

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

AMAZON.COM, INC. and AMAZON.COM SERVICES LLC,

Petitioner,

v.

NOKIA TECHNOLOGIES OY,

Patent Owner.

Case IPR2024-01176
U.S. Patent No. 8,175,148

EXHIBIT 2001

DECLARATION OF DOUGLAS A. CHRISSAN, Ph.D.

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I, Douglas A. Chrissan, declare as follows:

I. INTRODUCTION

1. I have been retained as a technical expert on behalf of Patent Owner Nokia Technologies Oy (“Nokia”) for the above-captioned inter-partes review (“IPR”). I have been asked to provide my opinions on the technology disclosed in U.S. Patent No. 8,175,148 (“the ’148 Patent”) (Ex. 1001) and on the unpatentability arguments presented in Amazon’s (“Petitioner”) Petition (“Pet.”) alleging that claims 1–23 of the ’148 Patent (the “Challenged Claims”) are invalid under 35 U.S.C. § 103.

2. I make this declaration based on my personal knowledge, consideration of the materials I discuss herein, and my expert opinion.

3. I am being paid for my work on this matter on an hourly basis at \$300/hour. My compensation is not contingent on reaching any particular findings or conclusions, or on any particular outcome in this matter. I have no financial interest in the outcome of this matter.

4. In preparing this Declaration, I have reviewed the ’148 Patent, its prosecution history, and considered each of the documents cited herein. I have also read and considered the IPR Petition concerning the ’148 Patent and the exhibits and evidence cited therein as grounds for invalidity, including but not limited to Exhibits 1001–12. Any additional documents reviewed are discussed in Section III below.

5. In formulating my opinions, I have also relied upon my experience, education, knowledge and expertise in the area of video processing, including video compression and decompression—also referred to as video encoding and decoding. In reviewing the material relevant to these proceedings, I have considered the viewpoint of a person of ordinary skill in the art in the April 2002 timeframe.

II. BACKGROUND AND QUALIFICATIONS

6. The following sections recite the most relevant aspects of my educational, professional, and technical background. A copy of my curriculum vitae, which describes my qualifications in more detail, is attached to this report as Exhibit 2002.

7. I am presently a technical consultant in the areas of communications systems, multimedia systems, computer systems, and digital signal processing. My past work experience includes at least four years of designing, programming and directly working with semiconductors and systems for video encoding and decoding.

8. I earned a B.S. and M.S. in Electrical Engineering from the University of Southern California in 1988 and 1990, respectively, and a Ph.D. in Electrical Engineering from Stanford University in 1998.

9. From 1993 to 1997, I was a full-time doctoral student at Stanford University. My Ph.D. dissertation and related publications were in the fields of statistical signal processing and communication systems, and more specifically in

the area of impulsive noise modeling for low-frequency communication systems. In 1995, I was the instructor for the graduate Statistical Signal Processing class (EE278) in the Electrical Engineering department at Stanford University. Prior to teaching this class, I was a teaching assistant for ten different classes in signal processing and radio frequency electronics at Stanford.

10. I was a Masters Fellow and Member of the Technical Staff at Hughes Aircraft Company in El Segundo, California, from 1988–1993. While at Hughes Aircraft, I designed and developed wireless communication systems for commercial and military spacecraft, including for the MILSTAR satellite program.

11. Between 1992 and 1993, while at Hughes Aircraft Company, I designed and built a state-of-the-art, 800 megabit-per-second (Mbps) telecommunications modem for the NASA Lewis Research Center.

12. From 1997–2003, I worked at 8x8, Inc., starting as a DSP software engineer in 1997, becoming a manager in 1998, a director in 1999, and Vice President of Engineering in 2000 (managing a team of approx. 60 engineers in the company’s microelectronics group). I played a key role in developing several semiconductor products used worldwide in multimedia and communications devices, mainly for video conferencing systems and Internet Protocol (“IP”) telephones. Some of these semiconductor products were in production more than ten years.

13. From 2003–2007, I was a Systems Architect and Engineering Program Manager at Texas Instruments in the Digital Subscriber Line (“DSL”) product business unit. At Texas Instruments, I was directly involved in the architecture, design, development and production of multicarrier DSL modem products. My work specifically included architecting a multicarrier DSL semiconductor and software product and managing all aspects of its development from inception to production. I also gained further experience with IEEE 802.11 (WLAN/WiFi) and WiMAX systems.

14. From 2009–2011, I was an Engineering Director at Maxim Integrated Products. At Maxim, I was directly involved in the architecture, design, development and production of semiconductors and systems for video encoding and decoding.

15. I have developed, and managed the development of, several successful semiconductor, software and systems products in the communications and multimedia fields. These products are listed in the attached curriculum vitae.

III. BASES OF OPINIONS

16. In the course of performing my analysis and forming my opinions, I have reviewed the Petition for this IPR2024-01176 and its Exhibits 1001–12. Exhibits 1001–12 include:

- U.S. Patent No. 8,175,148 (“the ’148 Patent”) (Ex. 1001) and its file history (Ex. 1002)

- Declaration of Dr. Eli Saber (Ex. 1003)
- ISO/IEC 11172-2 (1st ed.) Information technology - Coding of moving pictures and associated audio for digital storage media at up to about 1,5 Mbit/s - Part 2: Video (August 1, 1993) (“MPEG-1”) (Ex. 1005)
- ITU-T Recommendation H.263 (February 1998) (“H.263”) (Ex. 1006)

IV. APPLICABLE LEGAL STANDARDS

A. Ordinary Skill in the Art

17. My opinions in this declaration are based on the understandings of a person of ordinary skill in the art—sometimes referred to as an “ordinary artisan” or by the acronyms “POSA” or “POSITA”—as of the time of the invention, which I understand to be April 23, 2002, the filing date of the non-provisional application leading to the ’148 Patent. I understand that the person of ordinary skill in the art is a hypothetical person who is presumed to have known the art relevant to the Challenged Claims of the ’148 Patent at the time of the invention.

18. I understand that, in assessing the level of skill of a person of ordinary skill in the art, one should consider the type of problems encountered in the art, the prior solutions to those problems found in the prior art references, the rapidity with which innovations are made, the sophistication of the technology, the level of education of active workers in the field, and one’s own experience working with those of skill in the art at the time of the invention.

19. Petitioner submits that a POSITA at the time of the '148 Patent would have had (1) a Bachelor's degree in Electrical or Computer Engineering, Computer Science, or a comparable field of study such as Physics, and (2) approximately two to three years of practical experience with video and/or image processing or coding. More education could substitute for experience, and vice versa. I agree that this definition of a POSITA is sufficient for this IPR proceeding.

20. I was at the time of invention, and am, one of more than ordinary skill in the art through my education, research experience and work experience. As of the date of the invention, I was familiar with the types of problems encountered in video encoding/decoding systems and the rapidity at which innovations were made. I was and am familiar with people having this level of skill in the area of video encoding and decoding systems.

B. Claim Construction

21. I understand that the Challenged Claims of the '148 Patent in this IPR are generally interpreted according to their ordinary and customary meaning taking into consideration the so-called "intrinsic evidence" of the patent consisting of (1) the claim language; (2) the specification; and (3) the prosecution history.

22. I understand that claim terms may be explicitly defined in the patent specification or they may be implicitly defined through consistent usage in the specification. I also understand that the scope of claim terms may be limited by

statements in the specification or prosecution history where the applicant clearly disavows or disclaims subject matter.

23. I understand that claim construction is a matter of law. As of this time, my understanding is that no claim terms have been proposed for construction.

C. Obviousness

24. Counsel has informed me, and I understand, that an issued patent claim is invalid as obvious if it can be shown that the differences between the patented subject matter and the prior art are such that the subject matter as a whole would have been obvious, at the time the invention was made, to a person having ordinary skill in the art. Relevant considerations include the level of ordinary skill in the art; the scope and content of the prior art; differences between the prior art and the claims at issue; and the objective indicia, or secondary considerations, of nonobviousness.

25. In this regard, I am informed and I understand that the secondary considerations of nonobviousness could include factors such as commercial success, long felt but unresolved needs, the failure of others, skepticism by experts, praise by others, award and accolades, and copying.

26. Counsel has informed me, and I understand, that in order to evaluate the obviousness of any claim of the '148 Patent over a given prior art combination, I should analyze whether the prior art references, included collectively in the combination, disclose each and every element of the allegedly invalid claim as those

references are read by the person of ordinary skill in the art at the time of the invention.

27. Counsel has informed me, and I understand, that even where all of the claim limitations are expressly disclosed in the prior art references, there must be some showing that a person of ordinary skill in the art would have been motivated to combine such prior art references, and explanation of how the combination would be achieved, and that there would have been a reasonable expectation of successfully achieving the claimed invention from such combination.

28. Counsel has informed me, and I understand, that absent some additional reasoning, mere routine optimization for a person of ordinary skill in the art to arrive at the claimed invention through combination of prior art references is insufficient to support a conclusion of obviousness.

29. Counsel has informed me, and I understand, that to rely on a reference it must be analogous prior art. Counsel has informed me and I understand that a reference is considered analogous prior art: (1) if the reference is from the same field of endeavor as the claimed subject matter, or (2) if the reference “is reasonably pertinent to the particular problem with which the inventor is involved,” even though the reference is not within the field of the inventor’s endeavor.

30. Counsel has informed me, and I understand, in considering the obviousness of a claimed invention, one should not view the invention and the prior

art with the benefit of hindsight. In an obviousness analysis, one must be aware of the distortion caused by hindsight bias and must be cautious of arguments reliant upon ex post reasoning. Counsel has instructed me and I understand that when considering obviousness, I should not consider what is known today or what was learned from the asserted patents. Instead, obviousness is assessed by the person of ordinary skill in the art at the time the invention was made.

31. In this regard, I am informed and I understand that the '148 Patent may not be used as a guide to select and understand the prior art, because such an approach, at a minimum, discounts the value of combining various existing features or principles in a new way so as to achieve a new result.

32. Counsel has informed me, and I understand, that obviousness cannot be predicated on what was unknown at the time of the invention, even if the inherency of a certain feature is later established. Counsel has also informed me, and I understand, that unknown properties of the prior art may not be relied upon to provide the rationale for modifying or combining the prior art to reach the claimed subject matter.

33. Counsel has informed me, and I understand, that a reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant of the '148 Patent.

V. OVERVIEW OF THE '148 PATENT

34. The '148 Patent provides a detailed “Background of the Invention” section, which I reproduce or paraphrase for my overview description herein. *See* Ex. 1001, 1:18–10:43.

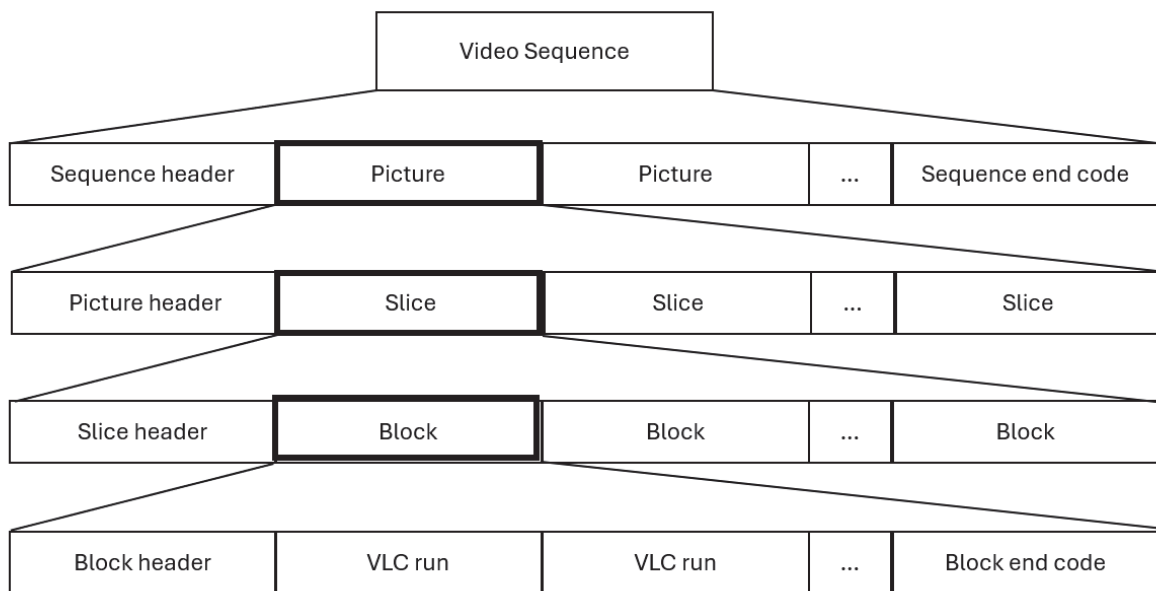
35. The '148 Patent explains that digital video sequences comprise a sequence of still images (“frames”), the illusion of motion being created by displaying the images one after the other at a given frame rate. *See id.*, 1:20–24. Each N by M frame of an uncompressed digital video sequence comprises a rectangular array of image picture elements, or “pixels,” N being the integer number of columns in each horizontal row of pixels, and M being the number of rows in each vertical column of pixels. *See id.*, 1:25–29.

36. Each pixel is represented by a certain number of bits, which carry information about the luminance (“luma”) and/or chrominance (“chroma”) content of the region of the image corresponding to the pixel. Commonly, a so-called YUV color model is used to represent the luma and chroma content of the image. The luminance (Y) component represents the intensity (brightness) of the image, while the color content of the image is represented by two chroma components labeled U and V. *See id.*, 1:29–38.

37. The human visual system is more sensitive to intensity variations than it is to color variations. YUV color models exploit this property by using a lower

spatial resolution for the chrominance components (U, V) than for the luminance component (Y). In other words, a color frame of 176 x 144 pixels may be represented by $176 \times 144 = 25,344$ luma values, but if the chroma components are sub-sampled in both the vertical and horizontal directions by two, those chroma components would be represented by $(176/2) * (144/2) = 6336$ U values and 6336 V values. In many cases, this could be done with minimal perceived degradation of video quality to an end viewer. In this way, the amount of information needed to code the color information in an image can be reduced while still maintaining an acceptable image quality. *See id.*, 1:43–49.

38. Video coders partition a video into a hierarchy of smaller units, each unit typically being one of: (1) Sequence, (2) Picture, (3) Slice or (4) Macroblock (or just “block”; see next paragraph). Each Sequence, Picture, Slice or Macroblock has an associated “syntax layer” in the encoded bitstream. For each layer, syntax elements may be included in the encoded bitstream that govern the coding of the unit(s) in the given layer and the units included from lower hierarchical layers. The layers build upon themselves as they become smaller, such that a block being coded may reference syntax all the way back to the sequence layer. To depict this hierarchy, I created the following diagram of a possible syntax layer arrangement:



39. As described above, a “macroblock” is a portion of a frame. A macroblock typically comprises 16 x 16 luma (Y) pixels plus the corresponding chroma pixels. For example, if the U and V chroma components are a result of sub-sampling by a factor of two in both the horizontal and vertical directions, then a macroblock corresponds of a set of 16 x 16 Y values, 8 x 8 U values and 8 x 8 V values. *See id.*, 1:58–65. Given that a macroblock is 16 x 16 (luma) pixels, a 176 x 144 pixel frame would be partitioned into 11 x 9 macroblocks.

40. Video encoding and decoding computations are often performed on a macroblock-by-macroblock basis, and encoded video bit streams have information partitioned within them on a macroblock-by-macroblock basis. Macroblocks are typically processed in raster-scan order, left-to-right and top-to-bottom (also denoted “coding order” in the ’148 Patent). *Id.*, 2:7–11, 4:4–7.

41. The '148 patent also describes that macroblocks may be organized together to form so-called “slices.” More specifically, each slice is formed from a number of consecutive macroblocks in coding order and is encoded in such a way that it can be decoded independently without making reference to any other slice of the same frame. *See id.*, 2:5–11. A slice is a subset of a single frame, and slices do not cross frame boundaries. *See id.*, 1:50–2:18.

42. Due to the large number of pixels in a frame (25,344 in the example above for a small 176 x 144 image, and over eight million per frame for today’s 4K video format), encoding techniques are required to create a compressed representation of videos, rather than storing and/or communicating videos in an uncompressed (or “raw”) format. Video coding algorithmic development centers on employing and improving these techniques for compression, while maintaining acceptable decoded video quality.

43. Video coding techniques typically exploit the redundancy in the video to reduce the amount of information—in terms of number of bits—that must actually exist in the encoded video bit stream that is stored and/or transmitted. Redundancies in video “can be categorised into spatial, temporal and spectral redundancy.” *Id.*, 2:49–59. Spatial redundancy “is the term used to describe the correlation (similarity) between neighbouring pixels within a frame.” *Id.* at 2:49–59. Temporal redundancy “expresses the fact that objects appearing in one frame of a sequence are likely to

appear in subsequent frames.” *Id.* at 2:49–59. Temporal redundancy is used with a technique known as motion compensated prediction, also referred to as “Inter” coding. An encoder performs motion compensated prediction by searching a previously encoded frame to find a group of pixels that closely resembles the current block to be coded. The encoder then generates a motion vector that indicates where the group of pixels is in the reference frame that can be copied over to predict the block to be coded. The motion vector is then used to generate a prediction from the appropriate area of the reference frame.

44. When generating this prediction, it is likely that the prediction will not perfectly match the original pixel values of the block to be coded. Because of this, encoders also include prediction error information in the encoded video bitstream, along with motion vectors, for motion compensated prediction. The prediction error information comprises a two-dimensional array of values, each of which represents the difference between a pixel value in the block of luminance or chrominance information being coded and a pixel value obtained by forming a motion-compensated prediction for the block. *Id.* at 6:3–9. As such, prediction error information represents values to be added to a predicted block to achieve a more accurate final decoded picture. *Id.*, 3:27–44.

45. Some frames may not utilize predictions from other reference frames. These are referred to as Intra-coded or I-frames. Intra coding is still performed on a

macroblock-by-macroblock basis, and predictions may be formed from macroblocks that have already been processed in coding order in the same frame (i.e., those macroblocks above the current row, or to the left of the current macroblock in the current row). *Id.*, 3:9–26. As such, INTRA coded macroblocks also have a prediction error, or if no prediction is used, un-predicted pixel values that still must be communicated in the encoded bitstream.

46. Prediction error is traditionally coded through the use of transform coding. Transform coding is the operation of using a block-based two-dimensional frequency transform—typically a Discrete Cosine Transform (DCT) or equivalent—to transform the spatial information into the frequency domain. The transform process represents all values for an $N \times M$ block of pixels (typically 8×8) through the use of the resulting transform coefficients. A DCT is used because the resulting transform coefficients can be encoded into an encoded video bitstream using fewer bits than the original, non-transformed prediction error values can for a similar decoded video quality. *Id.*, 2:60–3:8.

47. After the transform coefficients are derived, encoders typically quantize them to further compress the information in the encoded bitstream. Quantization is performed by effectively “dividing each coefficient value by the quantization parameter QP and rounding the result to the nearest integer.” *Id.* at 4:33–42. The output of this process is a block of quantized coefficient values that

“may be represented by a smaller number of data bits than required to represent the corresponding coefficient before quantization.” *Id.* at 4:33–42. The value of the QP affects both the compression efficiency and the video quality that results from the decoding process. Increasing the QP offers greater compression but reduced image quality, while reducing the QP reduces compression but increases image quality. When encoding video, it is important for encoders to be able to modify the QP used in order to “adjust the number of bits required to encode a video sequence to take into account e.g. the bandwidth available for transmission of the encoded sequence or the desired quality of the coded video.” *Id.* at 4:52–57.

48. The video encoding/decoding process must provide a means such that the exact QP used in encoding is also used in the decoder, so that the decoder may correctly reproduce the encoded video. Typically (i.e., prior to the '148 Patent), the QP was transmitted in an encoded bitstream at the frame, slice, or macroblock level (i.e., the QP was transmitted at the beginning of each frame, each slice or each macroblock). However, this led to an “increase in the number of bits needed to encode the image.” *Id.*, 10:34–40. This is because each time the QP changes on the encoder side, the QP must be sent again through the bitstream. The '148 Patent is directed to improving the process of signaling the QP to the decoder.

49. The '148 Patent describes an improved way of signaling a level of quantization, which is described as Quantization Parameter QP, in video coders

through the use of “a sequence level QP.” *Id.* at 8:45–48, 11:25–36. A sequence in video coding refers to a sequence of frames, i.e. a plurality of frames, and often a large number of frames. With the ’148 Patent’s invention, a QP can be used across multiple frames, requiring only the QP information that was sent with the sequence (typically at the beginning of the sequence). The QP described in the ’148 Patent is applied to at least two frames in an encoded video, thus forming a sequence with a default level of quantization.

50. The ’148 Patent also describes methods to vary the QP used on a slice or block level by “represent[ing the QP] as a difference with respect to the default level of quantization and an indication of the difference with respect to the default level of quantization.” *Id.* at 12:55–13:4. This is advantageous because an encoder must be able to adjust the QP as the encoding progresses to ensure that bitstream and image quality requirements are met. The ’148 Patent achieves this flexibility through signaling only an offset value, which saves bits in the encoded video bitstream by not transmitting the actual value.

51. The inventions claimed by the ’148 Patent provide several benefits in video coding. The use of a default level of quantization exploits the redundancy in QP levels between frames. The adjustments signaled through the use of offset information provide bit savings within the frame as the entire QP need not be encoded. Either of these benefits alone, or the two combined, can result in

meaningful efficiency gains in the encoding/decoding processes for video.

A. Challenged claims 1–23

52. Challenged claims 1–23 recite as follows, using the indexing of the
Petition:

Claim 1[pre]: A method of encoding a digital video sequence for use in a video coding application to produce an encoded video bit-stream representative of the digital video sequence, the digital video sequence comprising a number of frames, each frame of said sequence comprising an array of pixels divided into a plurality of blocks, each block comprising a certain number of said pixels, said method comprising:

1[a]: encoding a frame of the digital video sequence by applying motion compensated prediction to blocks of pixels for producing corresponding blocks of prediction error values;

1[b]: applying a transform coding technique to said blocks of prediction error values to produce sets of transform coefficient values representative of said blocks of prediction error values;

1[c]: defining a default level of quantization for use in encoding of the digital video sequence to quantize the sets of transform coefficient values; and

1[d]: providing an indication of the default level of quantization to a decoding process.

Claim 2: An encoding method according to claim 1, wherein said indication of the default level of quantization is provided in the encoded bit-stream representative of the digital video sequence.

Claim 3: An encoding method according to claim 2, wherein the encoded bit-stream is transmitted from a video encoding device to a corresponding video decoding device.

Claim 4: An encoding method according to claim 1, wherein the default level of quantization is updated during the encoding of the digital video sequence, said method further comprising providing an indication of the updated default level of quantization to a decoding process.

Claim 5: An encoding method according to claim 1, wherein said sets of transform coefficient values are quantized to yield sets of quantized transform coefficient values representative of said blocks of prediction error values based on a level of quantization different from the default level of quantization.

Claim 6: An encoding method according to claim 5, further comprising providing to a decoding process an indication of a difference between said level of quantization and the default level of quantization.

Claim 7: An encoding method according to claim 5, wherein said level of quantization is adjusted from one frame of the digital video sequence to another such that an actual level of quantization applied to the sets of transform coefficients for a particular frame of the digital video sequence is different from the default level of quantization.

Claim 8: An encoding method according to claim 7, wherein said actual level of quantization is representable as a difference with respect to the default level of quantization.

Claim 9: An encoding method according to claim 7, further comprising providing to a decoding process an indication of a difference between said actual level of quantization and the default level of quantization.

Claim 10: An encoding method according to claim 5, wherein the plurality of blocks of pixels, into which a frame of said digital video

sequence is divided, are grouped into one or more segments and wherein the level of quantization applied to said sets of transform coefficient values is adjusted from one segment of a frame to another such that an actual level of quantization applied to the sets of transform coefficients for a particular segment of a frame is different from the default level of quantization.

Claim 11: An encoding method according to claim 10, further comprising providing to a decoding process an indication of a difference between said level of quantization and the default level of quantization.

Claim 12[pre]: A video encoder for encoding a digital video sequence to produce an encoded video bit-stream representative of the digital video sequence, the digital video sequence comprising a number of frames, each frame of said sequence comprising an array of pixels divided into a plurality of blocks, each block comprising a certain number of said pixels, said video encoder comprising:

12[a]: means for encoding a frame of the digital video sequence by applying motion compensated prediction to blocks of pixels to provide corresponding blocks of prediction error values;

12[b]: means for transforming said blocks of prediction error values for providing sets of transform coefficient values representative of said blocks of prediction error values;

12[c]: means for selecting a default level of quantization for quantizing said sets of transform coefficient values; and

12[d]: means for providing an indication of said default level of quantization in the encoded bit-stream representative of the digital video sequence.

Claim 13: A video encoder according to claim 12, wherein said sets of transform coefficient values are quantized to yield sets of quantized transform coefficient values representative of said blocks of prediction error values based on a level of quantization different from the default level of quantization.

Claim 14: A video encoder according to claim 13, arranged to provide an indication of a difference between said level of quantization and the default level of quantization in the encoded bit-stream.

Claim 15: A video encoder according to claim 12, wherein the default level of quantization can be updated and the video encoder is arranged to provide an indication of the updated default level of quantization in the encoded bit-stream.

Claim 16: A video encoder according to claim 15, wherein said sets of transform coefficient values are quantized to yield sets of quantized transform coefficient values representative of said blocks of prediction error values based on a level of quantization different from the updated default level of quantization.

Claim 17: A video encoder according to claim 12, provided in a multimedia terminal.

Claim 18: A video encoder according to claim 12, provided in a radio telecommunications device.

Claim 19: A video encoder according to claim 13, wherein said level of quantization applied to said sets of transform coefficient values can be adjusted from one frame of the digital video sequence to another so as to apply an actual level of quantization to the sets of transform coefficients for a particular frame of the digital video sequence and wherein said actual level of quantization is different from the default level of quantization.

Claim 20: A video encoder according to claim 19, arranged to provide an indication of said difference with respect to the default level of quantization in the encoded bit-stream representative of the digital video sequence.

Claim 21: A video encoder according to claim 13, arranged to group the plurality of blocks into which a frame of said digital video sequence is divided into one or more segments and to adjust the level of quantization applied to said sets of transform coefficient values from one segment of a frame to another so as to apply an actual level of quantization to the sets of transform coefficients for a particular segment of a frame, wherein said actual level of quantization is different from the default level of quantization, said video encoder further arranged to represent the actual level of quantization for use in the particular segment as a difference with respect to the default level of quantization.

Claim 22: A video encoder according to claim 21, further arranged to provide an indication of said difference with respect to the default level of quantization in the encoded bit-stream representative of the digital video sequence.

Claim 23[pre]: A video encoder for encoding a digital video sequence to produce an encoded video bit-stream representative of the digital video sequence, the digital video sequence comprising a number of frames, each frame of said sequence comprising an array of pixels divided into a plurality of blocks, each block comprising a certain number of said pixels, said video encoder comprising:

23[a]: a module for encoding a frame of the digital video sequence by applying motion compensated prediction to blocks of pixels to provide corresponding blocks of prediction error values;

23[b]: a module for transforming said blocks of prediction error values for providing sets of transform coefficient values representative of said blocks of prediction error values; and

23[c]: a module for selecting a default level of quantization for quantizing said sets of transform coefficient values, wherein the default level is specific to the video coding applications.

VI. CLAIM CONSTRUCTION OF '148 PATENT CLAIM TERMS

53. My understanding is that no claim terms of the '148 Patent have been proposed for construction by Petitioner. It is also my understanding that no claim terms of the '148 Patent have been construed in any prior legal proceeding.

VII. THE ASSERTED PRIOR ART

A. MPEG-1 (Ex. 1005)

54. MPEG-1 is a video coding standard published in the early 1990s. As it relates to quantization, MPEG-1 describes a method using a “quantizer scale” (QP) and a “quantizer matrix.” The quantizer scale is a single value and the quantizer matrix is an 8 x 8 matrix of values.

55. The quantizer scale of MPEG-1 functions as the Quantization Parameter, or level of quantization, described in the background section of the '148 Patent. The quantizer matrix, on the other hand, provides an adjustment factor for the quantizer scale, such that the quantizer scale may be applied either uniformly or non-uniformly across the $8 \times 8 = 64$ values within a block of coefficients.

56. I disagree with Petitioner's characterizations of the quantizer matrix

disclosed in MPEG-1, because it is the quantizer scale—not the quantizer matrix—that controls the level of quantization. For example, MPEG-1 defines the quantizer scale as a “data element represented in the bitstream and used by the decoding process to scale the dequantization.” Ex. 1005, § 2.1.119, p. 25 (defining “quantizer scalefactor”). MPEG-1 also states that the varying the quantizer scale is “[o]ne method by which an encoder controls the bit rate.” Ex. 1005, § D.6.1, p. 94. The quantizer scale in MPEG-1 is signaled only at the slice or macroblock level, similar to many quantization parameters in the prior art. Ex. 1005, pp. 39, 45, 46, 72, 92.

57. To explain further, the quantizer matrix alone does not represent a level of quantization, and would not be used as such since—as explained below—its values are only adjustments to the quantizer scale. A quantizer matrix is a map of adjustments to how the level of quantization should be applied across the 8 x 8 transform coefficient block, i.e., it is a block of sixty-four integers that are used to modify the quantization scale when applied to specific locations within a block. Ex. 1005 at pp. 42, 83.

58. The quantizer matrix can either be a default matrix, or the quantizer matrix can be signaled with sixty four distinct integers. *Id.* Quantizer matrix values

typically have a range much smaller than the range of the quantizer scale itself.¹

59. To provide additional insight into the discussion above, I present here an overview of the frequency transform process and the quantization and de-quantization process.

60. As stated in Paragraph 46 above, the prediction error is typically coded using transform coding. Transform coding uses a block-based, two-dimensional frequency transform—typically a Discrete Cosine Transform (DCT) or equivalent—to transform spatial domain information into the frequency domain. A frequency transform is used because the resulting transform coefficients can be encoded into an encoded video bitstream using fewer bits than the original, non-transformed prediction error values can be for a similar decoded video quality. Ex. 1001, 2:60–3:8.

61. An 8 x 8 DCT operation takes an 8 x 8 array of prediction error (or “residual”) values as its input, performs well-known mathematical operations, and outputs an 8 x 8 array of frequency coefficients corresponding to those residual

¹ As discussed later, the calculation that utilizes the quantizer matrix to make the adjustments has a divide-by-sixteen operation at the end, so a quantizer matrix value of “16” is effectively a “1”, and means the quantizer scale value is not scaled or adjusted at all. *See, e.g.*, Ex. 1005 at pp. 42, 83 (showing that the default quantizer matrix for intra ranges from $8/16 = .5$ to $83/16 = 5.1875$, whereas the quantizer scale itself ranges from 1 to 31, and the default quantizer matrix for non-intra (i.e., inter coding) in fact consists of all 16 values, meaning no scaling of quantizer scale at all).

values. This is a reversible process; the 8 x 8 array of frequency coefficients may then be input to an “inverse DCT” (IDCT) operation that restores the original 8 x 8 array of residual values. In video encoding, the encoder performs a DCT, includes a representation of the frequency coefficients in the encoded bit stream, and the decoder uses that representation to perform an IDCT and re-generate the residual values.

62. However, the frequency coefficients are not included in the encoded bitstream using their full, original precision. Instead, they are “quantized,” which reduces their precision, sometimes significantly. The quantization operation saves bits but lowers image quality, because the 8 x 8 residual values reconstructed by the IDCT in the decoder are not the original 8 x 8 residual values that were input to the DCT in the encoder.

63. The goal of the encoder is to search and select the best of numerous encoding options that it has at its disposal, in order to make the recreated values close enough to the original values that the decoded video has acceptable quality to a viewer, all while using the fewest number of bits in the encoded bitstream. One of the encoding options it selects in this regard is the quantization level.

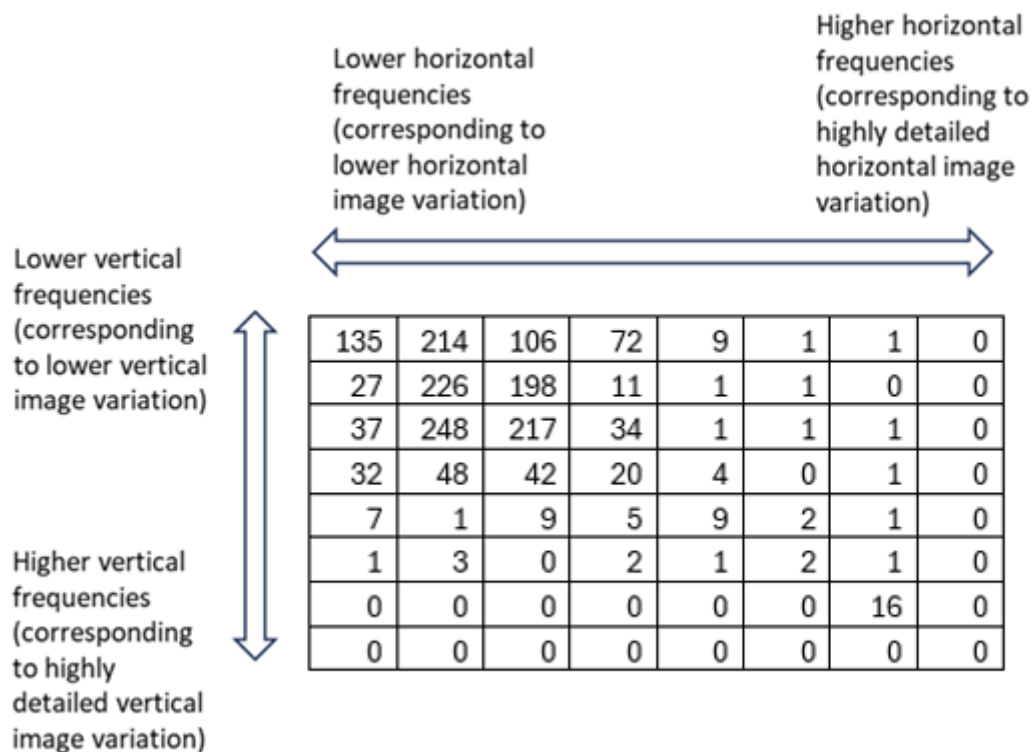
64. At the simplest level, quantization by a quantization level N means rounding down to the nearest multiple of N. For example, if a variable has a possible range of 0 to 99, then quantizing it using a quantization level of 10 would effectively

approximate any value 0–9 as zero, any value 10–19 as 10, any value 20–29 as 20, and so on, up to any value 90–99 being approximated as 90. It takes fewer bits to encode one of ten possible values instead of one of 100 possible values, so this operation trades number of encoded bits for precision. If, for example, the quantization level were 50 instead, then any value 0–49 would be approximated as 0 and any value 50–99 would be approximated as 50. In this extreme example, the value could be represented as a single bit (a zero means 0 and a one means 50), but the loss of precision is huge.

65. The DCT and IDCT are used in video coding because frequency transformed coefficients corresponding to actual image residual values tend to have large values concentrated in fewer coefficients, with many coefficients being zero or close to zero. The zero or close to zero coefficients can be ignored and treated as having a zero value. With fewer larger-valued (“significant”) coefficients to encode (versus all 64 coefficients), bits can be saved in the encoded bitstream.

66. Transform coefficients are typically arranged and depicted so that the most significant coefficients are included in the top left corner of the block. These coefficients represent low frequency detail which is more noticeable to the human visual system than higher frequency detail. The coefficients in the lower right of the block typically represent higher frequency content that add fine details that are often not noticeable to the human eye. A depiction of exemplary transformed coefficient

values (i.e., the output of a DCT) is provided in the diagram below:



67. An encoder generates a table of DCT-transformed values such as the above for each set of 8 x 8 pixels, typically resulting in many thousands of 8 x 8 DCT outputs per second of video. The encoder must choose a quantization level for quantizing each one, subject to how often it is allowed to signal a change in the quantization level in the encoded bitstream (as defined by the codec algorithm itself), and how often it chooses to do so versus the cost of the added bits in the encoded bitstream to signal the change.

68. Some video codec algorithms, such as MPEG-1, utilize a quantizer matrix. The quantizer matrix enables the encoder to indicate adjustments to the

effective quantization of each of the 64 coefficients individually, rather than quantizing them all the same. The encoder may do this to quantize more significant coefficients with higher resolution. Thus, a quantizer matrix is an 8 x 8 array of integers that influence how a quantizer scale is applied to a block of transform coefficients.

69. MPEG-1 provides example code that demonstrates how the transform coefficients are dequantized and reconstructed.

The DCT coefficients for each block present in the macroblock shall be reconstructed by any means equivalent to the following procedure:

```

for ( m=0; m<8; m++ ) {
    for ( n=0; n<8; n++ ) {
        i = scan[m][n];
        dct_recon[m][n] = ( ( 2 * dct_zz[i] ) + Sign(dct_zz[i]) ) *
                           quantizer_scale * non_intra_quant[m][n] ) / 16;
        if ( ( dct_recon[m][n] & 1 ) == 0 )
            dct_recon[m][n] = dct_recon[m][n] - Sign(dct_recon[m][n]);
        if (dct_recon[m][n] > 2047) dct_recon[m][n] = 2047;
        if (dct_recon[m][n] < -2048) dct_recon[m][n] = -2048;
        if ( dct_zz[i] == 0 )
            dct_recon[m][n] = 0;
    }
}

```

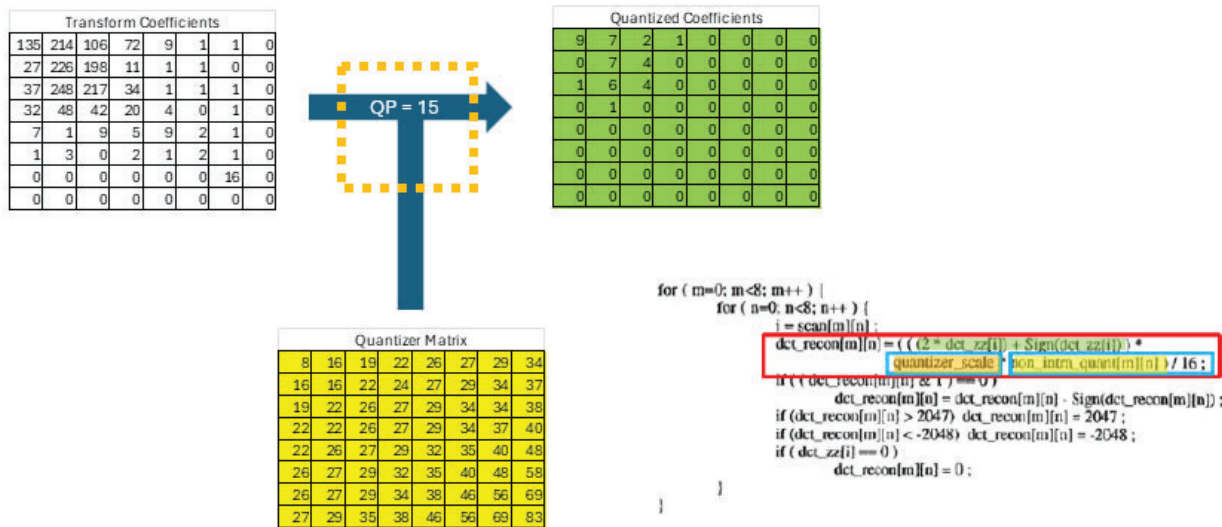
dct_recon[m][n] = 0 for all m, n in skipped macroblocks and when pattern[i] == 0.

Ex. 1005 at 53. The calculation of `dct_recon[m][n]` that utilizes the quantizer matrix `non_intra_quant[m][n]` to make the adjustments to `quantizer_scale` has a divide-by-sixteen operation at the end. Therefore, a quantizer matrix value of “16” is effectively a “1,” such that the `quantizer_scale` value is not scaled or adjusted at all.²

² Note the “2 *” in “2 * dct_zz[i]” at the start of the equation; this is designed into MPEG-1 and means the effective quantization level is in fact two times `quantizer_scale`.

In the code above, the level of quantization (“quantizer_scale”) is multiplied by the value of the [m][n] location in the quantizer matrix (“non_intra_quant[m][n]”) to adjust it for each pixel in the 8 x 8 block.

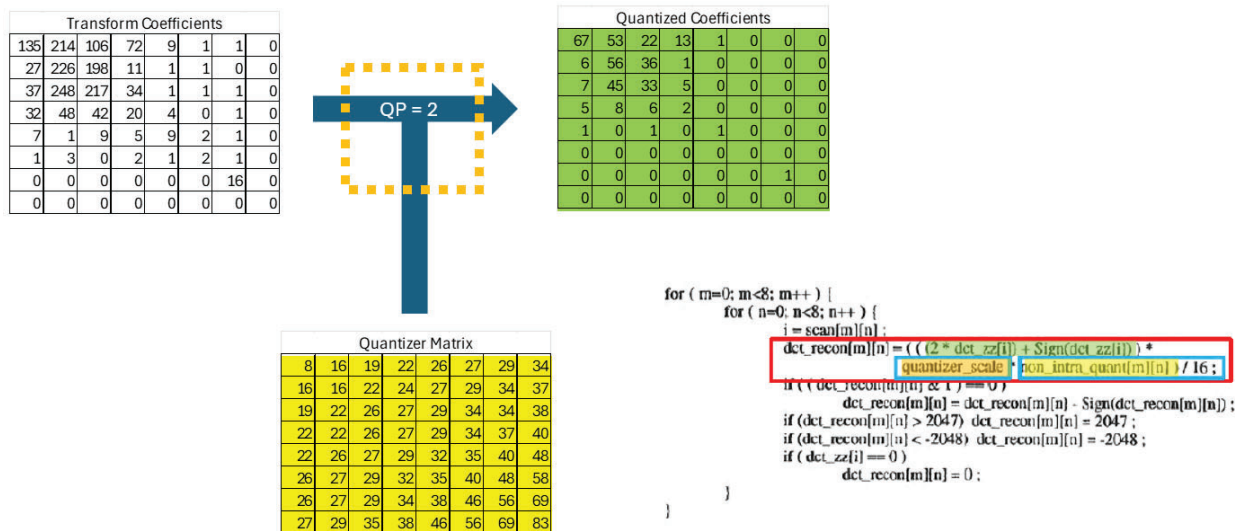
70. An example of a quantization process utilizing a quantizer matrix, using the exemplary transform coefficient values from above, is described here. The chosen quantizer_scale value is 15, the Quantizer Matrix is the default intra quantizer matrix from MPEG-1, and the “Transform Coefficients” are quantized to generate “Quantized Coefficients” as per the MPEG-1 pseudocode above. Note that the quantization level of 15 causes the smaller transform coefficients to be quantized to zero.



71. The QP of 15 is applied to every transform coefficient value in the block. The application of the QP is scaled by the Quantizer Matrix value at each

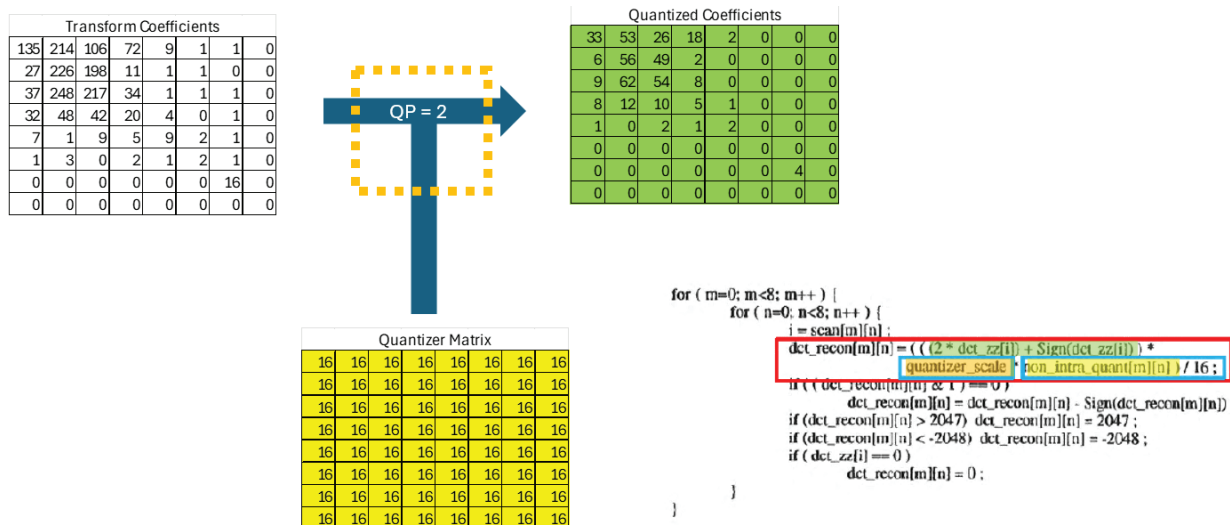
location within the block to adjust the effective quantization value. The Quantizer Matrix functions as a map, allowing the QP to encode more relevant information (the lower frequency coefficient levels) at a higher resolution, resulting in better image quality.

72. Another example is provided below, using the same transform coefficients and Quantizer Matrix but a smaller QP of 2. The smaller QP results in more resolution and fewer zero values in the resulting quantized coefficients.



73. If a uniform Quantizer matrix consisting of all the same values for every location is used, the QP is applied equally across the block. Furthermore, if the Quantizer Matrix includes the default value of 16 for every location, then the Quantizer Matrix has no effect on the quantization process. However, the QP still

operates on the Transform Coefficients. An example with the uniform, default inter Quantizer Matrix is depicted below:



74. As seen in the figure above, the quantized coefficients are all calculated using a QP=2 with no additional scaling, which effectively divides the coefficient by $2 \times 2 = 4$ and rounds down. (Because of the extra “2 *” factor in the MPEG-1 pseudocode above, the effective quantization is $2 * \text{quantizer_scale}$.)

B. H.263 (Ex. 1006)

75. H.263 is a video coding standard published in the early 2000s. H.263 includes four hierarchical syntax layers. In descending order they are (1) Picture; (2) Group of Blocks, or slice, or video picture segment, (3) Macroblock, and (4) Block. Ex. 1006 at p. 13, *passim* (also see Annex R for an explanation of video picture segment). This means that the highest level encoded bitstream syntax for H.263

occurs at the picture level, which is sent for every picture in a video.

76. As it relates to quantization of transform coefficients, H.263 describes the use of a quantizer, or quantization parameter, QUANT. Ex. 1006 at 30. The QUANT value is sent at the picture (i.e. frame) level for every picture in a video as PQUANT. Ex. 1006 at 30. The picture level PQUANT can also optionally be updated at either the Group of Blocks level (using GQUANT), the slice level (using SQUANT), or at the macroblock level (using DQUANT). Notably, the level of quantization specified by H.263 is entirely contained within a single picture and no redundancy is exploited for quantization levels between pictures in a sequence.

C. MPEG-1 in further view of the knowledge of a POSITA does not teach or disclose the Asserted Claims

77. In Ground 1, Petitioner asserts that MPEG-1 in further view of the knowledge of a POSITA teaches or discloses all of the challenged claims 1–23. I disagree, for the following reasons.

1. Claim 1 and dependents

78. I disagree with Petitioner’s argument that MPEG-1 discloses Claim 1 and its dependents. In my opinion, Petitioner mischaracterizes the role of the quantizer matrix found within MPEG-1 to equate the Quantizer Matrix with the claimed “default level of quantization.” However, as I discussed in my overview of MPEG-1, the quantizer matrix is not a quantization parameter. Petitioner seems to attribute the level of quantization with the Quantizer Matrix while referring to

MPEG-1's Quantizer Scale that operates on the output of inverse quantization. This is illogical because the Quantizer Scale and the Quantizer Matrix operate within the same formula (within the red box annotated by Petitioner).

```

for ( m=0; m<8; m++ ) {
    for ( n=0; n<8; n++ ) {
        i = scan[m][n];
        dct_recon[m][n] = ( ( 2 * dct_zz[i] ) + Sign(dct_zz[i]) ) *
            quantizer_scale * non_intra_quant[m][n] ) / 16 ;
        if ( ( dct_recon[m][n] & 1 ) == 0 )
            dct_recon[m][n] = dct_recon[m][n] - Sign(dct_recon[m][n]) ;
        if (dct_recon[m][n] > 2047) dct_recon[m][n] = 2047 ;
        if (dct_recon[m][n] < -2048) dct_recon[m][n] = -2048 ;
        if ( dct_zz[i] == 0 )
            dct_recon[m][n] = 0 ;
    }
}

```

Pet. at 11 (citing EX. 1006 at 53)

79. A POSITA would understand that the quantizer scale in MPEG-1 is the quantization parameter used during quantization while the quantizer matrix is an indication of whether to apply the quantization parameter equally, or instead to adjust it, throughout the block. The inter-coding default quantizer matrix for MPEG-1 does just this, applying an equal quantization scale to the entire block of transform coefficients.

80. The quantizer scale disclosed in MPEG-1 also fulfills the typical functions of a quantization parameter and those of the level of quantization in the '148 Patent. As an example, MPEG-1's quantizer scale is used in rate control to meet bandwidth requirements.

One method by which an encoder controls the bit rate is to vary the quantizer scale. This is set in each slice header, and may be set at the beginning of any macroblock, giving the encoder excellent control over the bit rate within a picture.

EX. 1006 at 94.

81. This mirrors one function of the Quantization Parameters described in the '148 Patent:

Again, selection of the quantization parameter QP is controlled by the control manager **160** via control line **115**. The accuracy of prediction error coding can be adjusted depending on the available bandwidth and/or required quality of the coded video. In a typical Discrete Cosine Transform (DCT) based system this is done by varying the Quantizer Parameter (QP) used in quantizing the DCT coefficients the DCT coefficients to a specific accuracy.

'148 Patent at 6:22–27.

82. MPEG-1's quantizer scale is also "used by the decoder to calculate the DCT coefficients from the transmitted quantized coefficients." Ex. 1005 at 92. This is the role of a Quantization Parameter in the '148 Patent's invention. However, MPEG-1's quantizer scale is not signaled higher than the slice level, and thus does not disclose a "default level of quantization for use in encoding of the digital video sequence." This is because MPEG-1's quantizer scale does not apply for a "video sequence" which is claimed as "comprising a number of frames." '148 Patent at Claim 1.

83. Seemingly in an attempt to traverse this fault, Petitioner chose to rely on the disclosure of MPEG-1's Quantizer Matrix as disclosing the "default level of quantization" instead. However, as discussed above, the Quantizer Matrix is a map for adjusting the Quantizer Scale, not a level of quantization itself. Finally, to the extent the Quantizer Matrix is ever changed, it is not adjusted in the same manner as the level of quantization claimed by the '148 Patent.

84. A POSITA would understand that MPEG-1's Quantizer Matrix is merely an adjustment of if and how to non-uniformly apply the Quantizer Scale to the transform coefficients. This is evident from the example code provided by MPEG-1:

```
for ( m=0; m<8; m++ ) {  
    for ( n=0; n<8; n++ ) {  
        i = scan[m][n];  
        dct_recon[m][n] = ( ( (2 * dct_zz[i]) + Sign(dct_zz[i]) ) *  
                             quantizer_scale * non_intra_quant[m][n] ) / 16 ;  
        if ( (dct_recon[m][n] & 1) == 0 )  
            dct_recon[m][n] = dct_recon[m][n] - Sign(dct_recon[m][n]) ;  
        if (dct_recon[m][n] > 2047) dct_recon[m][n] = 2047 ;  
        if (dct_recon[m][n] < -2048) dct_recon[m][n] = -2048 ;  
        if ( dct_zz[i] == 0 )  
            dct_recon[m][n] = 0 ;  
    }  
}
```

Pet. at 11 (citing MPEG-1 at 53) (annotated by Petitioner).

85. In the code above, `dct_recon[m][n]` is derived through the formula outlined in red. The `dct_recon[m][n]` is the reconstructed (inverse quantized) transform coefficient for location `[m][n]` in the block. The Quantizer Scale is

represented by the blue box on the left “quantizer_scale” and the Quantizer Matrix value for location $[m][n]$ is represented by the blue box on the right “non_intra_quant $[m][n]$.” During this inverse quantization process, the quantizer scale remains the same for every quantized value. However, the application of the Quantizer Scale can vary depending on the value present for the location in the Quantizer Matrix. If all values in the Quantizer Matrix are equal, then the Quantizer Scale is equally applied to all quantized values. If the Quantizer Matrix has unique values for each location, then the Quantizer Scale is applied according to those values. The default inter coding Quantizer Matrix of MPEG-1 includes values of “16” for every location, making it a uniform application of the Quantizer Scale. Also, as described in Section VII.A, these “16” values are effectively a scaling of one and result in no adjustment to Quantizer Scale.

86. Finally, MPEG-1’s Quantizer Matrix is not capable of being updated outside of the sequence header. This contradicts with the teachings of the ’148 Patent that states the level of quantization “can be updated during encoding of the digital video sequence.” ’148 Patent at 12:19–24. When the Quantizer Matrix is signaled in MPEG-1 the “values shall be in effect until the next occurrence of a sequence header.” A POSITA would understand that the entire sequence containing the Quantizer Matrix must use the originally signaled matrix. There is no updating of MPEG-1’s Quantizer Matrix possible within the sequence, which is counter to the

'148 Patent's teachings.

87. In my opinion, Petitioner has not shown that MPEG-1 discloses the limitation of “defining a default level of quantization for use in encoding of the digital video sequence to quantize the sets of transform coefficient values.” This is because Petitioner’s argument incorrectly focuses on the Quantizer Matrix disclosed in MPEG-1, rather than MPEG-1’s level of quantization. MPEG-1’s level of quantization (Quantizer Scale) is signaled at the frame level and does not meet the requirement that the default level be for use in “the digital video sequence.”

88. Further in my opinion, it is hindsight bias to assume that the knowledge of a POSITA would render the '148 Patent’s claims obvious in light of MPEG-1. As stated in Section V above, video coding algorithmic development centers on employing and improving techniques for compression, while maintaining acceptable decoded video quality. I worked in audio and video algorithm development in the 1997–2003 time frame, and essentially every feature, proposal or tradeoff required novel idea generation and thorough experimentation.

2. Claim 12 and dependents

89. In my opinion, Petitioner’s arguments regarding Claim 12 and its dependent claims suffer from the same issues as Petitioner’s arguments regarding Claim 1. Petitioner offers no additional argument that touches on a “level of quantization for use in encoding of the digital video sequence.” For this reason, I

believe Petitioner has failed to show that Claim 12 and its depending claims are obvious in light of MPEG-1.

3. Claim 23

90. In my opinion, Petitioner's arguments regarding Claim 23 suffer from the same issues as Petitioner's arguments regarding Claim 1. Petitioner offers no additional argument that touches on how the quantizer matrix discloses "a default level of quantization." As explained above, MPEG-1's Quantizer Matrix is not a level of quantization and Petitioner has made no showing that a default level of quantization is disclosed in MPEG-1. For this reason, I believe Petitioner has failed to show that Claim 23 and its depending claims are obvious in light of MPEG-1.

D. H.263 in further view of the knowledge of a POSITA does not teach or disclose the Asserted Claims

91. In Ground 2, Petitioner asserts that H.263 in further view of the knowledge of a POSITA teaches or discloses all of the challenged claims 1–22. I disagree, for the following reasons.

1. Claim 1 and dependents

92. In my opinion, H.263 does not disclose or render obvious Claim 1 because it does not disclose a "default level of quantization for use in encoding of the digital video sequence." H.263's highest level of syntax is at the picture level. The '148 Patent makes clear that a "video sequence" must "comprise a number of

frames.” This means that a default level of quantization for a video sequence must be a default across multiple frames. H.263’s quantization parameters PQUANT, GQUANT, SQUANT and DQUANT do not disclose this.

93. In H.263, a quantization parameter can be sent for a picture. This comes in the form of the PQUANT value. As Petitioner states, “every picture includes a PQUANT.” Pet. at 53. Petitioner has pointed to no mechanism, nor even made the claim, that H.263 discloses a level of quantization that can be used for multiple pictures in a sequence.

94. Petitioner attempts to rely on Patent Owner’s statements in a co-pending litigation regarding H.264. However, H.264 includes a syntax level for a “picture parameter set.” A picture parameter set can be used (and is typically intended to be used) by multiple frames within a sequence as evident by its definition in H.264: “[a] *syntax structure* containing *syntax elements* that apply to zero or more entire *coded pictures* as determined by the *pic_parameter_set_id syntax element* found in each *slice header*.” Ex. 1009 (“H.264”), § 3.93.1, p. 5 (defining “picture parameter set”) (emphasis in original). This is notably distinct from H.263, which does not use picture parameter sets but rather a unique picture header for each picture. H.263’s picture header includes a PQUANT value for every picture. Petitioner’s attempt to equate the two is misguided and does not change anything about what the ’148 Patent claims.

95. In my opinion, H.263 does not disclose or render obvious Claim 1 of the '148 Patent because it does not disclose any default level of quantization that is for use in encoding a digital video sequence. At most, it discloses a quantization level for a video frame.

96. Further in my opinion, it is hindsight bias to assume that the knowledge of a POSITA would render the '148 Patent's claims obvious in light of H.263. As stated in Section V above, video coding algorithmic development centers on employing and improving techniques for compression, while maintaining acceptable decoded video quality. I worked in audio and video algorithm development in the 1997–2003 time frame, and essentially every feature, proposal or tradeoff required novel idea generation and thorough experimentation.

3. Claim 12 and dependents

97. In my opinion, Petitioner's arguments regarding Claim 12 and its dependent claims suffer from the same issues as Petitioner's arguments regarding Claim 1. Petitioner offers no additional argument that explains how the PQUANT value in H.263 can be used across multiple frames in a sequence. For this reason, I believe Petitioner has failed to show that Claim 12 and its depending claims are obvious in light of H.263.

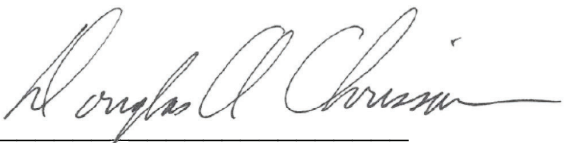
VIII. OPINIONS

98. For all the reasons described above, it is my opinion that neither

Petitioner's Asserted Ground 1, MPEG-1 in further view of the knowledge of a POSITA, nor Petitioner's Asserted Ground 2, H.263 in further view of the knowledge of a POSITA, renders obvious the Challenged Claims 1–23 of the '148 Patent.

99. The reasons described above do not necessarily represent the entirety of my opinions regarding Petitioner's Asserted Grounds. I reserve the right to provide further analysis in the event this IPR is instituted. I declare under penalty of perjury that the foregoing is true and correct. I acknowledge that willful false statements and the like are punishable by fine and/or imprisonment, that all statements made of my own knowledge are true, and that all statements made on information and belief are believed to be true.

Executed December 12, 2024, in Los Gatos, CA.

By: 
Douglas A. Chrissan, Ph. D.