

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

AMAZON.COM, INC., AMAZON.COM SERVICES, LLC,
Petitioner

v.

NOKIA TECHNOLOGIES OY,
Patent Owner

Case: IPR2024-00627
U.S. Patent No. 11,805,267

PATENT OWNER'S RESPONSE

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TABLE OF EXHIBITS

Exhibit	Description
2001	Declaration of Dr. Iain Richardson
2002	CV of Dr. Iain Richardson
2003	File History of App. Ser. No. 15/250,124 (“’124 Application”)
2004	File History of App. Ser. No. 15/490,469 (“’469 Application”)
2005	File History of App. Ser. No. 15/876,495 (“’495 Application”)
2006	File History of App. Ser. No. 16/729,974 (“’974 Application”)
2007	Pat. App. Pub. No. US 2009/0257503 to Yan Ye, Peisong Chen, and Marta Karczewicz (“Ye ’503”)
2008	Pat. App. Pub. No. US 2010/0086027 to Rahul Panchal and Marta Karczewicz (“Panchal”)
2009	Pat. App. Pub. No. US 2013/0142262 to Yan Ye and Alexandros Tourapis (“Ye ’262”)
2010	VCEG-AI33 by Yan Ye, Peisong Chen, and Marta Karczewicz
2011	U.S. Pat. No. 9,161,057 to Marta Karczewicz, Peisong Chen, and Yan Ye (“Karczewicz ’057”)
2012	Excerpts from “The H.264 Advanced Video Compression Standard”, Richardson, 2010 (Cover pages, book pages 28-38, 69, 106, 108, 223-229)
2013	CV of R. Mitch Verboncoeur
2014	Declaration Of R. Mitch Verboncoeur in Support of Motion for <i>Pro Hac Vice</i> Admission
2015	Declaration of Dr. Iain Richardson
2016	Deposition Transcript of Immanuel Freedman, dated November

Exhibit	Description
	26, 2024
2017	Marta Karczewicz 50 Leading Tech Voices, available at https://www.epo.org/en/about-us/50-epc-anniversary/50-leading-tech-voices/marta-karczewicz
2018	Richardson, The H.264 Advanced Video Compression Standard (page 283)

I. Introduction

Following the Board's Decision Granting Institution of *Inter Partes* Review ("Decision"), Patent Owner Nokia Technologies Oy ("Nokia") sets forth the substantive errors, omissions, and shortcomings underlying the alleged grounds for invalidity argued in the Petition for *Inter Partes* Review of U.S. Patent No. 11,805,267 (the "'267 Patent") ("Petition" or "Pet."). Both of Petitioners' Grounds are flawed.

First, Petitioners' Ground 1 identifies Walker's $(pred0)w0$ and $(pred1)w1$ products as the claimed "first prediction" and "second prediction." However, neither of these values is a prediction. The predictions in Walker are $pred0$ and $pred1$. In Walker, $pred0$ and $pred1$ approximately represent a block of pixel values. By contrast, Walker's weighting factors, $w0$ and $w1$, are not correlated with the prediction values $pred0$ and $pred1$, nor are they intended to approximately represent pixel values. Thus, Walker's products $(pred0)w0$ and $(pred1)w1$ are not predictions.

Second, the products $(pred0)w0$ and $(pred1)w1$ do not have a "second precision, higher than the first precision." This is because multiplying a value by a weight only scales the value and does not increase its precision. Petitioners' expert, Dr. Immanuel Freedman, defines "precision" as a "number of bits needed to represent possible values." Pet. at 12; *see also* Ex-2016 at 29:16-30:9. Patent owner agrees. However, Dr. Freedman then argues that the "absolute magnitude" of a

number determines its precision because—with conventional binary representation—a greater number of bits are typically used to represent larger numbers. Extending this reasoning leads to the absurd conclusion that multiplying any measurable quantity by an infinitely large number (e.g., a scaling factor) can result in infinite precision. A POSITA would understand that this is incorrect.

As Nokia will explain, Dr. Freedman’s position rests on an affirming the consequent fallacy.¹ That is, the parties agree that if one has a higher precision value, then one will require a greater number of bits to represent that value. However, it is a logical fallacy to assume that the converse of this statement follows. The mere fact a greater number of bits happens to be used to represent a value does not prove that the value is at a higher precision. For example, one can represent (using conventional binary representation) the value 251 with 8 bits. If one rounds this value up to 300, all observers should agree that precision is lost. Yet conventional binary representation may use 9 bits or more to represent the number 300, and thus Dr. Freedman’s position would require us to believe that we have increased precision by rounding and losing data—a clearly erroneous conclusion.

Nokia’s expert, Dr. Iain Richardson, advances a technically correct understanding of “precision” as the “number of bits needed to represent possible

¹ https://en.wikipedia.org/wiki/Affirming_the_consequent

values.” As Dr. Richardson explains in his accompanying declaration, precision correlates with the number of possible values a variable can take. In video coding, precision for pixel values relates to the number of values (e.g., of brightness or color) a pixel can take. Walker’s $(pred0)w0$ and $(pred1)w1$ are not at higher precisions than the predictions $pred0$ and $pred1$ because—even putting aside the issue of whether the products $(pred0)w0$ and $(pred1)w1$ constitute predictions— $w0$ and $w1$ are weighting factors that do not increase the number of possible values of the products.

Third, Walker’s products $(pred0)w0$ and $(pred1)w1$ are not obtained from pixel values of reference blocks as required by the challenged claims. Petitioners allege $pred0$ and $pred1$ are reference blocks. $Pred0$ and $pred1$ are not reference blocks. Rather, as Walker states repeatedly and as the presence of “pred” in these parameter names imply, $pred0$ and $pred1$ are Walker’s predictions (which are themselves obtained from reference blocks).

Fourth, Petitioners’ Ground 2 fails because a POSITA would not be motivated to modify Karczewicz-I and Karczewicz-II in the extensive and inefficient way Petitioners allege. The same inventors are on both references. As Dr. Richardson describes in his declaration, the inventors, particularly Marta Karczewicz, were people of extraordinary skill in the art at the time of the ’267 Patent. Yet they did not make the modifications that Petitioners allege would have been obvious to a POSITA.

Moreover, Petitioners' supposed inspiration for the modification is illusory. The Petition identifies similar video architectures and references to motion-compensated prediction as spurring an ordinary artisan to modify Karczewicz-I based on Karczewicz-II. However, none of these things constitute any motivation or inspiration for a POSITA to act. Indeed, the figures Dr. Freedman and Petitioners point to are generic architectures of video coders that have been widely known since the 1990s. A POSITA would not have been inspired by the fact that such generic architectures are generically mentioned in Karczewicz-I and Karczewicz-II. Nor would a POSITA have been inspired by the fact that the references relate to motion-compensated prediction, a ubiquitous category of techniques in video coding.

Finally, as Dr. Richardson explains in his declaration, the alleged modification is technically meritless and falls prey to the very type of inefficiencies that the Karczewicz references and the '267 Patent attempt to avoid, such as introducing unnecessary memory overhead and conditional branching.

II. Background

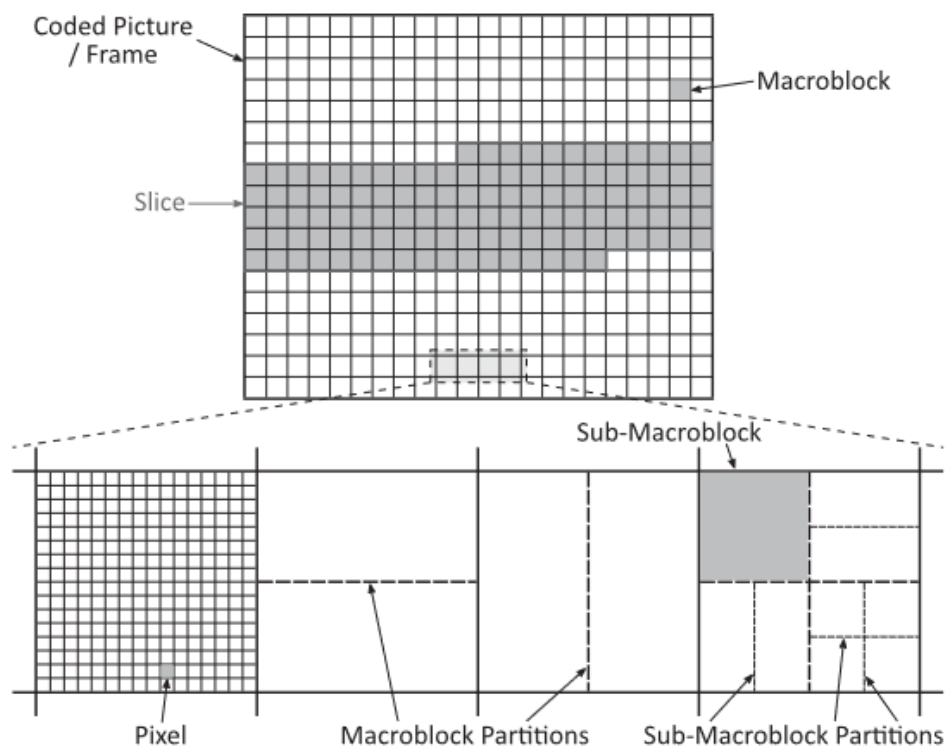
A. Technical Background

1. Components of Digital Video

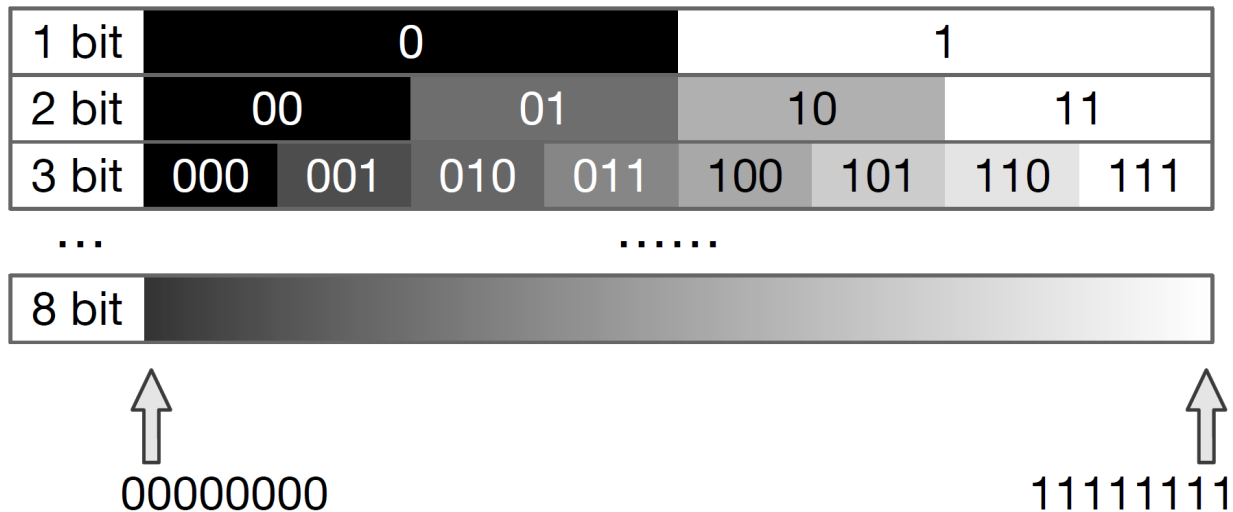
Video playback involves displaying a succession of individual frames or pictures to a viewer, creating the experience of viewing a moving picture. In digital

video, each of these pictures is included in a collection known as a sequence. A digital video can consist of multiple sequences.

The smallest addressable unit of a digital video is a pixel (picture element). Individual frames of digital video are typically partitioned into blocks, which consist of MxN collection of pixels. For example, one type of block called a “macroblock” is 16x16 pixels. Blocks, in turn, are commonly collected into groups known as “slices.”



Digital video can be represented in binary. For example, pixels with “8-bit” precision can have components (brightness or color) with 256 possible values.² 10-bit is higher precision because it allows for a greater range of possible values: 1024 possible values.



The difference between the lower precision and higher precision systems involves the extent of possible values (not the specific values themselves). In other words, there is a greater ability to express different brightnesses and colors in a higher precision system even though lower precision and higher precision systems can express both complete dark and the maximum brightness for a given pixel.

² An n-bit variable can take 2^n possible values. Ex-2015 at ¶ 44. The exact values represented by an 8-bit variable may vary depending on the convention used to interpret the bits. For example, an unsigned 8-bit variable could map to values from 0 to 255, while a signed 8-bit variable using two's complement could map to values from -128 to 127. In either case, eight bits can convey 256 possible values. *Id.* at ¶¶ 44, 72.

Digital videos today commonly display 30 frames per second, with each frame comprising resolutions such as 1920x1080 pixels (1080p video) or 3840x2160 (4K). Ex-2015 at ¶ 43. This results in a lot of pixel data. *See id.* at ¶ 146. For every second of 4K digital video played, 248,832,000 pixels are displayed on-screen. For a video using eight bits for each component of each pixel, this equates to 746 megabytes of pixel data being displayed per second. This enormous amount of information presents a problem: Bandwidth is limited, and devices have limited storage capacities. Accordingly, video coding experts have made significant efforts to develop techniques that compress video information to reduce the number of bits that must be transmitted to display high-quality digital video.

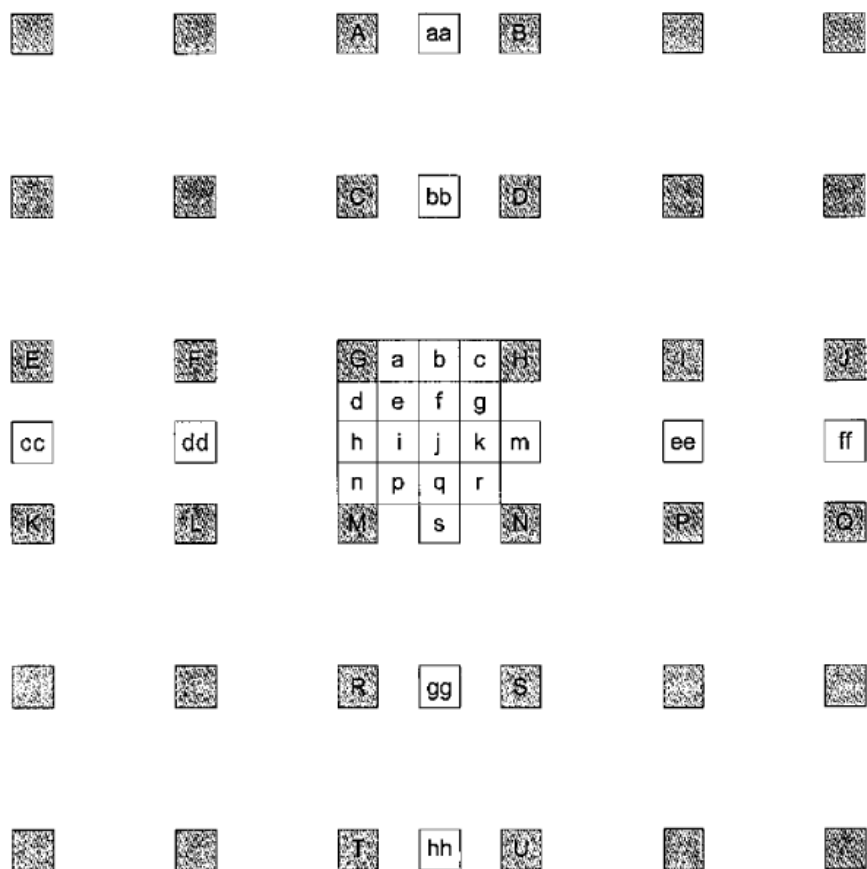
2. Motion-Compensated Prediction

One widely deployed technique for reducing the amount of information needed for digital video is motion-compensated prediction. With motion-compensated prediction, data for blocks of pixels in an image frame is not included in a bitstream. Rather, this data can be predicted using the data of another frame in the video called a “reference frame.” The best-matching blocks of a reference frame are identified through motion vectors. These motion vectors can be encoded into a bitstream or themselves predicted from other information in the bitstream. Once identified via a motion vector, the best-matching block is used to form a prediction of the pixel values of the current block. Then the difference between the prediction

and the current block—called a residual error—can be encoded. A better prediction means less residual error, which in turn reduces the amount of data that must be encoded into the bitstream to represent the error.

3. Sub-Pixel Interpolation

Although digital video frames consist of pixels, the motion between frames may not align exactly with the locations of these pixels. To account for this, video coding standards allow motion vectors to be represented at fractional pixel accuracy. For example, the H.264 Standard allows motion vectors to have up to quarter-pixel accuracy. Ex-1001 at 3:6-11.



When a motion vector points to a fractional pixel location, the value of samples used to predict a block based on that motion vector must be calculated by interpolation. Interpolation is typically performed using P-tap filters, which take a weighted average of P sample values on either side of the subpixel being computed to predict the subpixel value. Ex-2015 at ¶¶ 50-51. Figure 12, reproduced above, illustrates the original integer pixels (in shaded blocks) and the half-pixel and quarter-pixel subpixels that can be computed from them. Ex-1001 at 14:27-32, Fig. 12. For example, the subpixel labeled “b” might be predicted using the following 6-tap filter:

$$b = (3E - 17F + 78G + 78H - 17I + 3J + 1) \gg 1$$

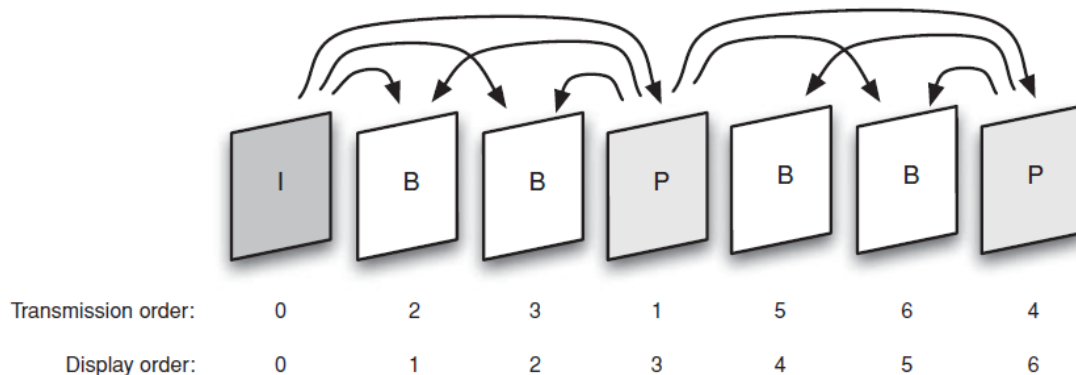
The capital letters E, F, . . . J represent the integer pixels shaded in Figure 12 above. By applying this 6-tap filter, the values of integer pixels are combined to form a high-precision prediction of the subpixel value. This higher precision results from the mathematics of the filter process. Each weighted integer pixel value has the same range of possible values before and after being multiplied by a weight. However, each pixel is independent of the other, which means that their sums can take a greater range of possible values than the individual pixel values themselves.³ A similar P-

³ As a simplified example, consider that two numbers selected independently from the set of even numbers, X=2 and Y=4, have an average value of 3, which is not an even number.

tap filtering process can be used to compute quarter-pixel values from half-pixel values. *See id.* at 3:6-10.

4. Bi-Prediction

Bi-prediction is a motion-compensated prediction technique in which two reference frames are used to predict a current picture instead of one. Two different motion vectors are used to point to two different best-matching blocks from different reference frames. The predictions formed from both best-matching blocks are combined to form a “combined prediction.” An advantage of bi-prediction is that this combined prediction may be more accurate than any single prediction, which reduces the residual error to be encoded. Thus, bi-prediction increases the degree to which video can be compressed at the cost of additional processing needed to form the two predictions and combine them.



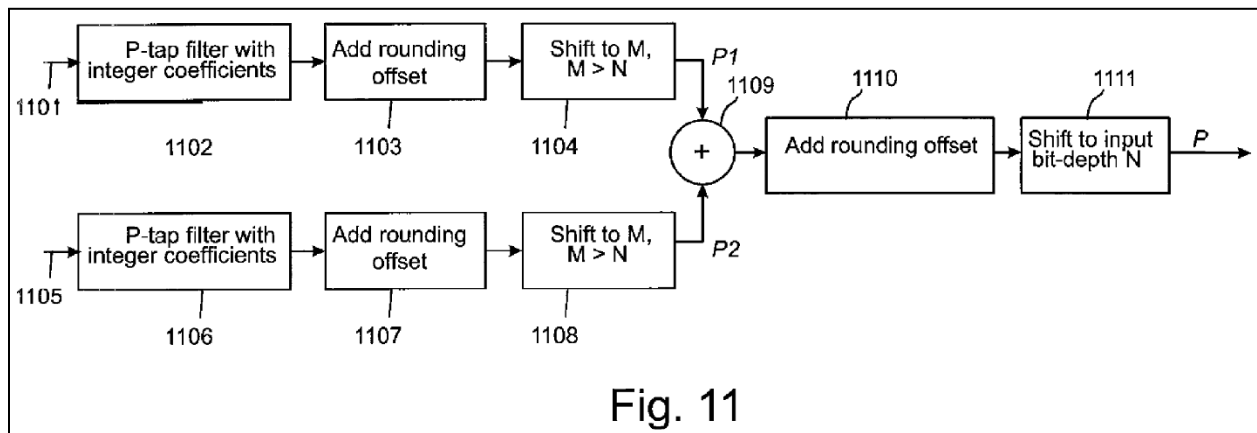
The H.264 Standard, which predates the '267 Patent, made use of two different methods for combining predictions from two reference frames: default bi-prediction and weighted bi-prediction. With default bi-prediction, the two

predictions are averaged, each contributing half of the final prediction value. With weighted bi-prediction, the two predictions are multiplied by weighting factors representing their relative contribution to the final prediction. Weights can be signaled explicitly in the bitstream or can be computed based on the relative distance between the current frame and the corresponding reference frame.

B. The '267 Patent

The inventors of the '267 Patent recognized the accumulation of rounding error in conventional bi-prediction was a longstanding problem in need of a more effective solution. Ex-1001 at 3:56-4:26. Although other techniques such as alternating upward and downward rounding of predictions had been suggested, these methods were suboptimal and increased the complexity of encoders and decoders. *Id.* As the '267 Patent explains, existing approaches increase complexity due to the need for “two separate code branches” for bi-directional averaging. *Id.* at 4:21-25. Moreover, the '267 Patent explains that “motion estimation routines in the encoder may need to be doubled for both cases of rounding and truncation.” *Id.*

The inventors of the '267 Patent also observed that the accuracy of predictions relates to coding efficiency. *Id.* at 3:12-24; 3:49-51. Because the residual error resulting from a more accurate prediction will be smaller, that residual contributes fewer bits when quantized, entropy coded and included in the bitstream. *Id.* at 3:25-30, 12:4-20; Ex-2015 at ¶¶ 47-48, 53, 64-65.



53. The inventors' solution to this issue was to reduce rounding errors by retaining more of the precision created by the application of P-tap filters when generating predictions, as shown in Fig. 11 above. This approach allows reference frames to be stored at their original bit depth but uses high bit-depth operations for sub-pixel interpolation and bi-prediction to avoid loss of precision before a final bi-prediction was calculated. *Id.* at 12:41-14:27. Rather than reducing interpolated values to the precision of input pixels, predictions are made at the same high precision and reduced to the input precision by right shifting after the predictions are combined. *Id.* at 14:4-10.

C. Alleged Prior Art

1. Ground 1 – Walker

U.S. Application No. 2005/0281334 (“Walker”) (Ex-1004) discloses a method and apparatus for “decoding of multiple weighted bi-directional encoding schemes with a single decoder.” Ex-1004 at ¶ 8. The “multiple encoding schemes”

mentioned in Walker’s description refers to the bi-prediction methods of MPEG-4 Part 2, Real Video 9 (“RV9”), Windows Media Video 9 (“WMV9”), and H.264/AVC. *Id.* at ¶¶ 6. Walker’s objective is to provide a single weighted bi-prediction decoder that can decode each of the enumerated standards and specifications. *Id.* at ¶¶ 8, 71-72.

Walker’s disclosure includes an overview of the bi-prediction algorithms for each standard and specification that it attempts to unify, devoting the most attention to H.264, which it describes as the “most complicated.” *See id.* at ¶¶ 58-70, 74. Following this restatement, Walker builds a series of equations that it proposes can be used for a “single implementation satisfying MPEG-4, RV9, WMV9, and H.264.” *Id.* at 71.

Walker discusses both the default prediction process and explicit weighed prediction methods of H.264. Ex-1004 at ¶¶ 36-38, 59-70. Walker presents three different “cases” in for motion compensated prediction in H.264. The first two cases presented do not correspond to bi-prediction because each uses only one reference frame to determine a final prediction. *Id.* at ¶¶ 62-66; Ex-2015 at ¶ 82.

$$Final_pred = Clip1[(((pred0)w0 + (pred1)w1 + 2^{\log WD}) >> (\log WD + 1)) + ((o_0 + o_1 + 1) >> 1)] \quad (13)$$

Walker’s H.264 “Case 3” corresponds to conventional bi-prediction in H.264, without any of the improvements claimed in the ’267 Patent. Walker describes this

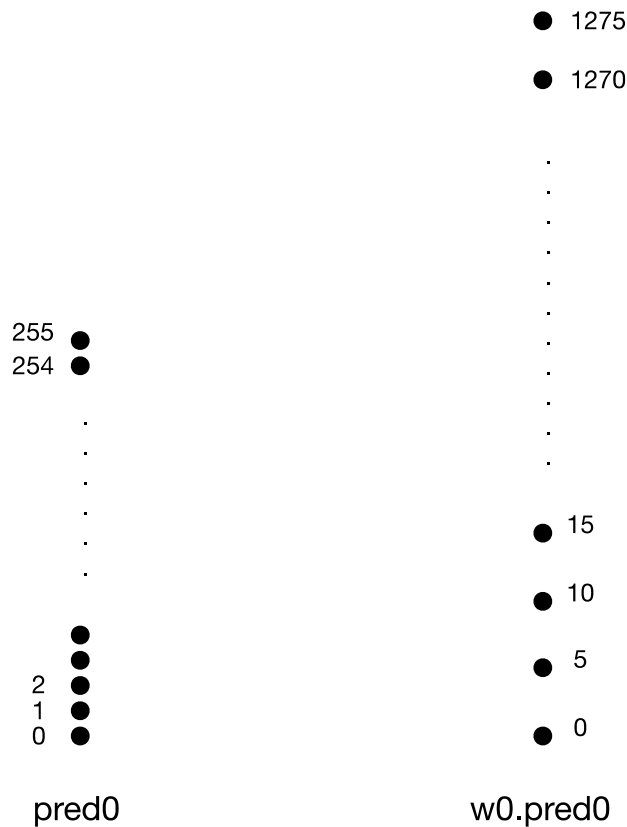
methodology using its Equation 13, reproduced above, which applies weighting factors, w_0 and w_1 , to the predictions $pred_0$ and $pred_1$. Ex-1004 at ¶¶ 67-70, Eqn. 13, Table 1; Ex-2015 at ¶¶ 83-84. Petitioners rely on Equation 13 as a basis for Ground 1. Pet. at 20-21, 23-24.

Although Petitioners rely on Equation 18 from Walker, Equation 18 has the same structure as Equation 13, with the exception of renaming the weighting factors to w_A and w_B , and including a right shift by 6 bits in the weighting process. *See* Ex-1004 at ¶¶ 67-70, Eqn. 18, Table 4; Ex-2015 at ¶¶ 83-84.

$$pred_{ij} = (((pred_0)w_A) \gg 6 + ((pred_1)w_B) \gg 6) + 2^7 \gg 8 + \text{Offset} \quad (18)$$

Petitioners allege that the products of weights and predictions (i.e., $(pred_0)w_A \gg 6$ and $(pred_1)w_B \gg 6$) are the higher precision predictions recited in the challenged claims of the '267 Patent. *Id.*

However, as Dr. Richardson illustrates below, the weighted bi-prediction methods discussed in Walker simply scale the predictions. The results of this scaling are larger numbers to increase the relative contribution of that prediction $pred_0$ or $pred_1$ to the final prediction. Ex-2015 at ¶¶ 105-106. As Dr. Richardson explains, multiplying predictions by weights does not increase the number of possible values. *Id.*



2. Ground 2 – Karczewicz-I and Karczewicz-II

Petitioners’ Ground 2 proposes modifying U.S. Application No. 2011/0007799 (Ex-1005) (“Karczewicz-I”) and U.S. Application No. 2009/0257499 (Ex-1006) (“Karczewicz-II”) with one another’s disclosures, arguing that the claims of the ’267 Patent would be an obvious result of such a modification.

a) Karczewicz-I

Karczewicz-I describes conventional bi-prediction, without the improvements of the ’267 Patent. Like Walker, Karczewicz-I also describes the conventional default, implicitly weighted, and explicitly weighted forms of bi-prediction from H.264. *See* Ex-1005 at ¶ 44.

Default	Bidirectional prediction: $\text{pred}(i,j) = (\text{pred0}(i,j) + \text{pred1}(i,j) + 1) \gg 1$
Implicit	Bidirectional prediction: $\text{pred}(i,j) = (\text{pred0}(i,j) * w0 + \text{pred1}(i,j) * w1 + 32) \gg 6$
Explicit	Bidirectional prediction: $\text{pred}(i,j) = (\text{pred0}(i,j) * w0 + \text{pred1}(i,j) * w1 + 2^r) \gg (r+1) + ((o1 + o2 + 1) \gg 1)$

Karczewicz-I does not disclose or suggest the '267 Patent's inventive approach to reducing accumulated rounding error. Rather, Karczewicz-I discusses adjusting the rounding offsets (annotated by Dr. Richardson above) applied during bi-prediction to reduce the loss of precision by using an upward, downward, or absent rounding offset. *Id.* at ¶¶ 64-68; Ex-2015 at ¶¶ 86-88. For example, rounding offsets of +1, +32, 2^r and +1 are expressed in the three equations above. Ex-2015 at ¶ 87. Karczewicz-I proposes that the performance of prediction can be improved by adjusting these rounding offsets such as by combining multiple offsets, using different offsets for bi-prediction compared to prediction from a single reference frame, and adaptively selecting upward, downward, or no rounding offsets. Ex-1005 at ¶¶ 64-68; Ex-2015 at ¶¶ 88-89.

Karczewicz-I's rounding adjustment techniques are discussed in the '267 Patent as early efforts to reduce the rounding error of H.264 that proved insufficient.

Ex-1001 at 3:56-4:26 (“For example, rounding up may be used for every other frame, and correspondingly, rounding down may be used for every other frame”).

b) Karczewicz-II

Karczewicz-II is not focused on bi-prediction. Rather, Karczewicz-II’s focus is the interpolation of subpixel values. Karczewicz-II discloses conventional interpolation, in which half-pixel values are computed from integer pixel values and quarter-pixel values are computed from half-pixel values. Ex-1006 at ¶ 86.

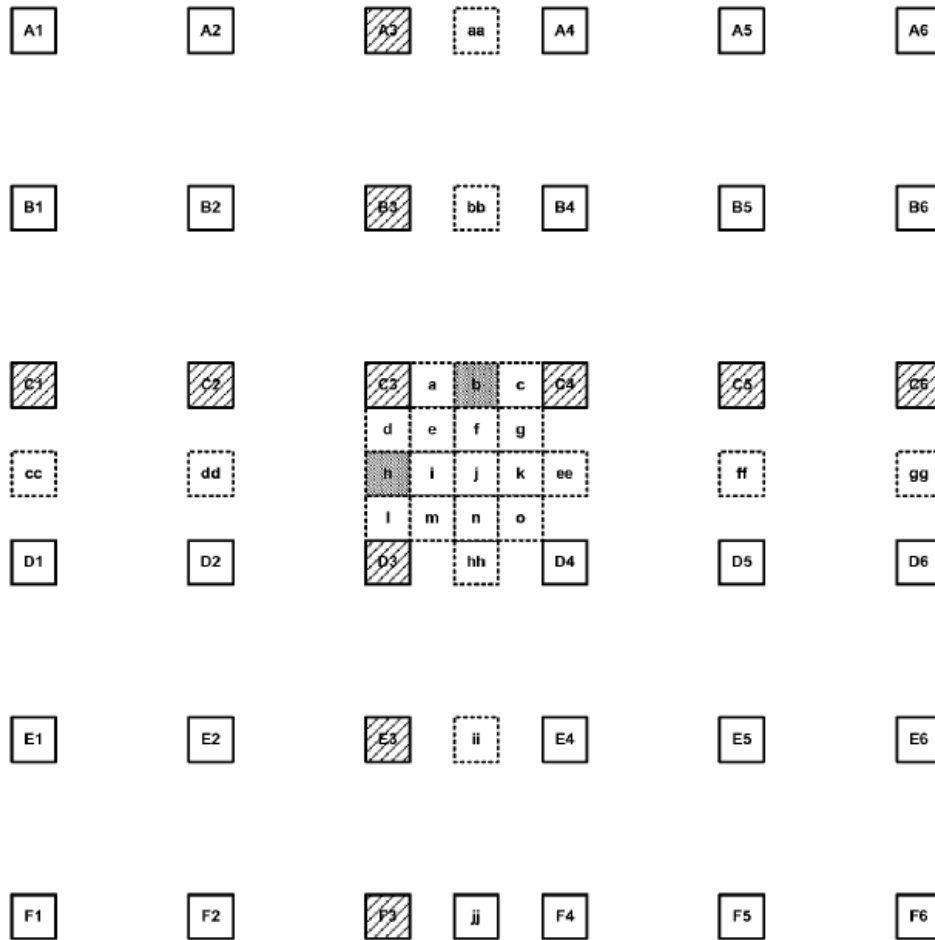


FIG. 4B

In H.264, half-pixel values would be rounded down after filtering and before being used to compute quarter-pixel values. Karczewicz-II proposes instead maintaining the half-pixel values at their full post-filtering precision until quarter-pixel values have been computed, at which point they are rounded down to the input precision (e.g., 8 bits). *See id.* at ¶¶ 100-102, 104, Tables 5-7; Ex-2015 at ¶¶ 90-93. For example, with reference to Figure 4B, reproduced above, Karczewicz-II

describes how a 6-tap filter with weights [1, -5, 20, 20, -5, 1] can be used to compute half-pixels “b” and “h.” Ex-2015 at ¶¶ 90-91.

$$b = C1 - 5 \cdot C2 + 20 \cdot C3 + 20 \cdot C4 - 5 \cdot C5 + C6$$

$$h = A3 - 5 \cdot B3 + 20 \cdot C3 + 20 \cdot D3 - 5 \cdot E3 + F3$$

Karczewicz-II discusses how quarter-pixel values can be computed using half-pixel values and integer pixel values. Karczewicz-II proposes maintaining higher-precision half-pixel values until quarter-pixel values have been calculated, at which point the final subpixel values are reduced to the input bit depth. *Id.* at ¶¶ 92-93.

Karczewicz-II does not teach maintaining predictions at a higher precision. Karczewicz-II rounds all interpolated prediction samples down at the end of Karczewicz-II’s subpixel interpolation process. *See* Ex-1006 at ¶ 102, Tables 5-8.

III. Person of Ordinary Skill in the Art

Nokia has applied Petitioners’ POSITA for the sake of this Response. Pet. at 11-12. According to Petitioner, a POSITA “would have had a (1) bachelor’s degree in electrical engineering, 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 encoding/decoding. Additional experience can substitute for the level of education, and vice-versa.” *Id.*

Nokia’s expert, Dr. Richardson, met this definition of POSITA as of the time of the invention. Ex-2015 at ¶ 42; Ex-2016 at 108:18-110:1 (“I don’t know [Dr.

Richardson] personally but I know of him . . . He wrote a book which is now in its second edition that describes some video coding techniques . . . his book has many citations. It's a well-known book.”).

IV. Claim Construction

A. “prediction”

The Board should construe the term “prediction” as used in the challenged claims to mean a value or set of values generated through some coding process that is itself intended to approximately represent the pixel values for a block and that can then be used to form a residual that represents the error between the prediction and its original value. Ex-2015 at ¶ 66 (citing Ex-1001 at 2:1-51). The objective of prediction in the context of video coding is to allow less information to be encoded in a bitstream by predicting it from other, already-encoded information. Ex-2015 at ¶¶ 47-48. Predictions are intended to approximate the pixel values for the blocks they predict so that the residual error following prediction is minimized. *Id.* at ¶ 66.

Dr. Richardson provides an illustration in his declaration using an exemplary 8-bit pixel value from a current block of pixels: 120. *Id.* at ¶ 67. Reasonable predictions for such a pixel value might be 116 or 121—values which approximate the original pixel value. *See id.* For each of these values, the residual would be computed by subtracting the prediction from the original value: $120 - 116 = 4$ and $120 - 121 = -1$. *See id.* The small error values of 4 and -1 reflect that a prediction is

generated with the intent of approximately representing a pixel value to maximize compression. *Id.*

B. “precision”

Petitioners and their expert, Dr. Freedman, contend that “precision” in the challenged claims refers to the “number of bits needed to represent possible values.” Pet. at 12; Ex-1003 at ¶ 39; Ex-2016 at 29:16-30:9. Dr. Freedman agreed during his deposition that this is the only definition of “precision” he is relying on for his opinions. Ex-2016 at 30:2-9 (“Q: When you say that precision is not necessarily limited to a number of bits to represent possible values, are there other definitions of precision that you have in mind for the purposes of these opinions in these IPRs? A: Not for the purpose of the opinions of these IPRs.”). Nokia does not dispute this definition for purposes of this proceeding. That said, Petitioners and Dr. Freedman misapply the definition.

Petitioners’ interpretation of “number of bits needed to represent possible values” is more akin to “number of bits conventionally used to represent a particular number.” When asked to explain his understanding of “precision” during deposition, Dr. Freedman clarified that he understood precision to correlate to a number’s absolute magnitude.

Q: As I understand your interpretation of the term “precision” as it relates to the magnitude of a number, the greater a given number is, you

will use in uncompressed binary form more bits; therefore, you have more precision?

A: Well, apart from the statement about the greater the number, to be caveated as greater the absolute magnitude number, then the more bits to represent it, the more precision.

Ex-2016 at 35:2-10. Dr. Freedman's answer is revelatory. Dr. Freedman does not define precision based on the number of bits needed to represent possible values of a variable consistent with the definition in the Petition. Rather, Dr. Freedman looks to how large a specific value of that variable is. *See* Ex-2015 at ¶¶ 72-74.

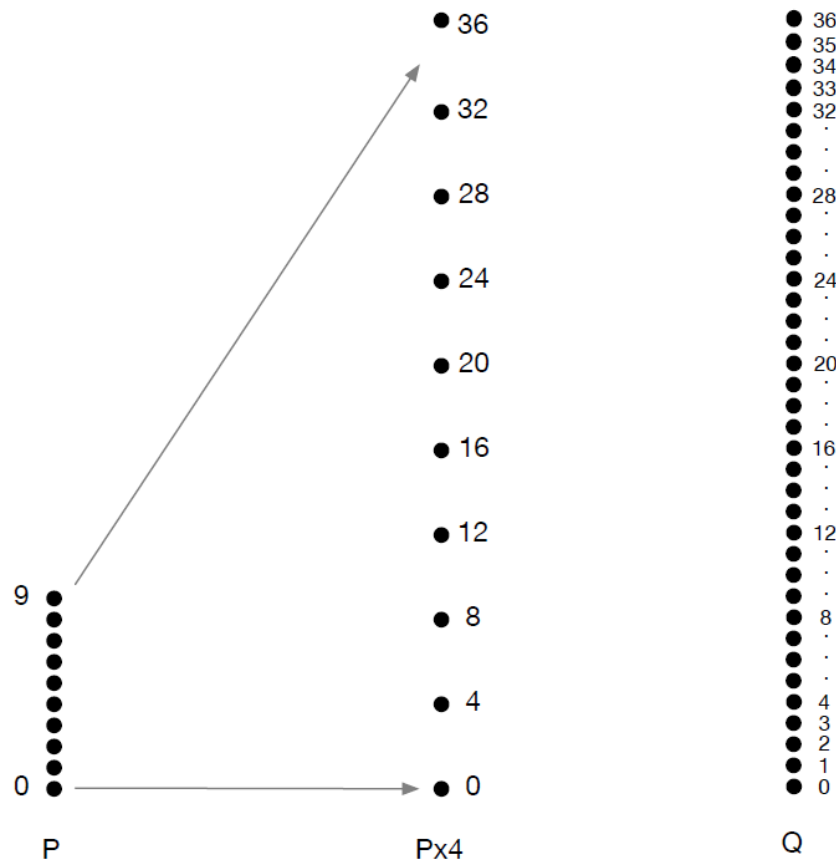
Dr. Freedman argues that the number of bits needed to represent data should be determined by examining "uncompressed representations of binary data." Ex-1003 at ¶ 40. For example, the value "3" is typically represented by two bits. If one multiplies "3" by two, the result is "6." Typically, one would represent the value "6" with three bits. Thus, Dr. Freedman concludes that the value "6" is more precise than the value "3" because—due to its greater absolute magnitude—a greater number of bits are used to represent the value "6" than the value "3." Put simply, Dr. Freedman's rule is that the greater the "absolute magnitude" of a number, the greater its precision. *See* Ex-2016 at 37:17-41:18.

However, a greater number of bits are not "needed to represent possible values" in the scenario above. Let us return to a 2-bit number. Two bits conveys four

possible values (one of these possible values can be, e.g., the number “3”). Ex-2015 at ¶ 44. If we multiply a particular 2-bit number by two (as we did in our example above), *we still have four possible values*. Ex-2015 at ¶¶ 68-70. For example, if our initial 2-bit number could be the set (0, 1, 2, 3), the result of multiplying by two is the set (0, 2, 4, 6). We have not changed the number of possible values. How many bits are needed to represent four possible values? Two bits. *See id.*

Dr. Freedman’s rejoinder is that—in typical uncompressed binary—conventional approaches may use more bits to represent a larger number such as “6” compared to a smaller number such as “3.” Ex-2016 at 37:17-38:12. But this only addresses conventional usage of bits to represent specific numbers. What matters under the definition of “precision” provided in the Petition is the number of bits *needed* to represent needed to represent *possible values*. Dr. Freedman’s “absolute magnitude” test ignores both the “needed” and “possible values” aspects of this definition.

Dr. Richardson illustrates the problem with Dr. Freedman’s approach using the figure reproduced below. Ex-2015 at ¶¶ 69-70.



According to Dr. Richardson, the two columns on the left side of the image, denoting possible values of a variable P and the same variable multiplied by a factor of four, have the same precision. *See id.* Dr. Richardson's reasoning is that the two columns have the same number of possible values, and thus the same number of bits is needed to represent those possible values. *Id.* Dr. Richardson's third column, labeled Q, occupies the same range as the middle column (0-36) but includes additional possible values. Based on this, Dr. Richardson concludes that more bits are needed to represent the larger number of possible values, which means that Q has a greater precision. *Id.* However, Dr. Freedman would conclude that at least some values in

the middle column of Dr. Richardson’s illustration would have greater precision than the leftmost one because, for example, the value “36” is greater than “9.” Ex-2015 at ¶¶ 73-75. This interpretation of precision is incorrect and leads to absurd results. Under Petitioners’ interpretation, all that is required to increase a variable’s precision is a multiplication. Under Petitioners’ theory, one can achieve infinite precision by multiplying any observed value by an infinitely large number. *Id.* at ¶¶ 75-77. By way of analogy, Petitioners take the view that a measurement of 15cm is more precise when written as “150mm,” and still more precise when written as “15,000,000nm.” But this is facially incorrect. Precision is not just another way of expressing how large a number is.

The Board should not accept such an arbitrary construction of “precision.” Instead, the Board should adopt a construction that recognizes that precision refers to the “number of bits needed to represent possible values,” such that the more possible values a variable can take in an instance, the greater the precision of that variable.

V. Argument

A. Ground 1 – Walker

As discussed above, Walker teaches a “single implementation satisfying MPEG-4, RV9, WMV9, and H.264.” Ex-1004 at ¶ 71. Petitioners rely on Equation 18 to argue that the product of a prediction and weight is a “prediction” having a

“second precision, higher than said first precision” as recited in the challenged claims. *See* Pet. at 21. Petitioners state that Equation 18 is a derivative of Equation 14. *Id.* at 21, Fn. 4. Equation 14 is a simplified representation of Equation 9, 10, and 13, which relate to conventional H.264 motion-compensated prediction. *Id.*; *see also* Ex-2015 at ¶ 85 (explaining how Walker develops a “universal formula” based on H.264 equations). Petitioners use $(pred0)_{w_A} \gg 6$ and $(pred1)_{w_B} \gg 6$ in the place of Equation 13’s $(pred0)_{w0}$ and $(pred1)_{w1}$, but this makes no difference to the substance of Petitioners’ argument. *See id.* at ¶ 21; Ex-2015 at ¶ 85.

1. Independent Claims 19, 25, and 31

a) Petitioners fail to identify a “prediction” with a second precision as claimed.

Walker does not teach the limitations “using said first reference block to obtain a first prediction, said first prediction having a second precision, which is higher than said first precision” and “using said second reference block to obtain a second prediction, said second prediction having the second precision.” Petitioners argue that Walker’s products $(pred0)_{w_A} \gg 6$ and $(pred1)_{w_B} \gg 6$ satisfy these limitations. Petitioners claim $(pred0)_{w_A} \gg 6$ and $(pred1)_{w_B} \gg 6$ are “predictions.” Pet. at 21-22, 24-25. In deciding to institute, the Board applied a preliminary construction of the term “prediction,” finding that it “encompasses values used for prediction that are calculated by mathematical operations including multiplying

pixel values in reference blocks with weights.” Decision at 16-17. The question is whether Walker’s products $(pred0)w_A \gg 6$ and $(pred1)w_B \gg 6$ (i.e., predictions $pred0$ and $pred1$ multiplied by weighting factors w_A and w_B) are predictions. *See id.* at 14. They are not.

Walker includes a restatement of four conventional approaches to bi-prediction, including those of MPEG-4 (Ex. 1004 at ¶¶ 47-49), RV9 (Ex. 1004 at ¶¶ 50-55), WMV9 (Ex. 1004 at ¶¶ 56-57), and H.264 (Ex. 1004 at ¶¶ 58-70). The stated objective of the reference is to obtain “a single implementation satisfying MPEG-4, RV9, WMV9, and H.264.” Ex. 1004 at ¶¶ 7, 70. Petitioners cite Walker for its disclosure of H.264-era bi-prediction. *See, e.g.,* Pet. at 13-14. The ’267 Patent discusses H.264 in its Background Information section as prior art that its inventions improve upon. *See* Ex-1001 at 1:34-37, 3:6-11, 3:49-51. As the inventors of the ’267 patent noted, a shortcoming of H.264 was that—when performing bi-prediction—prediction signals would be rounded down to a lower precision before being combined, resulting in a less accurate final prediction. *See id.* at 3:40-65, 4:36-38. The ’267 Patent solved this problem, in part by ensuring that “prediction signals are maintained in higher accuracy until the prediction signals have been combined,” something that H.264 did not do. *Id.*

Because Petitioners rely on Walker for its H.264 disclosure, they are faced with these very limitations. Walker’s “ $pred0$ ” and “ $pred1$ ” are repeatedly identified

as “predictions” throughout Walker’s specification. Ex-1004 at ¶¶ 59-60, 111, Table 1, Eqn. 8. However, “pred0” and “pred1” have been subjected to the rounding discussed in the background of the ’267 Patent. *See id.* at ¶¶ 60, 114 (pred0 and pred1 are 8-bit values despite being determined using a P-tap FIR filter). As a result, “pred0” and “pred1” have the same precision as the current block and reference blocks. *See id.* In other words, “pred0” and “pred1” are limited to the same number of possible color and brightness values as the current block and reference blocks.

To avoid this issue, Petitioners argue instead that “(pred0)_{WA}>>6” and “(pred1)_{WB}>>6,” the products of these lower-precision predictions and constant weighting factors, are the “predictions” of the challenged claims.⁴ Pet. at 20-21. However, (pred0)_{WA}>>6 and “(pred1)_{WB}>>6 are not predictions—the products are not intended to approximately represent the pixel values for a block of pixels.

Dr. Richardson provides an example in his declaration. Given a current pixel value of 120, reasonable predictions might be pred0=121 and pred1=116. Ex-2015 at ¶¶ 101-102. Applying weighted bi-prediction using weighting factors w0=5 and w1=11 also yields a reasonable prediction for the current pixel value.

$$Pred = ((5 \cdot pred0) + (11 \cdot pred1) + 8) \gg 4 = 118$$

⁴ Additionally, Petitioners argue that (pred0)_{WA}>>6 and “(pred1)_{WB}>>6 have a higher precision than pred0 and pred1 due to the multiplication by a weighting factor. This is incorrect as addressed in the next section.

Id. However, when taken individually, “(pred0)w0” and “(pred1)w1” are not predictive of the current pixel value 120. Dr. Richardson illustrates this by performing the weight multiplication and then right-shifting by 4 to compensate for the weighting factor.

$$(w0 \cdot pred0) \gg 4 = 605 \gg 4 = 37$$

$$(w1 \cdot pred1) \gg 4 = 1276 \gg 4 = 79$$

Unlike the predictions pred0 and pred1, the product of a weight and a prediction is not intended to approximately represent the pixel values for that block nor used to form a residual that represents the error between the prediction and its original value. *See id.* at ¶¶ 66-67, 101-102 This is by design. The weights w0 and w1, or w_A and w_B, each individually amount to less than one. Ex-2015 at ¶¶ 98-101. Any multiplication by these weights therefore departs from a prediction’s (e.g., pred0 or pred1) approximate representation of pixel values. *Id.* at ¶ 102. As a result, multiplying pred0 or pred1 by w_A or w_B, regardless of what weights are assigned, is not intended to approximately represent pixel values. The product (pred0)w_A >> 6 only represents the portion of the final prediction contributed by pred0 and requires the complimentary value of (pred0)w_B >> 6 to be added before the resulting sum is again a prediction.

Accordingly, Petitioners have failed to identify a “prediction” as recited in the challenged claims, and the Board should reject Ground 1 on this basis.

b) Petitioners' alleged prediction does not have a "second precision, which is higher than said first precision."

Although the Board should dispose of this Ground because Walker's $(pred0)_{w_A} >> 6$ and $(pred0)_{w_B} >> 6$ are not "predictions," this Ground also fails because Walker's $(pred0)_{w0}$ and $(pred1)_{w1}$ do not have "a second precision, which is higher than said first precision." Petitioners' argument equates the bitwidth used in Walker for $(pred0)_{w_A} >> 6$ and $(pred0)_{w_B} >> 6$ with a higher "precision." This is incorrect.

Petitioners and their expert, Dr. Freedman, contend that "precision" in the challenged claims refers to a "number of bits needed to represent possible values." Pet. at 12; Ex-1003 at ¶ 39; Ex-2016 at 29:16-30:9. For purposes of this proceeding, Nokia does not dispute this definition. However, Petitioners misapply this definition and read out "needed to represent possible values."

As Walker discloses, $pred0$ and $pred1$ have 8 bits of precision, meaning that their values can be one of the 256 values in the range 0-255. Ex-1004 at ¶ 60; Ex-2015 at ¶¶ 104-105. Walker's Table 4 discloses that, given a 15-bit weighting factor, product $(pred0)_{w_A} >> 6$ can result in a bitwidth of 17. Ex-1004 at ¶ 84, Table 4. Petitioners argue that this 17-bit result is a "second precision, which is higher than said first precision," but this argument is flawed. Specifically, the argument rests on an affirming the consequent fallacy.

An affirming the consequent fallacy occurs when one states that because the consequence of a conditional statement is true, the antecedent must be true. An affirming the consequent fallacy takes the following form:

If P , then Q .

Q .

Therefore, P .

The parties seem to agree a value with 17-bits of precision must be stored using at least 17-bits. However, Petitioners and Dr. Freedman incorrectly conclude from this fact that any value stored using a higher number of bits has a higher precision. Ex-2015 at ¶¶ 68, 104-106. That is, Petitioners' argument takes the following form:

If X is at higher precision, more bits are used to represent X .

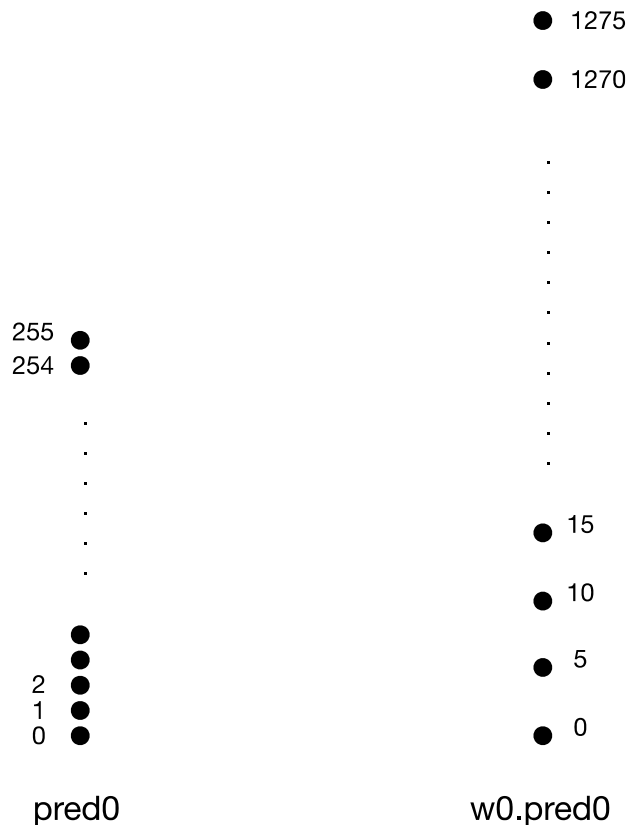
More bits are used to represent X .

Therefore, X is at a higher precision.

The conclusion of this argument does not follow from its premises. One can take a quantity that all observers should agree is imprecise under the parties' definition of "precision"—e.g., something with only two possible values—yet choose to represent that quantity with many bits. That is, rather than using one bit "0 or 1" to represent a quantity with two possible states, one could choose to use many bits arranged with only two possible states to represent the same quantity—

e.g., the two states “0000 or 1111.” A POSITA would have no reason to treat two possible states one chooses to represent as “0000 or 1111” as more precise than two possible states one chooses to represent as “0 or 1.” The mere fact one chooses to use more bits does not change the “number of bits needed to represent possible values.”

Dr. Richardson uses the below diagram to explain how a value that has 17 bits of precision must be stored using at least 17 bits, but Dr. Richardson explains that it is not the case that any value stored using a higher number of bits necessarily has a higher precision. *Id.* at ¶¶ 105-107.



Dr. Richardson's diagram, written in terms of $(pred0)w0$ and $(pred1)w1$, begins with an 8-bit value, $pred0$, on the left side. An 8-bit value can represent one of 256 possible numbers in the range 0-255. When $pred0$ is multiplied by a weighting factor, e.g., $w0 = 5$, the result is a scaled range—the value can now be a number in the range 0-1275. *Id.* Each value that the product of $w0$ and $pred0$ can take corresponds to one of the original 256 possible numbers that $pred0$ could be. For example, $0 \times 5 = 0$, $1 \times 5 = 5$, $2 \times 5 = 10$, and so on. The product cannot take any value such as 2, 3, 4, 6, 7, or any other that is not a multiple of 5 and a number in the range 0-255. The reason for this is simple: Although multiplying $pred0$ by $w0$ scales its range, such an operation cannot increase its precision. *Id.* at ¶¶ 70, 106. The number of bits ***needed*** to represent 256 possible values remains the same regardless of what those values are. *Id.* at ¶¶ 105-106. Because only 256 values could possibly result from multiplying $pred0$ by $w0$, the product $(pred0)w0$, or $(pred0)w_{A>>6}$, still has a precision of 8 bits. *Id.*

Petitioners' expert, Dr. Freedman, attempts to justify the counterintuitive reading of "precision" set forth in the Petition by explaining that that he equates the "precision" of a variable with its "absolute magnitude." Ex-2016 at 33:7-18 That is, Dr. Freedman ignores the number of possible values resulting from an operation and instead consider its precision to be, for a particular number, "the greater the number,

to be caveated as greater the absolute magnitude number, then the more bits to represent it, the more precision.” Ex-2016 at 35:2-10. This is incorrect.

Under Dr. Freedman’s interpretation, $(pred_0)w_0$ does not actually have a set precision because quantity $(pred_0)w_0$ ’s absolute magnitude depends on how large a chosen weighting factor is. With $w_0 = 5$, the product $(pred_0)w_0$ can reach as high as 1275, but if $w_0 = 50$, then a number as large as 12750 becomes possible. However, it is absurd to suggest that $(pred_0)w_0$ becomes increasingly precise as w_0 increases. Anyone who has taken a science lab understands that a measurement of 15cm does not become more precise when expressed as 150mm or 150,000,000nm. Ex-2015 at ¶¶ 77-78.

Dr. Freedman’s opinions additionally conflict with Ground 1. Relying on $(pred_0)w_A \gg 6$ and $(pred_0)w_B \gg 6$ from Equation 18 of Walker, petitioners argue that both values have the same “second precision” as claimed. Pet. at 23-24. However, the purpose of weighted prediction (as opposed to default weighted prediction) is to allow one prediction to contribute more to the final value than another. *See* Ex-1004 at ¶ 34; Ex-2015 at ¶¶ 53, 82-83. This is accomplished by selecting an appropriate value for w_A and w_B , with the larger of the two values signifying a greater contribution by the prediction to which it is applied. *See id.* Accordingly, one of $(pred_0)w_A \gg 6$ and $(pred_0)w_B \gg 6$ —the more heavily weighted one—will have a greater magnitude following the multiplication of the weight than the other. Under

Dr. Freedman's incorrect theory, then, $(pred0)_{w_A \gg 6}$ and $(pred0)_{w_B \gg 6}$ may have *different* precisions.

Petitioners may argue, inconsistently with Dr. Freedman's testimony, that the bitwidths used in Walker's Table 2 correlate to degrees of precision independent of the absolute magnitude of any given number merely because those bitwidths happen to be used to represent those numbers. However, this argument would substitute Petitioners' definition of "precision" as a "number of bits *needed to represent possible values*" for a clearly erroneous definition of "a number of bits *one happens to use*." In other words, this would be yet another way of arguing that 150mm is less precise than 150,000,000nm merely because of how one chooses to express that quantity. As explained, Walker's $(pred0)_{w_A \gg 6}$ and $(pred0)_{w_B \gg 6}$ do not have a greater number of possible values than pred0 and pred1, and thus a POSITA would understand $(pred0)_{w_A \gg 6}$ and $(pred0)_{w_B \gg 6}$ are not at a higher precision than the "first precision" of the claims.

Accordingly, the Board should reject Petitioners' Ground 1 because Walker's $(pred0)_{w_A \gg 6}$ and $(pred0)_{w_B \gg 6}$ are not predictions with a "second precision, higher than the first" as claimed.

c) Petitioners cannot identify the claimed “first reference block” and “second reference block,” which are made up of pixels.

The challenged independent claims recite “[determine/determining], for a current block, a first reference block based on a first motion vector and a second reference block based on a second motion vector, wherein the pixels of the current block, the first reference block, the first reference block, and the second reference block have values with a first precision.” Petitioners identify the “prediction blocks” disclosed in Walker (i.e., pred0 and pred1) as the “first reference block” and “second reference block” recited in the challenged claims. Pet. at 20-21, 23; Ex-1003 at ¶ 77; Ex-1004 at ¶ 60. The problem with Petitioners’ argument, however, is that pred0 and pred1 are predictions and therefore are not made up of picture elements—pixels—because they consist of computed values that are not part of the underlying frames.

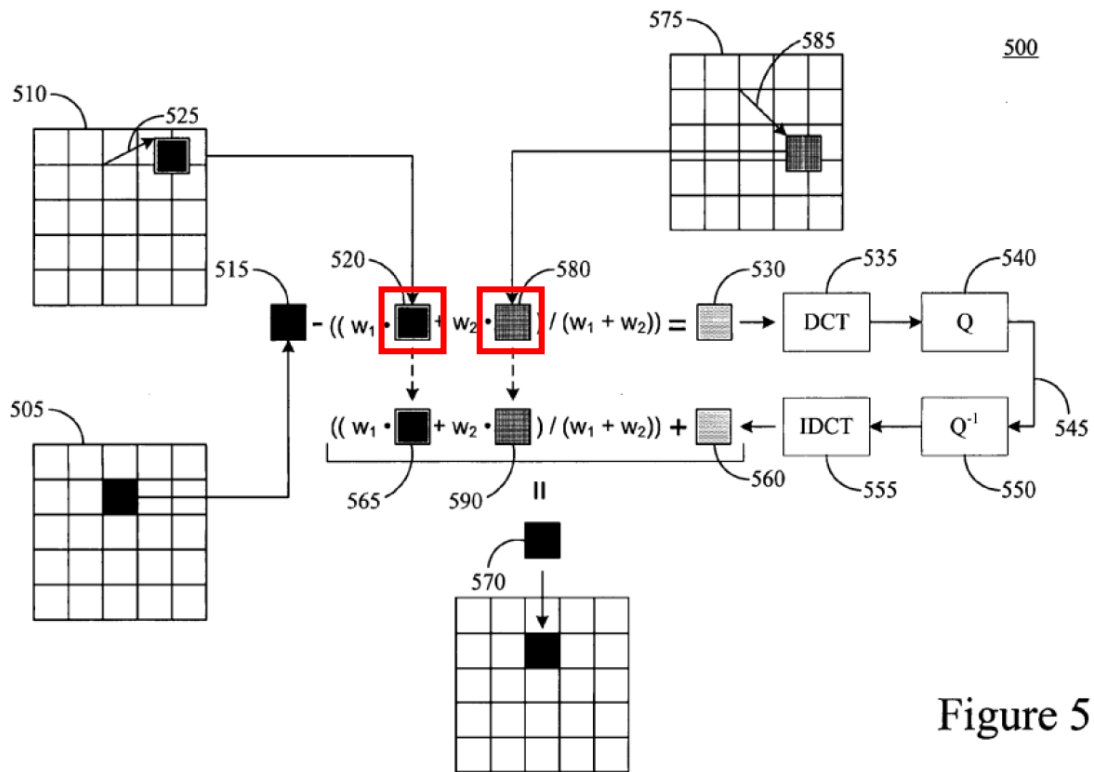


Figure 5

Figure 5 of Walker, reproduced above, illustrates the bi-prediction process for H.264 on which Petitioners rely for Ground 1. As Dr. Richardson has annotated, the blocks labeled 520 and 580 correspond to the “best matching macroblock,” which Petitioners identify as the “reference block[s]” recited in the claims. Pet. at 18-19; Ex-2015 at ¶¶ 109-111. Petitioners’ “first reference block” and “second reference block” therefore correspond to samples from what Walker describes as “‘prediction block’ from a past frame” and a “‘prediction block’ from a future frame.” See Pet. at 18, 22-24; Ex-1004 at ¶ 60 (“pred0 and pred1 are . . . samples from prediction blocks from the two reference frames”).

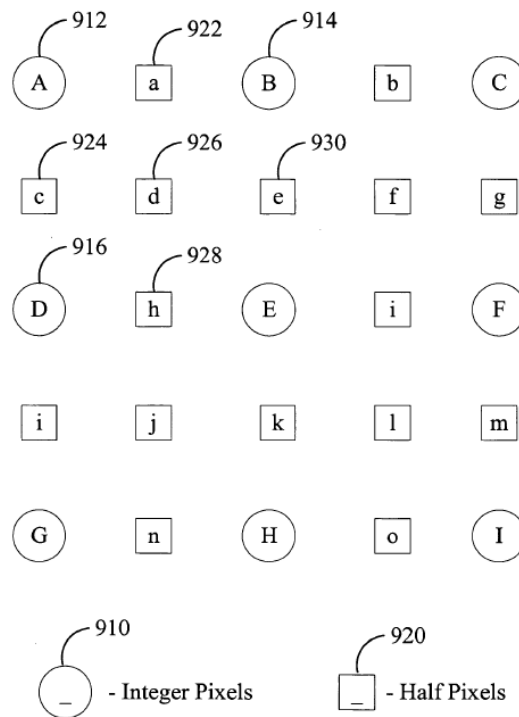


Figure 9

Walker explains how prediction blocks are computed when fractional motion vectors are used with reference to Figure 9, reproduced above. Ex-1004 at ¶ 114, Fig. 9. This figure shows “half pixel interpolation where one interpolated pixel is located between each of the original integer pixels.” *Id.* Unlike the “original integer pixel” values which make up the reference frames used to form predictions, predictions have values which are interpolated between pixels. Ex-2015 at ¶¶ 112-113. As a result, Petitioners have not identified any reference block “wherein the pixels of the current block, the first reference block, and the second reference block

have values with a first precision.” Accordingly, the Board should reject Petitioners’ Ground 1.

2. Dependent Claims 20, 26, and 32

Dependent claims 20, 26, and 32 depend on claims 19, 25, and 31. Accordingly, Petitioners have failed to demonstrate that Walker renders them obvious because they fail to properly identify a first and second “prediction” having a “second precision, higher than the first,” obtained from a first and second “reference block” for the reasons discussed above.

Additionally, Petitioners’ theory fails to disclose that “in an instance in which said first motion vector points to a subpixel, said first prediction is obtained by interpolation using pixel values of said first reference block.” Petitioners attempt to point to Walker’s disclosure of interpolation in support of their argument, but Walker is describing how what it calls a prediction—pred0 (which Petitioners have identified as the “first reference block”)—is obtained. *See* Pet. at 18; Ex-1004 at ¶ 60; Ex-2015 at ¶ 115. Petitioners attempt to eat their cake and have it too by reinterpreting Walker’s predictions as reference blocks but then arguing that Walker’s predictions (that Petitioners call reference blocks for their arguments against the independent claims) are obtained by interpolation. However, $(pred0)w_A \gg 6$ —what Petitioners have alleged to be the ’267 Patent’s higher precision prediction—is obtained by multiplying pred0 and $w_A \gg 6$. *Id.* No

interpolation is used. *Id.* The Board should reject this argument because Petitioners cannot show that $(pred0)_{w_A \gg 6}$ (i.e., what Petitioners allege to be Walker’s prediction) is “obtained by interpolation using pixel values” of $pred0$ (i.e., what Petitioners allege to be Walker’s reference block).

3. Dependent Claims 21, 27, and 33

Dependent claims 21, 27, and 33 depend on claims 20, 26, and 32. Accordingly, Petitioners have failed to demonstrate that Walker renders them obvious because they fail to properly identify a first and second “prediction” having a “second precision, higher than the first,” obtained from a first and second “reference block” for the reasons discussed above.

Additionally, Petitioners’ theory fails to disclose that “said first prediction is obtained by interpolation using values of said first reference block by: right shifting a sum of a P-tap filter using values of said first reference block.” Petitioners argue that Walker’s disclosure of interpolation suffices to show this limitation. Pet. at 31-32. Not so. Interpolation is used to obtain the value of $pred0$ (Petitioners’ “reference block”), but the product $(pred0)_{w_A \gg 6}$ is obtained using multiplication—not interpolation or filtering of any kind. Ex-2015 at ¶¶ 115, 118. Accordingly, the Board should find that claims 21, 27, and 33 are valid in view of Petitioners’ Ground 1.

4. Dependent Claims 22, 28, and 34

Dependent claims 22, 28, and 34 depend on claims 19, 25, and 31. Accordingly, Petitioners have failed to demonstrate that Walker renders them obvious because they fail to properly identify a first and second “prediction” having a “second precision, higher than the first,” obtained from a first and second “reference block” for the reasons discussed above.

Further, Petitioners argue that Walker (through its discussion of H.264) discloses instances where an integer motion vector is used as well as instances in which the weight w_1 is a power of two. Pet. at 32-34. Petitioners contend that Walker discloses that a multiplication by a power of two weight can be accomplished by left shifting. *Id.* According to Petitioners, this means that Walker discloses “wherein in an instance in which said second motion vector points to an integer sample, said second prediction is obtained by shifting values of said second reference block to the left.”

The problem with Petitioners’ argument, as Dr. Richardson explains, is that there is no relationship between the use of an integer motion vector and the use of a power of two weight. Ex-2015 at ¶ 120. Petitioners provide no argument that anything in Walker discloses that a power of two weight should be set *because* of an integer motion vector being used, as described in the challenged claim. This is because, in Walker, the use of an integer motion vector and a weight which is a

power of two would only occur by coincidence, as the weight used and the prediction values have no correlation with one another. *See id.* at ¶¶ 84, 120.

Further, although Petitioners contend that replacing a weight multiplication with a left shift would be “simpler” and therefore obvious to a POSITA, this is incorrect. Pet. at 34; *id.* at ¶¶ 121-122. A left shift can **only** multiply values by two, and therefore could not be used to replace a multiplication by a value like w_1 which can, but need not, be a power of two value. *See* Ex-2015 at ¶¶ 121-122. To include a left shift operation in the weighting process without constraining the allowed weight values would require introducing a completely unnecessary conditional branch that first checks if w_1 is a power of two and only then uses a left shift operation. *Id.* This would introduce additional technical cost for no improvement in performance whatsoever, and a POSITA would not be motivated to do this. Dr. Richardson provides pseudocode in his declaration illustrating the unnecessary conditional branching introduced by Petitioners’ proposal:

```
obtain  $w_1$ 

if ( $w_1$  is a power of two)
    calculate  $\text{pred}_1(w_1)$  using a left-shift
else ( $w_1$  is not a power of two)
    calculate  $\text{pred}_1(w_1)$  using a conventional multiplication
end
```

Ex-2015 at ¶¶ 121-122.

Accordingly, the Board should reject Petitioners' arguments as to dependent claims 4, 10, and 16, because Walker does not disclose using a left shift when an integer motion vector is present, and a POSITA would not be motivated to make Petitioners' proposed modification.

5. Dependent Claims 23, 29, and 35

Dependent claims 23, 29, and 35 depend on claims 19, 25, and 31. Accordingly, Petitioners have failed to demonstrate that Walker renders them obvious because they fail to properly identify a first and second "prediction" having a "second precision, higher than the first," obtained from a first and second "reference block" for the reasons discussed above.

6. Dependent Claims 24, 30, and 36

Dependent claims 24, 30, and 36 depend on claims 19, 25, and 31. Accordingly, Petitioners have failed to demonstrate that Walker renders them obvious because they fail to properly identify a first and second "prediction" having a "second precision, higher than the first," obtained from a first and second "reference block" for the reasons discussed above.

Further, even if the Board rejects the parties' definition of "precision," as the "number of bits needed to represent possible values," the Board should recognize that dependent claims 6, 12, and 18 expressly states that the "first precision indicates

a number of bits needed to represent the values of the pixels” and the “second precision indicates the number of bits needed to represent values of said first prediction and values of said second prediction.” Accordingly, the Board should find that claims 24, 30, and 36 are valid in view of Petitioners’ Ground 1.

B. Ground 2 – Karczewicz-I and Karczewicz-II

1. Independent Claims 19, 25, and 31

a) A POSITA would not be Motivated to Combine Karczewicz-I and Karczewicz-II.

Petitioners’ Karczewicz-I and Karczewicz-II Ground is not a straightforward combination but rather a modification of both references. Despite the “similar video-coding architecture” Petitioners claim would motivate a POSITA to combine the two references, the proposed modifications would change the architecture taught by both references. These modifications would in turn lead to increased technical complexity and unwanted costs that would dissuade a POSITA from building such a system.

i. The Karczewicz inventors did not perform the alleged modification.

The lack of any motivation to modify and combine the Karczewicz-I and Karczewicz-II references is confirmed by the fact that each reference was authored by the same inventors who—despite being people of extraordinary skill in the art—never made the modifications Petitioners now allege would have been obvious to an ordinary artisan.

Both Karczewicz-I and Karczewicz-II were authored by the same three inventors: Marta Karczewicz, Peisong Chen, and Yan Ye. Ex-1005 at (75), Ex-1006 at (75). Petitioners' expert Dr. Freedman disclaimed any knowledge of who Marta Karczewicz and her colleagues were. Ex-2016 at 76:19-78:22. However, the fact is that Dr. Marta Karczewicz is a renowned expert in the field of video coding and participated heavily in the standardization process for multiple video coding standards. Ex-2015 at ¶ 135. Dr. Karczewicz should be well known to video coding experts, including at the time of the '267 Patent. *Id.* The European Patent Office recognized her as one of the 50 leading voices in technology, with hundreds of patents in video coding. *Id.*; Ex-2017. The inventors of Karczewicz-I and Karczewicz-II, in particular Dr. Karczewicz, are giants in the field of video coding. Petitioners' Ground 2 calls into question why, if an ordinary artisan would be motivated to modify Karczewicz-I by alleged commonalities between the two references, the exceptionally skilled inventors of those same references failed to do so.

Petitioners argue that a POSITA would find it obvious to apply the subpixel interpolation methodologies of Karczewicz-II to the bi-prediction technique of Karczewicz-I. Pet. at 39-40. Yet by the time Karczewicz-I was filed, Karczewicz-II had already been on file for three months, and its provisional application had been disclosed another year prior. *Compare* Ex-1005 at (22) *with* Ex-1006 at (22), (60).

Further still, interpolation disclosures akin to Karczewicz-II were included in the VCEG-AI33 submission, authored by the inventors of the Karczewicz references. *Compare* Ex-1006 at ¶ 104, Table 7, 8; *with* Ex-2001 at ¶ 1-4 (showing the same interpolation process and 16-bit registers); *see also* Ex-2015 at ¶ 136. VCEG-AI33, in turn, was incorporated by reference into Karczewicz-I. Ex-1005 at ¶ 37. Put simply, Marta Karczewicz, Peisong Chen, and Yan Ye were certainly aware of the contents of Karczewicz-II at the time they drafted Karczewicz-I.

According to Petitioners, a POSITA would have a bachelor's degree and two to three years of practical experience with video encoding or decoding. Pet. at 11-12. Yet the Karczewicz inventors, each possessing far more experience than Petitioners' POSITA, did not combine them in the way that Petitioners now assert would be obvious. Dr. Freedman provides little explanation as to how this is possible, instead denying any familiarity with the '267 Patent's inventors and questioning whether they were POSITAs or even aware of their own inventions. Ex-2016 at 76:19-78:22. Petitioners sticking their heads in the sand as to the capabilities of the Karczewicz inventors should not suffice to meet their burden. On the other hand, Nokia's expert, Dr. Richardson, offers a simpler explanation: The inventions claimed in the '267 Patent were not obvious. Ex-2015 at ¶ 137.

ii. Petitioners fail to identify plausible motivation for their alleged modification of the Karczewicz references.

Petitioners argue a POSITA reading Karczewicz-I would look to Karczewicz-II to find “complementary teachings that improve Karczewicz-I by reducing rounding inaccuracies,” (Pet. at 40-41), but as explained the inventors of Karczewicz-I knew about Karczewicz-II at the time of Karczewicz-I was written and failed to make the modifications that allegedly would have been obvious to a POSITA.

Petitioners argue that a POSITA would be motivated to “implement teachings from Karczewicz-I and Karczewicz-II using their common architecture,” referring to the similar Figure 2 included in both references (reproduced below). Pet. at 40 (citing Ex-1005, Fig. 2; Ex-1006, Fig. 2).

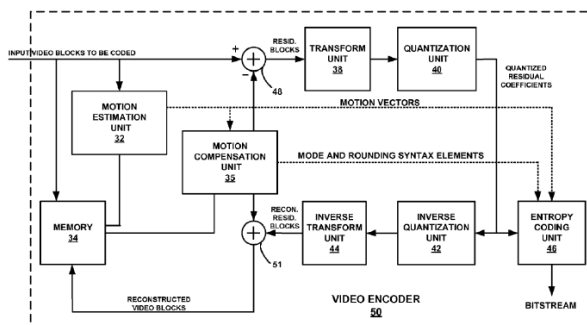


FIG. 2

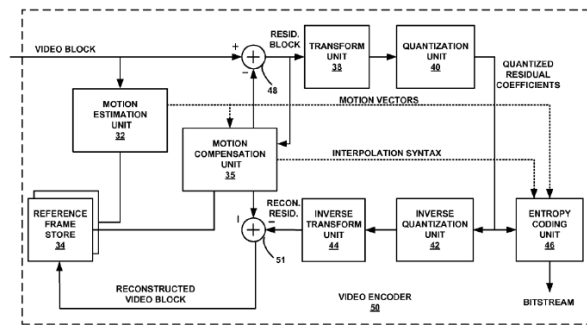


FIG. 2

As Dr. Richardson explains, this block diagram is a generic illustration of a video coding system that makes use of motion-compensated prediction and does not include any features unique to the Karczewicz references. Ex-2015 at ¶¶ 46, 133-134. Indeed, this “common architecture” is nothing more than a basic functional

diagram that could be applied to most, if not all, video coding systems since the 1990s. *Id.* This opinion is shared by Petitioners' expert, Dr. Freedman, who describes the architecture as a "fundamental model . . . used by major video encoding standards since the 1990s." Ex-1003 at ¶ 3. Because the architecture illustrated in Figure 2 does not characterize any of the alleged innovations of either Karczewicz-I or Karczewicz-II and can be found in numerous video coding systems, a POSITA would be unlikely to view Figure 2 as a compelling reason or inspiration to modify one reference using the teachings of the other. Further, as the two block diagrams are the same, a POSITA would not have been motivated to modify either reference in attempting a combination, as they already share a common, albeit ubiquitous, architecture.

Further, Petitioners overstate the relationship between the references by arguing "Karczewicz-I and Karczewicz-II both encompass motion prediction calculations that average interpolated picture values." Pet. at 41. As Dr. Richardson explains, Karczewicz-I relates to default and weighted bi-prediction. These techniques employ averaging of prediction values. Ex-2015 at ¶¶ 86-87. Karczewicz-II relates to interpolation of pixel values to produce predictions. *Id.* at ¶ 90. At best, these references are associated with motion-compensated prediction schemes like those found in H.264. A POSITA would find the fact both references relate to motion-compensated prediction unremarkable. Motion-compensated

prediction refers to a broad, widely known, and widely used category of techniques. *See id.* at ¶¶ 48, 86, 90. For example, H.264 includes a large number motion-compensated prediction techniques, many of which are not directly related to one another. *See id.*

iii. Petitioners’ alleged Karczewicz modifications are technically inefficient, and a POSITA would not be motivated to make them.

Guided by hindsight, Petitioners argue that a POSITA would use Karczewicz-II to modify Karczewicz-I. In its disclosure of conventional bi-prediction, Karczewicz-I discloses the following equation for combining two predictions:

$$pred(i,j) = (pred0(i,j) + pred1(i,j) + 1) \gg 1$$

Pet. at 44 (citing Ex-1005 at ¶¶ 58-60). This equation takes a first prediction (pred0) and a second prediction (pred1), both at the input bit depth, and averages them by summing their values, adding a rounding offset (+1), and applying a right shift, which has the mathematical effect of dividing by two. Ex-1005 at ¶¶ 57-60. Because these two predictions are at the input bit depth (i.e., the “first precision” disclosed in the claims of the ’267 Patent), Karczewicz-I does not disclose the challenged claims. Ex-2015 at ¶¶ 86-89, 138.

Attempting to account for this failing, Petitioners argue that Karczewicz-II could be applied to three different calculation scenarios (a subset of the possible scenarios) depending on whether the motion vectors used for bi-prediction

correspond to integer, half-pixel, and center-pixel motion-compensated predictions. *See* Pet. at 44-53; Ex-2016 at 101:2-103:22 (agreeing that the three enumerated scenarios in the Petition do not cover all possible motion vector calculation scenarios)

In their Scenario 1, which Petitioners argue applies when “averaging a half-pixel value with an integer pixel value,” Petitioners propose modifying the conventional bi-prediction equation of Karczewicz-I using equations disclosed in Karczewicz’s Table 3. Pet. at 44-48 (citing Ex-1006 at Table 3, shown below with Petitioners’ annotation).

TABLE 3

$a = (C3 \ll 5 + b1 + 32) \gg 6$
$c = (C4 \ll 5 + b1 + 32) \gg 6$
$d = (C3 \ll 5 + h1 + 32) \gg 6$
$l = (D3 \ll 5 + h1 + 32) \gg 6$
$f = (j1 \gg 5 + b1 + 32) \gg 6$
$i = (j1 \gg 5 + h1 + 32) \gg 6$
$k = (j1 \gg 5 + ee1 + 32) \gg 6$
$n = (j1 \gg 5 + hh1 + 32) \gg 6$

Petitioners argue that such a modification would yield a new equation, applicable to bi-prediction using half-pixel and integer motion vectors:

$$\text{pred}(i,j) = (\text{non-rounded}(\text{pred0}(i,j)) + \text{pred1}(i,j) \ll 5 + 32) \gg 6$$

Pet. at 48.

In their Scenario 2, which Petitioners argue would apply to a “first motion vector pointing to a center-pixel position and the second motion vector pointing to a half-pixel position,” Petitioners propose modifying the conventional bi-prediction equation using a different set of equations from Karczewicz-II’s Table 3. Pet. at 48-49 (citing Ex-1006 at Table 3, shown below with Petitioners’ annotations).

TABLE 3

$a = (C3 \ll 5 + b1 + 32) \gg 6$
$c = (C4 \ll 5 + b1 + 32) \gg 6$
$d = (C3 \ll 5 + h1 + 32) \gg 6$
$l = (D3 \ll 5 + h1 + 32) \gg 6$
$f = (j1 \gg 5 + b1 + 32) \gg 6$
$i = (j1 \gg 5 + h1 + 32) \gg 6$
$k = (j1 \gg 5 + ee1 + 32) \gg 6$
$n = (j1 \gg 5 + hh1 + 32) \gg 6$

This time, a different modified bi-prediction equation results, which Petitioners assert should be used for bi-prediction using center-pixel and half-pixel motion vectors:

$$\text{pred}(i,j) = (\text{non-rounded}(\text{pred0}(i,j)) \gg 5 + \text{non-rounded}(\text{pred1}(i,j)) + 32) \gg 6$$

Pet. at 51.

Finally, in Scenario 3, Petitioners propose that when “both motion vectors point to half-pixel positions,” equations from Karczewicz-II’s Table 4 should be

used to modify Karczewicz-I. Pet. at 51-53 (citing Ex-1006 at Table 4, shown below).

TABLE 4

$$\begin{aligned}e &= (b1 + h1 + 32) >> 6 \\g &= (b1 + ee1 + 32) >> 6 \\m &= (h1 + hh1 + 32) >> 6 \\o &= (ee1 + hh1 + 32) >> 6\end{aligned}$$

Petitioners argue that the modified bi-prediction equation of Karczewicz-I could then be constructed as:

$$\text{pred}(i,j) = (\text{non-rounded}(\text{pred0}(i,j)) + \text{non-rounded}(\text{pred1}(i,j)) + 32) >> 6$$

Pet. at 53.

As Dr. Richardson explains, the sum of these three scenarios (again, only a subset of possible scenarios) is a complex system that a POSITA would not think to construct. Ex-2015 at ¶¶ 141-144. The modifications Petitioners envision for these scenarios seems more like an attempt to emulate the language of the '267 Patent's claims than a plausible outcome from a POSITA reading the two Karczewicz references.

Because the equation to be used in a scenario can be determined only by considering both motion vectors used for bi-prediction, a system implementing Petitioners' proposal cannot determine whether it should make use of a rounded

prediction value, a partially rounded prediction value, or a non-rounded prediction value until after the second motion vector has been determined. *Id.* at ¶ 145. Such a configuration would be costly, especially for an encoder, which must repeatedly test possible pairs of motion vectors in order to determine which pair minimizes the residual error so that it can be coded into the resulting bitstream. *Id.* at ¶¶ 45-52, 145. Including a decoder operating according to Petitioners' three scenarios would also incur the same costs because a decoder that is configured to decode bi-predictions selected according to Petitioners' modified process would require an encoder to perform the complicated and inefficient process proposed by Petitioners. *See id.* at ¶¶ 145-146. Dr. Richardson notes that these costs would be especially prominent when implementing a video encoder or decoder in hardware, where additional memory would be required to store the possible values of predictions produced in each scenario. *Id.* Petitioners' expert, Dr. Freedman, provides no opposition on this point, noting in his deposition that he was "not qualified to speak about the internals of any piece of hardware." Ex-2016 at 104:3-16.

Even if implemented in software, Petitioners' argument assumes that a POSITA would have written "separate code branches" for various scenarios of bi-directional averaging. However, the '267 Patent explains that this is inefficient and undesirable. Ex-2015 at ¶ 146; Ex-1001 at 4:21-25. Moreover, as Dr. Richardson explains, three or more "separate code branches" would be needed for Petitioners'

alleged modification for operations that “may be carried out millions of times per second in a typical video coding application.” Ex-2015 at ¶ 146. A POSITA would not be motivated to create such an inefficient system, and other than incorrectly characterizing such extensive modifications as a “tiny change,” neither Dr. Freedman nor Petitioners advance any compelling reason to believe otherwise. Ex-2016 at 102:21-103:10.

Petitioners’ combination of Karczewicz-I and Karczewicz-II is a collage constructed from bi-prediction and subpixel interpolation techniques that would incur technical costs that a POSITA would find untenable. Additionally, the fact that both references originated from the same inventors and yet no such combination was made demonstrates that an ordinary artisan (much less someone of exceptional skill in the art) would not find such a combination obvious. For these reasons, the Board should reject Petitioners’ Ground 2 and find that the challenged claims are non-obvious and valid.

2. Dependent Claims 20, 26, and 32

Dependent claims 20, 26, and 32 depend on claims 19, 25, and 31. Accordingly, Petitioners have failed to demonstrate that a POSITA would be motivated to combine Karczewicz-I and Karczewicz-II to yield the inventions of claims 20, 26, and 32 for the reasons discussed above.

3. Dependent Claims 21, 27, and 33

Dependent claims 21, 27, and 33 depend on claims 20, 26, and 32. Accordingly, Petitioners have failed to demonstrate that a POSITA would be motivated to combine Karczewicz-I and Karczewicz-II to yield the inventions of claims 21, 27, and 33 for the reasons discussed above.

4. Dependent Claims 22, 28, and 34

Dependent claims 22, 28, and 34 depend on claims 19, 25, and 31. Accordingly, Petitioners have failed to demonstrate that a POSITA would be motivated to combine Karczewicz-I and Karczewicz-II to yield the inventions of 22, 28, and 34 for the reasons discussed above.

5. Dependent Claims 23, 29, and 35

Dependent claims 23, 29, and 35 depend on claims 19, 25, and 31. Accordingly, Petitioners have failed to demonstrate that a POSITA would be motivated to combine Karczewicz-I and Karczewicz-II to yield the inventions of claims 5, 11, and 17 for the reasons discussed above.

6. Dependent Claims 24, 30, and 36

Dependent claims 24, 30, and 36 depend on claims 19, 25, and 31. Accordingly, Petitioners have failed to demonstrate that a POSITA would be motivated to combine Karczewicz-I and Karczewicz-II to yield the inventions of claims 24, 30, and 36 for the reasons discussed above.

7. Karczewicz-I is not a printed publication under 35 U.S.C. § 311(b).

A patent can be challenged in an IPR “only on the basis of prior art consisting of patents or printed publications.” 35 U.S.C. § 311(b). The references which can be used to challenge a patent in IPRs are therefore limited to “prior art patent[s] or prior art printed publication[s].” *Qualcomm v. Apple Inc.*, 24 F.4th 1367, 1375 (Fed. Cir. 2022).

Karczewicz-I is a patent application, not a patent. Accordingly, it must qualify under the “prior art printed publication” category of permissible references. However, although Karczewicz-I was filed on July 9, 2009, it was not published until January 13, 2011—six days after the priority date of the ’267 Patent. *Compare* Ex-1005 at (43) with Ex-1001 at (63), 1:6-16. Therefore, Karczewicz-I is not a prior art publication as required under § 311(b).

This issue—whether a patent application published after the priority date of a challenged reference qualifies under 35 U.S.C. § 311(b)—is currently pending before the Federal Circuit. *See* Appellant’s Corrected Opening Reply Brief at 57-66, *Lynk Labs, Inc. v. Samsung Electronics Co., Ltd.*, CAFC-23-2346 (Fed. Cir. filed Aug. 31, 2023). Although the Federal Circuit has not yet resolved this question, the Board can and should adopt the appellant’s reasoning set forth in *Lynk Labs* and

reject Ground 2 because it relies on a reference which falls outside the bounds of the applicable statute. The statute says:

“[a] petition in an inter partes review may request to cancel as unpatentable 1 or more claims of a patent only on a ground that could be raised under section 102 or 103 and only on the basis of prior art consisting of patents or printed publications.

35 U.S.C. § 311(b). Karczewicz-I is not a patent, and “[t]he statutory phrase ‘printed publication’ has been interpreted to mean that before the critical date the reference must have been sufficiently accessible to the public interested in the art.” *See In re Cronyn*, 890 F.2d 1158, 1160 (Fed. Cir. 1989). Karczewicz-I was not published until after the priority date of the ’267 Patent. This means that Karczewicz-I is not a printed publication and is ineligible for use in an IPR.

VI. Conclusion

For the foregoing reasons, Patent Owner respectfully requests that the Board reject Petitioners’ arguments and uphold the challenged claims of the ’267 Patent as valid.

Dated: December 16, 2024

Respectfully submitted,

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CERTIFICATION OF WORD COUNT

The undersigned hereby certifies that the portions of the above-captioned **PATENT OWNER'S RESPONSE** specified in 37 C.F.R. §42.24 have 10,706 words, in compliance with the 14,000 word limit set forth in 37 C.F.R. §42.24(b)(2). This word count was prepared using Microsoft Word 2010.

Dated: December 16, 2024

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CERTIFICATION OF SERVICE

The undersigned hereby certifies that a copy of this **PATENT OWNER'S RESPONSE** is being served electronically via e-mail on December 16, 2024, in its entirety, on the following counsel for Petitioner:

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