

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Satoru Sakazume
U.S. Patent No.: 10,218,995 Attorney Docket No. 50095-0242IP2
Issue Date: February 26, 2019
Appl. Serial No.: 14/692,138
Filing Date: April 21, 2015
Title: MOVING PICTURE ENCODING SYSTEM, MOVING PICTURE
ENCODING METHOD, MOVING PICTURE ENCODING
PROGRAM, MOVING PICTURE DECODING SYSTEM,
MOVING PICTURE DECODING METHOD, MOVING PICTURE
DECODING PROGRAM, MOVING PICTURE REENCODING
SYSTEM, MOVING PICTURE REENCODING METHOD,
MOVING PICTURE REENCODING PROGRAM

Mail Stop Patent Board

Patent Trial and Appeal Board
U.S. Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

**PETITION FOR *INTER PARTES* REVIEW OF UNITED STATES PATENT
NO. 10,218,995 PURSUANT TO 35 U.S.C. §§ 311–319, 37 C.F.R. § 42**

TABLE OF CONTENTS

I.	REQUIREMENTS FOR IPR UNDER 37 C.F.R. § 42.104.....	1
A.	Grounds for Standing Under 37 C.F.R. § 42.104(a).....	1
B.	Challenge Under 37 C.F.R. § 42.104(b) and Relief Requested	1
C.	Claim Construction	3
D.	Level of Ordinary Skill in the Art.....	4
II.	THE '995 PATENT	4
A.	Technical Background	4
B.	Brief Description.....	5
C.	Examination History	5
III.	THE CHALLENGED CLAIMS ARE UNPATENTABLE.....	7
A.	[GROUND 1A] – Phek in view of YuChuan and He Renders Claims 1, 6, and 8-10 Obvious.....	8
1.	Phek Overview	8
2.	YuChuan Overview	9
3.	He Overview.....	13
4.	Combination of Phek, YuChuan, and He.....	16
5.	Analysis	39
B.	[GROUND 1B] – Phek in view of YuChuan, He, and Martins Renders Claims 1, 5-6, and 8-10 Obvious	73
1.	Martins Overview.....	73
2.	Analysis	75
IV.	PTAB DISCRETION SHOULD NOT PRECLUDE INSTITUTION.....	83
V.	CONCLUSION AND FEES	84
VI.	MANDATORY NOTICES UNDER 37 C.F.R § 42.8(a)(1).....	84
A.	Real Party-In-Interest Under 37 C.F.R. § 42.8(b)(1).....	84
B.	Related Matters Under 37 C.F.R. § 42.8(b)(2).....	84
C.	Lead And Back-Up Counsel Under 37 C.F.R. § 42.8(b)(3).....	85
D.	Service Information	85

LIST OF EXHIBITS

APPLE-1001	U.S. Patent No. 10,218,995 to Sakazume (“the ’995 Patent”)
APPLE-1002	Excerpts from the Prosecution History of the ’995 Patent (“the ’995 Patent File History”)
APPLE-1003	Declaration and Curriculum Vitae of David Lett
APPLE-1004	Complaint, <i>Advanced Coding Technologies LLC v. Apple Inc.</i> , 2-24-cv-00572-JRG, E.D. Tex., filed Jul. 22, 2024
APPLE-1005	English Translation of Japanese Patent Publication No. 2007316161 A with Translation Certificate (“Phek”)
APPLE-1006	Segall et al., <i>Spatial Scalability Within the H.264/AVC Scalable Video Coding Extension</i> ; IEEE Transactions on Circuits & Systems for Video Tech., Vol. 17, No. 9, September 2007 (“Segall”)
APPLE-1007	Martins et al., <i>A Unified Approach to Restoration, Deinterlacing and Resolution Enhancement in Decoding MPEG-2 Video</i> , IEEE Transactions on Circuits & Systems for Video Tech., Vol. 12, No. 9, September 2002 (“Martins”)
APPLE-1008	U.S. Patent Publication No.2008/0137753 (“He”)
APPLE-1009	U.S. Patent No. 5,886,736 (“Chen”)
APPLE-1010	Schwarz et al., <i>Overview of the Scalable Video Coding Extension of the H.264/AVC Standard</i> , IEEE Transactions on Circuits & Systems for Video Tech., Vol. 17, No. 9, September 2007 (“Schwarz”)
APPLE-1011	U.S. Patent Publication No. 2009/0154567 (“Lei”)
APPLE-1012	Park et al., <i>Super-Resolution Image Reconstruction: A Technical Overview</i> , IEEE Signal Processing Magazine, pp. 21-36, May 2003 (“Park”)

APPLE-1013	English Machine Translation of Japanese Patent Publication No. 2008053848 (“Hatanaka”)
APPLE-1014	U.S. Patent Publication No. 2010/0165077 (“Yin”)
APPLE-1015	U.S. Patent Publication No. 2009/0257664 (“Kao”)
APPLE-1016	U.S. Patent Publication No. 2009/0046995 (“K anumuri”)
APPLE-1017	U.S. Pat. 6,470,051 (“Campisano”)
APPLE-1018	U.S. Patent Publication No. 2006/0013306 (“Kim”)
APPLE-1019	Lu et al., Mechanisms of MPEG Stream Synchronization, ACM SIGCOMM Computer Communication Review, Vol. 24, Issue 1, pp. 57-67 (January 1994) (“Lu”)
APPLE-1020	U.S. Patent Publication No. 2003/0021345 (“Brusewitz”)
APPLE-1021	U.S. Patent Publication No. 2003/0021347 (“Lan”)
APPLE-1022	EE Times, <i>How Video Compression Works</i> (Aug. 6, 2007), available at https://www.eetimes.com/how-video-compression-works (retrieved Dec. 26, 2023) (“EETimes”)
APPLE-1023	Bier, <i>Introduction to Video Compression</i> , Berkeley Design Tech., Inc. (October 2005), available at https://www.bdti.com/MyBDTI/pubs/20051024_GSPx05_Video_Intro.pdf (retrieved Dec. 30, 2023) (“Bier”)
APPLE-1024	U.S. Patent No. 7,379,496 (“Holcomb”)
APPLE-1025	U.S. Patent Publication No. 2008/0043832 (“Barkley”)
APPLE-1026	U.S. Patent No. 6,173,013 (“Suzuki”)
APPLE-1027	Memorandum, Interim Procedure for Discretionary Denials in AIA Post-Grant Proceedings with Parallel District Court Litigation (USPTO June 21, 2022) (“Director’s Guidance”)
APPLE-1028	[RESERVED]
APPLE-1029	Declaration of June Ann Munford

APPLE-1030	Ely, <i>MPEG Video Coding: A Simple Introduction</i> , EBU Technical Review (Winter 1995) (“Ely”)
APPLE-1031	Japanese Patent Publication No. 2007316161 A with English Machine Translation
APPLE-1032	ITU-T Recommendation H.264 (11/07)
APPLE-1033	Karczewicz et al., The SP- and SI-Frames Design for H.264/AVC, IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, v.13 (July 2003)
APPLE-1034	ISO/IEC 11172-2: 1993 (E) (MPEG1 Video)
APPLE-1035	ISO/IEC 13818-2: 2000 (E) (MPEG2/H.262 Video)
APPLE-1036	ITU-T Recommendation H.263 (02/98)
APPLE-1037	Reader, Intraframe and Interframe Adaptive Transform Coding, Efficient Transmission of Pictorial Information, SPIE v.66, 108 (1975)
APPLE-1038	Reader, MPEG4: Coding for Content, Interactivity, and Universal Accessibility, Optical Engineering 35(1), 104 (January 1996)
APPLE-1039	Reader, MPEG Patents, in MPEG Video Compression Standard, Chapter 16, at 357-362 (Mitchell et al ed.) (1996)
APPLE-1040	Radha et al., The MPEG-4 Fine-Grained Scalable Video Coding Method for Multimedia Streaming Over IP, IEEE Transactions on Multimedia, v.3, 53 (March 2001)
APPLE-1041	H.264 / MPEG-4 Part 10 White Paper, January 31, 2003 (downloaded from https://github.com/yistLin/H264-Encoder/blob/1cdaf090b63642932ed726b102ed2cf80908edbb/doc/H.264%20%3A%20MPEG-4%20Part%2010%20White%20Paper.pdf on Jan. 5, 2024)
APPLE-1042	ISO/IEC 14496-2: 2004 (MPEG4)
APPLE-1043	ISO/IEC 13818-2: 1996 (MPEG2)

- APPLE-1044 Petition (Paper 2), IPR2024-00372, *Samsung Electronics. Co., Ltd. v. Advanced Coding Techs., LLC* (Jan. 8, 2024)
- APPLE-1045 Decision Instituting *Inter Partes* Review (Paper 9), IPR2024-00372, *Samsung Electronics. Co., Ltd. v. Advanced Coding Techs., LLC* (July 18, 2024)
- APPLE-1046 U.S. Patent Publication No. 2001/0043751 (“Takahashi”)
- APPLE-1047 Peter J. Burt et al., *The Laplacian Pyramid as a Compact Image Code*, IEEE TRANSACTIONS ON COMMUNICATIONS, VOL. COM-31, NO. 4, APRIL 1983 (“Burt”)
- APPLE-1048 Michael Elad et al., *Restoration of a Single Superresolution Image from Several Blurred, Noisy, and Undersampled Measured Images*, IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 6, NO. 12, DECEMBER 1997 (“Elad”)
- APPLE-1049 Michal Irani et al., *Super resolution from image sequences*, [1990] Proceedings. 10th International Conference on Pattern Recognition, Atlantic City, NJ, USA, 1990, pp. 115-120 vol.2, doi: 10.1109/ICPR.1990.119340 (“Irani”)
- APPLE-1050 U.S. Patent Publication No. 2007/0160133 (“Bao”)
- APPLE-1051 U.S. Patent Publication No. 2004/0170330 (“Fogg”)
- APPLE-1052 U.S. Patent Publication No. 2006/0126952 (“Suzuki”)
- APPLE-1053 U.S. Patent Publication No. 2004/0022318 (“Garrido”)
- APPLE-1054 U.S. Patent Publication No. 2005/0019000 (“Lim”)
- APPLE-1055 U.S. Patent Publication No. 2004/0156561 (“YuChuan”)
- APPLE-1056 U.S. Patent Publication No. 2008/0018506 (“Raveendran”)
- APPLE-1057 Hunt B R, *Super-Resolution of Images- Algorithms, Principles, Performance*, Intl. Jnl. of Imaging Sys. and Technol., Vol. 6, pp. 297-304, Wiley, 1995, Oct. 1995 (“Hunt_Oct_1995”)

APPLE-1058	Kramer P, O. Hadar, Benois-Pineau J, Domenger J-P, <i>Use of Motion Information in Super-Resolution Mosaicing</i> , ICIP, Oct. 2006 (“Kramer”)
APPLE-1059	Patti A J, Sezan M I, Tekalp M, <i>Superresolution video reconstruction with arbitrary sampling lattices and nonzero aperture time</i> , IEEE Trans. on Im. Proc., Vol. 6, No. 8, pp. 10 (“Patti”)
APPLE-1060	Erickson K J, Schultz R R, <i>MPEG-1 super-resolution decoding for the analysis of video still images</i> , 4th IEEE Southwest Symp. on Im. Anal. and Interp., Apr. 2000 (“Erickson”)
APPLE-1061	Tsai R Y, Huang T S, <i>Multiframe image restoration and registration</i> , <i>Advances in Computer Vision and Image Processing</i> , Vol. 1, T. S. Huang, ed., Jai Press, pp. 317-319, 1984 (“Tsai”)
APPLE-1062	WIPO Patent Publication No. WO2008/057308A2 (“Kao308”)
APPLE-1063	U.S. Patent No. 5,606,369 (“Keesman”)
APPLE-1064	U.S. Patent Publication No. 2007/0201560 (“Seagall560”)
APPLE-1065	U.S. Patent Publication No. 2004/0022518 (“Taga”)
APPLE-1066	U.S. Patent No. 6,510,177 (“DeBonet”)
APPLE-1067	U.S. Patent No. 6,023,535 (“Aoki”)
APPLE-1068	U.S. Patent Publication No. 2007/0160153 (“Sullivan”)
APPLE-1069	U.S. Patent Publication No. 2006/0222079 (“Park079”)
APPLE-1070	Exhibit SAMSUNG-1006 as submitted in IPR2024-00327
APPLE-1071	Exhibit SAMSUNG-1007 as submitted in IPR2024-00327
APPLE-1072	Exhibit SAMSUNG-1010 as submitted in IPR2024-00327
APPLE-1073	JP2009182776A and English Machine Translation (“Kuroda”)
APPLE-1074	U.S. Patent No. 8,023,561 (“Garrido561”)

APPLE-1075	U.S. Patent No. 6,580,754 (“Wan”)
APPLE-1076	U.S. Patent No. 5,408,270 (“Lim270”)
APPLE-1077	EP 1811786 (“Wang”)
APPLE-1078	Declaration of Dr. Clifford Reader from IPR2024-00372

LISTING OF CLAIMS

Claim 1	
[1.P]	A moving picture encoding system comprising:
[1.1]	a first encoder configured to work on a subsequence of a sequence of moving pictures with a standard resolution to implement a first combination of processes for an encoding and a decoding to create a first sequence of encoded bits and a set of decoded pictures with the standard resolution;
[1.2]	a first super-resolution enlarger configured to work on the subsequence of the sequence of moving pictures with the standard resolution to implement an interpolation of pixels with a first enlargement to create a set of super-resolution enlarged pictures with a first resolution higher than the standard resolution;
[1.3]	a first resolution converter configured to work on the set of super-resolution enlarged pictures to implement a process for a first resolution conversion to create a set of super-resolution enlarged and converted pictures with a standard resolution;
[1.4]	a second super-resolution enlarger configured to acquire the set of decoded pictures with the standard resolution from the first encoder to work on the sequence of decoded pictures to implement an interpolation of pixels with a second enlargement to create a set of super-resolution enlarged decoded pictures with a second resolution higher than the standard resolution;
[1.5]	a second resolution converter configured to work on the set of super-resolution enlarged decoded pictures to implement a process for a second resolution conversion to create a set of super-resolution enlarged and converted decoded pictures with a standard resolution; and
[1.6.i]	a second encoder configured to: have the set of super-resolution enlarged and converted pictures from the first resolution converter as a set of encoding target pictures, the set of decoded pictures from the first encoder as a set of first reference pictures, and the

	set of super-resolution enlarged and converted decoded pictures from the second resolution converter as a set of second reference pictures,
[1.6.ii]	select one of the set of first reference pictures and the set of second reference pictures to create reference picture selection information to identify the set of selected reference pictures to implement a second process for encoding to create a second sequence of encoded bits based on the set of encoding target pictures and the set of selected reference pictures, and implement a third process for encoding for the reference picture selection information to create a sequence of encoded bits of the reference picture selection information,
[1.7]	wherein the set of encoding target pictures, the set of first reference pictures, and the set of second reference pictures have the same value in spatial resolution.
Claim 5	
[5.1]	The moving picture encoding system according to claim 1, wherein the first super-resolution enlarger comprises: a positioner configured to work in a processing for superresolution enlargement, on a combination of a base picture constituting a base therein and one or more observation pictures to be based on, to make a positioning to pixel positions of a desirable high resolution, for an interval-unequal sampling to create nonhomogeneous high resolution pictures;
[5.2]	an interpolator configured to work on nonhomogeneous high resolution pictures created at the positioner, to implement a process for a prescribed nonhomogeneous interpolation to create interpolated pictures with a desirable high resolution;
[5.3]	an estimated picture creator configured to acquire interpolated pictures created at the interpolator, to implement thereon a process for a prescribed reconstruction to create estimated pictures with a desirable resolution; and

[5.4]	a repetition determiner configured to acquire a nonhomogeneous high resolution picture from the positioner and a nonhomogeneous estimated picture from the estimated picture creator, for employment of the acquired pictures to follow a prescribed determination method to determine whether or not a repetition of the processing for super-resolution enlargement is necessary, and work depending on a result thereof, to operate as the repetition is necessary, to provide the interpolator with information for a control to continue the processing, and operate as the repetition is unnecessary, to provide the estimated picture creator with information for a control to output a set of estimated pictures with a high resolution after super-resolution enlargement.
Claim 6	
[6]	The moving picture encoding system according to claim 1, further comprising a multiplexer configured to operate complying with a prescribed syntax structure to multiplex the first sequence of encoded bits from the first encoder, the second sequence of encoded bits from the second encoder, and information on encoding parameters of respective types used in the encoding at the first encoder and the encoding at the second encoder.
Claim 10	
[10]	The moving picture encoding system according to claim 1, wherein the second encoder divides an encoding target picture into a plurality of regions to select one of the set of first reference pictures and the set of second reference pictures for each divided region.
Claim 8	
[8.P]	8. A moving picture encoding method comprising:
[8.1]	a step of implementing a first combination of processes for an encoding and a decoding on a sequence of moving pictures with a standard resolution, creating a first sequence of encoded bits and a set of decoded pictures with the standard resolution;

[8.2]	a step of implementing an interpolation of pixels with a first enlargement on the sequence of moving pictures with the standard resolution, creating a set of super-resolution enlarged pictures with a first resolution higher than a standard resolution;
[8.3]	a step of implementing a process for a first resolution conversion on the set of super-resolution enlarged pictures, creating a set of super-resolution enlarged and converted pictures with a standard resolution;
[8.4]	a step of acquiring the set of decoded pictures with the standard resolution to work on the sequence of decoded pictures to implement an interpolation of pixels with a second enlargement to create a set of super-resolution enlarged decoded pictures with a second resolution higher than the standard resolution;
[8.5]	a step of working on the set of super-resolution enlarged decoded pictures to implement process for a second resolution conversion to create a set of super-resolution enlarged and converted decoded pictures with a standard resolution; and
[8.6.i]	a step of: having the set of super-resolution enlarged and converted pictures as a set of encoding target pictures, the set of decoded pictures as a set of first reference pictures, and the set of super-resolution enlarged and converted decoded pictures as a set of second reference pictures,
[8.6.ii]	selecting one of the set of first reference pictures and the set of second reference pictures to create reference picture selection information to identify the set of selected reference pictures to implement a second process for encoding to create a second sequence of encoded bits based on the set of encoding target pictures and the set of selected reference pictures, and implementing a third process for encoding for the reference picture selection information to create a sequence of encoded bits of the reference picture selection information,
[8.7]	wherein the set of encoding target pictures, the set of first reference pictures, and the set of second reference pictures have the same value in spatial resolution.

Claim 9	
[9.P]	A recording medium storing a moving picture encoding program comprising a non-transitory computer-readable medium configured to have a computer execute:
[9.1]	a step of implementing a first combination of processes for an encoding and a decoding on a sequence of moving pictures with a standard resolution, creating a first sequence of encoded bits and a set of decoded pictures with the standard resolution;
[9.2]	a step of implementing an interpolation of pixels with a first enlargement on the sequence of moving pictures with the standard resolution, creating a set of super-resolution enlarged pictures with a first resolution higher than the standard resolution;
[9.3]	a step of implementing process for a first resolution conversion on the set of super-resolution enlarged pictures, creating a set of super-resolution enlarged and converted pictures with a standard resolution;
[9.4]	a step of acquiring the set of decoded pictures with the standard resolution from the first encoder to work on the sequence of decoded pictures to implement an interpolation of pixels with a second enlargement to create a set of super-resolution enlarged decoded pictures with a second resolution higher than the standard resolution;
[9.5]	a step of working on the set of super-resolution enlarged decoded pictures to implement a process for a second resolution conversion to create a set of super-resolution enlarged and converted decoded pictures with a standard resolution; and
[9.6.i]	a step of: having the set of super-resolution enlarged and converted pictures as a set of encoding target pictures, the set of decoded pictures as a set of first reference pictures, and the set of super-resolution enlarged and converted decoded pictures as a set of second reference pictures,
[9.6.ii]	selecting one of the set of first reference pictures and the set of second reference pictures to create reference picture selection

	information to identify the set of selected reference pictures to implement a second process for encoding to create a second sequence of encoded bits based on the set of encoding target pictures and the set of selected reference pictures, and implementing a third process for encoding for the reference picture selection information to create a sequence of encoded bits of the reference picture selection information,
[9.7]	wherein the set of encoding target pictures, the set of first reference pictures, and the set of second reference pictures have the same value in spatial resolution.

Apple Inc. (“Apple” or “Petitioner”) petitions for *Inter Partes* Review (“IPR”) of claims 1, 5-6, and 8-10 (“the Challenged Claims”) of U.S. Patent No. 10,218,995 (“the ’995 patent”).

I. REQUIREMENTS FOR IPR UNDER 37 C.F.R. § 42.104

A. Grounds for Standing Under 37 C.F.R. § 42.104(a)

Petitioner certifies that the ’995 Patent is available for IPR. This Petition is being filed within one year of service of a complaint against Apple. Apple is not barred or estopped from requesting review of the Challenged Claims on the grounds identified below.

B. Challenge Under 37 C.F.R. § 42.104(b) and Relief Requested

Apple requests institution of IPR and cancellation of the Challenged Claims based on the following grounds:

Ground	Claims	35 U.S.C. § 103
1A	1, 6, 8-10	Phek in view of YuChuan and He
1B	1, 5-6, 8-10	Phek in view of YuChuan, He, and Martins

Grounds 1A-1B are further supported by the expert analysis of Mr. David B. Lett (APPLE-1003) and additional corroborating evidence cited throughout the Petition.

The ’995 Patent claims earliest priority to Japanese Application No. 2008-

142433, filed on May 30, 2008. APPLE-1001, Cover. Petitioner does not concede that the Challenged Claims are entitled to the benefit of the filing date of any earlier-filed application in the alleged priority chain, but this Petition nonetheless treats May 30, 2008 as the Critical Date of the Challenged Claims for purposes of this IPR. Each reference that forms the basis of Grounds 1A-1B qualified as prior art even as early as May 30, 2008:

Reference	U.S. Filing Date	Publication Date	Pre-AIA Prior Art
Phek	---	12/06/2007	§102(a)
YuChuan	01/16/2004	08/12/2004	§102(a)-(b), (e)
He	12/06/2006	06/12/2008	§102(e)
Martins	---	09/2002	§102(a)-(b)

Petitioner also submits evidence demonstrating that Martins was published by IEEE well before the Critical Date of the '995 Patent. *See* IPR2014-00527, Paper 41, 11 (PTAB May 18, 2015) (“IEEE is a well-known, reputable compiler and publisher of scientific and technical publications.”). Ms. June Munford, an expert librarian, reviewed MARC records and a physical copy of the IEEE journal in which Martins published, which confirms that Martins was available to the interested public before the Critical Date. APPLE-1029, ¶¶6-9, 14-18; *generally id.*, ¶¶1-19; *see also* APPLE-1070, -1071, -1072 (corresponding exhibits reviewed by Ms. Munford).

C. Claim Construction

All claim terms should be construed according to the *Phillips* standard.

Phillips v. AWH Corp., 415 F.3d 1303 (Fed. Cir. 2005); 37 C.F.R. §42.100.

Petitioner submits that no formal constructions are presently necessary for purposes of demonstrating obviousness of the Challenged Claims based on Grounds 1A-1E. *Wellman, Inc. v. Eastman Chem. Co.*, 642 F.3d 1355, 1361 (Fed. Cir. 2011) (“claim terms need only be construed to the extent necessary to resolve the controversy”) (internal quotations omitted).

Petitioner reserves the right to respond to any constructions offered by Patent Owner or adopted by the Board. Petitioner is not conceding that the Challenged Claims satisfy all statutory requirements, nor is Petitioner waiving any arguments concerning indefiniteness or claim scope that can only be raised in district court or otherwise outside the context of an IPR. IPR2018-00272, Paper 35, 6-8 (PTAB 2019). The Board has regularly compared indefinite claims to the prior art for purposes of considering unpatentability. *See, e.g.*, CBM2013-00027, Paper 33, 3 (PTAB 2014); CBM2013-00013, Paper 61, 29 (PTAB 2014). For this Petition, Petitioner applies prior art in a manner consistent with disclosure of the claimed features in the '995 Patent itself and Patent Owner's allegations of infringement before the district court.

D. Level of Ordinary Skill in the Art

A person of ordinary skill in the art relating to the subject matter of the '995 Patent as of the Critical Date ("POSITA") would have had at least a bachelor's degree in computer science, electrical engineering, computer engineering, or a related field, with 2-3 years of experience in digital video processing, or a related field. APPLE-1003, ¶¶40-42. Additional graduate education could substitute for professional experience, and *vice versa*. *Id.*

II. THE '995 PATENT

A. Technical Background

The '995 Patent^{1,2} describes compressive video coding technology, including the application of "super-resolution" processing to enhance "reference pictures" in

¹ The '995 Patent sometimes uses the term "resolution" to refer to the amount of detail (e.g., information content) in a picture and at other times uses the term "resolution" to refer to the size (e.g., number of pixels) in the picture. APPLE-1003, ¶¶25-27. The meaning is context dependent. *Id.*

² Common forms of layered, hierarchical coding include multi-view coding (e.g., for stereoscopic video) and scalable coding for transmission of multiple streams differentiated by signal-to-noise ratio, frame rate, and/or spatial resolution.

APPLE-1003, ¶¶28-33

a video coding system. The claimed subject matter is directed to a predictable collection of conventional video coding features that were well known to a POSITA before the Critical Date. APPLE-1003, ¶¶25-27, §II.

B. Brief Description

APPLE-1003, ¶¶28-33.

C. Examination History

The '995 Patent issued from a U.S. application (14/692,138), filed on April 21, 2015, by JVC Kenwood Corporation. APPLE-1001, face. The '995 Patent claims priority to several earlier-filed applications, the earliest being May 30, 2008. *Id.* APPLE-1003, ¶34.

During prosecution, the Examiner issued four Office Actions rejecting the claims as obvious over combinations involving Phek³ (APPLE-1005) in view of Holcomb (APPLE-1024), Barkley (APPLE-1025), and Suzuki (APPLE-1026). APPLE-1002, 273-296 and 300-325 (first action and response), 207-228, 230-255 (second action and response), 131-150 and 154-179 (third action and response), 58-105 (fourth action and response), 9-19 (notice of allowance). APPLE-1003, ¶35.

³ The file history refers to a machine translation of the Phek prior art reference by the name “Ong” rather than Phek.

Throughout examination, the Examiner repeatedly found that Phek discloses most of the examined claim limitations but relied on additional references for disclosure of a “first resolution converter” and “second resolution converter,” for example. APPLE-1002, 88-91, 165-167. Although the Examiner stated that Phek “does not explicitly disclose a first resolution converter,” the Examiner nonetheless observed that “the use of resolution converters for multi-resolution encoding and decoding to enhance current and reference frames and to implement resampling of pixels was well known in the art at the time of the invention was made as evidence from the teaching of Holcomb.” APPLE-1002, 89 (citing APPLE-1024, 3:3-12, 3:56-64, 7:23-48, FIGS. 2-3). The applicant never disputed the Examiner’s finding in this regard. APPLE-1003, ¶36.

The Examiner likewise acknowledged that Phek and Holcomb “do not explicitly disclose a second resolution converter” as claimed and relied on Barkley’s teaching of “spatial enhancement layers” for this limitation. APPLE-1002, 90-91 (citing APPLE-1025, [0053]-[0056]). The applicant also never disputed the relevance of Barkley’s teachings in this regard. APPLE-1003, ¶37.

In the fourth and final rejection before allowance, the Examiner asserted that Barkley teaches the use of two sets of reference pictures as recited by the then-pending language of the “second decoder” limitation in claim 23. APPLE-1002, 91. The Examiner specifically asserted that Barkley disclosed reference picture

selection features since Barkley’s system “selectively decode[s] video information from the base layer and one or more enhancement layers to playback or reproduce the video information at a desired level of quality.” *Id.* (citing APPLE-1025, [0005], FIGS. 1, 3, 5-8). In response, the applicant amended claims to require reference picture selection “***based on reference picture selection information.***” APPLE-1002, 65-66 (emphasis added). The applicant argued that “*Barkley* (newly-cited) only encodes information on a plurality of layers” and “[t]hus, *Barkley’s* device fails to disclose a technique for selecting one of two kinds of reference pictures and fails to suggest using any such reference picture selection information to identify the selected reference picture.” APPLE-1002, 62 (emphasis in original). The Examiner subsequently allowed the application and identified the “second decoder” limitation (including the added requirement for “reference picture selection information”) in the reasons for allowance. *Id.*, 17-18. APPLE-1003, ¶38.

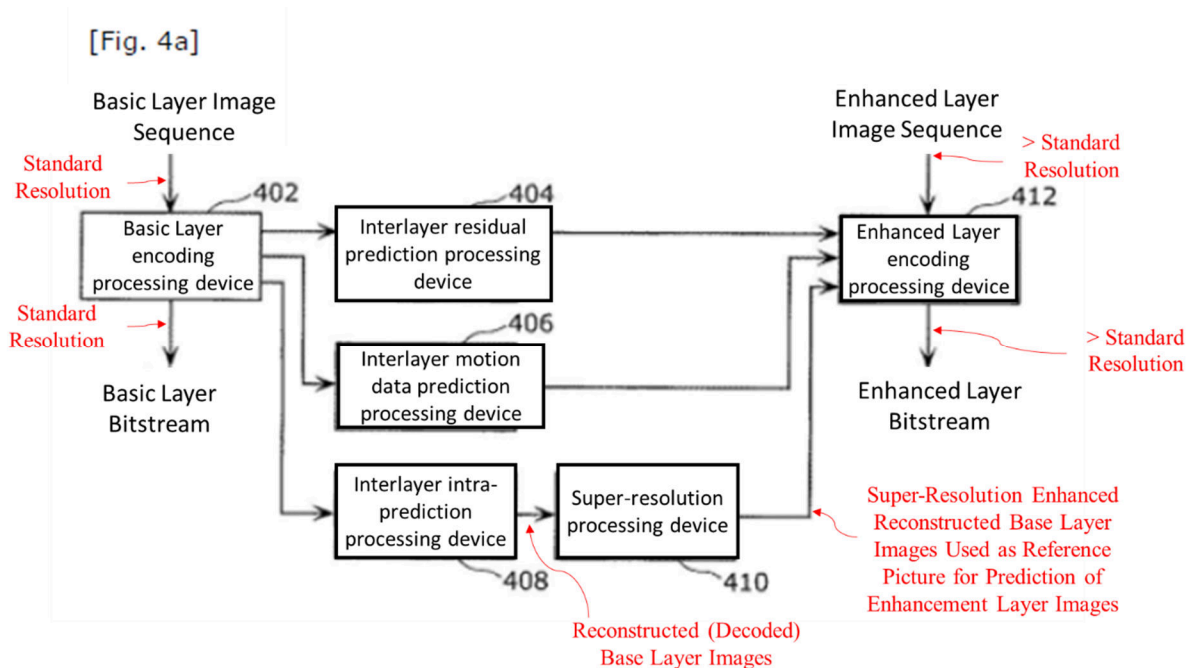
The file history contains no indication that the Examiner ever considered Phek’s teachings in combination with the teachings of YuChuan, He, or Martins as set forth in Grounds 1A-1B of this Petition. If these combinations had been considered, the application never should have been allowed. *Infra*, §IV. APPLE-1003, ¶39.

III. THE CHALLENGED CLAIMS ARE UNPATENTABLE

**A. [GROUND 1A] – Phek in view of YuChuan and He Renders
Claims 1, 6, and 8-10 Obvious**

1. Phek Overview

Phek discloses a video coding system that uses “[i]nterlayer prediction ... for hierarchical encoding in order to improve encoding efficiency.” APPLE-1005, [0014]. “One example of hierarchical encoding that uses interlayer prediction is ... scalable video encoding.” *Id.* Phek’s interlayer coding system includes a basic layer and an enhanced layer, where “an intra image of the basic layer or a reconstructed image of the basic layer” is used “as an additional reference image for encoding the image of the enhanced layer.” *Id.* Moreover, “super-resolution processing ... is used to improve these additional reference images” from the basic layer. *Id.*; *see also id.*, [0011]-[0020], FIGS. 1a-1b, 3a-3b, 4a-4b, 5.



APPLE-1005, FIG. 4a (modified and annotated)⁴; APPLE-1003, ¶44.

2. YuChuan Overview

YuChuan describes techniques for reconstructing “enhanced-resolution images” from multiple low-resolution images using an improved iterative “super-resolution algorithm.” APPLE-1055, Abstract, [0016], [0018]; APPLE-1003, ¶45.

YuChuan’s super-resolution enhancement technique involves (1) well-chosen initial interpolation, (2) robust image registration, and (3) automatic image selection, followed by optional post-processing for further image enhancement.

APPLE-1055, Abstract, [0015], [0017]. APPLE-1003, ¶45.

⁴ For improved readability, Petitioner has added labels to the boxes in Phek’s figures using text of the labels that are external to the boxes in the certified English translation. *See* APPLE-1005. Petitioner also notes that the English translations of Phek (APPLE-1005 and -1031) use the terms “base” and “basic” layers (or streams) interchangeably, and further use the terms “extended,” “enhanced,” and “enhancement” layers (or streams) interchangeably. This Petition cites and quotes disclosure from the certified translation that uses different ones of these terms, but this Petition typically refers simply to “base” and “enhancement” layers (or streams) consistent with common usage of these terms in the field. APPLE-1003, ¶44.

YuChuan's process begins by storing a set of M low-resolution images, from which one is selected as a prototype, and interpolating extra pixels based on a user-defined magnification factor to create an initial high-resolution (**super-resolution**) estimate. APPLE-1055, [0019]-[0033]. YuChuan teaches creating a super-resolution image by employing interpolation techniques like third-order (cubic) interpolation during the initial guess phase to estimate high-resolution pixel values from neighboring low-resolution pixels, balancing computational complexity and reconstructed image quality. APPLE-1055, [0043]-[0046]; APPLE-1003, ¶46.

YuChuan's prototype image is iteratively refined by a process of down-sampling, comparison with the stored low-resolution images, and adjustment of pixel values until desired resolution is achieved. APPLE-1055, [0019], [0035]-[0038]. *See also*, APPLE-1055, [0047]-[0056], [0057]-[0062]. The result of this iterative process – the interpolated prototype image whose pixel values have converged to a satisfactory result – is referred to as the enhanced-resolution image (i.e., a super-resolution enlarged image). APPLE-1055, [0019]; APPLE-1003, ¶47.

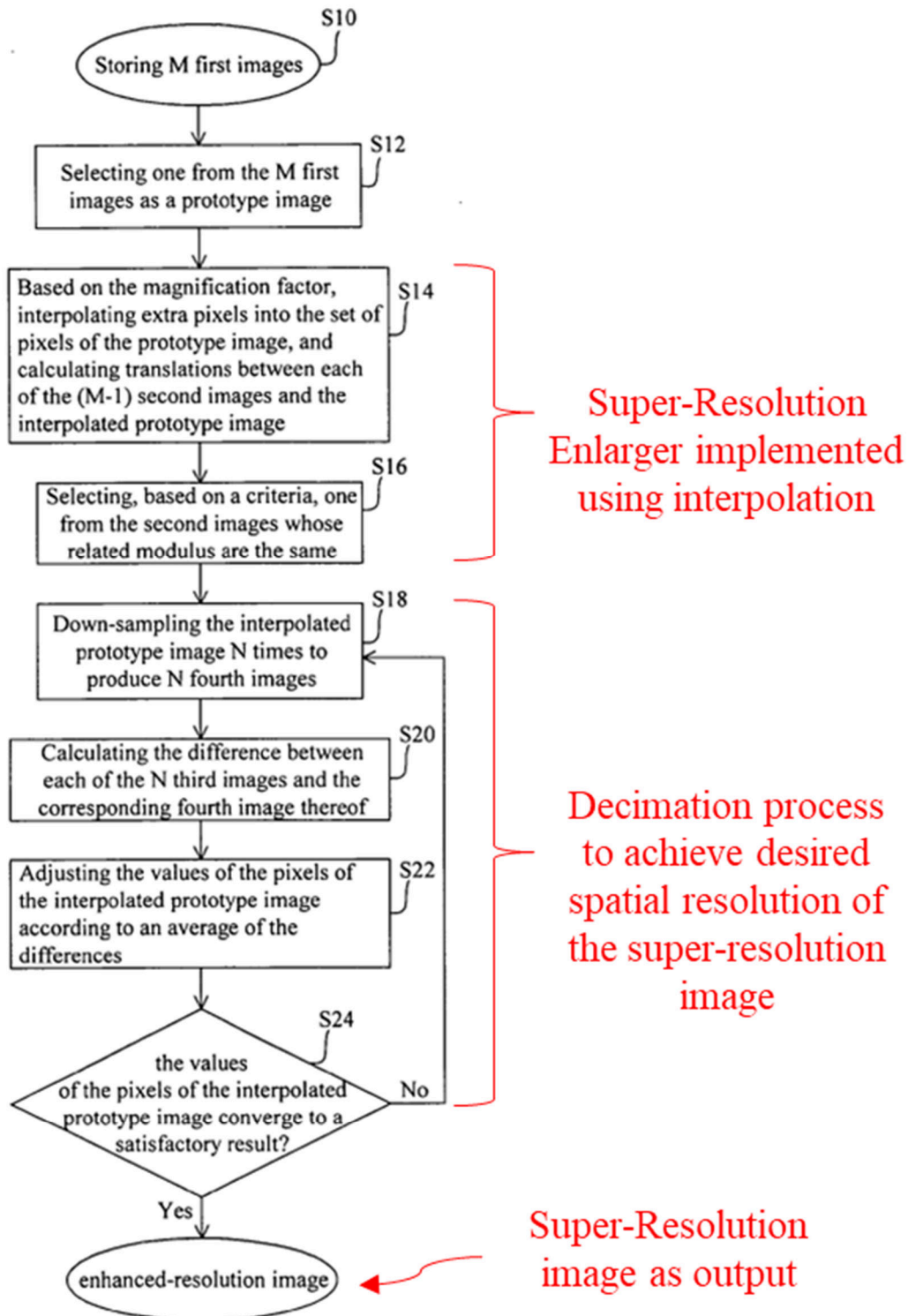


FIG. 1

APPLE-1055, FIG. 1 (annotated).

Image registration is performed by calculating translations between the prototype and the remaining low-resolution images, using global matching for stationary scenes and local matching for moving objects. APPLE-1055, [0047]-[0056], [0057]-[0062]. Automatic image selection is then used to identify the most relevant images for inclusion in the reconstruction process, thereby reducing unnecessary computational overhead. APPLE-1055, [0034], [0063]-[0065]; APPLE-1003, ¶48.



FIG.5A



FIG.5B



FIG.5C



FIG.5D

APPLE-1055, FIGs. 5A-D; *see also*, *id.*, FIGs. 4A-4B, 6A-D, 8A-D.

Third-order interpolation can be used for the initial guess, balancing computational efficiency and image quality. APPLE-1055, [0046]. YuChuan's

method produces high-quality enhanced-resolution images, with significant reductions in computation time when automatic image selection is used. APPLE-1055, [0067], [0070]-[0071]; APPLE-1003, ¶49.

3. He Overview

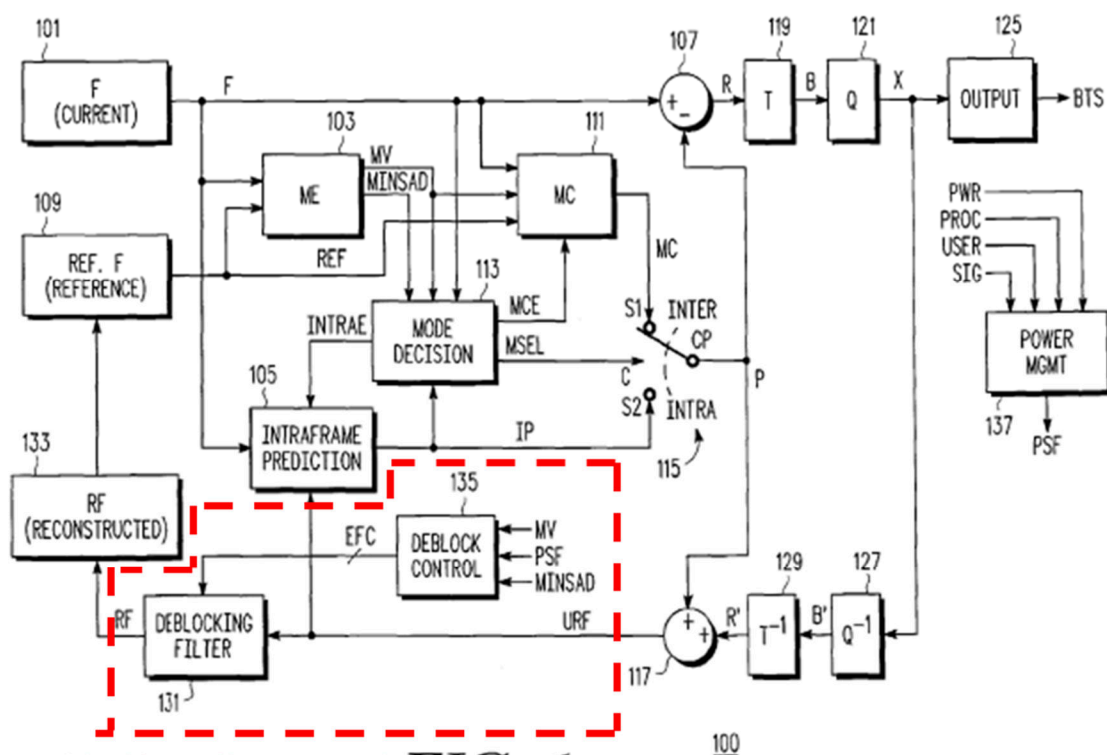
He discloses techniques for selective in-loop filtering in a scalable video coding system. APPLE-1003, ¶¶166-169. He specifically focuses on selective in-loop deblock filtering to control deblock filtering parameters at each layer of scalable coding hierarchy. APPLE-1008, [0002]-[0006], [0022], [0028], [0032]-[0037], FIGS. 1-4; APPLE-1003, ¶¶50-54.

According to He, “[t]he deblocking filter enhances the decoded picture quality and increases the encoding efficiency by removing the block effects in the boundary of each 4x4, 8x8, and/or 16/16 block,” although “[t]he deblocking filter[] ... also consumes a significant amount of power and processing cycles.” APPLE-1008, [0006]. “Disabling the entire deblocking filter [] provides a significant reduction of computational complexity and power consumption, especially in the decoder of a video processing system.” *Id.*, [0028]. He thus proposes techniques for examining “the content of the video information ... to determine whether to disable the deblock filtering,” e.g., based on “a characteristic indicative of a relative amount of content complexity and/or a relative amount of motion of the

video information” and “also based on power savings considerations.” *Id.*, [0028], [0037].

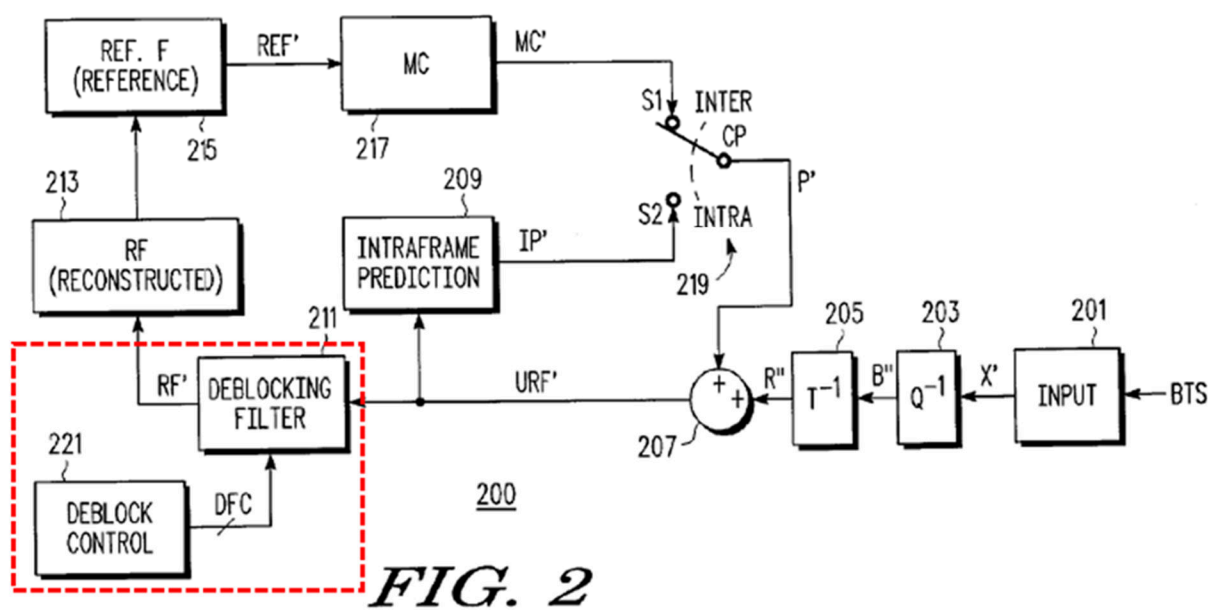
FIG. 2 (reproduced below) depicts a video decoder 200 configured to implement selective deblock filtering. APPLE-1008, [0032], FIG. 2. The decoder 200 receives a coded bitstream (BTS) and performs prediction and reconstruction operations to decode at least a portion of a picture, thereby generating “unfiltered reconstructed frame information URF’.” *Id.*, [0032]. URF’ is provided to a deblocking filter 211, controlled by a deblock control circuit 221. *Id.*, [0033]-[0034]. Deblock control circuit 221 issues a “decoder filter control DFC signal” that selectively enables or disables the deblocking filter 211. *Id.*, [0034]. When filter 211 is disabled, deblock filtering operations are bypassed and “URF’ is passed as the ‘filtered’ reconstructed information RF’ to a reference frame buffer 213 for use as a reference picture for motion-compensated prediction processes. *Id.* When filter 211 is enabled, URF’ is filtered to generate RF’ for use as a reference picture in the motion compensated prediction processes. *Id.*

FIG. 1 (also reproduced below) shows the corresponding encoder 100 that He further explains “provides control information within the bitstream BTS to cause the deblock control circuit 221 of the video decoder 200 to provide the DFC signal to adaptively disable deblock filtering for a corresponding slice or frame of URF’ information being processed in the video decoder 200.” *Id.*



In-Loop Deblocking Filter 131 and *FIG. 1*
Deblock Control Circuit 135

APPLE-1008, FIG. 1 (annotated); APPLE-1003, ¶¶50-54.



In-Loop Deblocking Filter 211 and Control Circuit 221

APPLE-1008, FIG. 2 (annotated); APPLE-1003, ¶¶50-54.

He thus provides a conventional solution for selecting between reference pictures in a video coding prediction process. The coder can select to use an enhanced reference picture by activating the in-loop (deblocking) filter or select a non-enhanced reference picture by disabling the in-loop (deblocking) filter. A POSITA also would have understood He's teachings to be just one example of a class of prior art techniques for selecting among different types of reference pictures to optimize coding efficiency and performance. APPLE-1003, ¶54; APPLE-1046, [0131], [0253], FIGs. 6, 12, 15 (describing additional known techniques for selecting among different reference pictures in a hierarchical/scalable coding system); APPLE-1003, ¶¶50-54.

4. Combination of Phek, YuChuan, and He

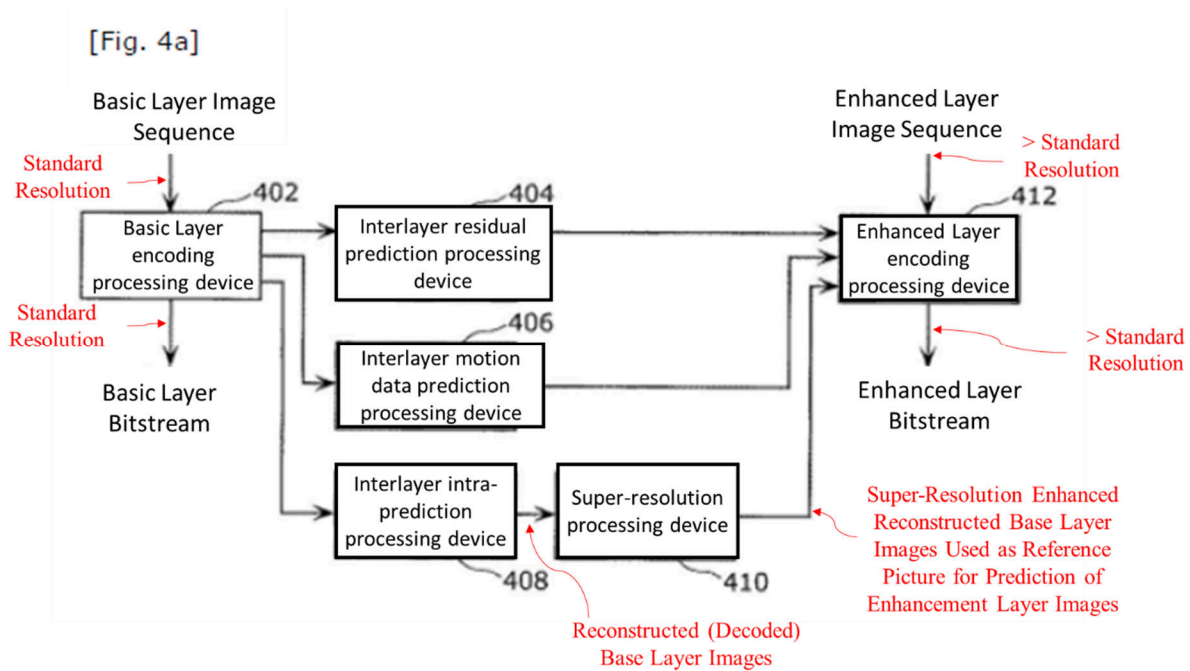
Like the '995 Patent, Phek discloses a layered video coding system that processes decoded base layer pictures to create reference pictures for the prediction of pictures in an enhancement layer. *Supra*, §II.A-B. While Phek's disclosure focuses on details of a super-resolution algorithm used to enhance decoded base layer pictures, Phek's description of the layered coding system itself (which uses the proposed super-resolution algorithm) is less detailed. Indeed, Phek acknowledges that its encoder/decoder descriptions are "simplified" and "do not

have to be performed as shown.” APPLE-1005, [0013]. Phek’s system is thus ripe for improvement; APPLE-1003, ¶55.

As described below, a POSITA reviewing YuChuan and He would have found it obvious to improve Phek’s layered coding system in at least the following ways. APPLE-1003, ¶¶55-76.

(a) Obvious based on Phek to form an enhancement layer video input by super-resolution processing a base layer video input

Phek teaches that “Fig. 4a and Fig. 4b are two block diagrams showing use of a super-resolution processing device for intra-layer prediction in, respectively, an encoding device (encoder) and decoding device (decoder).” APPLE-1005, [0014]. According to Phek, “[i]nterlayer prediction is used for hierarchical encoding in order to improve encoding efficiency” and “[o]ne example of hierarchical encoding that uses interlayer prediction is ... known as scalable video encoding.” *Id.* As shown in FIG. 4A, “[a] basic layer image sequence is encoded using a basic layer encoding processing device 402” and “[a]n enhanced layer image sequence is encoded using an enhanced layer encoding processing device 412,” where “[t]he enhanced layer encoding processing device 412 uses interlayer prediction to reduce redundancy between the enhanced layer and the basic layer, thereby improving encoding efficiency compared to encoding performed using only an enhanced layer.” *Id.*



APPLE-1005, FIG. 4A.

To the extent Phek does not expressly describe how the enhanced layer image sequence encoded by enhanced layer encoding processing device 412 is formed, it would have been obvious for the enhanced layer image sequence to be formed by applying super-resolution processing to the base layer image sequence.⁵

⁵ Any conventional super-resolution processing technique would be suitable for this purpose, including Phek's super-resolution processing or Yu-Chuan's super-resolution processing. APPLE-1005, [0016]-[0020]; APPLE-1055, [0030]-[0071]; *cf.*, APPLE-1001, 22:38-23:21 ('995 Patent explaining that "any such super-resolution" process known in the art may be applied); APPLE-1003, ¶¶55-63.

APPLE-1003, ¶¶57-58. Multiple reasons would have prompted a POSITA to apply Phek's super-resolution processing to the base layer image sequence to generate the enhanced layer image sequence. APPLE-1003, ¶58.

First, a POSITA would have recognized Phek's super-resolution processing technique as a known and beneficial option for *enhancing* the quality of a video stream. It therefore would have been obvious and beneficial to generate an enhanced layer image sequence to achieve Phek's express goal of obtaining such an *enhanced* layer image sequence for encoding. APPLE-1003, ¶59. Indeed, Phek specifically teaches that its "super-resolution processing method ... improves the ... quality of image sequences" while "reduc[ing] grid artifact[s]" in the enhanced images. APPLE-1005, (57); *see also id.*, [0002] ("Super-resolution processing is a technique for generating high-resolution images from a plurality of low-resolution images. This technique can be used ... to improve the resolution and quality of the imputed image sequences to be displayed."), [0003] ("improved by repeatedly subjecting [an estimated frame] to blurring, frame difference, point spreading inverse function, regularization, and refinement processing"), [0011] ("present invention uses a super-resolution processing device 320 to improve the quality and resolution of reference frames"), [0013] ("super-resolution processing can be used in encoders and decoders to improve encoding efficiency or picture quality"). Considering the quality- enhancements offered by super-resolution processing—

which are expressly touted in Phek—super-resolution processing would have been obvious to use in forming an enhanced layer image sequence that could be encoded by the enhanced layer encoding processing device 412. APPLE-1003, ¶59.

Second, a POSITA would have recognized that applying super-resolution processing to the base layer image sequence to produce an enhanced layer image sequence for encoding is consistent with Phek’s multiple teachings for applying super-resolution processing before encoding/compression. APPLE-1003, ¶60. To this point, Phek explains that “[w]hen super-resolution processing is used in recording devices ..., *the resolution and quality of images subject to transcoding and storage can be improved.*” APPLE-1005, [0002] (emphasis added). Phek also discloses with respect to FIG. 2 that super-resolution processing can be used in a “pre-processing device” that obtains an uncompressed image sequence D254 and that thereafter applies super-resolution processing to produce a super-resolution image sequence D266 that can be displayed, stored, or *compressed* (which a POSITA would have understood to include encoding). APPLE-1005, [0010] (“[c]ompression may also be used”), FIG. 2; APPLE-1003, ¶60. Thus, even if Phek does not specifically discuss details of the enhanced layer image sequence encoded by the system shown in FIG. 4A, Phek does expressly disclose how a source image sequence D254 akin to the base layer image sequence of FIG. 4A can be enhanced by super-resolution processing and subsequently encoded. *Id.* In this

context, a POSITA naturally would have understood and found it obvious to apply an enhancement technique like that expressly disclosed in Phek (i.e., super-resolution processing) to obtain an enhanced layer image for encoding by the layered encoding system of FIG. 4A. *Boston Scientific Scimed, Inc. v. Cordis Corp.*, 554 F.3d 982, 991 (Fed. Cir. 2009) (“Combining two embodiments disclosed adjacent to each other in a prior art patent does not require a leap of inventiveness”); APPLE-1003, ¶60.

Third, a POSITA would have sought to form the enhanced layer image sequence by applying super-resolution processing to the base layer image sequence to produce an enhanced layer image sequence that is related to the base layer image sequence. APPLE-1003, ¶61. The relationship between the two image sequences would have improved coding efficiency because the layered coding system removes significant redundancies between the base layer image sequence and the enhanced layer image sequence during coding. *Id.*; APPLE-1005, [0014]. Super-resolution processing also has the effect increasing the quality (e.g., information content, signal-to-noise ratio (SNR)) of an input image sequence, which is a characteristic of enhancement layer image sequences that are commonly differentiated between layers of a scalable video coding system like that disclosed in Phek. APPLE-1005, (57), [0002]-[0004], [0011], [0013]; APPLE-1010, 1104 (“The usual modes of scalability are temporal, spatial, and **quality** scalability.”),

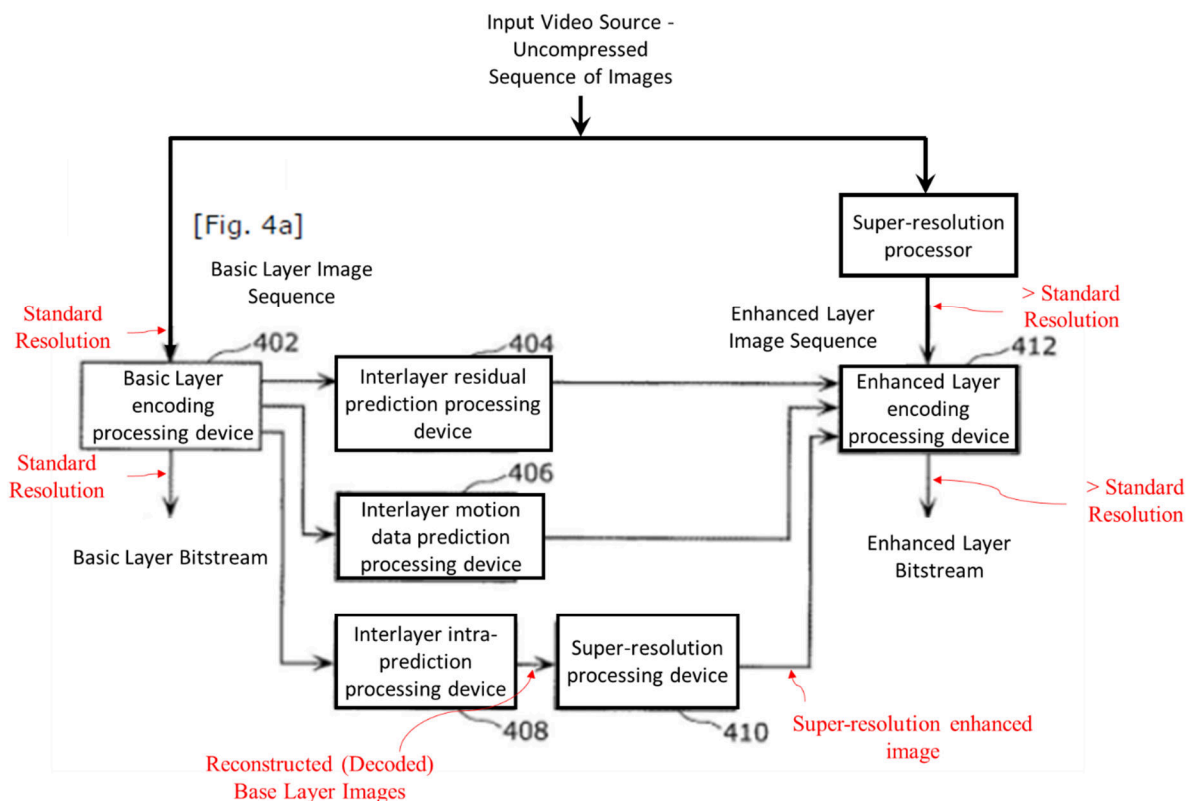
1103; APPLE-1003, ¶61. A POSITA thus would have recognized super-resolution processing as a beneficial technique for generating an enhanced layer image sequence that could be suitably encoded by a layered/scalable coding system as taught in Phek. APPLE-1003, ¶61.

Fourth, a POSITA would have sought to form the enhanced layer image sequence based on super-resolution processing to overcome limitations that may have suppressed the quality of the original input video (base layer image sequence). APPLE-1003, ¶62. For example, the original input video may have been under-sampled or subject to movement or vibration that caused blurring or other quality degradations in the image sequence of the input video. APPLE-1003, ¶62. Super-resolution processing would have been obvious and beneficial to enhance the quality of the original video such that the video could be later coded, decoded, and viewed with enhanced quality. APPLE-1055, [0012] (“an enhanced-resolution output image and can then be easily observed and recognized.”); APPLE-1012, 2 (“In the process of recording a digital image, there is a natural loss of spatial resolution caused by the optical distortions (out of focus, diffraction limit, etc.), motion blur due to limited shutter speed, noise that occurs within the sensor or during transmission, and insufficient sensor density Thus, the recorded image usually suffers from blur, noise, and aliasing effects. ... [T]he main concern of an SR algorithm is to reconstruct HR images from undersampled

HR images,” while also “cover[ing] image restoration techniques that produce high quality images from noisy, blurred images.”); APPLE-1003, ¶62. Moreover, by performing super-resolution at the encoding system before compression and storage or transmission of the video, the viewer’s device would beneficially be capable of reproducing the video at a higher quality simply by decoding the enhancement layer stream, without need to further apply super-resolution post-processing to a decoded version of the base layer image sequence at the receiver/viewing device. *Id.*; *see also* APPLE-1007, 804-805 (describing super-resolution post-processing performed at the receiver/viewing device).

Fifth, a POSITA would have found it obvious to generate Phek’s enhanced layer image sequence by applying super-resolution processing to the base layer image sequence because doing so merely entails the predictable application of known technique (e.g., super-resolution processing) to a known system (e.g., Phek’s layered coding system) to achieve predictable results. *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 417 (2007) (a supposed invention that “simply arranges old elements with each performing the same function it had been known to perform” is obvious). “It’s enough... to show that there was a known problem... in the art, that [another known teaching] ... helped address that issue, and that combining the teachings of ... wasn’t beyond the skill of an ordinary artisan. Nothing more is required to show a motivation to combine under *KSR*.” *Intel Corp.*

v. PACT XPP Schweiz AG, 61 F.4th 1373, 1380-81, (Fed. Cir. 2023). Here, Phek and the '995 Patent both confirm that super-resolution processing was a known technique and the implementation of such techniques was well within the capability of a POSITA. APPLE-1005, [0016]-[0020]; APPLE-1001, 22:38-23:21 APPLE-1003, ¶63. A POSITA would have reasonably expected success using super-resolution to enhance image quality for the enhanced layer image sequence in Phek's system, especially since such super-resolution techniques were well known and commonly implemented by the Critical Date. *Id.*



First Intermediate Illustration of Proposed Combination (Phek)

(b) Obvious based on YuChuan to downscale super-resolution enlarged images to the original (standard) resolution of the base layer image sequence

As discussed above, it would have been obvious to apply super-resolution processing to enhance the quality of the base layer input video stream as part of a process for forming an enhancement layer input video stream. *Supra*, §III.A.4.(a); APPLE-1003, ¶64. Phek likewise discloses the use of super-resolution processing to enhance the quality of decoded base layer images provided as reference pictures for interlayer prediction by the enhanced layer encoding processing device 412. APPLE-1005, [0014]-[0015], FIGS. 4a-4b; *see also id.*, [0011]-[0013], FIGS. 3a-3b. The effect of applying super-resolution processing is typically two-fold—(1) it enhances image quality by interpolating additional information into the image based on other images of the same or similar scene, and (2) it increases the size or spatial resolution of the image since additional pixels are added to the image. *See e.g.*, APPLE-1005, (57) “a super-resolution processing method and device that improves the resolution and quality of image sequences”), [0002] (“improve the resolution and quality”), [0011] (“improve the quality and resolution”); APPLE-1055, [0012] (“improve the image quality and resolution”); APPLE-1012, 1-3.

While super-resolution processing can produce the dual benefits of enhanced quality and increased resolution images, it is in some cases desirable merely to

enhance the quality of images without increasing their resolution . APPLE-1003, ¶65. For example, a POSITA would have known from background knowledge of the art that “[a] related problem to SR [super-resolution] techniques is image restoration, which is a well-established area in image processing applications The goal of image restoration is to recover a degraded (e.g., blurred, noisy) image, but it *does not change the size of image*.” APPLE-1012, 2; *see also id.*, (“restoration and SR reconstruction are closely related theoretically, and SR reconstruction can be considered as a second-generation problem of image restoration”); APPLE-1067, 7:10-30 (describing super-resolution technique that produces “output[s] at least *at the original resolution*” according to a “resolution factor” that is “predetermined or user-selected on the fly”), 1:12-51, 2:1-15. Indeed, the coder depicted in FIG. 4a of Phek is a scalable video coding apparatus, and a well-known form of scalable coding is “quality” scalability (also referred to as signal-to-noise ratio (SNR) scalability) that involves coding pictures at a higher quality in the enhancement layer than the base layer—but still coding the base and enhancement layer pictures at the same spatial resolution. APPLE-1010, 1104 (“With quality scalability, the substream *provides the same spatio-temporal resolution* as the complete bit stream, but with a lower fidelity.”); APPLE-1006, 1121 (“[T]he SVC extensions support . . . quality scalability (fidelity enhancement for pictures *of the same resolution*).”).

A POSITA seeking to implement a form of quality/fidelity/SNR scalability in Phek's system while maintaining the same resolution of images in the base and enhancement layers would have turned to references such as YuChuan to understand how the increased resolution of a super-resolution enlarged image could be reduced to the original (standard) resolution of the base layer image. APPLE-1003, ¶66. For example, YuChuan teaches that a super-resolution enlarged image (e.g., referred to as an interpolated or enhanced-resolution image) can be decreased by down-sampling the enlarged image. *See e.g.*, APPLE-1055, [0019] ("The interpolated prototype image is down-sampled N times according to the respective translations ..."), [0035] ("[S]tep S18 is performed to down-sample, according to the respective translation ..., the interpolated prototype image ..."), [0039]-[0042], FIGS. 1, 5A-5D. YuChuan's down-sampling operation reduces the size or spatial resolution of the interpolated prototype image (i.e., a super-resolution enlarged image). YuChuan's method is performed according to user-defined magnification factor. APPLE-1055, [0014], [0019], [0031], FIG. 1.

It would have been obvious to implement Phek's hierarchical coding device to include a down-sampling as suggested by YuChuan (i.e., a type of downscaler) to reduce the resolution of the super-resolution enlarged base layer input image sequence when forming the enhancement layer input image sequence. APPLE-1003, ¶67. A POSITA would have been motivated to implement this

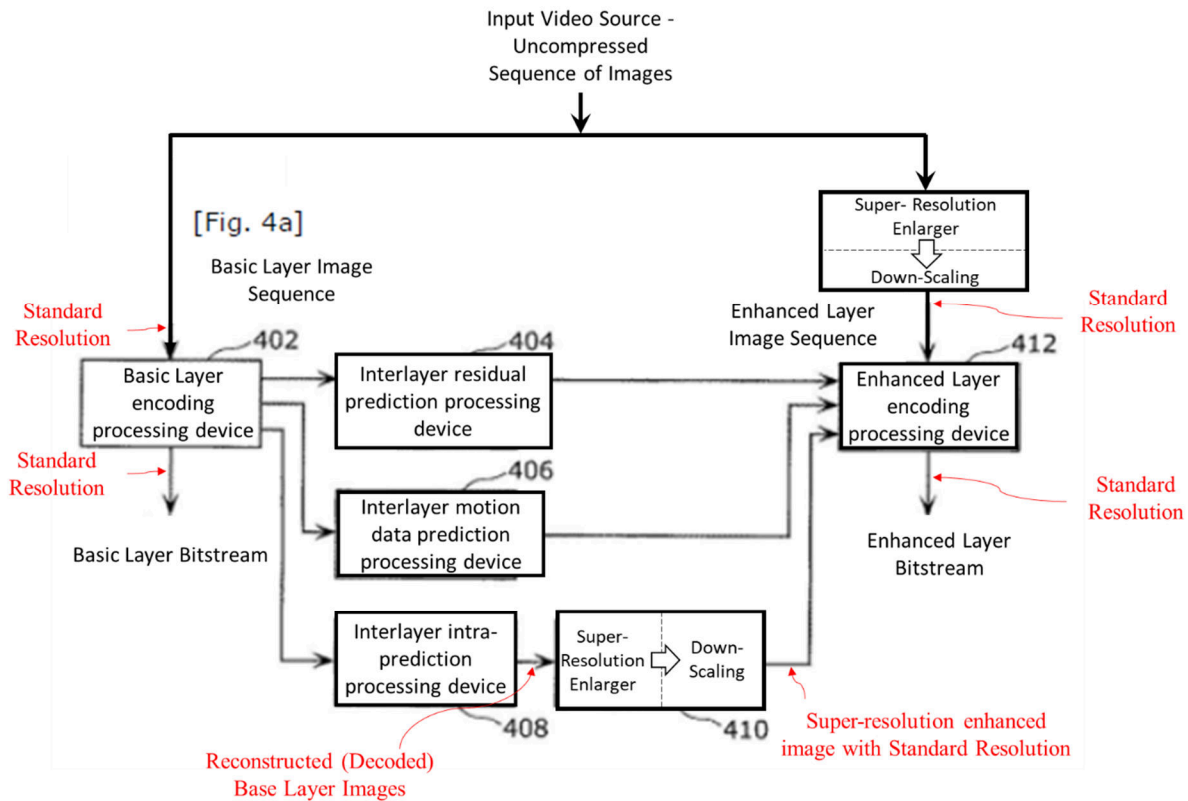
straightforward combination for multiple reasons. *Id.* For example, downscaling the super-resolution enlarged base layer input image sequence would be beneficial to permit the base layer and enhancement layer input image sequences to be encoded at the same spatial resolution. APPLE-1003, ¶67. Thus, the base and enhancement layers would be differentiated by quality alone (rather than both quality and spatial resolution), which was a common form of scalable coding before the Critical Date. APPLE-1010, 1104; APPLE-1006, 1121; APPLE-1003, ¶67. A POSITA would have appreciated that enhanced spatial resolution (spatial scalability) would be undesirable for many systems, especially where the base layer is already coded at a sufficiently high spatial resolution, where the receiver is incapable of decoding images at a resolution higher than the standard resolution of the base layer, and/or where the channel bandwidth is limited and unable to reliably support transmission of an enhancement layer at both a higher quality and spatial resolution. APPLE-1003, ¶67. The selection of a spatial resolution for the enhancement layer would also have been seen as an obvious design choice, especially since users were commonly provided the option of specifying a desired magnification factor for super-resolution enlarged images (including a magnification of 1). APPLE-1055, [0014], [0019], [0031], FIG. 1 (describing user-defined “magnification factor”); APPLE-1067, 7:10-30 (describing super-resolution technique that produces “output[s] at least *at the original resolution*”

according to a “resolution factor” that is “predetermined or user-selected on the fly”); APPLE-1007, p. 2 (“The algorithm has two steps. In the first step, a superresolution version ... of each directly decoded picture is constructed. In the second step, the super-resolution picture is decimated to the desired format.”), p. 1 (“obtain a sequence of higher fidelity ... in the same format as the directly decoded one”), FIG. 2 (annotated); *see also id.*, p. 5, §IV (“DECIMATION”); APPLE-1003, ¶67. The use of a downscaler to down-convert the resolution of images before coding, viewing, recording, and the like was exceedingly common and well known before the ’995 Patent. *See, e.g.*, APPLE-1055, [0014], [0019], [0031], FIG. 1 (describing benefits of down-sampling to facilitate iterative super-resolution process); APPLE-1007, 2 (“the super-resolution picture is *decimated to the desired format*”), 6 (§IV), FIG. 2; APPLE-1068, [0085] (“Once the encoder has chosen a spatial resolution for a current picture or area within a current picture, *the encoder re-samples the original picture to the desired resolution before coding it.*”), [0082]-[0088], FIGS. 6, 8, 10.

Because the enhancement layer in the Phek-YuChuan system is encoded at the same (standard) spatial resolution as the base layer, a POSITA also would have found it obvious to implement a downscaler at the output of Phek’s super-resolution processing device 410 so that the enhanced reference pictures produced by the super-resolution processing device 410 would be downsampled to match the

standard resolution of the base layer. APPLE-1003, ¶68. Notably, a POSITA would have appreciated that reference pictures used for interlayer predictions were ordinarily and commonly scaled to the same size as images in the enhancement layer for which the reference pictures will be used to predict. *See, e.g.*, APPLE-1006, §II (“the width and height of the scaled regions of lower resolution and higher resolution pictures must have the **same** scaling ratio”); APPLE-1026, 25:27-37 (“the resolution converter 205 converts the resolution of the base layer image signal to the resolution corresponding to the enhancement image signal”); APPLE-1046, [0128] (“a resolution conversion circuit 3 for subjecting regenerated data ... to resolution conversion in a way that its resolution becomes equal to that of the high-resolution image signal”); APPLE-1024, 9:30-35 (“the encoder sets the resolution for the reference frame (630) before setting the resolution for the current frame (620)”), 14:40-46 (“the one or more spatial resolution scaling factors are constrained to be identical to the one or more spatial resolution scaling factors for the reference”), FIG. 6; APPLE-1068, [0082]-[0088], FIGS. 6, 8, 10. It would have been obvious to downscale the super-resolution enlarged reference pictures from super-resolution processing device 410 to maintain the quality enhancements obtained from super-resolution processing while better facilitating interlayer prediction by setting the resolution of the reference picture to the resolution of the enhancement layer. APPLE-1003, ¶¶68-69.

Finally, the implementation of downscalers in Phek's device to reduce the super-resolution enlarged images would have been obvious because it merely involves the predictable application of a known technique (e.g., downscaling / resolution conversion) to a known system (e.g., Phek's layered coding system) to achieve predictable results. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 417 (2007) (a supposed invention that "simply arranges old elements with each performing the same function it had been known to perform" is obvious). "It's enough... to show that there was a known problem... in the art, that [another known teaching] ... helped address that issue, and that combining the teachings of ... wasn't beyond the skill of an ordinary artisan. Nothing more is required to show a motivation to combine under *KSR*." *Intel Corp. v. PACT XPP Schweiz AG*, 61 F.4th 1373, 1380-81, (Fed. Cir. 2023). A POSITA would have reasonably expected success implementing the combination since down-sampling techniques were well known and commonly applied by the Critical Date. *Id.*



Second Intermediate Illustration of Proposed Combination (Phek-YuChuan)

(c) Obvious based on He to selectively enhance reference pictures using SR-D (super-resolution + downscaling) loop filter

Next, a POSITA would have found it obvious based on He to configure Phek's enhanced layer encoding processing device 412 to selectively enable or disable super-resolution processing and downscaling of reference pictures for interlayer prediction. APPLE-1003, ¶70.

As discussed above, it would have been obvious based on Phek and YuChuan to perform super-resolution processing and downscaling of reference pictures used for interlayer prediction in Phek's hierarchical encoding device.

APPLE-1005, [0011]-[0015], FIGS. 3a-3b, 4a-4b; APPLE-1007, 1-2, 6; *supra*, §III.A.4.(a)-(b). APPLE-1003, ¶71. A POSITA would have understood that the super-resolution and downscaling operations performed on reference pictures collectively function as a type of “loop filter,” which will be referred to as a “super-resolution and downscaling loop filter” (or simply an “SR-D filter”).

APPLE-1003, ¶71. Like other loop filters known in the art, the Phek-YuChuan-He SR-D loop filter enhances decoded frames before they are used as a reference for the prediction of frames in an enhancement layer. *Supra*, §II.A; APPLE-1022, 10-11; APPLE-1008, [0006]. As Mr. Lett notes, a wide range of loop filters were known in the art before the ’995 Patent and the SR-D filter in the proposed combination similarly serves to enhance the quality of reference pictures consistent with other conventional loop filters. APPLE-1003, ¶71 (citing APPLE-1078, §II.F and *generally* §§II, V); *see also* APPLE-1008, [0006] (describing in-loop filter that “enhances the decoded picture quality and increases the encoding efficiency”); APPLE-1015, [0068] (explaining that in-loop filters “are placed in the coding loop (in-loop), so the filtered frames are used as referenced frames for motion compensation of subsequent coded frames”); APPLE-1011, [0022]-[0023] (“fidelity enhancement techniques can be performed on the processed data at a number of stages in the encoder”), FIGS. 2-5; *supra*, §II.A.

Phek does not explicitly disclose conditions for the use of super-resolution

processing on reference pictures. As discussed above, however, He explains that loop filtering can be computationally expensive, and He acknowledges that these costs may or may not be justified for a given frame depending on the amount of improvement in decoded image quality and compression realized by loop filtering as compared to the computational expense and associated latency and power consumption required to perform loop filtering. *Supra*, §III.A.3; APPLE-1003, ¶72. For example, He explains that its in-loop filter “consumes a significant amount of power and processing cycles” and “[g]enerally speaking, the entire [] filter ... consumes approximately 8% of the computations at the encoder and approximately 35% at the decoder for H.264/AVC.” APPLE-1008, [0006]. “Disabling the entire [] filter, therefore, provides a significant reduction of power and processing complexity, especially in the decoder.” *Id.* To maintain a “desired tradeoff between video quality and complexity reduction,” He provides control signals that allow an encoder to selectively enable or disable the loop filter. *Id.*, [0069].

Considering these teachings, it would have been obvious to a POSITA to apply He’s suggestion for selective in-loop filtering to the Phek-YuChuan-He combination to achieve benefits of the same nature as those expressly disclosed in He—including to reduce the power consumption, processing time, and computational complexity of coding frames in the enhancement layer. APPLE-

1008, [0028], [0031], [0037], [0076], [0069]; APPLE-1003, ¶73. In the combination, and based on He’s teaching, control flags in an encoded stream would similarly indicate whether an in-loop SR-D filter should be applied when coding a given frame or slice in the enhancement layer. *Id.*

Although He’s preferred embodiments focus on selective loop filtering in the context of “deblocking” filters, a POSITA would have appreciated that He’s teachings are equally applicable to other types of loop filters including SR-D filtering. APPLE-1003, ¶74. Indeed, the same concerns that motivated He’s use of selective “deblocking”-type loop-filters—including computational complexity and power consumption concerns—are similarly, if not more, applicable to SR-D filtering, especially since SR-D filtering involves processing of more images and imposes an even greater computational burden than traditional deblocking filters. APPLE-1003, ¶74; APPLE-1007, 6 (describing need to “keep the algorithmic complexity down”); APPLE-1012, 13 (describing importance implementing “an efficient [super-resolution] algorithm that reduces the computational cost”). YuChuan also explains that conventional iterative super-resolution processing methods can increase “the runtime of image reconstruction ... on the order of hours” depending on the capabilities of the computer system. APPLE-1055, [0014]-[0015], [0017], [0071]. Accordingly, a POSITA would have recognized that it would be beneficial to bypass SR-D filtering when super-resolution

processing is too costly and/or the improvement in coded picture quality and compression efficiency achieved by SR-D filtering are too small to justify the additional processing expense for a given frame or slice. APPLE-1003, ¶74.

A POSITA also would have known that super-resolution processing is often most effective to improve the quality of an image when “some relative scene motions ... exist from frame to frame.” APPLE-1012, 2; APPLE-1003, ¶75. But in the absence of motion, or if the lower-resolution images from which the super-resolution image is constructed are merely “shifted by integer [pixel] units,” then “no new information can be used to reconstruct” a super-resolution image and super-resolution processing will be less effective. APPLE-1012, 2; APPLE-1003, ¶75. YuChuan also teaches that super-resolution processing works effectively for “low-resolution image sequences associated with a moving object,” but can be less important for other content. APPLE-1055, [0070]-[0071] (“the object becomes more distinct” and “the edges of words are more discernible”), [0043].

Accordingly, when super-resolution processing does not improve the reference picture significantly, imposes an undue increase in computational load, and/or when the power consumption required for super-resolution processing is substantial, it would have been obvious to bypass SR-D filtering based on He’s teachings for selective in-loop filtering. APPLE-1003, ¶75. For example, consistent with He’s teaching to use an unfiltered reference picture when loop

filtering is disabled, it would have been obvious for the enhancement layer encoder 412 in the combination to use a decoded base layer-frame that has not been SR-D filtered as a reference picture for inter-layer prediction when conditions dictate that SR-D filtering is unnecessary or unwarranted. *Id.*; APPLE-1008, [0026] (“the unfiltered reconstructed frame information URF is passed as the reconstructed information RF” when loop filtering is disabled), FIG. 2.

The fact that selective loop filtering was standard in video coders before the '995 Patent, and that He specifically describes such techniques in a layered coding system like Phek's, underscores that a POSITA would have found the combination obvious, would have been motivated to make the combination, and would have reasonably expected success. APPLE-1003, ¶76. Indeed, integration of selective loop filtering in the Phek-YuChuan-He combination involves no more than the predictable application of a known technique (e.g., selective in-loop filtering) to a conventional system having an in-loop filter (e.g., Phek-YuChuan's hierarchical encoder) to achieve predictable results. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 417 (2007) (a supposed invention that “simply arranges old elements with each performing the same function it had been known to perform” is obvious). “It's enough... to show that there was a known problem... in the art, that [another known teaching] ... helped address that issue, and that combining the teachings of ... wasn't beyond the skill of an ordinary artisan. Nothing more is required to show

a motivation to combine under *KSR*.” *Intel Corp. v. PACT XPP Schweiz AG*, 61 F.4th 1373, 1380-81, (Fed. Cir. 2023). Moreover, a POSITA would have understood that He’s techniques are representative of a range of conventional solutions for selecting among different types of reference pictures to optimize coding efficiency and performance. APPLE-1003, ¶76; APPLE-1046, [0131], [0253], FIGs. 6, 12, 15 (describing additional known techniques for selecting among different reference pictures in a hierarchical/scalable coding system). Considering the advanced state of the art at the time before the Critical Date of the ’995 Patent, selectively applying SR-D filtering in the combination would have been an obvious and straightforward technique. APPLE-1003, ¶76.

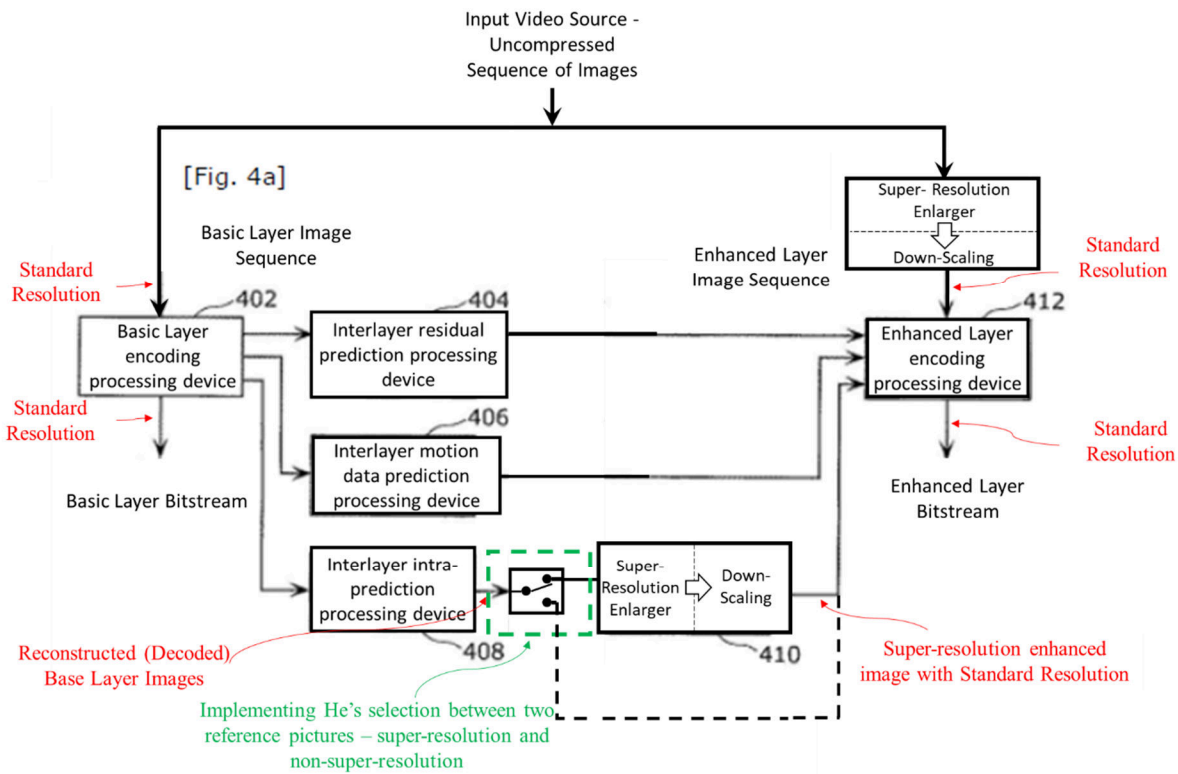


Illustration of Proposed Combination (Phek-YuChuan-He)

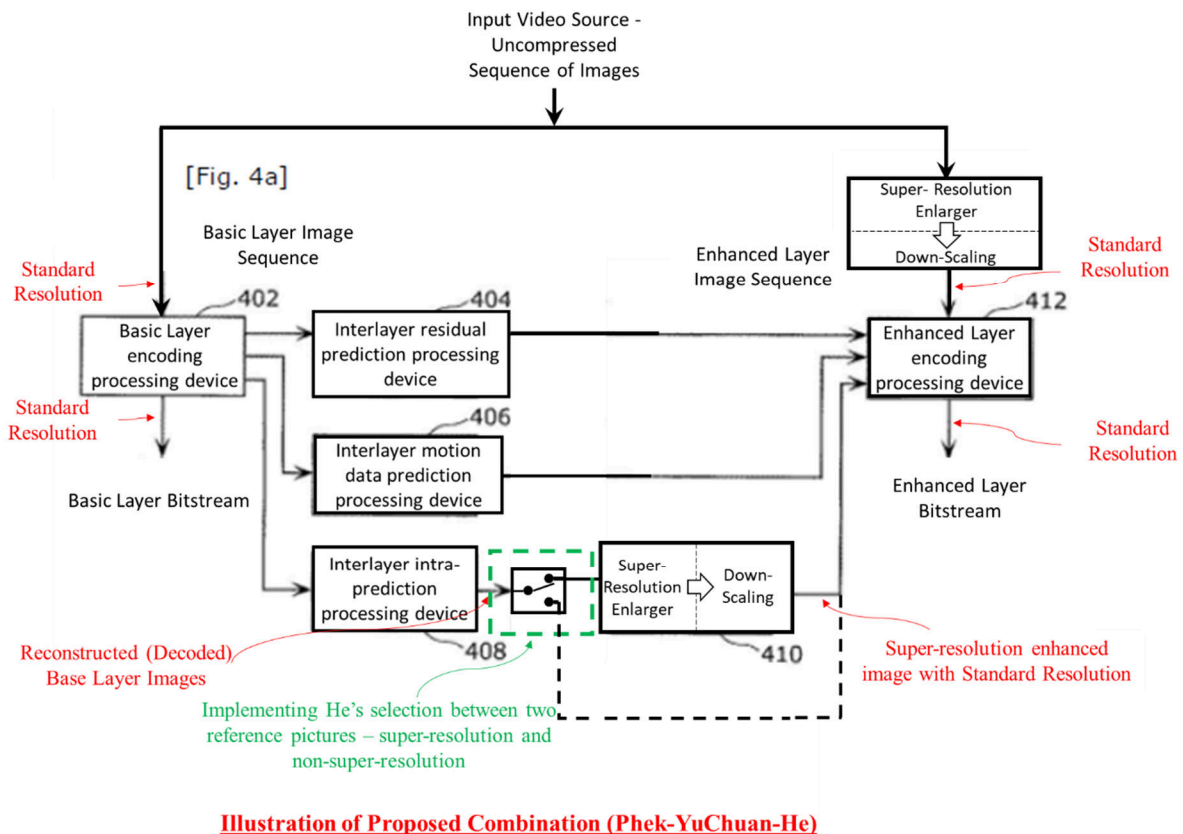
5. Analysis

(a) Claim 1

[1.P]

To the extent the preamble is limiting, the Phek-YuChuan-He combination renders obvious [1.P]. APPLE-1003, ¶¶77-86. For example, in FIG. 4a, Phek illustrates a hierarchical video coding system that encodes moving picture sequences at a base layer and an enhancement layer. APPLE-1005, [0002], [0014], FIG. 4a. Phek teaches super-resolution processing as “a technique for generating high-resolution images from a plurality of low-resolution images.” APPLE-1005, [0002].

Phek's hierarchical video coding system includes a basic layer encoder and an enhanced layer encoder, with "interlayer intra-prediction processing" using reconstructed standard-resolution images from the base layer as reference pictures for encoding the enhanced layer. APPLE-1005, [0014], FIG. 4A. The super-resolution processing device in Phek "improves these additional reference images" upscaled from the basic layer. APPLE-1005, [0014]. This upscaling is used to enhance reference frames for "motion detection, motion compensation prediction, and display." APPLE-1005, [0013]; *see also id.*, [0011]-[0015], FIGS. 3a-4b.



[1.1]

Phek-YuChuan-He renders obvious [1.1]. APPLE-1003, ¶¶77-86. For example, Phek's hierarchical encoding system includes a basic layer encoding processing device 402 that, alone or together with interlayer intra-prediction processing device 408, provides a "first encoder" that works on a subsequence of the basic layer image sequence ("a sequence of moving pictures with a standard resolution") to implement a combination of processes for an encoding and a decoding to create a first sequence of encoded bits and a set of decoded pictures with the standard resolution. APPLE-1005, [0014]. The "basic layer encoding processing device 402" operates on basic layer image sequence having low (standard) resolution images, performing encoding processes to create a basic layer bitstream. APPLE-1005, [0014] ("A basic layer image sequence is encoded using a basic layer encoding processing device 402."), [0002]. Phek teaches that "the intra image of the basic layer or a reconstructed image of the basic layer is used as an additional reference image for encoding the image of the enhanced layer." APPLE-1005, [0014].

The coding process implemented by Phek's basic layer encoder includes decoding steps to generate decoded or reconstructed images. APPLE-1005, [0014]. Phek explains that the encoder utilizes "reconstructed images" as a reference for interlayer prediction, confirming that the basic layer encoder implements both encoding and decoding processes to produce the images used as

references for interlayer prediction. APPLE-1005, [0014]. This reconstruction occurs as part of the encoder's standard operation, ensuring compatibility with inter-layer prediction mechanisms. APPLE-1005, [0014]. Phek describes the operation of encoding devices like the basic layer encoding processing device 402 with respect to FIG. 3A and explains that the encoding device implements a combination of processes for an encoding and a decoding to create a sequence of encoded bits and a set of decoded pictures of the same resolution. APPLE-1005, [0011] ("In the encoder, the image sequence is intra-coded or inter-coded" and "an encoded video bit stream is produced. The target frame is reconstructed using a local decoder ..., and the reconstructed target frame is stored as a reference frame for use by the motion detection processing device 302."), FIG. 3A. It also would have been obvious for the basic layer encoder to work on only a subsequence of the basic layer image sequence to encode and decode a portion of the basic layer image sequence.

A POSITA would have understood that Phek's basic layer encoder performs these dual functions to facilitate hierarchical encoding. The generation of decoded pictures at the input resolution is disclosed in Phek's framework, which uses reconstructed images for reference in the enhanced layer encoding process. APPLE-1005, [0014].

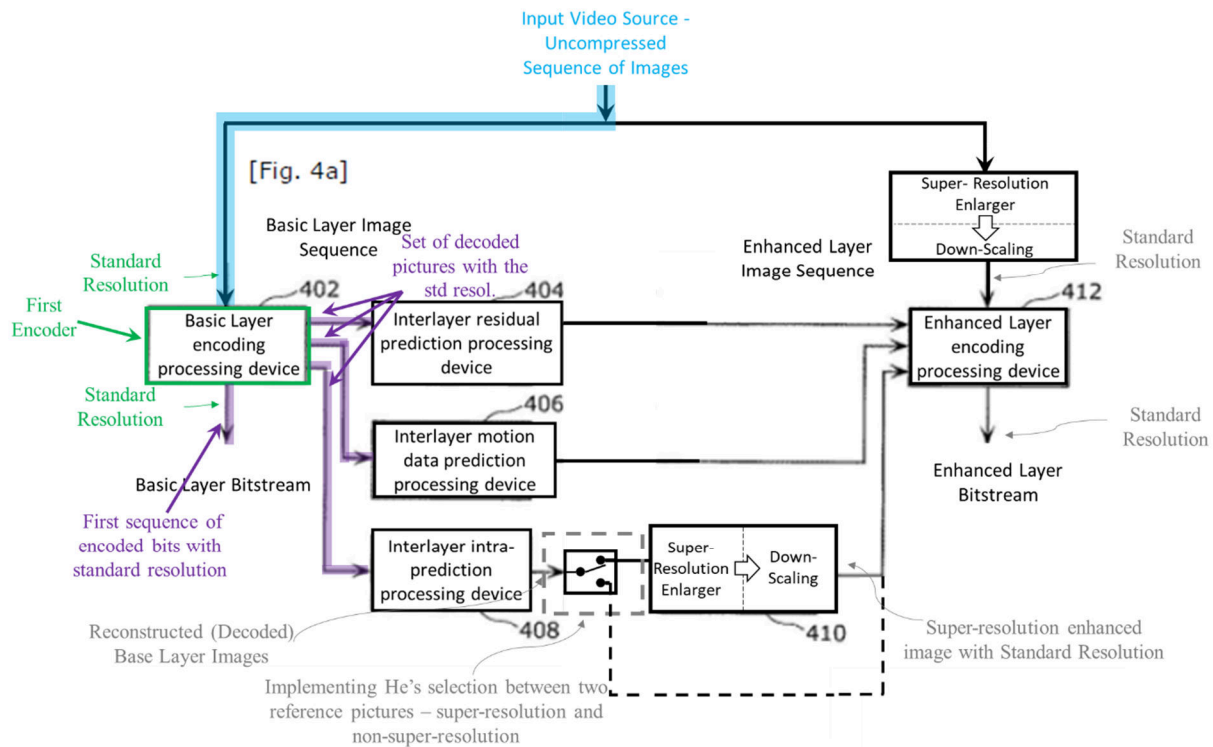


Illustration of Proposed Combination (Phek-YuChuan-He)

[1.2]

Phek-YuChuan-He renders obvious [1.2]. APPLE-1003, ¶¶77-86. For example, Phek explains that “[s]uper-resolution processing is a technique for generating high-resolution images from a plurality of low-resolution images.” APPLE-1005, [0002]. “Super-resolution processing methods include methods that involve image registration. In these methods, motion compensation is performed on observed low-resolution images to convert them into a common high-resolution grid known as a registered image. An initial estimated high-resolution frame is obtained using a spatial interpolation method such as bicubic interpolation. This estimated frame is improved by repeatedly subjecting it to blurring, frame

difference, point spreading inverse function, regularization, and refinement processing. A residual image is generated during the operation of finding frame differences. The registered image is thus subtracted from the blurred high-resolution estimated frame.” *Id.*, [0003]; *see also id.*, [0004]-[0009]. Phek further describes an improved super-resolution processing method with respect to FIGS. 1, 5, and 6. *Id.*, [0016]-[0020]. The effect of applying super-resolution processing to an image is to enhance the quality and spatial resolution of the image by incorporating into the image additional information about a scene depicted in other images in the moving pictural sequence. *Id.*, [0011], FIGS. 1, 5, 6a-6b.

In the combination, YuChuan also discloses super-resolution processing techniques that can optionally be used with or as an alternative to Phek’s super-resolution processing in some examples. *Supra*, §§III.A.2., III.A.4.(a)-(b); APPLE-1055, [0031]-[0044], FIGS. 1, 5, 6.

Phek’s hierarchical encoding system includes a super-resolution processing device 410 that operates on decoded pictures from the basic layer encoder to generate super-resolution enlarged decoded pictures with a resolution higher than the standard resolution. APPLE-1005, [0014], FIG. 4A. While Phek focuses on improving reference images for inter-layer prediction by super-resolution processing, Phek explains that super-resolution processing can also be applied for a variety of purposes including “to improve the resolution and quality of [] inputted

image sequences to be displayed” and of “images subject to transcoding and storage.” APPLE-1005, [0002]; *see also id.*, [0010]-[0011], [0014], FIGS. 2, 4A-B.

Phek’s hierarchical encoding system includes a basic layer encoding processing device 402 configured to encode a basic layer image sequence and an enhanced layer encoding processing device 412 configured to encode an enhanced layer image sequence. APPLE-1005, [0014], FIG. 4A. Based on Phek’s specific focus on enhancing images through super-resolution processing, and for the reasons discussed in further detail above (*supra* §III.A.4.(a)), it would have been obvious to a POSITA for the extended layer image sequence to be formed by applying super-resolution processing to the basic layer image sequence, thereby enhancing the quality and spatial resolution of the extended layer image sequence. APPLE-1005, [0014], FIG. 4A; *supra*, §III.A.4.(a). The encoding system would thus employ a super-resolution processing device, e.g., device 208, configured to work on a sequence of moving pictures from the basic layer image sequence with the standard resolution to implement a process for a first super-resolution enlargement to create a set of super-resolution enlarged pictures with a resolution higher than the standard resolution as part of the process for forming the extended layer image sequence. APPLE-1005, [0002]-[0003], [0016]-[0020], [0014], FIGS. 1-2, 4A, 5, 6A-6B; *supra*, §III.A.4.(a).

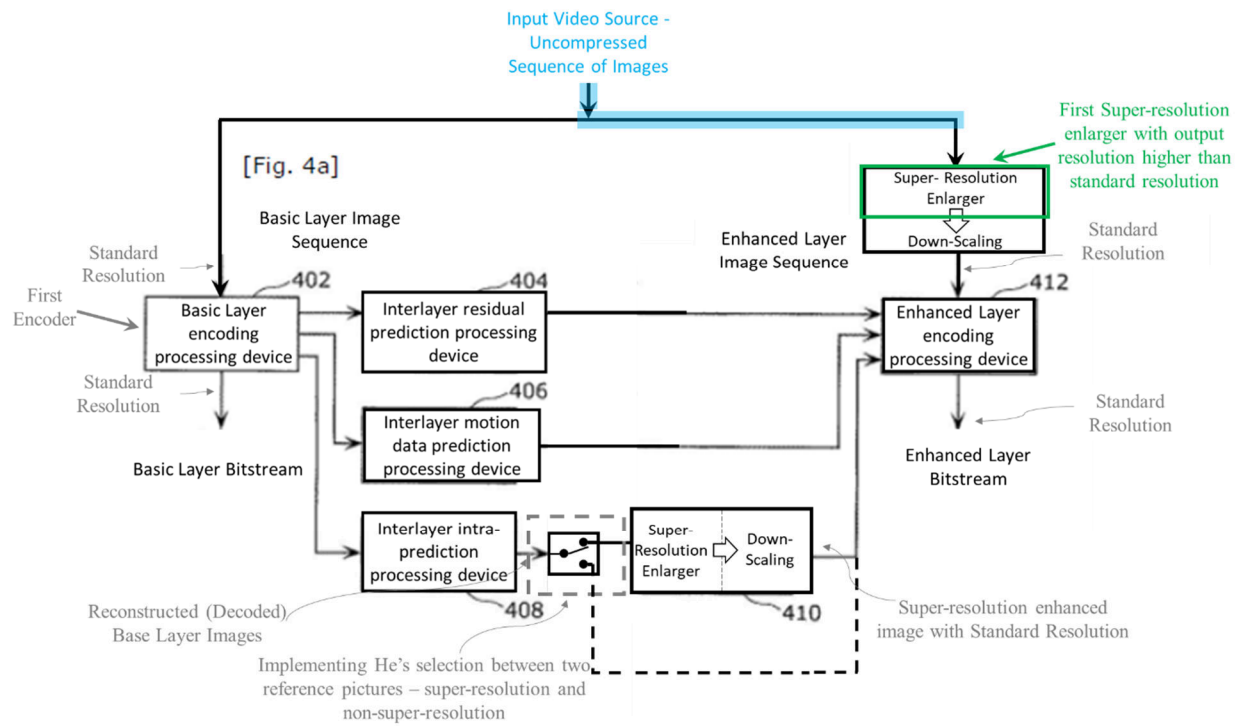


Illustration of Proposed Combination (Phek-YuChuan-He)

[1.3]

Phek-YuChuan-He renders obvious [1.3]. APPLE-1003, ¶¶77-86. For example, YuChuan explicitly discloses a process for adjusting the resolution of enhanced images to match a user-defined output, which a POSITA would have understood and found obvious to include standard resolution. APPLE-1055, [0031]; *supra*, §III.A.4.(b). The method “can converge the enhanced image by downsampling to the resolution output desired by the user.” *Id.*, *see also id.*, [0019] (“The interpolated prototype image is down-sampled N times according to the respective translations ...”), [0035] (“[S]tep S18 is performed to down-sample, according to the respective translation ..., the interpolated prototype image ...”),

[0039]-[0042], FIGS. 1, 5A-5D. YuChuan's down-sampling operation serves to reduce the size or spatial resolution of the interpolated prototype image (i.e., a super-resolution enlarged image). *Id.* YuChuan's method is performed according to user-defined magnification factor. APPLE-1055, [0014], [0019], [0031], FIG. 1. YuChuan's teachings thus provide a technical basis for implementing a resolution converter that processes super-resolution enlarged pictures to create standard-resolution images by down-sampling/downscaling/decimating the super-resolution enlarged pictures.

For each of the reasons described in detail above in the overview of the Phek-YuChuan-He combination, it would have been obvious to implement Phek's hierarchical encoding device in accordance with YuChuan's suggestion to down-sample enhanced (super-) resolution images such that the enhancement/extended layer input image sequence would be formed by super-resolution processing of images in the basic layer followed by down-conversion to the standard resolution of the basic layer images. *Supra*, §III.A.4.(b), III.A.2. This would have allowed Phek's hierarchical coder to implement well-known quality scalable coding techniques in which the enhanced layer encodes higher-quality images than the base layer, while maintaining the same spatial resolution at each layer. *Id.* The following figure illustrates an example use of a first resolution converter configured to work on the set of super-resolution enlarged pictures to implement a

process for a first resolution conversion to create a set of super-resolution enlarged and converted pictures with a standard resolution in the Phek-YuChuan-He combination:

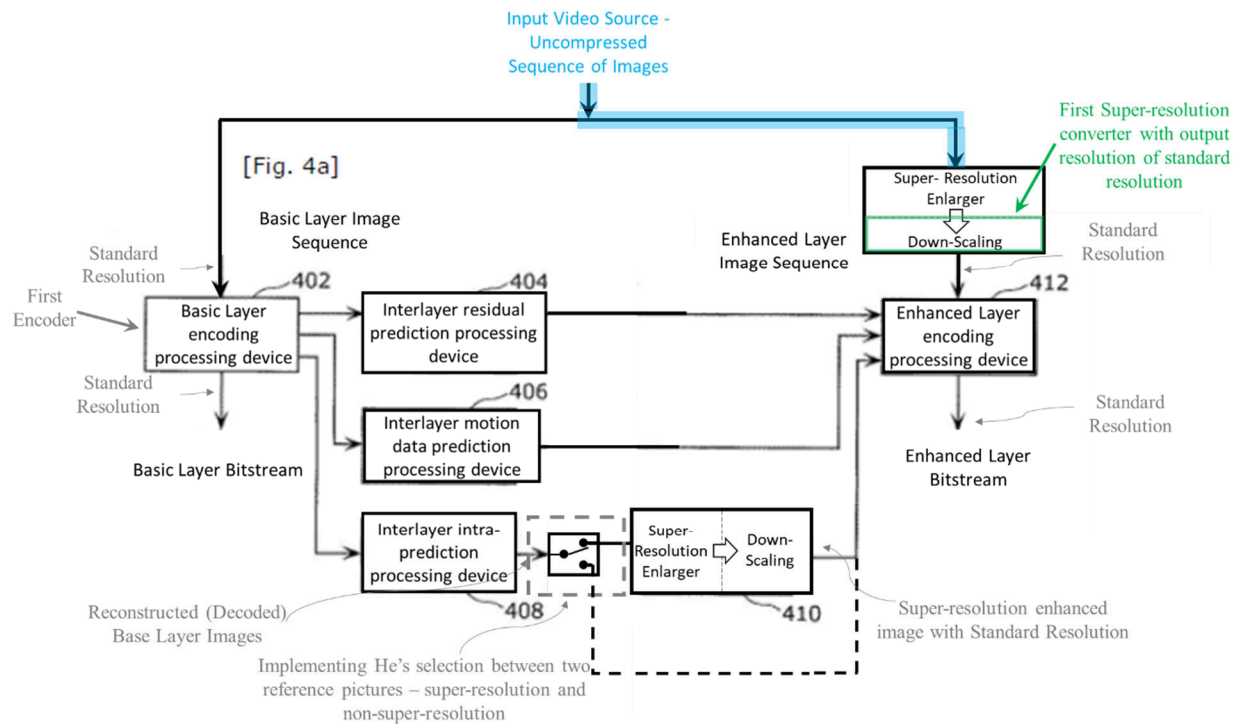


Illustration of Proposed Combination (Phek-YuChuan-He)

[1.4]

Phek-YuChuan-He renders obvious [1.4]. APPLE-1003, ¶¶77-86. As discussed above, Phek discloses that “[s]uper-resolution processing is a technique for generating high-resolution images from a plurality of low-resolution images.” APPLE-1005, [0002]. “Super-resolution processing methods include methods that involve image registration. In these methods, motion compensation is performed on observed low-resolution images to convert them into a common high-resolution

grid known as a registered image. An initial estimated high-resolution frame is obtained using a spatial interpolation method such as bicubic interpolation. This estimated frame is improved by repeatedly subjecting it to blurring, frame difference, point spreading inverse function, regularization, and refinement processing. A residual image is generated during the operation of finding frame differences. The registered image is thus subtracted from the blurred high-resolution estimated frame.” *Id.*, [0003]; *see also id.*, [0004]-[0009]. Phek further describes an improved super-resolution processing method with respect to FIGS. 1, 5, and 6. *Id.*, [0016]-[0020]. The effect of applying super-resolution processing to an image is to enhance the quality and spatial resolution of the image by incorporating into the image additional information about a scene depicted in other images in the moving pictorial sequence. *Id.*, [0011], FIGS. 1, 5, 6a-6b.

In the combination, YuChuan also discloses super-resolution processing techniques that can optionally be used with or as an alternative to Phek’s super-resolution processing in some examples. *Supra*, §§III.A.2., III.A.4.(a)-(b); APPLE-1055, [0031]-[0044], FIGS. 1, 5, 6.

Phek’s hierarchical encoding system includes a super-resolution processing device 410, i.e., a second super-resolution enlarger, that operates on decoded pictures from the basic layer encoder to implement an interpolation of pixels with a second enlargement to generate super-resolution enlarged decoded pictures with a

second resolution higher than the standard. APPLE-1005, [0014], FIG. 4A. For example, Phek explains that “[t]he interlayer intra-prediction processing device 408 uses an intra image of the basic layer or a reconstructed image of the basic layer as an additional reference image for encoding the image of the enhanced layer” and “[a] super-resolution processing device 410 is used to improve these additional reference images.” *Id.*, [0014]; *see also id.*, [0011] (“The present invention uses a super-resolution processing device 320 to improve the quality and resolution of reference frames used by the motion detection processing device 302 and motion compensation processing device 318.”), FIGS. 3A-3B, 4B. In the Phek-YuChuan-He combination, the super-resolution enlarged reference pictures are subsequently resolution converted down to the standard resolution to match the resolution of images in the enhanced layer. *Supra*, §III.A.4.(b); *infra*, [1.5].

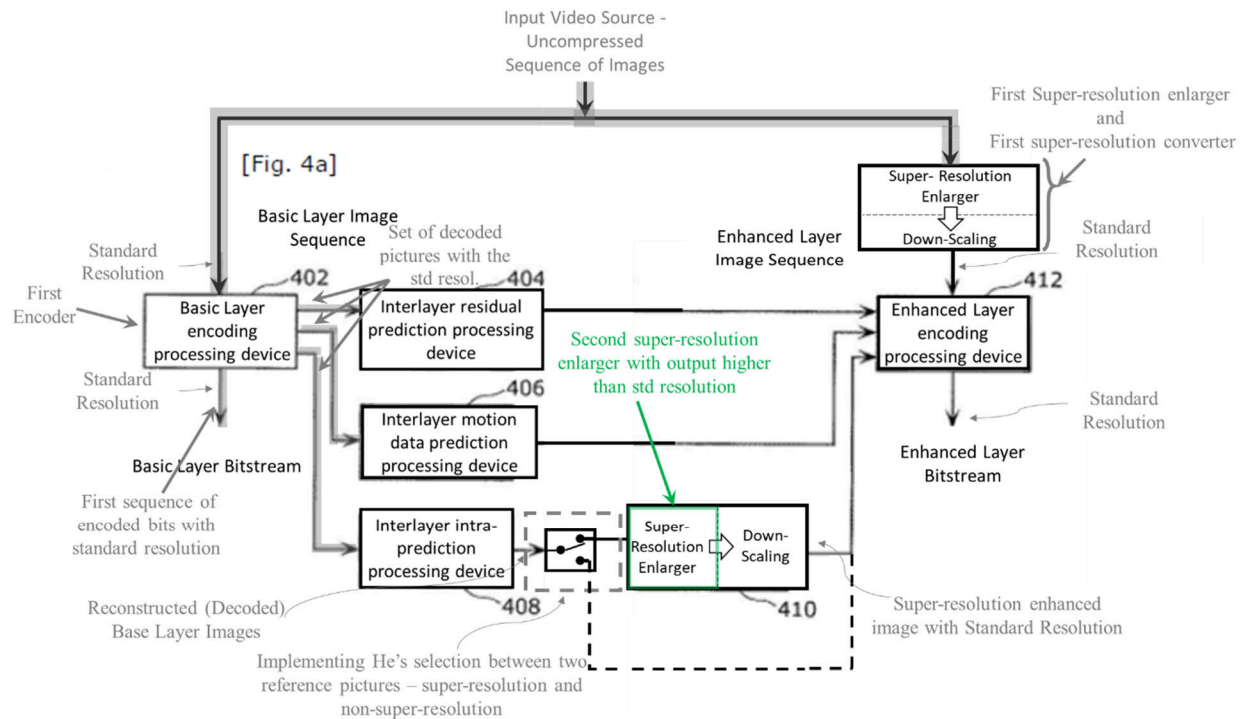


Illustration of Proposed Combination (Phek-YuChuan-He)

[1.5]

Phek-YuChuan-He renders obvious [1.5]. APPLE-1003, ¶¶77-86. For example, YuChuan explicitly discloses a process for adjusting the resolution of enhanced images to match a user-defined magnification factor, a POSITA would have understood and found obvious to include standard resolution. APPLE-1055, [0031]; *supra*, §III.A.4.(b). The method “can converge the enhanced image by downsampling to the resolution output desired by the user.” *Id.*, *see also id.*, [0019] (“The interpolated prototype image is down-sampled N times according to the respective translations ...”), [0035] (“[S]tep S18 is performed to down-sample, according to the respective translation ..., the interpolated prototype image ...”),

[0039]-[0042], FIGS. 1, 5A-5D. YuChuan's down-sampling operation serves to reduce the size or spatial resolution of the interpolated prototype image (i.e., a super-resolution enlarged image). *Id.* YuChuan's method is performed according to user-defined magnification factor. APPLE-1055, [0014], [0019], [0031], FIG. 1. YuChuan's teachings thus provide a technical basis for implementing a resolution converter that processes super-resolution enlarged pictures to create standard-resolution images by downscaling the super-resolution enlarged pictures.

For each of the reasons described in detail above in the overview of the Phek-YuChuan-He combination, it would have been obvious to implement Phek's hierarchical encoding device in accordance with YuChuan's suggestion to down-sample enhanced (super-) resolution images such that the enhanced layer input image sequence would be formed by super-resolution processing images in the basic layer followed by down-conversion to the standard resolution of the basic layer images. *Supra*, §III.A.4.(b), III.A.2. This would have allowed Phek's hierarchical coder to implement well-known quality scalable coding techniques in which the enhanced layer encodes higher-quality images than the base layer, while maintaining the same spatial resolution at each layer. *Id.* Likewise, it would have been obvious to include in Phek's hierarchical encoding system a resolution converter for downscaling the reference pictures produced by Phek's super-resolution processing device 410 to ensure the reference pictures matched the

resolution of images coded at the enhancement layer. *Supra*, §III.A.4.(b). The following figure illustrates an example use of a second resolution converter configured to work on the set of super-resolution enlarged decoded pictures to implement a process for a second resolution conversion to create a set of super-resolution enlarged and converted decoded pictures with a standard resolution in the Phek-YuChuan-He combination:

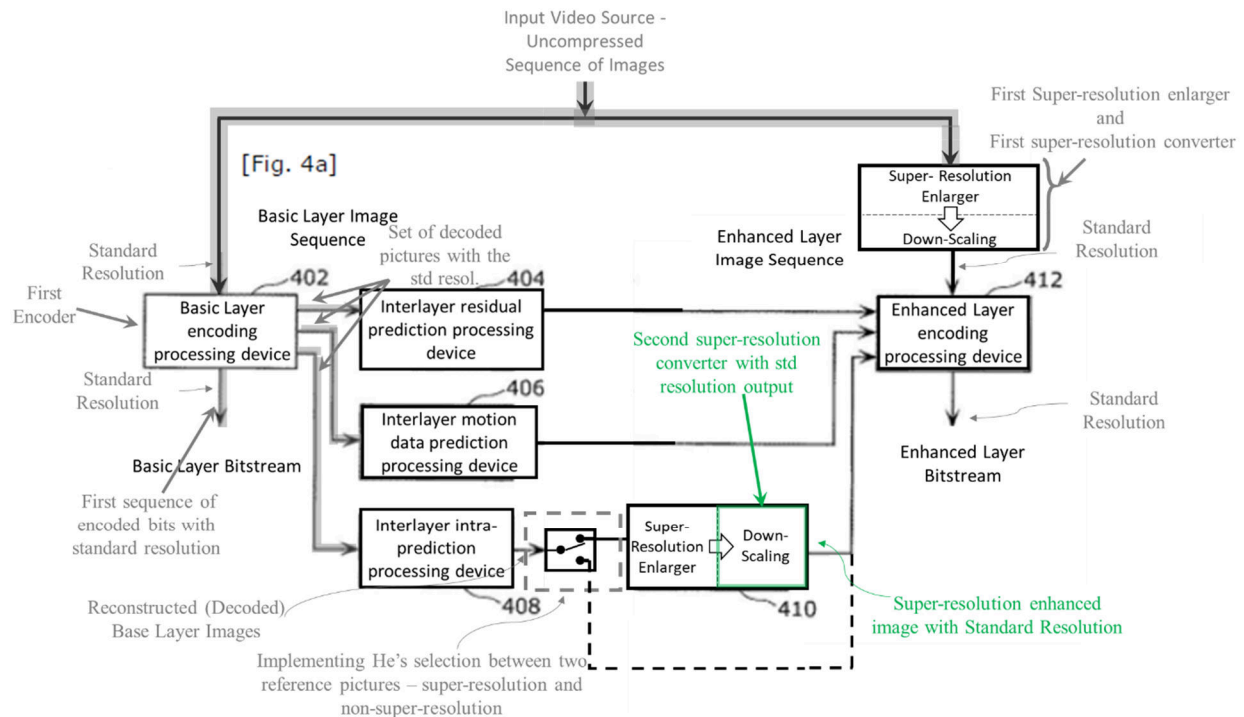


Illustration of Proposed Combination (Phek-YuChuan-He)

[1.6.i]

Phek-YuChuan-He renders obvious [1.6.i]. APPLE-1003, ¶¶77-86. For example, Phek’s hierarchical encoding system includes an enhanced layer encoding processing device 412 that corresponds to the claimed “second encoder.”

APPLE-1005, [0014]-[0015], FIG. 4a. In Phek's system, enhanced layer encoding processing device 412 obtains an enhanced layer image sequence as a set of encoding target pictures and uses a super-resolution enlarged version of a decoded base layer picture from super-resolution processing device 410 as a reference picture for predicting a target picture in the enhancement layer. APPLE-1005, [0014] ("An enhanced layer image sequence is encoded using an enhanced layer encoding processing device 412. The enhanced layer encoding processing device 412 uses interlayer prediction to reduce redundancy between the enhanced layer and the basic layer, thereby improving encoding efficiency compared to encoding performed using only an enhanced layer. ... The interlayer intra-prediction processing device 408 uses an intra image of the basic layer or a reconstructed image of the basic layer as an additional reference image for encoding the image of the enhanced layer. A super-resolution processing device 410 is used to improve these additional reference images."), FIG. 4A; *see also id.*, [0011], FIG. 3A. The enhanced layer encoding processing device 412 implements a combination of processes for a prediction and an encoding to create an enhanced layer bitstream (e.g., a third sequence of encoded bits). APPLE-1005, [0011], [0014], FIG. 4A.

As discussed above, it would have been obvious based on Phek and YuChuan to generate the enhanced layer image sequence that forms the set of encoding target pictures for the enhanced layer encoding processing device 412 by

super-resolution enlarging the base layer image sequence and then downscaling the super-resolution enlarged target pictures to the original, standard resolution of the base layer. *Supra*, §III.A.4.(a). In this case, the enhanced layer encoding processing device 412 (second encoder) would be configured to have the set of super-resolution enlarged and downscaled (converted) pictures from the first downscaler (first resolution converter) as the set of encoding target pictures. *Id.*

As further discussed above, it would have been obvious based on the teachings of He for the enhanced layer encoding processing device 412 (second encoder) to use a (i) set of super-resolution enlarged and converted decoded pictures obtained by downscaling the output of the super-resolution processing device 410 (second super-resolution enlarger) as one set of reference pictures and (ii) the set of decoded pictures from base layer encoding processing device 402 as an alternate set of reference pictures. *Supra*, §III.A.4.(c), III.A.3. For example, based on He's teachings, the enhanced layer encoding processing device 412 selects among these reference picture using Phek's inter-layer prediction mechanisms. APPLE-1008, [0002]-[0006], [0022], [0028], [0032]-[0037], FIGS. 1-4; APPLE-1005, [0014]. In the combination, Phek's enhanced layer encoder "utilizes interlayer prediction to reduce redundancy between the enhanced layer and the basic layer," employing both super-resolution and downscaled ("SR-D"

filtered) and non-SR-D filtered reference pictures as part of this process. APPLE-1005, [0014]; *supra*, §III.A.4.(c).

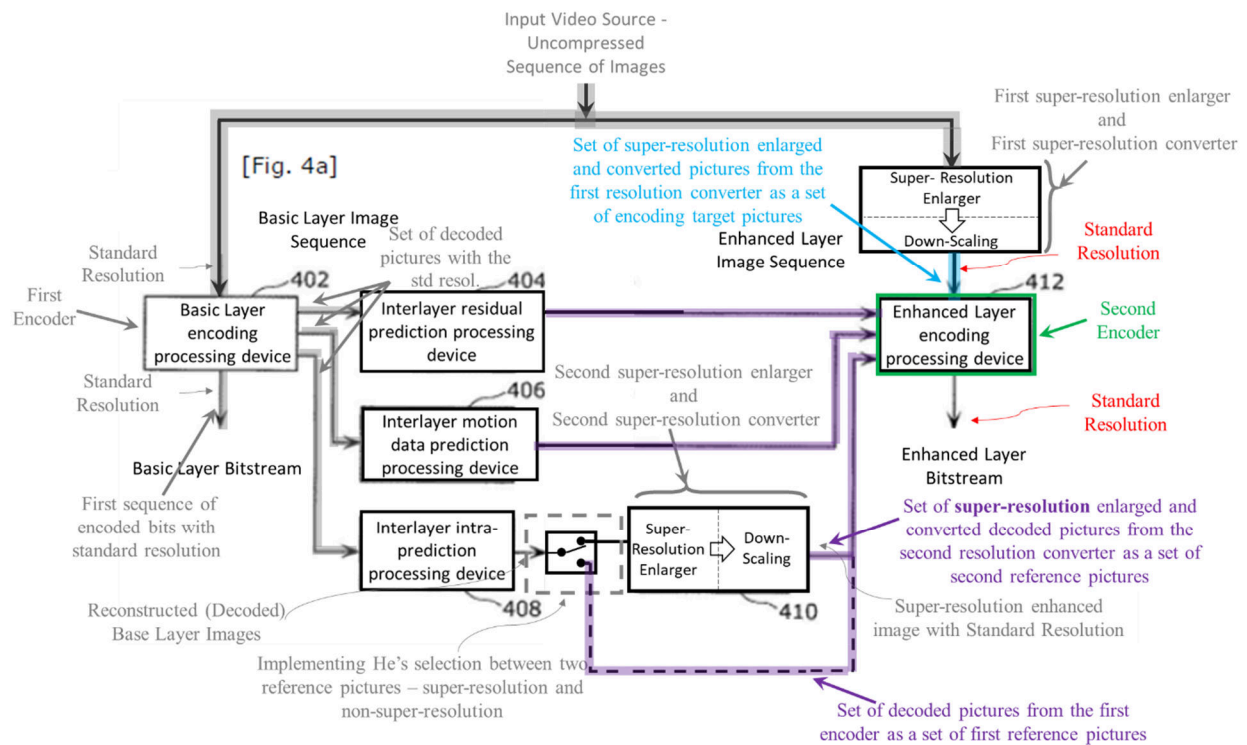


Illustration of Proposed Combination (Phek-YuChuan-He)

[1.6.ii]

Phek-YuChuan-He renders obvious [1.6.ii]. APPLE-1003, ¶¶77-86. As discussed above (*supra*, §III.A.5.[1.6]-[1.6.i]), in the combination, Phek’s enhanced layer encoding device 412 “utilizes interlayer prediction to reduce redundancy between the enhanced layer and the basic layer,” employing both super-resolution and downsampled (“SR-D” filtered) and non-SR-D filtered reference pictures as part of this process. APPLE-1005, [0014], FIG. 4a; *supra*, §III.A.4.(c). The enhancement layer encoding processing device 412 selects

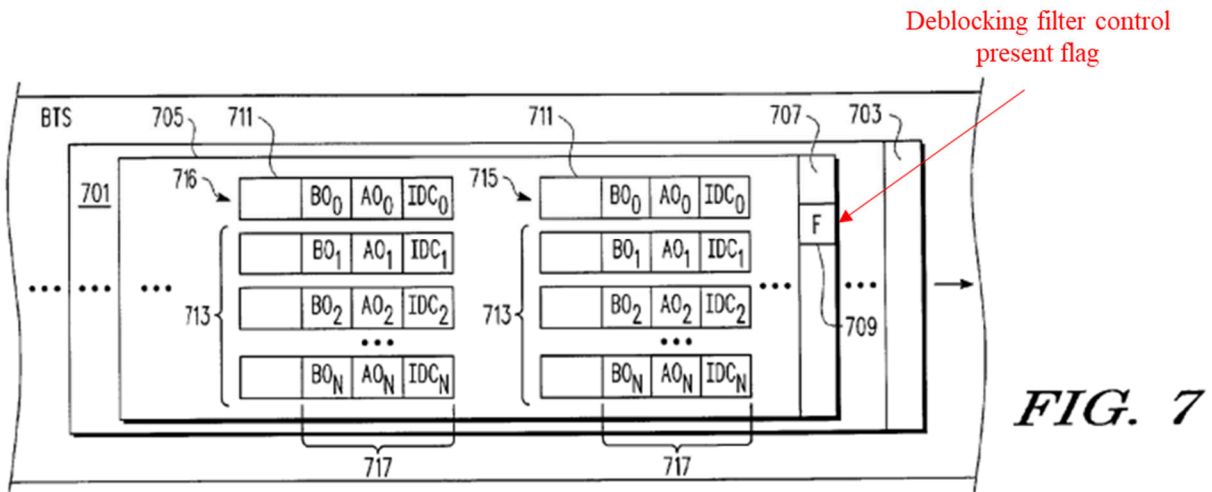
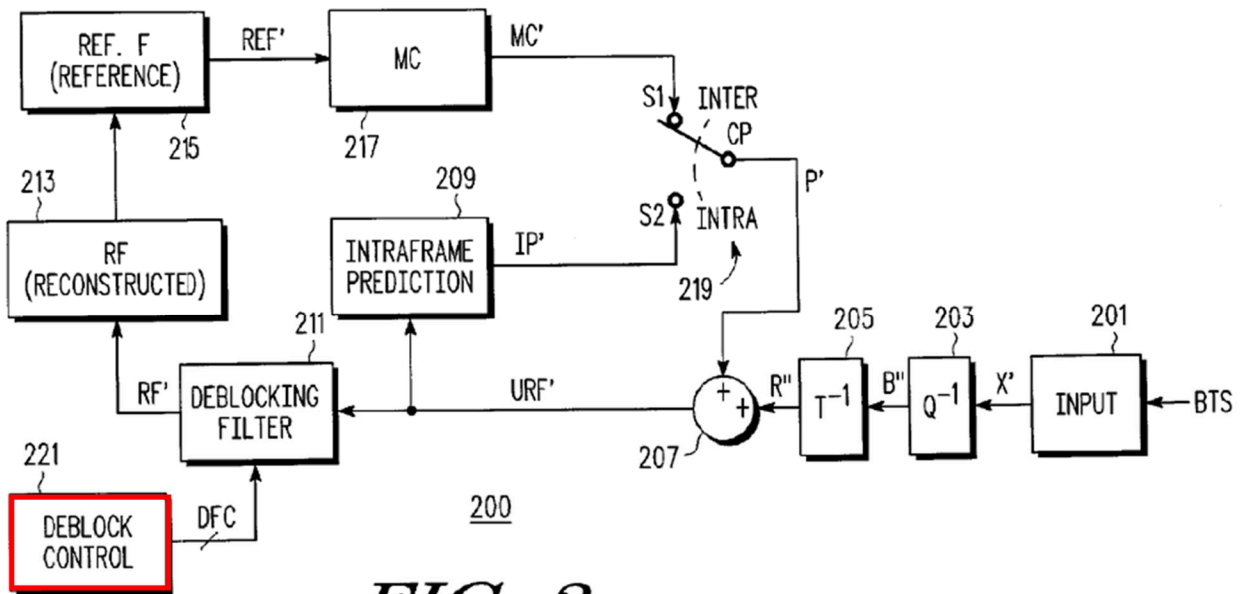
between SR-D filtered or non-SR-D filtered reference pictures based on content characteristics and other factors that balance the desire for improved reference picture quality and compression efficiency against the computational expense, power consumption, and additional processing time required to implement SR-D filtering. *Supra*, §III.A.4.(c).

For example, He describes how an in-loop filter such as a deblocking filter can “consume[] a significant amount of power and processing cycles” and “[g]enerally speaking, the entire [] filter ... consumes approximately 8% of the computations at the encoder and approximately 35% at the decoder for H.264/AVC.” APPLE-1008, [0006]. “Disabling the entire [] filter, therefore, provides a significant reduction of power and processing complexity, especially in the decoder.” *Id.* To maintain a “desired tradeoff between video quality and complexity reduction,” He provides control signals that allow an encoder to selectively enable or disable the loop filter. *Id.*, [0069].

A POSITA would have found it obvious and would have been motivated to apply He’s suggestion for selective in-loop filtering to the Phek-YuChuan-He combination to achieve benefits of the same nature as those expressly disclosed in He—including to reduce the power consumption, processing time, and computational complexity of coding frames in the enhancement layer. APPLE-1008, [0028], [0031], [0037], [0076], [0069]; *supra*, §III.4.(c). In the combination,

and based on He's teaching, the enhanced layer encoding processing device 412 can create reference picture selection information such as control flags in frame or slice header(s) to indicate whether an in-loop SR-D filter should be applied when decoding a given frame or slice in the first enhancement layer (i.e., to identify the selected set of reference pictures) *Id.*

For instance, in more detail, He discloses "a deblocking control flag of scalable video system for indicating presentation of deblocking parameters for multiple layers " in a bitstream. APPLE-1008, [0002]. He discloses that "[t]he deblocking parameters determine whether deblock filtering is enabled or disabled and additional deblocking settings when enabled. A deblocking enable/disable parameter is set to "0" to enable deblock filtering and to "1" to disable deblock filtering." APPLE-1008, [0007]. In FIG. 7, He illustrates "deblocking filter control information provided in an output bitstream BTS from the SVC video encoder 601 (e.g., OBTS), or provided in an input bitstream BTS (e.g., IBTS) to the video decoder 603... The bitstream BTS includes at least one video information sequence 701... The video information sequence 701 further includes one or more video frames including an exemplary video frame 705... The video frame 705, for example, includes a frame header 707 at the front of the video frame 705 which further includes a deblocking filter control present flag 709, labeled "F"." APPLE-1008, [0052], [0069] (reference selection flag).



APPLE-1008, FIGS. 2 and 7 (annotated); *see also id.*, FIG. 1.

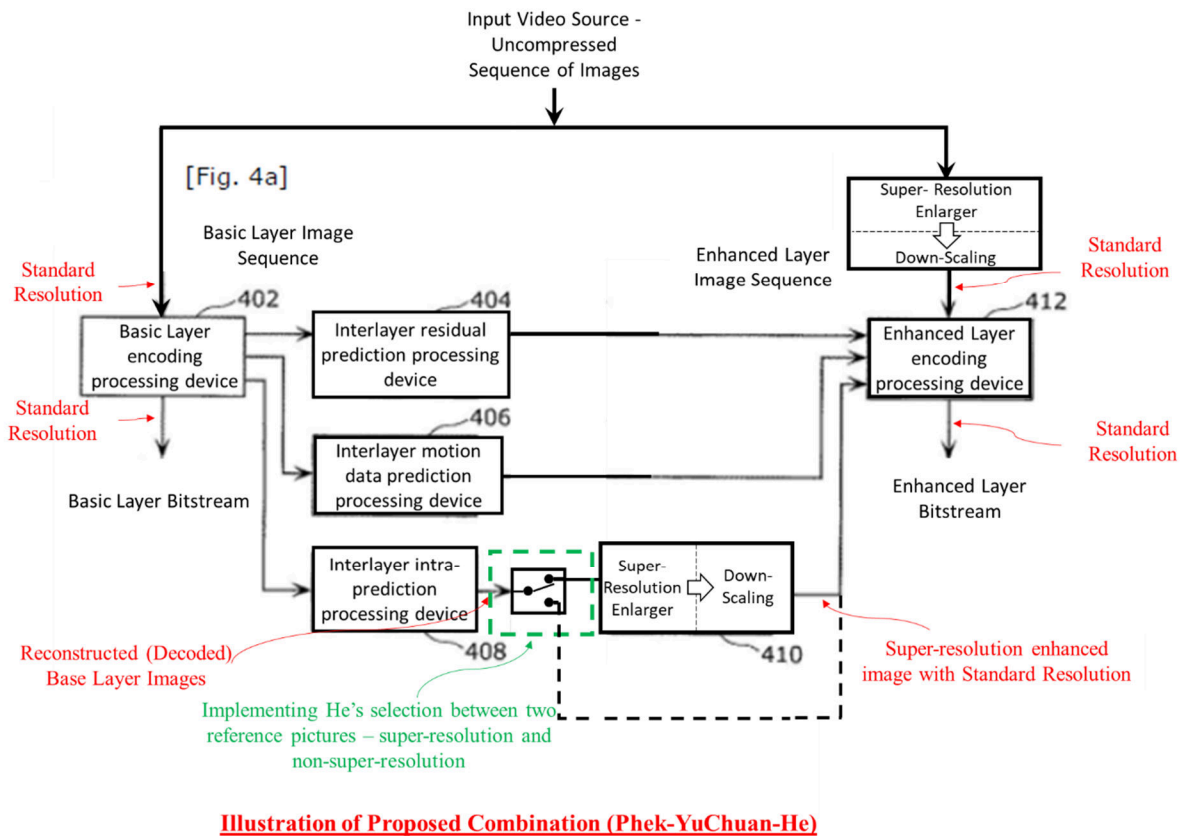
He discloses, in FIG. 2, a deblock control circuit 221, and similarly in FIG. 1, a deblock control circuit 135. APPLE-1008, FIGS. 1-2. Based on the value of the deblocking control flag, the deblock control circuit 221 issues control signals to a deblocking filter 131 to selectively enable/disable the use of a deblock filter on

reconstructed (decoded) frames. APPLE-1008, [0006]-[0008]. When the deblock filter is enabled, the filtered (enhanced) reconstructed frame is used as a reference picture for prediction of a subsequent frame. When the deblock filter is disabled, the original (unfiltered or non-enhanced) reconstructed frame is used as the reference picture for prediction of a subsequent frame. *Id.*, [0034]. Likewise, in the encoder, “[a] deblock control circuit 135 provides an encoder filter control (EFC) signal to deblocking filter 131” that controls whether the in-loop filter enabled or disabled. APPLE-1008, [0027]-[0028], FIG. 1.

He discloses that deblocking filter 211, like filter 131, is controlled by a decoder filter control (DFC) signal from deblock control circuit 221. When disabled, filtering is bypassed and unfiltered reconstructed frame information (URF’) is output as the filtered reference (RF’). APPLE-1008, [0027]-[0028], [0034]-[0037], FIGs. 1, 2, 7; *see supra* §III.A.4.(c), III.A.3.

Based on He’s teachings, a POSITA would have found it obvious to implement an analogous filter control circuit in the Phek-YuChuan-He combination to selectively enable/disable SR-D filtering of decoded base layer frames that are used for prediction of enhancement layer frames. The control circuit would selectively enable/disable the super-resolution enlarger and downscaler circuits, which form a loop filter analogous to He’s deblock filter. As discussed above, a POSITA would have been motivated to apply He’s control

mechanism to Phek's super-resolution loop to enable switching between reference picture sets based on channel conditions, power constraints, or content complexity. *Id.*; *see also*, APPLE-1005, [0013]-[0015], FIG. 4b; APPLE-1008, [0006], [0034]-[0037], FIG. 7; *supra*, §§III.A.3, III.A.4.(c). In the combination, Phek's enhanced layer encoding processing device 412 creates an enhanced layer bitstream (i.e., a second sequence of encoded bits) based on the set of encoding target pictures (i.e., the enhanced layer input images) and the set of selected reference pictures (i.e., SR-D enhanced or non-SR-D enhanced decoded base layer images). APPLE-1005, [0014]-[0015] ("enhanced layer bitstream"), FIGS. 4a-4b. The enhanced layer encoding processing device 412 also predictably implements a third process for encoding control information indicating whether to use SR-D filtered reference pictures or non-SR-D filtered reference pictures (i.e., reference picture selection information) to create a sequence of encoded bits indicating the selection, consistent with He's teachings. APPLE-1008, [0002], [0007], [0052], [0069], FIGS. 1, 2, 7 (describing process for encoding loop filter "control flag" as reference picture selection information in encoded bitstream).



Moreover, as discussed above, a POSITA would have understood that He's techniques are illustrative of a range of conventional solutions for selecting among different types of reference pictures to optimize coding efficiency and performance. APPLE-1046, [0131], [0253], FIGs. 6, 12, 15 (describing additional known techniques for selecting between different reference pictures in a hierarchical/scalable coding system). Considering the advanced state of the art at the time before the Critical Date of the '995 Patent, selectively applying SR-D filtering in the combination would have been an obvious and straightforward technique.

[1.7]

Phek-YuChuan-He renders obvious [1.7]. APPLE-1003, ¶¶77-86. Phek explains that its hierarchical coding device implements scalable video coding techniques. APPLE-1005, [0014], FIG. 4a. A common form of scalable coding techniques known before the '995 Patent was quality scalability (also referred to as fidelity or SNR scalability). As discussed above, it would have been obvious to implement quality scalability in Phek's system to efficiently encode both an enhanced-quality version and a base-quality version of the input video stream. *Supra*, §III.A.4.(b). A POSITA would have known that quality scalability allows base and enhancement layers to be coded at the same spatial (and temporal) resolutions. *See also* APPLE-1010, 1104 ("With quality scalability, the substream ***provides the same spatio-temporal resolution*** as the complete bit stream, but with a lower fidelity."); APPLE-1006, 1121 ("[T]he SVC extensions support ... quality scalability (fidelity enhancement for pictures ***of the same resolution***).").

Further, a POSITA would have understood and found it obvious to scale all reference pictures used by the enhancement layer coding device 412—including the non-SR-D enhanced reference pictures (***set of first reference pictures***) and the SR-D enhanced reference pictures (***set of second reference pictures***)—to the same spatial resolution as target pictures in the enhancement layer (i.e., the standard resolution). Indeed, it was the conventional practice long before the Critical Date

of the '995 Patent to scale reference pictures to the same resolution as the target pictures being coded so that the target pictures can be predicted using the reference pictures at their native resolution. *Supra*, §III.A.4.(b); APPLE-1006, §II (“the width and height of the scaled regions of lower resolution and higher resolution pictures must have the same scaling ratio”); APPLE-1026, 25:27-37 (“the resolution converter 205 converts the resolution of the base layer image signal to the resolution corresponding to the enhancement image signal”); APPLE-1046, [0128] (“a resolution conversion circuit 3 for subjecting regenerated data ... to resolution conversion in a way that its resolution becomes equal to that of the high-resolution image signal”); APPLE-1024, 9:30-35 (“the encoder sets the resolution for the reference frame (630) before setting the resolution for the current frame (620)”), 14:40-46 (“the one or more spatial resolution scaling factors are constrained to be identical to the one or more spatial resolution scaling factors for the reference”), FIG. 6; APPLE-1068, [0082]-[0088], FIGS. 6, 8, 10. Accordingly, the set of encoding target pictures, the set of first reference pictures, and the set of second reference pictures would all have the same value in spatial resolution in the Phek-YuChuan-He combination.

(b) Claim 6

[6]

Phek-YuChuan-He renders obvious [6]. APPLE-1003, ¶¶77-86. As an initial matter, Phek discloses multiplexing as a component of its hierarchical video coding system. For example, Phek describes a “video source that is separated from the other sources using an inverse multiplexer 202” to manage multiple data streams within its encoding architecture, and a POSITA would have understood that the use of an inverse multiplexer 202 implies that the video streams were previously multiplexed by a multiplexer according to a prescribed structure. APPLE-1005, [0010]. This multiplexing infrastructure enables coordinated processing of base and enhancement layer bitstreams, as Phek’s hierarchical encoder separately processes the base-layer bitstream and the enhancement-layer bitstream during decoding operations. APPLE-1005, [0014] (“A basic layer image sequence is encoded using a basic layer encoding processing device 402. An enhanced layer image sequence is encoded using an enhanced layer encoding processing device 412.”). Phek further specifies that the base layer and enhancement layer outputs are structured for systems-level integration, necessitating multiplexing to synchronize and transmit the hierarchically related streams. APPLE-1005, [0014], FIGS. 4a-4b.

The techniques disclosed in Phek are illustrative of the conventional practice of multiplexing bit streams in hierarchical coding systems before the Critical Date of the '995 Patent. A POSITA would have been familiar with this conventional practice and many prior art systems that implemented the same. *See, e.g.*, APPLE-1026, FIG. 1 (referring to multiplexer 206), 32:21-27 (“the bit streams generated by the enhancement layer encoder 203 and the base layer encoder 204, respectively, are input to the multiplexer 206 as shown in FIG. 1. The multiplexer 206 shown in FIG. 1 multiplexes the enhancement layer bit stream and the base layer bit stream into a single bit stream”); APPLE-1051, FIGs. 1 (referring to multiplexer 115), 4 (referring to multiplexer 425), [0080], [0084]; APPLE-1053, FIG. 5c, [0123]-[0125] (“[o]nly during the final iteration are the video bitstreams (5022, 5252) actually generated, multiplexed into the program stream 5262”); APPLE-1069, FIGs. 15 (referring to multiplexing unit 1560), 16 (referring to multiplex 1650), [0080] (“[t]he multiplexing unit 1560 multiplexes the spatio-temporal low-frequency and high-frequency images encoded by the temporal image scalable encoding unit 1530 and the spatial image scalable encoding unit 1540 and outputs a bitstream (operation 1650).”). The features recited in claim 6 merely reflect the conventional practice of multiplexing bit streams in a hierarchical coding system.

Further, a POSITA reviewing Phek ,and knowing the conventional practice of multiplexing encoded bit streams in hierarchical coding systems, would have found it obvious before the Critical Date to multiplex the encoded bitstreams of the Phek-YuChuan-He combination as recited in claim 6 to achieve known and predictable technical benefits. For example, multiplexing the encoded bit streams for the basic layer, enhanced layer, and information on encoding parameters for each of the basic and enhanced layers would improve utilization of channel bandwidth, reduce signaling overhead and optimize network resource utilization. APPLE-1005, [0010]. This approach would also facilitate synchronization of hierarchically related streams through timestamp coordination, maintaining temporal alignment between base and enhancement layers during decoding. APPLE-1006, §II.A. For example, by transmitting a multiplexed stream, a receiver would be capable of selectively decoding the base layer based on the base layer bitstream or the enhancement layer based on a combination of the base and enhancement layer bitstreams. Additionally, multiplexing enables error resilience by allowing selective prioritization or discarding of enhancement-layer data during transmission bottlenecks while preserving base-layer integrity. APPLE-1008, [0004]-[0009]. Finally, multiplexing supports backward compatibility with legacy decoders by structuring base-layer data for independent extraction and processing. APPLE-1006, §II, FIG. 1.

Multiplexing based on a prescribed syntax structure was likewise a well-established technique before the Critical Date of the '995 Patent, as demonstrated by extensive prior art disclosing standardized protocols for organizing and transmitting hierarchical video streams. *See* APPLE-1046 [0067]-[0070], [0132], [0143], [0147], [0148]-[0167] (“in multiplexing a plurality of separate data, each separate data is divided into packets corresponding to the prescribed amount of data before being multiplexed,” with systematic requirements that “the ratio of the data amounts of the respective separate data is made agree with the ratio of the lengths or numbers of the packets corresponding to the respective separate data”), FIGS. 1, 2A-2B, 3A-3B; APPLE-1053, [0013]-[0015], [0113]-[0114], [0275]-[0279], FIGS. 8A-8B; APPLE-1018, [0039]-[0041], [0046]-[0050], FIGS. 1, 2A-2B; APPLE-1051, [0005], [0080], [0084], [0150]-[0151], FIGS. 1, 4, 19; APPLE-1065, [0010], [0025], FIG. 1. These conventional multiplexing practices – encompassing both prescribed syntax structures for packet organization and systematic inclusion of encoding parameter information – were standard in hierarchical coding systems before the Critical Date, making the claimed combination obvious to implement with reasonable expectation of success. Indeed, a POSITA would have sought to implement conventional multiplexing according to a prescribed syntax structure as recited in claim 6 to enable the receiver to properly de-multiplex the encoded sequences/bits using the prescribed

syntax structure, thereby ensuring that the different sequences/bits could be parsed and decoded as desired. A POSITA would have reasonably expected success implementing these features in the combination since multiplexing according to a prescribed syntax structure was an established practice before the '995 Patent.

(c) Claim 10

[10]

Phek-YuChuan-He renders obvious [10]. APPLE-1003, ¶¶77-86. The additional features recited in [10] simply reflect the common practice of applying different coding modes and techniques to different portions (e.g., blocks) of a picture in a video stream (e.g., rather than uniformly encoding the entire picture as a whole). *See also* APPLE-1030, 8 (“Whereas the basic coding unit for spatial redundancy reduction in MPEG is based on an 8 x 8 block, motion-compensation is usually based on a 16 pixel by 16 line macroblock. The size of the macroblock is a trade-off between the need to minimize the bit-rate required to transmit the motion representation (known as motion vectors) to the decoder, which supports the case for a large macroblock size, and the need to vary the prediction process locally within the picture content and movement, which supports the case for a small macroblock size.”); *supra*, §II.A. Phek itself teaches that enhancement layer pictures can be coded by macroblocks. APPLE-1005, [0014] (“motion data

include the partition size and type used of each macroblock, as well as the prediction direction and motion vector”).

He likewise discloses that “[e]ach video frame is subdivided” into 16x16 macroblock (MB). APPLE-1008, [0004], [0034], [0086]. “The video decoder 200 generally processes information one macroblock at a time.” *Id.*, [0034]. He further teaches that separate loop filter (e.g., deblocking filter) controls can be applied to each “slice” in a coded video stream, where “each slice incorporates one or more macroblocks.” *Id.*, [0053]-[0054]. For instance, the loop filter can be selectively enabled or disabled for each slice. *Id.*

It would have been obvious to apply He’s teachings regarding slice-level or other region-based selective loop filtering in the Phek-YuChuan-He combination so that the enhancement layer processing device (second encoder) would divide an encoding target picture in the enhancement layer video stream into a plurality of regions (e.g., slices) and select whether to use an SR-D filtered version or a non-SR-D filtered version of a reference picture for prediction of each divided region. A POSITA would have sought to implement these techniques in the combination to reduce the size of the coding unit and allow for greater flexibility in the prediction processes applied to code different regions of the target picture, which would allow for greater compression and improved prediction quality for individual regions. *Id.*; APPLE-1030, 8. A POSITA would have reasonably

expected success given that region-based coding was commonly implemented in video coding systems before the Critical Date and He itself specifically taught known techniques for selective loop filtering on a region-by-region basis.

(d) Claim 8

[8.P]

Supra §III.A.6.[1.P]. APPLE-1003, ¶¶77-86.

[8.1]

Supra §III.A.6.[1.1]. APPLE-1003, ¶¶77-86.

[8.2]

Supra §III.A.6.[1.2]. APPLE-1003, ¶¶77-86.

[8.3]

Supra §III.A.6.[1.3]. APPLE-1003, ¶¶77-86.

[8.4]

Supra §III.A.6.[1.4]. APPLE-1003, ¶¶77-86.

[8.5]

Supra §III.A.6.[1.5]. APPLE-1003, ¶¶77-86.

[8.6]

Supra §III.A.6.[1.6]. APPLE-1003, ¶¶77-86.

[8.6.i]

Supra §III.A.6.[1.6.i]. APPLE-1003, ¶¶77-86.

[8.6.ii]

Supra §III.A.6.[1.6.ii]. APPLE-1003, ¶¶77-86.

[8.7]

Supra §III.A.6.[1.7]. APPLE-1003, ¶¶77-86.

(e) Claim 9

[9.P]

Supra §III.A.6.[1.P]. APPLE-1003, ¶¶77-86.

[9.1]

Supra §III.A.6.[1.1]. APPLE-1003, ¶¶77-86.

[9.2]

Supra §III.A.6.[1.2]. APPLE-1003, ¶¶77-86.

[9.3]

Supra §III.A.6.[1.3]. APPLE-1003, ¶¶77-86.

[9.4]

Supra §III.A.6.[1.4]. APPLE-1003, ¶¶77-86.

[9.5]

Supra §III.A.6.[1.5]. APPLE-1003, ¶¶77-86.

[9.6]

Supra §III.A.6.[1.6]. APPLE-1003, ¶¶77-86.

[9.6.i]

Supra §III.A.6.[1.6.i]. APPLE-1003, ¶¶77-86.

[9.6.ii]

Supra §III.A.6.[1.6.ii]. APPLE-1003, ¶¶77-86.

[9.7]

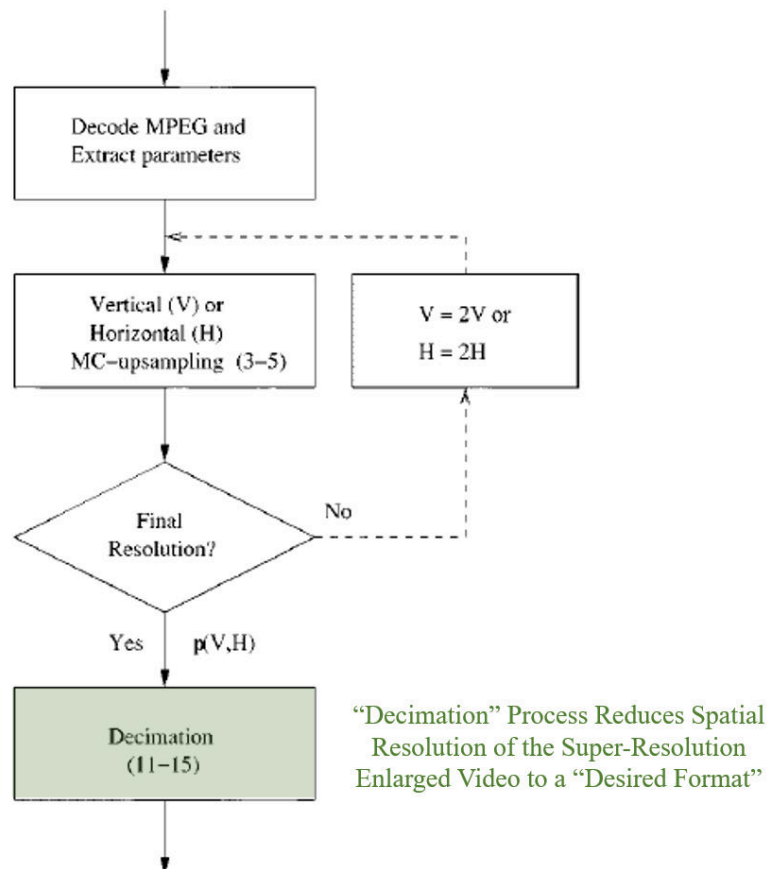
Supra §III.A.6.[1.7]. APPLE-1003, ¶¶77-86.

**B. [GROUND 1B] – Phek in view of YuChuan, He, and
Martins Renders Claims 1, 5-6, and 8-10 Obvious**

1. Martins Overview

Martins is an IEEE paper titled “A Unified Approach to Restoration, Deinterlacing and Resolution Enhancement in Decoding MPEG-2 Video.” APPLE-1007, 1. Martins discloses an algorithm by which “[t]he quality and spatial resolution of video can be improved by combining multiple pictures to form a single super-resolution picture.” *Id.*, Abstract. “The superresolution pictures obtained by the algorithm are of much higher visual quality and have lower [mean-squared error] than superresolution pictures obtained by simple spatial interpolation.” *Id.* “The algorithm is based on motion-compensated spatial upsampling from multiple images and decimation to the desired format.” *Id.*; APPLE-1003, ¶87.

FIG. 2 illustrates Martins' process, which involves first up-sampling lower-resolution images to obtain super-resolution images before downscaling the images to a lower spatial resolution according to a desired format, which can be the same resolution as the original lower-resolution images. APPLE-1007, p. 2 ("The algorithm has two steps. In the first step, a superresolution version ... of each directly decoded picture is constructed. In the second step, the super-resolution picture is decimated to the desired format.").



APPLE-1007, FIG. 2 (annotated); *see also id.*, p. 5, §IV ("DECIMATION");
APPLE-1003, ¶88.

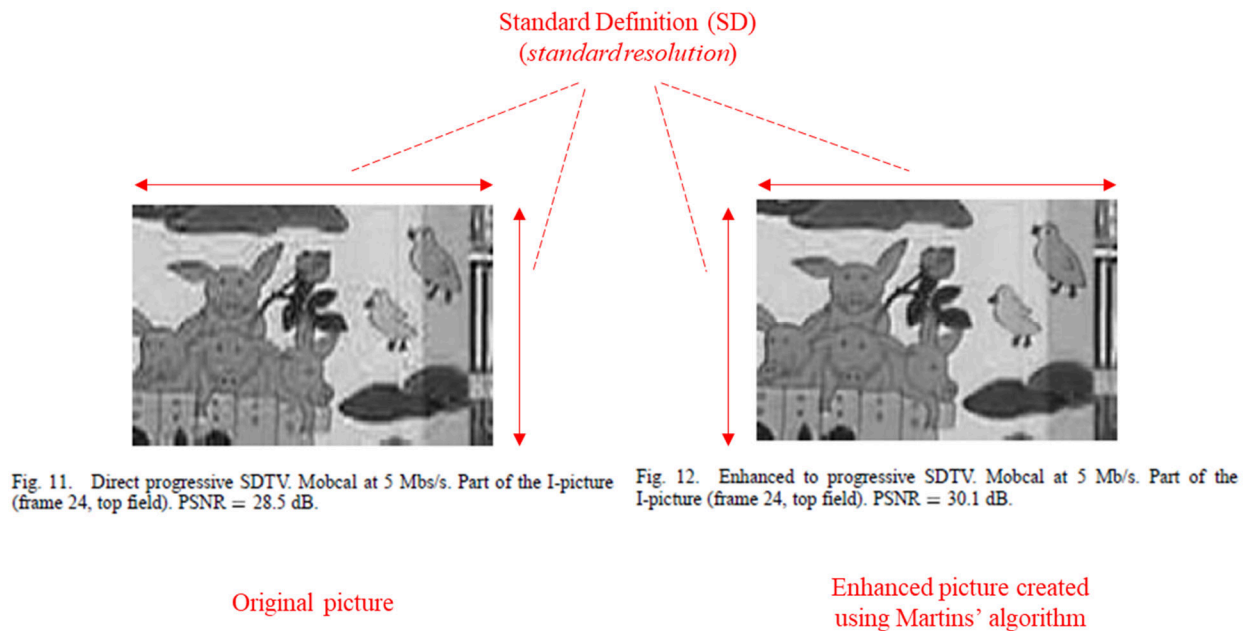
2. Analysis

(a) Claims 1, 6, 8-10

As discussed above in Ground 1A, YuChuan discloses techniques for downscaling super-resolution enlarged images using a resolution conversion process. *Supra*, §III.A.2, Ground 1A at [1.3], [1.5]. To the extent YuChuan does not expressly disclose resolution conversion to a desired format including the standard resolution, these features were nonetheless known and obvious before the Critical Date as confirmed by Martins. APPLE-1003, ¶89. Recall that Martins discloses a method for applying super-resolution enlargement to images in a video stream and thereafter decimating the super-resolution enlarged images to a desired format, including the original resolution of the images before super-resolution enlargement. APPLE-1007, p. 2 (“The algorithm has two steps. In the first step, a superresolution version ... of each directly decoded picture is constructed. In the second step, the super-resolution picture is decimated to the desired format.”), p. 1 (“obtain a sequence of higher fidelity ... in the same format as the directly decoded one”), FIG. 2 (annotated); *see also id.*, p. 5, §IV (“DECIMATION”).

Through FIGs. 11-12, Martins illustrates results of their super-resolution and decimation enhancement techniques. APPLE-1007, 8-9. In FIG. 11, Martins illustrates “the result of using simple upsampling of a directly decoded sequence.” *Id.*, 8-9. FIG. 12, by contrast, shows “the results of our enhancement to

progressive SDTV ... images[]” *Id.*, 8-9. Thus, Martins’ decimation preserves enhanced spatial detail from super-resolution processing while restoring the image to its original input resolution. *Id.*; *see also, id.*, 1-2, 5, 8-9, FIGs. 1-2; APPLE-1003, ¶89 (citing APPLE-1078, ¶¶218-221).



APPLE-1007, FIGs. 11 and 12 (annotated) (FIG. 12 illustrates improved PSNR and visual quality over simple upsampling (FIG. 11), proving decimation retains super-resolution gains); *id.*, 8-9.

A POSITA would have found it obvious to apply Martins’ suggestion for performing super-resolution enlargement followed by downscaling to a desired format including the same/standard resolution in the combination with Phek, YuChuan, and He to achieve known and predicable benefits from Martins’ approach. Specifically, Martins’ technique would have improved SR-D filtering of

both the base layer video input stream and the decoded base layer images used as reference pictures for interlayer prediction in the combination for multiple reason.

Id.

First, for example, it would have been obvious to apply SR-D filtering as taught in Martins to obtain enhanced video images at the standard resolution but at higher quality than the base layer images. *Supra*, §III.A.4.(a)-(b). A POSITA would have recognized that obtaining higher-quality images for the enhancement layer through SR-D filtering would have been beneficial to facilitate quality scalable coding in Phek's hierarchical coding device, which was a known and desirable form of scalable coding before the Critical Date. *Supra*, III.4.(a)-(b) (describing additional benefits of quality scalability).

Second, it would have been obvious to apply SR-D filtering as taught in Martins because Martins specifically explains that its approach beneficially allows super-resolution enlarged images to be downsampled without materially degrading the signal-to-noise ratio of the enhanced images. APPLE-1007, p. 2 ("We do not want to trade resolution for improved peak signal-to-noise ratio (PSNR) by spatial filtering at this stage so the noise reducing filtering is deferred to the decimation step.").

Third, a POSITA would have understood the combination to be obvious for the reasons that downscaling would have been obvious as described above in

Ground 1A (*supra*, §III.A.4(b)) and because it merely involves a predictable application of a known technique (e.g., SR-D filtering as taught in Martins) to a conventional system (e.g., Phek-YuChuan-He's hierarchical encoder) to achieve predictable results. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 417 (2007) (a supposed invention that "simply arranges old elements with each performing the same function it had been known to perform" is obvious). The selection of a Martins' super-resolution processing technique also would have amounted to no more than an obvious design choice, especially considering the range of prior art techniques that the '995 Patent acknowledged to be suitable before the Critical Date. APPLE-1001, 22:38-23:32.

The resulting Phek-YuChuan-He-Martins combination includes the same processing blocks as the Phek-YuChuan-He combination described above in Ground 1A and would have rendered Claims 1, 6, and 8-10 obvious for the same reasons described above in Ground 1A. *Supra*, §III.A.4-5. In the combination, super-resolution processing would predictably be performed according to any of Phek's, YuChuan's, or Martins' super-resolution processing techniques, and the downscaling of the resolution converters would be performed further based on Martins' teachings.

(b) Claim 5

Claim 5 recites merely conventional super-resolution enlargement

techniques that were well known in the art before the Critical Date. APPLE-1003, ¶89. Indeed, the '995 Patent expressly acknowledges that the disclosed systems use known processes for super-resolution enlargement, and the specification cites several prior art papers to that effect. *See* APPLE-1001, 22:38-23:25 (explaining that “the process for the prescribed super-resolution enlargement may for instance be an application of any such super-resolution process as described” in the cited prior art papers including Park (APPLE-1012)); *see also id.*, 23:25-32. The specification also confirms that the super-resolution enlargement operations described in FIG. 4 and recited in claim 5 represent merely “an example of basic configuration of a process for super-resolution enlargement in the present embodiment according to the present invention.” *Id.*, 23:22-25. Patent Owner’s admitted prior art and the similar techniques disclosed in Martins render the additional features recited in claim 5 obvious.

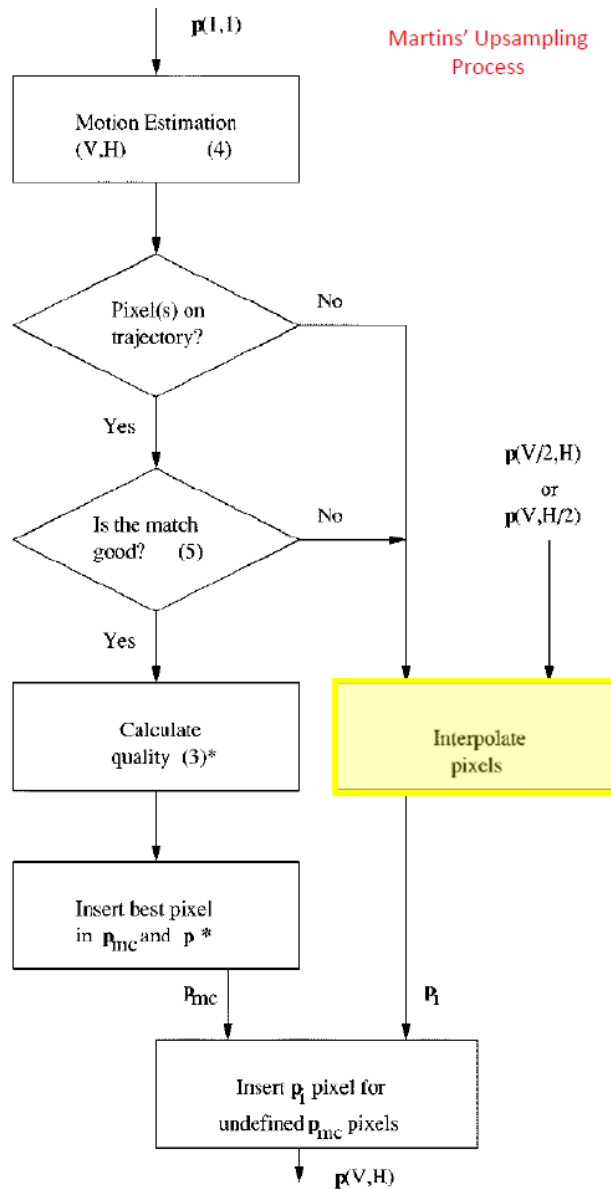
[5.1]

Martins “align[s] pixels of the current picture frame at time t with pixels of one of the reference pictures using motion estimation,” and “combine[s] the information from all the references pictures to form a single superresolution picture at t ” (“*positioner configured to work...on a combination of a base picture...and one or more observation pictures...to make a position to pixel positions of a desirable high resolution*”). APPLE-1007, 4; APPLE-1003, ¶89. The resulting

superresolution picture of Martins is an “MC [motion-compensated] upsampled high-resolution image” (“*nonhomogenous high resolution pictures*”). *Id.* Martins forms the superresolution picture “by mapping pixels from each of the references pictures” using a “block-based motion-compensation scheme” accounting for pixels at varying quality. *Id.*, 4-5. A POSITA would have understood that the aspect of Martins’ superresolution enlarger that performs these operations corresponds to a “positioner” that provides the claimed functionality.

[5.2]

Martins uses “spatial interpolation” to “[c]omplete the [s]uperresolution [p]icture” by “alternat[ing] between horizontal and vertical 2:1 upsampling.” APPLE-1007, 6, FIG. 3. A POSITA would have understood that the aspect of Martins’ superresolution enlarger that performs these operations corresponds to an “interpolator” that provides the claimed functionality. APPLE-1003, ¶89.



APPLE-1007, FIG. 3 (annotated)

[5.3]

Following the process described in [5.2], Martins outputs a resulting superresolution picture at a particular high resolution. APPLE-1007, 6; APPLE-1003, ¶¶87-89. Each pixel of the resulting superresolution picture has an “attribute” showing “whether it was determined by motion compensation” or

“interpolation.” APPLE-1007, 6. A POSITA would have understood that the aspect of Martins’ superresolution enlarger that performs these operations corresponds to an “estimated picture creator” that provides the claimed functionality. APPLE-1003, ¶89.

[5.4]

Martins’ upsampling algorithm determines whether the resulting superresolution picture requires further repetitions to reach the prescribed “Final Resolution,” including for both a high resolution picture upsampled using motion compensation (“*a nonhomogenous high resolution picture from the positioner*”) and a high resolution picture upsampled using interpolation (“*a nonhomogenous estimated picture from the estimated picture creator*”). APPLE-1007, 4, Fig. 2; APPLE-1003, ¶339. If the “Final Resolution” has not been met, Martins’ upsampling process repeats until the desired resolution is achieved. APPLE-1007, 4, Fig. 2. Otherwise, repetition is unnecessary. APPLE-1007, 4, Fig. 2. A POSITA would have found it obvious that Martins’ super-resolution enlarger included a “repetition determiner” for performing this functionality. APPLE-1003, ¶339; APPLE-1003, ¶89.

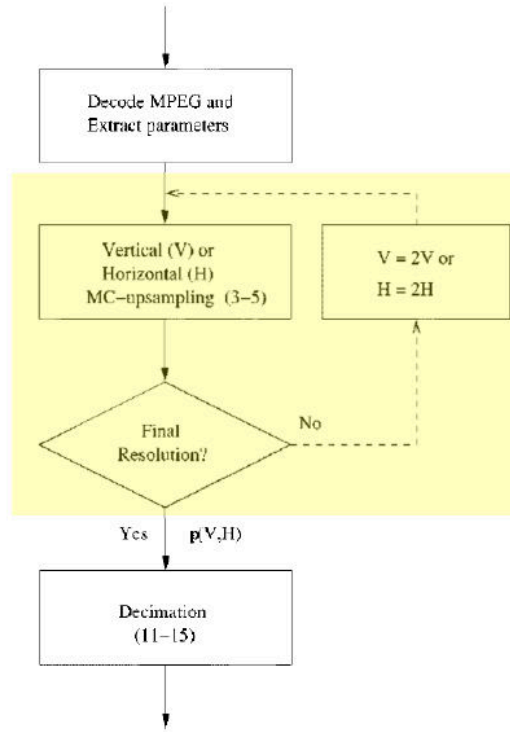


Fig. 2. Overview block diagram. MC upsampling alternates between doubling the resolution vertically and horizontally. Then final step is decimation to the desired format. Equation numbers are given in (). Dashed line marks control flow.

APPLE-1007, FIG. 2 (annotated)

IV. PTAB DISCRETION SHOULD NOT PRECLUDE INSTITUTION

Petitioner believes that discretionary denial is unwarranted, and yet, Petitioner intends to utilize the bifurcated briefing process contemplated by the March 26, 2025, Stewart Memorandum to rebut contentions if offered by Patent Owner to the contrary. See <https://www.uspto.gov/about-us/events/learnaboutnew-interim-processes-relating-institution-aia-proceedings> (April 24, 2025); <https://uspto.cosocloud.com/p9xpz6s4jn75> (Video).

V. CONCLUSION AND FEES

The Challenged Claims are unpatentable. Petitioner authorizes charge of fees to Deposit Account 06-1050.

VI. MANDATORY NOTICES UNDER 37 C.F.R § 42.8(a)(1)

A. Real Party-In-Interest Under 37 C.F.R. § 42.8(b)(1)

Apple Inc. is the sole petitioner and real party-in-interest.

B. Related Matters Under 37 C.F.R. § 42.8(b)(2)

The '995 Patent is the subject of the following pending civil actions:

Advanced Coding Technologies LLC v. Apple Inc., 2:24-cv-00572 (E.D. Tex.), filed July 22, 2024 (*see* APPLE-1004) and *Advanced Coding Technologies LLC v. Google LLC*, 2:24-cv-00353 (E.D. Tex.), filed May 10, 2024.

Apple filed an IPR petition challenging a different subset of claims of the '995 Patent on May 9, 2025 in **IPR2025-00984**. Apple also filed an IPR petition on related U.S. Patent No. 9,042,448 in **IPR2025-01070** on June 2, 2025. The '995 Patent is a divisional of the '448 Patent. Google filed an IPR petition challenging claims of the '995 Patent on May 12, 2025 in IPR2025-01000.

The '995 Patent was also previously asserted in *Advanced Coding Technologies LLC v. Samsung Electronics Co. Ltd.*, 2:22-cv-00499 (E.D. Tex.) and *Advanced Coding Technologies LLC v. LG Electronics, Inc.*, 2:22-cv-00501 (E.D. Tex.). Samsung previously filed an IPR on the '995 Patent in IPR2024-00372.

Apple understands that these prior district court actions and the-00372 IPR involving the '995 Patent have all been terminated or dismissed due to settlement between the parties in those proceedings. Apple was not a party to those proceedings.

C. Lead And Back-Up Counsel Under 37 C.F.R. § 42.8(b)(3)

Petitioner provides the following designation of counsel.

Lead Counsel	Backup counsel
W. Karl Renner, Reg. No. 41,265 Fish & Richardson P.C. 60 South Sixth Street Suite 3200 Minneapolis, MN 55402 Tel: 202-783-5070 Fax: 877-769-7945 Email: IPR50095-0242IP2@fr.com	Jeremy J. Monaldo, Reg. No. 58,680 Nicholas Stephens, Reg. No. 74,320 Fish & Richardson P.C. 60 South Sixth Street, Suite 3200 Minneapolis, MN 55402 Tel: 202-783-5070 Fax: 877-769-7945 IPR50095-0242IP2@fr.com

D. Service Information

Please address all correspondence and service to the address listed above.

Petitioner consents to electronic service by email at IPR50095-0242IP2@fr.com.

Respectfully submitted,

Dated: June 13, 2025

/Nicholas W. Stephens/

W. Karl Renner, Reg. No. 41,265

Jeremy J. Monaldo, Reg. No. 58,680

Nicholas Stephens, Reg. No. 74,320

Fish & Richardson P.C.

60 South Sixth Street, Suite 3200

Minneapolis, MN 55402

T: 202-783-5070

F: 877-769-7945

(Control No. IPR2025-01158)

Attorneys for Petitioner

CERTIFICATION UNDER 37 CFR § 42.24

Under the provisions of 37 CFR § 42.24(d), the undersigned hereby certifies that the word count for the foregoing Petition for *Inter partes* Review totals 13,868 words, which is less than the 14,000 allowed under 37 CFR § 42.24.

Dated: June 13, 2025

/Nicholas W. Stephens/

W. Karl Renner, Reg. No. 41,265
Jeremy J. Monaldo, Reg. No. 58,680
Nicholas Stephens, Reg. No. 74,320
Fish & Richardson P.C.
60 South Sixth Street, Suite 3200
Minneapolis, MN 55402
T: 202-783-5070
F: 877-769-7945

Attorneys for Petitioner

CERTIFICATE OF SERVICE

Pursuant to 37 CFR §§ 42.6(e)(4)(i) *et seq.* and 42.105(b), the undersigned certifies that on June 13, 2025 a complete and entire copy of this Petition for *Inter partes* Review, Power of Attorney, and all supporting exhibits were provided via Federal Express, to the Patent Owner by serving the correspondence address of record as follows:

JOSHUA GOLDBERG
Nath, Goldberg & Meyer
112 S. West Street
Alexandria, VA 22314
UNITED STATES
(703) 548-6284

/Crena Pacheco/
Crena Pacheco
Fish & Richardson P.C.
60 South Sixth Street, Suite 3200
Minneapolis, MN 55402
pacheco@fr.com