

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

AMAZON.COM SERVICES LLC,
Petitioner

v.

INTERDIGITAL, INC.,
Patent Owner.

IPR2026-00192
U.S. Patent No. 12,143,606

DECLARATION OF JOSEPH P. HAVLICEK, PH.D.

I, Joseph P. Havlicek, hereby declare as follows:

I. INTRODUCTION

1. I have been retained on behalf of Amazon.com Services LLC (“Amazon” or “Petitioner”) to offer technical opinions related to U.S. Patent No. 12,143,606 (“the ’606 patent”) (EX-1001). I understand that Amazon is requesting that the Patent Trial and Appeal Board (“PTAB” or “Board”) institute an inter partes review (“IPR”) proceeding of the ’606 patent. Specifically, I have been asked to consider the validity of claims 1-6 and 10-20 of the ’606 patent (the “Challenged Claims”) in view of prior art and obviousness considerations from the perspective of a person of ordinary skill in the art at the time of the invention (“POSITA”) as it relates to the ’606 patent.

2. I am being compensated for my time at my standard consulting rate \$450/hour. I am also being reimbursed for expenses that I incur during the course of this work. My compensation is not contingent upon the results of my study, the substance of my opinions, or the outcome of any proceeding involving the Challenged Claims. I have no financial interest in the outcome of this matter or any other matter that may exist between Petitioners and Interdigital, Inc. (“Interdigital,” “Patent Owner,” or “PO”). This compensation does not depend in any way on the conclusions I reach.

3. My analysis here is based on my years of education, research and experience, as well as my investigation and study of relevant materials, including those cited herein.

4. I may rely upon these materials, my knowledge and experience, and/or additional materials to rebut arguments raised by the Patent Owner. Further, I may also consider additional documents and information in forming any necessary opinions, including documents that may not yet have been provided to me.

5. My analysis of the materials in this proceeding is ongoing, and I will continue to review any new material as it is provided. This declaration represents only those opinions I have formed to date. I reserve the right to revise, supplement, and/or amend my opinions stated herein based on new information and on my continuing analysis of the materials already provided.

II. BACKGROUND AND QUALIFICATIONS

6. I am currently Gerald Tuma Presidential Professor and Williams Companies Foundation Presidential Professor of Electrical and Computer Engineering at the University of Oklahoma.

7. Available at EX-1004 is a copy of my current curriculum vitae, which provides further details about my academic and professional background and qualifications.

A. Educational Background

8. I received a Bachelor of Science Degree in electrical engineering with minors in mathematics and computer science from Virginia Tech in 1986. I also received a Master of Science degree in electrical engineering from Virginia Tech in 1988. I received a Ph.D. degree in Electrical and Computer Engineering from the University of Texas at Austin in 1996. My Ph.D. research was in the field of image processing.

B. Professional Experience

9. From December 1984 to May 1987, I was a software engineer at Management Systems Laboratories, Blacksburg, VA. My main job responsibilities included developing software for nuclear materials management under contract with the United States Department of Energy.

10. From June 1987 to January 1997, I was an electrical engineer at the United States Naval Research Laboratory. For the period of June 1987 through August 1989, I was an on-site contractor affiliated with SFA, Inc., Landover, Maryland. From August 1989 through January 1997, I was a regular government employee. I was on leave without pay from August 1987 through July 1988 while completing my Master of Science Degree. I was also on leave without pay for much of the period from August 1990 through January 1997 while I completed my Ph.D. degree. My main job responsibilities at the United States Naval Research Laboratory

included designing digital and analog circuits to process real-time video signals and designing and implementing target detection, tracking, and identification algorithms. I developed missile warning receivers for Navy aircraft including the Navy's first two-color infrared system. I was a recipient of the 1990 Department of the Navy Award of Merit for Group Achievement for this work. The production version of this system was deployed on Navy helicopters and saw combat in Afghanistan and Iraq.

11. From January 1993 through December 1993, I was an on-site contractor at International Business Machines (IBM) Corporation, Austin, TX. My main job responsibilities included designing and implementing image compression and decompression algorithms (CODECs) for IBM products.

12. Since January 1997, I have been a regular faculty member in the School of Electrical and Computer Engineering at the University of Oklahoma, Norman, OK. I was an Assistant Professor from January 1997 through June 2002. I was promoted to the rank of Associate Professor and granted tenure in July 2002. I was promoted to the rank of Professor in July 2007. I was appointed to the Williams Companies Foundation Presidential Professorship in April 2009. In April 2017, I was appointed to the Gerald Tuma Presidential Professorship. My main job responsibilities at the University of Oklahoma include conducting academic research in electrical and computer engineering, teaching graduate and undergraduate courses

in electrical and computer engineering, and performing professional and institutional service.

13. I am a member of several professional societies and organizations, including the Institute of Electrical and Electronics Engineers (IEEE), the IEEE Signal Processing Society, the IEEE Computer Society, and the IEEE Intelligent Transportation Society. I am a Senior Member of the IEEE. From November 2015 through February 2018, I served as a Senior Area Editor for the IEEE Transactions on Image Processing. I was formerly an Associate Editor for the IEEE Transactions on Image Processing from December 2010 through October 2015. I served as a Technical Area Chair for the IEEE International Conference on Image Processing in the area of Image & Video Analysis, Synthesis, and Retrieval (2012, 2013) and have served on the organizing committee of that conference (2007). I have also served as a Technical Area Chair for the IEEE International Conference on Acoustics, Speech, and Signal Processing in the area of Image, Video, and Multidimensional Signal Processing (2012-2014).

14. For over 35 years, I have conducted research and taught classes in the field of image processing and image analysis. My main scholarly contributions have been in the areas of modulation domain image models and image processing (AM-FM image models), video target tracking, and distributed control of video networks for intelligent transportation systems. I have supervised or co-supervised 12 Ph.D.

students to completion and I am currently supervising three Ph.D. students. I have been a member of 68 additional doctoral-dissertation committees. I have supervised 28 M.S. students to completion and I am currently supervising one additional M.S. students. I have served as a committee member on 73 additional M.S. committees.

15. I teach a variety of courses at the University of Oklahoma, including the required junior-level Signals and Systems course ECE 3793 (taught 21 times), the graduate level Digital Image Processing course ECE 5273 (taught 26 times), and the graduate level Digital Signal Processing course ECE 5213 (taught 19 times). I have received a number of teaching awards, including the University of Oklahoma College of Engineering Outstanding Faculty Advisor Award (2005-2006) and the University of Texas Engineering Foundation Award for Exemplary Engineering Teaching while Pursuing a Graduate Degree (1992).

16. Since joining the University of Oklahoma in January 1997, I have been Principal Investigator or Co-Principal Investigator on over 115 externally funded grants and contracts with a total value of \$27,801,061. My main research contributions have been in the areas of signal, image, and video processing, video target tracking, and intelligent transportation systems. I have been author or coauthor on over 130 scholarly publications in these areas. I was a recipient of the 1990 Department of the Navy Award of Merit for Group Achievement for my work in video target tracking. My research group at the University of Oklahoma originated

the Virtual Traffic Management Center concept featured in a December 2014 FHWA technical report (Guidelines for Virtual Transportation Management Center Development) and a November 2014 FHWA national webinar with the same title. I am co-founder and director of the University of Oklahoma Center for Intelligent Transportation Systems. Under my supervision, the Center has collaborated with the Oklahoma Department of Transportation since 1998 to design and implement the Oklahoma Statewide Intelligent Transportation System, including a geographically distributed video network that is currently deployed on major highways and interstates across the entire State of Oklahoma.

C. Publications

17. A complete listing of my publications is found in my curriculum vitae (EX-1004). I highlight some of the publications relevant to the subject matter of the '606 patent below.

18. I have published numerous peer reviewed scholarly journal articles, book chapters, and conference papers, including 24 journal articles, 9 book chapters, and 100 conference papers; the following are representative:

- a. J.P. Havlicek, T.N. Arian, H. Soltani, T. Przebinda, and M. Özeydin, "A preliminary case for Hirschman transform video coding," in Proc. IEEE Southwest Symp. Image Anal. & Interp., Santa Fe, NM, Mar. 29-31, 2020, pp. 104-107.
- b. E. Vorakitolan, J.P. Havlicek, R.D. Barnes, and A.R. Stevenson, "Simple, Effective Rate Control for Video Distribution in Heterogeneous Intelligent Transportation System Networks," in

Proc. IEEE Southwest Symp. Image Anal. & Interp., San Diego, CA, Apr. 6-8, 2014, pp. 37-40.

- c. V. DeBrunner, J.P. Havlicek, T. Przebinda, and M. Özaydın, “Entropy- Based Uncertainty Measures for $L_2(\mathbb{R}^n)$, $l_2(\mathbb{Z})$, and $l_2(\mathbb{Z}/N\mathbb{Z})$ with a Hirschman Optimal Transform for $l_2(\mathbb{Z}/N\mathbb{Z})$,” *IEEE Trans. Signal Process.*, vol. 53, no. 8, pp. 2690-2699, Aug. 2005.
- d. A.C. Bovik, J.P. Havlicek, M.D. Desai, and D.S. Harding, “Limits on Discrete Modulated Signals,” *IEEE Trans. Signal Process.*, vol. 45, no. 4, pp. 867- 879, Apr. 1997.
- e. J.P. Havlicek and A.C. Bovik, “Image Modulation Models,” in *Handbook of Image and Video Processing*, A.C. Bovik, ed., Communications, Networking, and Multimedia Series by Academic Press, San Diego, 2000, pp. 305- 316.
- f. P.C. Tay, J.P. Havlicek, S.T. Acton, and J.A. Hossack, “Properties of the magnitude terms of orthogonal scaling functions,” *Digital Signal Process.*, vol. 20, no. 5, pp. 1330-1340, Sep. 2010.
- g. O. Alkhoul, V. DeBrunner, and J. Havlicek, “Hirschman Optimal Transform (HOT) DFT Block LMS Algorithm,” in *Adaptive Filtering*, L. Garcia, ed., ISBN: 978-953-307-158-9, InTech, Sep. 2011, pp. 135-152.
- h. V. DeBrunner, M. Özaydın, T. Przebinda, and J. Havlicek, “The optimal solutions to the continuous- and discrete-time versions of the Hirschman uncertainty principle,” in *Proc. IEEE Int’l. Conf. Acoust., Speech, Signal Process.*, Istanbul, Turkey, Jun. 5-9, 2000, vol. 1, pp. 81-84.

III. SUMMARY OF OPINIONS

19. For the reasons I discuss below, it is my opinion that claims 1-6 and 10-20 of the ’606 patent are disclosed in the prior art, and are rendered obvious by the prior art.

IV. '606 PATENT OVERVIEW

20. The '606 patent is titled “Methods and Apparatus for Improved Intra Chroma Encoding and Decoding” and issued November 12, 2024, from Application No. 16/903,819 (filed June 17, 2020). The '606 patent is a continuation of Application No. 13/389,872 (filed August 11, 2010) and claims priority to Provisional Application No. 61/233,310 (filed August 12, 2009). I understand that, for purposes of this Petition only, Petitioner has used August 12, 2009 as the priority date for the '606 patent.

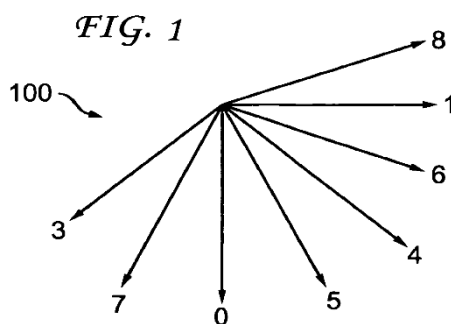
A. Technology Background

21. The '606 patent is directed to encoding and decoding video. To store or send digital videos, the video must first be “encoded” into digital data—binary zeros and ones. The encoded video data is then provided to a decoder, such as by transmitting it over a network. The decoder then reconstructs the video sequence from the encoded video data.

22. Because a video sequence is a series of still images played in rapid succession, simply storing and transmitting each video image—also called a “picture” or “frame”—separately in its raw or native form would require a significant amount of data. For this reason, videos are often “compressed” during encoding to reduce the amount of data needed to store them and transmit them to a decoder where the video may be reconstructed for display. In video coding standards

such as MPEG-4 AVC (also known as the H.264 standard, as promulgated by the Joint Video Team (JVT), a partnership between ITU-T Video Coding Experts Group (VCEG) and the ISO/IEC JTC 1 Moving Picture Experts Group (MPEG), known as JVT), each frame is partitioned into macroblocks for compression. Each macroblock represents a small rectangular region of a video frame. In video coding standards such as MPEG-4 AVC, video encoders and decoders generally process the video data in terms of macroblock units. Compression techniques generally include, among others, predicting the values of the pixels in a given macroblock that is currently being processed (i.e., encoded or decoded) based on the values of the pixels in previously processed macroblocks. Two main techniques for performing this prediction are referred to as “intra prediction” and “inter prediction.” Intra prediction exploits spatial redundancy within a frame, predicting macroblocks in the frame based on nearby macroblocks in that same frame that have already been encoded or decoded.

23. For example, intra predictions may be based on directional structure (e.g., directional texture patterns) of spatially nearby pixels that are most similar to the pixels currently being coded, as shown in Figure 1 of the '606 patent. EX-1001, Fig. 1, 1:45-65.



24. This figure shows how each direction (or mode) is represented. So, the “vertical prediction mode,” where the value of the current block is predicted to be similar to the value of the block above it, is represented as the arrow going directly down (labeled 0). EX-1001, 1:50-65. Similarly, “horizontal prediction mode,” (the current block is predicted to be similar to the value of the block to its left) is the arrow going to the right, labeled 1, and the other directions are represented by other numbers. *Id.*

25. When intra prediction is used for a block of pixels, it is generally applied to all color components, typically including a luma component representing the monochrome signal conveying brightness information but not color and two chroma components representing the color information of the pixels.

26. While color television displays and computer displays usually operate on color information in a red/green/blue (“RGB”) color space, for coding and transmission it is efficient to represent color images by separating the luma (or luminance) information from the color information. See EX-1009, Iain E.

Richardson, The H.264 Advanced Video Compression Standard, Second Edition (“Richardson”), 13. This representation includes four components:

- Y – luma or luminance – intuitively, the “brightness” of a pixel – given by a weighted sum of the red, green, and blue information;
- Cr – chroma – the color difference between red (R in the RGB color space) and luminance;
- Cb – chroma – the color difference between blue (B in the RGB color space) and luminance;
- Cg – chroma – the color difference between green (G in the RGB color space) and luminance.

Richardson, 13.

27. Because Y is a weighted sum of R, G, and B, Cg can always be calculated if Y, Cr, and Cb are known. Thus, only Y, Cr, and Cb need be coded. Richardson, 13-14. Further, because the human visual system is less sensitive to color than to luminance, Cr and Cb may be represented at lower spatial resolution than Y without significantly impacting perceived image quality. Richardson, 14. This is called *chroma subsampling*.

28. MPEG-4 AVC supports three chroma subsampling formats for video represented in the YCbCr color space, known as 4:2:0, 4:2:2, and 4:4:4. EX-1001, 2:30-3:18, 8:58-9:8; Richardson, 14-15. In the 4:4:4 format, each of the luma and

the two chroma components has the same spatial resolution (i.e., the same number of “pixels” or “samples”). EX-1001, 2:31-39; Richardson, 14-15. However, in the 4:2:2 and 4:2:0 formats the chroma components are subsampled to a lower spatial resolution, meaning that the Cb and Cr chroma components will each comprise a smaller number of “pixels” or “samples” than the luma component.

29. In the 4:2:2 format the number of chroma samples is reduced by one-half horizontally, but the chroma components maintain full spatial resolution vertically. In other words, for a “full HD” 1080p video image with a spatial resolution of 1920 columns of pixels horizontally by 1080 rows of pixels vertically, the size of the luma component would be 1920 x 1080 samples (full spatial resolution), but, with 4:2:2 chroma subsampling, the two chroma components Cb and Cr would each have a size of only 960 (horizontal) x 1080 (vertical) samples (because $1920 \div 2 = 960$).

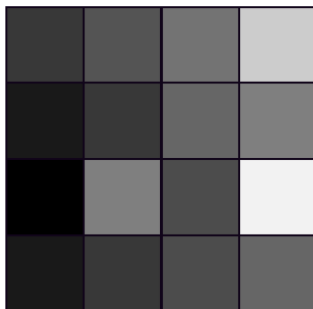
30. In the 4:2:0 format, the number of chroma samples is reduced by one-half *both* horizontally *and* vertically. In other words, for a “full HD” 1080p video image with a spatial resolution of 1920 columns of pixels horizontally by 1080 rows of pixels vertically, the size of the luma component would still be 1920 x 1080 samples (full spatial resolution), but with 4:2:0 chroma subsampling, the two chroma components Cb and Cr would each have a size of only 960 (horizontal) x 540 (vertical) samples (because $1920 \div 2 = 960$ and $1080 \div 2 = 540$).

31. When chroma subsampling is used, the color video image that gets displayed (e.g., on a television screen or computer monitor) still has the same number of pixels as the luma component. However, each sample of the reduced-resolution chroma arrays then contributes color information to more than one pixel of the displayed image. For example, in the 4:2:0 format where the chroma components are subsampled to one-half resolution both vertically and horizontally, each “sample” in the reduced resolution Cb and Cr arrays corresponds to a block of 2x2 luma “samples,” and hence also to a block of 2x2 pixels in the color image that gets displayed. In other words, in the 4:2:0 format each sample of the Y (luma) component specifies the brightness of exactly one pixel in the color image that is displayed – because the luma component is not subsampled and maintains full spatial resolution. But each sample of the Cb chroma component contributes color information to a *block* of 2x2 pixels in the color image that is displayed. Similarly, each sample of the Cr component also contributes color information to a *block* of 2x2 pixels in the color image that is displayed. With 4:2:2 chroma subsampling, each sample of the Cb and Cr components contributes color information to a block of 2x1 pixels in the color image that is displayed.

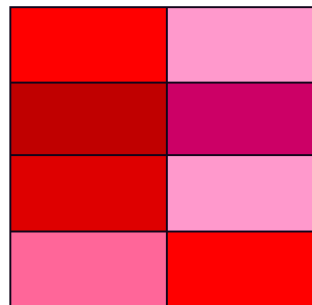
32. Because the Cb and Cr chroma components have a different size compared to the Y (luma) component of a video image when chroma subsampling is used, it is customary to refer to the color video image as comprising an array of

color *pixels*, but to the Y, Cb, and Cr components as each comprising an array of *samples*. While this is not a “hard and fast” rule, it widely used, e.g., in the H.264 standard where the elements of the Y, Cb, and Cr arrays are referred to as *samples*. See generally EX-1010.

33. To illustrate these concepts further, consider the 4:2:2 format where each chroma component is subsampled to half the horizontal sample rate of the luma component (i.e., the horizontal resolution of the chroma components is halved. In other words, while there is a luma sample to represent the brightness of every pixel in the displayed video image, each chroma sample in the Cb and Cr components corresponds to a block of pixels in the displayed video image that is 1 pixel high by 2 pixels wide. I illustrate this in the figures below.



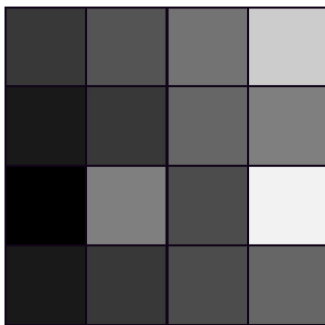
16 pixels (4 pixel by 4 pixel block) showing luma values for each pixel



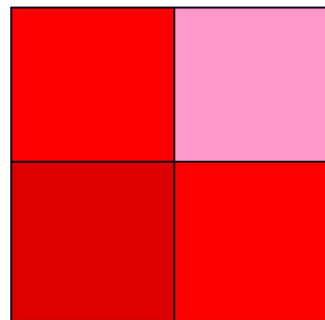
8 chroma samples (in each chroma component), covering 16 pixels (each chroma sample is 2 pixels wide and 1 pixel high)

34. In the 4:2:0 format (traditionally used for mass market consumer video), each chroma component is subsampled to half the sample rate of the luma component both horizontally and vertically (i.e., the resolution of the chroma

components is halved both horizontally and vertically). So, while each luma sample again represents the brightness of exactly one pixel in the video image that is displayed, each chroma sample in the Cb and Cr components provides color information for a block of pixels in the displayed video image that is 2 pixels high by 2 pixels wide. I illustrate this in the figures below.

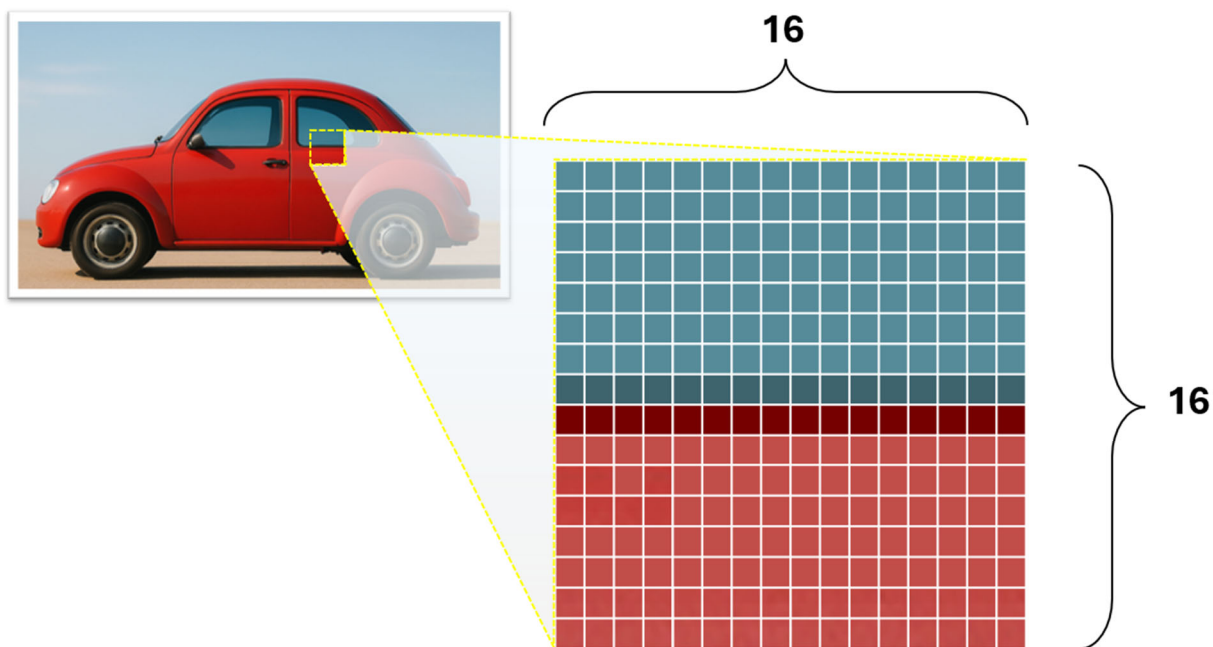


16 pixels (4 pixel by 4 pixel block) showing luma values for each pixel

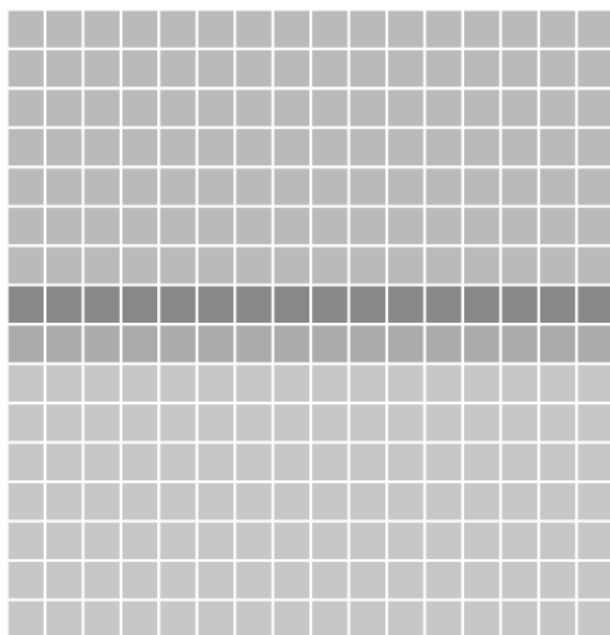


4 chroma samples (in each chroma component), covering 16 pixels (each sample 2 pixels wide and 2 pixels high)

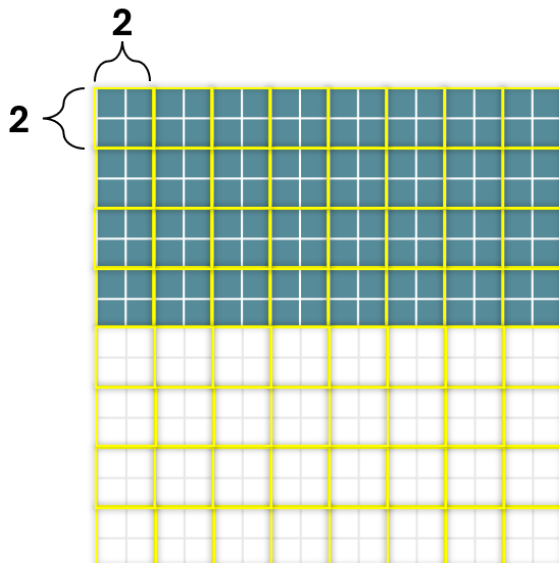
35. I will now present an example of how chroma subsampling, and in particular, how chroma subsampling in the 4:2:0 format, works. This example is simplified for demonstration purposes. Below is a photograph of a red car in front of a blue sky. This image could be a single frame in a video. Also in the below image is a blow up of representation of a 16 pixel by 16 pixel section of the image. (This portion is simplified for demonstration purposes, and is not necessarily to scale with the actual image.)



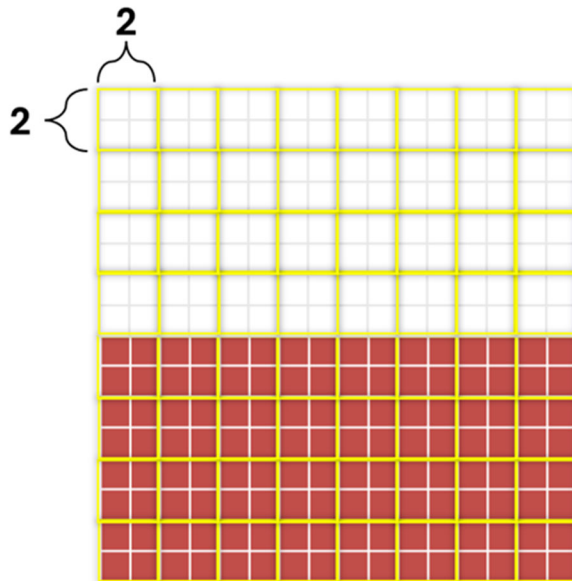
36. Below is a simplified version of the luma values for each of the pixels in the 16 pixel by 16 pixel section of the image (Y in the YCbCr format). Note that this represents only brightness, and does not include any color information.



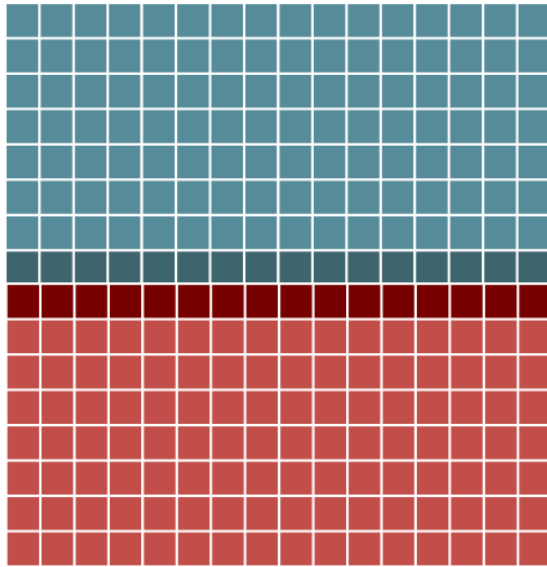
37. The chroma component Cb in the YCbCr format includes the color difference between blue and luminance. Unlike luma, which provides a sample for each pixel of the image, in the 4:2:0 format the chroma components (including Cb) only provide a sample for each 2 pixel by 2 pixel block of the image. Below is a demonstrative illustration of such sampling for the 16 pixel by 16 pixel section of the image above. These 2 pixel by 2 pixel blocks are represented by the yellow boxes, each of which is represented by a single Cb chroma sample and a single Cr chroma sample. The chroma information does not change for each of the pixels in the 2 pixel by 2 pixel sample. Instead, one value is applied to the entire 2 pixel by 2 pixel sample. For simplification, instead of showing the true difference between blue and luminance, the below image shows the blue coloring itself.



38. The Cr component is the difference between the red color and the luminance. As with the Cb component, the Cr values are sampled at a reduced spatial resolution, providing just one sample for each 2 pixel by 2 pixel block of the image, as shown in the illustration below. Again, for simplification, while Cr is technically the difference between red and luminance, the image below shows the red coloring itself.



39. Below is a demonstration of how the luma component (Y) values, the blue color difference chroma component (Cb) values, and red color difference chroma component (Cr) values are combined to create the 16 pixel by 16 pixel macroblock of the color image that gets displayed. Again, while the luma values can vary per pixel (and affect the brightness of each displayed pixel), the chroma information only varies per 2 pixel by 2 pixel block.



40. Thus, the number of pixels in the luma component of a macroblock may be different from the number of pixels in each chroma component of the same macroblock depending on the chroma subsampling. As noted above, a chroma subsampling format of 4:2:0 has traditionally been used for mass market consumer video.

B. Purported Invention

41. For each of the Y (luma) and Cb and Cr (chroma) components of a macroblock, when intra prediction is used it is typically performed on a block or subblock basis within the macroblock. For each component, the '606 patent refers to the sizes and arrangement of the intra prediction blocks within a macroblock as the “partition” or “partition type.”

42. According to the '606 patent, the purported invention allows different partition types (i.e., the size and shape of the partition) for intra prediction, including a set of chroma partition types and a set of luma partition types, where the set of chroma partition types is different from the set of luma partition types. EX-1001, 3:27-34.

43. The '606 patent discloses two methods for encoding luma and chroma partition types. In "Method 1" (embodied in "Embodiment 1") the chroma partition type for intra prediction is determined by the luma partition type. EX-1001, 9:10-12. The specification distinguishes this method from the prior art by asserting that the chroma partition type is aligned with the luma partition type for a predefined set of partition types. EX-1001, 9:12-15. For example, according to the '606 patent, if the luma partition type is 8x8 and the format is 4:2:0, then the chroma partition type will be 4x4. EX-1001, 9:15-18. In this embodiment, since the chroma partition type is decided based on the luma partition type, only the luma partition type is signaled from the encoder to the decoder. EX-1001, 9:28-32.

44. In "Method 2" (embodied in "Embodiment 2") the luma partition type and chroma partition type for intra prediction are independently coded. EX-1001, 11:58-60. The luma partition type, chroma partition type, luma intra prediction mode, and chroma intra prediction mode are all signaled. EX-1001, 12:31-33.

45. Each of the independent claims of the '606 patent require determining a chroma partition type from a set of multiple chroma partition types in response to a luma partition type used to encode (or decode) a block. EX-1001, claims 1, 2, 10, 14. Further, each independent claim requires that “only luma partition type is signaled, not the chroma partition type.” EX-1001, claims 1, 2, 10, 14. The '606 patent thus does not claim Embodiment 2, which performs independent determination of the chroma and luma partition types, and signals both. Instead, to the extent the claims of the '606 patent claim either embodiment of the '606 patent, it would be Embodiment 1, where the chroma partition type is determined from the luma partition type, and only the luma partition type is signaled.

C. Prosecution

46. While I have reviewed the prosecution history for the '606 patent, and considered it in rendering my opinions, I am not relying on any particular portion of the prosecution history for any of my opinions.

V. LEVEL OF ORDINARY SKILL

47. A person of ordinary skill in the art (“POSITA”) in the field of video encoding and decoding at the time of the purported invention of the '606 patent would have had at least a bachelor’s degree in electrical engineering, computer science, computer engineering, or a related field, and approximately three years of experience in design, development, and/or testing of relevant multimedia processing,

such as video, and/or image processing or coding. Advanced graduate studies with coursework and/or research focusing on topics of video encoding and decoding could substitute for working experience in the field.

VI. MATERIALS CONSIDERED AND RELIED UPON

48. In developing my opinions below relating to the '606 patent, I have considered the materials cited herein, including those itemized in the table below:

No.	Exhibit
1001	U.S. Patent No. 12,143,606 (“’606 patent”)
1002	File History of the ’606 patent
1005	U.S. Patent Pub. No. 2008/0170615 (“Sekiguchi”)
1006	Enlarging MB size for high fidelity video coding beyond HD (“VCEG-AJ21”), available at https://www.itu.int/wftp3/av-arch/video-site/0810_San/VCEG-AJ21.zip
1007	WO2006/026903 (“Xiong”)
1008	Certified English Translation of WO2006/026903
1009	Iain E. Richardson, The H.264 Advanced Video Compression Standard, Second Edition (“Richardson”)
1010	ITU-T Recommendation H.264 (Nov. 2007) (“H.264”)
1011	Editing State of Text Relating to ITU-T Rec. H.264 ISO/IEC 14496-10 Amendments 1 and 2 (“ITU-T H.264 Draft”)
1012	Declaration of Dr. Clifford Reader (“Reader”)
1013	Declaration of June Ann Munford (“Munford”)

No.	Exhibit
1014	Mathias Wien, Variable Block-Size Transforms for H.264/AVC (“Wien”)
1015	ITU-T Recommendation H.264 (March 2005) (“H.264 (03/2005)”)
1016	Recommendation H.264 (2005) Amendment 1 (06/06) (Munford, Appendix H26402) (“Amendment 1”)
1017	Recommendation H.264 (2005) Amendment 2 (04/07) (Munford, Appendix H26403) (“Amendment 2”)
1018	Fu et al., Fast Intra Prediction Algorithm in H.264/AVC, Proceedings 7th International Conference on Signal Processing, 2004. Proceedings. ICSP '04. 004., Beijing, 2004, pp. 1191-1194 vol.2, doi: 10.1109/ICOSP.2004.1441537 (“Fu”)
1019	Pan et al., Fast Mode Decision for Intra Prediction (“JVT-G013” or “Pan”) (Mar. 2003)

I have also considered any materials cited in this declaration even if not included in the list above.

VII. LEGAL STANDARDS

49. I am not a lawyer and do not provide any legal opinions, but I have been advised that certain legal standards are to be applied by technical experts in forming opinions regarding meaning and validity of patent claims. I have applied the legal standards described below.

50. It is my understanding that assessing the validity of a U.S. patent based on a prior art analysis involves two steps. First, one must assess what meaning a

POSITA would have given the terms. Second, after assessing the meaning of the claim terms, one may then assess validity by comparing a patent claim to the “prior art.” I understand that the teaching of the prior art is viewed through the eyes of a POSITA at the time the invention was made. My analysis as to what constitutes a relevant POSITA is set forth above.

A. Legal Standards for Priority Date

51. I understand that the “priority date” (or “earliest effective filing date”) of a patent is the date on which it is filed, or the date on which an earlier application was filed if the patentee properly claims the benefit of the earlier application’s filing date. For purposes of my analysis in this declaration, I have assumed that the ’606 patent is entitled to a priority date of August 12, 2009.

B. Legal Standards for Obviousness

52. My understanding is that a patent claim is invalid as obvious only if the subject matter of the claimed invention “as a whole” would have been obvious to a POSITA at the time the invention was made. To determine the differences between a prior art reference (or a proposed combination of prior art references) and the claims, the question of obviousness is not whether the differences themselves would have been obvious, but whether the claimed invention as a whole would have been obvious. Also, obviousness grounds cannot be sustained by mere conclusory

statements. Rather, it is necessary to provide some articulated reasoning with rational underpinning to support the legal conclusion of obviousness.

53. I understand that a patent claim that comprises several elements is not proved obvious by simply showing that each of its elements was independently known in the prior art. In my evaluation of whether any claim of the '606 patent would have been obvious, I considered whether a POSITA would have had a reason with a rational basis that would have motivated a POSITA to combine the elements or concepts from the prior art in the same way as in the claimed invention.

54. It is my understanding that there is no single way to define the line between true inventiveness on one hand—which is patentable—and the application of common sense and ordinary skill to solve a problem on the other hand—which is not patentable. For instance, factors such as market forces or other design incentives may be the source of what produced a change, rather than true inventiveness.

55. I understand that the decision-maker may consider whether the change was merely the predictable result of using prior art elements according to their known functions, or whether it was the result of true inventiveness. And the decision-maker may also consider whether there is some teaching or suggestion in the prior art to make the modification or combination of elements recited in the claim at issue. Also, the decision-maker may consider whether the innovation applies a known technique that had been used to improve a similar device or method in a

similar way. The decision-maker may also consider whether the claimed invention would have been obvious to try, meaning that the claimed innovation was one of a relatively small number of possible approaches to the problem with a reasonable expectation of success by those skilled in the art.

56. I understand that in considering obviousness, it is important to be careful not to engage in hindsight and that many true inventions might seem obvious after the fact. I understand that obviousness is considered from the perspective of a POSITA at the time the claimed invention was made, and not based on what is known today or what is learned from the teaching of the patent.

57. I understand that the following factors must be evaluated to determine whether a claim is obvious: the scope and content of the prior art; the difference or differences, if any, between the claim of the patent and the prior art; the level of ordinary skill in the art at the time the claimed invention was made; and, if available, the objective indicia of non-obviousness, also known as “secondary considerations.”

58. I understand that the secondary considerations can include: commercial success of a product due to the merits of the claimed invention; a long felt need for the solution provided by the claimed invention; unsuccessful attempts by others to find the solution provided by the claimed invention; copying of the claimed invention by others; unexpected and superior results from the claimed invention; acceptance by others of the claimed invention as shown by praise from others in the

field or from the licensing of the claimed invention; teaching away from the conventional wisdom in the art at the time of the invention; independent invention of the claimed invention by others before or at about the same time as the named inventor thought of it; and other evidence tending to show obviousness.

59. I understand that, to establish a secondary consideration, the evidence must demonstrate a nexus between that secondary consideration and the claimed invention.

60. I understand that a petition must identify, for any terms with means-plus-function limitations, the specific portions of the specification of the challenged patent that describe the structure, material, or acts corresponding to each claimed function. I also understand a rebuttable presumption exists that with use of the term, “means,” a claim term is interpreted as means-plus-function.

61. I also understand that a petitioner seeking to demonstrate that the prior art discloses a means-plus-function limitation must prove that the corresponding structure—or an equivalent—was present in the prior art and performing the same claimed function.

62. I understand that the standard for determining whether the prior art discloses the corresponding structure or an equivalent is whether there are insubstantial differences, which means that if the assertedly equivalent structure performs the claimed function in substantially the same way to achieve substantially

the same result as the corresponding structure described in the specification, it is equivalent.

63. I understand that proving structural equivalence does not require a component-by-component analysis, but rather that it is sufficient to show structure, materials, or acts that perform the claimed function in substantially the same way to achieve substantially the same result because the claim limitation is the overall structure corresponding to the claimed function and not individual components.

VIII. CLAIM CONSTRUCTION

64. I understand that Petitioner has not proposed any terms for construction because no constructions are necessary to resolve any disputes identified in the Petition. I agree that no terms need to be construed to determine the unpatentability of the challenged claims.

IX. DETAILED EXPLANATION OF GROUNDS

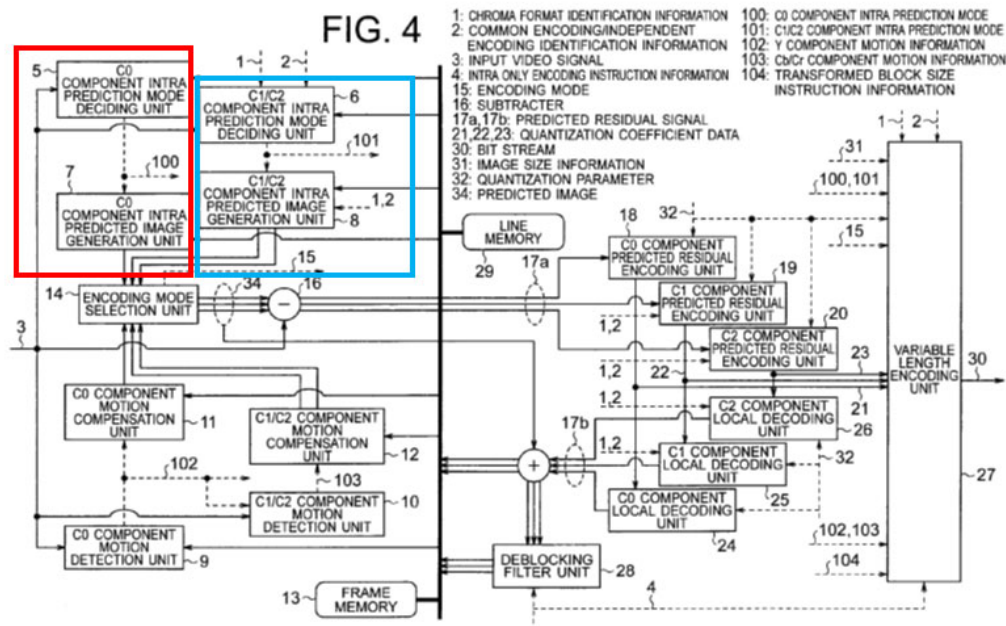
A. Ground 1A: Sekiguchi in view of VCEG-AJ21

1. Sekiguchi

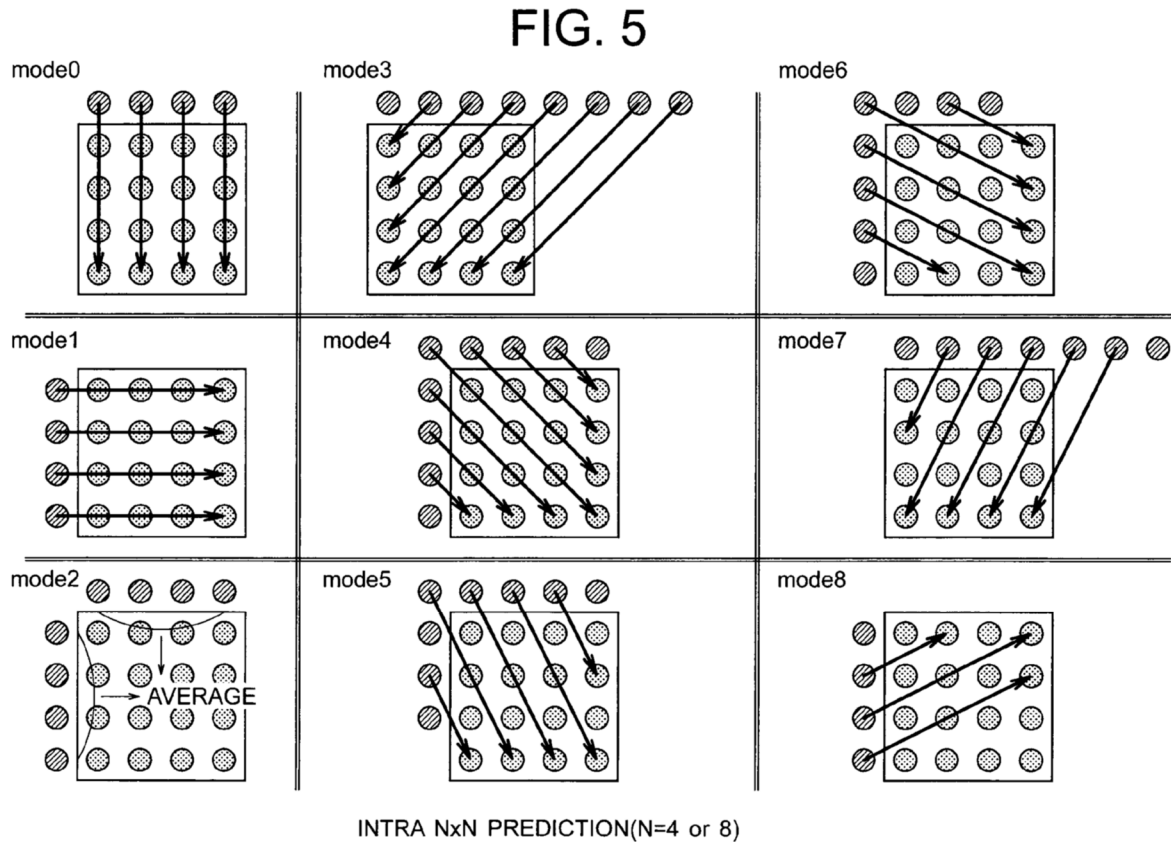
65. Sekiguchi (U.S. Patent Pub. No. 2008/0170615) was published on July 17, 2008. I understand Sekiguchi qualifies as prior art under 35 U.S.C. §§102(a) and 102(b).

66. Sekiguchi discusses “‘Information Technology Coding of Audio-Visual Objects Part 10: Advanced Video Coding’, ISO/IEC 14496-10, 2003,” as

“related art.” Sekiguchi [0004]. That reference is the 2003 version of the H.264 standard, which is the same as MPEG-4 AVC, as discussed above. Therefore, it is my opinion that a POSITA would have understood Sekiguchi as disclosing an encoding and decoding method that was compatible with, and in fact builds upon, the H.264 standard, and in particular the 2003 version of that standard. Sekiguchi discloses using “a first intra prediction mode deciding unit” and “a first intra prediction image generation unit” for luminance and “a second intra prediction mode deciding unit” and “a second intra prediction image generation unit” for chrominance. Sekiguchi, Abstract. The separated luma and chroma mode deciding and image generation units are shown as items 5 and 7 (for luma, outlined in red below) and 6 and 8 (for chroma, outlined in blue below) in Figure 4. Sekiguchi, Fig. 4, [0043], [0045].



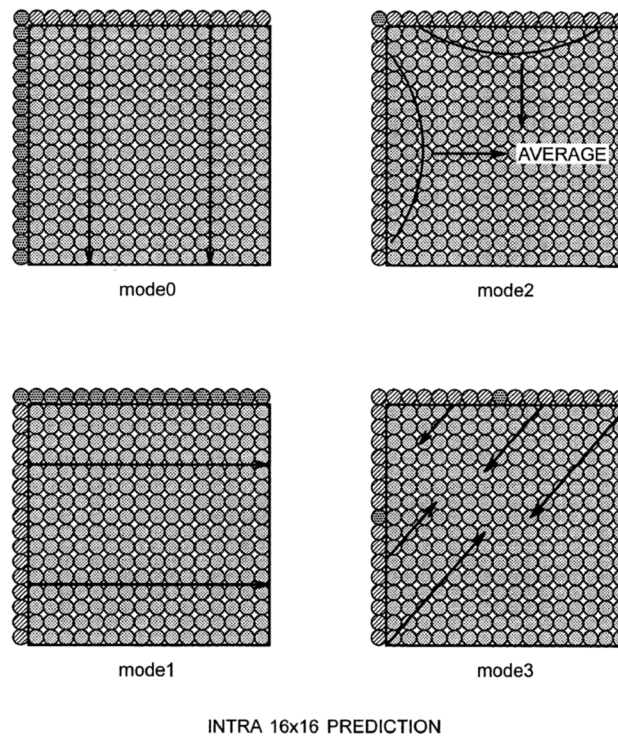
67. For 4:2:0 and 4:2:2 formats, Sekiguchi provides three available intra prediction mode types for luma: 4x4, 8x8, and 16x16. Sekiguchi, [0043]. For the 4x4 and 8x8 intra prediction mode types, there are nine modes, as shown in Figure 5 of Sekiguchi. Sekiguchi, [0043], Fig. 5.



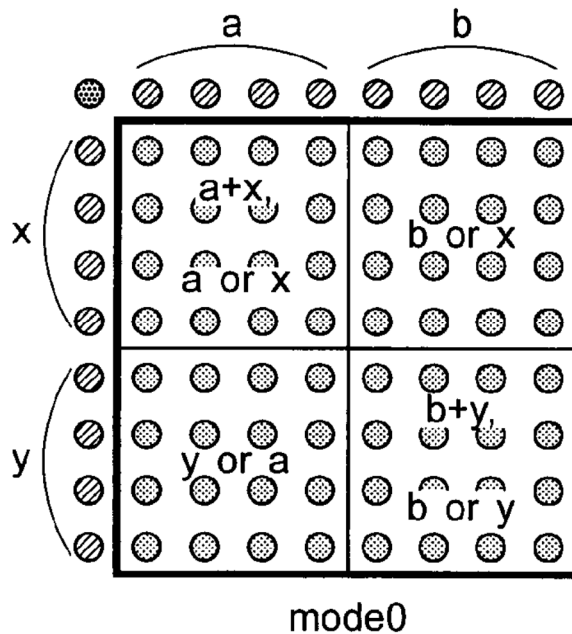
68. For the 16x16 intra prediction mode type, there are four modes, as shown in Figure 6. Sekiguchi, [0044], Fig. 6.

¹ Annotations to figures have been added throughout this declaration unless otherwise noted.

FIG. 6



69. Sekiguchi discloses four different modes for chroma intra prediction. Sekiguchi, [0045]. For intra 4:2:0 format, three of these modes (modes 1, 2, and 3) use 8x8 pixel blocks for intra prediction. *Id.* For the other mode (mode 0), the 8x8 pixel block is divided into four 4x4 pixel blocks. *Id.* As shown in Figure 7, a different formula is used for calculating the intra predictions in each of those 4x4 pixel blocks. *Id.*, [0045], Fig. 7 (excerpted).



2. VCEG-AJ21

70. VCEG-AJ21 is a printed publication that was publicly available by October 8, 2008. Reader, ¶¶31-48. I understand VCEG-AJ21 is prior art to the '606 patent under 35 U.S.C. §102(a).

71. VCEG-AJ21 extended the architecture of the H.264 codec with enlarged macroblock sizes. VCEG-AJ21, 1 (Abstract). In particular, VCEG-AJ21 discloses enlarging the H.264 macroblock size of 16x16 to "NxN," where N is increased according to powers of 2, and VCEG-AJ21 gives examples of 32x32, 64x64, and 128x128. VCEG-AJ21, 3 ("N indicates the maximum pixel size for the enlarged MB and can be increased with power of 2 such as 32, 64 or 128."). Further,

VCEG-AJ21 discloses a luma block of 32x32, with each chroma block being 16x16 (for the 4:2:0 format). This is shown in Figure 5 of VCEG-AJ21.

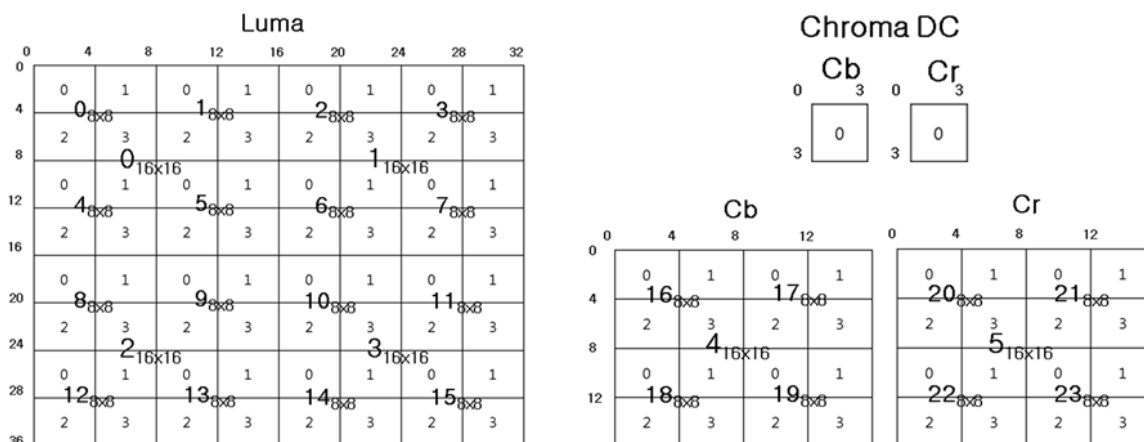


Fig. 5 Block indexing for 32x32 MB

72. Note that VCEG-AJ21 is focused on enlarged macroblocks for inter prediction. VCEG-AJ21, 1 (“the extended architecture with the enlarged MB structure are first proposed for ME&MC”). In particular, VCEG-AJ21 did experiments with H.264 reference software to show “the proportion of the large block modes such as SKIP and 16x16 modes increase in proportion to the video resolution sizes.” *Id.*, 1-2. According to VCEG-AJ21, this shows the value of adding enlarged macroblocks, larger than 16x16. *Id.*, 2-3. In Table 2, VCEG-AJ21 provides partition block modes for enlarged macroblocks up to 128x128.

Table 2. Possible partition block modes (mb_type) for enlarged MB's of 128x128, 64x64 and 32x32

128x128 MB size	SKIP_128x128(0), 128x128(1), 128x64(2), 64x128(3), SKIP_64x64(4), 64x64(5), 64x32(6), 32x64(7), SKIP_32x32(8), 32x32(9), 32x16(10), 16x32(11), SKIP_16x16(12), 16x16(13), 16x8(14), 8x16(15), 8x8(16), 8x4(17), 4x8(18), 4x4(19),
64x64 MB size	SKIP_64x64(0), 64x64(1), 64x32(2), 32x64(3), SKIP_32x32(4), 32x32(5), 32x16(6), 16x32(7), SKIP_16x16(8), 16x16(9), 16x8(10), 8x16(11), 8x8(12), 8x4(13), 4x8(14), 4x4(15),
32x32 MB size	SKIP_32x32(0), 32x32(1), 32x16(2), 16x32(3), SKIP_16x16(4), 16x16(5), 16x8(6), 8x16(7), 8x8(8), 8x4(9), 4x8(10), 4x4(11),

73. While Table 2's modes are explicitly for inter prediction, and VCEG-AJ21 says that intra prediction is "not yet addressed," it is my opinion that a POSITA would have understood that the inter prediction modes listed in Table 2 are a super set of the intra prediction modes for enlarged macroblocks. Based on the disclosures of VCEG-AJ21, it would have required only routine engineering well within the capabilities of a POSITA to "address" and complete the specification of the accompanying partition types for intra prediction with the enlarged macroblocks proposed by VCEG-AJ21. This is because a POSITA would have been well aware of and appreciated the fact that, within the context of "H.264-like" video codecs providing spatial intra prediction at the time, the set of macroblock partition types available for intra prediction was a subset of the types available for inter prediction—specifically consisting of the "square" partition types and omitting the "oblong rectangular" partition types. In other words, a POSITA would have understood that all square partition types available for motion estimation (ME) and motion compensated (MC) inter prediction would be equivalently available for intra

prediction. For example, in H.264 (11/2007), the macroblock partition types (including “subpartition types” as they are called in H.264) available for inter prediction are given in Tables 7-13, 7-14, 7-17, and 7-18 and include: 16x16, 16x8, 8x16, 8x8, 8x4, 4x8, and 4x4. The macroblock partition (and “subpartition”) types available for intra prediction are given in Table 7-11 and include: 16x16, 8x8, and 4x4; i.e., the partition types available for intra prediction are a subset of the types available for inter prediction consisting exactly of the square partition types. EX-1010 at 91, 93, 94, 98, 99. Therefore, for the 32x32 enlarged macroblock proposed by VCEG-AJ21, it is my opinion that it would have been understood to a POSITA that the accompanying partition types for intra prediction would be exactly the square ones listed in the last row (the “32x32 MB size” row) of Table 2 of VCEG-AJ21, or: 32x32, 16x16, 8x8, and 4x4.

3. Motivation to Combine Sekiguchi and VCEG-AJ21

74. It is my opinion that a POSITA would have been motivated to combine Sekiguchi and VCEG-AJ21 to extend Sekiguchi’s teachings of separating luma and chroma intra prediction to larger block sizes and would have had a reasonable expectation of success in doing so.

75. Both references build upon H.264. Sekiguchi [0004] (referencing “‘Information Technology Coding of Audio-Visual Objects Part 10: Advanced Video Coding’, ISO/IEC 14496-10, 2003,” which is the 2003 version of H.264);

VCEG-AJ21, 1 (Abstract). Both references also disclose macroblock sizes, luminance components, and chroma components. Sekiguchi, [0005]; VCEG-AJ21, 1, 3, 4-5. Both references also disclose using the 4:2:0 format. Sekiguchi, [0005]; VCEG-AJ21, 4. The references present overlapping, compatible concepts such as enhancing the efficiency of the prior art (H.264) video encoding and decoding process by providing a correspondence between a luma block and a chroma block. Sekiguchi, [0045]; VCEG-AJ21, 1 (Abstract), 6 (Conclusion), 4-5, Figs. 4, 5.

76. While Sekiguchi focuses on intra prediction of luma and chroma blocks using traditional 16x16 macroblocks—which VCEG-AJ21 also discloses—VCEG-AJ21 discloses larger macroblock sizes for luma and chroma encoding, including 32x32 luma blocks. VCEG-AJ21, 5, Fig. 5.

77. It is my opinion that a POSITA would have been motivated to apply Sekiguchi's separate intra prediction for luma and chroma to VCEG-AJ21's larger macroblock sizes, because doing so would benefit the efficiency goals of VCEG-AJ21's enlarged macroblock size. This combination would have involved only routine engineering tasks, such as modifying the firmware/software embodying Sekiguchi's system of determining chroma partition type based on luma partition type to incorporate the 32x32 luma partition and 16x16 chroma partition disclosed in VCEG-AJ21. This would have been as simple as an additional conditional statement (e.g., if/then, or "switch" statement) to account for VCEG-AJ21's 32x32

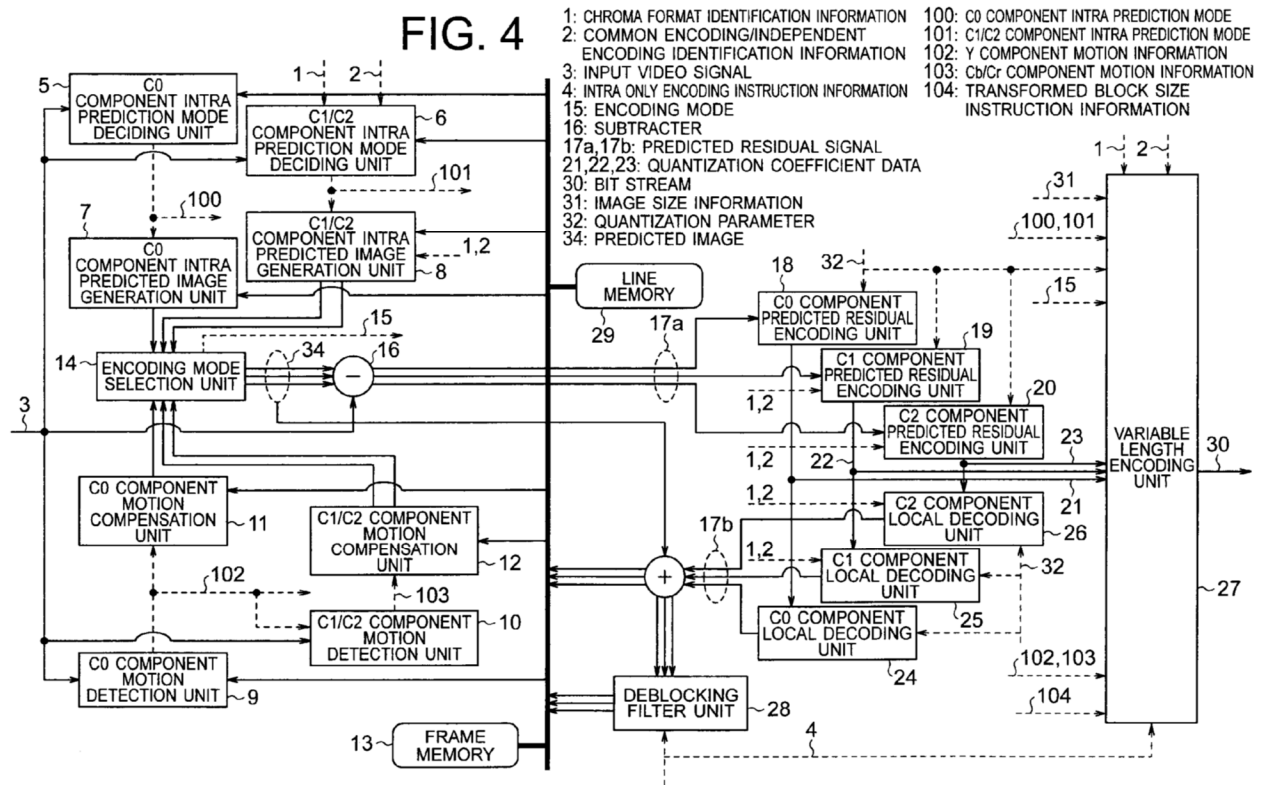
luma partition. Those routine engineering tasks would have yielded predictable results: a more efficient encoding of luma and chroma intra prediction, taking advantage of VCEG-AJ21's larger block sizes, and would not have adversely affected Sekiguchi's system (and in fact would have enhanced it). VCEG-AJ21, 1 ("Thus, we attempt to improve the coding efficiency of H.264 by enlarging MB size to the maximum 128x128."), 6 ("The statistics show that the enlarged MB can provide enhanced coding efficiency for high resolution video coding.").

4. Claim 1

a. 1[pre]: *A video encoding apparatus, comprising:*

78. If limiting, Sekiguchi discloses or suggests 1[pre]. In particular, Sekiguchi discloses *a video encoding apparatus* that is illustrated in Figure 4. Sekiguchi, [0007] ("moving image encoding device"), Fig. 4.²

² Italicized text is claim text unless otherwise noted.



Sekiguchi, Fig. 4

b. 1[a]: a memory and a processor, configured for:

79. Sekiguchi discloses or suggests 1[a]. In particular, a POSITA would have understood that Sekiguchi uses a *memory* and *processor* for encoding video. Sekiguchi, [0041]-[0049], Fig. 4. This is shown, for example, in the video encoder of Figure 4, which depicts components such as memory (e.g., “frame memory,” item 13) for the video data being encoded. A POSITA would also have understood that implementing the software/firmware components of Figure 4 would require storing

machine instructions in a memory, and furthermore that some form of processor would be needed to execute those instructions and operate on the data.

c. 1[b]: *encoding picture data for at least a block in a picture, by performing intra prediction with multiple partition types for chroma encoding of the block, the multiple partition types comprising a set of multiple chroma partition types of sizes 16×16, 8×8, 4×4 and a set of multiple luma partition types, the set of multiple chroma partition types being different than the set of multiple luma partition types, and*³

80. Sekiguchi in combination with VCEG-AJ21 discloses or suggests 1[b].

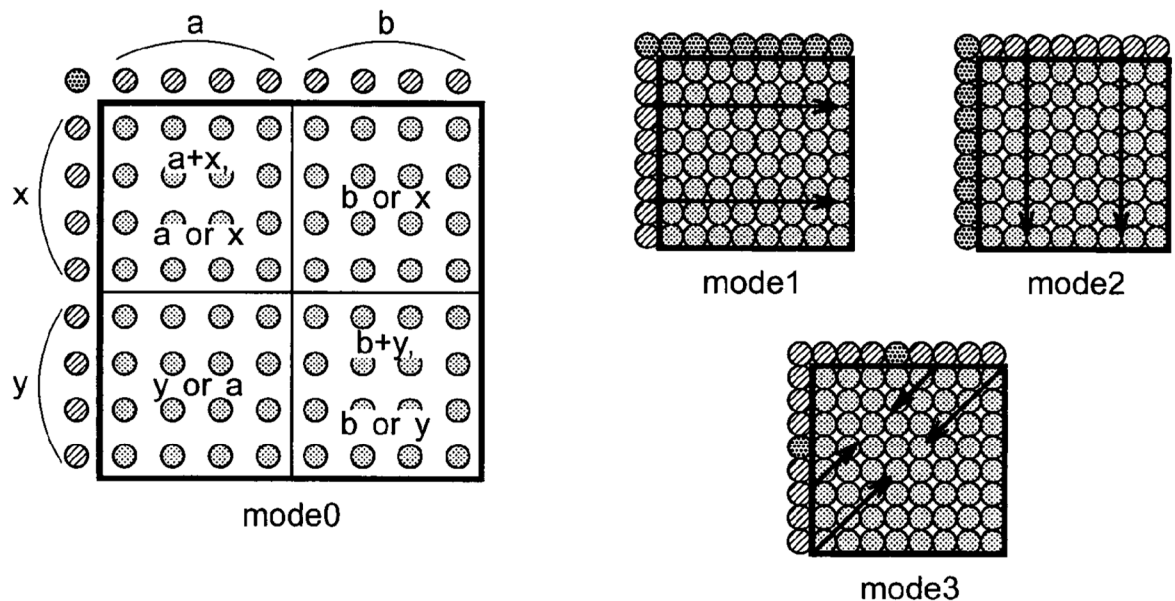
Sekiguchi discloses *encoding picture data* for a macroblock using intra prediction. Sekiguchi, [0041]-[0049]. In particular, Sekiguchi discloses that encoding is performed on a block of 4x4, 8x8, or 16x16. Sekiguchi, [0043] (“there are three selectable types of modes, an intra 4x4 prediction mode, an intra 8x8 prediction mode, and an intra 16x16 prediction mode. For the intra 4x4 prediction mode and the intra 8x8 prediction mode, a macroblock is divided into blocks of 4x4 pixels or 8x8 pixels”); *see also id.*, [0010], [0017], [0026], [0034] (“The picture is further divided into square blocks called macroblocks, and applied to a prediction, transform, or quantization process by a macroblock unit to perform video compression.”). Sekiguchi further discloses a set of luma partition types for intra prediction that include 16x16, 8x8, and 4x4. Sekiguchi, [0043].

³ Limitation 1[b] includes text as corrected by the September 2, 2025 Certificate of Correction.

81. VCEG-AJ21 likewise discloses a luma partition of 16x16, as well as a larger partition of 32x32. VCEG-AJ21, 4-5, Figs. 4-5. The combination of Sekiguchi and VCEG-AJ21 thus discloses or suggests a set of luma partition types that includes 4x4, 8x8, 16x16, and 32x32 for intra prediction. See §IX.A.3.

82. Sekiguchi also discloses chroma partition types of sizes 8x8 and 4x4. Sekiguchi, [0045]. For intra prediction in the 4:2:0 format, Sekiguchi discloses three intra prediction modes (modes 1, 2, and 3) using 8x8 pixel blocks, and one intra prediction mode (mode 0) that divides those 8x8 pixel blocks into 4x4 pixel blocks, as shown in Figure 7. Sekiguchi, [0045], Fig. 7.

FIG. 7



4:2:0/4:2:2 Cb/Cr INTRA PREDICTION

83. VCEG-AJ21 likewise discloses a chroma partition type of 8x8 and further describes a chroma partition type of 16x16, as shown in Figures 4 and 5, respectively. VCEG-AJ21, 4-5, Figs. 4, 5.

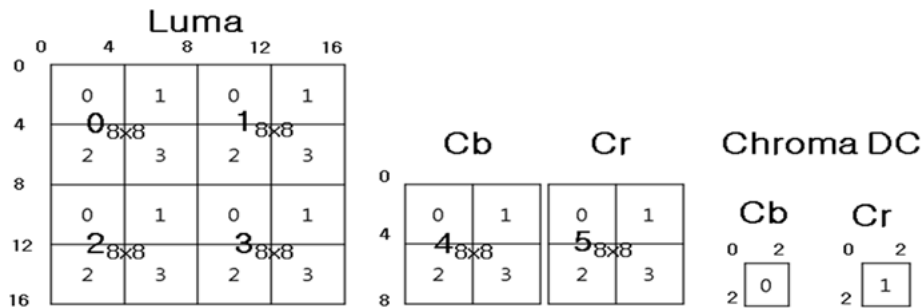


Fig. 4 Block indexing for 16x16 MB

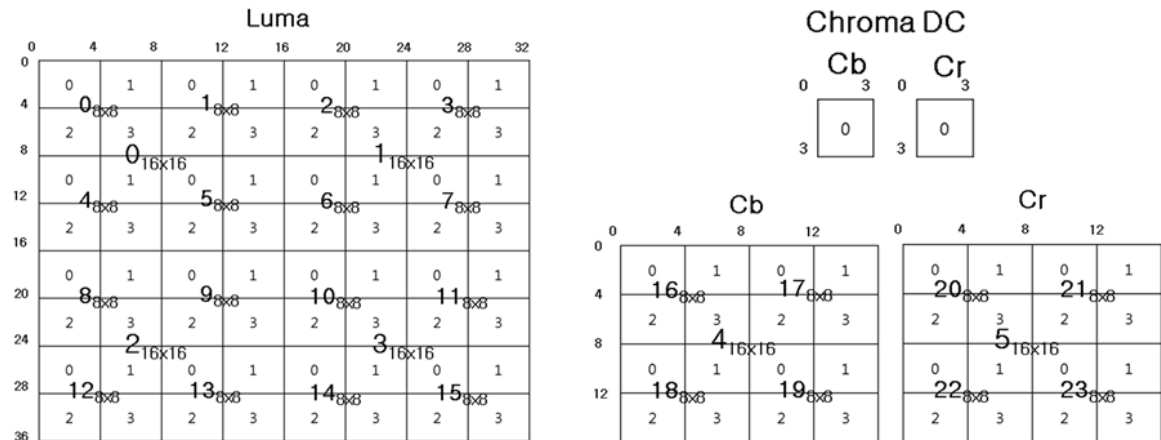


Fig. 5 Block indexing for 32x32 MB

84. To the extent PO argues that Figures 4 and 5 of VCEG-AJ21 do not explicitly disclose 8x8 and 16x16 chroma partitions, it is my opinion that a POSITA would have understood this to be disclosed by VCEG-AJ21 by those figures in combination with Table 2 of VCEG-AJ21. Table 2 of VCEG-AJ21 includes 32x32

and 16x16 prediction modes usable for both inter and intra prediction, as discussed above. See §IX.A.2 (¶¶72, 73).

Table 2. Possible partition block modes (mb_type) for enlarged MB's of 128x128, 64x64 and 32x32

128x128 MB size	SKIP_128x128(0), 128x128(1), 128x64(2), 64x128(3), SKIP_64x64(4), 64x64(5), 64x32(6), 32x64(7), SKIP_32x32(8), 32x32(9), 32x16(10), 16x32(11), SKIP_16x16(12), 16x16(13), 16x8(14), 8x16(15), 8x8(16), 8x4(17), 4x8(18), 4x4(19),
64x64 MB size	SKIP_64x64(0), 64x64(1), 64x32(2), 32x64(3), SKIP_32x32(4), 32x32(5), 32x16(6), 16x32(7), SKIP_16x16(8), 16x16(9), 16x8(10), 8x16(11), 8x8(12), 8x4(13), 4x8(14), 4x4(15),
32x32 MB size	SKIP_32x32(0), 32x32(1), 32x16(2), 16x32(3), SKIP_16x16(4), 16x16(5), 16x8(6), 8x16(7), 8x8(8), 8x4(9), 4x8(10), 4x4(11),

85. A POSITA would have understood these prediction modes to use, respectively, 16x16 and 8x8 partitions for luma prediction. A POSITA would have understood that, for the 4:2:0 format, the partitions used for the chroma components could be, at most, one quarter the size of the luma partition (because in the 4:2:0 format the number of samples in each chroma component Cb and Cr is halved both horizontally and vertically compared to the number of samples in the Y or luma component). So, for the 32x32 mode, the chroma partition could be, at most, 16x16. And for the 16x16 mode, the chroma partition could be, at most, 8x8. A POSITA would have understood VCEG-AJ21 to disclose both of these chroma partitions, e.g. as explicitly shown in Figs. 4 and 5 of VCEG-AJ21.

86. Therefore, the combination of Sekiguchi and VCEG-AJ21 discloses or suggests 16x16, 8x8, and 4x4 chroma partitions (*multiple partition types comprising a set of multiple chroma partition types of sizes 16×16, 8×8, 4×4*) for performing

intra prediction. See §IX.A.3. But because the combination does not teach a set of chroma partition types that includes 32x32, the set of multiple chroma partition types is different than the set of multiple luma partition types (32x32, 16×16, 8×8, 4×4) (a set of multiple luma partition types, the set of multiple chroma partition types being different than the set of multiple luma partition types). And a POSITA would have been motivated to make the combination of Sekiguchi and VCEG-AJ21 for the reasons stated above. See §IX.A.3.

d. 1[c]: *determining a particular chroma partition type using a single chroma intra prediction mode that is different than a luma intra prediction mode, for encoding a partitioned block from the set of multiple chroma partition types in response to a luma partition type utilized to encode the block, the luma partition type being included in the set of multiple luma partition types and only luma partition type is signaled, not the chroma partition type,*⁴

87. Sekiguchi in combination with VCEG-AJ21 discloses or suggests 1[c]. Sekiguchi discloses using an 8x8 chroma partition type in response to a 16x16 luma partition type (for modes 1, 2, and 3), and a 4x4 chroma partition type in response to a 16x16 partition type (for mode 0). Sekiguchi, [0043]-[0045].

88. As discussed for limitation 1[b], VCEG-AJ21 discloses using an 8x8 chroma partition type with a 16x16 luma partition type, and a 16x16 chroma partition

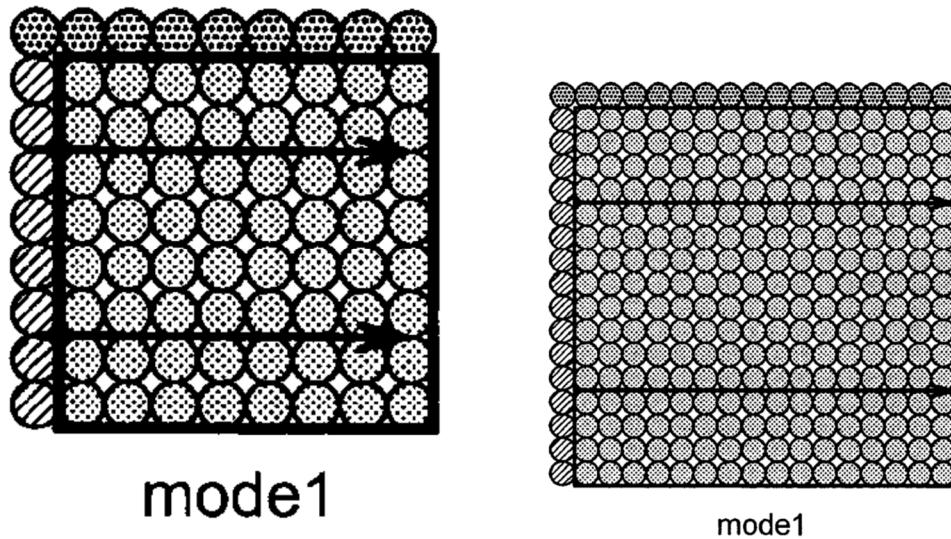
⁴ Limitation 1[c] includes text as corrected by the September 2, 2025 Certificate of Correction.

type with a 32x32 luma partition type. VCEG-AJ21, 4-5, Figs. 4-5; §IX.A.4.c. Therefore, Figure 4 shows *determining* an 8x8 chroma partition type *in response to* a 16x16 luma partition type, and Figure 5 shows *determining* a 16x16 chroma partition type *in response to* a 32x32 luma partition type.

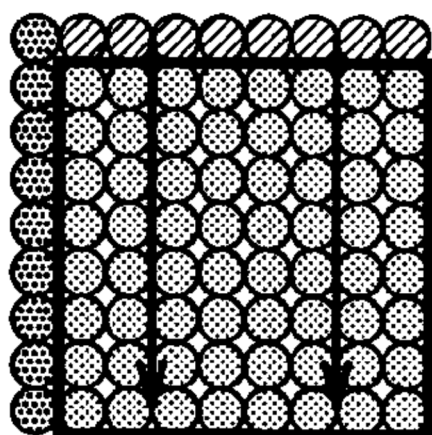
89. As also discussed for limitation 1[b], to the extent PO argues Figures 4 and 5 do not show particular partition types, it is my opinion that a POSITA would have understood that VCEG-AJ21 discloses, based on Table 2, a luma partition type of 32x32 (for the 32x32 mode) and a luma partition type of 16x16 (for the 16x16 mode). *See* §IX.A.4.c. Moreover, the luma partition type of 16x16 was already explicitly provided in H.264 which VCEG-AJ21 builds upon by providing additional enlarged macroblock sizes.

90. Sekiguchi does not disclose signaling any chroma partition type. Therefore, in the combination of Sekiguchi and VCEG-AJ21, there would be no capability to signal using a chroma partition smaller than the largest chroma partition available. For this reason, it is my opinion that in the combination of Sekiguchi and VCEG-AJ21, a POSITA would have been motivated to simply scale up the modes shown in Figure 7 to work with a 16x16 chroma partition type (for modes 1, 2, and 3) and an 8x8 chroma partition type (for mode 0). This would have been straightforward and would require nothing more than routine engineering. In fact, scaling up the directional 8x8 intra prediction modes to a size of 16x16 is already

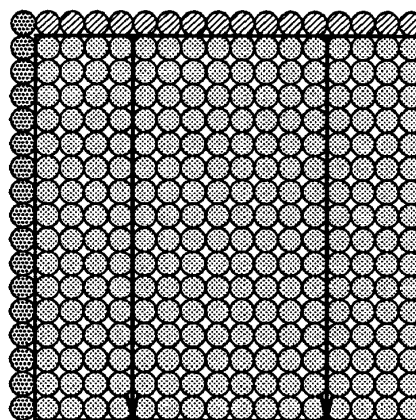
suggested by Sekiguchi: as shown below, the scaled up version of mode 1 of Figure 7 (horizontal intra prediction of an 8x8 block of samples) is equivalent to mode 1 of Figure 6 (horizontal intra prediction of a 16x16 block of samples).



91. Similarly, as shown below, the scaled up version of mode 2 of Figure 7 (vertical intra prediction of an 8x8 block of samples) is equivalent to mode 0 of Figure 6 (vertical intra prediction of a 16x16 block of samples).

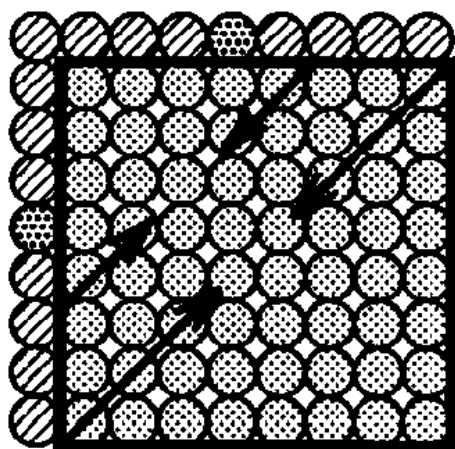


mode2

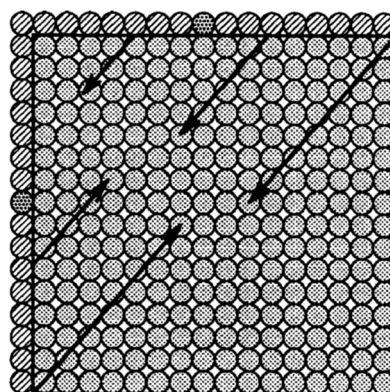


mode0

92. As shown below, the scaled up version of mode 3 of Figure 7 (planar intra prediction of an 8x8 block of samples) is equivalent to mode 3 of Figure 6 (planar intra prediction of a 16x16 block of samples).

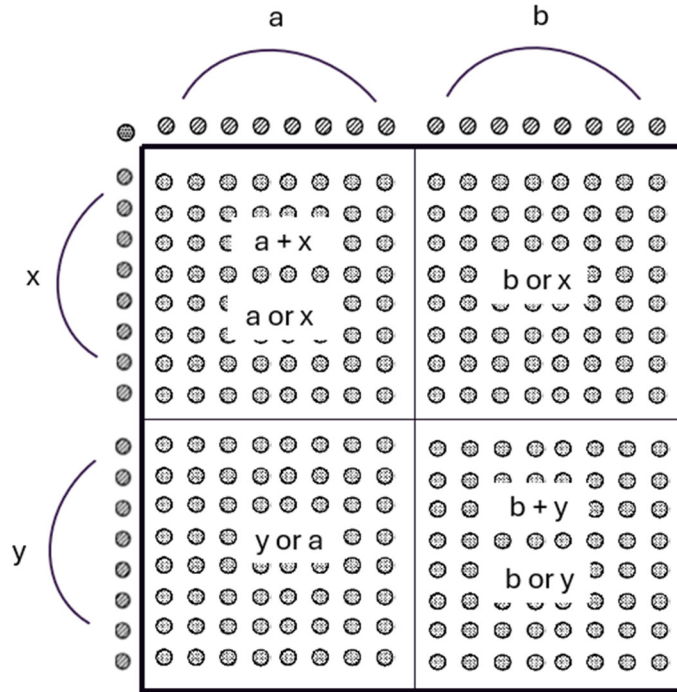


mode3



mode3

93. Similarly, the scaled up version of mode 0 of Figure 7 (intra prediction of 4x4 blocks) would be intra prediction of 8x8 blocks, as I illustrate below.

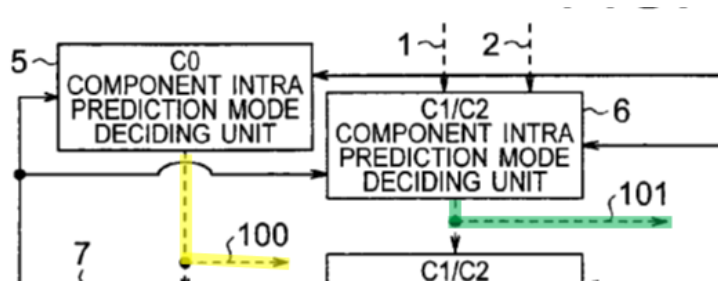


94. Therefore, Sekiguchi's method would be expanded by *determining* a 16x16 chroma partition type *in response to* a 32x32 luma partition type (for modes 1, 2, and 3), and *determining* an 8x8 chroma partition type *in response to* a 32x32 luma partition type (for mode 0).

95. Thus, each reference (and the combination of references) discloses *determining a particular chroma partition type...for encoding a partitioned block from a set of multiple chroma partition types in response to a luma partition type utilized to encode the block.*

96. In the 4:2:0 and 4:2:2 formats, Sekiguchi uses C0 for the luma component (Y), and C1 and C2 are each one of the chroma components (Cb, Cr). Sekiguchi, [0043], [0045]. As shown in Figure 4 (excerpted below, and annotated),

there is a C0 Component Intra Prediction Mode Deciding Unit (item 5) that provides a luma prediction mode (signal 100, highlighted yellow), and a C1/C2 Component Intra Prediction Mode Deciding Unit (item 6) that provides a chroma prediction mode (signal 101, highlighted green).

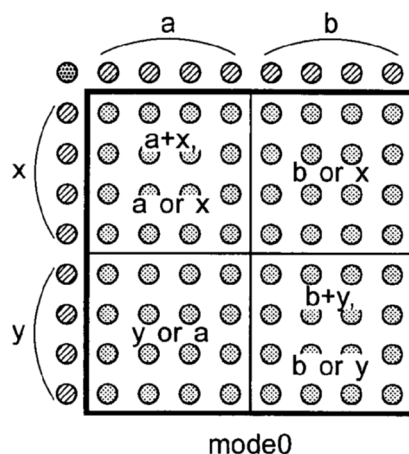


Sekiguchi, Fig. 4 (excerpted)

97. Sekiguchi discloses that C1/C2 component intra prediction mode is split into 101a and 101b (“those corresponding to C1 and C2 are 101a and 101b, respectively”). Sekiguchi, [0045]. But “101a and 101b are always equal in value in the case of 4:2:0 and 4:2:2, and one of 101a and 101b is multiplexed on a bit stream” (*a single chroma intra prediction mode*). Sekiguchi, [0045]. Sekiguchi also discloses “a C1/C2 component intra prediction mode 101 [the *single chroma intra prediction mode*] different from the Y component” (*that is different than a luma intra prediction mode*). In other words, Sekiguchi signals only one chroma intra prediction mode, because the intra prediction modes for both chroma components within each chroma partition of a macroblock are the same. But Sekiguchi signals both luma intra prediction mode and chroma intra prediction mode, because it recognizes that those may be different modes. It is my opinion that a POSITA would have

recognized that Sekiguchi's teachings specifically allow for the luma and chroma intra prediction modes to be independently selected and to be different from one another; for otherwise, if the luma and chroma intra prediction modes were required to always be the same, then Sekiguchi's encoder would be wasting both processing capacity (by having separate intra prediction mode deciding units for luma and chroma) and bandwidth (by independently signaling both luma intra prediction mode and chroma intra prediction mode). Moreover, Sekiguchi expressly discloses a chroma intra prediction mode that is different from the luma (Y component) prediction mode: "For Cb and Cr components, by the C1/C2 component intra prediction mode deciding unit 6, a C1/C2 component intra prediction mode 101 ***different from the Y component...*** is decided." *Id.*, [0045], *emphasis added*.

98. Furthermore, Sekiguchi provides an example of a chroma intra prediction mode that has no matching luma intra prediction mode. And notably, Sekiguchi refers to different "modes" for luma intra prediction and chroma intra prediction. Sekiguchi, [0045]. For example, "mode 0" for chroma intra prediction—shown in Figure 7 (excerpted below)—includes four modes for chroma intra prediction of 4x4 blocks. Sekiguchi, [0045], Fig. 7.



99. As shown for mode 0, each 4x4 block has intra prediction modes, where “an average value is predicted from the sides” of the 4x4 blocks. Sekiguchi, [0045]. Sekiguchi discloses multiple ways to do this: “for a 4x4 block of the upper left part, all 8 pixels of areas ‘a’ and ‘x’ are averaged, or 4 pixels of ‘a’ or ‘x’ are averaged, and one of those average values is used as a predicted value.” Sekiguchi, [0045]. Sekiguchi does not disclose any luma intra prediction mode similar to the “a or x,” the “b or x,” the “y or a,” the “b+y,” nor the “b or y” chroma intra predictions used for the 4x4 blocks of mode 0 in Figure 7. Therefore, whenever chroma intra prediction mode is determined to be that of mode 0, it is a different intra prediction mode from any luma intra prediction mode.

100. The combination of Sekiguchi and VCEG-AJ21 also discloses or suggests that *only luma partition type is signaled, not the chroma partition type*. Sekiguchi discloses three “selectable types of modes,” each associated with a particular luma partition type: 4x4, 8x8, and 16x16. Sekiguchi, [0043]. This

information is provided as part of signal 100 from the C0 component (“Y” or “luma” component in YCrCb format parlance) intra prediction mode deciding unit. Sekiguchi, [0043], [0044]. Unlike luma, Sekiguchi does not disclose including the chroma partition type in signal 101 coming from the C1/C2 component intra prediction mode deciding unit. Sekiguchi, [0045]. Instead, Sekiguchi only discloses that signal as including whether the chroma components are using mode 0, 1, 2, or 3. Sekiguchi, [0045].

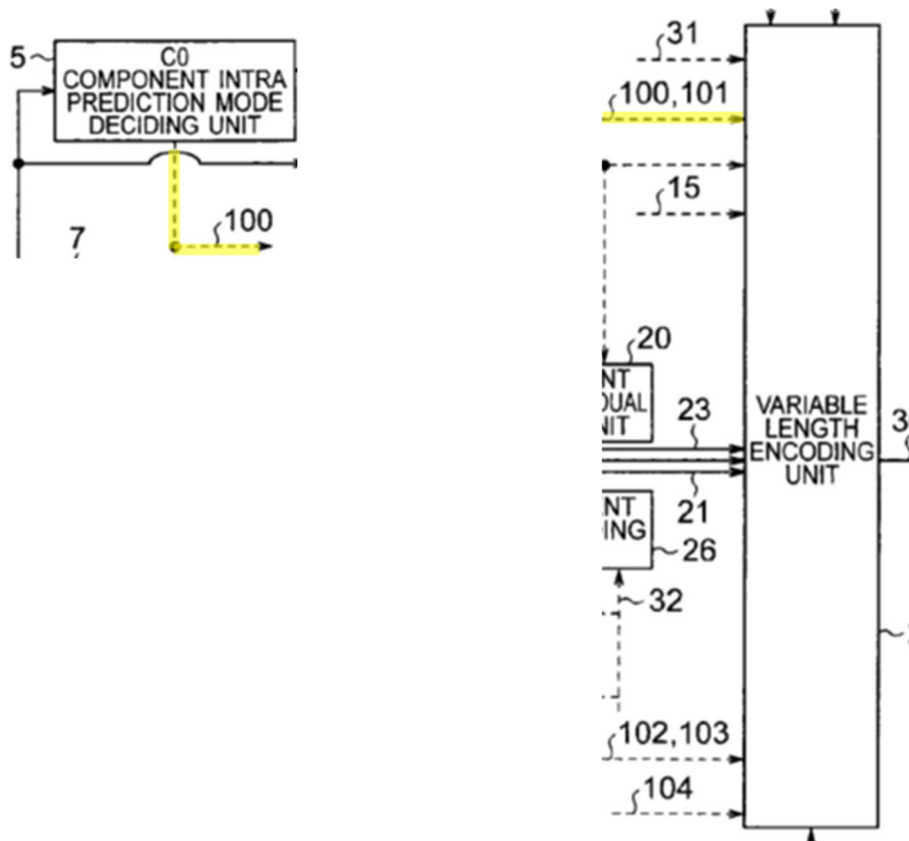
101. Thus, the combination of Sekiguchi and VCEG-AJ21 discloses or suggests using a 16x16 chroma partition type in response to a 32x32 luma partition type (from VCEG-AJ21) and a 4x4 chroma partition type in response to a 16x16 luma partition type (mode 0 from Sekiguchi) (*determining a particular chroma partition type...for encoding a partitioned block from the set of multiple chroma partition types in response to a luma partition type utilized to encode the block*), from the set of luma partition types of 32x32, 16x16, 8x8, and 4x4 (*the luma partition type being included in the set of multiple luma partition types*). See §IX.A.3. The combination also discloses or suggests independent determination of intra prediction modes for luma and chroma via a separate C0 Component Intra Prediction Mode Deciding Unit (item 5), which provides a luma prediction mode, and C1/C2 Component Intra Prediction Deciding Unit resulting in a C1/C2 component intra prediction mode 101 different from the Y component (*using a*

single chroma intra prediction mode that is different than a luma intra prediction mode). See §IX.A.3. Further, the combination sends luma partition type as part of signal 100, but not chroma partition type as part of signal 101 (*only luma partition type is signaled, not the chroma partition type*). And a POSITA would have been motivated to combine Sekiguchi and VCEG-AJ21 for the reasons stated above. See §IX.A.3.

e. 1[d]: said encoding comprising: setting a luma partition,

102. Sekiguchi in combination with VCEG-AJ21 discloses or suggests 1[d]. Sekiguchi discloses setting the luma partition as part of setting the intra prediction mode to either 16x16, 8x8, or 4x4. Sekiguchi, [0043]. It is my opinion that a POSITA reading VCEG-AJ21 would further have understood that the VCEG-AJ21 luma partition could be set to 32x32. VCEG-AJ21, 4, Table 2, Fig. 4-5. The combination of Sekiguchi and VCEG-AJ21 thus teaches that the luma partition could be set to 16x16 or 32x32.

103. Furthermore, Figure 4 of Sekiguchi (excerpted and annotated below) shows this intra prediction mode is part of the encoding as it is output as item 100 (yellow highlighting) by C0 Component Intra Prediction Mode Deciding Unit 5 in FIG. 4 and then input to variable length encoding unit 27 which generates the encoded bitstream 30. Sekiguchi, [0043], Fig. 4.



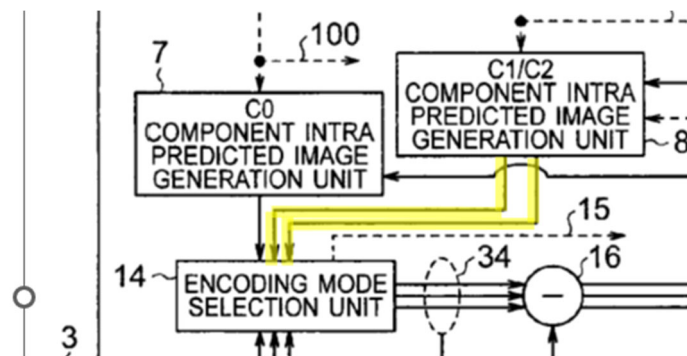
Sekiguchi, Fig. 4 (excerpted)

104. Thus, the combination of Sekiguchi and VCEG-AJ21 discloses or suggests setting the luma partition to 32x32, 16x16, 8x8, or 4x4 (*encoding comprising: setting a luma partition*). See §IX.A.3. And a POSITA would have been motivated to combine Sekiguchi and VCEG-AJ21 for the reasons stated above. See §IX.A.3.

f. 1[e]: *setting a chroma partition from the set of multiple chroma partition types; and,*

105. Sekiguchi in combination with VCEG-AJ21 discloses or suggests 1[e]. As discussed for limitation 1[c], the combination of Sekiguchi and VCEG-AJ21 determines a chroma partition type in response to a luma partition type. See

§IX.A.4.d. Those chroma partition types include at least 16x16, 8x8, and 4x4. *See* §IX.A.4.e. Therefore, the determined chroma partition type is from *the set of multiple chroma partition types*. The combination of Sekiguchi and VCEG-AJ21 also discloses or suggests *setting* that chroma partition to the determined chroma partition type. *See* §IX.A.3. In particular, as shown below in relevant part and annotated, the C1/C2 Component Intra Predicted Image Generation Unit generates a chroma intra prediction image (signals highlighted in yellow) by setting a chroma partition based on the determined chroma partition type. Sekiguchi, [0049] (“Based on the intra prediction modes of the respective color components decided through the aforementioned process, predicted images are generated by the C0 component intra predicted image generation unit 7 and the C1/C2 component intra predicted image generation unit 8.”), Fig. 4.

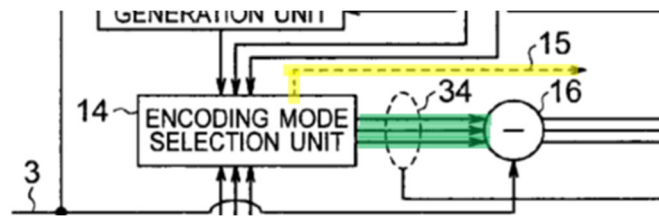


Sekiguchi, Fig. 4 (excerpted)

g. 1[f]: setting a luma prediction mode, setting a chroma prediction mode, wherein chroma and luma have different modes; and encoding the block.

106. Sekiguchi in combination with VCEG-AJ21 discloses or suggests 1[f].

107. As discussed for limitation 1[c], Sekiguchi discloses determining a single chroma intra prediction mode that is different from the luma intra prediction mode. *See* §IX.A.4.d. The different luma and chroma intra prediction modes determined for limitation 1[c] are set by Sekiguchi’s encoder. In particular, Sekiguchi discloses the encoding mode selection unit 14 outputting signals 15 (“encoding mode,” highlighted yellow below) and 34 (“predicted image,” highlighted green below) to C0 component predicted residual encoding unit 18, C1 component predicted residual encoding unit 19, and C2 component predicted residual encoding unit 20 and then ultimately to variable length encoding unit 27 which generates the encoded bitstream 30. Sekiguchi, [0048]-[0049], [0061]-[0067], Fig. 4.



Sekiguchi, Fig. 4 (excerpted)

108. Sekiguchi further discloses “encoded data of the macroblock.” Sekiguchi, [0035].

109. Therefore, the combination of Sekiguchi and VCEG-AJ21 discloses independent determination of intra prediction modes for luma and chroma via a separate C0 Component Intra Prediction Mode Deciding Unit (item 5), which would

provide a luma prediction mode, and C1/C2 Component Intra Prediction Deciding Unit resulting in a C1/C2 component intra prediction mode 101 different from the Y component (*setting a luma prediction mode, setting a chroma prediction mode, wherein chroma and luma have different modes*) and *encoding the block*. And a POSITA would have been motivated to combine Sekiguchi and VCEG-AJ21 for the reasons stated above. *See* §IX.A.3.

5. Claim 2

a. 2[pre]: *A method comprising:*

110. If limiting, Sekiguchi discloses or suggests 2[pre] when it describes “a digital image signal encoding method.” Sekiguchi, [0002]; *see also id.*, [0006], claim 9.

b. 2[a]: *encoding picture data for at least a block in a picture, by perform[ing] intra prediction with multiple partition types for chroma encoding of the block, the multiple partition types comprising a set of multiple chroma partition types of sizes 16×16, 8×8, 4×4 and a set of multiple luma partition types, the set of multiple chroma partition types being different than the set of multiple luma partition types, and*

111. Sekiguchi in combination with VCEG-AJ21 discloses or suggests 2[a] for substantially the same reasons as 1[b]. *See* §IX.A.4.c.

- c. ***2[b]: determining a particular chroma partition type using a single chroma intra prediction mode that is different than a luma intra prediction mode, for encoding a partitioned block from the set of multiple chroma partition types in response to a luma part[ition] type utilized to encode the block, the luma partition type being included in the set of multiple luma partition types and only luma partition type is signaled, not the chroma partition type,***

112. Sekiguchi in combination with VCEG-AJ21 discloses or suggests 2[b] for substantially the same reasons as 1[c]. See §IX.A.4.d.

- d. ***2[c]: said encoding comprising: setting a luma partition,***

113. Sekiguchi in combination with VCEG-AJ21 discloses or suggests 2[c] for substantially the same reasons as 1[d]. See §IX.A.4.e.

- e. ***2[d]: setting a chroma partition from the set of multiple chroma partition types; and,***

114. Sekiguchi in combination with VCEG-AJ21 discloses or suggests 2[d] for substantially the same reasons as 1[e]. See §IX.A.4.f.

- f. ***2[e]: setting a luma prediction mode, setting a chroma prediction mode, wherein chroma and luma have different intra prediction modes; and encoding the block.***

115. Sekiguchi in combination with VCEG-AJ21 discloses or suggests 2[e] for substantially the same reasons as 1[f]. See §IX.A.4.g.

6. Claim 3: *The method of claim 2, wherein a particular chroma partition type for coding the block is determined from the set of chroma partition types responsive to a luma partition type utilized to code the block or one or more neighboring blocks the luma partition type being included in the set of luma partition types.*

116. The combination of Sekiguchi and VCEG-AJ21 discloses or suggests the additional limitation of this claim for substantially the same reasons discussed above for 1[c]. *See* §IX.A.4.d.

7. Claim 5: *The method of claim 3, wherein from among a particular luma partition type and a particular chroma partition type selected to code the block only the particular luma partition type is signaled, the particular luma partition type being selected from the set of luma partition types and the particular chroma partition type being selected from the set of chroma partition types.*

117. Sekiguchi in combination with VCEG-AJ21 discloses or suggests the additional limitation of this claim for substantially the same reasons as 1[c] and 2[b]. *See* §§IX.A.4.d, IX.A.5.c.

8. Claim 10

a. 10[pre]: *A method comprising:*

118. If limiting, Sekiguchi discloses or suggests 10[pre] when it describes “a digital image signal decoding method.” Sekiguchi, [0002]; *see also id.*, [0006], claims 6, 7.

b. 10[a]: decoding picture data for at least a block in a picture, by performing intra prediction with multiple partition types for chroma decoding of the block, the multiple partition types comprising a set of multiple chroma partition types of sizes 16×16 , 8×8 , 4×4 and a set of multiple luma partition types, the set of multiple chroma partition types being different than the set of multiple luma partition types, and

119. Sekiguchi in combination with VCEG-AJ21 discloses or suggests 10[a]. As described for limitation 1[b], the combination of Sekiguchi and VCEG-AJ21 discloses or suggests the *encoding* side of this limitation. See §IX.A.4.c.

120. Sekiguchi further discloses a decoding device, shown in Figure 16 (below), where bit stream 30 (highlighted yellow below) is input, and the decoded video image (highlighted green below) is the output. Sekiguchi, [0025], [0077]-[0078], Fig. 16.

component, and an independently encoded C1/C2 component intra prediction mode 101 is decoded for the Cb/Cr component.” Sekiguchi, [0092]; *see also id.*, [0100], [0102]. It is my opinion that a POSITA would have understood this to describe *decoding* the picture data that was encoded according to the method disclosed in Sekiguchi—as explained above for limitation 1[b]—and the combination of Sekiguchi and VCEG-AJ21 thus discloses or suggests this limitation. Furthermore, a POSITA would have been motivated to combine Sekiguchi and VCEG-AJ21 for the reasons stated above. *See* §IX.A.3.

- c. 10[b]: *determining a particular chroma partition type using a single chroma intra prediction mode that is different than a luma intra prediction mode, for decoding a partitioned block from the set of multiple chroma partition types in response to a luma partition type utilized to decode the block, the luma partition type being included in the set of multiple luma partition types and only luma partition type is signaled, not the chroma partition type,***

123. Sekiguchi in combination with VCEG-AJ21 discloses or suggests 10[b]. As described for limitation 1[c], the combination of Sekiguchi and VCEG-AJ21 discloses or suggests the *encoding* side of this limitation. *See* §IX.A.4.d. And as described for limitation 10[a], Sekiguchi discloses decoding the picture data that was encoded according to the method disclosed in Sekiguchi. *See* §IX.A.8.b. It is my opinion that a POSITA would therefore have understood that Sekiguchi discloses *decoding* the picture data that was encoded according to the method described in

Sekiguchi—as explained above for limitation 1[c]—such that the combination of Sekiguchi and VCEG-AJ21 discloses or suggests this limitation. And a POSITA would have been motivated to make the combination for the reasons stated above. *See* §IX.A.3.

d. 10[c]: *said decoding comprising: parsing a luma partition,*

124. Sekiguchi in combination with VCEG-AJ21 discloses or suggests 10[c]. As described for limitation 1[d], the combination of Sekiguchi and VCEG-AJ21 discloses or suggests the *encoding* side of this limitation. *See* §IX.A.4.e. And as described for limitation 10[a], Sekiguchi discloses decoding the picture data that was encoded according to the method disclosed in Sekiguchi. *See* §IX.A.8.b. It is my opinion that a POSITA would therefore have understood that Sekiguchi discloses *decoding* the picture data that was encoded according to the method disclosed in Sekiguchi—as explained above for limitation 1[d]—such that the combination of Sekiguchi and VCEG-AJ21 discloses or suggests this limitation. *See, e.g.,* Sekiguchi at [0092] (“a C0 component intra prediction mode 100... is decoded”). And a POSITA would have been motivated to make the combination for the reasons stated above. *See* §IX.A.3.

e. 10[d]: *setting a chroma partition from the set of multiple chroma partition types; and,*

125. Sekiguchi in combination with VCEG-AJ21 discloses or suggests 10[d]. As described for limitation 1[e], the combination of Sekiguchi and VCEG-

AJ21 discloses or suggests the *encoding* side of this limitation. *See* §IX.A.4.f. And as described for limitation 10[a], Sekiguchi discloses decoding the picture data that was encoded according to the method disclosed in Sekiguchi. *See* §IX.A.8.b. It is my opinion that a POSITA would therefore have understood that Sekiguchi discloses *decoding* the picture data that was encoded according to the method disclosed in Sekiguchi—as explained above for limitation 1[e]—such that the combination of Sekiguchi and VCEG-AJ21 discloses or suggests this limitation. And a POSITA would have been motivated to combine Sekiguchi and VCEG-AJ21 for the reasons stated above. *See* §IX.A.3.

f. 10[e]: *parsing a luma prediction mode, parsing a chroma prediction mode, wherein chroma and luma have different intra prediction modes; and decoding the block.*

126. Sekiguchi in combination with VCEG-AJ21 discloses or suggests 10[e]. As described for limitation 1[f], the combination of Sekiguchi and VCEG-AJ21 discloses or suggests the *encoding* side of this limitation. *See* §IX.A.4.g. And as described for limitation 10[a], Sekiguchi discloses decoding the picture data that was encoded according to the method disclosed in Sekiguchi. *See* §IX.A.8.b. It is my opinion that a POSITA would therefore have understood that Sekiguchi discloses *decoding* the picture data that was encoded according to the method disclosed in Sekiguchi—as explained above for limitation 1[f]—such that the combination of Sekiguchi and VCEG-AJ21 discloses or suggests this limitation. *See, e.g.,* Sekiguchi

at [0092] (“a C0 component intra prediction mode 100... is decoded for the Y component, and an independently encoded C1/C2 component intra prediction mode 101 is decoded for the Cb/Cr component”). And a POSITA would have been motivated to make the combination for the reasons stated above. *See* §IX.A.3.

9. Claim 12: *The method of claim 10, wherein from among a particular luma partition type and a particular chroma partition type selected to decode the block only information indicating the particular luma partition type is received from a corresponding encoder for use in decoding the block, the particular luma partition type being selected from the set of luma partition types and the particular chroma partition type being selected from the set of chroma partition types.*

127. Sekiguchi in combination with VCEG-AJ21 discloses or suggests the additional limitation of 12.

128. As described for claim 5, the combination of Sekiguchi and VCEG-AJ21 discloses or suggests the *encoding* side of this claim. *See* §IX.A.7. And as described for limitation 10[a] above, Sekiguchi discloses decoding the picture data that was encoded according to the method disclosed in Sekiguchi. *See* §IX.A.8.b. It is my opinion that a POSITA would have therefore understood Sekiguchi to disclose *decoding* the picture data that was encoded according to the method described in Sekiguchi—as explained above for claim 5—such that the combination of Sekiguchi and VCEG-AJ21 thus discloses or suggests this claim. And a POSITA would have been motivated to make the combination for the reasons stated above. *See* §IX.A.3.

10. Claim 14

a. 14[pre]: *A video decoding apparatus, comprising:*

129. If limiting, Sekiguchi discloses or suggests 14[pre]. Sekiguchi describes a video decoding apparatus. Sekiguchi, [0076]-[0077], Fig. 16.

b. 14[a]: *a memory and a processor, configured for:*

130. Sekiguchi discloses or suggests 14[a]. In particular, A POSITA would have understood that Sekiguchi uses a *memory* and *processor* for decoding video. Sekiguchi, [0076]-[0120], Fig. 16; VCEG-AJ21, 1 (Introduction); §IX.A.3. This is shown, for example in the video decoder of Figure 16, which depicts components such as memory (e.g., “frame memory,” item 201) for the video data being decoded. It is my opinion that a POSITA would also have understood that implementing the software/firmware components of Figure 16 would require storing machine instructions in a memory. And some form of processor is needed to execute those instructions and operate on the data.

c. 14[b]: *operating on picture data for at least a block in a picture,*

131. Sekiguchi in combination with VCEG-AJ21 discloses or suggests 14[b] for substantially the same reasons discussed for 1[b] and 10[a]. See §§IX.A.3, IX.A.4.c, IX.A.8.b.

- d. 14[c]: by performing intra prediction with multiple partition types for chroma decoding of the block, the multiple partition types comprising a set of multiple chroma partition types of sizes 16×16 , 8×8 , 4×4 and a set of multiple luma partition the set of multiple chroma partition types being different than the set of multiple luma partition types, and**

132. Sekiguchi in combination with VCEG-AJ21 discloses or suggests 14[c] for substantially the same reasons discussed above for 1[b] and 10[a]. See §§IX.A.3, IX.A.4.c, IX.A.8.b.

- e. 14[d]: determining a particular chroma partition type using a single chroma intra prediction mode that is different than a luma intra prediction mode, for decoding a partitioned block from the set of multiple chroma partition types in response to a luma partition type utilized to decode the block, the luma partition type being included in the set of multiple luma partition types and only luma partition type is signaled, not the chroma partition type,**

133. Sekiguchi in combination with VCEG-AJ21 discloses or suggests 14[d] for substantially the same reasons as 1[c] and 10[b]. See §§IX.A.3, IX.A.4.d, IX.A.8.c.

- f. 14[e]: said decoding comprising: parsing a luma partition,**

134. Sekiguchi in combination with VCEG-AJ21 discloses or suggests 14[e] for substantially the same reasons as 1[d] and 10[c]. See §§IX.A.3, IX.A.4.e, IX.A.8.d.

g. 14[f]: *setting a chroma partition from the set of multiple chroma partition types; and,*

135. Sekiguchi in combination with VCEG-AJ21 discloses or suggests 14[f] for substantially the same reasons as 1[e] and 10[d]. See §§IX.A.3, IX.A.4.f, IX.A.8.e.

h. 14[g]: *parsing a luma prediction mode, parsing a chroma prediction mode, wherein chroma and luma have different intra prediction modes; and decoding the block.*

136. Sekiguchi in combination with VCEG-AJ21 discloses or suggests 14[g] for substantially the same reasons as 1[f] and 10[e]. See §§IX.A.3, IX.A.4.g, IX.A.8.f.

11. Claim 16: *The apparatus of claim 14, wherein from among a particular luma partition type and a particular chroma partition type selected to decode the block only information indicating the particular luma partition type is received from a corresponding encoder for use in decoding the block, the particular luma partition type being selected from the set of luma partition types and the particular chroma partition type being selected from the set of chroma partition types.*

137. Sekiguchi in combination with VCEG-AJ21 discloses or suggests claim 16 for substantially the same reasons as claim 12. See §IX.A.9.

12. Claim 18: *A non-transitory computer readable storage medium comprising data for instruction to implement the method of claim 10.*

138. Sekiguchi in combination with VCEG-AJ21 discloses or suggests the additional limitation of claim 18.

139. It is my opinion that a POSITA would have understood that the methods disclosed in Sekiguchi and VCEG-AJ21 would have been implemented as software, as prior video decoding standards, such as H.264, had been, and that software would have been represented as data for instructions to implement the video decoding methods. VCEG-AJ21, 2 (“In this contribution, we attempt to extend with enlarged MB sizes the JM reference software architecture.”). Therefore, a POSITA would have understood the combination of Sekiguchi and VCEG-AJ21 discloses or suggests implementing the method of claim 10 in a series of instructions stored on a non-transitory computer readable storage medium. A POSITA would have been motivated to make the combination of Sekiguchi and VCEG-AJ21 for the reasons stated above. *See* §IX.A.3.

13. Claim 19: *The apparatus of claim 1, wherein a particular chroma partition type for coding the block is determined from the set of chroma partition types responsive to a luma partition type utilized to code the block or one or more neighboring blocks, the luma partition type being included in the set of luma partition types.*

140. Sekiguchi in combination with VCEG-AJ21 discloses or suggests claim 19 for substantially the same reasons as claims 1 and 3. *See* §§IX.A.4, IX.A.6.

B. Ground 1B: Sekiguchi in view of VCEG-AJ21 and H.264

1. H.264

141. H.264 is a standard for “higher compression of moving pictures for various applications such as videoconferencing, digital storage media, television broadcasting, Internet streaming, and communication.” H.264, i. The revision of H.264 referenced herein (EX-1010) was approved by the ITU-T Study Group 16 in November 2007 and was publicly available by August 12, 2008. H.264, i; Munford, ¶¶7-36. It is my understanding that H.264 is prior art under §102(b).⁵

2. Motivation to combine Sekiguchi, VCEG-AJ21, and H.264

142. It is my opinion that a POSITA would have been motivated to combine H.264 with the combination of Sekiguchi and VCEG-AJ21 discussed above (*see* §**Error! Reference source not found.**) to extend H.264’s macroblock structure to larger macroblocks, and to separate luma and chroma intra prediction, as taught by Sekiguchi and VCEG-AJ21, and would have had a reasonable expectation of success in doing so.

143. Each of Sekiguchi and VCEG-AJ21 expressly build upon H.264. Sekiguchi, [0004] (“An international standard video encoding system such as MPEG

⁵ I understand that the substance of EX-1010 reference was also available, in the form of Amendments 1 and 2 to the 2005 version of H.264, which were publicly available no later than September 2007. EX-1015 (“H.264 (03/2005)”; Munford, ¶36, Appendices H26402 (EX-1016 (“Amendment 1”)), H26403 (EX-1017 (“Amendment 2”)). Alternative citations to H.264 (03/2005), Amendment 1, and/or Amendment 2 are provided as footnotes throughout this Declaration.

or ITU-T H.26x (e.g., ‘Information Technology Coding of Audio-Visual Objects Part 10: Advanced Video Coding’, ISO/IEC 14496-10, 2003,” also known as MPEG-4 Part 10, MPEG-4 AVC standard, and H.264 (2003 version)); VCEG-AJ21, 1 (Abstract).

144. Sekiguchi recognized that H.264 used “a macroblock area composed of luminance components 16x16 pixels” and “corresponding chrominance components are 8x8 pixel blocks.” Sekiguchi, [0005]. Sekiguchi disclosed enhancements including different intra partition types and intra prediction modes for luma and chroma. Sekiguchi, [0043], [0045].

145. VCEG-AJ21 proposes “extend[ing] the architecture of H.264 codec with enlarged MB sizes.” VCEG-AJ21, 1. VCEG-AJ21 recognizes the limitation of H.264’s 16x16 macroblock and the benefits of larger macroblocks, especially for High Definition (“HD”) video. *Id.*, 1 (“It may not be efficient for the HD or beyond HD since the MB size of 16x16 pixels is relatively small for high resolution video contents.”), 2 (“It implies that relatively large block modes are more advantageous to the high resolution videos in terms of the Rate-distortion optimization.”). In particular, VCEG-AJ21 discloses a macroblock using a 32x32 pixel block for a luma partition, and a 16x16 pixel block for a chroma partition. VCEG-AJ21, 4-5, Fig. 5.

146. It is my opinion that a POSITA would have understood the teachings of Sekiguchi and VCEG-AJ21 to build on the work of H.264 by adding larger block

sizes, additional partition types, and additional intra prediction modes using routine engineering. In particular, the new intra prediction partition types and modes would be added to Table 7-11 of H.264, and the macroblock syntax of Section 7.3.5 would be adjusted to include encoding of the different intra partition types and modes. H.264, 51-53, 91.⁶ Doing so would not adversely affect (and would in fact benefit) the H.264 standard.

3. Claim 4: *The method of claim 3, wherein for the particular chroma partition type, a largest-size available transform matching the particular chroma partition type is selected from a set of transforms.*

147. Sekiguchi in view of VCEG-AJ21 and H.264 discloses or suggests the additional limitation of claim 4.

148. For the 4:2:0 format, H.264 discloses a single transform available to be used for chroma: 4x4. H.264, 172.⁷ So for each *particular chroma partition type* (16x16, 8x8, 4x4) in the combination of Sekiguchi, VCEG-AJ21, and H.264, the *largest-size available transform (4x4) is selected from a set of transforms* (the set containing the single element: the 4x4 transform).

149. To the extent PO argues that H.264 discloses two *available transforms*—i.e., 8x8 and 4x4—the combination of Sekiguchi, VCEG-AJ21, and

⁶ H.264 (03/2005), 50, 87.

⁷ H.264 (03/2005), 162; Amendment 2, 29-30.

H.264 nevertheless still discloses or suggests this limitation. H.264 explains that when an 8x8 chroma partition type is used (for the 4:4:4 format), there is an 8x8 transform available for chroma. H.264, 174 (Section 8.5.5).⁸ It is my opinion that a POSITA would have understood that for the combined system of Sekiguchi and VCEG-AJ21—which includes an 8x8 chroma partition type, as shown for limitation 1[b]—there would be a motivation to use the larger 8x8 chroma partition disclosed in H.264 for the 4:4:4 format because large transforms provide better energy compaction and better preservation of detail than small transforms. Wien, 604, 608 (“With ABT, the encoder can trade energy compaction by larger transforms against the size of the region a single prediction direction is applied to.”). So for at least 8x8 and 4x4 chroma partition types, the combination of Sekiguchi, VCEG-AJ21, and H.264 discloses or suggests selecting the *largest-size available transform* (8x8 for an 8x8 chroma partition and 4x4 for a 4x4 chroma partition), from *a set of transforms* (the set consisting of the 8x8 and 4x4 transforms), meeting this limitation.

150. Further, for the 16x16 chroma partition, it would have been “obvious to try” the 8x8 transform. There are a finite number of options available (the 4x4 and 8x8 transforms) described in H.264. As both options are provided in H.264, they are each an identified, predictable solution. Therefore, it is my opinion that a POSITA would have had two potential options, and it would have been obvious to try them

⁸ Amendment 2, 30.

both to determine which provided better energy compaction and better preservation of detail. As discussed above, because given the better energy compaction and better preservation of detail available from a larger transform, a POSITA would have had success using the larger (8x8) transform. Wien, 604, 608. Therefore, the combination of Sekiguchi, VCEG-AJ21, and H.264 discloses or suggests selecting the *largest-size available transform* (8x8 for a 16x16 chroma partition, 8x8 for an 8x8 chroma partition, and 4x4 for a 4x4 chroma partition), from *a set of transforms* (the set consisting of the 8x8 and 4x4 transforms). A POSITA would have been motivated to make the combination of Sekiguchi, VCEG-AJ21, and H.264 for the reasons stated above. See §IX.B.2.

4. Claim 6: *The method of claim 5, wherein the particular luma partition type is absolutely coded or differentially coded from one or more neighboring blocks.*

151. VCEG-AJ21 and H.264 disclose or suggest the additional limitation of claim 6.

152. Section 7.3.5 of H.264 provides a syntax for encoding macroblocks, which includes encoding `mb_type` (outlined in red below) and `transform_size_8x8_flag` (outlined in blue below).

macroblock_laver() {	C	Descriptor
mb_type	2	ue(v) ae(v)
if(mb_type == I_PCM) {		
while(!byte_aligned())		
pcm_alignment_zero_bit	3	f(1)
for(i = 0; i < 256; i++)		
pcm_sample_luma[i]	3	u(v)
for(i = 0; i < 2 * MbWidthC * MbHeightC; i++)		
pcm_sample_chroma[i]	3	u(v)
} else {		
noSubMbPartSizeLessThan8x8Flag = 1		
if(mb_type != I_NxN &&		
MbPartPredMode(mb_type, 0) != Intra_16x16 &&		
NumMbPart(mb_type) == 4) {		
sub_mb_pred(mb_type)	2	
for(mbPartIdx = 0; mbPartIdx < 4; mbPartIdx++)		
if(sub_mb_type[mbPartIdx] != B_Direct_8x8) {		
if(NumSubMbPart(sub_mb_type[mbPartIdx]) > 1)		
noSubMbPartSizeLessThan8x8Flag = 0		
} else if(!direct_8x8_inference_flag)		
noSubMbPartSizeLessThan8x8Flag = 0		
} else {		
if(transform_8x8_mode_flag && mb_type == I_NxN)		
transform_size_8x8_flag	2	u(1) ae(v)
mb_pred(mb_type)	2	
}		
if(MbPartPredMode(mb_type, 0) != Intra_16x16) {		
coded_block_pattern	2	me(v) ae(v)
if(CodedBlockPatternLuma > 0 &&		
transform_8x8_mode_flag && mb_type != I_NxN &&		
noSubMbPartSizeLessThan8x8Flag &&		
(mb_type != B_Direct_16x16 direct_8x8_inference_flag))		
transform_size_8x8_flag	2	u(1) ae(v)
}		
if(CodedBlockPatternLuma > 0 CodedBlockPatternChroma > 0		
MbPartPredMode(mb_type, 0) == Intra_16x16) {		
mb_qp_delta	2	se(v) ae(v)
residual(0, 0, 15)	3 4	
}		
}		
}		

H.264, 51.⁹

153. H.264's Table 7-11 includes the allowed macroblock types for intra prediction frames. H.264, 91.¹⁰ Both mb_type (red) and transform_size_8x8_flag (blue) are included in Table 7-11, reproduced in part and annotated below.

⁹ H.264 (03/2005), 50.

¹⁰ H.264 (03/2005), 87.

mb_type	Name of mb_type	transform_size_8x8_flag	MbPartPredMode (mb_type, 0)	Intra16x16 PredMode	CodedBlock PatternChroma	CodedBlock PatternLuma
0	I_NxN	0	Intra_4x4	na	Equation 7-34	Equation 7-34
0	I_NxN	1	Intra_8x8	na	Equation 7-34	Equation 7-34
1	I_16x16_0_0_0	na	Intra_16x16	0	0	0
2	I_16x16_1_0_0	na	Intra_16x16	1	0	0
3	I_16x16_2_0_0	na	Intra_16x16	2	0	0

H.264, 93 (excerpted)

154. Also in Table 7-11 is the result of the function MbPartPredMode(mb_type,0) (yellow). As shown, *the particular luma partition type is absolutely coded* by the combination of the syntax elements mb_type and transform_size_8x8_flag. For example, when mb_type is encoded as 0 and transform_size_8x8_flag is encoded as 0, MbPartPredMode(mb_type,0) results in a luma partition type of Intra_4x4. When mb_type is encoded as 0 and transform_size_8x8_flag is encoded as 1, MbPartPredMode(mb_type,0) results in luma partition type of Intra_8x8. When mb_type is set to any value in the range 1-24, then transform_size_8x8_flag is not present in the bitstream, transform_size_8x8_flag is inferred to be equal to 0 (*see, e.g., H.264, 90, NOTE*

2),¹¹ and MbPartPredMode(mb_type,0) results in a luma partition type of Intra_16x16.. This is summarized by the table I created below.

mb_type	Name of mb_type	transform_size_8x8_flag	MbPartPredMode (mb_type,0)
0	I_NxN	0	Intra_4x4
0	I_NxN	1	Intra_8x8
1-24	I_16x16_X	N/A	Intra_16x16
25	I_PCM	N/A	N/A

155. Section 7.3.5.1 of H.264 (“Macroblock prediction syntax”) describes a function “mb_pred()” with if/then statements for intra prediction of luma based on the result of MbPartPredMode() discussed above. H.264, 52.¹²

¹¹ H.264 (03/2005), 86, NOTE 2.

¹² H.264 (03/2005), 51; Amendment 2, 13.

if(MbPartPredMode(mb_type, 0) == Intra_4x4 MbPartPredMode(mb_type, 0) == Intra_8x8 MbPartPredMode(mb_type, 0) == Intra_16x16) {		
if(MbPartPredMode(mb_type, 0) == Intra_4x4)		
for(luma4x4BlkIdx=0; luma4x4BlkIdx<16; luma4x4BlkIdx++) {		
prev_intra4x4_pred_mode_flag[luma4x4BlkIdx]	2	u(1) ae(v)
if(!prev_intra4x4_pred_mode_flag[luma4x4BlkIdx])		
rem_intra4x4_pred_mode[luma4x4BlkIdx]	2	u(3) ae(v)
}		
if(MbPartPredMode(mb_type, 0) == Intra_8x8)		
for(luma8x8BlkIdx=0; luma8x8BlkIdx<4; luma8x8BlkIdx++) {		
prev_intra8x8_pred_mode_flag[luma8x8BlkIdx]	2	u(1) ae(v)
if(!prev_intra8x8_pred_mode_flag[luma8x8BlkIdx])		
rem_intra8x8_pred_mode[luma8x8BlkIdx]	2	u(3) ae(v)
}		
if(ChromaArrayType == 1 ChromaArrayType == 2)		
intra_chroma_pred_mode	2	ue(v) ae(v)

H.264, 52 (excerpted)

156. For example, if the luma intra prediction partition type is set to Intra_4x4 as indicated by the return value of MbPartPredMode(mb_type,0), there is a for loop that processes intra prediction for luma for each 4x4 block, as shown below. This signaling is unlike chroma intra prediction modes (as distinct from chroma intra prediction *partitions*, which are *not* signaled) and luma intra prediction modes for luma 16x16 intra prediction partitions, which are not differentially coded. The syntax elements prev_intra4x4_pred_mode_flag and rem_intra4x4_pred_mode differentially encode the luma 4x4 intra prediction *mode* (i.e., the intra prediction “method” or “algorithm” as distinct from the luma intra prediction *partition*) based on the intra prediction modes used in neighboring blocks.

if(MbPartPredMode(mb_type, 0) == Intra_4x4)		
for(luma4x4BlkIdx=0; luma4x4BlkIdx<16; luma4x4BlkIdx++) {		
prev_intra4x4_pred_mode_flag[luma4x4BlkIdx]	2	u(1) ae(v)
if(!prev_intra4x4_pred_mode_flag[luma4x4BlkIdx])		
rem_intra4x4_pred_mode[luma4x4BlkIdx]	2	u(3) ae(v)
}		

H.264, 52 (excerpted)

157. The H.264 function mb_pred() also defines a similar loop that processes intra prediction modes similarly for luma 8x8 intra prediction blocks, as shown below.

if(MbPartPredMode(mb_type, 0) == Intra_8x8)		
for(luma8x8BlkIdx=0; luma8x8BlkIdx<4; luma8x8BlkIdx++) {		
prev_intra8x8_pred_mode_flag[luma8x8BlkIdx]	2	u(1) ae(v)
if(!prev_intra8x8_pred_mode_flag[luma8x8BlkIdx])		
rem_intra8x8_pred_mode[luma8x8BlkIdx]	2	u(3) ae(v)
}		

H.264, 52 (excerpted)

158. VCEG-AJ21 adds a 32x32 pixel macroblock to H.264, as illustrated in Figure 5 below. VCEG-AJ21, 4-5, Fig. 5.

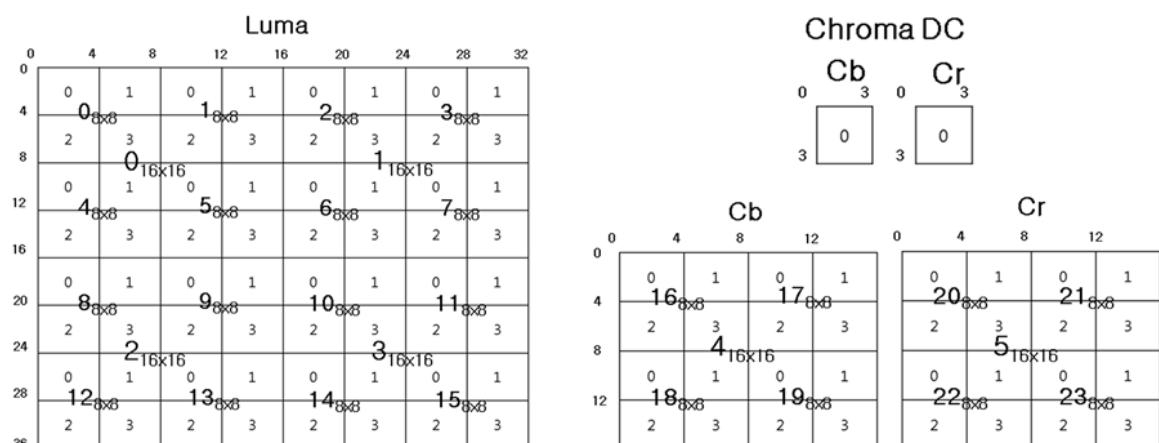
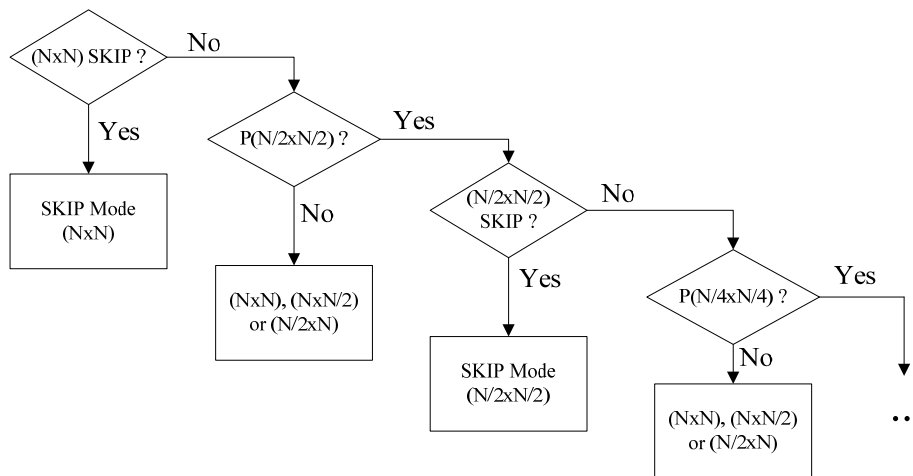


Fig. 5 Block indexing for 32x32 MB

159. The third row of Table 2 lists the possible partition block modes for inter prediction for the 32x32 block. VCEG-AJ21, 4 (“SKIP_32x32(0), 32x32(1), 32x16(2), 16x32(3), SKIP_16x16(4), 16x16(5), 16x8(6), 8x16(7), 8x8(8), 8x4(9), 4x8(10), 4x4(11)”). A POSITA would have understood that to be a superset of partition types that would apply to intra prediction. In particular, any partition type using a square partition (i.e., 32x32, 16x16, 8x8, 4x4) would be applicable for intra prediction. And Figure 6 of VCEG-AJ21 further shows the hierarchical processing of the enlarged macroblock, such as the 32x32 block, for the case of the P type modes.



160. Again, while VCEG-AJ21 expressly focuses on inter prediction, and while the flow chart of Fig. 6 is illustrative for the case of P type inter prediction modes while omitting the case of B type inter prediction modes, a POSITA would have understood that similar logic to that illustrated in the flow chart of Figure 6 would also apply to the syntax for the square partitions of intra prediction (i.e., NxN,

N/2xN/2, N/4xN/4). Thus, a POSITA would have understood that while VCEG-AJ21 expressly focuses on inter prediction, it also discloses or suggests partition types for enlarged 32x32 macroblocks, which in the 4:2:0 format would comprise partition types for 32x32 luma blocks and 16x16 chroma blocks that a POSITA would have found obvious to use for intra prediction for the reasons I already discussed above. *See* §IX.B.2.

161. It is my opinion that a POSITA would have further understood that using an enlarged 32x32 macroblock would require encoding luma at that partition size, along with 4x4, 8x8, and 16x16 (as is shown in Table 7-11 of H.264). In particular, a POSITA would have updated Table 7-11 of H.264 to include additional rows for mb_type values representing intra prediction of luma blocks of size 32x32 (each of which would result in a return value of Intra_32x32 from MbPartPredMode(mb_type,0)). It should be noted that in VCEG-AJ21, macroblocks larger than 16x16 are generally referred to as “enlarged” macroblocks or MB’s and the string “EMB” may be added to names and identifiers as in, e.g., “CBP_EMB.” VCEG-AJ21, 5, Fig. 7. The updated table would include the following logic (new rows highlighted yellow):

mb_type	Name of mb_type	transform_size_8x8_flag	MbPartPredMode
0	I_NxN	0	Intra_4x4

0	I_NxN	1	Intra_8x8
1-24	I_16x16_X	N/A	Intra_16x16
25	I_PCM	N/A	N/A
26	I32EMB_NxN	0	Intra_4x4
26	I32EMB_NxN	1	Intra_8x8
27	I32EMB_16x16	N/A	Intra_16x16
28-51	I32EMB_32x32_X	N/A	Intra_32x32
52	I32EMB_PCM	N/A	N/A

162. In addition, the syntax of H.264 clauses 7.3.5 and 7.3.5.1 would be easily updated to account for the new intra prediction of 32x32 blocks, requiring only routine engineering to expand the “if-then-else” statements and loops to account for the added mb_types and partitions. It is also my opinion that more sophisticated alternative implementations potentially providing corresponding coding efficiency improvements or reduced complexity would also be obvious for a POSITA to implement, albeit with increased amounts of routine engineering. For example, it would be obvious for a POSITA to increase the number of bits used for coded block pattern (CBP in H.264, CBP_EMB in VCEG-AJ21) to specify which out of a larger number than four luma blocks and two chroma blocks may contain non-zero transform coefficient levels, to define additional Intra_16x16 mb_types

that could implicitly encode all or part of the CBP_EMB or 16x16 luma intra prediction modes for the macroblock, or to alternatively define a single Intra_32x32 mb_type and signal the CBP_EMB or luma intra prediction mode in the macroblock header, potentially using more than 6 bits for the CBP_EMB.

163. Thus, the combination of Sekiguchi, VCEG-AJ21, and H.264 discloses or suggests that mb_type and transform_size_8x8_flag encode the partition information for luma intra prediction for each particular 4x4, 8x8, 16x16, and 32x32 block, without reference to any other block (*the particular luma partition type is absolutely coded*). A POSITA would have been motivated to make the combination of Sekiguchi, VCEG-AJ21, and H.264 for the reasons stated above. See §IX.B.2.

5. Claim 11: *The method of claim 10, wherein for the particular chroma partition type, a largest-size available transform matching the particular chroma partition type is selected from a set of transforms.*

164. Sekiguchi in view of VCEG-AJ21 and H.264 discloses or suggests the additional limitation of claim 11.

165. As described for claim 4, the combination of Sekiguchi, VCEG-AJ21, and H.264 discloses or suggests the *encoding* side of this claim. See §IX.B.3. As described for limitation 10[a], Sekiguchi discloses decoding the picture data that was encoded according to the method disclosed in Sekiguchi. See §IX.A.8.b. It is my opinion that a POSITA would therefore have understood that Sekiguchi discloses

decoding the picture data that was encoded according to the method disclosed in Sekiguchi—as explained above for claim 4—and the combination of Sekiguchi, VCEG-AJ21, and H.264 discloses or suggests this claim. A POSITA would have been motivated to make the combination of Sekiguchi, VCEG-AJ21, and H.264 for the reasons stated above. *See* §IX.B.2.

6. Claim 13: *The method of claim 12, wherein the particular luma partition type is absolutely decoded or differentially decoded from one or more neighboring blocks.*

166. Sekiguchi in view of VCEG-AJ21 and H.264 discloses or suggests the additional limitation of 13.

167. As described for claim 6, the combination of Sekiguchi and VCEG-AJ21 discloses or suggests the *encoding* side of this claim. *See* §IX.B.4. And as described for limitation 10[a], Sekiguchi discloses decoding the picture data that was encoded according to the method disclosed in Sekiguchi. *See* §IX.A.8.b. It is my opinion that a POSITA would therefore have understood that Sekiguchi discloses *decoding* the picture data that was encoded according to the method disclosed in Sekiguchi—as explained above for claim 6—and the combination of Sekiguchi, VCEG-AJ21, and H.264 discloses or suggests this claim. A POSITA would have been motivated to make the combination of Sekiguchi, VCEG-AJ21, and H.264 for the reasons stated above. *See* §IX.B.2.

7. Claim 15: *The apparatus of claim 14, wherein for the particular chroma partition type, a largest-size available transform matching the particular chroma partition type is selected from a set of transforms.*

168. Sekiguchi in view of VCEG-AJ21 and H.264 discloses or suggests the additional limitation of claim 15 for substantially the same reasons as claims 11 and 14. *See* §§IX.B.5, IX.A.10.

8. Claim 17: *The apparatus of claim 14, wherein the particular luma partition type is absolutely decoded or differentially decoded from one or more neighboring blocks.*

169. Sekiguchi in view of VCEG-AJ21 and H.264 discloses or suggests the additional limitation of claim 17 for substantially the same reasons as claims 13 and 14. *See* §§IX.B.6, IX.A.10.

9. Claim 20: *The apparatus of claim 19, wherein for the particular chroma partition type, a largest-size available transform matching the particular chroma partition type is selected from a set of transforms.*

170. Sekiguchi in view of VCEG-AJ21 and H.264 discloses or suggests the additional limitation of claim 20 for substantially the same reasons as claim 4. *See* §IX.D.2.

C. Ground 2A: Xiong in view of VCEG-AJ21

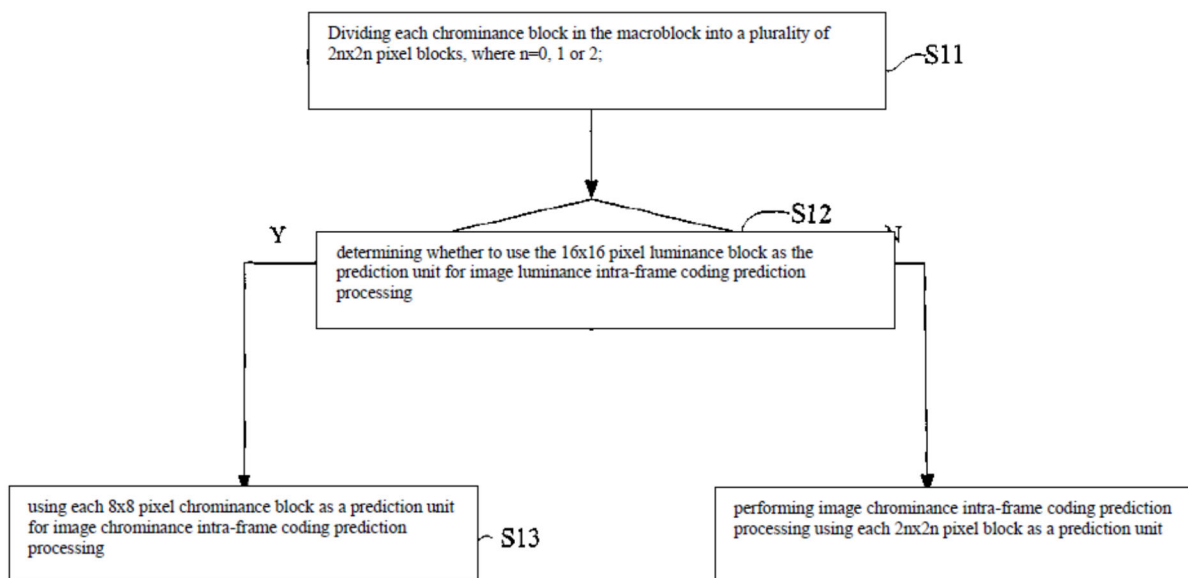
1. Xiong

171. Xiong (WO2006/026903) was published on March 16, 2006. I understand that Xiong qualifies as prior art under 35 U.S.C. §§102(a) and 102(b).

172. Xiong discloses a method for intra-frame coding. Xiong, 1 (Abstract).¹³

In particular, Xiong proposes a method that improves image chrominance coding efficiency in video coding. Xiong, 5:11-13. Xiong determines the chrominance block based on the size of the luminance block. Xiong, 5:10-6:20.

173. In Xiong's first embodiment, which is the embodiment I use for the combinations in my opinions contained herein, when a 16x16 pixel luma block is used, Xiong's method uses an 8x8 pixel block as a prediction unit for chroma intra-frame coding prediction processing. Xiong, 5:20-24; 10:5-9. Or when a different sized luma block is used, Xiong's method uses $2^n \times 2^n$ pixel blocks as a prediction unit for chroma intra-frame coding processing, where $n = 0, 1$, or 2 . Xiong, 5:15-24, 9:26-10:9. This is shown in Figure 6. Xiong, Fig. 6.



¹³ Citations to Xiong refer to the English translation of WO2006/026903, EX-1008.

174. The determination of whether $n = 0, 1, \text{ or } 2$ is made for each implementation of Xiong's method (applicable to each of Xiong's disclosed embodiments). Xiong describes " $n=2$, i.e., dividing each chrominance block into four 4×4 pixel blocks, as the most preferred implementation." Xiong, 9:5-11. Therefore, in Xiong's "most preferred implementation," Xiong uses either 8×8 or 4×4 pixel blocks for intra-frame chroma prediction.

2. Motivation to Combine Xiong and VCEG-AJ21

175. It is my opinion that a POSITA would have been motivated to combine Xiong and VCEG-AJ21 to extend Xiong's teachings of determining chroma block sizes based on luma block sizes to include larger block sizes, and a POSITA would have had a reasonable expectation of success in doing so.

176. Both references build upon H.264. Xiong, 3:8-15; VCEG-AJ21, 1 (Abstract). Both references also disclose macroblock sizes, luminance components, and chroma components. Xiong, 3:16-20, 5:10-23; VCEG-AJ21, 1, 3, 4-5. Both references also use the 4:2:0 format. Xiong, 8:18-24; VCEG-AJ21, 4. The references present overlapping, compatible concepts such as enhancing the efficiency of the prior art (H.264) video encoding and decoding process by providing a correspondence between a luma block and a chroma block. Xiong, 5:10-22; VCEG-AJ21, 1 (Abstract), 6 (Conclusion), 4-5, Figs. 4, 5.

177. While Xiong focuses on intra prediction of luma and chroma blocks using traditional 16x16 macroblocks—which VCEG-AJ21 also discloses—VCEG-AJ21 discloses larger macroblock sizes for luma and chroma encoding, including 32x32 luma blocks. VCEG-AJ21, 5, Fig. 5. A POSITA would have been motivated to apply Xiong’s separate intra prediction for luma and chroma to VCEG-AJ21’s larger macroblock size because doing so would allow for more efficient encoding of luma and chroma intra prediction by taking advantage of VCEG-AJ21’s larger block sizes, and it would not have adversely affected Xiong’s system (and in fact would have enhanced it). This combination would have involved only routine engineering tasks, such as modifying the firmware/software of Xiong’s system to incorporate the 32x32 luma partition and 16x16 chroma partition disclosed in VCEG-AJ21. This would have been as simple as an additional conditional statement (e.g., if/then, or “switch” statement) to account for VCEG-AJ21’s 32x32 luma partition.

3. Claim 1

a. 1[pre]: *A video encoding apparatus, comprising:*

178. If limiting, Xiong discloses or suggests 1[pre]. Xiong discloses intra-frame coding implementations that could be used in, for example, “conference television, videophone, streaming media, high-definition laser video disc (HD DVD, High-definition digital video disc) and video surveillance.” Xiong, 3:8-15. Each of these would be a *video encoding apparatus* for Xiong’s disclosed method.

b. 1[a]: a memory and a processor, configured for:

179. Xiong discloses or suggests 1[a].

180. As discussed above, Xiong discloses intra-frame coding in, for example, “conference television, videophone, streaming media, high-definition laser video disc (HD DVD, High-definition digital video disc) and video surveillance.” Xiong, 3:8-15. It is my opinion that a POSITA would have understood such devices include a memory for storing the software/firmware instructions corresponding to Xiong’s method as well as a processor to execute those instructions. It was well understood at the time that memory and processors were routinely used to implement video encoders and decoders. For example, Xiong’s Figure 1, “which is a schematic diagram of the process of compressing and encoding an image using the H.264 compression encoding technology in the prior art” (see Xiong, 3:16-17), includes a box labeled “Code Control,” which a POSITA would have understood to imply executable software/firmware code to be stored in memory and executed on some type of processor (contrast the accompanying box located further right in Figure 1 and labeled “Data Control”), as well as boxes labeled “Intra-frame Inter-frame” and “Intra-frame Prediction,” both of which a POSITA would have understood to require memory for storing previously encoded macroblocks so that they could be used to form intra predictions. As another example, the prologue of the H.264 standard itself states “[a]s the costs for *both processing power and memory* have reduced, network

support for coded video data has diversified...” (see H.264 (Nov. 2007), subclause 0.1, emphasis added), again demonstrating that a POSITA would have well understood that memory and processors were routinely used to implement video encoders and decoders at the time.

- c. ***1[b]: encoding picture data for at least a block in a picture, by performing intra prediction with multiple partition types for chroma encoding of the block, the multiple partition types comprising a set of multiple chroma partition types of sizes 16×16, 8×8, 4×4 and a set of multiple luma partition types, the set of multiple chroma partition types being different than the set of multiple luma partition types, and***

181. Xiong in combination with VCEG-AJ21 discloses or suggests 1[b].

Xiong discloses encoding picture data for a block of a picture, using intra prediction. Xiong, 5:10-24, 10:5-9, Fig. 6. In particular, Xiong discloses luma partition types that include at least 16x16 pixel blocks, and chroma partition types that include at least 8x8 and 4x4 pixel blocks. Xiong, 5:10-24 (“determining whether to use the 16x16 pixel luminance block as the prediction unit for image luminance intra-frame coding prediction”), (“using each 8 x 8-pixel chrominance block as a prediction unit for image chrominance intra-frame coding prediction”), (“performing image chrominance intra-frame coding prediction using each 2ⁿx2ⁿ pixel block as a prediction unit”), 9:5-11, 10:5-9, Fig. 6 (S13 (“8x8 pixel chrominance block”), S14 (“2^[n]x2^[n] pixel block”).

182. VCEG-AJ21 likewise discloses a luma partition of 16x16 but adds 32x32, 8x8, and 4x4. VCEG-AJ21, 4-5, Figs. 4-5, Table 2. The combination of Xiong and VCEG-AJ21 thus discloses or suggests *a set of multiple luma partition types* that includes 4x4, 8x8, 16x16, and 32x32. See §IX.C.2.

183. VCEG-AJ21 additionally discloses chroma partition types of 8x8 and 16x16, as shown in Figures 4 and 5, respectively. VCEG-AJ21, 4-5, Figs. 4, 5.

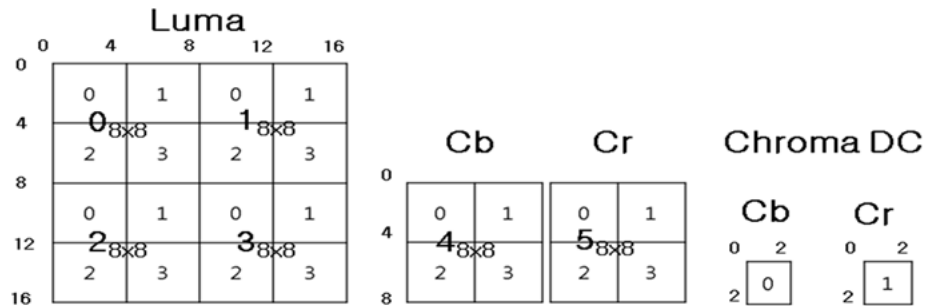


Fig. 4 Block indexing for 16x16 MB

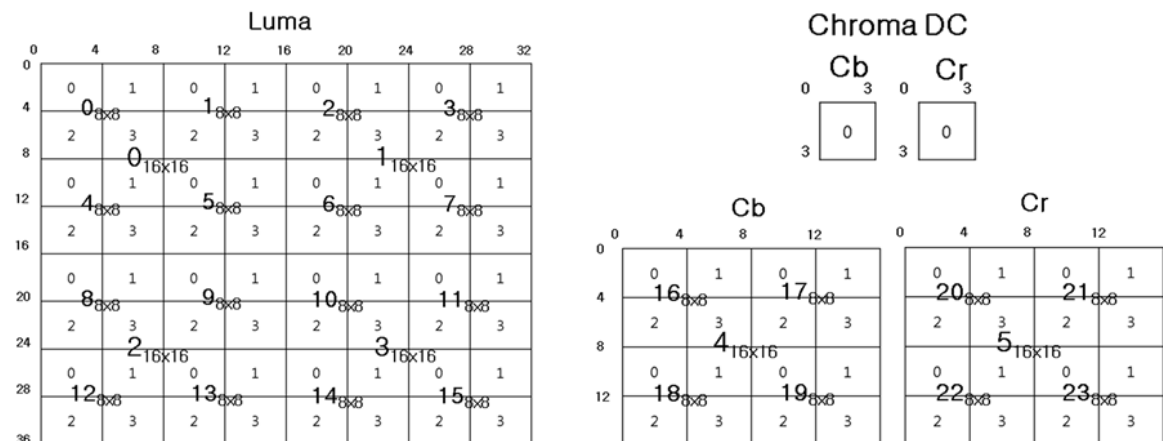


Fig. 5 Block indexing for 32x32 MB

184. To the extent PO argues that Figures 4 and 5 of VCEG-AJ21 do not explicitly disclose 8x8 and 16x16 chroma partitions, it is my opinion that a POSITA

would have understood this to be disclosed by VCEG-AJ21 by those figures in combination with Table 2 of VCEG-AJ21. Table 2 of VCEG-AJ21 includes 32x32 and 16x16 prediction modes usable for both inter and intra prediction, as discussed above. *See* §IX.A.2 (¶¶72, 73).

Table 2. Possible partition block modes (mb_type) for enlarged MB's of 128x128, 64x64 and 32x32

128x128 MB size	SKIP_128x128(0), 128x128(1), 128x64(2), 64x128(3), SKIP_64x64(4), 64x64(5), 64x32(6), 32x64(7), SKIP_32x32(8), 32x32(9), 32x16(10), 16x32(11), SKIP_16x16(12), 16x16(13), 16x8(14), 8x16(15), 8x8(16), 8x4(17), 4x8(18), 4x4(19),
64x64 MB size	SKIP_64x64(0), 64x64(1), 64x32(2), 32x64(3), SKIP_32x32(4), 32x32(5), 32x16(6), 16x32(7), SKIP_16x16(8), 16x16(9), 16x8(10), 8x16(11), 8x8(12), 8x4(13), 4x8(14), 4x4(15),
32x32 MB size	SKIP_32x32(0), 32x32(1), 32x16(2), 16x32(3), SKIP_16x16(4), 16x16(5), 16x8(6), 8x16(7), 8x8(8), 8x4(9), 4x8(10), 4x4(11),

185. A POSITA would have understood VCEG-AJ21's 32x32 enlarged macroblock to provide luma intra prediction partitions of 32x32, 16x16, 8x8, and 4x4 and VCEG-AJ21's 16x16 macroblock, like the standard H.264 16x16 macroblock, to provide luma intra prediction partitions of 16x16, 8x8, and 4x4 for luma intra prediction. A POSITA would have understood that, for the 4:2:0 format, the partitions used for the chroma components could be, at most, one quarter the size of the luma partition. So, for the 32x32 mode, the chroma partition could be, at most, 16x16. And for the 16x16 mode, the chroma partition could be, at most, 8x8. A POSITA would have understood VCEG-AJ21 to disclose both of these chroma partitions as well as a 4x4 chroma partition like the one disclosed by Xiong, as shown in both Fig. 4 and Fig. 5 of VCEG-AJ21. VCEG-AJ21, 4-5, Figs. 4, 5, Table 2.

186. The combination of Xiong and VCEG-AJ21 thus also discloses or suggests *multiple partition types comprising a set of multiple chroma partition types of sizes 16×16 , 8×8 , 4×4 . See §IX.C.2.* And because the combination of Xiong and VCEG-AJ21 does not teach a set of chroma partition types that includes 32×32 , the *set of multiple chroma partition types is different than the set of multiple luma partition types.* A POSITA would have been motivated to make the combination of Xiong and VCEG-AJ21 for the reasons stated above. See §IX.C.2.

d. 1[c]: *determining a particular chroma partition type using a single chroma intra prediction mode that is different than a luma intra prediction mode, for encoding a partitioned block from the set of multiple chroma partition types in response to a luma partition type utilized to encode the block, the luma partition type being included in the set of multiple luma partition types and only luma partition type is signaled, not the chroma partition type,*

187. Xiong in combination with VCEG-AJ21 discloses or suggests 1[c]. For the 4:2:0 format, VCEG-AJ21 discloses using an 8×8 chroma partition type in response to a 16×16 luma partition type (*see VCEG-AJ21, Fig. 4*), and a 16×16 chroma partition type in response to a 32×32 luma partition type (*see VCEG-AJ21, Fig. 5*) (*determining a particular chroma partition type...in response to a luma partition type utilized to encode the block, the luma partition type being included in the set of multiple luma partition types*). VCEG-AJ21, 4-5, Figs. 4-5.

188. Further, Xiong discloses that if a 16x16 luma partition is used for intra-picture prediction, then an 8x8 chroma partition is used. Xiong, 5:10-24 ((“determining whether to use the 16x16 pixel luminance block as the prediction unit for image luminance intra-frame coding prediction, and if yes, go to step (A1-2) [which is] using each 8 x 8-pixel chrominance block as a prediction unit for image chrominance intra-frame coding prediction”)), 9:5-11, 10:5-9, Fig. 6 (S13 (“8x8 pixel chrominance block”)). And in the “most preferred implementation” as applied to the first embodiment, Xiong discloses using a 4x4 chroma block if a luma block other than 16x16 pixels is used. Xiong, 5:10-24 (“performing image chrominance intra-frame coding prediction using each $2^n \times 2^n$ pixel block as a prediction unit”), 9:5-11, 10:5-9, Fig. 6 (S14 (“ $2^{[n]} \times 2^{[n]}$ pixel block”)). Xiong thus *determin[es] a particular chroma partition type...for encoding a partitioned block from the set of multiple chroma partition types in response to a luma partition type utilized to encode the block* (8x8 chroma block in response to 16x16 luma block; 4x4 chroma block in response to non-16x16 luma block).

189. In addition, Xiong discloses *using a single chroma intra prediction mode that is different than a luma intra prediction mode*. Xiong discloses ways of determining the chroma intra prediction mode that include “calculating respectively the coding efficiency of image chrominance intra-frame coding prediction in various prediction modes with each 8x8 [or $2^n \times 2^n$] pixel chrominance block as a prediction

unit, and taking the prediction mode corresponding to the highest coding efficiency as the same prediction mode based on rate-distortion optimization.” Xiong, 6:20-7:8.

190. Xiong does not describe the details of how to determine luma intra prediction mode. However, at the time of the purported invention of the ’606 patent it was well known in the art and would have been appreciated by a POSITA that rate-distortion optimization (RDO) was a widely accepted and widely-used method for selecting the best luma and chroma intra prediction modes for encoding a block and that the “best” or “optimal” (in the rate-distortion sense) intra prediction modes for luma and chroma were expected in general to be different from one another for a given block.

191. For example, a POSITA would have been familiar with the paper “Fast intra prediction algorithm in H.264/AVC” by Fu, Lin, and Xu published by IEEE in the proceedings of the 2004 International Conference on Signal Processing (“Fu”, EX-1018). In the Introduction, Fu opens this paper with the teaching that

H.264 [1] is the ITU-T’s newest video coding recommendation, which is also known as MPEG-4 Advanced Video Coding (AVC). H.264/AVC employs rate distortion optimization (RDO) techniques to achieve the best coding efficiency. During the implementation of

RDO[,] H.264/AVC has to exhaustively compute rate and distortion of all the intra and inter prediction modes for encoding one macroblock(MB), which leads to drastic increase of coding complexity. Some fast prediction algorithms have ever been proposed to reduce the coding complexity [2][3]. In this paper, we propose an efficient algorithm to reduce the complexity of intra prediction when RDO is used.

EX-1018, 1191. Similarly, a POSITA would have been familiar with the JVT document JVT-G013 by Pan, et al., from the March, 2003 meeting of the Joint Video Team (JVT) of ISO/IEC MPEG & ITU-T VCEG, which states in its introduction that

To achieve the highest coding efficiency, H.264 employs rate distortion optimization (RDO) technique to get the best coding result in terms of maximizing coding quality and minimizing resulting data bits. This means that, in order to achieve RDO, the encoder has to encode the video by exhaustively using all the mode combinations, including different intra and inter prediction modes.

EX-1019, 1. These teachings demonstrate that a POSITA would have appreciated and understood that RDO was a widely accepted and widely used method for choosing the best luma and chroma intra prediction modes for a block.

192. Pan teaches a fast mode decision method for intra prediction, and in Section 3.3 proposes to carry out a separate RDO calculation for the chroma components independent of the luma component. This can result in up to three candidate intra prediction modes for chroma (one from the Cb component edge direction histogram, one from the Cr component edge direction histogram, plus the DC prediction mode) that are different in general from the candidate intra prediction modes for luma. Since the motivation for Pan's method is that RDO is computationally expensive and it is therefore advantageous to modify the exhaustive full-search approach of the then-current version of H.264 by reducing the number of RDO calculations required for the mode decisions, a POSITA would have appreciated that Pan would not perform a separate expensive RDO analysis for chroma unless it was advantageous for optimizing coding efficiency to choose different luma and chroma intra prediction modes. Otherwise, if the best intra prediction modes for luma and chroma were always expected to be the same, then there would be no reason for Pan to waste computational bandwidth performing a separate independent RDO for chroma as Pan teaches in Section 3.3. EX-1019, 6-7.

193. Fu teaches that the luma and chroma components can have different characteristics, implying that different intra prediction modes may be best for coding luma and chroma components in a block. Specifically, Fu teaches that a luma intra prediction block size of 4x4 is “well suited for coding parts of a picture with significant details” and that a luma block size of 16x16 is “more suited for coding very smooth areas of a picture [4],” but that “*Since chroma components (U and V) are usually smooth over large area [4],* the prediction modes of the chroma samples in an MB are the same as those of intra16x16” (stating that in H.264 the directions of the intra prediction modes available for encoding chroma are the same as the directions of the intra prediction modes available for encoding intra 16x16 luma partitions). EX-1018, 1191 (emphasis added). From this teaching, a POSITA would have understood that RDO may be expected to often choose different intra prediction modes for luma and for chroma at least because chroma is expected to be “usually smooth over large area” whereas luma may be expected to sometimes have “significant details” and other times be “very smooth,” motivating the provision of up to nine directional intra prediction modes for luma but only four for chroma in H.264. *Id.*

194. In Section 2.1 of EX-1019, Fu describes a modified prediction routine (relative to H.264) for using RDO to choose optimal intra prediction modes for luma and chroma (it should be noted that Fu refers to the luma component as Y and the

chroma components as U and V instead of Cb and Cr). Unlike the then-current JM7.3 reference software of H.264/AVC, the modified prediction routine taught by Fu uses RDO to independently select the optimal intra prediction mode for chroma first before performing separate RDO analyses at block sizes of 16x16 and 4x4 to select the luma intra prediction mode. From these teachings, a POSITA would have understood that the optimal intra prediction mode choices for luma and chroma are generally expected to be different, for otherwise Fu would not expend the computational resources to perform expensive independent and separate RDO analyses for chroma and luma. *Id.*, 1192. In fact, in the Conclusion section, Fu's first claimed contribution of the paper is "reducing the correlation between chroma mode decision and luma mode decision." *Id.*, 1194.

195. Thus, it is my opinion that a POSITA would have understood that determining the chroma intra prediction mode based on rate-distortion optimization will often result in a luma intra prediction mode that is different from the chroma intra prediction mode (*a single chroma intra prediction mode that is different than a luma intra prediction mode*). To the extent a POSITA used a different calculation (other than rate-distortion optimization) to determine the luma intra prediction mode, it would also be expected to often be the case that the resulting luma intra prediction mode would be different from the chroma intra prediction mode for at least the

reason that luma and chroma are expected to generally have different characteristics as taught by Fu and as I already pointed out above. EX-1018, 1191.

196. Furthermore, Xiong's disclosures indicate that the single chroma intra prediction mode is different than a luma intra prediction mode through its disclosure and use of mapping tables. For example, Xiong discloses determining chroma intra prediction modes using two mapping relationship tables: a "first mapping relationship table" between a prediction mode for 16x16 luminance blocks and the prediction mode adopted and the image chrominance intra-frame coding prediction process for $2^n \times 2^n$ pixel blocks; and a "second mapping relationship table" between a prediction mode for 4x4 luminance blocks and the prediction mode adopted and the image chrominance intra-frame coding prediction process for $2^n \times 2^n$ pixel blocks. Xiong, 6:27-7:5. Either the first or second mapping relationship table is used "to determine the corresponding prediction mode as the same prediction mode according to the prediction mode or prediction mode combination adopted by the luminance block in the image luminance intra-frame coding prediction." Xiong, 7:6-13. Notably, the reference to "the same prediction mode" relates to the same chroma prediction mode for each of the $2^n \times 2^n$ pixel blocks. Xiong, 6:8-9 ("The plurality of $2^n \times 2^n$ pixel blocks divided from each macroblock adopt the same prediction mode to perform image chrominance intra-frame coding prediction"). It is my opinion that a POSITA would have understood that a mapping table is necessary because the

chroma intra prediction mode corresponding to each luma intra prediction mode is generally different from the luma intra prediction mode. Providing such a mapping table saves both processing power (because the chroma prediction mode is looked up based on luma prediction mode rather than being independently calculated) and bandwidth (because only the luma prediction mode for the larger block need be encoded). If the inputs to the mapping table matched the outputs of the mapping table, there would be no need for the mapping table at all. Therefore, the fact that Xiong uses mapping tables indicates that *a single chroma intra prediction mode that is different than a luma intra prediction mode*.

197. Neither Xiong nor VCEG-AJ21 expressly address the details of signaling for the intra prediction partition types. However, the combination of Xiong and VCEG-AJ21 discloses or suggests that *only luma partition type is signaled, not the chroma partition type* because the determination of chroma partition type is made by using only information that is available to both the encoder and the decoder (i.e., the luma partition type), so there would be no need for Xiong's encoder to signal the chroma partition type to the decoder—which would improve system efficiency. It is my opinion that a POSITA would have understood that where there is a one-to-one relationship between two items of data, such as the luma intra prediction partition type and the chroma intra prediction partition type in this case, transmitting both items of data is essentially redundant. Further, it is my opinion that a POSITA would

have understood that transmitting such redundant information would be a waste of bandwidth and storing such redundant information in an encoded video signal would be a counterproductive waste of storage capacity.

198. Therefore, the combination of Xiong and VCEG-AJ21 discloses or suggests using a 16x16 chroma partition type in response to a 32x32 luma partition type (from VCEG-AJ21) and an 8x8 chroma partition type in response to a 16x16 luma partition type (from Xiong) (*determining a particular chroma partition type...for encoding a partitioned block from the set of multiple chroma partition types in response to a luma partition type utilized to encode the block*), from the set of luma partition types of 32x32, 16x16, 8x8, and 4x4 (*the luma partition type being included in the set of multiple luma partition types*). The combination also discloses or suggests determining the chroma intra prediction mode that is different from a luma intra prediction mode, either because each mode is determined independently (resulting in different RDO, for example), or based on a mapping between a luma intra prediction mode and a chroma intra prediction mode (*using a single chroma intra prediction mode that is different than a luma intra prediction mode*). See §IX.C.2. Further, it is my opinion that a POSITA would have understood that the combined system signals only the luma partition for efficiency (*only luma partition type is signaled, not the chroma partition type*). And a POSITA would have been

motivated to combine Xiong and VCEG-AJ21 for the reasons stated above. *See* §IX.C.2.

e. 1[d]: *said encoding comprising: setting a luma partition,*

199. Xiong in combination with VCEG-AJ21 discloses or suggests 1[d]. As discussed for limitation 1[c], Xiong discloses determining the chroma partition type based on whether the luma partition type is 16x16 or otherwise. *See* §IX.C.3.d. Xiong also discloses that in H.264, upon which Xiong builds, “the image luminance prediction process includes two prediction units: 16x16 block prediction and 4x4 block prediction.” Xiong, 4:1-3. While that is true for the main profile in H.264, a POSITA would also have been aware and appreciated that additional 8x8 luma intra prediction modes are provided in the H.264 high profiles. In addition, a POSITA reading VCEG-AJ21, which also builds on H.264, would have further found it obvious to set the luma partition to 32x32 or to 8x8. VCEG-AJ21, 4-5, Fig. 4, Fig. 5.

200. Therefore, the combination of Xiong and VCEG-AJ21 discloses or suggests setting the luma partition to 32x32, 16x16, 8x8 or 4x4 (*encoding comprising: setting a luma partition*). A POSITA would have been motivated to make the combination of Xiong and VCEG-AJ21 for the reasons stated above. *See* §IX.C.2.

f. 1[e]: *setting a chroma partition from the set of multiple chroma partition types; and,*

201. Xiong in combination with VCEG-AJ21 discloses or suggests 1[e]. As discussed for limitation 1[c], the combination of Xiong and VCEG-AJ21 determines a chroma partition type in response to a luma partition type. *See* §IX.C.3.d. The combination of Xiong and VCEG-AJ21 discloses chroma partition types that include, at least 16x16, 8x8, and 4x4. *See* §IX.C.3.d. Therefore, the determined chroma partition type is *from the set of multiple chroma partition types*. The combination of Xiong and VCEG-AJ21 also discloses or suggests *setting a chroma partition* to the determined chroma partition type. And a POSITA would have been motivated to combine Xiong and VCEG-AJ21 in this way for the reasons stated above. *See* §IX.C.2.

g. 1[f]: *setting a luma prediction mode, setting a chroma prediction mode, wherein chroma and luma have different modes; and encoding the block.*

202. Xiong in combination with VCEG-AJ21 discloses or suggests 1[f]. Xiong discloses luma prediction modes and chroma prediction modes for different sized partitions. Xiong, 4:5-6:9; Figs. 2-3. As discussed for limitation 1[c], the combination of Xiong and VCEG-AJ21 discloses *using a single chroma intra prediction mode that is different than a luma intra prediction mode* because Xiong determines the chroma prediction mode independently from the luma prediction mode. *See* §§IX.C.2, IX.C.3.d. For substantially the same reasons, the combination

of Xiong and VCEG-AJ21 discloses *setting a luma prediction mode, setting a chroma prediction mode, wherein chroma and luma have different modes*.

203. Xiong further discloses thereafter encoding the block. Xiong, 3:16-23, Fig. 1.

204. The combination of Xiong and VCEG-AJ21 thus discloses independent determination of intra prediction modes for luma and chroma (*setting a luma prediction mode, setting a chroma prediction mode, wherein chroma and luma have different modes*) and *encoding the block*. And a POSITA would have been motivated to combine Xiong and VCEG-AJ21 for the reasons stated above. *See §IX.C.2.*

4. Claim 2

a. 2[pre]: *A method comprising:*

205. If limiting, Xiong discloses or suggests 2[pre] when it describes “a method for image chrominance based on intra-frame coding.” Xiong, 1 (Abstract), 5:10-13. Further, Xiong is built as an improvement on H.264 video encoding and decoding methods. Xiong, 3:16-23, Fig. 1.

- b. **2[a]: *encoding picture data for at least a block in a picture, by perform[ing] intra prediction with multiple partition types for chroma encoding of the block, the multiple partition types comprising a set of multiple chroma partition types of sizes 16×16, 8×8, 4×4 and a set of multiple luma partition types, the set of multiple chroma partition types being different than the set of multiple luma partition types, and***

206. Xiong in combination with VCEG-AJ21 discloses or suggests 2[a] for substantially the same reasons as 1[b]. See §IX.C.3.c.

- c. **2[b]: *determining a particular chroma partition type using a single chroma intra prediction mode that is different than a luma intra prediction mode, for encoding a partitioned block from the set of multiple chroma partition types in response to a luma part[ition] type utilized to encode the block, the luma partition type being included in the set of multiple luma partition types and only luma partition type is signaled, not the chroma partition type,***

207. Xiong in combination with VCEG-AJ21 discloses or suggests 2[b] for substantially the same reasons as 1[c]. See §IX.C.3.d.

- d. **2[c]: *said encoding comprising: setting a luma partition,***

208. Xiong in combination with VCEG-AJ21 discloses or suggests 2[c] for substantially the same reasons as 1[d]. See §IX.C.3.e.

- e. **2[d]: *setting a chroma partition from the set of multiple chroma partition types; and,***

209. Xiong in combination with VCEG-AJ21 discloses or suggests 2[d] for substantially the same reasons as 1[e]. See §IX.C.3.f.

- f. **2[e]:** *setting a luma prediction mode, setting a chroma prediction mode, wherein chroma and luma have different intra prediction modes; and encoding the block.*

210. Xiong in combination with VCEG-AJ21 discloses or suggests 2[e] for substantially the same reasons as 1[f]. *See* §IX.C.3.g.

5. **Claim 3:** *The method of claim 2, wherein a particular chroma partition type for coding the block is determined from the set of chroma partition types responsive to a luma partition type utilized to code the block or one or more neighboring blocks the luma partition type being included in the set of luma partition types.*

211. The combination of Xiong and VCEG-AJ21 discloses or suggests the additional limitation of this claim for substantially the same reasons discussed above for 1[c]. *See* §IX.C.3.d.

6. **Claim 5:** *The method of claim 3, wherein from among a particular luma partition type and a particular chroma partition type selected to code the block only the particular luma partition type is signaled, the particular luma partition type being selected from the set of luma partition types and the particular chroma partition type being selected from the set of chroma partition types.*

212. Xiong in combination with VCEG-AJ21 discloses or suggests the additional limitation of this claim for substantially the same reasons as 1[c] and 2[b]. *See* §§IX.C.3.d, IX.C.4.c.

7. **Claim 10**

- a. **10[pre]:** *A method comprising:*

213. If limiting, Xiong discloses or suggests 10[pre] when it describes “a method for image chrominance based on intra-frame coding.” Xiong, 1 (Abstract),

5:10-13. Further, Xiong is built as an improvement on H.264's methods of video encoding and decoding. Xiong, 3:16-23, Fig. 1.

b. 10[a]: *decoding picture data for at least a block in a picture, by performing intra prediction with multiple partition types for chroma decoding of the block, the multiple partition types comprising a set of multiple chroma partition types of sizes 16×16 , 8×8 , 4×4 and a set of multiple luma partition types, the set of multiple chroma partition types being different than the set of multiple luma partition types, and*

214. Xiong in combination with VCEG-AJ21 discloses or suggests 10[a]. As described for limitation 1[b], the combination of Xiong and VCEG-AJ21 discloses or suggests the *encoding* side of this limitation. See §IX.C.3.c.

215. Although Xiong discloses an encoder in detail, it is my opinion that a POSITA would have understood that Xiong also describes—at least implicitly—a decoder and the process by which the decoder would decode a bitstream into video. Xiong, 3:6-7 (“The present invention relates to the technical field of video coding and decoding, and further to a method for method for image chrominance prediction based on intra-frame coding.”), 7:9-13 (referring to a “reconstructed pixel value”); Fig. 1 (“Decoder”). Xiong further discloses that its method is implemented in devices (e.g., “conference television, videophone, streaming media, high-definition laser video disc (HD DVD, High-definition digital video disc) and video surveillance”) that include decoders. Xiong, 3:8-15. A POSITA would have

understood that H.264—upon which Xiong builds—provides for both encoding and associated decoding. Xiong, 3:8-23. To the extent Xiong’s encoded video data could not be decoded using H.264, a POSITA would have understood that the decoding of Xiong’s disclosed encoding method would be the inverse of the encoding method.

- c. 10[b]: *determining a particular chroma partition type using a single chroma intra prediction mode that is different than a luma intra prediction mode, for decoding a partitioned block from the set of multiple chroma partition types in response to a luma partition type utilized to decode the block, the luma partition type being included in the set of multiple luma partition types and only luma partition type is signaled, not the chroma partition type,***

216. Xiong in combination with VCEG-AJ21 discloses or suggests 10[b]. As described for limitation 1[c], the combination of Xiong and VCEG-AJ21 discloses or suggests the *encoding* side of this limitation. See §IX.C.3.d. And as described for limitation 10[a], Xiong discloses decoding the picture data that was encoded according to Xiong’s method. See §IX.C.7.b. It is my opinion that a POSITA would therefore have understood that Xiong discloses *decoding* the picture data that was encoded according to the method disclosed in Xiong—as explained above for limitation 1[c]—such that the combination of Xiong and VCEG-AJ21 discloses or suggests this limitation. And a POSITA would have been motivated to make the combination for the reasons stated above. See §IX.C.2.

d. 10[c]: *said decoding comprising: parsing a luma partition,*

217. Xiong in combination with VCEG-AJ21 discloses or suggests 10[c]. As described for limitation 1[d], the combination of Xiong and VCEG-AJ21 discloses or suggests the *encoding* side of this limitation. *See* §IX.C.3.e. And as described for limitation 10[a], Xiong discloses decoding the picture data that was encoded according to the method disclosed in Xiong. *See* §IX.C.7.b. It is my opinion that a POSITA would therefore have understood that Xiong discloses *decoding* the picture data that was encoded according to the method disclosed in Xiong—as explained above for limitation 1[d]—and the combination of Xiong and VCEG-AJ21 discloses or suggests this limitation because correctly decoding Xiong’s encoded picture data would require the decoder to parse the luma partition from the encoded bitstream in order to have knowledge of the luma partition type that was decided by the encoder for the block currently being decoded by the decoder. A POSITA would have been motivated to make the combination of Xiong and VCEG-AJ21 for the reasons stated above. *See* §IX.C.2.

e. 10[d]: *setting a chroma partition from the set of multiple chroma partition types; and,*

218. Xiong in combination with VCEG-AJ21 discloses or suggests 10[d]. As described for limitation 1[e], the combination of Xiong and VCEG-AJ21 discloses or suggests the *encoding* side of this limitation. *See* §IX.C.3.f. And as described for limitation 10[a], Xiong discloses decoding the picture data that was

encoded according to the method disclosed in Xiong. *See* §IX.C.7.b. It is my opinion that a POSITA would therefore have understood that Xiong discloses *decoding* the picture data that was encoded according to the method disclosed in Xiong—as explained above for limitation 1[e]—such that the combination of Xiong and VCEG-AJ21 discloses or suggests this limitation. And a POSITA would have been motivated to combine Xiong and VCEG-AJ21 for the reasons stated above. *See* §IX.C.2.

f. 10[e]: parsing a luma prediction mode, parsing a chroma prediction mode, wherein chroma and luma have different intra prediction modes; and decoding the block.

219. Xiong in combination with VCEG-AJ21 discloses or suggests 10[e]. As described for limitation 1[f], the combination of Xiong and VCEG-AJ21 discloses or suggests the *encoding* side of this limitation. *See* §IX.C.3.g. And as described for limitation 10[a], Xiong discloses decoding the picture data that was encoded according to the method disclosed in Xiong. *See* §IX.C.7.b. It is my opinion that a POSITA would therefore have understood that Xiong discloses *decoding* the picture data that was encoded according to the method disclosed in Xiong—as explained above for limitation 1[f]—such that the combination of Xiong and VCEG-AJ21 discloses or suggests this limitation because correctly decoding Xiong’s encoded picture data would require the decoder to parse the luma prediction mode and the chroma prediction mode from the encoded bitstream in order to have knowledge of

which intra prediction modes were chosen by the encoder for encoding the block currently being decoded by the decoder. Without this knowledge, correct decoding of Xiong's encoded bitstream would not be possible because the decoder would be unable to reconstruct the same intra prediction values that would necessarily have to be added to the encoded residual data in order to obtain the decoded Y, Cb, and Cr values for the block. And a POSITA would have been motivated to make the combination for the reasons stated above. *See* §IX.C.2.

8. Claim 12: *The method of claim 10, wherein from among a particular luma partition type and a particular chroma partition type selected to decode the block only information indicating the particular luma partition type is received from a corresponding encoder for use in decoding the block, the particular luma partition type being selected from the set of luma partition types and the particular chroma partition type being selected from the set of chroma partition types.*

220. Xiong in combination with VCEG-AJ21 discloses or suggests the additional limitation of 12.

221. As described for claim 5, the combination of Xiong and VCEG-AJ21 discloses or suggests the *encoding* side of this limitation. *See* §IX.C.6. And as described for limitation 10[a], Xiong discloses decoding the picture data that was encoded according to the method disclosed in Xiong. *See* §IX.C.7.b. It is my opinion that a POSITA would therefore have understood that Xiong discloses *decoding* the picture data that was encoded according to the method disclosed in Xiong—as

explained above for claim 5—such that the combination of Xiong and VCEG-AJ21 discloses or suggests this claim. And a POSITA would have been motivated to make the combination for the reasons stated above. *See* §IX.C.2.

9. Claim 14

a. 14[pre]: *A video decoding apparatus, comprising:*

222. If limiting, Xiong discloses or suggests 14[pre]. Xiong’s intra-frame coding is implemented in, for example, “conference television, videophone, streaming media, high-definition laser video disc (HD DVD, High-definition digital video disc) and video surveillance.” Xiong, 3:8-15. Each of these would include *a video decoding apparatus*.

b. 14[a]: *a memory and a processor, configured for:*

223. Xiong discloses or suggests 14[a].

224. As discussed above, Xiong’s intra-frame coding is implemented in, for example, “conference television, videophone, streaming media, high-definition laser video disc (HD DVD, High-definition digital video disc) and video surveillance.” Xiong, 3:8-15. It is my opinion that a POSITA would have understood such devices would include a memory and a processor for storing the software/firmware instructions corresponding to Xiong’s method as well as a processor to execute those instructions for the same reasons I already discussed for limitation 1[a]. *See* §IX.C.3.b.

c. 14[b]: *operating on picture data for at least a block in a picture,*

225. Xiong in combination with VCEG-AJ21 discloses or suggests 14[b] for substantially the same reasons discussed for 1[b] and 10[a]. *See* §§IX.C.2, IX.C.3.c, IX.C.7.b.

d. 14[c]: *by performing intra prediction with multiple partition types for chroma decoding of the block, the multiple partition types comprising a set of multiple chroma partition types of sizes 16×16 , 8×8 , 4×4 and a set of multiple luma partition the set of multiple chroma partition types being different than the set of multiple luma partition types, and*

226. Xiong in combination with VCEG-AJ21 discloses or suggests 14[c] for substantially the same reasons discussed for 1[b] and 10[a]. *See* §§IX.C.2, IX.C.3.c, IX.C.7.b.

e. 14[d]: *determining a particular chroma partition type using a single chroma intra prediction mode that is different than a luma intra prediction mode, for decoding a partitioned block from the set of multiple chroma partition types in response to a luma partition type utilized to decode the block, the luma partition type being included in the set of multiple luma partition types and only luma partition type is signaled, not the chroma partition type,*

227. Xiong in combination with VCEG-AJ21 discloses or suggests 14[d] for substantially the same reasons as 1[c] and 10[b]. *See* §§IX.C.2, IX.C.3.d, IX.C.7.c.

f. 14[e]: *said decoding comprising: parsing a luma partition,*

228. Xiong in combination with VCEG-AJ21 discloses or suggests 14[e] for substantially the same reasons as 1[d] and 10[c]. *See §§IX.C.2, IX.C.3.e, IX.C.7.d.*

g. 14[f]: *setting a chroma partition from the set of multiple chroma partition types; and,*

229. Xiong in combination with VCEG-AJ21 discloses or suggests 14[f] for substantially the same reasons as 1[e] and 10[d]. *See §§IX.C.2, IX.C.3.f, IX.C.7.e.*

h. 14[g]: *parsing a luma prediction mode, parsing a chroma prediction mode, wherein chroma and luma have different intra prediction modes; and decoding the block.*

230. Xiong in combination with VCEG-AJ21 discloses or suggests 14[g] for substantially the same reasons as 1[f] and 10[e]. *See §§IX.C.2, IX.C.3.g, IX.C.7.f.*

10. Claim 16: *The apparatus of claim 14, wherein from among a particular luma partition type and a particular chroma partition type selected to decode the block only information indicating the particular luma partition type is received from a corresponding encoder for use in decoding the block, the particular luma partition type being selected from the set of luma partition types and the particular chroma partition type being selected from the set of chroma partition types.*

231. Xiong in combination with VCEG-AJ21 discloses or suggests claim 16 for substantially the same reasons as claim 12. *See §IX.C.8.*

11. Claim 18: *A non-transitory computer readable storage medium comprising data for instruction to implement the method of claim 10.*

232. Xiong in combination with VCEG-AJ21 discloses or suggests the additional limitation of claim 18.

233. A POSITA would have understood that the methods disclosed in Xiong and VCEG-AJ21 would have been implemented as software, as prior video decoding standards (e.g., H.264) had been, and that software would have been represented as data for instructions to implement the video decoding methods. VCEG-AJ21, 2 (“In this contribution, we attempt to extend with enlarged MB sizes the JM reference software architecture.”). Therefore, it is my opinion that a POSITA would have understood the combination of Xiong and VCEG-AJ21 discloses or suggests implementing the method of claim 10 in a series of instructions stored on a non-transitory computer readable storage medium. A POSITA would have been motivated to make the combination of Xiong and VCEG-AJ21 for the reasons stated above. *See* §IX.C.8.

12. Claim 19: The apparatus of claim 1, wherein a particular chroma partition type for coding the block is determined from the set of chroma partition types responsive to a luma partition type utilized to code the block or one or more neighboring blocks, the luma partition type being included in the set of luma partition types.

234. Xiong in combination with VCEG-AJ21 discloses or suggests claim 19 for substantially the same reasons as claims 1 and 3. *See* §§IX.C.3, IX.C.5.

D. Ground 2B: Xiong in view of VCEG-AJ21 and H.264

1. Motivation to combine Xiong, VCEG-AJ21, and H.264

235. It is my opinion that a POSITA would have been motivated to combine H.264 with the combination of Xiong and VCEG-AJ21 discussed above (*see* §IX.C.2) to extend H.264's macroblock structure to larger macroblocks with separate luma and chroma intra prediction (as taught by Xiong and VCEG-AJ21), and a POSITA would have had a reasonable expectation of success in doing so.

236. Each of Xiong and VCEG-AJ21 expressly build upon H.264. Xiong, 3:8-26; VCEG-AJ21, 1 (Abstract). Xiong recognizes that for H.264, "image chrominance prediction is only carried out with 8x8 blocks as prediction units, but there is no further consideration of using 4x4 blocks as prediction units for intra-frame coding prediction, as in the luminance prediction." Xiong, 5:5-8. According to Xiong, "[t]his results in the defect the image chrominance coding having low efficiency in the H.264 intra-frame coding prediction technology." Xiong, 5:8-10. To address this problem, Xiong proposes "a method for image chrominance based

on intra-frame coding which can effectively improve the image chrominance coding efficiency in video image coding technology” using different sized luma and chroma blocks for intra prediction. Xiong, 5:10-6:20; *see* §IX.C.1.

237. VCEG-AJ21 likewise proposes “extend[ing] the architecture of H.264 codec with enlarged MB sizes.” VCEG-AJ21, 1. VCEG-AJ21 recognizes the limitation of H.264’s 16x16 macroblock and the benefits of larger macroblocks, especially for High Definition (“HD”) video. *Id.*, 1 (“It may not be efficient for the HD or beyond HD since the MB size of 16x16 pixels is relatively small for high resolution video contents.”), 2 (“It implies that relatively large block modes are more advantageous to the high[-]resolution videos in terms of the Rate-distortion optimization.”). VCEG-AJ21 therefore discloses a macroblock using a 32x32 pixel block for a luma partition and 16x16 pixel blocks for a chroma partition. VCEG-AJ21, 4-5, Fig. 5.

238. It is my opinion that a POSITA would have understood the teachings of Xiong and VCEG-AJ21 supplement H.264 by adding larger block sizes, additional partition types, and additional intra prediction modes using routine engineering. In particular, the new intra prediction partition types and modes would be added to Table 7-11 of H.264, and the macroblock syntax of Section 7.3.5 would be adjusted to include encoding of the different intra partition types and modes.

H.264, 51, 91. Doing so would not adversely affect (and would in fact benefit) the H.264 standard.

2. Claim 4: *The method of claim 3, wherein for the particular chroma partition type, a largest-size available transform matching the particular chroma partition type is selected from a set of transforms.*

239. VCEG-AJ21 and H.264 disclose or suggest the additional limitation of this claim for substantially the same reasons those references disclose or suggest the additional limitation for Ground 1B. *See* §IX.B.3. A POSITA would have been motivated to make the combination of Xiong, VCEG-AJ21, and H.264 for the reasons stated above. *See* §IX.D.1.

3. Claim 6: *The method of claim 5, wherein the particular luma partition type is absolutely coded or differentially coded from one or more neighboring blocks.*

240. VCEG-AJ21 and H.264 disclose or suggest the additional limitation of this claim for substantially the same reasons those references disclose or suggest the additional limitation for Ground 1B. *See* §IX.B.4. A POSITA would have been motivated to make the combination of Xiong, VCEG-AJ21, and H.264 for the reasons stated above. *See* §IX.D.1.

4. Claim 11: *The method of claim 10, wherein for the particular chroma partition type, a largest-size available transform matching the particular chroma partition type is selected from a set of transforms.*

241. Xiong in view of VCEG-AJ21 and H.264 discloses or suggests the additional limitation of claim 11.

242. As described for claim 4, the combination of Xiong, VCEG-AJ21, and H.264 discloses or suggests the *encoding* side of this limitation. *See* §IX.D.2. And as described for limitation 10[a], Xiong discloses decoding the picture data that was encoded according to the method disclosed in Xiong. *See* §IX.C.7.b. It is my opinion that a POSITA would therefore have understood that Xiong discloses *decoding* the picture data that was encoded according to the method disclosed in Xiong—as explained above for claim 4—such that the combination of Xiong, VCEG-AJ21, and H.264 discloses or suggests this claim. And a POSITA would have been motivated to combine Xiong, VCEG-AJ21, and H.264 for the reasons stated above. *See* §IX.D.1.

5. Claim 13: *The method of claim 12, wherein the particular luma partition type is absolutely decoded or differentially decoded from one or more neighboring blocks.*

243. Xiong in view of VCEG-AJ21 and H.264 discloses or suggests the additional limitation of 13.

244. As described for claim 6, the combination of Xiong, VCEG-AJ21, and H.264 discloses or suggests *wherein the particular luma partition type is absolutely coded or differentially coded from one or more neighboring blocks*. See §IX.D.3.

245. As described for limitation 10[a], Xiong discloses decoding the picture data that was encoded according to Xiong's method. See §IX.C.7.b.

6. Claim 15: *The apparatus of claim 14, wherein for the particular chroma partition type, a largest-size available transform matching the particular chroma partition type is selected from a set of transforms.*

246. Xiong in view of VCEG-AJ21 and H.264 discloses or suggests claim 15 for substantially the same reasons as claims 11 and 14. See §§IX.D.4, IX.C.9.

7. Claim 17: *The apparatus of claim 14, wherein the particular luma partition type is absolutely decoded or differentially decoded from one or more neighboring blocks.*

247. Xiong in view of VCEG-AJ21 and H.264 discloses or suggests claim 17 for substantially the same reasons as claims 13 and 14. See §§IX.D.5, IX.C.9.

8. Claim 20: *The apparatus of claim 19, wherein for the particular chroma partition type, a largest-size available transform matching the particular chroma partition type is selected from a set of transforms.*

248. Xiong in view of VCEG-AJ21 and H.264 discloses or suggests claim 20 for substantially the same reasons as claims 1 and 4. See §§IX.C.3, IX.D.2.

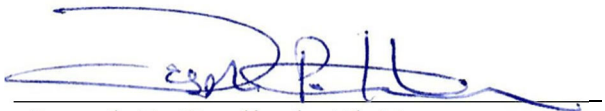
X. CONCLUSION

249. I currently hold the opinions expressed in this declaration. But my analysis may continue, and I may acquire additional information and/or attain supplemental insights that may result in added observations.

250. I hereby declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct to the best of my knowledge. I understand that willful false statements are punishable by fine or imprisonment or both. *See* 18 U.S.C. § 1001.

Date: January 4, 2026

By:



Joseph P. Havlicek, Ph.D.