

Petition for *Inter Partes* Review of USP 9,042,448

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re *Inter Partes* Review of:)
U.S. Patent No. 9,042,448)
Issued: May 26, 2015)
Application No.: 12/995,039)
Filing Date: May 28, 2009)

For: **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, And Moving Picture Reencoding Program**

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 9,042,448**

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EXHIBIT LIST

Exhibit	Description
1001	U.S. Patent No. 9,042,448 to Sakazume (“the ’448 Patent”)
1002	Excerpts from the Prosecution History of the ’448 Patent (“the ’448 Patent File History”)
1003	Declaration and Curriculum Vitae of Dr. Clifford Reader
1004	[reserved]
1005	English Translation of Japanese Patent Publication No. 2007316161 A with Translation Certificate (“Phek”)
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”)
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”)
1008	U.S. Patent Application Publication No. 2008/0137753 (“He”)
1009	U.S. Patent No. 5,886,736 (“Chen”)
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”)
1011	U.S. Patent Application Publication No. 2009/0154567 (“Lei”)
1012	Park et al., <i>Super-Resolution Image Reconstruction: A Technical Overview</i> , IEEE Signal Processing Magazine, pp. 21-36, May 2003 (“Park”)
1013	English Machine Translation of Japanese Patent Publication No. 2008053848 (“Hatanaka”)
1014	U.S. Patent Application Publication No. 2010/0165077 (“Yin”)
1015	U.S. Patent Application Publication No. 2009/0257664 (“Kao”)
1016	U.S. Patent Application Publication No. 2009/0046995 (“Kanumuri”)
1017	U.S. Pat. 6,470,051 (“Campisano”)
1018	U.S. Patent Application Publication No. 2006/0013306 (“Kim”)

1019	Lu et al., Mechanisms of MPEG Stream Synchronization, ACG SIGCOMM Computer Communication Review, Vol. 24, Issue 1, pp. 57-67 (January 1994) (“Lu”)
1020	U.S. Patent Publication No. 2003/0021345 (“Brusewitz”)
1021	U.S. Patent Publication No. 2003/0021347 (“Lan”)
1022	EE Times, How Video Compression Works (Aug. 6, 2007), available at https://www.eetimes.com/how-video-compressionworks (retrieved Dec. 26, 2023) (“EETimes”)
1023	Bier, Introduction to Video Compression, Berkeley Design Tech., Inc. (October 2005), available at https://www.bdti.com/MyBDTI/pubs/20051024_GSPx05_Video_Intro.pdf (retrieved Dec. 30, 2023) (“Bier”)
1024	U.S. Patent No. 7,379,496 (“Holcomb”)
1025	U.S. Patent Publication No. 2008/0043832 (“Barkley”)
1026	U.S. Patent No. 6,173,013 (“Suzuki”)
1027	[reserved]
1028	[reserved]
1029	Declaration of June Ann Munford
1030	Ely, MPEG Video Coding: A Simple Introduction, EBU Technical Review (Winter 1995) (“Ely”)
1031	Japanese Patent Publication No. 2007316161 A with English Machine Translation
1032	ITU-T Recommendation H.264 (11/07)
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)
1034	ISO/IEC 11172-2: 1993 (E) (MPEG1 Video)
1035	ISO/IEC 13818-2: 2000 (E) (MPEG2/H.262 Video)
1036	ITU-T Recommendation H.263 (02/98)
1037	Reader, Intraframe and Interframe Adaptive Transform Coding, Efficient Transmission of Pictorial Information, SPIE v.66, 108 (1975)
1038	Reader, MPEG4: Coding for Content, Interactivity, and Universal Accessibility, Optical Engineering 35(1), 104 (January 1996)
1039	Reader, MPEG Patents, in MPEG Video Compression Standard,

	Chapter 16, at 357-362 (Mitchell et al ed.) (1996)
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)
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)
1042	ISO/IEC 14496-2: 2004 (MPEG4)
1043	ISO/IEC 13818-2: 1996 (MPEG2)
1044	[reserved]
1045	Third Amended Docket Control Order
1046	U.S. Patent Publication No. 2007/0140350 to Sakazume (“Sakazume”)
1047	IPR2024-00372, Paper 9
1048	Loop Filters in the Okubo RM2 (1986)
1049	U.S. Patent No. 6,580,754 to Wan et al. (“Wan”)

LIST OF CHALLENGED CLAIM ELEMENTS

Claim 1	
[1.P]	A moving picture encoding system that makes an encoding of a sequence of moving pictures with a resolution higher than a standard resolution using moving pictures contents which include a sequence of moving pictures with the standard resolution and do not include a sequence of moving pictures with a resolution higher than the standard resolution, the moving picture encoding system comprising:
[1.1]	a first encoder configured to work on 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 sequence of moving pictures 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;
[1.3]	a second super-resolution enlarger configured to acquire the set of decoded pictures from the first encoder to implement thereon a process for a second super-resolution enlargement to create a set of super-resolution enlarged decoded pictures with a resolution higher than the standard resolution;
[1.4]	a third resolution converter configured to acquire the set of decoded pictures from the first encoder to implement thereon a process for a third resolution conversion to create a set of resolution converted enlarged decoded pictures with a resolution higher than the standard resolution; and
[1.5]	a third encoder configured to have the set of super-resolution enlarged pictures from the first super-resolution enlarger as a set of encoding target pictures, employing the set of super-resolution enlarged decoded pictures from the second super-resolution

	enlarger and the set of resolution converted enlarged decoded pictures from the third resolution converter as sets of reference pictures, to implement thereon a third combination of processes for a prediction and an encoding to create a third sequence of encoded bits,
[1.6]	wherein a spatial resolution of the set of super-resolution enlarged pictures, that of the set of super-resolution enlarged decoded pictures, and that of the set of resolution converted enlarged decoded pictures are made equal; and
[1.7]	wherein the third encoder controls a selection of a set of reference pictures and creates a set of data on the selection of the set of reference pictures to identify a selected set of reference pictures during the process for prediction of the third combination.
Claim 2	
[2.P]	A moving picture encoding system that makes an encoding of a sequence of moving pictures with a resolution higher than a standard resolution using moving pictures contents which include a sequence of moving pictures with the standard resolution and do not include a sequence of moving pictures with a resolution higher than the standard resolution, the moving picture encoding system comprising:
[2.1]	a first encoder configured to work on 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;
[2.2]	a first super-resolution enlarger configured to work on the sequence of moving pictures 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;
[2.3]	a third resolution converter configured to acquire the set of decoded pictures from the first encoder to implement thereon a process for a third resolution conversion to create a set of

	resolution converted enlarged decoded pictures with a resolution higher than the standard resolution; and
[2.4]	a third encoder configured to have the set of super-resolution enlarged pictures from the first super-resolution enlarger as a set of encoding target pictures, employing the set of resolution converted enlarged decoded pictures from the third resolution converter as a set of reference pictures, to implement thereon a third combination of processes for a prediction and an encoding to create a third sequence of encoded bits,
[2.5]	wherein a spatial resolution of the set of super-resolution enlarged pictures, and that of the set of resolution converted enlarged decoded pictures are made equal; and
[2.6]	wherein the third encoder controls a selection of a set of reference pictures and creates a set of data on the selection of the set of reference pictures to identify a selected set of reference pictures during the process for prediction of the third combination.
Claim 3	
[3.P]	A moving picture encoding system that makes an encoding of a sequence of moving pictures with a resolution higher than a standard resolution using moving pictures contents which include a sequence of moving pictures with the standard resolution and do not include a sequence of moving pictures with a resolution higher than the standard resolution, the moving picture encoding system comprising:
[3.1]	a first encoder configured to work on 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;
[3.2]	a first super-resolution enlarger configured to work on the sequence of moving pictures 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;
[3.3]	a second super-resolution enlarger configured to acquire the set of decoded pictures from the first encoder to implement thereon

	a process for a second super-resolution enlargement to create a set of super-resolution enlarged decoded pictures with a resolution higher than the standard resolution; and
[3.4]	a third encoder configured to have the set of super-resolution enlarged pictures from the first super-resolution enlarger as a set of encoding target pictures, employing the set of super-resolution enlarged decoded pictures from the second super-resolution enlarger as a set of reference pictures, to implement thereon a third combination of processes for a prediction and an encoding to create a third sequence of encoded bits,
[3.5]	wherein a spatial resolution of the set of super-resolution enlarged pictures, and that of the set of super-resolution enlarged decoded pictures are made equal; and
[3.6]	wherein the third encoder controls a selection of a set of reference pictures and creates a set of data on the selection of the set of reference pictures to identify a selected set of reference pictures during the process for prediction of the third combination.

I. INTRODUCTION

Google LLC (“Petitioner” or “Google”) requests *Inter Partes* Review (“IPR”) of claims 1-3 (“the Challenged Claims”) of U.S. Patent No. 9,042,448 (the “’448 Patent”) (Ex.1001).

II. IDENTIFICATION OF CHALLENGES (37 C.F.R. § 42.104(b))

- **Ground 1:** Claims 1-3 are unpatentable under 35 U.S.C. § 103 over Phek (Ex.1005) in view of Martins (Ex.1007), and He (Ex.1008).
- **Ground 2:** Claims 1-3 are unpatentable under 35 U.S.C. § 103 over Sakazume (Ex.1046) in view of Martins (Ex.1007), and He (Ex.1008).

The ’448 Patent claims earliest priority to a Japanese Application No. 2008-142433, filed on May 30, 2008. Ex.1001, Face. Petitioner does not concede that the Challenged Claims are entitled to the benefit of any of the claimed priority dates of the ’448 Patent, but this Petition nonetheless treats May 30, 2008, as the Critical Date of the Challenged Claims for purposes of analyzing the claims and prior art. As shown below, each reference that forms the basis of Grounds 1 and 2 qualifies as prior art even treating May 30, 2008, as the Critical Date.¹

¹ Martins was published in IEEE journals before the Critical Date. IPR2014-00527, Paper 41, 11 (PTAB May 18, 2015) (“IEEE is a well-known, reputable compiler and publisher of scientific and technical publications”). Expert librarian June Munford

Reference	Filing Date	Publication Date	Pre-AIA Prior Art
Phek	---	Dec. 6, 2007	§102(a)
Martins	---	Sept. 2002	§102(a)-(b)
He	Dec. 6, 2006	June 12, 2008	§102(e)
Sakazume	---	June 21, 2007	§102(a)

III. BACKGROUND

A. The '448 Patent (Ex.1001)

1. Technical Background

The '448 Patent relates to video coding technology, and more particularly to the use of “super-resolution” techniques to enhance pictures in a video coding system.

As Dr. Reader explains in detail in his declaration, the subject matter of the '448 Patent amounts to no more than an obvious collection of video coding

reviewed MARC records and physical copies of these IEEE journals from the Carnegie Library of Pittsburgh and presents compelling evidence that Martins was publicly accessible through the IEEE journals before the Critical Date. Ex.1029, ¶¶9-12.

concepts that were well known to a person of ordinary skill in the art (“POSITA”) before the Critical Date. Ex.1003, §§II, V.A-B. These concepts include:

(i) **motion-compensated coding** in which pictures (or regions of pictures) in a video stream are compressed by using one or more of a previously decoded picture or a region of the previously decoded picture—referred to as a “reference picture”—to predict other picture(s) (or region(s) of the other picture(s)) in the video stream (Ex.1003, ¶¶62-73);

(ii) **loop filtering** in which the previously decoded pictures—i.e., “reference pictures”—are enhanced before being used to predict other picture(s) (Ex.1003, ¶¶74-78);

(iii) **super-resolution processing** in which multiple lower resolution pictures of the same scene are registered with sub-pixel accuracy and used to form a super-resolution picture of the scene that has both higher spatial frequencies (e.g., more detail) than any of the individual lower-resolution input pictures and a higher spatial resolution (e.g., higher pixel count²) than

² The ’448 Patent sometimes uses the term “resolution” to refer to the amount of detail (e.g., spatial frequency or 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. Ex.1003, ¶¶150-155.

the input pictures (Ex.1003, ¶¶44-54); and

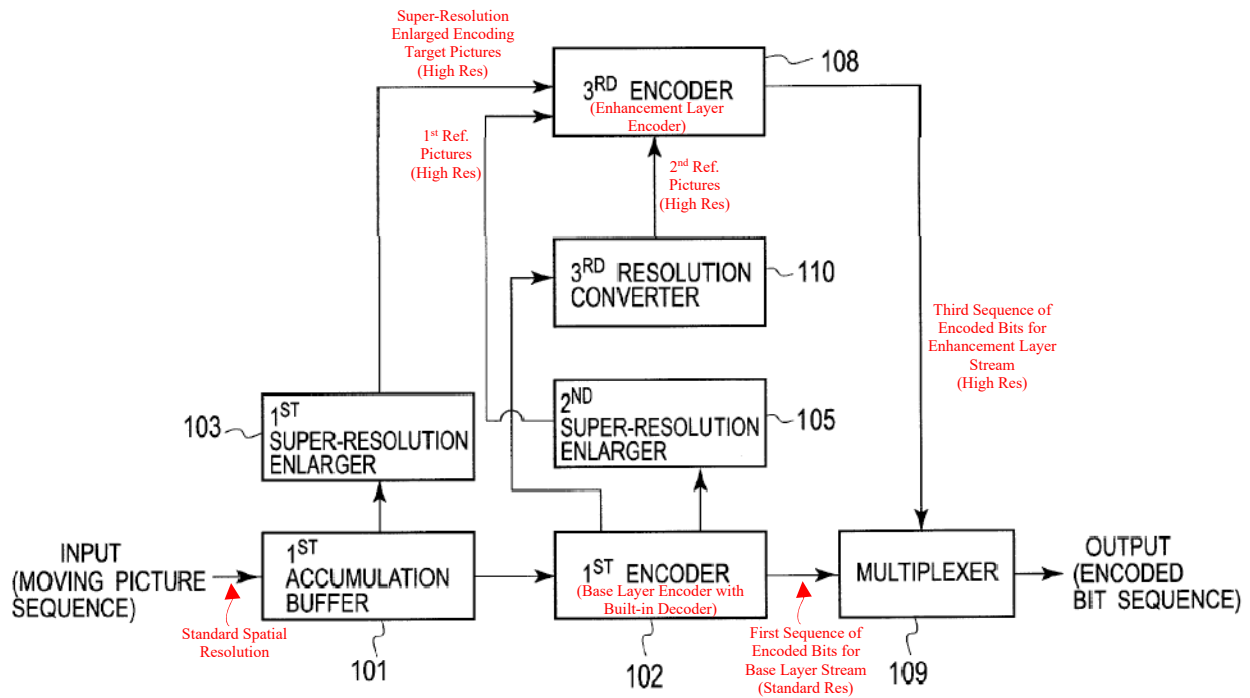
(iv) **layered, hierarchical coding** in which a single bitstream comprises a set of sub-streams (e.g., two or more related video stream that provide a base layer that can be encoded independent of the other layers and one or more enhancement layers that are encoded in dependence on the base layer) (Ex.1003, ¶¶97-134).³

2. Brief Description

The '448 Patent describes a layered video coding system that uses conventional super-resolution algorithms to enhance the quality of input base layer pictures and decoded base-layer pictures that are used as reference pictures for the subsequent encoding of enhancement layer pictures. Ex.1003, ¶¶177-214. FIG. 13's depiction of an encoding apparatus is instructive:

³ 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. Ex.1003, ¶¶97-134.

FIG. 13



Ex.1001, FIG. 13 (annotated)

As shown above, the encoding apparatus passes pictures from the input video through an accumulation buffer 101 to each of two encoding paths. Ex.1001, 34:5-7, 13:20-17:16. In the first path, a base version of the input video is encoded by the first encoder 102 to produce a first coded bitstream for the base version of the video. *Id.*, 34:8-12, 13:29-13:55. In the second path, a super-resolution enhanced version of the input video is encoded by the third encoder 108 to produce a second coded bitstream for the super-resolution enhanced version of the input video. *Id.*, 34:46-61. The system generates the super-resolution enhanced version of the input video using a first super-resolution enlarger 103 to increase the spatial resolution and information content (e.g., quality) of pictures in the input video. *Id.*, 34:13-18,

13:36-55. For each input video picture that is to be subjected to super-resolution processing, the first accumulation buffer 101 accumulates subsequences of pictures from the neighborhood of the input video picture that is to be super-resolution enhanced, in which the pictures in the subsequences are registered with sub-pixel accuracy to provide a corresponding super-resolution image. *Id.*, 4:27-42.

To remove redundancies in information coded between the base- and enhancement-layer streams, the third encoder 108 implements inter-layer predictive processes to predict pictures in the enhancement-layer stream from decoded pictures in the base-layer stream. Ex.1001, 34:46-61. Decoded pictures from the base-layer stream can also be enhanced before being used as reference by the third encoder 108 by subjecting base-layer pictures that have been encoded and then decoded by the first encoder 102 to processing by the second super-resolution enlarger 105 to create super-resolution enhanced base layer pictures or alternatively to processing by the third resolution converter 110 to create resolution enlarged base layer pictures. *Id.*, 34:19-45; Ex.1003, ¶¶202-205 (explaining that the choice of super-resolution or resolution enlargement is dependent on which technique will be optimal). The third encoder 108 selects either super-resolution enhanced base layer pictures or resolution converted enlarged base layer pictures as reference pictures for encoding of the enhancement layer video stream. Ex.1001, 35:33-58; Ex.1003, ¶205 (explaining that the selection may be on a picture or region (e.g., block) basis). The

base and enhancement layer streams are then multiplexed (109) into a single output signal, together with a signal indicating which base-layer picture was selected, and the multiplexed signal is transmitted to a decoding apparatus. *Id.*, 35:49-36:44, 29:30-35, 58:59-59:16.

B. Prosecution History

The application (U.S. Serial No. 12/995,038) resulting in the '448 Patent was filed on May 28, 2009, by Satoru Sakazume. Ex.1001, Face. The '448 Patent claims priority to several earlier-filed applications, with the earliest claimed priority date being May 30, 2008. *Id.*

During original examination, the Examiner required the applicant to narrow the application that issued as the '448 Patent to a single species of claims. Ex.1002, 230-235. In response, the applicant elected a single species—"Species D" and Figure 13—and identified a limited set of claims encompassing that species. *Id.*, 237-239. In the following Office Action, the Examiner rejected claims 7 (issued claim 1), claim 8 (issued claim 2), and claim 9 (issued claim 3) as obvious over prior art combinations based on Phek (Ex.1031), along with additional references including Holcomb (Ex.1024) and Wan (Ex.1047). Ex.1002, 245-261. The applicant subsequently amended the claims to add further detail to the preambles and to add limitations corresponding to issued claim limitations [1.5] and [1.6], and withdrew the remaining claims. *Id.*, 317-344. The Examiner subsequently allowed

the application. *Id.*, 352-362. The file history contains no indication that the Examiner ever considered Phek's teachings in combination with the teachings of Martins and He as set forth in Ground 1, or the teachings of Sakazume (Ex.1046). If the combinations had been considered, the application never should have been allowed. *Infra*, §§IV-V.

C. Person of Ordinary Skill in the Art

A POSITA relating to the subject matter of the '448 Patent as of the Critical Date would have had a bachelor's degree in computer science, electrical engineering, computer engineering, or a related field, with two years of experience in digital video processing, or a related field. Ex.1003, ¶¶142-144. Additional graduate education could substitute for professional experience, and *vice versa*. *Id.*

D. Claim Construction

The prior art relied on in this Petition disclosed the subject matter of the Challenged Claims under any reasonable construction, including their plain meaning.⁴ Petitioner reserves the right to respond to any constructions offered by Patent Owner or adopted by the Board.

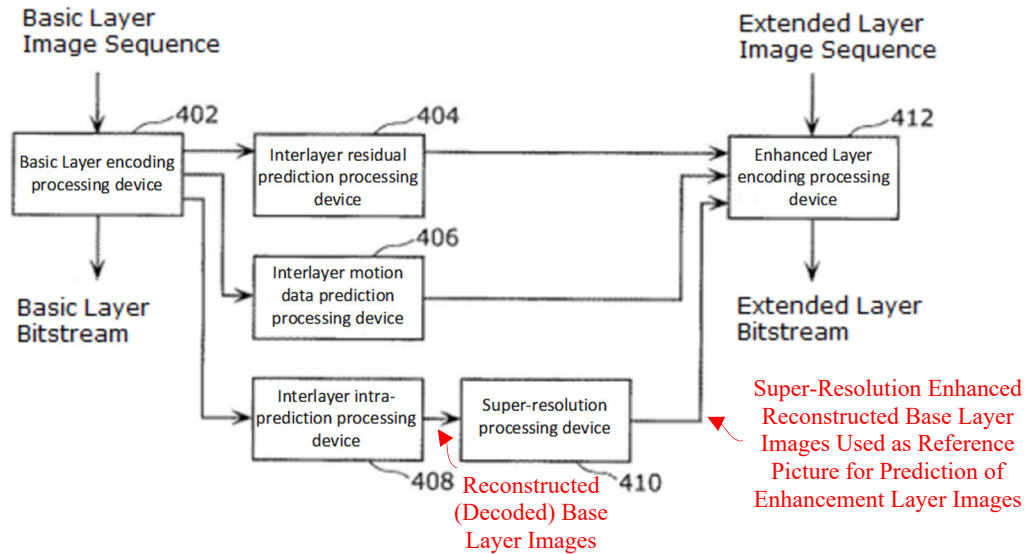
⁴ Petitioner reserves the right to argue alternative constructions in other proceedings, and where such a defense is available, that the claims are indefinite.

IV. Ground 1: Claims 1-3 are rendered obvious by Phek in view of Martins and He

A. Overview of the Prior Art

1. Phek (Ex.1005)

Phek discloses a video coding system that uses “[i]nterlayer prediction ... for hierarchical encoding in order to improve encoding efficiency.” Ex.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.



Ex.1005, FIG. 4a (annotated, showing the encoding process)⁵; Ex.1003, ¶¶218-219.

⁵ For ease of reading, Petitioner has identified the blank boxes in each of Phek's figures reproduced in this Petition using the labels provided external to the boxes in the certified English translation. See Ex.1005. Petitioner also notes that the English translations of Phek (Ex.1005 and Ex.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. Ex.1003, FN14.

2. Martins (Ex.1007)

Martins is an IEEE paper titled “A Unified Approach to Restoration, Deinterlacing and Resolution Enhancement in Decoding MPEG-2 Video.” Ex.1007, p.803. 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 super-resolution pictures obtained by the algorithm are of much higher visual quality and have lower [mean-squared error] than super-resolution 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.* Martins teaches processing decoded pictures utilizing data from the encoding and decoding process to facilitate the super-resolution enhancement using motion compensation information (e.g., motion compensation vectors). *See id.*, 803, 805; Ex.1003, ¶¶220-221.

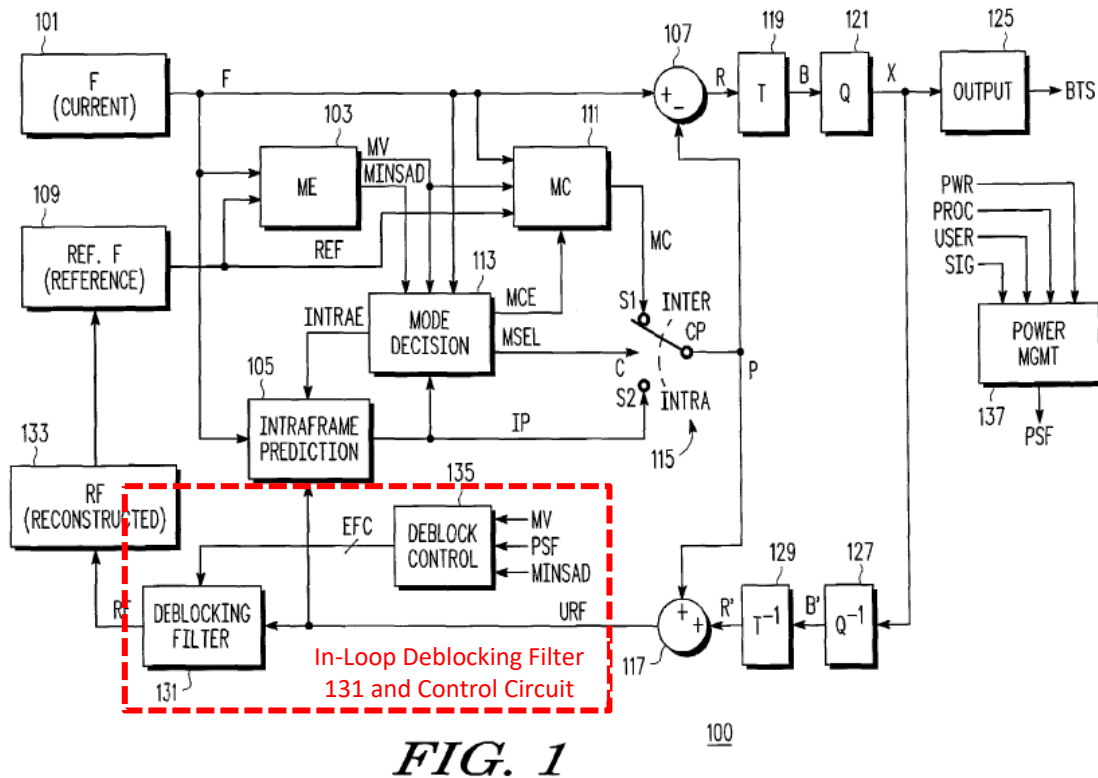
3. He (Ex.1008)

He discloses techniques for selective in-loop filtering in a scalable video coding system. Ex.1003, ¶¶222-227. He specifically focuses on selective in-loop deblock filtering to control deblock filtering parameters at each layer of scalable coding hierarchy. Ex.1008, [0002]-[0006], [0022], [0028], [0032]-[0037], FIGS. 1-4.

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.” Ex.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. 1 (reproduced below) depicts a video encoder 100 configured to implement selective deblock filtering. Ex.1008, [0023], FIG. 1. The encoder 100 performs encoding operations to encode at least a portion of a picture and outputs a coded bitstream BTS that contains “video information” for that picture. *Id.* The encoder 100 includes a frame buffer 109 that provides reference information (REF), which “includes information from one or more previously encoded and decoded frames that have been further filtered, such as by deblocking filter 131.” *Id.* URF is provided to the deblocking filter 131 which, when enabled, “filters the unfiltered reconstructed frame information URF and provides filtered reconstructed

information RF to an RF buffer 133.” *Id.*, [0026]. If the deblocking filter is disabled, “the unfiltered reconstructed frame information URF is passed as the reconstructed information RF in which deblock filtering is bypassed.” *Id.* He explains that disabling the deblocking filter 131 significantly reduces computational complexity and power consumption. *Id.*, [0028]. For example, “[i]f the video information content exhibits a relatively low amount of motion or is relatively simple content,” “the deblocking filter 131 may be fully disabled without significant degradation in visual quality.” *Id.* He explains that its “video encoder 100 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.” Ex.1008, [0032-0034], FIG. 2.



Ex.1008, FIG. 1 (annotated).

4. Combination of Phek, Martins, and He

Like the '448 Patent, Phek discloses a layered video coding system that enhances reference picture quality in an enhancement layer by selectively employing super-resolution processing. *Supra*, §IV.A.1. While Phek's disclosure focuses on details of its super-resolution algorithm, Phek's description of the layered coding system itself (which uses the proposed super-resolution algorithm) is less detailed (though very well known in the art). Indeed, Phek acknowledges that its encoder/decoder descriptions are "simplified" and "do not have to be performed as shown." Ex.1005, [0013]. Phek's system is thus ripe for improvement. Ex.1003, ¶229.

The following subsections address straightforward modifications to Phek's system that would have been obvious to implement in view of Martins and He.⁶ Ex.1003, ¶¶231-256.

a. *Obvious to Generate Phek's Extended Layer Image Sequence Target Images by Super-Resolution Processing*

Phek discloses providing an extended layer image sequence to the enhanced layer encoding processing device 412 as the encoding target to generate the enhancement layer bitstream. Ex.1005, [0014], Fig. 4a. In the context of spatial scalability, one of the types of hierarchical coding schemes implemented by Phek's system, this input extended layer image sequence would have been a higher spatial resolution sequence than the base layer image sequence. Ex.1003, ¶232.

Phek does not specify how the extended layer image sequence in Figure 4a is generated. Ex.1003, ¶233. However, it would have been obvious to generate the extended layer image sequence in Figure 4a using other teachings within Phek, for example, the teachings of Figures 1a, 1b, or 2, which take as input an image sequence corresponding to raw video (such as the Base Layer image sequence) and output a super-resolution version of that same image sequence (i.e., a higher spatial resolution

⁶ This overview of the Phek-Martins-He combination is referenced and incorporated in the analysis of each claim element in Section IV.B below.

sequence than the base layer image sequence). Ex.1003, ¶233. For example, Phek's Figure 2 includes a pre-processing device that can perform super-resolution processing on raw data input. Ex.1005, [0010].

Additionally, or alternatively, a POSITA would have recognized that it would have been obvious to generate the extended layer image sequence from the base layer image sequence by applying the teachings of Martins. Ex.1003, ¶¶234-235. Specifically, Martins' FIG. 2 discloses "combining multiple pictures to form a single super-resolution picture" using an algorithm "based on motion-compensated spatial upsampling from multiple images." Ex.1007, Abstract. Through upsampling, pixels of the current picture are aligned with pixels of a reference picture using "motion estimation." *Id.*, 807. The resulting information "from all the reference pictures" are combined "to form a single super-resolution picture." *Id.* Martins also discloses its super-resolution enlarger may enlarge an image using "spatial interpolation." *Id.*

Combining the teachings would have been nothing more than the predictable application of known techniques to yield predictable results, for which a POSITA would have had a reasonable expectation of success, given the known use of super-resolution processing techniques on images before the '448 Patent. *KSR Int'l Co. v. Teleflex, Inc.*, 550 U.S. 398, 417 (2007).

In the combination, the extended layer image sequence of Phek is generated by applying either Phek's teachings of super-resolution processing (e.g., Phek's Fig

1a) (first example), or Martins' teachings of super-resolution upscaling (second example), to the base layer image sequence, as illustrated below. Ex.1003, ¶¶236-238.

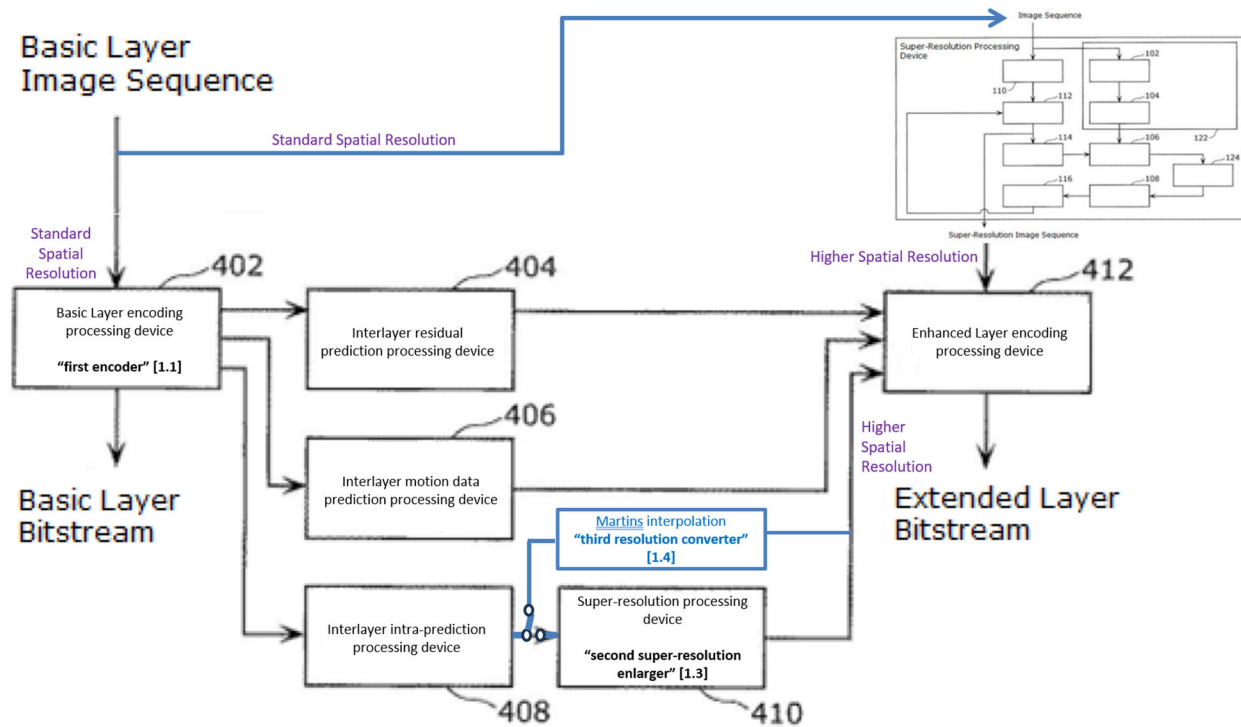


Illustration of using Phek's Fig. 1a for generating Extended Layer Image Sequence (first example)

For simplicity, Phek's teachings of generating a higher spatial resolution image sequence via super-resolution processing, as taught, e.g., by Phek's Fig. 1a, are represented by the illustration below. This simplified illustration is used throughout the limitation-by-limitation analysis that follows.

Basic Layer Image Sequence

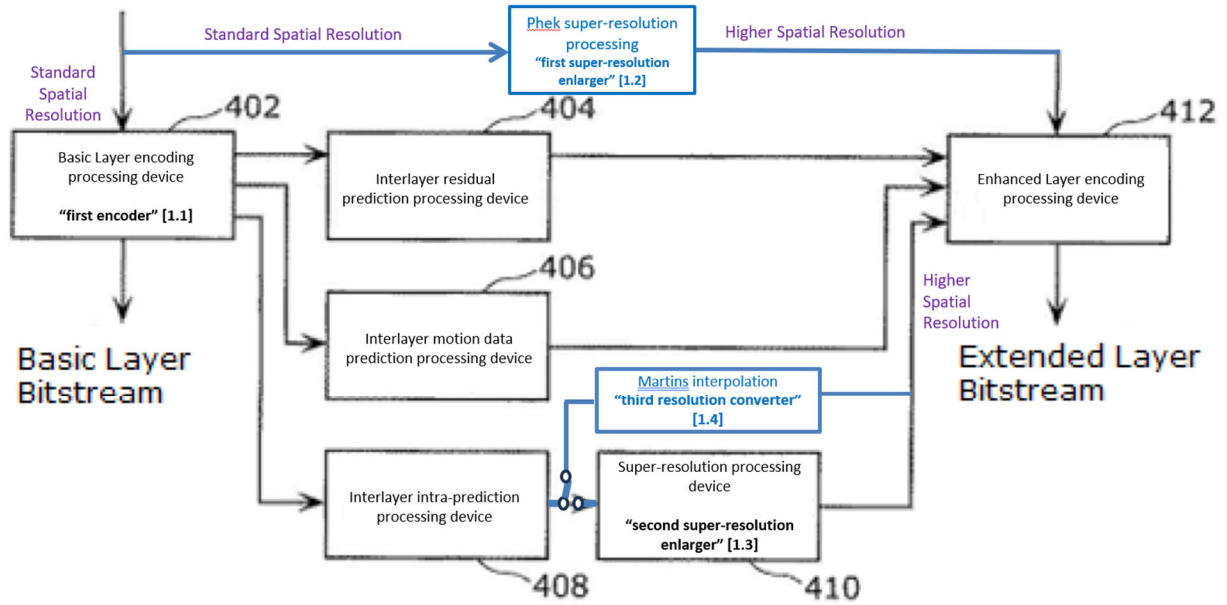


Illustration of Phek-Martins-He Combination (first example).

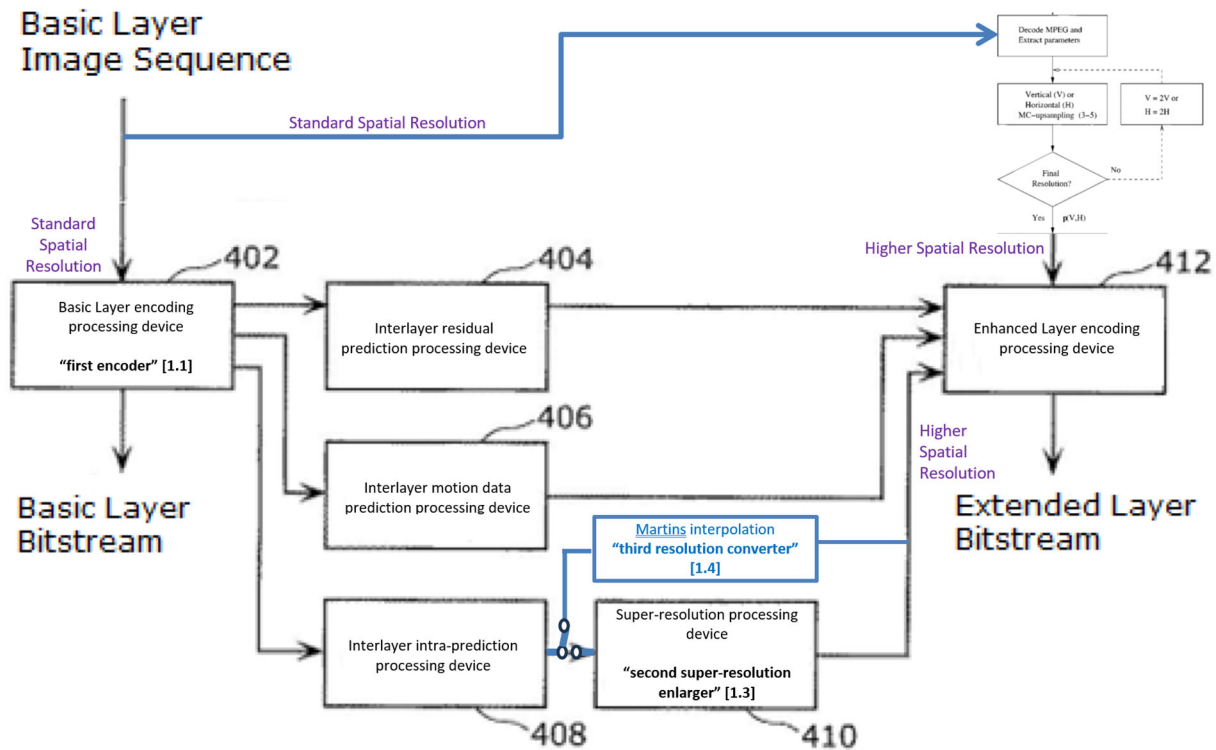


Illustration of using Martins' super-resolution algorithm for generating Extended Layer Image Sequence (second example)

For simplicity, Martins' teachings of generating a higher spatial resolution image sequence via super-resolution processing, as taught, e.g., by Martins' Fig. 2, are represented by the illustration below. This simplified illustration is used throughout the limitation-by-limitation analysis that follows.

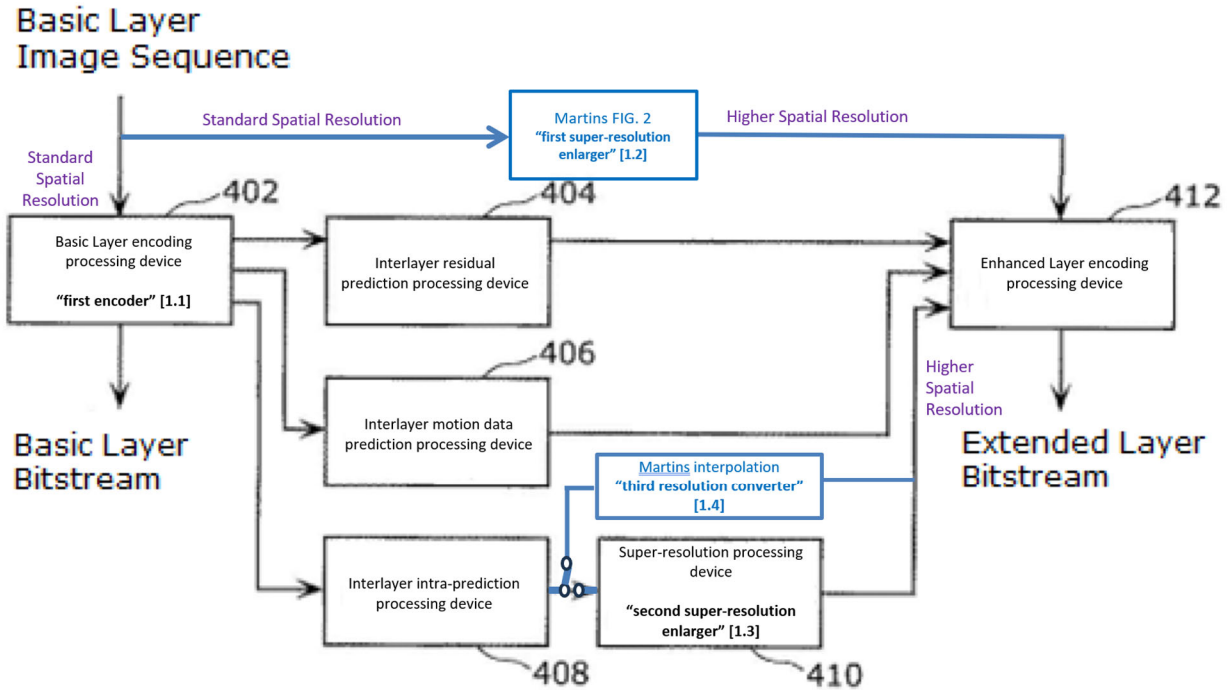


Illustration of Phek-Martins-He Combination (second example).

b. *Obvious to Upscale Phek's Reference Pictures and Encoding Target Pictures to the Same Spatial Resolution*

Phek discloses a “hierarchical encoding” system “that uses interlayer prediction” between video streams coded at a base layer and an enhancement layer. Ex.1005, [0014]-[0015], FIGs. 4a-4b. Phek states that “[i]nterlayer prediction is used for hierarchical encoding in order to improve encoding efficiency.” Ex.1005, [0014]. Phek does not expressly disclose (nor does it restrict) the type(s) of hierarchical coding that can be implemented by its system, nor does it expressly disclose or restrict the relative spatial resolutions of the base- and enhancement-layer video streams. *Id.* “One example of hierarchical encoding that uses interlayer prediction is ... scalable video encoding.” Ex.1005, [0014]. A POSITA would have

understood that a common form of scalable coding is for transmission of base and enhancement layers differentiated by spatial resolution. Ex.1003, ¶¶239-240.

Phek further discloses that the enhancement layer is encoded using reference images from the base layer. Ex.1005, [0014]. Specifically, Phek's encoding path for generating these reference images for the enhancement layer includes "a super-resolution processing device 410 [that] is used to improve [the] reference images." Ex.1005, [0014]. The use of "super-resolution processing ... improve[s] encoding efficiency or picture quality by improving the reference frames used for motion detection, motion compensation prediction, and display." *Id.*, [0013]. Phek's super-resolution enhancement involves processing of a set of lower-resolution images to generate a super-resolution enlarged image of higher quality and higher spatial resolution than the individual lower-resolution images. Ex.1005, [0002] ("Super-resolution processing is a technique for generating high-resolution images from a plurality of low-resolution images."). Subjecting reference pictures to super-resolution processing yields enlarged images whose spatial resolution is greater than the resolution of the decoding targets in the enhancement layer streams. Ex.1005, FIG. 4a, [0014]; Ex.1003, ¶241.

Phek discloses that, at the encoder, "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 “super-resolution processing device 410 is used to improve these additional reference images.” Ex.1005, [0014]. Based on fundamental encoding techniques, it would have been obvious that inter-layer intra-prediction processing device 408 obtains decoded base layer images as reference pictures for the interlayer prediction of enhancement layer images. Ex.1003, ¶242 (citing, e.g., Ex.1005, [0014]).

Further, as will be discussed below, He teaches that super-resolution processors, which form a loop filter analogous to He’s deblocking loop filter, can be selectively applied to filter/enhance reference pictures in an enhancement layer of a layered video coding system. Ex.1008, [0034]; *supra*, §IV.A.3. When super-resolution filtering is not applied (bypassed) to a sequence of images, enhanced layer encoding processing device 412 uses the decoded base layer sequence of images (rather than super-resolution filtered versions) acquired by inter-layer intra-prediction processing device 408 as a set of first reference pictures. *Id.*; Ex.1003, ¶243.

It would have been obvious to upscale both the super-resolution (“SR”) filtered and unfiltered reference pictures that Phek’s enhancement layer uses for prediction to a spatial resolution equal to the spatial resolution of the extended layer image sequence used by the enhanced layer coding processing device 412 as the encoding target stream. Ex.1003, ¶¶244-246. In particular, a POSITA would have

known before the '448 Patent that the reference images used by enhanced layer coding processing device 412 would need to be at the same spatial resolution, whether those reference images were super-resolution enhanced or not. In the latter case, when a reference image is not super-resolution enhanced, resolution conversion to the spatial resolution used by enhanced layer coding processing device 412 would have been obvious, given the well-known nature of resolution conversion at the time of the '448 patent. Ex.1003, ¶¶244-246. A POSITA would have sought to upscale Phek's reference and target images to obtain similar benefits. Ex.1003, ¶¶244-246 (citing Ex.1021, [0003], [0011], [0016]-[0029], Abstract, FIGS. 2-4; Ex.1020, Abstract, [0002], [0026], FIG. 4; Ex.1012, [0002]-[0003], [0006], [0026]-[0027]).

Additionally, Martins teaches that its super-resolution algorithm creates a super-resolution picture using motion-compensated upsampling, but “[u]sually, some of the pixels” of the super-resolution picture “are undefined because there was no accurate match (of adequate quality) in any of the reference pictures.” Ex.1007, 806. Thus, to complete the super-resolution picture, those pixels “are assigned values from an interpolated super-resolution picture ... having the same resolution” as the picture generated by motion-compensated upsampling. *Id.* A POSITA would have recognized interpolation as a common technique for upconversion consistent with the '448 Patent, and thus Martins motivates a POSITA to incorporate

interpolation techniques (i.e., resolution conversion techniques) within a super-resolution processing system. Ex.1003, ¶¶244-246.

Further, upscaling the pictures in the combination would have been obvious as a predictable application of known techniques to yield predictable results, for which a POSITA would have had a reasonable expectation of success, given the known use of upscaling techniques on images before the '448 Patent. *KSR*, 550 U.S. at 417; Ex.1003, ¶247.

c. *Obvious Based on He to Selectively Apply Phek's/Martin's Super-Resolution (and Upscaling) Loop Filter*

A POSITA would have next found it obvious based on He to implement Phek's enhancement layer encoder in the combination to selectively encode information reflecting the use of super-resolution processing or upscaling of reference pictures in the enhancement layer of the Phek-Martins-He combination.⁷ Ex.1003, ¶¶248-249.

⁷ In its decision instituting trial on the related '995 patent, the Board preliminarily agreed with the previous petitioner's argument that He's teachings of selectively applying in-loop filtering would have been combined with Phek and Martins. *See* Ex.1047, pp. 14-19.

As previously discussed, the Phek-Martins teachings render obvious techniques for performing super-resolution processing and upscaling of reference images used for inter-layer prediction of images in the enhancement layer. Ex.1005, [0011]-[0015], FIGS. 3a-3b, 4a-4b; Ex.1007, 803-804, 808; *supra*, §IV.A.4.a-b.

The super-resolution and upscaling (“SR-U”) operations performed on reference pictures in the enhancement layer encoding path form a type of “loop filter,” which the Petition will refer to as a “super-resolution and upscaling loop filter” (or simply an “SR-U filter”). Ex.1003, ¶¶250-251. Like other loop filters known in the art, the Phek-Martins-He SR-U loop filter enhances decoded frames before they are used as references for the prediction of frames in the enhancement layer. Ex.1022, 10-11; Ex.1008, [0006]. As Dr. Reader explains, a wide range of loop filters were known in the art before the ’448 Patent and the SR-U filter in the proposed combination similarly serves to enhance the quality of reference pictures consistent with other known loop filters. Ex.1003, ¶251 (citing Ex.1008, [0006]; Ex.1015, [0068]; Ex.1011, [0022]-[0023], FIGS.2-5; Ex.1048, p.4 (“the filter must be capable of being switched on or off”)); *supra*, §III.A.1-2.

Phek does not explicitly disclose criteria or conditions for the use of super-resolution processing on reference pictures, nor does Martins explain when SR-U filtering should be applied for loop filtering. As discussed above, however, He describes known costs attendant to loop filtering, which may or may not be justified

depending on factors such as the degree of improvement in the encoded image quality and compression that would be realized by use of the loop filter, power consumption, and the like. *Supra*, §IVA.3; Ex.1003, ¶252. For example, He explains that an in-loop “deblocking filter[] ... consumes a significant amount of power and processing cycles” and “[g]enerally speaking, the entire deblocking filter ... consumes approximately 8% of the computations at the encoder and approximately 35% at the decoder for H.264/AVC.” Ex.1008, [0006]. “Disabling the entire deblocking filter, therefore, provides a significant reduction of power and processing complexity.” *Id.* To maintain a “desired tradeoff between video quality and complexity reduction,” He discloses control signals that allow a decoder 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-Martins combination to achieve benefits like those expressly described in He—including to reduce the power consumption and computational complexity of encoding frames in at least the enhancement layer. Ex.1008, [0028], [0031], [0037], [0076], [0069]; Ex.1003, ¶253. In the combination, and based on He’s teaching, an encoder can determine whether or not to apply an in-loop SR-U filter and encode control flags in frame or slice header(s) to signal to a decoder whether an in-loop SR-U filter was applied. *Id.*

Although He describes selective loop filtering in the context of “deblocking” filters, He’s teachings are readily and obviously applicable to other types of loop filters including SR-U filtering. Ex.1003, ¶254. 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-U filtering especially since SR-U filtering involves processing of more images and imposes an even greater computational burden than traditional deblocking filters. Ex.1003, ¶254; Ex.1007, 808 (describing need to “keep the algorithmic complexity down”); Ex.1012, 13 (describing importance implementing “an efficient [super-resolution] algorithm that reduces the computational cost”).

A POSITA also would have known that super-resolution processing is most effective to improve the quality of an image when “some relative scene motions ... exist from frame to frame.” Ex.1011, 2; Ex.1003, ¶255. 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. Ex.1011, 2; Ex.1003, ¶255. Accordingly, when super-resolution processing does not improve the reference picture significantly, imposes an unacceptable 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-U filtering based on He's teachings for selective in-loop filtering. Ex.1003, ¶255. 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 in the combination to use a decoded base layer-frame that has not been SR-U filtered for inter-layer prediction of a corresponding frame in the enhancement layer when the SR-U filter is disabled. Ex.1003, ¶255 (noting that both Phek and Martins disclose using interpolation without super-resolution processing when super-resolution processing fails, suggesting a motivation to combine with He); Ex.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 '448 Patent and that He specifically describes such techniques in a layered coding system like Phek's underscores the obviousness of the combination and that a POSITA would have had a reasonable expectation of success implementing selective SR-U loop filtering in the combination. Ex.1003, ¶256; *KSR*, 550 U.S. at 417.

B. Claim 1

1. **[1.P] A moving picture encoding system that makes an encoding of a sequence of moving pictures with a resolution higher than a standard resolution using moving pictures contents which include a sequence of moving pictures with**

the standard resolution and do not include a sequence of moving pictures with a resolution higher than the standard resolution, the moving picture encoding system comprising:

Phek-Martins-He renders obvious [1.P]. Ex.1003, ¶¶258-264. For example, Phek's FIG. 4a describes an "encoding device (encoder)" in an "[i]nterlayer predictive" coding system. Ex.1005, FIG. 4a, [0014]; *see also id.*, [0011]-[0015], FIGs. 3a-3b, 4b. In an encoder, "the image sequence is intra-coded or inter-coded." Ex.1005, [0011].

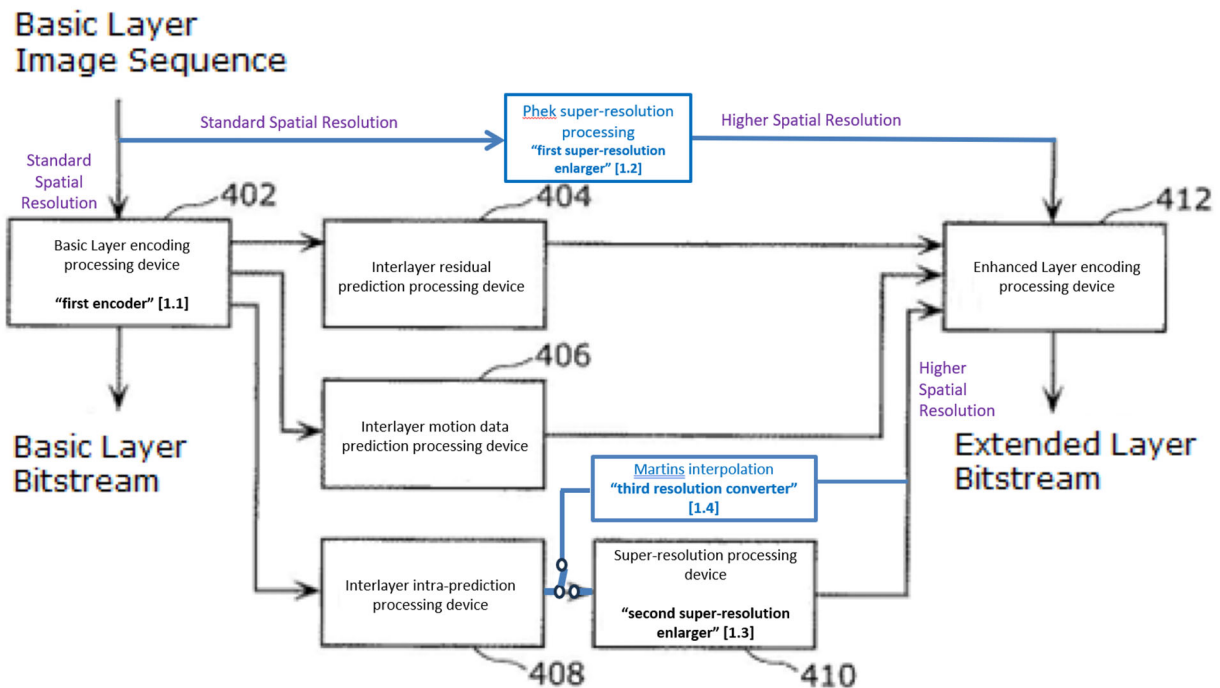


Illustration of Phek-Martins-He Combination (first example).

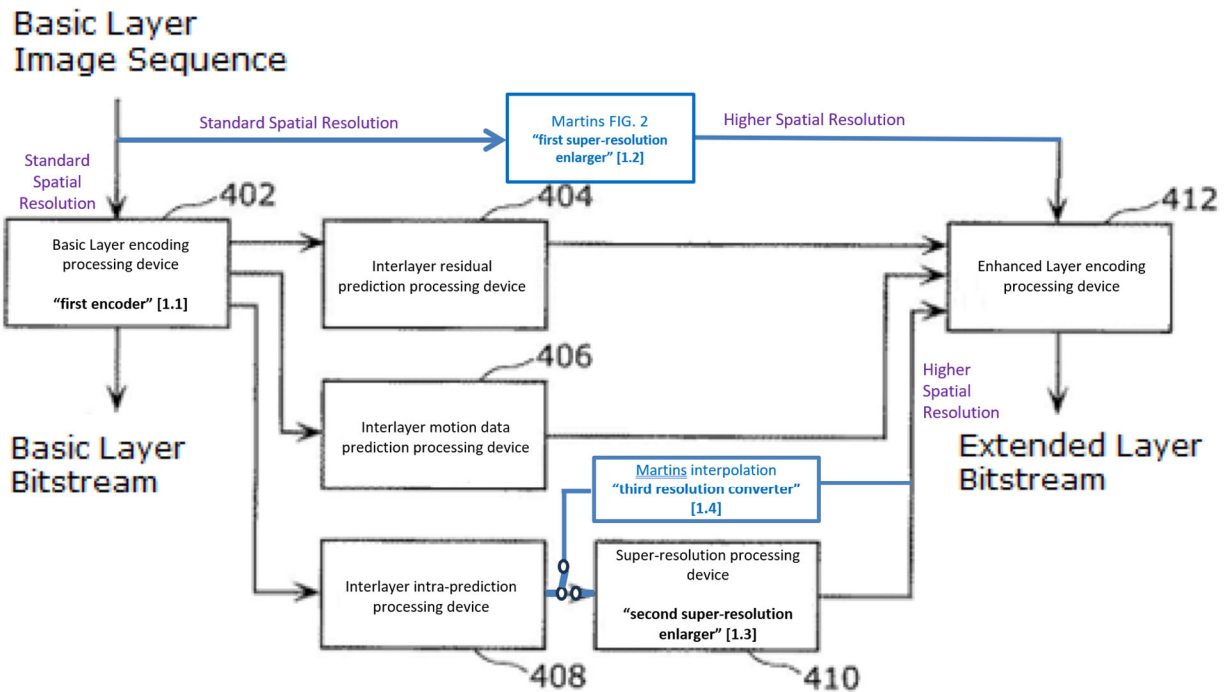


Illustration of Phek-Martins-He Combination (second example).

Phek's encoding device in FIG. 4a includes (i) basic layer encoding processing device 402 that encodes a basic layer image sequence, (ii) interlayer intra-prediction processing device 408 that "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 (iii) super-resolution processing device 410 that "performs residual interpolation" and "improve[s]" the "additional reference images." Ex.1005, [0014].

As discussed, Phek does not expressly disclose (nor does it restrict) the type(s) of hierarchical coding that can be implemented by its system. Ex.1005, [0014]; *supra*,

§§IV.A.1, IV.A.4.a-b. However, a POSITA understood that a common form of scalable coding is for transmission of base and enhancement layers differentiated by spatial resolution (“*encoding of a sequence of moving pictures with a resolution higher than a standard resolution*”). Ex.1003, ¶261.

Phek’s “basic layer image sequence” corresponds to the recited “*sequence of moving pictures with the standard resolution.*” As shown in the annotated figures above, demonstrating the combined teachings of Phek, Martins, and He, the extended layer image sequence of Phek may be generated from Phek’s basic layer image sequence (via, e.g., the teachings of either Phek or Martins). Thus, the “*sequence of moving pictures with a resolution higher than a standard resolution*” may be generated “*using moving pictures contents which include a sequence of moving pictures with the standard resolution and do not include a sequence of moving pictures with a resolution higher than the standard resolution,*” that is, only the basic layer image sequence is used, and not any pictures with a higher resolution. *Infra*, §IV.B.2-3. The “*moving picture encoding system*” of the combination as shown in the annotated figures therefore renders obvious the preamble. Ex.1003, ¶¶258-264.

2. [1.1] a first encoder configured to work on 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

Phek-Martins-He renders obvious [1.1]. Ex.1003, ¶¶265-267. Specifically, the combination includes Phek's FIG.4a encoder for "hierarchical encoding" which "uses interlayer prediction" where "[a] basic layer image sequence is encoded using a basic layer encoding processing device 402." Ex.1005, [0014].

Basic layer encoding processing device 402 ("***first encoder***") processes the basic-layer image sequence ("***sequence of moving pictures with a standard resolution***") to implement a process of encoding to create a bitstream for the basic-layer image sequence ("***first sequence of encoded bits***") and decoding to create a decoded set of the basic-layer image sequence for use by interlayer residual prediction processing device 404, interlayer motion data prediction processing device 406, and interlayer intra-prediction processing device 408 ("***set of decoded pictures with the standard resolution***"). See Ex.1005, [0014] ("reconstructed image of the basic layer"); Ex.1003, ¶¶266-267; *supra*, §IV.A.1. The basic layer image sequence is encoded and decoded with a first spatial resolution ("***standard resolution***"). *Supra*, §IV.A.1; Ex.1005, [Phek] [0014]; Ex.1003, ¶¶266-267.

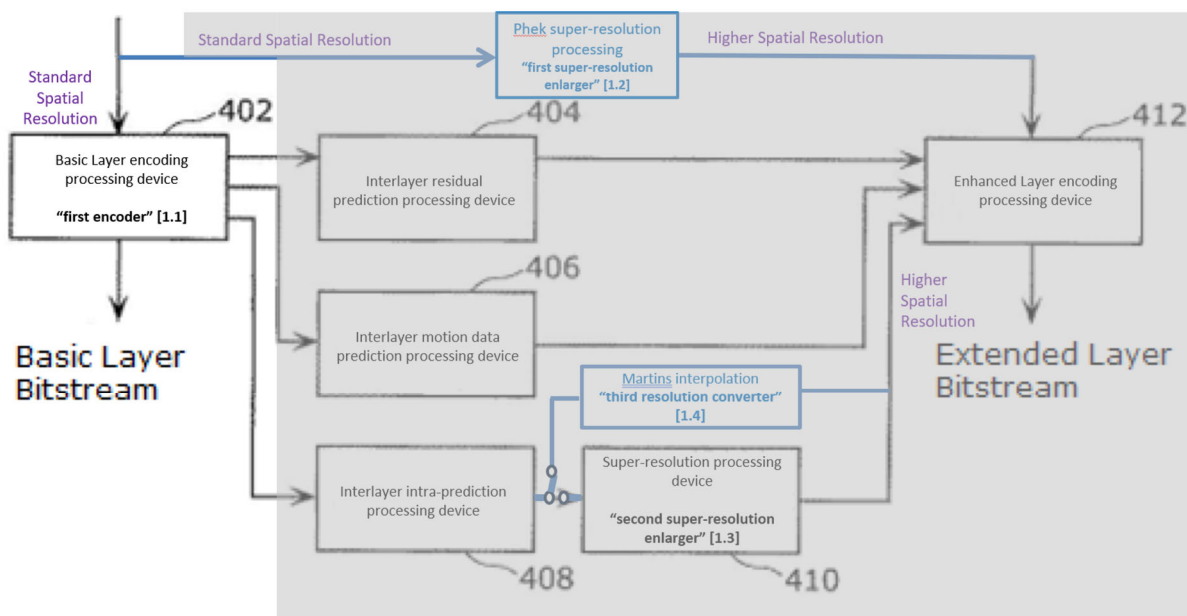
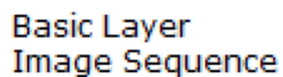


Illustration of Phek-Martins-He Combination (first example).

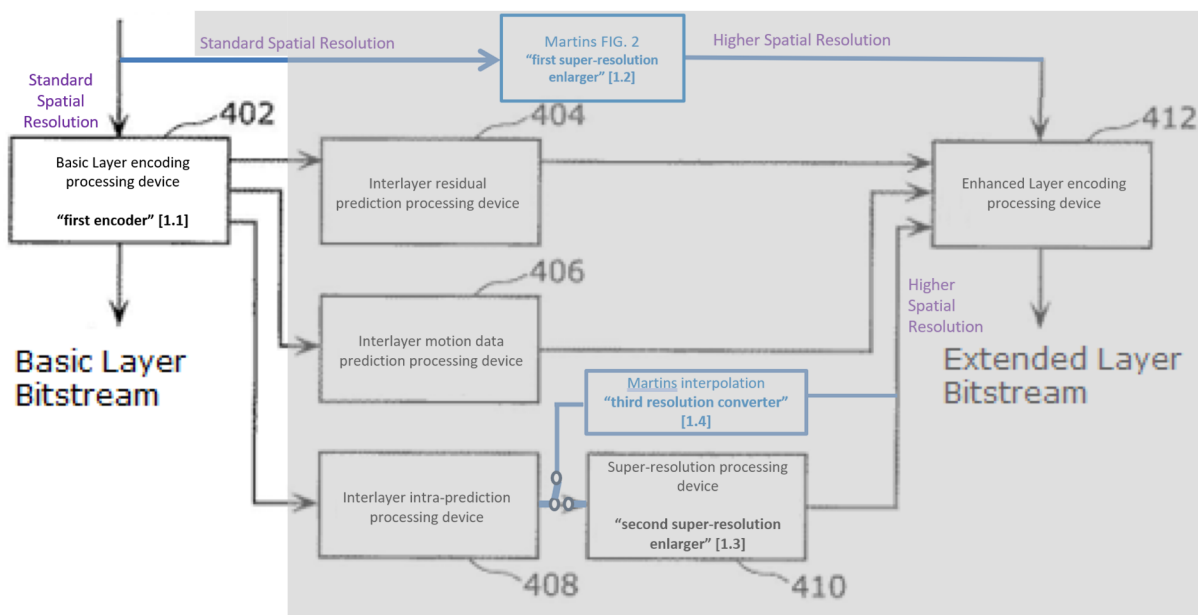
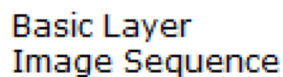


Illustration of Phek-Martins-He Combination (second example).

3. **[1.2] a first super-resolution enlarger configured to work on the sequence of moving pictures 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**

Phek-Martins-He renders obvious [1.2]. Ex.1003, ¶¶268-277. Phek explains that “[s]uper-resolution processing is a technique for generating high-resolution images from a plurality of low-resolution images.” Ex.1005, [0002], *see also* [0003]-[0009]. Phek describes an improved super-resolution processing method with respect to FIGS. 1, 5, and 6. Ex.1005, [0016]-[0020]. Applying super-resolution processing to an image enhances 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 picture sequence. Ex.1005, [0011], FIGS. 1, 5, 6a-6b.

With respect to Fig. 1a, Phek’s “processing devices (functional block) in the super-resolution processing device)” include “interpolation processing device 110” which uses interpolation to create “the initial high-resolution estimated image” as well as a “motion detection processing device 102” and “registration processing device 104.” Ex.1005, [0016], Fig. 1a. The functional blocks of Fig. 1a create a “high-resolution estimated image” and repeatedly process the image “until a predetermined number of cycles has been reached, or until the values of the enhancement coefficients fall below a certain threshold value.” Ex.1005, [0016], Fig. 1a.

Phek's super-resolution technique corresponds to the "enlargement" recited in this limitation: "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." Ex.1005, [0003]; Ex.1001, 22:17-29 ('448 Patent describing registration function as an example of super-resolution enlargement).

Phek's hierarchical encoding system in Figure 4a 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. Ex.1005, [0010], [0014], FIG. 4A. However, while Phek focuses on improving reference images for inter-layer prediction by super-resolution processing, Phek more generally 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." Ex.1005, [0002].

Phek's hierarchical encoding system includes enhanced layer encoding processing device 412 configured to encode an enhanced layer image sequence. Ex.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* §IV.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. Ex.1005, [0014], FIG. 4a; §IV.A.4.a. The encoding system would thus employ a super-resolution processing device, e.g., Phek's super-resolution processing device depicted in Figures 1a or 1b, 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 the extended layer image sequence. Ex.1005, [0002]-[0003], [0010], [0016]-[0020], [0014], FIGS. 1-2, 4A, 5, 6A-6B; *supra*, §IV.A.4.a.

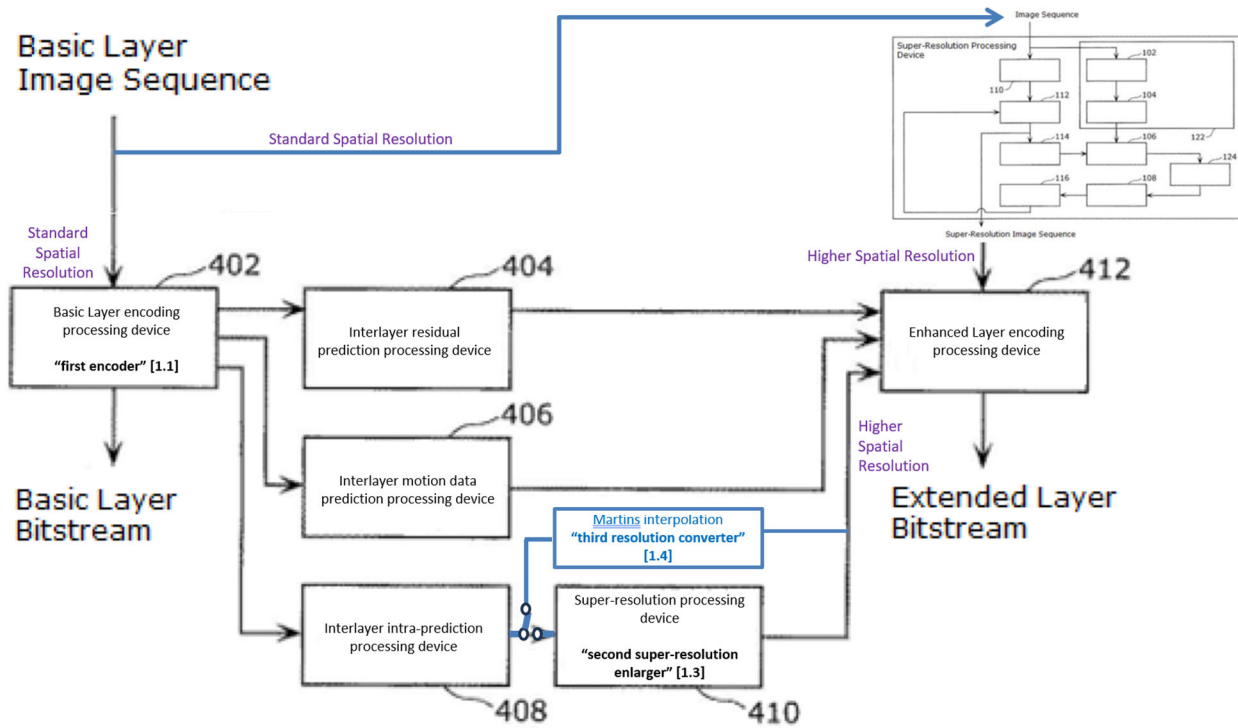


Illustration of Phek’s creation of superresolution enlarged pictures from the sequence of moving pictures as taught by Fig. 1a (first example).

Additionally or alternatively, as discussed, Martins’ FIG. 2 discloses “combining multiple pictures to form a single super-resolution picture” using an algorithm “based on motion-compensated spatial upsampling from multiple images.” Ex.1007, Abstract; *supra*, §§IV.A.2, IV.A.4.a-b. Martins explains this algorithm in Section III, “Upsampling to Superresolution Using Motion Compensation,” which includes alignment of pixels of a current picture with pixels of reference pictures using motion estimation, and then combining that information from reference pictures to form a superresolution picture. Ex.1007, p. 805. Martins states that the

“term *superresolution picture* is used to refer to the initial MC [motion compensated] upsampled high-resolution image.” Ex.1007, p. 805.

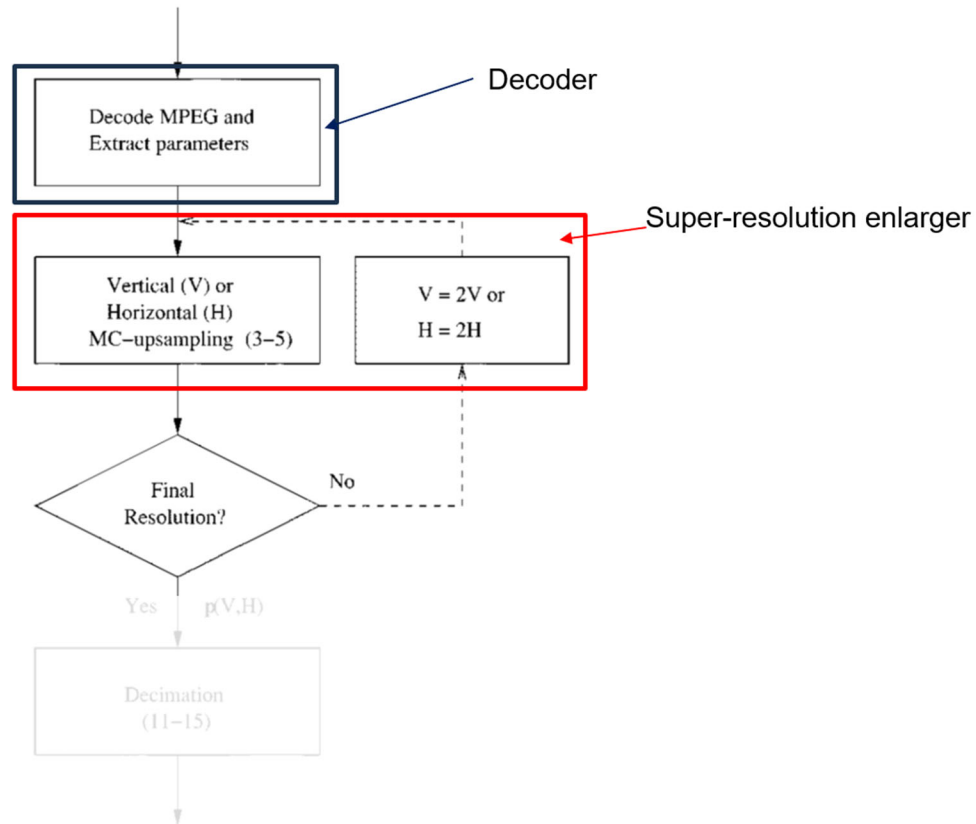


Fig. 2. Overview block diagram. MC upsampling alternates between doubling the resolution vertically and horizontally. Then final step is decimation to the desired format. Equation numbers are given in (). Dashed line marks control flow.

Ex.1007, FIG. 2 (annotated).

In the combination, Martins’ upsampling technique (i.e., enlargement) is applied to the basic layer image sequence (“*sequence of moving pictures with the standard resolution*”) to create the extended layer image sequence in the enhancement layer “to form a single super-resolution picture” (“*to implement a process for a first super-resolution enlargement to create a set of super-resolution*

enlarged pictures with a first resolution higher than the standard resolution”)

prior to the encoding processing device 412’s processing. *Id.*; see also Abstract (“obtain a sequence of higher fidelity.”). A POSITA would have understood that Martins’ upsampling technique can be applied to the basic layer image sequence of Phek prior to the encoding processing device 412’s processing. Ex.1003, ¶¶268-277.

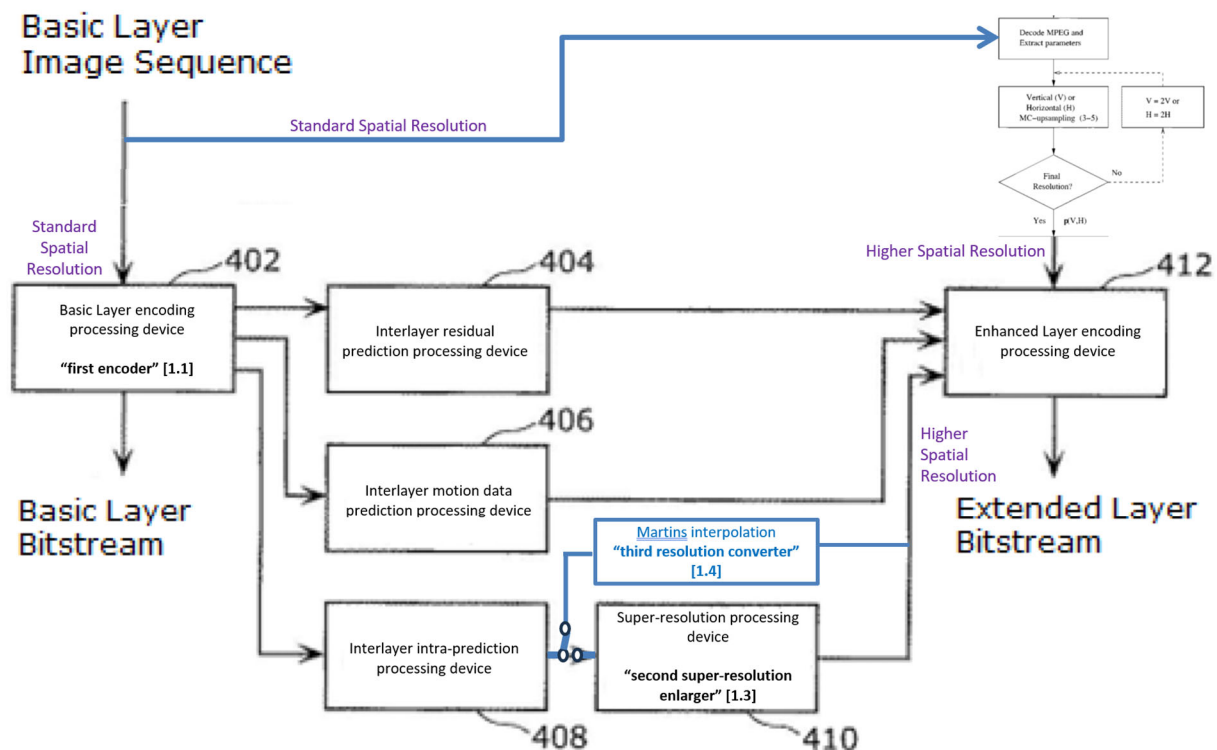


Illustration of using Martins’ super-resolution algorithm for generating Extended Layer Image Sequence (second example)

4. [1.3] a second super-resolution enlarger configured to acquire the set of decoded pictures from the first encoder to implement thereon a process for a second super-resolution enlargement to create a set of super-resolution enlarged

decoded pictures with a resolution higher than the standard resolution

Phek-Martins-He renders obvious [1.3]. Ex.1003, ¶¶278-284. In FIG. 4a, Phek describes a “super-resolution processing device 410...used to improve the[] additional reference images” provided by interlayer intra-prediction processing device 408, which “uses an intra image of the basic layer or a reconstructed image of the basic layer for encoding the image of the enhanced layer” based on the basic layer image sequence received by basic layer encoding processing device 402. Ex.1005, [0014], FIG. 4a; Ex.1003, ¶279. Super-resolution processing device 410 “performs residual interpolation.” Ex.1005, [0014]; Ex.1003, ¶280. Phek explains “super-resolution processing...improve[s] encoding efficiency or picture quality by improving the reference frames used for motion detection, motion compensation prediction, and display.” Ex.1005, [0013], [0014]. Super-resolution processing device 410 is thus a “*second super-resolution enlarger*” configured to acquire reference images (“*set of decoded pictures with the standard resolution*”) from basic layer encoding processing device 402 (“*first encoder*”), which encoded the basic layer image sequence to produce the set of decoded reference images, through interlayer intra-prediction processing device 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.*” Ex.1003, ¶280.

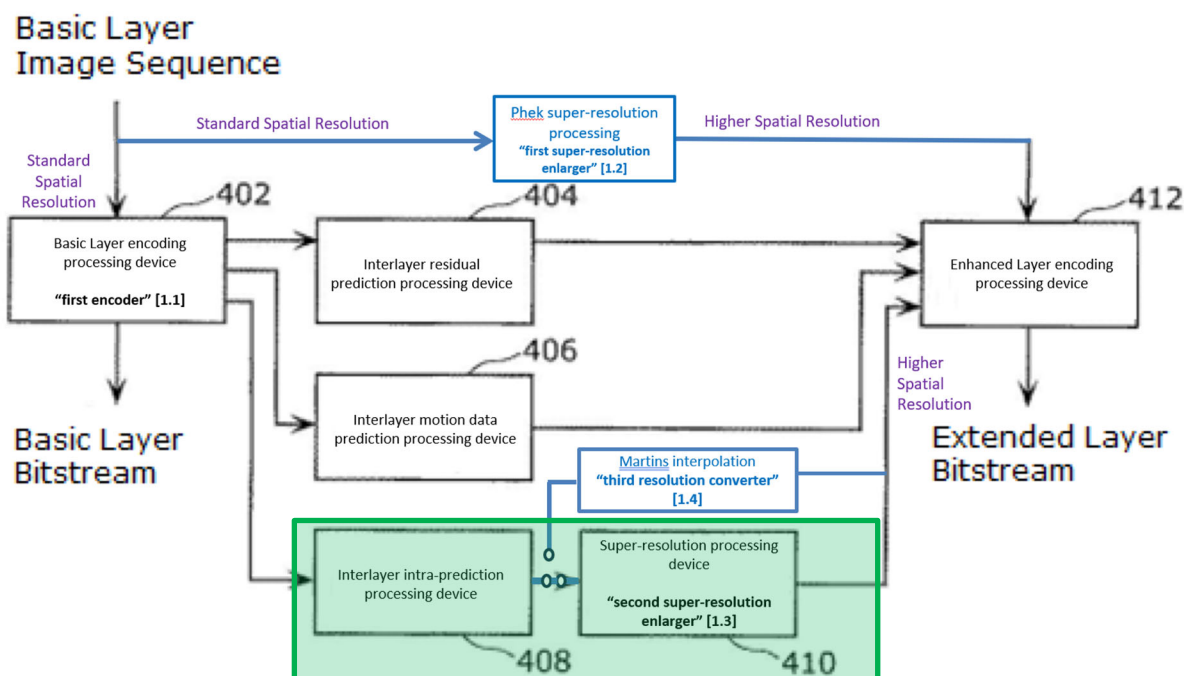


Illustration of Phek-Martins-He Combination (first example).

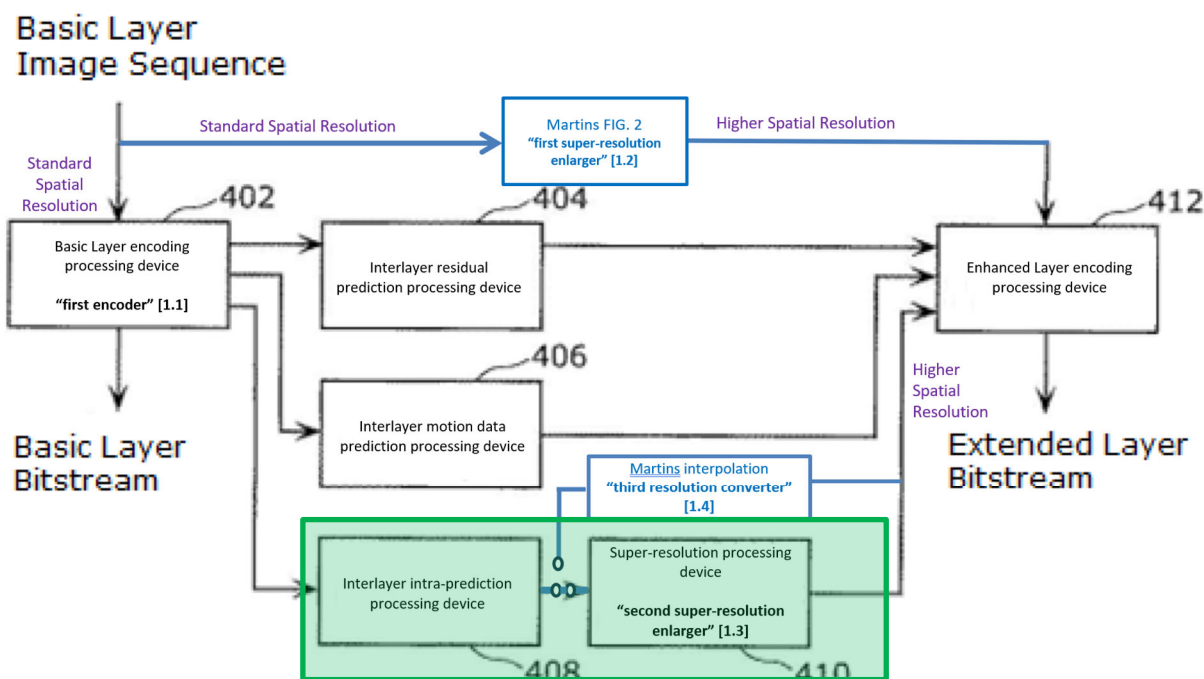


Illustration of Phek-Martins-He Combination (second example).

Phek's super-resolution processing creates a super-resolution enlarged image with improved quality and higher spatial resolution than individual lower-resolution images used as input. *Supra*, §IV.A.1; Ex.1005, [0002]; Ex.1003, ¶281.

Thus, Phek's super-resolution processing device 410 outputs "***a set of super-resolution enlarged decoded pictures with a second resolution higher than the standard resolution.***" Ex.1003, ¶282.

Martins' super-resolution processing and enlargement techniques would also have been obvious to apply in addition to or as an alternative to Phek's super-resolution algorithm. *Supra*, §§IV.A.2, IV.A.4.a-b. Martins' super-resolution enlarger uses "spatial interpolation" to enlarge an image, which improves "quality and spatial resolution of video" by combining multiple images. *Supra*, §IV.B.3; Ex.1007, Abstract, 5, FIG. 2. Martins obtains the super-resolution images using an algorithm "based on motion-compensated upsampling from multiple images and decimation to the desired format." *Supra*, §IV.A.2; Ex.1007, Abstract; Ex.1003, ¶¶283-284.

5. [1.4] **a third resolution converter configured to acquire the set of decoded pictures from the first encoder to implement thereon a process for a third resolution conversion to create a set of resolution converted enlarged decoded pictures with a resolution higher than the standard resolution**

Phek-Martins-He renders obvious [1.4]. Ex.1003, ¶¶285-291. Phek discloses that the basic layer encoding processing device 402 ("***first encoder***") creates a

decoded set of the basic-layer image sequence (“*set of decoded pictures with the standard resolution*”). Ex.1005, [0014]; Ex.1003, ¶286; *supra*, §IV.B.2.

As discussed, Phek, discloses this set of decoded base layer images is used as reference pictures for the interlayer prediction of enhancement layer images. Ex.1003, ¶287; Ex.1005, [0014] (“uses...reconstructed image of the basic layer as an additional reference image for encoding the image of the enhanced layer”); *supra*, §IV.A.1.

In the combined teachings of Phek-Martins-He, based on the teachings of He, a POSITA would have recognized that in some instances, super-resolution processing may not be applied, for example, if super-resolution processing does not improve the reference picture significantly. As discussed, He teaches that SR-U processors, which form a loop filter analogous to He’s deblocking loop filter, can be selectively applied to filter/enhance reference pictures in an enhancement layer of a layered video coding (e.g., SVC) system. Ex.1008, [0034]. *See also, id.*, [0006]-[0008], [0023]-[0035], [0086]-[0087], FIGs. 1-3, 7; *supra*, §IV.A.4.b. When SR-U filtering is not applied (bypassed) to a sequence of images, enhanced layer encoding processing device 412 uses the decoded base layer sequence of images (rather than SR-U filtered versions) acquired by inter-layer intra-prediction processing device 408 as a set of reference pictures. *Id.*; Ex.1003, ¶288.

A POSITA would have found it obvious that the decoded base layer sequence of images would need to be upscaled (resolution converted) to the same (higher) spatial resolution as the encoding target image sequence in order to efficiently serve as reference pictures, and that this upscaling would be done by a “**resolution converter.**” Ex.1003, ¶289 (also noting this is consistent with Phek, which discloses the use of interpolation when super-resolution is not used to create missing pixels in the high-resolution picture, *see* Ex.1005, [0004-0005], [0016]; *supra*, §IV.A.4.a-b.

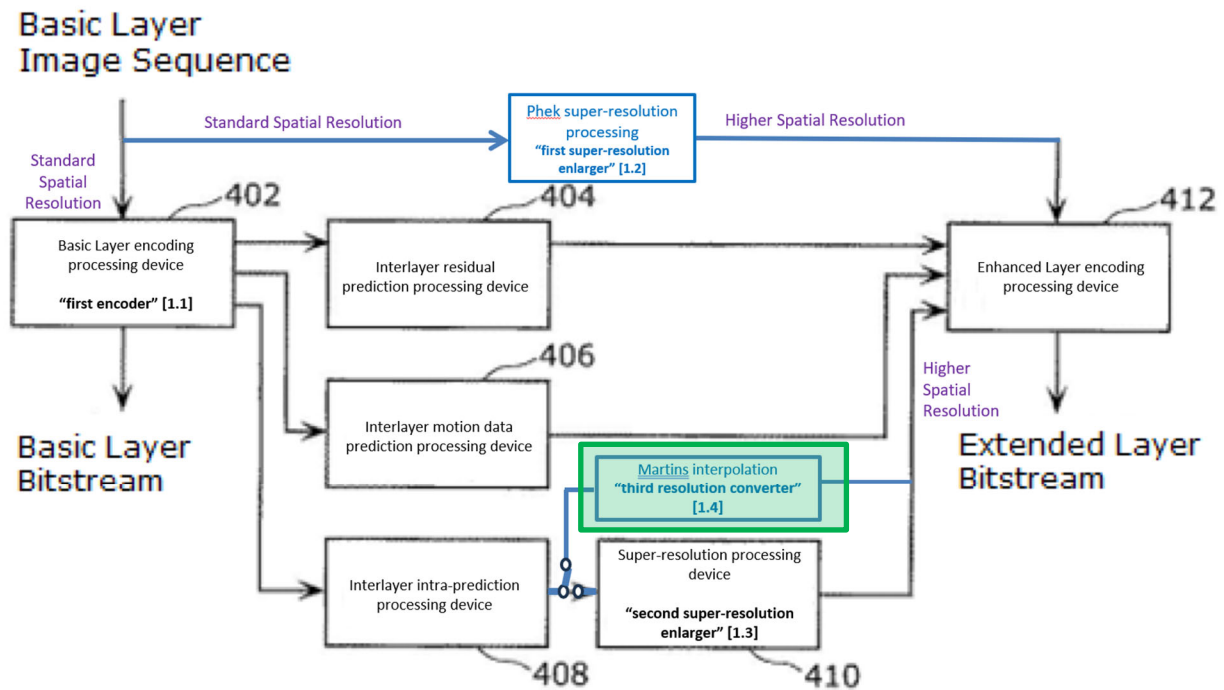


Illustration of Phek-Martins-He Combination (first example).

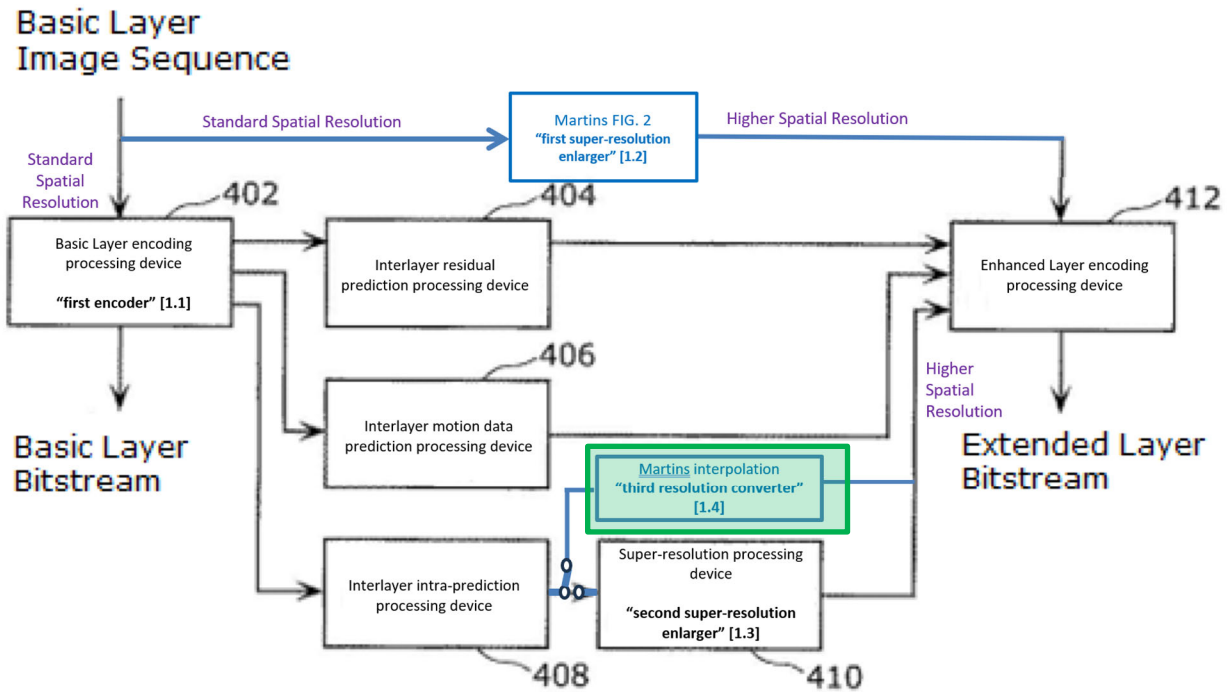


Illustration of Phek-Martins-He Combination (second example).

Upscaling, or resolution conversion, of the decoded base layer sequence of images would have been obvious given the teachings of Martins' super-resolution algorithm. For example, (like Phek) Martins explains that its algorithm may result in some pixels of the super-resolution picture being "undefined because there was no accurate match (of adequate quality) in any of the reference pictures." Ex.1007, 807. Such pixels are therefore "assigned values from an **interpolated superresolution picture** ... having the same resolution" as the super-resolution picture obtained by motion compensation upsampling. Ex.1007, 807; Ex.1003, ¶290. A POSITA would have recognized that interpolation, as Martins teaches, is the same

method that the '448 Patent itself achieves resolution conversion (*see* Ex.1001, 25:1-41), and thus, Martins' teachings of assigning values from an interpolated super-resolution picture teaches the "***third resolution converter***" as recited. Ex.1003, ¶291.

6. [1.5] a third encoder configured to have the set of super-resolution enlarged pictures from the first super-resolution enlarger as a set of encoding target pictures, employing the set of super-resolution enlarged decoded pictures from the second super-resolution enlarger and the set of resolution converted enlarged decoded pictures from the third resolution converter as sets of reference pictures, to implement thereon a third combination of processes for a prediction and an encoding to create a third sequence of encoded bits

Phek-Martins-He renders obvious [1.5]. As discussed, Phek discloses, and the combination includes, enhanced layer encoding processing device 412 that provides a "***third encoder.***" Ex.1005, [0014], FIG. 4a. Enhanced layer encoding processing device 412 encodes the basic layer image sequence received and superresolution enlarged either by Phek Fig. 1a or Martins Fig. 2 as a set of encoding target pictures, employing as reference pictures the pictures decoded by basic layer encoding processing device 402, processed through the interlayer intra-prediction processing device 408, and either processed via the super-resolution processing device 410 taught by Phek, the superresolution device taught by Martins (claimed "***second super-resolution enlarger***"), or the resolution converter as taught by Martins (the claimed "***third resolution converter***"). Ex.1005, [0014]; Ex.1003, ¶292.

Basic Layer Image Sequence

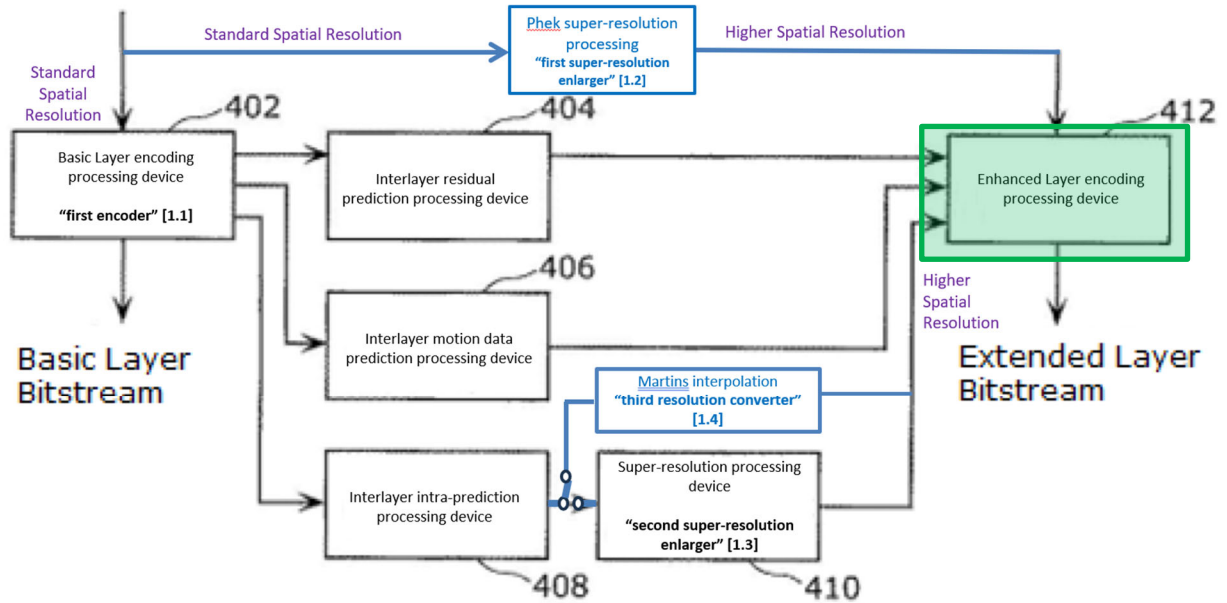


Illustration of Phek-Martins-He Combination (first example).

Basic Layer Image Sequence

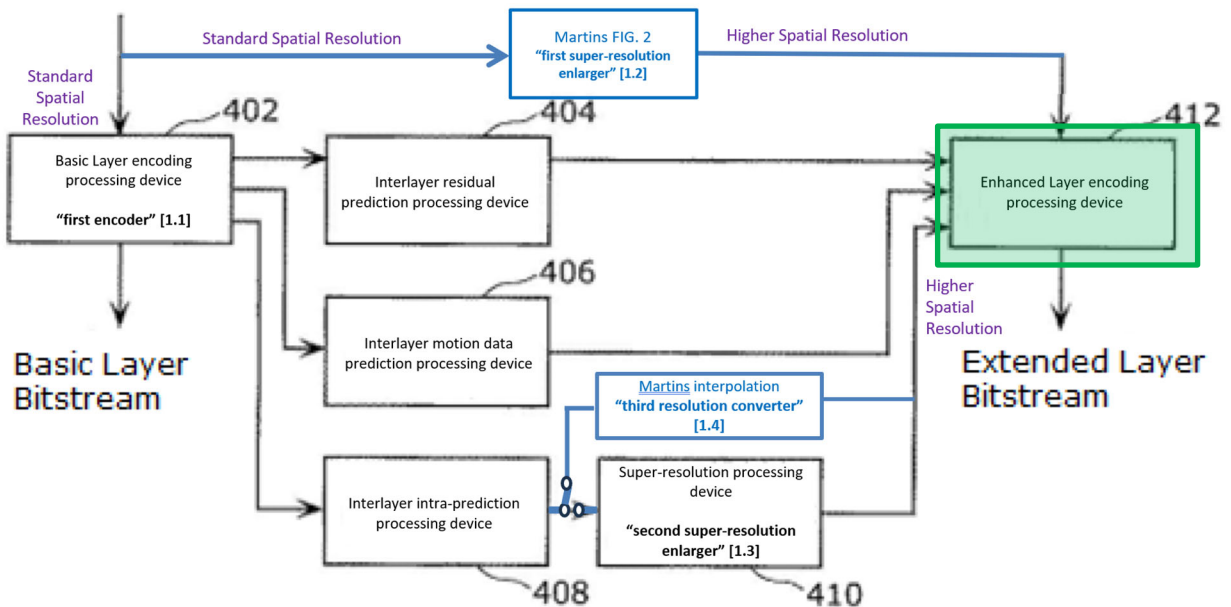


Illustration of Phek-Martins-He Combination (second example).

Phek teaches enhanced layer encoding processing device 412 acquires the higher spatial resolution image sequence from the first super-resolution enlarger taught by Phek or Martins (“***set of super-resolution enlarged pictures***”). Ex.1005, [0014], FIG. 4a; Ex.1003, ¶293. Enhanced layer encoding processing device 412 acquires the higher spatial resolution image sequence as “***a set of encoding target pictures***” allowing the third encoder to encode the enhancement/extended layer bigstream (e.g., using residual values that represent differences between predicted pictures and target pictures in the enhancement stream). Ex.1005, [0014], FIG. 4a; Ex.1003, ¶293. The combination’s third encoder is also configured to acquire (i) “***the set of super-resolution enlarged decoded pictures***” from the second super-resolution enlarger, and (ii) “***the set of resolution converted enlarged decoded pictures***” from the third resolution converter. Ex.1005, [0014], FIG. 4a; Ex.1003, ¶293.

Phek discloses that, at the encoder, “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 “super-resolution processing device 410 is used to improve these additional reference images.” Ex.1005, [0014]. Based on fundamental decoding techniques, it would have been obvious that inter-layer intra-prediction processing

device 408 obtains decoded base layer images as reference pictures for the interlayer prediction of enhancement layer images. Ex.1003, ¶294.

Further, He teaches that SR-U processors, which form a loop filter analogous to He's deblocking loop filter, can be selectively applied to filter/enhance reference pictures in an enhancement layer of a layered video coding (e.g., SVC) system. Ex.1008, [0034]. *See also, id.*, [0006]-[0008], [0023]-[0035], [0086]-[0087], FIGs. 1-3, 7; *supra*, §IV.A.4.c. When applying SR-U filtering to a sequence of images, enhanced layer encoding processing device 412 acquires SR-U filtered versions of the decoded base layer sequence of images (“***set of super-resolution enlarged decoded pictures from the second super-resolution enlarger***”) as a set of first reference pictures. Ex.1005, [0014]-[0015], FIG. 4b; *supra*, §IV.A.4.b. When SR-U filtering is not applied (bypassed) to a sequence of images, enhanced layer encoding processing device 412 uses the decoded base layer sequence of images (rather than SR-U filtered versions) acquired by inter-layer intra-prediction processing device 408 and resolution converted as a set of second reference pictures (“***set of resolution converted enlarged decoded pictures from the third resolution converter***”). *Id.*; Ex.1003, ¶¶295-296.

The combination's “***third encoder***” thus acquires the SR-U filtered first set of reference pictures when SR-D filtering is enabled and acquires the decoded, resolution converted base layer sequence of images as a set of second reference

pictures both when SR-U filtering is enabled (as needed to perform the SR-U filtering) and when it is not. Ex.1003, ¶¶297-299.

The following figures illustrate using the SR-U filtered version of decoded base layer images as a set of first reference pictures when the SR-U filter is enabled:

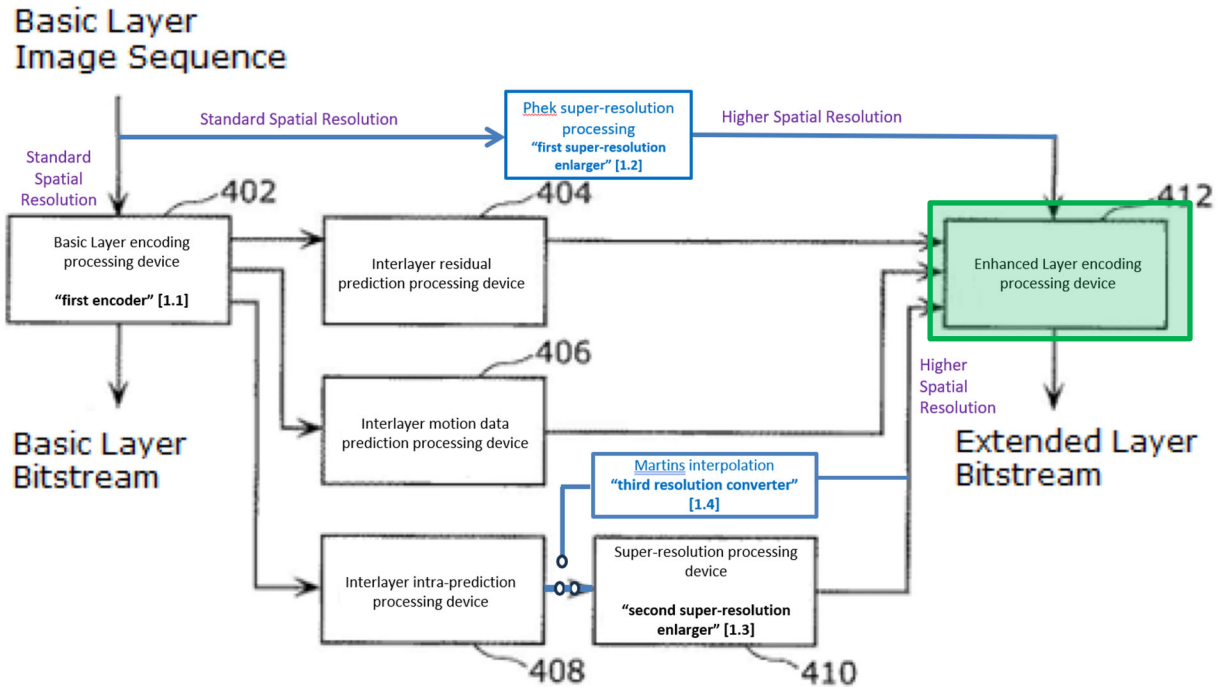


Illustration of Phek-Martins-He Combination (first example) (1st reference picture).

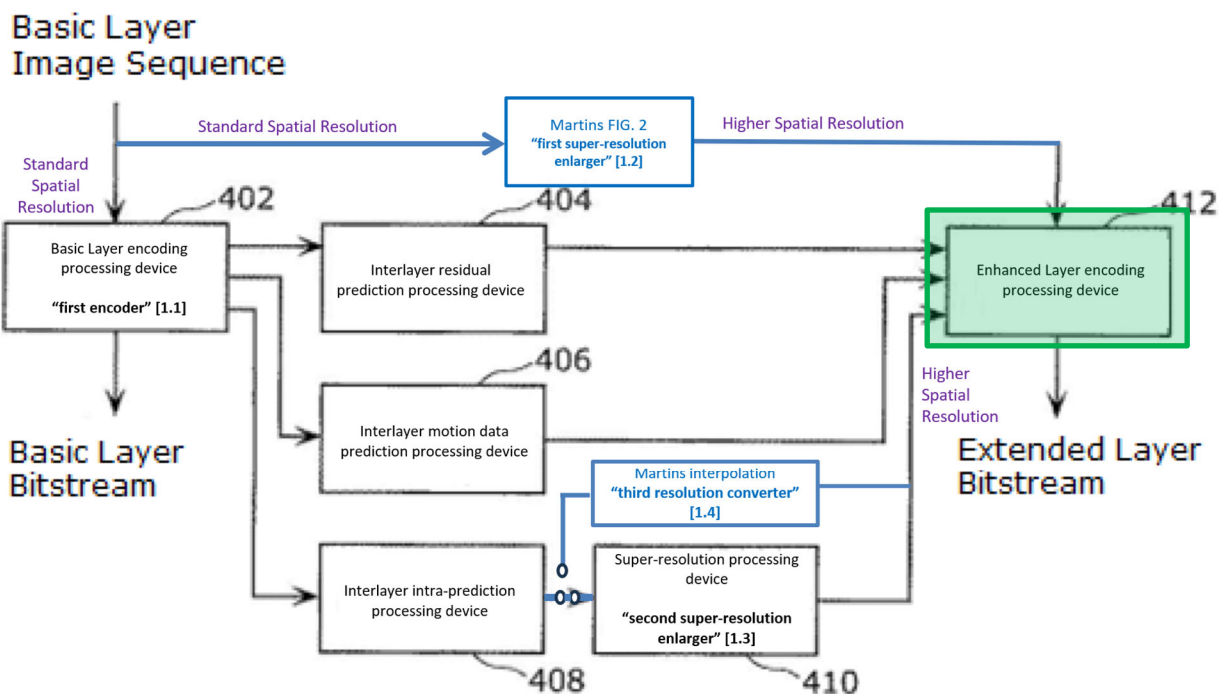


Illustration of Phek-Martins-He Combination (second example) (1st reference picture).

By contrast, the following figures illustrate using the non-SR-U filtered version of decoded base layer images as a set of second reference pictures when the SR-U filter is disabled:

Basic Layer Image Sequence

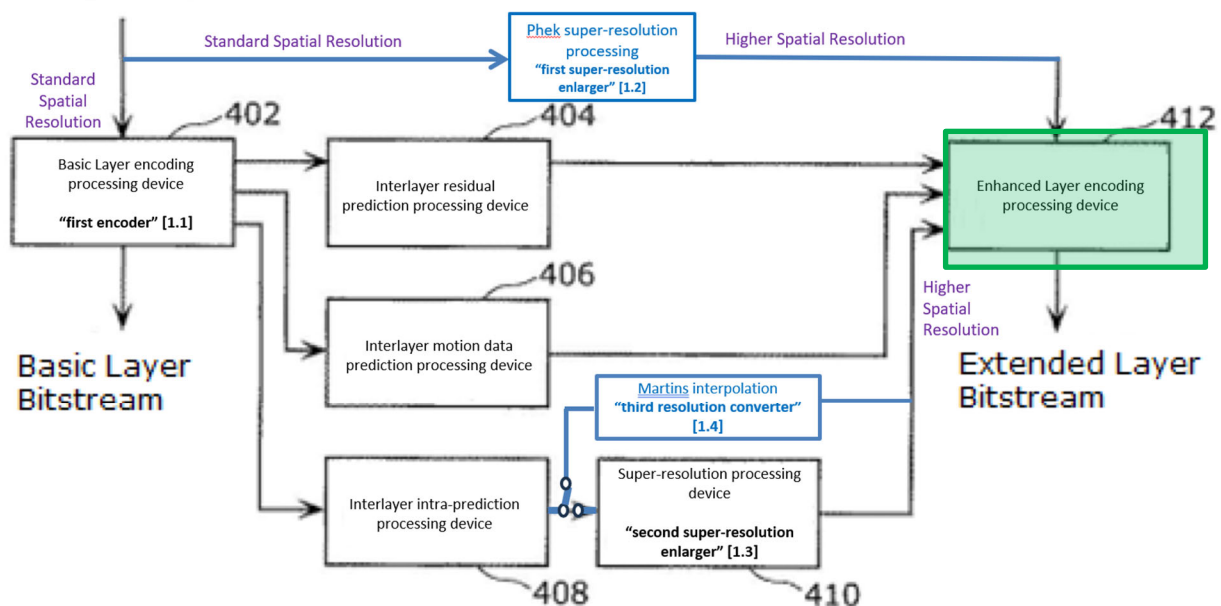


Illustration of Phek-Martins-He Combination (first example) (2nd reference picture).

Basic Layer Image Sequence

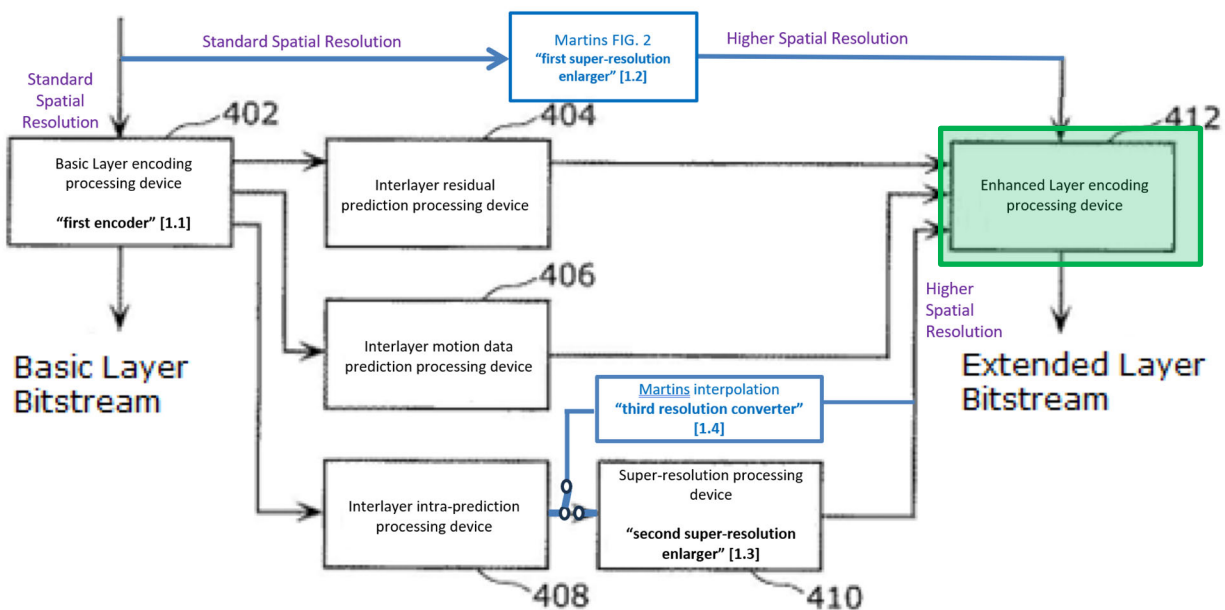


Illustration of Phek-Martins-He Combination (second example) (2nd reference picture).

7. **[1.6] wherein a spatial resolution of the set of super-resolution enlarged pictures, that of the set of super-resolution enlarged decoded pictures, and that of the set of resolution converted enlarged decoded pictures are made equal**

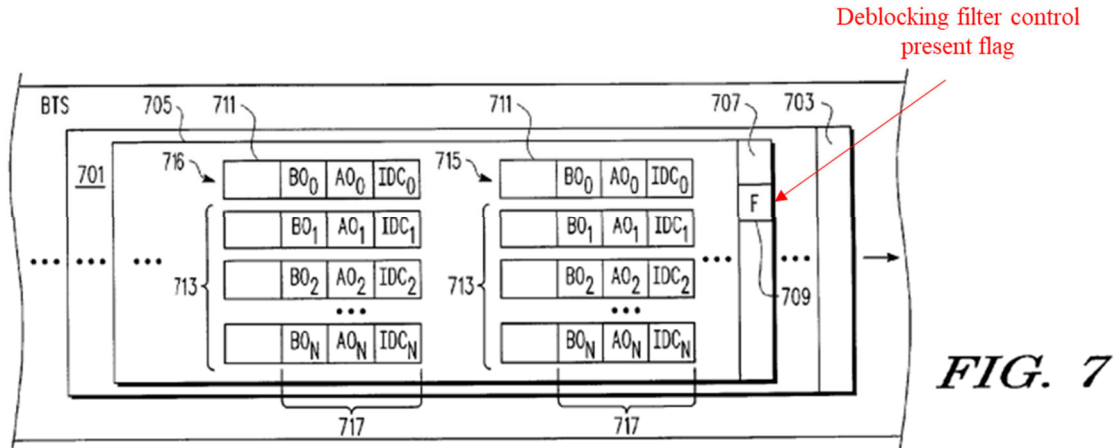
Phek-Martins-He renders obvious [1.6]. It would have been obvious to implement the Phek-Martins-He combination's encoding device such that the set of encoding targets, set of first reference pictures (e.g., decoded base layer pictures with SR-U filtering), and set of second reference pictures (e.g., resolution converted enlarged decoded base layer pictures without SR-U filtering) have the same resolution. *Supra*, §§IV.A.4.a-b; Ex.1003, ¶300.

8. **[1.7] wherein the third encoder controls a selection of a set of reference pictures and creates a set of data on the selection of the set of reference pictures to identify a selected set of reference pictures during the process for prediction of the third combination**

The combination's enhancement layer encoding device 412 encodes pictures in the enhancement layer bitstream using either decoded base layer pictures enhanced by SR-U filtering (“*the set of super-resolution enlarged pictures from the first super-resolution enlarger*”) or decoded base layer pictures not enhanced by SR-U filtering (“*the set of resolution converted enlarged decoded pictures from the third resolution converter*”). Ex.1003, ¶301. Enhancement layer encoding processing device 412 (and/or other components in the enhancement layer corresponding to the “*third encoder*”) selects whether to use SR-U filtered or non-filtered reference

pictures based on control information, such as a MINSAD (minimum sum of absolute differences) value used to measure complexity of the video content, motion vectors, or a power saving factor (PSF), based on He. Ex.1008, [0029]-[0031], FIG. 1; *see also supra*, §IV.A.4.c; Ex.1003, ¶¶302-309.

He discloses “a deblocking control flag of scalable video system for indicating presentation of deblocking parameters for multiple layers” in a bitstream. Ex.1008, [0002]. “The deblocking parameters determine whether deblock filtering is enabled or disabled” where the parameter is “set to ‘0’ to enable deblock filtering and to ‘1’ to disable deblock filtering.” Ex.1008, [0007]. He’s FIG. 7 illustrates “deblocking filter control information provided in an output bitstream BTS...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’.” Ex.1008, [0052]; Ex.1003, ¶303.



Ex.1008, FIG. 7

He's FIG. 2 discloses deblock control circuit 221 which, based on the deblocking control flag, issues control signals to deblocking filter 131 to selectively enable/disable use of a deblock filter on reconstructed (decoded) frames. Ex.1008, FIG. 2, [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 disabled, the original (unfiltered or non-enhanced) reconstructed frame is used as the reference picture for prediction of a subsequent frame. *Id.*, [0034]; Ex.1003, ¶304.

He's "deblocking filter 211 is configured in a similar manner as the deblocking filter 131, and includes a similar decoder filter control DFC signal provided by a deblock control circuit 221....if the deblocking filter 211 is disabled, then the unfiltered reconstructed frame information URF' is passed as the "filtered"

reconstructed information RF' in which deblock filtering is bypassed.” Ex.1008, [0034]; Ex.1003, ¶¶305-306.

It would have been obvious to implement an analogous “control circuit” in the Phek-Martins combination configured to selectively enable/disable SR-U filtering of base layer frames used to predict enhancement layer frames. Ex.1003, ¶¶307-308. It would have been obvious for the control circuit to be configured to selectively enable/disable the super-resolution enlarger and upscaler circuits, which form a loop filter analogous to He’s deblock filter. *Supra*, §IV.A.4.b; Ex.1003, ¶¶307-308.

Basic Layer Image Sequence

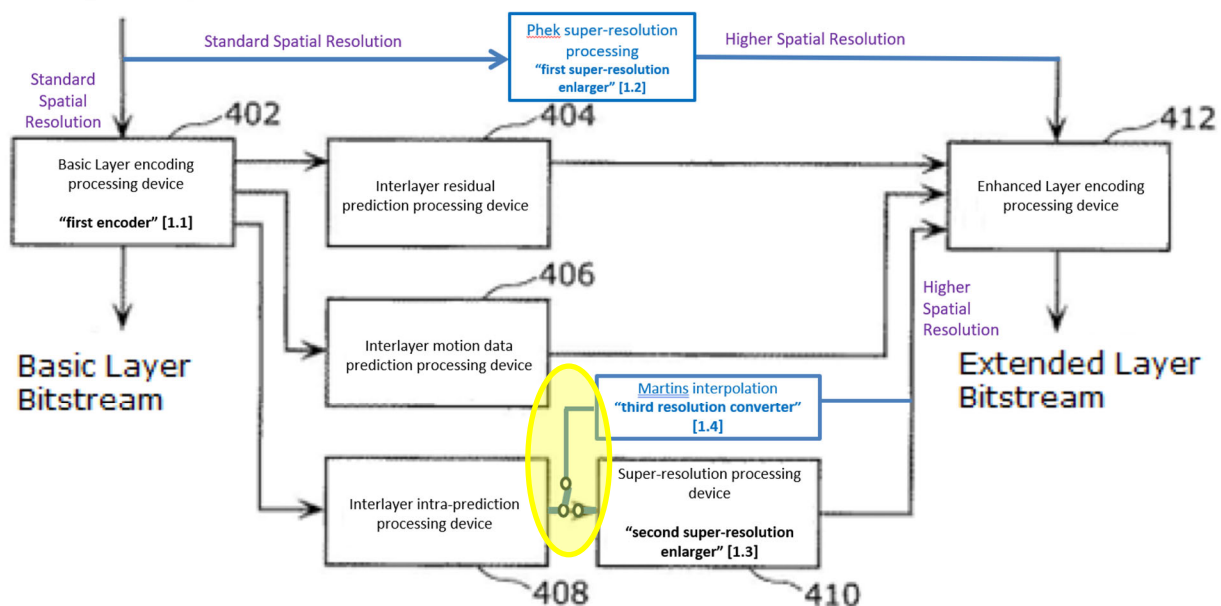


Illustration of Phek-Martins-He Combination (first example) (reference picture selection).

Basic Layer Image Sequence

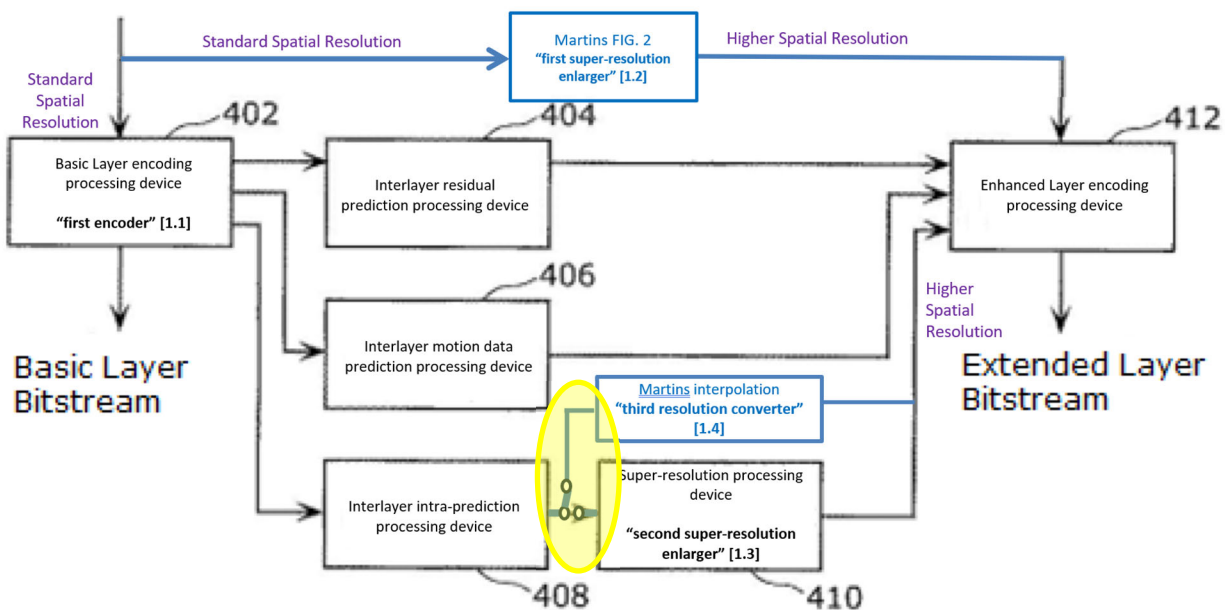


Illustration of Phek-Martins-He Combination (second example) (reference picture selection).

These figures illustrate selectivity of the SR-U filter in yellow. As illustrated above, the “*third encoder*” as implemented in the Phek-Martins-He combination selects either the super-resolution enlarged base-layer decoded pictures sequence (when SR-U filter is enabled) as the set of first reference pictures or the resolution converted enlarged base-layer decoded pictures sequence (when SR-U filter is disabled) as a set of second reference pictures. Control signals like He teaches (e.g., analogous to He’s “deblocking enable/disable parameter” and “deblocking control flag”) would thus be created by the “*third encoder*” in the combination to provide an enhancement-layer decoding path with “*a set of data on the selection of the set of reference pictures to identify a selected set of reference pictures.*” Ex.1003, ¶¶307-309. This is consistent with Martins’ teachings that “[e]ach pixel of the resulting superresolution picture ... is assigned the attribute of whether it was determined by motion compensation” (i.e., whether the pixel belongs to a super-resolution picture obtained by motion-compensated super-resolution processing) “... or interpolation” (i.e., whether the pixel belongs to an interpolated super-resolution picture). Ex.1007, 807. In other words, Martins teaches that super-resolution processing is enabled or disabled on a pixel-by-pixel basis, and an attribute (i.e., “*data*”) is assigned to determine whether a pixel is interpolated or super-resolution processed, as in the proposed combination on a picture basis. Ex.1003, ¶¶307-309.

C. Claim 2

1. **[2.P] A moving picture encoding system that makes an encoding of a sequence of moving pictures with a resolution higher than a standard resolution using moving pictures contents which include a sequence of moving pictures with the standard resolution and do not include a sequence of moving pictures with a resolution higher than the standard resolution, the moving picture encoding system comprising:**

Supra [1.P]; Ex.1003, ¶310.

2. **[2.1] a first encoder configured to work on 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**

Supra [1.1]; Ex.1003, ¶311.

3. **[2.2] a first super-resolution enlarger configured to work on the sequence of moving pictures 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**

Supra [1.2]; Ex.1003, ¶312.

4. **[2.3] a third resolution converter configured to acquire the set of decoded pictures from the first encoder to implement thereon a process for a third resolution conversion to create a set of resolution converted enlarged decoded pictures with a resolution higher than the standard resolution**

Supra [1.4]; Ex.1003, ¶313.

5. **[2.4] a third encoder configured to have the set of super-resolution enlarged pictures from the first super-resolution enlarger as a set of encoding target pictures, employing the set of resolution converted enlarged decoded pictures from the**

third resolution converter as a set of reference pictures, to implement thereon a third combination of processes for a prediction and an encoding to create a third sequence of encoded bits

The only difference between [2.4] and [1.5] is that [2.4] only requires one set of reference pictures, namely “the set of resolution converted enlarged decoded pictures from the third resolution converter.” Thus, the combination renders obvious this limitation for the same reasons as described for [1.5]. *Supra* [1.5]; Ex.1003, ¶314.

6. **[2.5] wherein a spatial resolution of the set of super-resolution enlarged pictures, and that of the set of resolution converted enlarged decoded pictures are made equal**

The only difference between [2.5] and [1.6] is that [2.5] only requires one set of reference pictures, namely “the set of resolution converted enlarged decoded pictures” to be made equal to the spatial resolution of the “the set of super-resolution enlarged pictures.” Thus, the combination renders obvious this limitation for the same reasons as described for [1.6]. *Supra* [1.6]; Ex.1003, ¶315.

7. **[2.6] wherein the third encoder controls a selection of a set of reference pictures and creates a set of data on the selection of the set of reference pictures to identify a selected set of reference pictures during the process for prediction of the third combination**

Supra [1.7]; Ex.1003, ¶316.

D. Claim 3

1. **[3.P] A moving picture encoding system that makes an encoding of a sequence of moving pictures with a resolution**

higher than a standard resolution using moving pictures contents which include a sequence of moving pictures with the standard resolution and do not include a sequence of moving pictures with a resolution higher than the standard resolution, the moving picture encoding system comprising

Supra [1.P]; Ex.1003, ¶317.

2. **[3.1] a first encoder configured to work on 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**

Supra [1.1]; Ex.1003, ¶318.

3. **[3.2] a first super-resolution enlarger configured to work on the sequence of moving pictures 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**

Supra [1.2]; Ex.1003, ¶319.

4. **[3.3] a second super-resolution enlarger configured to acquire the set of decoded pictures from the first encoder to implement thereon a process for a second super-resolution enlargement to create a set of super-resolution enlarged decoded pictures with a resolution higher than the standard resolution**

Supra [1.3]; Ex.1003, ¶320.

5. **[3.4] a third encoder configured to have the set of super-resolution enlarged pictures from the first super-resolution enlarger as a set of encoding target pictures, employing the set of super-resolution enlarged decoded pictures from the second super-resolution enlarger as a set of reference pictures, to implement thereon a third combination of**

processes for a prediction and an encoding to create a third sequence of encoded bits

The only difference between [3.4] and [1.5] is that [3.4] only requires one set of reference pictures, namely “the set of super-resolution enlarged decoded pictures from the second super-resolution enlarger.” Thus, Phek discloses this limitation for the same reasons as described for [1.5]. *Supra* [1.5]; Ex.1003, ¶321.

6. [3.5] wherein a spatial resolution of the set of super-resolution enlarged pictures, and that of the set of super-resolution enlarged decoded pictures are made equal

The only difference between [3.5] and [1.6] is that [3.5] only requires one set of reference pictures, namely “the set of super-resolution enlarged pictures” to be made equal to the spatial resolution of the “the set of super-resolution enlarged pictures.” Thus, the combination renders obvious this limitation for the same reasons as described for [1.6]. *Supra* [1.6]; Ex.1003, ¶322.

7. [3.6] wherein the third encoder controls a selection of a set of reference pictures and creates a set of data on the selection of the set of reference pictures to identify a selected set of reference pictures during the process for prediction of the third combination

Supra [1.7]; Ex.1003, ¶323.

V. Ground 2: Claims 1-3 are rendered obvious by Sakazume in view of Martins and He

A. Overview of the Prior Art

1. Sakazume (Ex.1046)

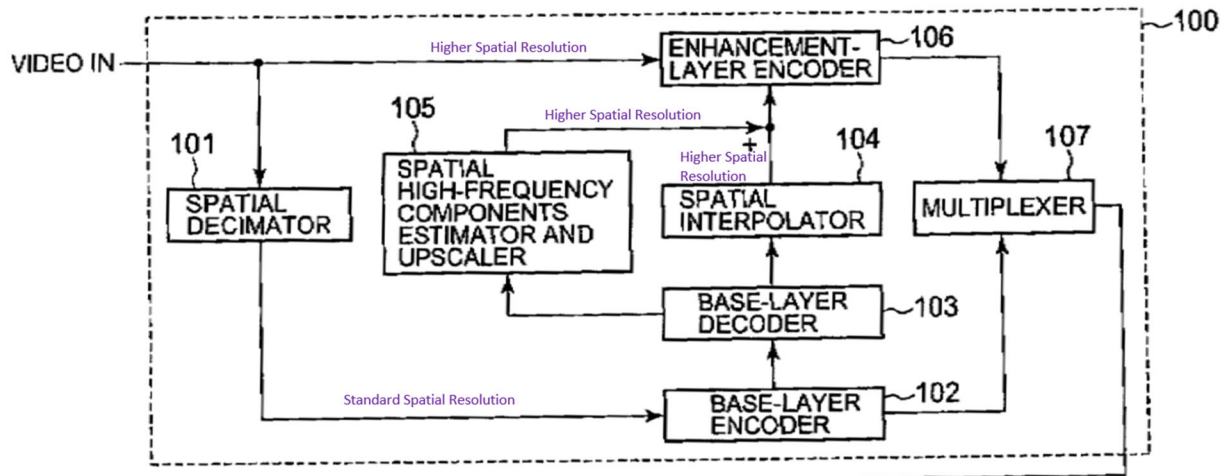
Sakazume⁸ discloses a video coding system where “input video signal is encoded at a plurality of coding layers exhibiting different spatial resolutions.” Ex.1046, Abstract.

In the system of Sakazume, considering the base layer spatial resolution signal entering the base-layer encoder 102, “[s]patial interpolation is applied to the decoded signal of the lower coding layer to generate an upscaled decoded video signal.” *Id.*, Abstract, [0039]-[0041], Fig. 1 (reproduced below).

Specifically, “[t]he spatial interpolator 104 applies a spatial interpolation (scale up) procedure to the base-layer decoded video frame (locally decoded signal), thus generating an upscaled video frame (step S104).” *Id.*, [0039]. “The upscaled video frame exhibits a spatial resolution corresponds to that before the scale-down procedure at the spatial decimator 101.” *Id.*. In addition, “[a] spatial high-frequency components estimation and scale up procedure is applied to the decoded signal of

⁸ The first-named inventor of Sakazume is the inventor of the challenged ’448 patent.

the lower coding layer to generate a high-frequency components signal.” *Id.*, Abstract.⁹



Ex.1046 [Sakazume], FIG. 1 (annotated); Ex.1003, ¶326.

Sakazume’s Figure 1 shows that the output of spatial high-frequency components estimator and upscaler 105 and spatial interpolator 104 are added before being provided to encoder 106, but also contemplates that “the frames generated by the estimator and upscaler 105 and the interpolator 104 may be separately supplied to the encoder 106.” Ex.1046, [0041]; Ex.1003, ¶¶324-328.

⁹ The “high-frequency components signal” generated using the “high-frequency components estimation and scale up procedure” corresponds to a “super-resolution process” as detailed throughout the ’448 patent specification. Ex.1003, ¶326 (citing Ex.1001, 22:51-54).

2. Combination of Sakazume, Martins, and He

Like the '448 Patent, Sakazume discloses a layered video coding system that enhances reference picture quality in an enhancement layer by use of a decoded spatially interpolated base-layer frame as well as high frequency components generated from the encoded and decoded base layer as the reference. *Supra*, §V.A.1.

The following subsections address straightforward modifications to Sakazume's system that would have been obvious to implement in view of Martins and He.¹⁰ Ex.1003, ¶¶329-345.

a. *Obvious Based on Martins to Use Super-resolution for Upscaling Base-layer Resolution Video*

Sakazume describes a layered coding system with enhancement layers at higher spatial resolution than the base layer. Ex.1046, [0002]-[0004]. In the system of Sakazume, with reference to Figure 1 in particular, Sakazume's apparatus "receives enhancement-layer picture element signals that carry enhancement-layer video frames" (i.e., shown in Figure 1 as Video In) which "exhibit a spatial resolution for enhancement-layer coding." Ex.1046, [0036]. Sakazume then teaches that this input is decimated "producing a ... base-layer video frame." Ex.1046, [0036].

¹⁰ This overview of the Sakazume-Martins-He combination is referenced and incorporated in the analysis of each claim element in Section V.A.b. below.

Although Sakazume itself describes receiving enhancement-layer video frames and decimating those frames to base-layer video frames, a POSITA would have recognized that Sakazume's teachings would apply to situations in which base-layer video frames are received and processed (instead of processing decimated enhancement-layer video frames). Accordingly, given the prior art within the knowledge of a POSITA, a POSITA would have recognized that Sakazume's teachings are clearly applicable to not just the situation in which enhancement layer video is input, but also to situations in which the enhancement layer is generated by processing from the base layer. Thus, in the proposed combination, base layer (i.e., lower or standard resolution video) is input as shown in the proposed Sakazume-Martins-He combination below and processed through the teachings of the Sakazume-Martins-He combination to output higher resolution target video to the enhancement layer encoder 106. Ex.1003, ¶¶331-335.

A POSITA would have understood that an upsampling technique, such the super-resolution upsampling disclosed in Martins, can be applied to the base layer sequence of Sakazume to create a higher resolution enhancement layer sequence, and a POSITA would have known to use either upscaling or decimation as options depending on the resolution of the input stream and the desired output resolutions for the base and enhancement layers. Ex.1003, ¶336. This would have been an obvious variation of Sakazume's teachings that was readily apparent to a POSITA

considering the reference. Ex.1003, ¶336. The output of the Martins' Figure 2 super-resolution processing would provide to the enhancement layer encoder 106 of Sakazume video frames at the same, higher resolution as in Sakazume unmodified, i.e., enhancement-layer video frames.

Further, this is consistent with Martins' explicitly stated goal of "improv[ing] MPEG-2 decoding, or rather to postprocess the decoded sequence re-using information in the MPEG-2 bitstream to obtain a sequence of **higher fidelity**, especially with regard to the artifacts." Ex.1007, 803; Ex.1003, ¶337. Additionally, "[t]he super-resolution pictures obtained by the [Martins] algorithm are of much higher visual quality and have lower [mean-squared error] than super-resolution pictures obtained by simple spatial interpolation." Ex.1007, 803; Ex.1003, ¶337. Thus, the Martins algorithm provides higher visual quality super-resolution pictures than the pictures output by the spatial high-frequency components estimator and upscaler 105 and spatial interpolator 104 of Sakazume, which rely on interpolation; accordingly, the higher-resolution video output by the combination would have desirable "higher visual quality". Ex.1003, ¶337.

Using Martin's super-resolution upscaling in the combination to enhance base layer video would have been obvious as a predictable application of known techniques to yield predictable results for which a POSITA would have had a

reasonable expectation of success, especially since super-resolution upsampling was commonly performed before the '448 Patent. *KSR*, 550 U.S. at 417; Ex.1003, ¶338.

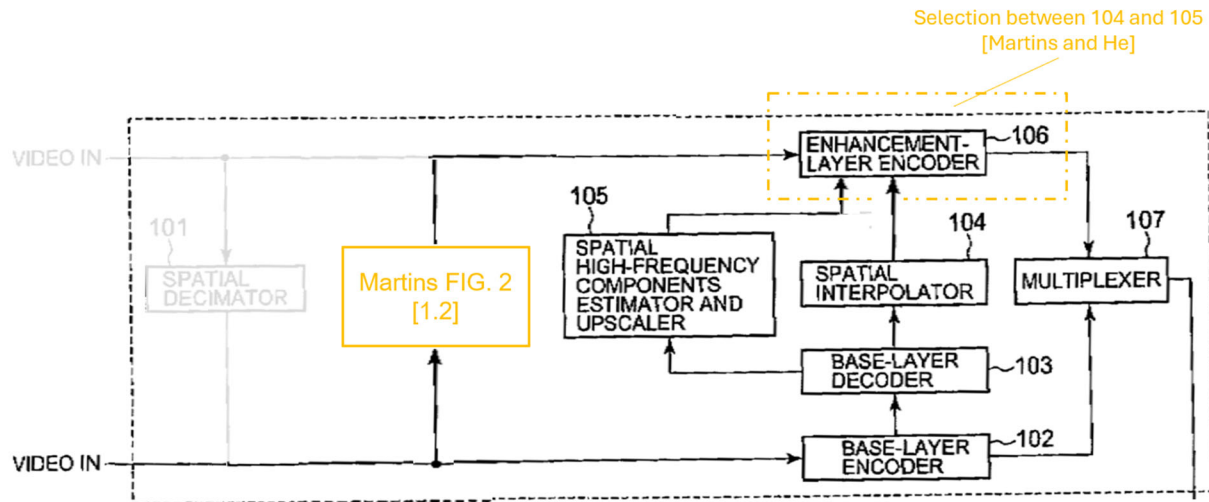


Illustration of the Sakazume-Martins-He combination.

b. *Obvious Based on Martins and He to Selectively Use Super-Resolution or Interpolated Images*

As discussed, the teachings of Sakazume-Martins render obvious techniques for performing super-resolution processing and upscaling of reference images used for inter-layer prediction of images in the enhancement layer. Ex.1046, [0039], [0055], FIGS. 1-2; Ex.1007, 803-804, 808; *supra*, §V.A.2.

Sakazume also teaches applying spatial interpolation (i.e., spatial interpolator 104) and spatial high-frequency components estimating and upscaling (i.e., in unit 105) and separately providing the frames output by those units to the enhancement layer encoder as reference images. *See, e.g.*, Ex.1046, [0041]

(“frames ... may be separately supplied”), [0042-0043], [0057-0061]. For example, Sakazume teaches, with respect to Figure 1, that the enhancement-layer encoder 106 performs a prediction procedure between an enhancement-layer video frame and “the frames generated by the estimator and upscaler 105 and the interpolator 104” which “may be separately supplied to the encoder 106.” Ex.1046, [0041], *see also* [0043] (“and the composite base-layer high-frequency-components-estimated video frame (or, **the upscaled video frame from the spatial interpolator 104 and the high-frequency components frame from the spatial high-frequency components estimator and upscaler 105**).” In this scenario, i.e., when the frame from 104 and the frame from 105 are received separately, a POSITA would have recognized that the enhancement layer encoder 106 would select between the two frames to perform prediction according to the frame that would result in the lowest amount of residual information to reduce the amount of information needed for coding. Thus, Sakazume teaches selection between frames used for prediction. Ex.1003, ¶¶340-342.

A POSITA would have understood that Martins and He explicitly teach such selection techniques. For example, as described with reference to Ground 1, a POSITA would have understood that Martins teaches selection on a pixel basis between super-resolution pixels obtained by motion compensation and super-resolution pixels obtained by interpolation, which is analogous to the outputs of

Sakazume's units 105 and 104, respectively, and He similarly teaches selective in-loop filtering using deblocking control flags. Ex.1008, [0028], [0031], [0037], [0076], [0069]; Ex.1003, ¶343; *supra*, §IV. Thus, combining the teachings of Martins and/or He of encoding information reflecting whether a pixel or a picture was obtained by one of two techniques would have been obvious when considering Sakazume, as doing so would have been nothing more than the combination of prior art elements according to known techniques (e.g., encoding data reflecting a selection).

In the combination, and based on Martins' and He's teaching, control flags in the frame can predictably indicate whether super-resolution processing was applied when encoding a given frame in the enhancement layer. Ex.1008, [0028], [0031], [0037], [0076], [0069]. When the super-resolution processing is not applied, the reference frames are generated by resolution conversion of the base layer pictures, without super-resolution processing. Ex.1003, ¶344.

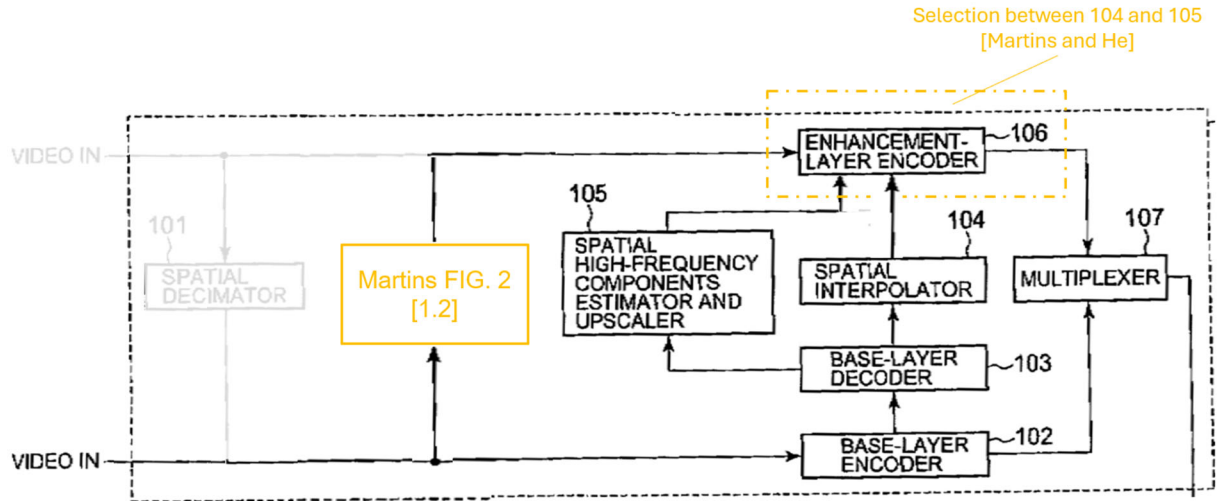


Illustration of the Sakazume-Martins-He combination.

The fact that selective loop filtering was standard in video coders before the '448 Patent and a POSITA would have had a reasonable expectation of success implementing data reflecting selective super-resolution processing in the combination. Ex.1003, ¶345; *KSR*, 550 U.S. at 417.

B. Claim 1

1. [1.P] A moving picture encoding system that makes an encoding of a sequence of moving pictures with a resolution higher than a standard resolution using moving pictures contents which include a sequence of moving pictures with the standard resolution and do not include a sequence of moving pictures with a resolution higher than the standard resolution, the moving picture encoding system comprising:

Sakazume-Martins-He renders obvious [1.P]. Ex.1003, ¶¶347-350. For example, Sakazume describes that its invention “relates to layered coding and decoding methods, apparatuses, and programs for moving pictures based on spatial-

and time-domain and also interlayer correlation.” Ex.1046, [0002]; *see also id.*, [0010], Fig. 1.

Sakazume discloses that “[a]n input video signal is encoded at a plurality of coding layers exhibiting different spatial resolutions.” Ex.1046, [Abstract]. Specifically, “[a] spatial-domain resolution scalable layered video coding scheme produces interlayer predictive signals for use in coding enhancement layers that exhibit higher spatial resolutions than base layers also to be coded” (“*an encoding of a sequence of moving pictures with a resolution higher than a standard resolution*”). *Id.*, [0004]; Ex.1003, ¶¶348-350. And as discussed below, the enhancement layer is encoded “*using moving pictures contents which include a sequence of moving pictures with the standard resolution and do not include a sequence of moving pictures with a resolution higher than the standard resolution.*” *Infra*, §V.B.2-3. Specifically, in the proposed combination, a POSITA would have recognized that Sakazume’s teachings were applicable to base layer video, i.e., “*moving pictures contents which include a sequence of moving pictures with the standard resolution and do not include a sequence of moving pictures with a resolution higher than the standard resolution*” and thus the proposed combination renders obvious the preamble of claim 1. Ex.1003, ¶350.

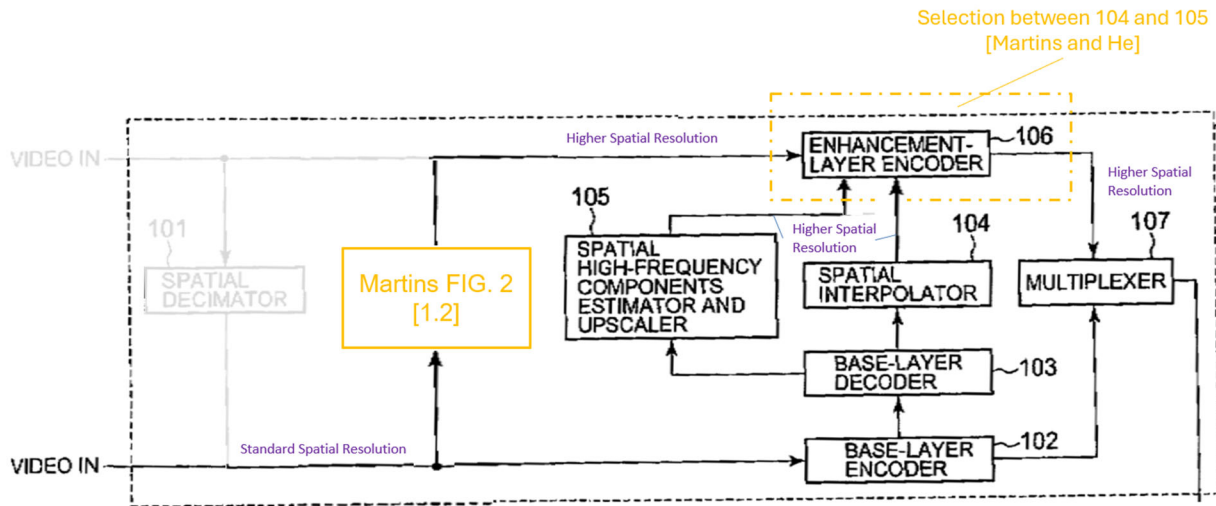


Illustration of the Sakazume-Martins-He combination.

2. [1.1] a first encoder configured to work on 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

Sakazume-Martins-He renders obvious [1.1]. Sakazume describes a “base-layer encoder 102” and a “base-layer decoder 103” that together are the claimed “*first encoder*.” Ex.1046, [0036]-[0038]; Fig. 1. The “base-layer encoder 102” receives and processes “base-layer video frame[s]” to generate a “base-layer bitstream” and sends this to a “base-layer decoder 103.” *Id.*, [0036]-[0038]; Fig. 1. In the Sakazume-Martins-He combination, the resolution of the base-layer is the claimed “standard resolution.” *Id.*, [0004]; Ex.1003, ¶¶352-354.

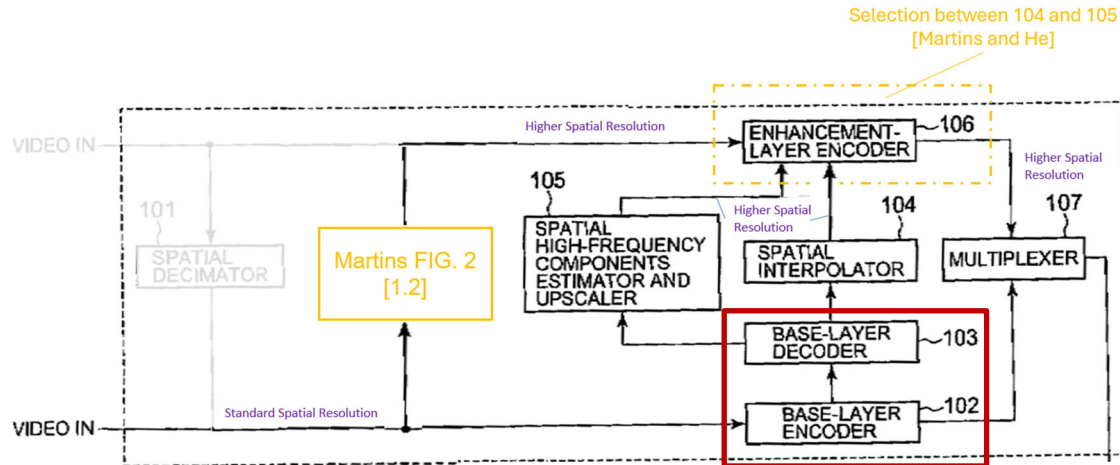


Illustration of the Sakazume-Martins-He combination.

Sakazume further teaches that “base-layer decoder 103 decodes the base-layer bitstream generated by the base-layer encoder 102 (step 5103), thus generating a base-layer decoded video frame” (“*set of decoded pictures with the standard resolution*”). *Id.*, [0038].

3. [1.2] a first super-resolution enlarger configured to work on the sequence of moving pictures 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

Sakazume-Martins-He renders obvious [1.2]. As detailed above, it would have been obvious based on the teachings of Martins, that when the input moving picture video signal is base layer video frames, instead of enhancement layer video frames, the base layer video frames could be upsampled by super-resolution

processing to create enhancement layer video frames. Ex.1003, ¶¶356-357; *supra*, §V.A.2.a.

Thus, in the combination, as illustrated below, in addition to the encoding/decoding by Sakazume’s base layer encoder 102 and base layer decoder 103, Martins’ super-resolution upsampling technique (“*a first super-resolution enlarger*”) is applied to the input moving picture video signal at base layer spatial resolution (“*subsequence of the sequence of moving pictures with the standard resolution*”) to create enhancement layer video frames at a higher spatial resolution (“*set of super-resolution enlarged pictures with a first resolution higher than the standard resolution*”). *Id.*

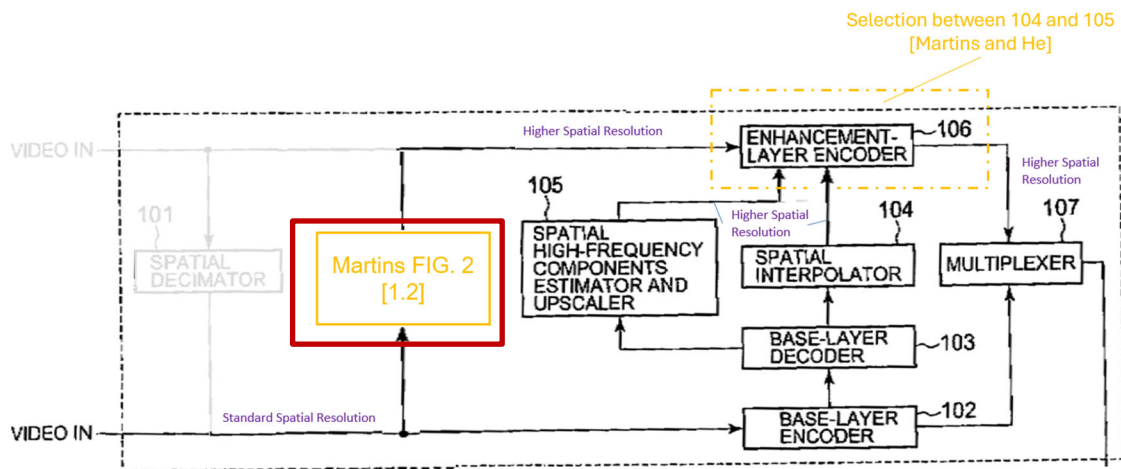


Illustration of the Sakazume-Martins-He combination.

4. [1.3] a second super-resolution enlarger configured to acquire the set of decoded pictures from the first encoder to implement thereon a process for a second super-resolution enlargement to create a set of super-resolution enlarged

decoded pictures with a resolution higher than the standard resolution

Sakazume-Martins-He renders obvious [1.3]. Sakazume discloses that “spatial high-frequency components estimator and upscaler 105 applies a spatial high-frequency components estimation and scale-up procedure, in a specific direction in the spatial domain, to the base-layer decoded frame supplied by the base-layer decoder 103” i.e., the estimator and upscaler 105 (“*a second super-resolution enlarger*”) “*acquire[s] the set of decoded pictures from the first encoder to implement thereon a process for a second super-resolution enlargement*” as recited. Ex.1046, [0040]. Sakazume further discloses that “spatial high-frequency components estimator and upscaler 105 “generates a **high frequency components frame** that carries estimated high frequency components. The estimated high-frequency components correspond to a video frame that exhibits a spatial resolution before subjected to the scale-down procedure” (Ex.1046, [0040]), i.e., the high frequency components frame is a picture “*with a resolution higher than the standard resolution*” as recited. Ex.1003, ¶¶359-360; *supra*, §V.A.2.a.

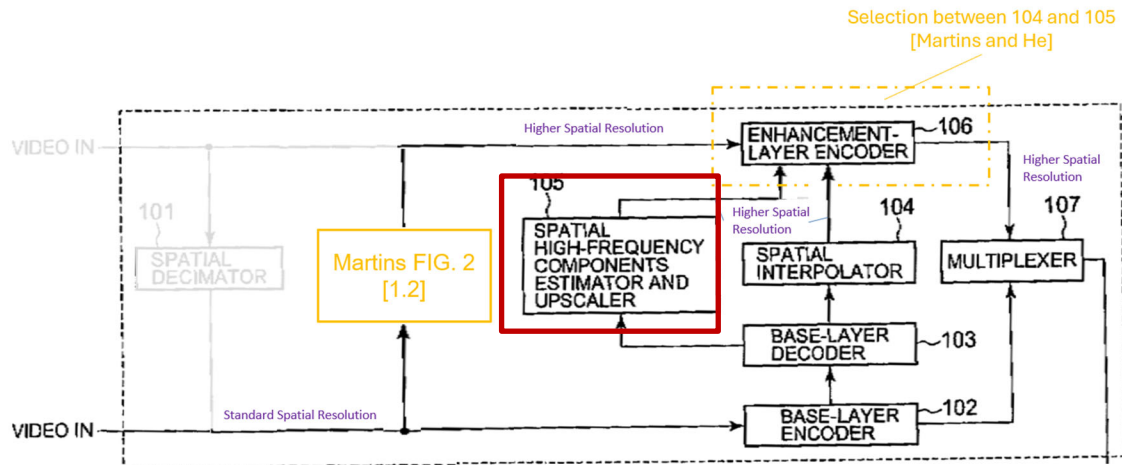


Illustration of the Sakazume-Martins-He combination.

5. [1.4] a third resolution converter configured to acquire the set of decoded pictures from the first encoder to implement thereon a process for a third resolution conversion to create a set of resolution converted enlarged decoded pictures with a resolution higher than the standard resolution

Sakazume-Martins-He renders obvious [1.4]. Sakazume discloses that “[t]he spatial interpolator 104 applies a spatial interpolation (scale up) procedure to the base-layer decoded video frame (locally decoded signal), thus generating an upscaled video frame (step S104)” and that “[t]he upscaled video frame exhibits a spatial resolution correspond[ing] to ... the **spatial resolution of the enhancement layer** which is one layer higher than the base layer.” Ex.1046, [0039]. Thus, Sakazume’s “spatial interpolator 104” corresponds to the recited “**third resolution converter**” and, as it receives the “base-layer decoded video frame” and converts it to a spatial resolution of the enhancement layer, the interpolator 104 “**implement[s] thereon a process for a third resolution conversion to create a set of resolution**

converted enlarged decoded pictures with a resolution higher than the standard resolution” as recited. Ex.1003, ¶¶362-363.

As detailed below, the teachings of Martins and He describe selecting between two pictures, one being a super-resolution enlarged picture (e.g., the output of Sakazume’s estimator and upscaler 105) and the other being an interpolated picture (e.g., the output of Sakazume’s interpolator 104). Ex.1003, ¶364; *supra*, §V.A.2.b.

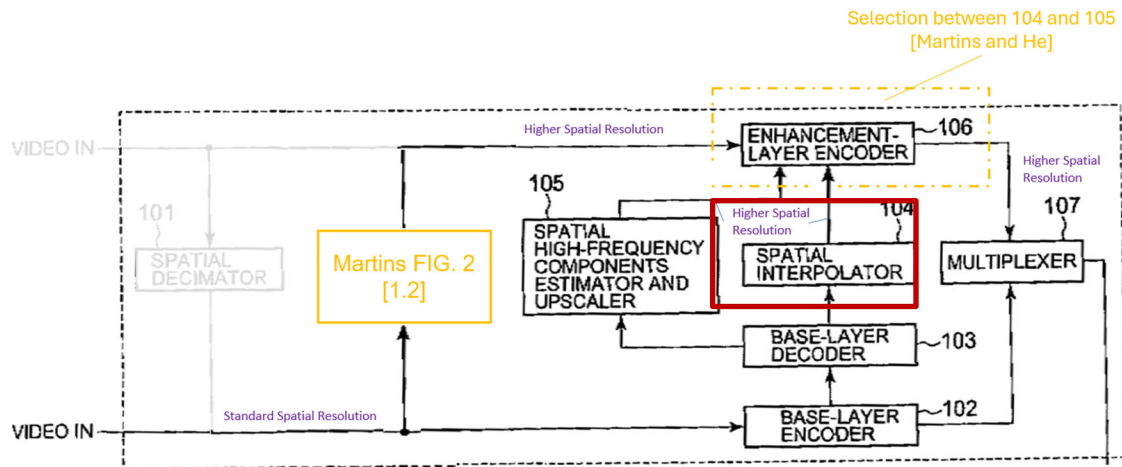


Illustration of the Sakazume-Martins-He combination.

6. [1.5] a third encoder configured to have the set of super-resolution enlarged pictures from the first super-resolution enlarger as a set of encoding target pictures, employing the set of super-resolution enlarged decoded pictures from the second super-resolution enlarger and the set of resolution converted enlarged decoded pictures from the third resolution converter as sets of reference pictures, to implement thereon a third combination of processes for a

prediction and an encoding to create a third sequence of encoded bits

Sakazume-Martins-He renders obvious [1.5]. Sakazume discloses that the enhancement-layer encoder 106 (*“third encoder”*) receives enhancement-layer video frames from the input moving-picture video signal as encoding targets and uses upscaled video frames from the spatial interpolator 104 as reference frames in order to perform an enhancement-layer coding procedure and create an enhancement layer bitstream (*“implement thereon a third combination of processes for a prediction and an encoding to create a third sequence of encoded bits”*). Ex.1046, [0042]-[0043], [0045].

Specifically, as discussed above, in the Sakazume-Martins-He combination, the enhancement-layer encoder 106 (*“third encoder”*) receives enhancement-layer video frames from the input moving-picture video signal, processed by Martins Fig. 2 resulting in higher spatial resolution video (*“the set of super-resolution enlarged pictures from the first super-resolution enlarger”*), as encoding targets, super-resolution enlarged decoded pictures from the second super-resolution enlarger (the Sakazume spatial high-frequency components estimator and upscaler 105) (a second *“set of super-resolution enlarged decoded pictures from the second super-resolution enlarger”*) as a first set of reference pictures, and resolution converted decoded pictures from the resolution converter (the Sakazume spatial interpolator 104) (*“set of resolution converted enlarged decoded pictures”*) as a second set of

reference pictures. Ex.1003, ¶¶366-367; *supra*, §V.B.3-5; Ex.1046, [0041-0043], [0057-0061].

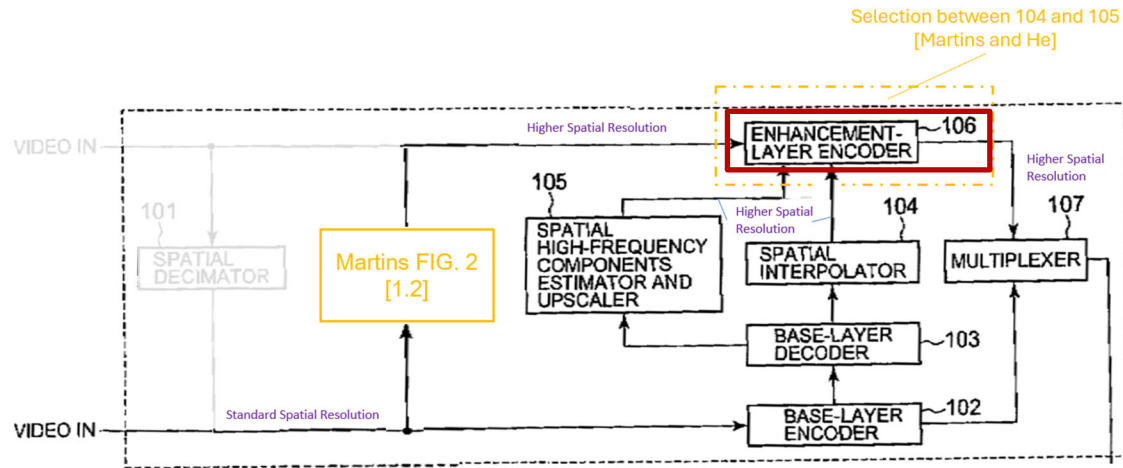


Illustration of the Sakazume-Martins-He combination.

7. [1.6] wherein a spatial resolution of the set of super-resolution enlarged pictures, that of the set of super-resolution enlarged decoded pictures, and that of the set of resolution converted enlarged decoded pictures are made equal

Sakazume-Martins-He renders obvious [1.6]. As discussed, Sakazume discloses further that “[t]he upscaled video frame exhibits a spatial resolution correspond[ing] to ... the spatial resolution of the enhancement layer which is one layer higher than the base layer.” Ex.1046, [0039], [0042]-[0043], [0045], FIGs. 1-2; *supra*, §V.B.4.

In the Sakazume-Martins-He combination, as described above, the first set of reference pictures is provided by the second super-resolution enlarger (i.e., Sakazume’s spatial high-frequency components estimator and upscaler 105) and the

second set of reference pictures is provided by the third resolution converter (i.e., Sakazume's spatial interpolator 104). Based on Sakazume's teachings, it would have been obvious to convert not only the first set of reference pictures, but also the second set of reference pictures to the same spatial resolution as the enhancement layer. And a POSITA would have been motivated to do so with a reasonable expectation of success for the same reasons as described for Ground 1. Ex.1003, ¶¶369-370; *supra*, §IV.A.4.b.

8. **[1.7] wherein the third encoder controls a selection of a set of reference pictures and creates a set of data on the selection of the set of reference pictures to identify a selected set of reference pictures during the process for prediction of the third combination**

Sakazume-Martins-He renders obvious [1.7]. The Sakazume-Martins-He combination's enhancement layer encoder 106 ("*third encoder*") encodes pictures in the enhancement layer bitstream by controlling selection of either decoded base layer pictures enhanced by super-resolution enlargement (e.g., pictures output by Sakazume's spatial high-frequency components estimator and upscaler 105) or decoded base layer pictures not enhanced by SR-U filtering (e.g., pictures output by Sakazume's spatial interpolator 104) as reference pictures. Ex.1003, ¶372. It would have been obvious based on Martins, as well as He, to use He's teachings of a "deblocking control flag" as "*a set of data on the selection of the set of reference*

pictures to identify a selected set of reference pictures” for the same reasons as described for Ground 1. *Supra*, §V.A.2.

C. Claim 2

1. [2.P]

Supra [1.P]; Ex.1003, ¶373.

2. [2.1]

Supra [1.1]; Ex.1003, ¶374.

3. [2.2]

Supra [1.2]; Ex.1003, ¶375.

4. [2.3]

Supra [1.4]; Ex.1003, ¶376.

5. [2.4]

The only difference between [2.4] and [1.5] is that [2.4] only requires one set of reference pictures, namely “the set of resolution converted enlarged decoded pictures from the third resolution converter.” Thus, the combination renders obvious this limitation for the same reasons as described for [1.5]. *Supra* [1.5]; Ex.1003, ¶377.

6. [2.5]

The only difference between [2.5] and [1.6] is that [2.5] only requires one set of reference pictures, namely “the set of resolution converted enlarged decoded pictures” to be made equal to the spatial resolution of the “the set of super-resolution

enlarged pictures.” Thus, the combination renders obvious this limitation for the same reasons as described for [1.6]. *Supra* [1.6]; Ex.1003, ¶378.

7. [2.6]

Supra [1.7]; Ex.1003, ¶379.

D. Claim 3

1. [3.P]

Supra [1.P]; Ex.1003, ¶380.

2. [3.1]

Supra [1.1]; Ex.1003, ¶381.

3. [3.2]

Supra [1.2]; Ex.1003, ¶382.

4. [3.3]

Supra [1.3]; Ex.1003, ¶383.

5. [3.4]

The only difference between [3.4] and [1.5] is that [3.4] only requires one set of reference pictures, namely “the set of super-resolution enlarged decoded pictures from the second super-resolution enlarger.” Thus, the combination renders obvious this limitation for the same reasons as described for [1.5]. *Supra* [1.5]; Ex.1003, ¶384.

6. [3.5]

The only difference between [3.5] and [1.6] is that [3.5] only requires one set of reference pictures, namely “the set of super-resolution enlarged pictures” to be made equal to the spatial resolution of the “the set of super-resolution enlarged pictures.” Thus, the combination renders obvious this limitation for the same reasons as described for [1.6]. *Supra* [1.6]; Ex.1003, ¶385.

7. [3.6]

Supra [1.7]; Ex.1003, ¶386.

VI. THE BOARD SHOULD REACH THE MERITS OF THIS PETITION

A. The *Fintiv* Factors Favor Institution

Discretionary denial under 35 U.S.C. §314(a) is not appropriate in this proceeding. Patent Owner filed its complaint in the District Court for the Eastern District of Texas on May 10, 2024, then filed two amended complaints on August 2, 2024 and January 17, 2025, respectively. This petition is filed over 2 months before the one-year bar date and soon after receiving Patent Owner’s initial infringement contentions identifying the asserted claims.

The district court litigation is at an early stage. Under the current schedule, the claim construction hearing will not occur until September 16, 2025, and expert discovery will not close until November 18, 2025. Ex.1048, 4. The trial is not scheduled to begin until March 2, 2026. Ex.1048, 1.

B. The *Advanced Bionics* Factors Favor Institution

The Board applies a two-part framework in determining whether to exercise its discretion to deny institution. *Advanced Bionics LLC v. MED-EL Elektromedizinische Gerate GmbH*, IPR2019-01469, Paper 6 at 8 (P.T.A.B. Feb. 13, 2020) (precedential). First, the Board considers “whether the same or substantially the same art previously was presented to the Office or whether the same or substantially the same arguments previously were presented to the Office.” *Id.* When either condition of the first part is satisfied, the Board next considers “whether the petitioner has demonstrated that the Office erred in a manner material to the patentability of challenged claims.” *Id.*

In applying this framework, the Board evaluates six factors (“the *Becton* factors”). *Id.*, 8-10 (citing *Becton, Dickinson and Co. v. B. Braun Melsungen AG*, IPR2017-01586, Paper 8 (P.T.A.B. Dec. 15, 2017) (precedential as to §III.C.5, first paragraph) (“*Becton*”); see Trial Practice Guide July 2019 Update, 28-31, Fed. Reg. 33,925 (July 16, 2019). These factors are known as the *Becton* factors (a) through (f). *Advanced Bionics* at 9, n.10 (citing *Becton*). As discussed below, the *Becton* factors favor institution.

1. Google’s Grounds And Obviousness Rationales Were Not Previously Considered By The Office

Becton factors (a), (b), and (d) support institution because this Petition does not present substantially the same prior art combinations or arguments that were

before the Office during original examination of the '448 Patent. Though the Examiner applied Phek in obviousness rejections during original examination, the secondary references combined with Phek in this Petition were not similarly applied. *Supra*, §III.B. Indeed, the file history contains no indication that Martins, He, or Sakazume were addressed or even made available to the Examiner during original examination. *Id.*; *see also* Ex.1001, Face. The Phek-Martins-He combination advanced in Ground 1 and Sakazume-Martins-He combination advanced in Ground 2 of this Petition therefore are not cumulative of the prior art evaluated by the Office before issuance.

2. The Office Erred In Granting The '448 Patent

The Board need not consider part two of the *Advanced Bionics* frameworks because part one is not satisfied. Even so, *Becton* factors (c), (e), and (f) support institution.

The '448 patent file history contains no indication that the Examiner ever considered Phek in combination with Martins, and He as set forth in Ground 1. Martins, He, and Sakazume are not even cited on the face of the '448 Patent, and thus the extent of the Examiner's consideration of any teachings of the prior art cited in Grounds 1 and 2 does not warrant exercise of the Board's discretion to deny institution. To the extent the Examiner should have been aware of prior art like Martins, He, and Sakazume, the original examination was infected with error

because it failed to account for the relevant and non-cumulative teachings from these references cited in Grounds 1 and 2. The omission of these references and failure to consider their teachings in combination with Phek as proposed in the Petition constituted material error and warrants reconsideration of the patentability of the Challenged Claims, especially since the features that were amended into the claims immediately before allowance were all known and obvious to apply in combination with Phek before the Critical Date.

For each of these reasons, the second part of the *Advanced Bionics* framework is not satisfied. The Board should decline to exercise its discretion to deny institution.

C. The *General Plastic* Factors Favor Institution

Under the relevant *General Plastic* factors, the Petition should be instituted. *See General Plastic Industrial Co., Ltd. v. Canon Kabushiki Kaisha*, IPR2016-01357, Paper 19 (P.T.A.B. Sept. 6, 2017) (precedential); *Valve Corp. v. Electronic Scripting Products, Inc.*, IPR2019-00062, Paper 11 (P.T.A.B. Apr. 2, 2019) (precedential). Petitioner has not previously filed a petition directed to any claim of the '448 Patent.

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

A. Real Party-In-Interest

Google LLC is the petitioner and real party-in-interest.¹¹

B. Related Matters

The '448 patent is at issue in *Advanced Coding Technologies LLC v. Google LLC*, No. 2:24-cv-00353-JRG (E.D. Tex.), *Advanced Coding Technologies LLC v. Apple Inc.*, No. 2:24-cv-00572-JRG (E.D. Tex.), and IPR2025-01070.

Petitioner is not aware of any other disclaimers, reexamination certificates, or IPR petitions addressing the '448 Patent.

C. Grounds for Standing

Petitioner certifies that the '448 Patent is available for IPR and Petitioner is not barred from requesting same.

D. Counsel and Service Information

Pursuant to 37 C.F.R. §§ 42.8(b)(3), 42.8(b)(4), and 42.10(a), Petitioner designates the following lead counsel:

¹¹ Google LLC is a subsidiary of XXVI Holdings Inc., which is a subsidiary of Alphabet Inc. XXVI Holdings Inc. and Alphabet Inc. are not real parties-in-interest to this proceeding.

- Raghav Bajaj (Reg. No. 66,630), raghav.bajaj@lw.com, Latham & Watkins LLP; 300 Colorado St. Suite 2400; Austin, TX 78701; 737.910.7370.

Google also designates the following backup counsel:

- Douglas E. Lumish (*pro hac vice* motion to be filed), doug.lumish@lw.com, Latham & Watkins LLP; 140 Scott Drive; Menlo Park, CA 94025; 650.463.2633.
- Patricia Young (*pro hac vice* motion to be filed), patricia.young@lw.com, Latham & Watkins LLP; 1271 Avenue of the Americas; New York, NY 10020; 212.906.1661.
- Linfong Tzeng (Reg. No. 65,140), linfong.tzeng@lw.com, Latham & Watkins LLP; 140 Scott Drive; Menlo Park, CA 94025; 650.463.3092
- Joseph H. Lee (*pro hac vice* motion to be filed), joseph.lee@lw.com, Latham & Watkins LLP; 650 Town Center Drive, 20th Floor; Costa Mesa, CA 92626-1925; 714.755.8046.

Pursuant to 37 C.F.R. § 42.10(b), a Power of Attorney from Petitioner is attached. Petitioner consents to electronic service.

E. IPR Fee

The Director is authorized to charge the fee specified by 37 C.F.R. § 42.15(a) to Deposit Account No. 506269.

VIII. CONCLUSION.

For the reasons set forth above, Petitioner Google respectfully requests *inter partes* review of the Challenged Claims of the '448 Patent.

Respectfully submitted,

Dated: July 11, 2025

By: / Raghav Bajaj /

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CERTIFICATE OF COMPLIANCE WITH 37 C.F.R. § 42.24

I hereby certify that this Petition complies with the word count limitation of 37 C.F.R. § 42.24(a)(1)(i) because the Petition contains a total of 13,983 words calculated by Microsoft Word's word-count feature. This total excludes the cover page, signature block, and the parts of the Petition exempted by 37 C.F.R. § 42.24(a)(1).

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CERTIFICATE OF SERVICE

The undersigned certifies that a complete copy of this Petition for *Inter Partes* Review of U.S. Patent No. 9,042,448 and all Exhibits and other documents filed together with this Petition were served on the official correspondence address for the patent shown in Patent Center:

Joshua Goldberg
Nath, Goldberg & Meyer
112 S. West Street
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via FEDERAL EXPRESS next business day delivery, on July 11, 2025.

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