patent and knew of its infringement, including by way of this lawsuit.

602. LG intended to induce patent infringement by third-party customers and users of the LG '105 Products and had knowledge that the inducing acts would cause infringement or was willfully blind to the possibility that its inducing acts would cause infringement. LG specifically intended and was aware that the normal and customary use of the accused products would infringe the '105 patent. LG performed the acts that constitute induced infringement, and would induce actual infringement, with knowledge of the '105 patent and with the knowledge that the induced acts would constitute infringement. For example, LG provides the LG '105 Products that have the capability of operating in a manner that infringe one or more of the claims of the '105 patent, including at least claim 1, and LG further provides documentation and training materials that cause customers and end users of the LG '105 Products to utilize the products in a manner that directly infringe one or more claims of the '105 patent.[94] By providing instruction and training to

[94] *See, e.g., Large Ultra HD Signage: UM3C Series*, LG SPECIFICATION SHEET (2018); *Multiple Screen Split-Ultra HD Signage: Ultra HD UH5C Series*, LG SPECIFICATION SHEET (2016); *LG Help Library: Ultra HD 4K Upscaling – UHD TV Video*, LG Support Website (last visited March 2019), *available at*: https://www.lg.com/us/support/product-help/CT10000018-1432737109927-general-specifications; *98UB9800, 98UB9810, 105UC9*, OWNER'S MANUAL LED TV, *available at*: https://www.lg.com/us/support-product/lg-98UB9810 (last visited Nov. 2018); *40UB8000, 49UB8200, 55UB8200, 60UB8200, 49UB8300, 55UB8300, 65UB9200*, OWNER'S MANUAL LED TV, *available at*: https://www.lg.com/us/support-product/lg-55UB8200 (last visited Nov. 2018); *50UH5500, 50UH5530, 65UH5500*, OWNER'S MANUAL SAFETY AND REFERENCE LED TV, *available at*: https://www.lg.com/us/support-product/lg-50UH5530 (last visited Nov. 2018); *LM-V405AQ*, USER GUIDE (2018); *LM-V35OULM*, USER GUIDE (2018); *LG*

customers and end-users on how to use the LG '105 Products in a manner that directly infringes one or more claims of the '105 patent, including at least claim 1, LG specifically intended to induce infringement of the '105 patent. LG engaged in such inducement to promote the sales of the LG '105 Products, e.g., through LG user manuals, product support, marketing materials, and training materials to actively induce the users of the accused products to infringe the '105 patent. Accordingly, LG has induced and continues to induce users of the accused products to use the accused products in their ordinary and customary way to infringe the '105 patent, knowing that such use constitutes infringement of the '105 patent.

603. The '105 patent is well-known within the industry as demonstrated by multiple citations to the '105 patent in published patents and patent applications assigned to technology companies and academic institutions. LG is utilizing the technology claimed in the '105 patent without paying a reasonable royalty. LG is infringing the '105 patent in a manner best described as willful, wanton, malicious, in bad faith, deliberate, consciously wrongful, flagrant, or characteristic of a pirate.

604. To the extent applicable, the requirements of 35 U.S.C. § 287(a) have been met with respect to the '105 patent.

605. As a result of LG's infringement of the '105 patent, Dynamic Data has suffered monetary damages, and seeks recovery in an amount adequate to compensate for LG's infringement, but in no event less than a reasonable royalty for the use made of the invention by LG together with interest and costs as fixed by the Court.

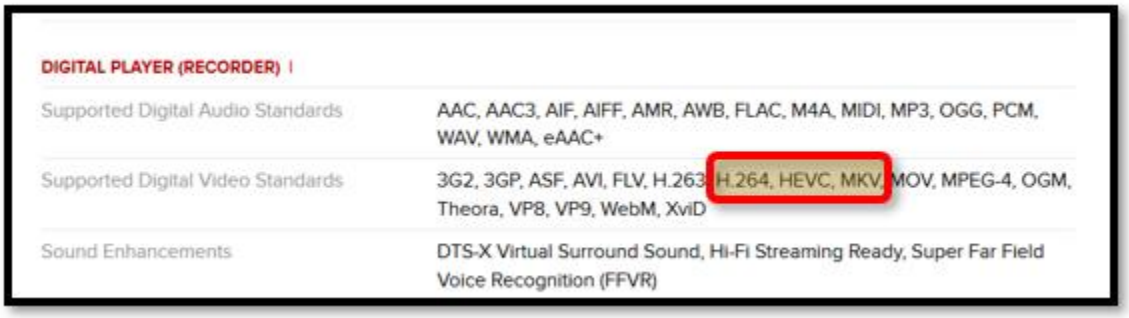
Stylo 4 LM-Q71OULM, USER GUIDE (2018); *LG V30*, USER GUIDE (2018); *LM-X410AS*, USER GUIDE (2018).

COUNT XV
INFRINGEMENT OF U.S. PATENT NO. 8,311,112

606. Dynamic Data references and incorporates by reference the preceding paragraphs of this Complaint as if fully set forth herein.

607. LG designs, makes, uses, sells, and/or offers for sale in the United States products and/or services for video compression.

608. LG designs, makes, sells, offers to sell, imports, and/or uses LG products that contain and/or enable H.265 encoding functionality, including the following products: LG V35 ThinQ, LG V40 ThinQ, and LG G7 ThinQ (collectively, the "LG '112 Products").[95]



DIGITAL PLAYER (RECORDER)	
Supported Digital Audio Standards	AAC, AAC3, AIF, AIFF, AMR, AWB, FLAC, M4A, MIDI, MP3, OGG, PCM, WAV, WMA, eAAC+
Supported Digital Video Standards	3G2, 3GP, ASF, AVI, FLV, H.263, H.264, HEVC, MKV, MOV, MPEG-4, OGM, Theora, VP8, VP9, WebM, XviD
Sound Enhancements	DTS-X Virtual Surround Sound, Hi-Fi Streaming Ready, Super Far Field Voice Recognition (FFVR)

LG V35 ThinQ Specifications, CNET WEBSITE, *available at*: https://www.cnet.com/products/lg-v35-thinq/specs/ (annotation added).

609. One or more LG subsidiaries and/or affiliates use the LG '112 Products in regular business operations.

610. The LG '112 Products select the selected image selection area based on a range of possible motion vectors in the selected image search area. Further, the search area of the selected image segment has a center. Specifically, the LG '112 Products contain functionality for selecting a coding unit. The coding unit comprises a selected image segment.

[95] *LG G7 ThinQ Update Brings 4K @ 60fps Video Recording*, XDA DEVELOPERS WEBSITE (June 26, 2018), available at: https://www.xda-developers.com/lg-g7-thinq-update-4k-60fps/ ("Recording 4K video at 60fps has become a highly requested feature and the South Korean LG G7 ThinQ just received this feature with its latest OTA update.").

611. The H.265/HEVC encoding performed by the LG '112 Products enables the selection of an image segment of a given image corresponding to an image segment of a first video image. The selected image segment has a center and a search area is defined around the image segment.

612. The LG '112 Products contain an image processing unit that receives, at a minimum, two frames of a video from memory. These frames are then processed by the video compensation unit of the LG '112 Products. Further, the LG '112 Products contain an encoder for motion estimation. "[T]he encoder needs to perform motion estimation, which is one of the most computationally expensive operations in the encoder, and complexity is reduced by allowing less candidates."[96]

613. The LG '112 Products perform encoding using motion compensation, specifically, inter-picture prediction wherein the LG '112 Product makes use of the temporal correlation between pictures in order to derive a motion-compensated prediction for a block of image samples. Each image is divided into blocks (prediction units) and the LG '112 Product compares the prediction unit in a first image with the spatially neighboring prediction units in a second image (reference image). The displacement between the current prediction unit and the matching prediction unit in the second image (reference image) is signaled using a motion vector.

614. The LG '112 Products contain functionality wherein during the motion estimation process the block size used for prediction units can range from 4 × 8/8 × 4 to 64 × 64.

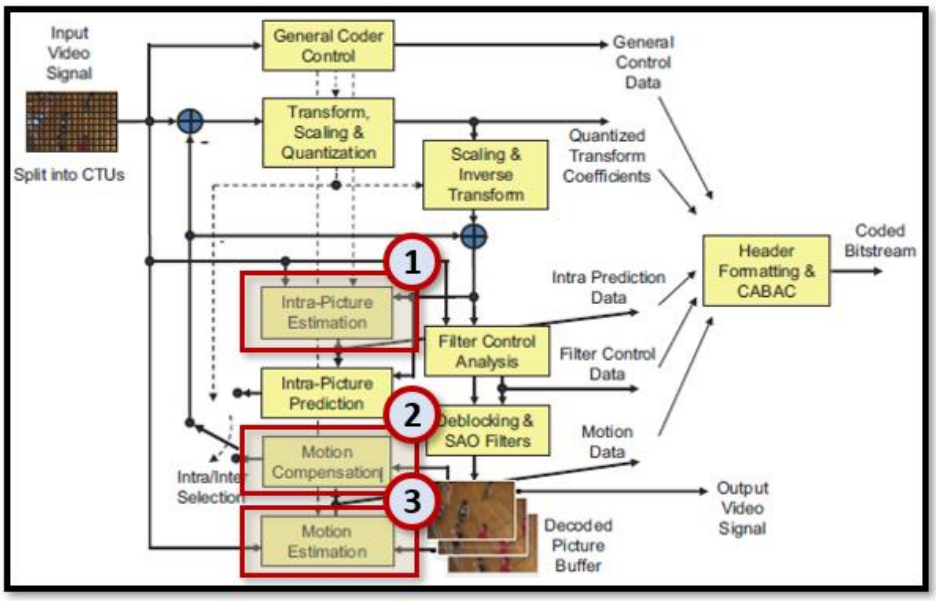
> A block-wise prediction residual is computed from corresponding regions of previously decoded pictures (inter-picture motion compensated prediction) or neighboring previously decoded samples from the same picture (intra-picture spatial prediction). The residual is then processed by a block transform, and the

[96] Gary J. Sullivan, *et al.*, *Overview of the High Efficiency Video Coding (HEVC) Standard*, PRE-PUBLICATION DRAFT, TO APPEAR IN IEEE TRANS. ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY at 13 (December 2012) (emphasis added).

> transform coefficients are quantized and entropy coded. Side information data such as motion vectors and mode switching parameters are also encoded and transmitted.

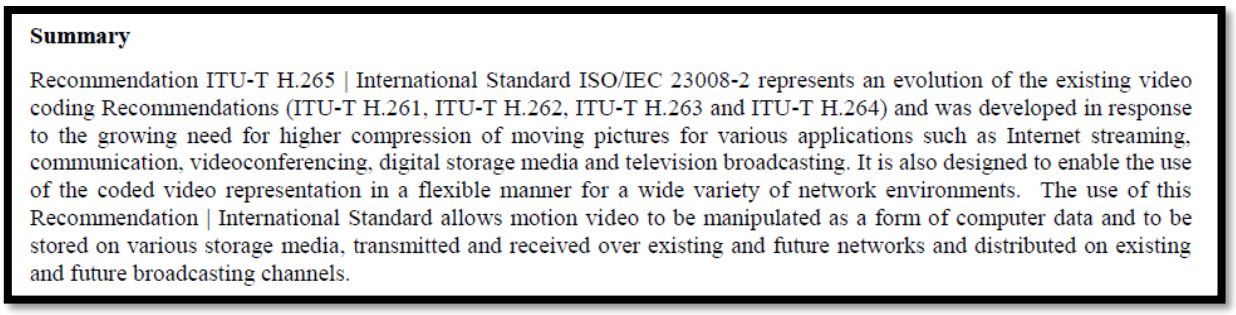
Standardized Extensions of High Efficiency Video Coding (HEVC), IEEE JOURNAL OF SELECTED TOPICS IN SIGNAL PROCESSING, Vol. 7, No. 6 at 1002 (December 2013) (emphasis added).

615. The LG '112 Products use intra-picture estimation between blocks (prediction units) within an image retrieved from memory. The frames are then processed using both motion compensation and motion estimation. The motion compensation functionality used by the LG '112 Products include quarter-sample precision for the motion vectors and 7-tap or 8-tap filters that are used for interpolation of fractional-sample positions.



Standardized Extensions of High Efficiency Video Coding (HEVC), IEEE JOURNAL OF SELECTED TOPICS IN SIGNAL PROCESSING, VOL. 7, NO. 6 at 1002 (December 2013) (emphasis added) (the annotations showing (1) intra-picture prediction, (2) motion compensation, and (3) motion estimation).

616. The LG '112 Products contain functionality for motion compensation where two or more motion vectors can be applied. Further, one or two motion vectors can be applied to the image processing process. The application of the motion vectors leads to uni-predictive or bi-predictive coding, respectively, where bi-predictive coding uses an averaged result of two predictions to form the final prediction.



Summary

Recommendation ITU-T H.265 | International Standard ISO/IEC 23008-2 represents an evolution of the existing video coding Recommendations (ITU-T H.261, ITU-T H.262, ITU-T H.263 and ITU-T H.264) and was developed in response to the growing need for higher compression of moving pictures for various applications such as Internet streaming, communication, videoconferencing, digital storage media and television broadcasting. It is also designed to enable the use of the coded video representation in a flexible manner for a wide variety of network environments. The use of this Recommendation | International Standard allows motion video to be manipulated as a form of computer data and to be stored on various storage media, transmitted and received over existing and future networks and distributed on existing and future broadcasting channels.

Series H: Audiovisual and Multimedia Systems- Infrastructure of Audiovisual Services – Coding of Moving Video, INTERNATIONAL TELECOMMUNICATIONS UNIONS - TU-T H.265, V.5 at I (February 2018).

617. The LG '112 Products comprise a system wherein an intra-frame coding unit is configured to perform predictive coding on a set of pixels of a macroblock of pixels. Further, the predictive coding functionality uses a first group of reference pixels and a macroblock of pixels from the video frame. Specifically, the LG '112 Products, when selecting a temporal candidate for HEVC intra-frame encoding, default to the right bottom position just outside of the collocated prediction unit.

> It can be seen from Fig. 5.4b that only motion vectors from spatial neighboring blocks to the left and above the current block are considered as spatial MVP candidates. This can be explained by the fact that the blocks to the right and below the current block are not yet decoded and hence, their motion data is not available. Since the co-located picture is a reference picture which is already decoded, it is possible to also consider motion data from the block at the same position, from blocks to the right of the co-located block or from the blocks below**.** In HEVC, the block to the bottom right and at the center of the current block have been determined to be the most suitable to provide a good temporal motion vector predictor (TMVP).

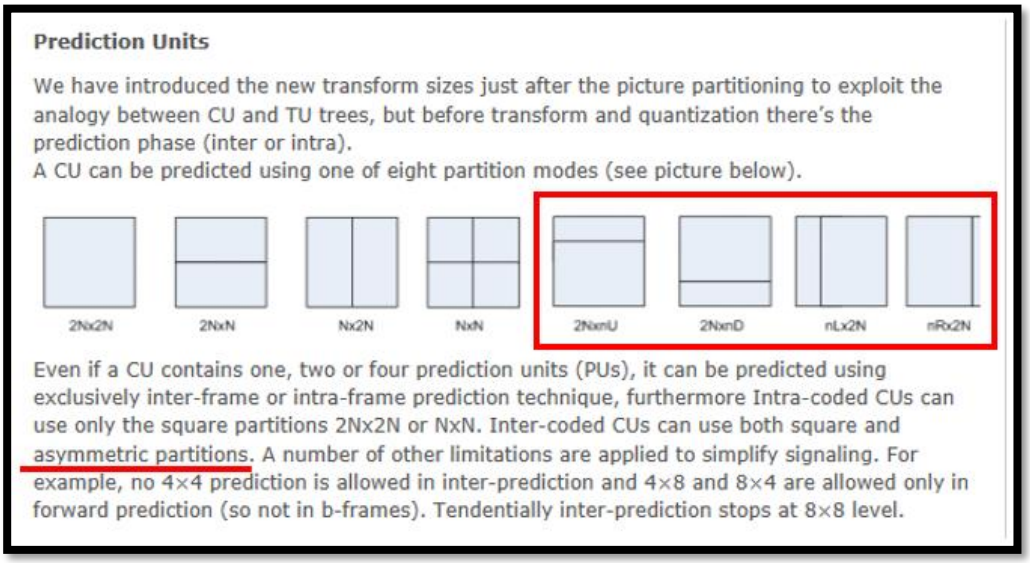
Benjamin Bross, *et al., Inter-picture prediction in HEVC,* in HIGH EFFICIENCY VIDEO CODING (HEVC) at 119 (2014) (emphasis added);

618. Descriptions of the HEVC encoding process, which are implemented by the LG '112 Products, state "for the temporal candidate, the right bottom position just outside of the collocated PU of the reference picture is used if it is available. Otherwise, the center position is used instead." Gary J. Sullivan, *et al., Overview of the High Efficiency Video Coding (HEVC)*

Standard, IEEE TRANS. ON CIRCUIT AND SYSTEMS FOR VIDEO TECHNOLOGY at 13 (December 2012).

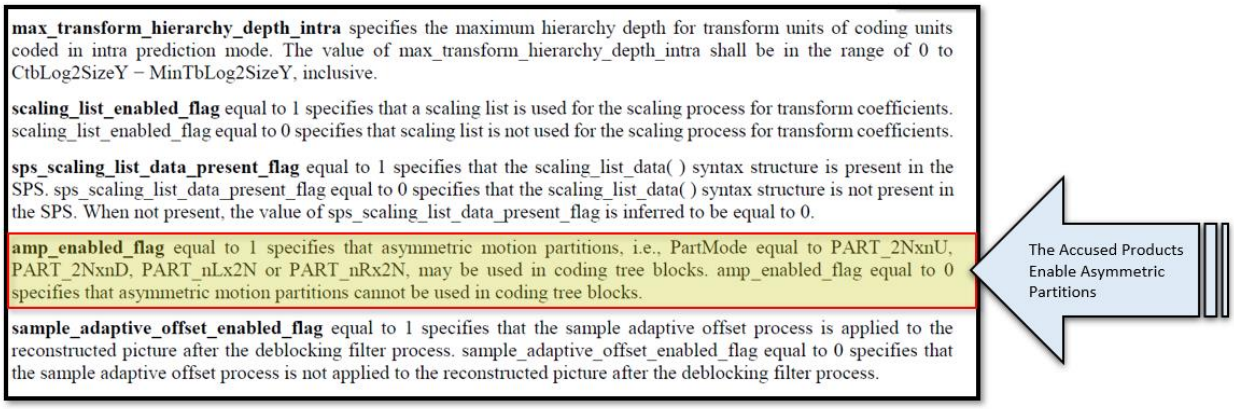
619. The LG video encoder in the LG '112 Products selects an image segment of a second video image corresponding to an image segment of a first video image. The image segment further has an image segment center.

620. The LG '112 Products encode video data such that a predetermined search area (S) center is offset from the center of the image segment. The predetermined search area is called a partition and there are eight different partition modes in the H.265 standard, these partition modes are shown in the figure below. The last four partition modes are asymmetric, meaning their center is offset from the overall CU center.



Fabio Sonnati, *H265 – Part I: Technical Overview*, VIDEO ENCODING & STREAMING TECHNOLOGIES WEBSITE (June 20, 2014) (emphasis added).

621. The figure below shows the syntax as well as the instructions for enabling the asymmetric partitions within the H.265 standard, which is used by the LG '112 Products.



High Efficiency Video Coding, SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 at 76 (April 2015) (annotation added).

622. The LG '112 Products receive encoded video data that is encoded using intra-frame coding. Specifically, the encoded video stream received by the LG '112 Products is coded using a reference group of pixels in the video frame. Intra-frame prediction used in the encoded video data received by the LG '112 Products allows a transform block to span across multiple prediction blocks for intra-frame-picture predicted coding units to maximize the potential coding efficiency benefits of the quadtree-structured transform block partitioning.

> The basic source-coding algorithm is a hybrid of interpicture prediction to exploit temporal statistical dependences, intrapicture prediction to exploit spatial statistical dependences, and transform coding of the prediction residual signals to further exploit spatial statistical dependences.

G. J. Sullivan, J.-R. Ohm, W.-J. Han, and T. Wiegand, *Overview of the High Efficiency Video Coding (HEVC) standard*, IEEE TRANS. CIRCUITS SYST. VIDEO TECHNOL., vol. 22, no. 12, p. 1654 (December 2012) (emphasis added).

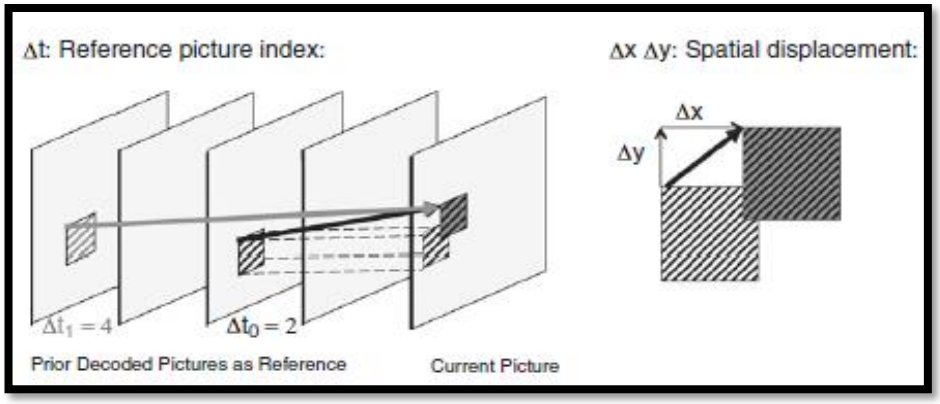
623. The LG '112 Products comprise functionality for retrieving image motion data related to the search area. Specifically, the LG '112 Products retrieve data relating to the motion search area. The data, which includes the motion vector index, is sent from the encoder and retrieved by the decoder.

> Since inter-picture prediction typically compensates for the motion of real-world objects between pictures of a video sequence, it is also referred to as motion-

> compensated prediction. While intra-picture prediction exploits the spatial redundancy between neighboring blocks inside a picture, motion-compensated prediction utilizes the large amount of temporal redundancy between pictures. In either case, the resulting prediction error, which is formed by taking the difference between the original block and its prediction, is transmitted using transform coding, which exploits the spatial redundancy inside a block and consists of a decorrelating linear transform, scalar quantization of the transform coefficients and entropy coding of the resulting transform coefficient levels.

Heiko Schwarz, Thomas Schierl, Detlev Marpe, *Block Structures and Parallelism Features in HEVC*, in HEVC, HIGH EFFICIENCY VIDEO CODING (HEVC) at 49 (September 2014) (emphasis added).

624. LG '112 Products comprise an inter-frame coding unit that is configured to perform predictive coding on the rest of the macroblock of pixels using a second group of reference pixels. The second group of reference pixels that are used to perform inter-frame coding are drawn from at least one other video frame. The image data processed by the LG '112 Products is encoded using inter-picture prediction that makes use of the temporal correlation between pictures to derive a motion-compensated prediction (MCP) for a block of image samples. For this block-based motion compensated prediction, an image is divided into rectangular blocks. Assuming homogeneous motion inside one block, and that moving objects are larger than one block, for each block, a corresponding block in a previously decoded picture can be found that serves as a predictor (a second image). Both the first and second images are retrieved by the LG '112 Product from storage such as on chip memory. The general concept of inter-frame-based encoding using motion-compensated prediction based on a translational motion model is illustrated below.



Benjamin Bross, *Inter-Picture Prediction In HEVC*, HIGH EFFICIENCY VIDEO CODING (HEVC) at 114 (September 2014).

625. By complying with the HEVC standard, the LG devices – such as the LG '112 Products – necessarily infringe the '112 patent. The mandatory sections of the HEVC standard require the elements required by certain claims of the '112 patent, including but not limited to claim 11 of the '112 patent. *High Efficiency Video Coding*, SERIES H: AUDIOVISUAL AND Multimedia SYSTEMS: INFRASTRUCTURE OF AUDIOVISUAL SERVICES – CODING OF MOVING VIDEO REC. ITU-T H.265 (February 2018) (The following sections of the HEVC Standard are relevant to LG's infringement of the '112 patent: "8.3.2 Decoding process for reference picture set;" "8.5.4 Decoding process for the residual signal of coding units coded in inter prediction mode;" "8.6 Scaling, transformation and array construction process prior to deblocking filter process;" "8.5.2 Inter prediction process;" "8.5.3 Decoding process for prediction units in inter prediction mode;" and "8.7.2 Deblocking filter process;" "8.7.3 Sample adaptive offset process.").

626. One or more LG subsidiaries and/or affiliates use the LG '112 Products in regular business operations.

627. One or more of the LG '112 Products include technology for video compression.

628. LG has directly infringed and continues to directly infringe the '112 patent by, among other things, making, using, offering for sale, and/or selling technology for video compression, including but not limited to the LG '112 Products.

629. One or more of the LG '112 Products perform predictive coding on a macroblock of a video frame such that a set of pixels of the macroblock is coded using some of the pixels from the same video frame as reference pixels and the rest of the macroblock is coded using reference pixels from at least one other video frame.

630. One or more of the LG '112 Products include a system for video compression comprising an intra-frame coding unit configured to perform predictive coding on a set of pixels of a macroblock of pixels using a first group of reference pixels, the macroblock of pixels and the first group of reference pixels being from a video frame.

631. One or more of the LG '112 Products include a system for video compression comprising an inter-frame coding unit configured to perform predictive coding on the rest of the macroblock of pixels using a second group of reference pixels, the second group of reference pixels being from at least one other video frame.

632. The LG '112 Products are available to businesses and individuals throughout the United States.

633. The LG '112 Products are provided to businesses and individuals located in the Eastern District of Texas.

634. By making, using, testing, offering for sale, and/or selling products and services for interpolating a pixel during the interlacing of a video signal, including but not limited to the LG '112 Products, LG has injured Dynamic Data and is liable to the Plaintiff for directly infringing one or more claims of the '112 patent, including at least claim 11 pursuant to 35 U.S.C. § 271(a).

635. LG also indirectly infringes the '112 patent by actively inducing infringement under 35 U.S.C. § 271(b).

636. LG has had knowledge of the '112 patent since at least service of the Original Complaint in this case or shortly thereafter, and on information and belief, LG knew of the '112 patent and knew of its infringement, including by way of this lawsuit.

637. LG intended to induce patent infringement by third-party customers and users of the LG '112 Products and had knowledge that the inducing acts would cause infringement or was willfully blind to the possibility that its inducing acts would cause infringement. LG specifically intended and was aware that the normal and customary use of the accused products would infringe the '112 patent. LG performed the acts that constitute induced infringement, and would induce actual infringement, with knowledge of the '112 patent and with the knowledge that the induced acts would constitute infringement. For example, LG provides the LG '112 Products that have the capability of operating in a manner that infringe one or more of the claims of the '112 patent, including at least claim 11, and LG further provides documentation and training materials that cause customers and end users of the LG '112 Products to utilize the products in a manner that directly infringe one or more claims of the '112 patent.[97] By providing instruction and training to customers and end-users on how to use the LG '112 Products in a manner that directly infringes one or more claims of the '112 patent, including at least claim 11, LG specifically intended to induce infringement of the '112 patent. LG engaged in such inducement to promote the sales of

[97] *See, e.g.*, *LG V35 ThinQ*, LG USER GUIDE (2018); *LG V40 ThinQ*, USER GUIDE (2018); LG G7 THINQ, USER GUIDE (2018); *LG V40 ThinQ Camera: The New 5 Camera Phone*, LG WEBSITE (last visited March 2019), *available at*: https://www.lg.com/us/mobile-phones/v40-thinq/camera; *LG at CES 2019-LG ThinQ*, LG GLOBAL YOUTUBE CHANNEL (January 12, 2019), available at: https://www.youtube.com/watch?v=4QXpEr1EsjA; *LG Help Library: LG G7 ThinQ – Camera Overview and Settings*, LG SUPPORT WEBSITE (last visited March 2019), *available at*: https://www.lg.com/us/support/product-help/CT10000027-20150726477193-settings-features

the LG '112 Products, e.g., through LG user manuals, product support, marketing materials, and training materials to actively induce the users of the accused products to infringe the '112 patent. Accordingly, LG has induced and continues to induce users of the accused products to use the accused products in their ordinary and customary way to infringe the '112 patent, knowing that such use constitutes infringement of the '112 patent.

638. The '112 patent is well-known within the industry as demonstrated by multiple citations to the '112 patent in published patents and patent applications assigned to technology companies and academic institutions. LG is utilizing the technology claimed in the '112 patent without paying a reasonable royalty. LG is infringing the '112 patent in a manner best described as willful, wanton, malicious, in bad faith, deliberate, consciously wrongful, flagrant, or characteristic of a pirate.

639. To the extent applicable, the requirements of 35 U.S.C. § 287(a) have been met with respect to the '112 patent.

640. As a result of LG's infringement of the '112 patent, Dynamic Data has suffered monetary damages, and seeks recovery in an amount adequate to compensate for LG's infringement, but in no event less than a reasonable royalty for the use made of the invention by LG together with interest and costs as fixed by the Court.

PRAYER FOR RELIEF

WHEREFORE, Dynamic Data respectfully requests that this Court enter:

A. A judgment in favor of Dynamic Data that LG has infringed, either literally and/or under the doctrine of equivalents, the '944, '376, '918, '177, '039, '230, '041, '450, '979, '529, '054, '073, '689, '105, and '112 Patents;

B. An award of damages resulting from LG's acts of infringement in accordance with 35 U.S.C. § 284;

C. A judgment and order finding that LG's infringement was willful, wanton, malicious, bad-faith, deliberate, consciously wrongful, flagrant, or characteristic of a pirate within the meaning of 35 U.S.C. § 284 and awarding to Dynamic Data enhanced damages.

D. A judgment and order finding that this is an exceptional case within the meaning of 35 U.S.C. § 285 and awarding to Dynamic Data its reasonable attorneys' fees against LG.

E. Any and all other relief to which Dynamic Data may show themselves to be entitled.

JURY TRIAL DEMANDED

Pursuant to Rule 38 of the Federal Rules of Civil Procedure, Dynamic Data Technologies, LLC requests a trial by jury of any issues so triable by right.

Dated: March 12, 2019

Respectfully submitted,

/s/ Daniel P. Hipskind
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Attorneys for Dynamic Data Technologies, LLC

CERTIFICATE OF SERVICE

I hereby certify that counsel of record who are deemed to have consented to electronic service are being served this 12th of March, 2019 with a copy of this document via the Court's CM/ECF System per Local Rule CV-5(a)(3). Any other counsel of record will be served by electronic mail, facsimile transmission and/or first class mail on this same date.

/s/ Daniel P. Hipskind
Daniel P. Hipskind