IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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

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EXHIBITS

SAMSUNG-1001	U.S. Patent No. 10,218,995 to Sakazume ("the '995 Patent")
SAMSUNG-1002	Excerpts from the Prosecution History of the '995 Patent ("the '995 Patent File History")
SAMSUNG-1003	Declaration and Curriculum Vitae of Dr. Clifford Reader
SAMSUNG-1004	Complaint, *Advanced Coding Technologies LLC v. Samsung Electronics Co., Ltd. et al.*, 2:22-cv-00499-JRG, E.D. Tex., filed December 30, 2022
SAMSUNG-1005	English Translation of Japanese Patent Publication No. 2007316161 A with Translation Certificate ("Phek")
SAMSUNG-1006	Segall et al., *Spatial Scalability Within the H.264/AVC Scalable Video Coding Extension*; IEEE Transactions on Circuits & Systems for Video Tech., Vol. 17, No. 9, September 2007 ("Segall")
SAMSUNG-1007	Martins et al., *A Unified Approach to Restoration, Deinterlacing and Resolution Enhancement in Decoding MPEG-2 Video*, IEEE Transactions on Circuits & Systems for Video Tech., Vol. 12, No. 9, September 2002 ("Martins")
SAMSUNG-1008	U.S. Patent Publication No.2008/0137753 ("He")
SAMSUNG-1009	U.S. Patent No. 5,886,736 ("Chen")
SAMSUNG-1010	Schwarz et al., *Overview of the Scalable Video Coding Extension of the H.264/AVC Standard*, IEEE Transactions on Circuits & Systems for Video Tech., Vol. 17, No. 9, September 2007 ("Schwarz")
SAMSUNG-1011	U.S. Patent Publication No. 2009/0154567 ("Lei")
SAMSUNG-1012	Park et al., *Super-Resolution Image Reconstruction: A Technical Overview*, IEEE Signal Processing Magazine, pp. 21-36, May 2003 ("Park")

SAMSUNG-1013	English Machine Translation of Japanese Patent Publication No. 2008053848 ("Hatanaka")
SAMSUNG-1014	U.S. Patent Publication No. 2010/0165077 ("Yin")
SAMSUNG-1015	U.S. Patent Publication No. 2009/0257664 ("Kao")
SAMSUNG-1016	U.S. Patent Publication No. 2009/0046995 ("Kanumuri")
SAMSUNG-1017	U.S. Pat. 6,470,051 ("Campisano")
SAMSUNG-1018	U.S. Patent Publication No. 2006/0013306 ("Kim")
SAMSUNG-1019	Lu et al., Mechanisms of MPEG Stream Synchronization, ACG SIGCOMM Computer Communication Review, Vol. 24, Issue 1, pp. 57-67 (January 1994) ("Lu")
SAMSUNG-1020	U.S. Patent Publication No. 2003/0021345 ("Brusewitz")
SAMSUNG-1021	U.S. Patent Publication No. 2003/0021347 ("Lan")
SAMSUNG-1022	EE|Times, *How Video Compression Works* (Aug. 6, 2007), *available at* https://www.eetimes.com/how-video-compression-works (retrieved Dec. 26, 2023) ("EETimes")
SAMSUNG-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")
SAMSUNG-1024	U.S. Patent No. 7,379,496 ("Holcomb")
SAMSUNG-1025	U.S. Patent Publication No. 2008/0043832 ("Barkley")
SAMSUNG-1026	U.S. Patent No. 6,173,013 ("Suzuki")
SAMSUNG-1027	Memorandum, Interim Procedure for Discretionary Denials in AIA Post-Grant Proceedings with Parallel District Court Litigation (USPTO June 21, 2022) ("Director's Guidance")
SAMSUNG-1028	Samsung Stipulation Letter Regarding IPR grounds in District Court Litigation
SAMSUNG-1029	Declaration of June Ann Munford

SAMSUNG-1030	Ely, *MPEG Video Coding: A Simple Introduction*, EBU Technical Review (Winter 1995) ("Ely")
SAMSUNG-1031	Japanese Patent Publication No. 2007316161 A with English Machine Translation
SAMSUNG-1032	ITU-T Recommendation H.264 (11/07)
SAMSUNG-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)
SAMSUNG-1034	ISO/IEC 11172-2: 1993 (E) (MPEG1 Video)
SAMSUNG-1035	ISO/IEC 13818-2: 2000 (E) (MPEG2/H.262 Video)
SAMSUNG-1036	ITU-T Recommendation H.263 (02/98)
SAMSUNG-1037	Reader, Intraframe and Interframe Adaptive Transform Coding, Efficient Transmission of Pictorial Information, SPIE v.66, 108 (1975)
SAMSUNG-1038	Reader, MPEG4: Coding for Content, Interactivity, and Universal Accessibility, Optical Engineering 35(1), 104 (January 1996)
SAMSUNG-1039	Reader, MPEG Patents, in MPEG Video Compression Standard, Chapter 16, at 357-362 (Mitchell et al ed.) (1996)
SAMSUNG-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)
SAMSUNG-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)
SAMSUNG-1042	ISO/IEC 14496-2: 2004 (MPEG4)
SAMSUNG-1043	ISO/IEC 13818-2: 1996 (MPEG2)

LISTING OF CHALLENGED CLAIM ELEMENTS

Claim 2	
[2.P]	A moving picture decoding system comprising:
[2.1]	a demultiplexer configured to work on a sequence of input encoded bits to implement a process for a prescribed demultiplexing to output at least a first and a second sequence of encoded bits;
[2.2]	a first decoder configured to acquire the first sequence of encoded bits obtained with a standard resolution at the demultiplexer to implement thereon a process for a prescribed first decoding to create a sequence of decoded pictures with a standard resolution;
[2.3]	a first super-resolution enlarger configured to acquire the sequence of decoded pictures created with a standard resolution at the first decoder to work on the sequence of decoded pictures to implement an interpolation of pixels with a first enlargement to create a sequence of super-resolution enlarged decoded pictures with a first resolution higher than a standard resolution;
[2.4]	a first resolution converter configured to acquire the sequence of super-resolution enlarged decoded pictures created at the first super-resolution enlarger to work on the sequence of super-resolution enlarged decoded pictures to implement a process for a prescribed resolution conversion to create a sequence of super-resolution decoded pictures with a standard resolution;
[2.5.i]	a second decoder configured to acquire the second sequence of encoded bits obtained with a standard resolution at the demultiplexer as a set of decoding targets, the sequence of decoded pictures created with the standard resolution at the first decoder as a set of first reference pictures, and the sequence of super-resolution decoded pictures created with the standard resolution at the first resolution converter as a set of second reference pictures, and
[2.5.ii]	select one of the set of first reference pictures and the set of second reference pictures based on reference picture selection information to implement a combination of processes for a prescribed prediction and a prescribed second decoding being a decoding with an extension of the standard resolution, to create a sequence of super-resolution pictures decoded with the standard resolution based on the set of decoding targets and the set of selected reference pictures; and

[2.6]	a second resolution converter configured to acquire the sequence of decoded pictures with the standard resolution from the first decoder to work on the sequence of decoded pictures to implement an interpolation of pixels with the second enlargement to create a sequence of enlarged decoded pictures with a high resolution as a second resolution higher than the standard resolution,
[2.7]	wherein the set of decoding targets, the set of first reference pictures, and the set of second reference pictures have the same value in spatial resolution.
Claim 3	
[3.P]	A moving picture decoding method comprising:
[3.1]	a step of implementing a process for a prescribed demultiplexing on a sequence of input encoded bits, outputting at least a first and a second sequence of encoded bits;
[3.2]	a step of acquiring the first sequence of encoded bits obtained with a standard resolution through the process for the prescribed demultiplexing, implementing thereon a process for a prescribed first decoding, creating a sequence of decoded pictures with the standard resolution;
[3.3]	a step of acquiring the sequence of decoded pictures created with the standard resolution through the process for the prescribed first decoding, working on the sequence of decoded pictures to implement an interpolation of pixels with a first enlargement, creating a sequence of super-resolution enlarged decoded pictures with a first resolution higher than the standard resolution;
[3.4]	a step of acquiring the sequence of super-resolution enlarged decoded pictures created through the process for the prescribed super-resolution enlargement working on the sequence of super-resolution enlarged decoded pictures to implement a process for a first resolution conversion, creating a sequence of super-resolution decoded pictures with a standard resolution;
[3.5.i]	a step of acquiring the second sequence of encoded bits obtained with a standard resolution through the process for the prescribed demultiplexing as a set of decoding targets, the sequence of decoded pictures created with the standard resolution through the process for the prescribed first decoding as a set of first reference pictures, and the sequence of super-resolution decoded pictures created with the

	standard resolution through the process for the prescribed resolution conversion as a set of second reference pictures, and
[3.5.ii]	selecting one of the set of first reference pictures and the set of second reference pictures based on reference picture selection information to implement a combination of processes for a prescribed prediction and a prescribed second decoding being a decoding with an extension of the standard resolution, based on the set of decoding targets and the set of selected reference pictures to create a sequence of super-resolution pictures decoded with the standard resolution; and
[3.6]	a step of acquiring the sequence of decoded pictures created with the standard resolution through the process for the prescribed first decoding working on the sequence of decoded pictures to implement an interpolation of pixels with the second enlargement, creating a sequence of enlarged decoded pictures with a high resolution as a second resolution higher than the standard resolution,
[3.7]	wherein the set of decoding targets, the set of first reference pictures, and the set of second reference pictures have the same value in spatial resolution.
Claim 4	
[4.P]	A recording medium storing a moving picture decoding program comprising a non-transitory computer-readable medium configured to have a computer execute:
[4.1]	a step of implementing a process for a prescribed demultiplexing on a sequence of input encoded bits, outputting at least a first and a second sequence of encoded bits;
[4.2]	a step of acquiring the first sequence of encoded bits obtained with a standard resolution through the process for the prescribed demultiplexing, implementing thereon a process for a prescribed first decoding, creating a sequence of decoded pictures with the standard resolution;
[4.3]	a step of acquiring the sequence of decoded pictures created with the standard resolution through the process for the prescribed first decoding, working on the sequence of decoded pictures to implement an interpolation of pixels with a first enlargement, creating a sequence of super-resolution enlarged decoded pictures with a first resolution higher than the standard resolution;
[4.4]	a step of acquiring the sequence of super-resolution enlarged decoded pictures created through the process for the prescribed super-

	resolution enlargement working on the sequence of super-resolution enlarged decoded pictures to implement a process for a first resolution conversion, creating a sequence of super-resolution decoded pictures with a standard resolution;
[4.5.i]	a step of acquiring the second sequence of encoded bits obtained with a standard resolution through the process for the prescribed demultiplexing as a set of decoding targets, the sequence of decoded pictures created with the standard resolution through the process for the prescribed first decoding as a set of first reference pictures, and the sequence of super-resolution decoded pictures created with the standard resolution through the process for the prescribed resolution conversion as a set of second reference pictures, and
[4.5.ii]	selecting one of the set of first reference pictures and the set of second reference pictures based on reference picture selection information to implement a combination of processes for a prescribed prediction and a prescribed second decoding being a decoding with an extension of the standard resolution, based on the set of decoding targets and the set of selected reference pictures to create a sequence of super-resolution pictures decoded with the standard resolution; and
[4.6]	a step of acquiring the sequence of decoded pictures created with the standard resolution through the process for the prescribed first decoding, working on the sequence of decoded pictures to implement an interpolation of pixels with the second enlargement creating a sequence of enlarged decoded pictures with a high resolution as a second resolution higher than the standard resolution,
[4.7]	wherein the first resolution is different from the second resolution,
[4.8]	wherein the standard resolution of the second sequence of encoded bits is the same as the standard resolution of the super-resolution decoded pictures,
[4.9]	and wherein the set of decoding targets, the set of first reference pictures, and the set of second reference pictures have the same value in spatial resolution.
Claim 11	
[11]	The moving picture decoding system according to claim 2, wherein the second decoder divides a decoding target into a plurality of regions to select one of the set of first reference pictures and the set of second reference pictures for each divided region.

Samsung Electronics Co., Ltd. ("Petitioner" or "Samsung") petitions for *Inter Partes* Review ("IPR") of claims 2-4 and 11 ("the Challenged Claims") of U.S. Patent No. 10,218,995 ("the '995 Patent").

I. REQUIREMENTS FOR IPR

A. Ground for Standing

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

B. Challenge and Relief Requested

Samsung requests institution of IPR and cancellation of the Challenged Claims based on the following ground:

Ground	Claim(s)	35 U.S.C. § 103
1	2-4, 11	Phek in view of Segall, Martins, and He

Ground 1 is further supported by the expert testimony of Dr. Clifford Reader, Ph.D. *See* SAMSUNG-1003.

The '995 Patent claims earliest priority to a Japanese Application No. 2008-142433, filed on May 30, 2008. SAMSUNG-1001, Face. Petitioner does not concede that the Challenged Claims are entitled to the benefit of any of the claimed priority dates of the '995 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 Ground 1 qualifies as prior art even treating May 30, 2008, as the Critical Date.[1]

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

C. Claim Construction

All claim terms should be construed according to the *Phillips* standard. *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005); 37 C.F.R. §42.100. Petitioner submits that no formal constructions are presently necessary for purposes of

[1] Segall and Martins were each 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 reviewed MARC records and physical copies of these IEEE journals from the Carnegie Library of Pittsburgh and presents compelling evidence that Segall and Martins were public accessibility through the IEEE journals before the Critical Date. SAMSUNG-1029, ¶¶6-9, 14-17; *generally id.*, ¶¶1-19.

demonstrating obviousness of the Challenged Claims based on Ground 1. *Wellman, Inc. v. Eastman Chem. Co.*, 642 F.3d 1355, 1361 (Fed. Cir. 2011) ("claim terms need only be construed to the extent necessary to resolve the controversy") (internal quotations omitted).

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

D. Level of Ordinary Skill in the Art

A person of ordinary skill in the art ("POSITA") relating to the subject matter of the '995 Patent as of the Critical Date would have had at least a bachelor's degree in computer science, electrical engineering, computer engineering, or a related field, with 2-3 years of experience in digital video processing, or a related

field. SAMSUNG-1003, ¶¶123-125. Additional graduate education could substitute for professional experience, and *vice versa*. *Id*.

II. THE '995 PATENT

A. Technical Background

The '995 Patent relates to video coding technology, and more particularly to the use of "super-resolution" techniques to enhance "reference pictures" in a video coding system.

As Dr. Reader explains in detail in his declaration, the subject matter of the '995 Patent amounts to no more than than an obvious collection of video coding concepts that were well known to a POSITA before the Critical Date. SAMSUNG-1003, §II. These concepts include:

(i) **motion-compensated coding** in which pictures (or regions of pictures) in a video stream are compressed by using 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 (SAMSUNG-1003, ¶¶58-66);

(ii) **loop filtering** in which the previously decoded pictures—i.e., "reference pictures"—are enhanced before being used to predict other picture(s) (SAMSUNG-1003, ¶¶67-71);

(iii) **super-resolution processing** in which multiple lower resolution pictures of the same scene are registered 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 count[2]) than the input pictures (SAMSUNG-1003, ¶¶44-54, 132-140); and

(iv) **layered, hierarchical coding** in which two or more related video streams are coded together to provide a base layer that can be decoded independent of the other layers and one or more enhancement layers that are decoded in dependence on the base layer (SAMSUNG-1003, ¶¶83-91; *see also id.*, ¶¶92-115).[3]

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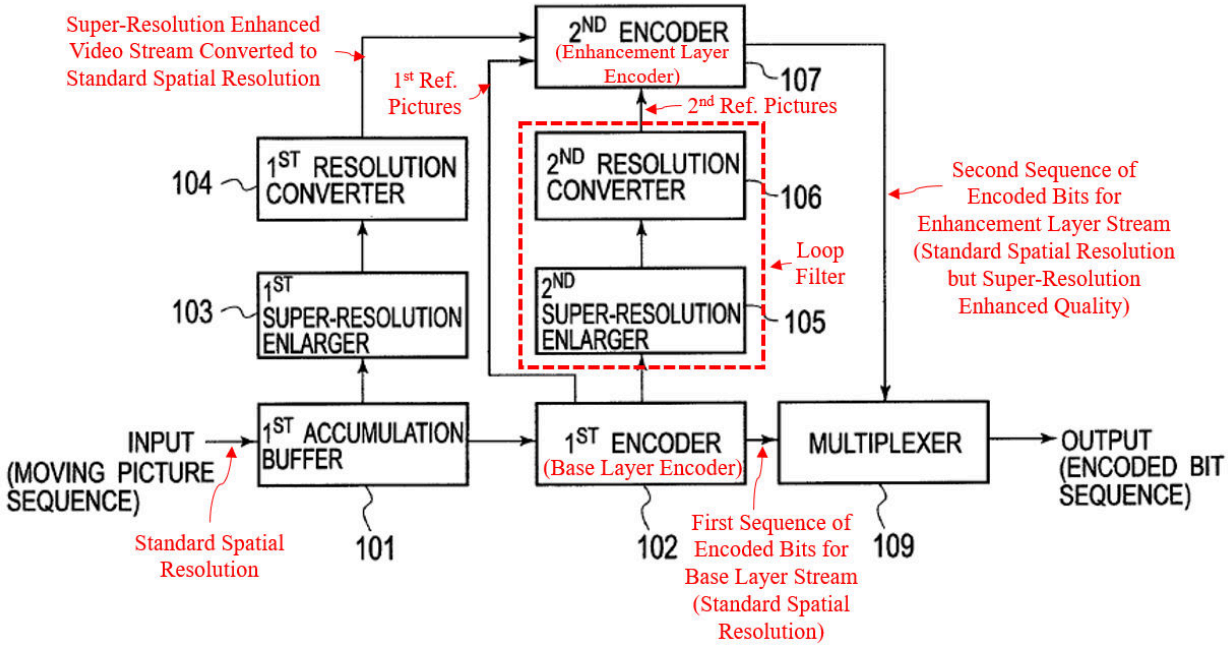
[2] The '995 Patent sometimes uses the term "resolution" to refer to the amount of detail (e.g., spatial frequency or information content) in a picture and at other times uses the term "resolution" to refer to the size (e.g., number of pixels) in the picture. SAMSUNG-1003, ¶¶131-133.

[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. SAMSUNG-1003, ¶86; *generally id.*, ¶¶83-91, 174.

B. Brief Description

The '995 Patent describes a layered video coding system that uses conventional super-resolution algorithms to enhance the quality of decoded base-layer pictures that are used as reference pictures for the subsequent decoding of enhancement layer pictures. SAMSUNG-1003, ¶¶127-146. FIG. 1's depiction of an encoding apparatus is instructive:

FIG. 1



SAMSUNG-1001, FIG. 1 (annotated)

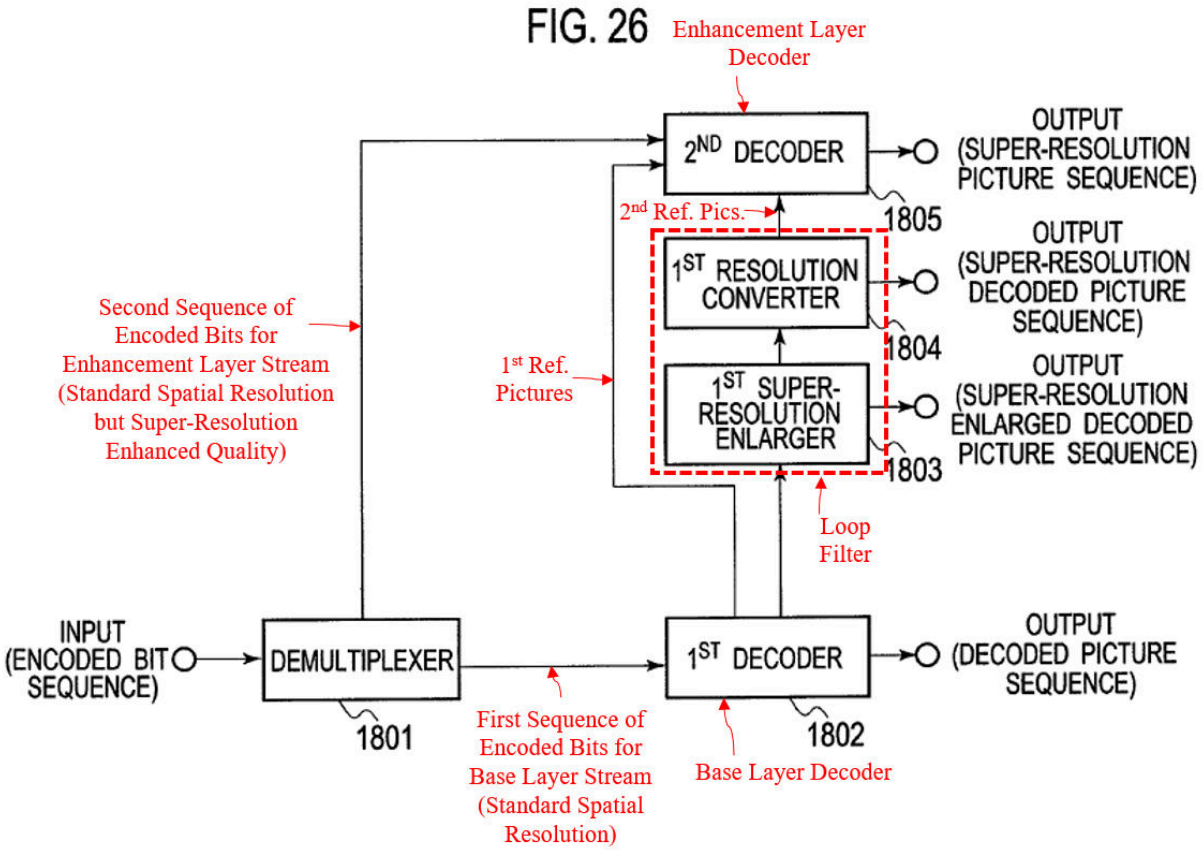
As shown above, the encoding apparatus passes pictures from the input video through an accumulation buffer 101 to each of two encoding paths. SAMSUNG-1001, 13:40-17:45. In the first path, a base version of the input video is en-

coded by the first encoder 102 to produce a first coded bitstream for the base version of the video. *Id.*, 13:46-14:9. In the second path, a super-resolution enhanced version of the input video is encoded by the second encoder 107 to produce a second coded bitstream for the super-resolution enhanced version of the input video. *Id.*, 15:30-42. The system generates the super-resolution enhanced version of the input video using (i) a first super-resolution enlarger 103 to increase the spatial resolution and information content (e.g., quality) of pictures in the input video, and then using (ii) a first resolution converter 104 to reduce the spatial resolution of the super-resolution enlarged video. *Id.*, 14:10-48. For each input video picture that is to be subjected to super-resolution processing, the first accumulation buffer 103 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.*, 4:34-49.

To remove redundancies in information coded between the base- and enhancement-layer streams, the second encoder 107 implements inter-layer predictive processes to predict pictures in the enhancement-layer stream from decoded pictures in the base-layer stream. SAMSUNG-1001, 15:30-64. Decoded pictures from the base-layer stream can also be enhanced before being used as references

by the second encoder 107 by subjecting base-layer pictures that have been encoded and then decoded by the first encoder 102 to processing by the second-resolution enlarger 105 and second-resolution converter 106. *Id.*, 14:49-16:18. The super-resolution enlarger 105 and second-resolution converter 106 form a type of loop filter to enhance the quality of the reference picture and revert the reference picture back to a standard resolution. SAMSUNG-1003, ¶143. The second encoder 107 selects either non-super resolution enhanced base layer pictures or super-resolution enhanced base layer pictures as reference pictures for encoding of the enhanced video stream. SAMSUNG-1001, 15:30-16:45. 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.*, 16:64-17:20, 16:46-63, 29:67-30:5, 59:62-60:20.

FIG. 26 illustrates techniques for decoding the multiplexed signal from the encoding apparatus of FIG. 1. SAMSUNG-1001, 59:4-41, 50:39-54:6.



SAMSUNG-1001, FIG. 26 (annotated)

Demultiplexer 1801 parses the input encoded bit sequence to produce the first and second bitstreams corresponding to the base- and enhancement- layer video streams, respectively. SAMSUNG-1001, 50:52-51:18. The first decoder 1802 decodes the base layer stream and the second decoder 1805 decodes the enhancement layer stream. *Id.*, 51:16-37, 52:27-53:46. Like the encoding apparatus of FIG. 1, the decoding apparatus of FIG. 26 includes a loop filter in the form of a first super-resolution enlarger 1803 and a first resolution converter 1804 that enhances decoded base layer pictures from the first decoder 1802. *Id.*, 51:38-52:26.

The output of the first decoder is also passed directly to the second decoder. *Id.* The second decoder 1805 selects either non-super-resolution enhanced decoded base layer pictures or super-resolution enhanced decoded base layer pictures for inter-layer prediction of pictures in the enhancement-layer video stream, where the selection of which picture to used is based on reference picture selection information embedded in the signal from the encoding apparatus. *Id.*, 52:40-53:46.

In additional embodiments, the non-super-resolution enhanced decoded base layer pictures can be upscaled to a higher spatial resolution by a second resolution converter 1806 as shown in FIG. 23.

C. Examination History

The application (U.S. Serial No. 14/692,138) resulting in the '995 Patent was filed on April 21, 2015, by JVC Kenwood Corporation. SAMSUNG-1001, face. The '995 Patent claims priority to several earlier-filed applications, with the earliest claimed priority date being May 30, 2008. *Id.*

During original examination, four cycles of rejections and responses between the Examiner and the applicant ensued before allowance. SAMSUNG-1002, 273-296 and 300-325 (first action and response), 207-228, 230-255 (second action and response), 131-150 and 154-179 (third action and response), 58-105 (fourth action and response), 9-19 (notice of allowance). In each Office Action,

the claims were rejected as obvious over prior art combinations based on Phek[4] (SAMSUNG-1005) along with additional references including Holcomb (SAMSUNG-1024), Barkley (SAMSUNG-1025), and Suzuki (SAMSUNG-1026).

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

The Examiner likewise acknowledged that Phek and Holcomb "do not explicitly disclose a second resolution converter" as claimed and relied on Barkley's teaching of "spatial enhancement layers" for this limitation. SAMSUNG-1002,

[4] The file history refers to a machine translation of the Phek prior art reference by the name "Ong" rather than Phek.

90-91 (citing SAMSUNG-1025, [0053]-[0056]). The applicant also never disputed the relevance of Barkley's teachings in this regard.

In the fourth and final rejection before allowance, the Examiner asserted that Barkley teaches the use of two sets of reference pictures as recited by the then-pending language of the "second decoder" limitation in claim 23. SAMSUNG-1002, 91. The Examiner specifically asserted that Barkley met the reference picture selection requirement of claim 23 since Barkley's decoder "selectively decode[s] video information from the base layer and one or more enhancement layers to playback or reproduce the video information at a desired level of quality." *Id.* (citing SAMSUNG-1025, [0005], FIGS. 1, 3, 5-8). In response, the applicant amended claim 23 to recite that the "second decoder" must further "select one of the set of first reference pictures and the second set of reference pictures ***based on reference picture selection information***." SAMSUNG-1002, 65-66 (emphasis added). The applicant argued that "*Barkley* (newly-cited) only encodes information on a plurality of layers" and "[t]hus, *Barkley's* device fails to disclose a technique for selecting one of two kinds of reference pictures and fails to suggest using any such reference picture selection information to identify the selected reference picture." SAMSUNG-1002, 62 (emphasis in original). The Examiner subsequently allowed the application and identified the "second decoder" limitation

(including the added requirement for "reference picture selection information") in the reasons for allowance. *Id.*, 17-18.

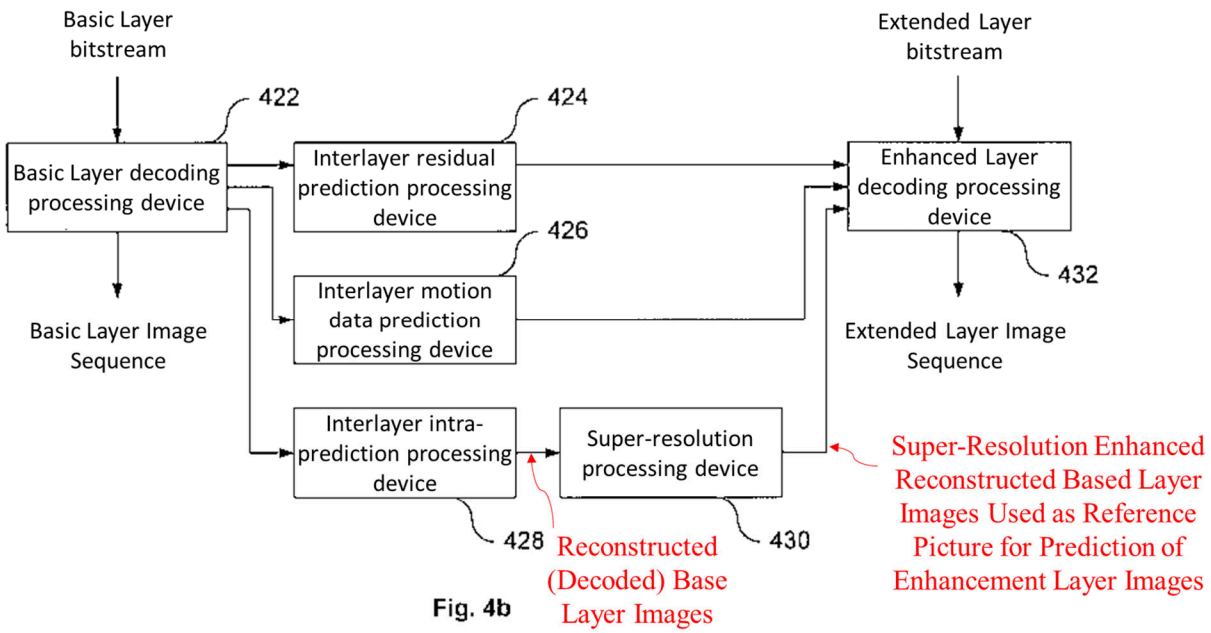
The file history contains no indication that the Examiner ever considered Phek's teachings in combination with the teachings of Segall, Martins, and He as set forth in Ground 1 of this Petition. If the combination had been considered, the application never should have been allowed. *Infra*, §IV.A.

III. THE CHALLENGED CLAIMS ARE UNPATENTABLE

A. [GROUND 1] – Phek in view of Segall, Martins, and He Renders Claims 2-4 and 11 Obvious

1. Overview of Phek

Phek discloses a video coding system that uses "[i]nterlayer prediction … for hierarchical encoding in order to improve encoding efficiency." SAMSUNG-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.



SAMSUNG-1005, FIG. 4b (modified and annotated)[5]; SAMSUNG-1003, ¶162.

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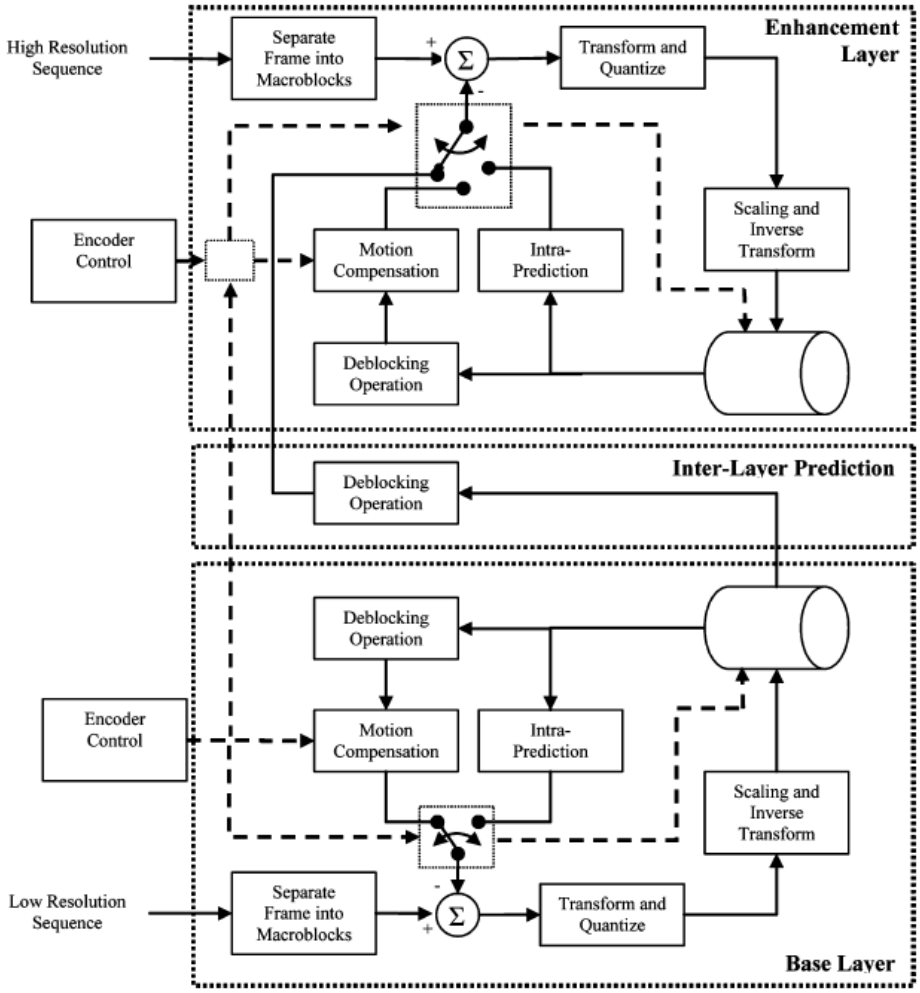
[5] For ease of reading, Petitioner has identified the blank boxes in each of Phek's figures reproduced in this Petition using the labels provided external to the boxes in the certified English translation. *See* SAMSUNG-1005. Petitioner also notes that the English translations of Phek (SAMSUNG-1005 and -1031) use the terms "base" and "basic" layers (or streams) interchangeably, and further use the terms "extended," "enhanced," and "enhancement" layers (or streams) interchangeably. This Petition cites and quotes disclosure from the certified translation that uses different ones of these terms, but this Petition typically refers simply to "base" and "enhancement" layers (or streams) consistent with common usage of these terms in the field. SAMSUNG-1003, FN6.

2. Overview of Segall

Segall is an IEEE paper titled "Spatial Scalability Within the H.264/AVC Scalable Video Coding Extension." SAMSUNG-1006, 1. Segall surveys aspects of the scalable video coding (SVC) extension that "provide[] support for multiple display resolutions within a single compressed bit stream (or in hierarchically related bit streams), which is referred to [] as *spatial scalability*." *Id.* (emphasis in original). Segall describes spatial scalability with reference to a layered coding system like Phek's, which is illustrated in FIG. 1:



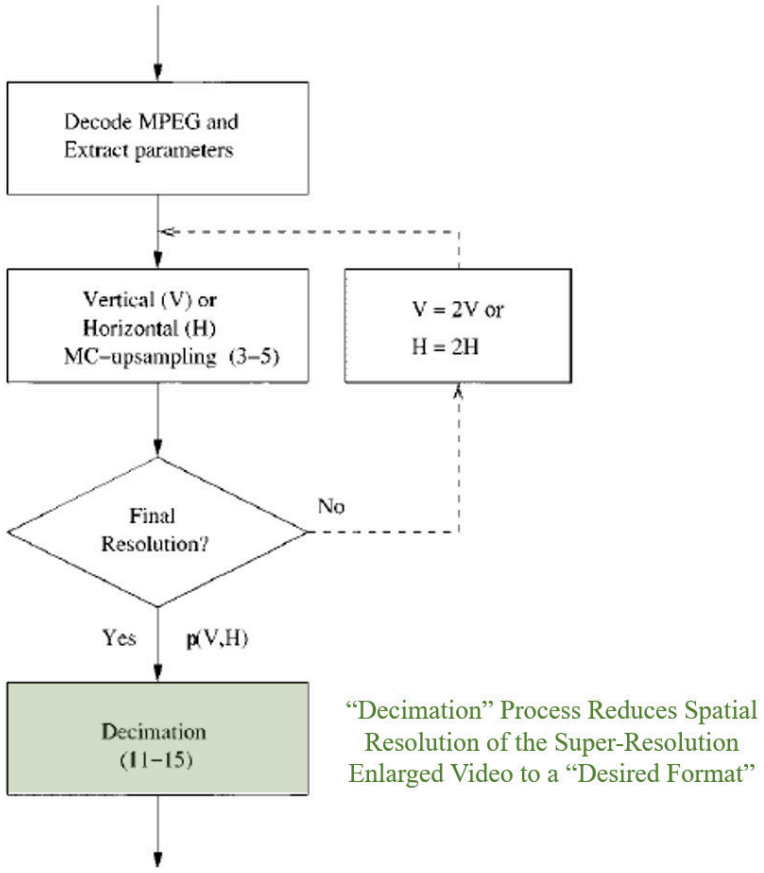
SAMSUNG-1006, FIG. 1

According to Segall, "[t]he 'base layer' encoder takes a lower resolution video sequence as input and encodes it with the H.264/AVC video coding standard while conforming to a legacy profile." SAMSUNG-1006, 2. "The enhancement layer encoder takes a higher resolution sequence as input" and encodes it "with ordinary H.264/AVC technologies." *Id.* "Moreover, inter-layer prediction can be used to provide additional coding choices" and "[f]or the case of intra-picture coded blocks in the base layer, reconstructed intensities provide a prediction for the enhancement layer." *Id.* "For the case of inter-picture coded blocks in the base layer, enhancement layer motion vectors and residual difference information can be predicted from the base layer." *Id.*; SAMSUNG-1003, ¶¶163-164.

3. Overview of Martins

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

from multiple images and decimation to the desired format." *Id.* FIG. 2 illustrates Martins' algorithm, which specifically includes a "decimation" process to downscale the super-resolution enlarged image to a lower spatial resolution:



SAMSUNG-1007, FIG. 2 (annotated); *see also id.*, p. 5, § IV ("DECIMATION"); SAMSUNG-1003, ¶165.

4. Overview of He

He discloses techniques for selective in-loop filtering in a scalable video coding system. SAMSUNG-1003, ¶¶166-169. He specifically focuses on selective in-loop deblock filtering to control deblock filtering parameters at each layer

of scalable coding hierarchy. SAMSUNG-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." SAMSUNG-1008, [0006]. "Disabling the entire deblocking filter [] provides a significant reduction of computational complexity and power consumption, especially in the decoder of a video processing system." *Id.*, [0028]. He thus proposes techniques for examining "the content of the video information … to determine whether to disable the deblock filtering," e.g., based on "a characteristic indicative of a relative amount of content complexity and/or a relative amount of motion of the video information" and "also based on power savings considerations." *Id.*, [0028], [0037].

FIG. 2 (reproduced below) depicts a video decoder 200 configured to implement selective deblock filtering. SASMUNG-1008, [0032], FIG. 2. The decoder 200 receives a coded bitstream (BTS) and performs prediction and reconstruction operations to decode at least a portion of a picture, thereby generating "unfiltered reconstructed frame information URF'." *Id.*, [0032]. URF' is provided to a deblocking filter 211, controlled by a deblock control circuit 221. *Id.*, [0033]-

[0034]. Deblock control circuit 221 issues a "decoder filter control DFC signal" that selectively enables or disables the deblocking filter 211. *Id.*, [0034]. When filter 211 is disabled, deblock filtering operations are bypassed and "URF' is passed as the 'filtered' reconstructed information RF' to a reference frame buffer 213 for use as a reference picture for motion-compensated prediction processes. *Id.* When filter 211 is enabled, URF' is filtered to generate RF' for use as a reference picture in the motion compensated prediction processes. *Id.*

He further explains that "the 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." *Id.*

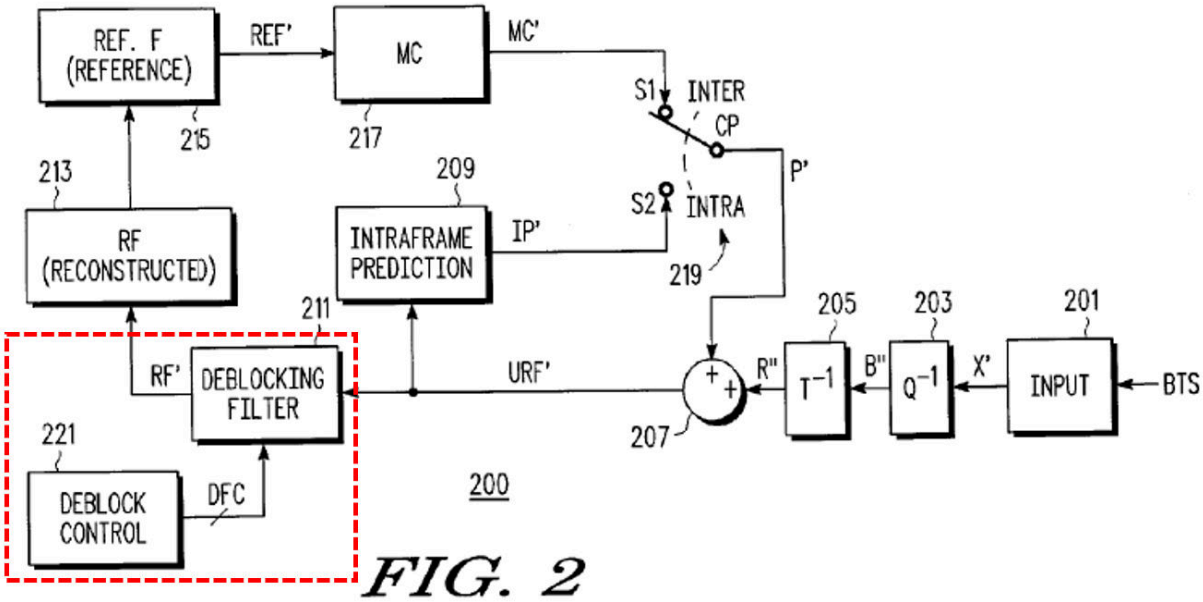


FIG. 2

In-Loop Deblocking Filter 211 and Control Circuit 221

SAMSUNG-1008, FIG. 2 (annotated)

5. Combination of Phek, Segall, Martins and He

Like the '995 Patent, Phek discloses a layered video coding system that enhances reference picture quality in an enhancement layer by super-resolution processing. *Supra*, §III.A. 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. Indeed, Phek acknowledges that its encoder/decoder descriptions are "simplified" and "do not have to be performed as shown." SAMSUNG-1005, [0013]. Phek's system is thus ripe for improvement. SAMSUNG-1003, ¶171.

The following subsections address five straightforward modifications to Phek's system that would have been obvious to implement in view of Segall, Martins, and He.[6] SAMSUNG-1003, ¶¶171-172.

i. Obvious based on Segall to Encode/Decode Phek's Base and (First) Enhancement Layer Streams at 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.

[6] This overview of the Phek-Segall-Martins-He combination is referenced and incorporated in the analysis of each claim element in Section III.A.6 below.

SAMSUNG-1005, [0014]-[0015], FIGs. 4a-4b. 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." SAMSUNG-1005, [0014].

Segall teaches that scalable coding systems can implement "combinations of temporal scalability (frame rate enhancement) and quality scalability (fidelity enhancement for pictures of the same resolution)" as well as "spatial scalability" for spatial resolution enhancement. SAMSUNG-1006, 1. Scalable video coding allows for the "mixing" of layers including "layers that provide temporal or quality scalability." *Id.* Hierarchical video coders can also be used for multi-view coding to encode/decode video streams corresponding to different viewpoints of a scene with the same spatial resolution. *Supra*, §II.A.

Based on Segall's teachings, it would have been obvious to implement Phek's system to encode/decode the base- and enhancement-layer streams at a

same spatial resolution.[7] SAMSUNG-1003, ¶¶173-177. For example, it would have been obvious for Phek's first enhancement-layer[8] to implement quality scalability, temporal scalability, and/or multi-view coding—all of which can use hierarchical coding and interlayer prediction between streams of the same spatial resolution. *Id.* More specifically, quality scalability would have been obvious and beneficial to allow receivers of the scalable bitstream to decode different quality versions of video content depending on capabilities of the receiver and differences in

[7] A POSITA would have understood that the video streams encoded in the base- and enhancement layers can be obtained, and optionally pre-processed, in any suitable manner. For example, it would have been obvious for a video stream captured by a low-resolution camera to be super-resolution enhanced before being encoded (compressed) to increase the quality and detail of the video being encoded. SAMSUNG-1003, FN8; SAMSUNG-1005, [0002] ("resolution and quality of images subject to transcoding and storage can be improved"); SAMSUNG-1012, 1-2. The enhanced video stream can be encoded in the enhancement layer and a temporally or quality-decimated version of the video stream can be encoded in the basic layer, consistent with common scalable encoding techniques. SAMSUNG-1003, FN8.

[8] A second enhancement layer is described below in §III.A.5.ii.

channel bandwidth and transmission rates that can impact whether the receiver successfully receives a quality enhancement layer stream in addition to the base layer. SAMSUNG-1003, ¶175. Temporal scalability would have been obvious and beneficial to efficiently encode streams with different frame rates and to allow for higher frame rate decoding when a temporally enhanced stream is received, and multi-view coding would have been obvious and beneficial to allow receivers to decode video from multiple viewpoints (e.g., allowing for stereoscopic or 3D video reproduction). *Id.*

Further, whether implementing quality scalability, temporal scalability, multi-view coding, or a combination thereof, it would have been obvious to code the base- and enhancement-layer streams at the same spatial resolution—particularly when the spatial resolution of the base layer is adequate for an intended display device and the display does not support higher resolutions. SAMSUNG-1003, ¶176. Segall teaches, for example, that "lower resolution displays … are [] popular in applications constrained by size, power and weight." SAMSUNG-1006, 1. Upscaling Phek's first enhancement-layer video stream in time and/or quality—but not spatially—relative to the base-layer stream would have allowed lower resolution displays to present a temporally- or quality-enhanced video despite limitations on the display's native/maximum spatial resolution. SAMSUNG-1003, ¶176. Ac-

cording to Segall, "it is rarely justifiable to design a device with low display resolution with the capacity for decoding and down-sampling high resolution video material" since "[s]uch a requirement could increase the cost and power of the device" and results in "a waste of [the device's] receiving channel bit rate." *Id.* Similarly, in multi-view coding, different viewpoints can be encoded at the same spatial resolution in different layers to allow for reproduction of the video stream in each layer on the same display device. SAMSUNG-1003, ¶176.

Coding Phek's base- and enhancement-layer video streams at the same spatial resolution also would have been obvious as a predictable application of known layered coding techniques to achieve predictable results. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 417 (2007) (a supposed invention that "simply arranges old elements with each performing the same function it had been known to perform" is obvious). A POSITA would have had a reasonable expectation of success implementing Phek's system in this manner especially since layered coding systems commonly coded video streams with the same spatial resolution before the Critical Date. SAMSUNG-1003, ¶177.

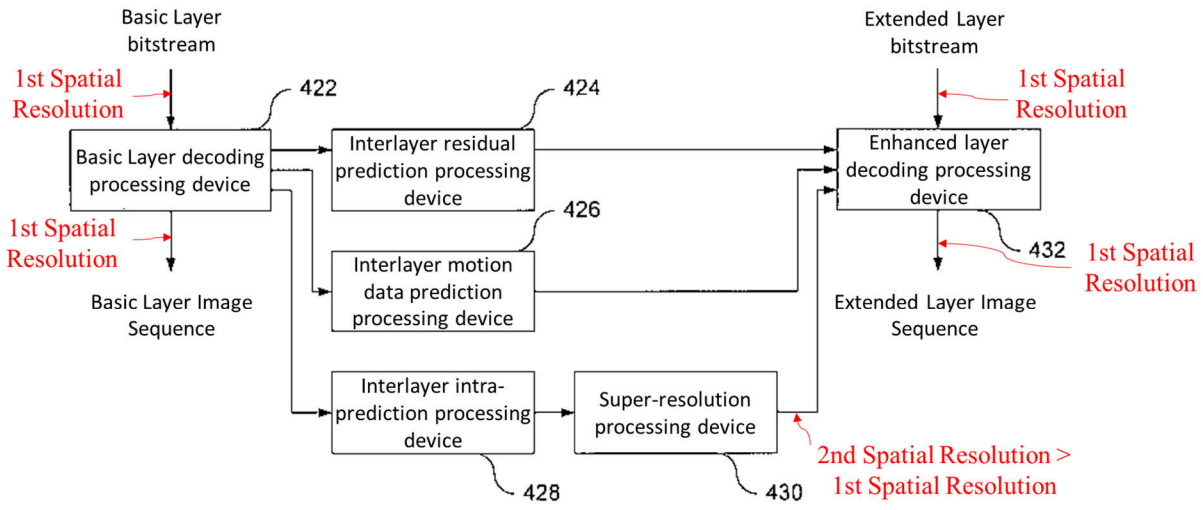


Fig. 4b

First Intermediate Illustration of Proposed Combination (Phek-Segall)

ii. Obvious based on Segall to Implement a Second Enhancement Layer in Phek's System for Spatial Scalability

Segall teaches that scalable video coding allows for "the mixing of spatial scalability layers with other layers that provide temporal or quality scalability." SAMSUNG-1006, 1-2; *supra*, § III.A.2. It would have been obvious based on Segall to implement a second enhancement layer in Phek's system, i.e., a second enhancement layer that codes a video stream with a higher spatial resolution than the video streams in the base and first enhancement layers. SAMSUNG-1003, ¶178. The second enhancement layer can be a spatially scalable layer, for example, that encodes video whose frames are predicted from frame(s) in the base layer, the first enhancement layer, or both. *Id.*

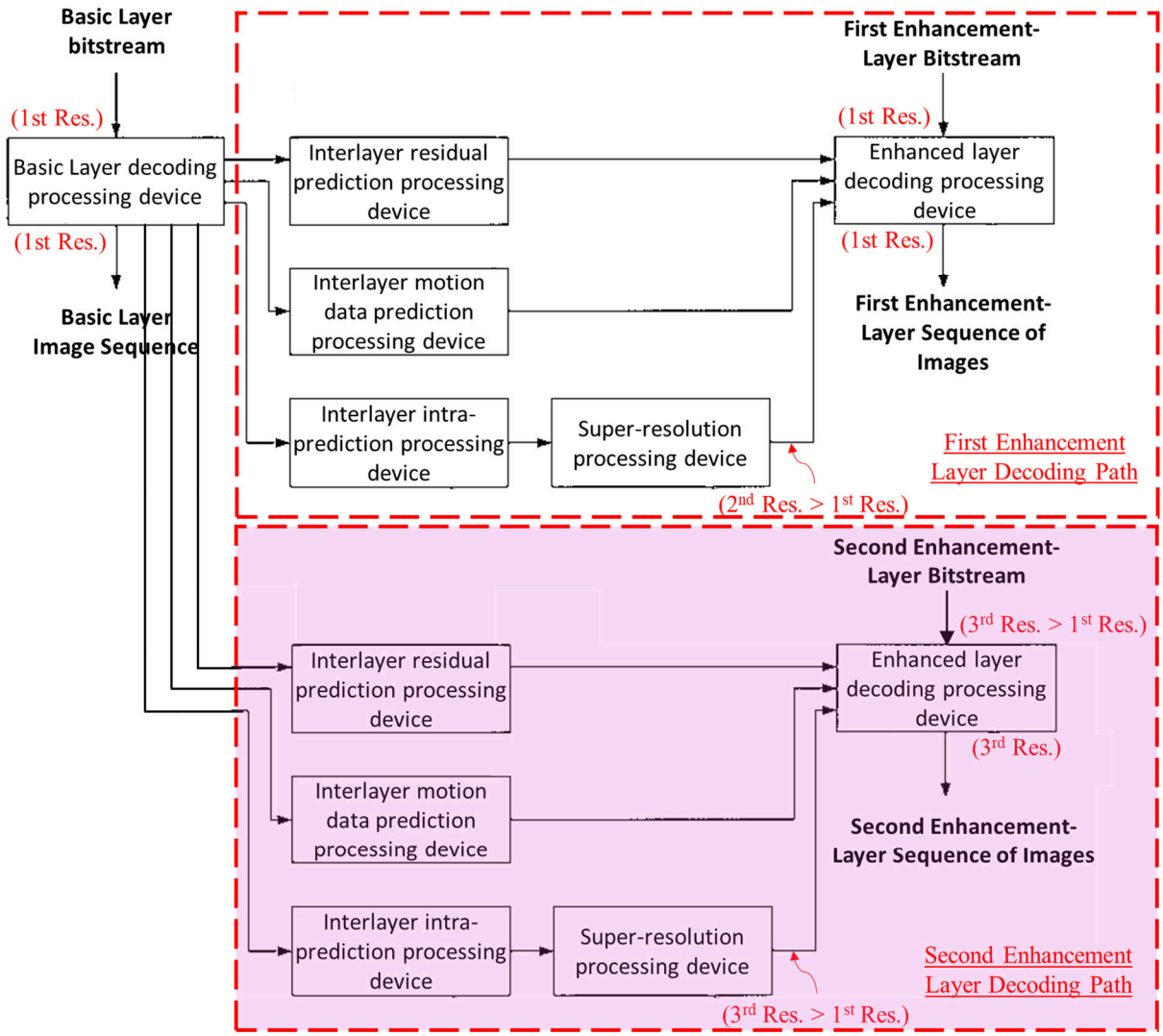
Encoding a video stream with a higher spatial resolution in the second enhancement layer would have been obvious to support display devices can render video at higher resolutions than the video coded in the base and first enhancement layers. SAMSUNG-1003, ¶179. Segall, for example, recognized that "[t]he resolution diversity of current display devices motivates the need for spatial scalability." SAMSUNG-1006, 1. In particular, Segall noted that "larger format, high definition displays are becoming common in consumer applications, with displays containing over two million pixels readily available." *Id.* The provision of coded video streams at a lower resolution in the base and first enhancement layers as well as a higher-resolution stream in a second enhancement layer would have furthered Segall's goal of supporting a broader range of display devices through "resolution diversity." *Id.*

The addition of a second enhancement layer in Phek's decoder (including a second enhancement layer decoder processor) would have been beneficial to allow higher-definition display devices to decode and display the higher resolution video. SAMSUNG-1003, ¶180. For example, the decoder of a higher-definition display could switch from decoding a lower-layer stream to a higher-layer stream at a higher spatial resolution when the transmission rate of a streaming video program increases sufficiently to allow the decoder to successfully receive and decode the additional video data in the second enhancement layer. SAMSUNG-1006, 1.

Segall underscores this point through its teaching that "[d]iverse, limited, and time-varying channel capacity provides an [additional] motivation for spatial scalability." *Id.* According to Segall, "[s]patial scalability allows for the rapid bit rate adaptation" that can be needed to address time-varying channel conditions. *Id.* Increased viewer satisfaction would be realized by allowing the decoder to decode and display video at higher spatial resolutions when channel conditions are favorable, while nonetheless allowing the decoder to continue playing video from a lower-layer stream under degraded channel conditions. SAMSUNG-1003, ¶180.

The addition of a spatial enhancement layer to Phek's system also would have been obvious as a predictable application of known spatial scalability techniques to achieve predictable results. *KSR*, 550 U.S. at 417. A POSITA would have had a reasonable expectation of success given the common use of multiple enhancement layers before the '995 Patent. SAMSUNG-1003, ¶181. For example, Segall teaches that standard scalable coding techniques before the '995 Patent "support[ed] multilayer scenarios including special multiple spatial scalability layers and the mixing of spatial scalability layers with other layers that provide temporal or quality scalability." SAMSUNG-1006, 3. Further, "[c]onsiderable flexibility is [] provided in regard to the selection of the reference layer for each enhancement layer[] …." *Id.*; *see also* SAMSUNG-1010, 2 (describing how "different types of scalability" can "be combined, so that a multitude of representations

with different spatio-temporal resolutions and bit rates can be supported").



Second Intermediate Illustration of Proposed Combination (Phek-Segall)

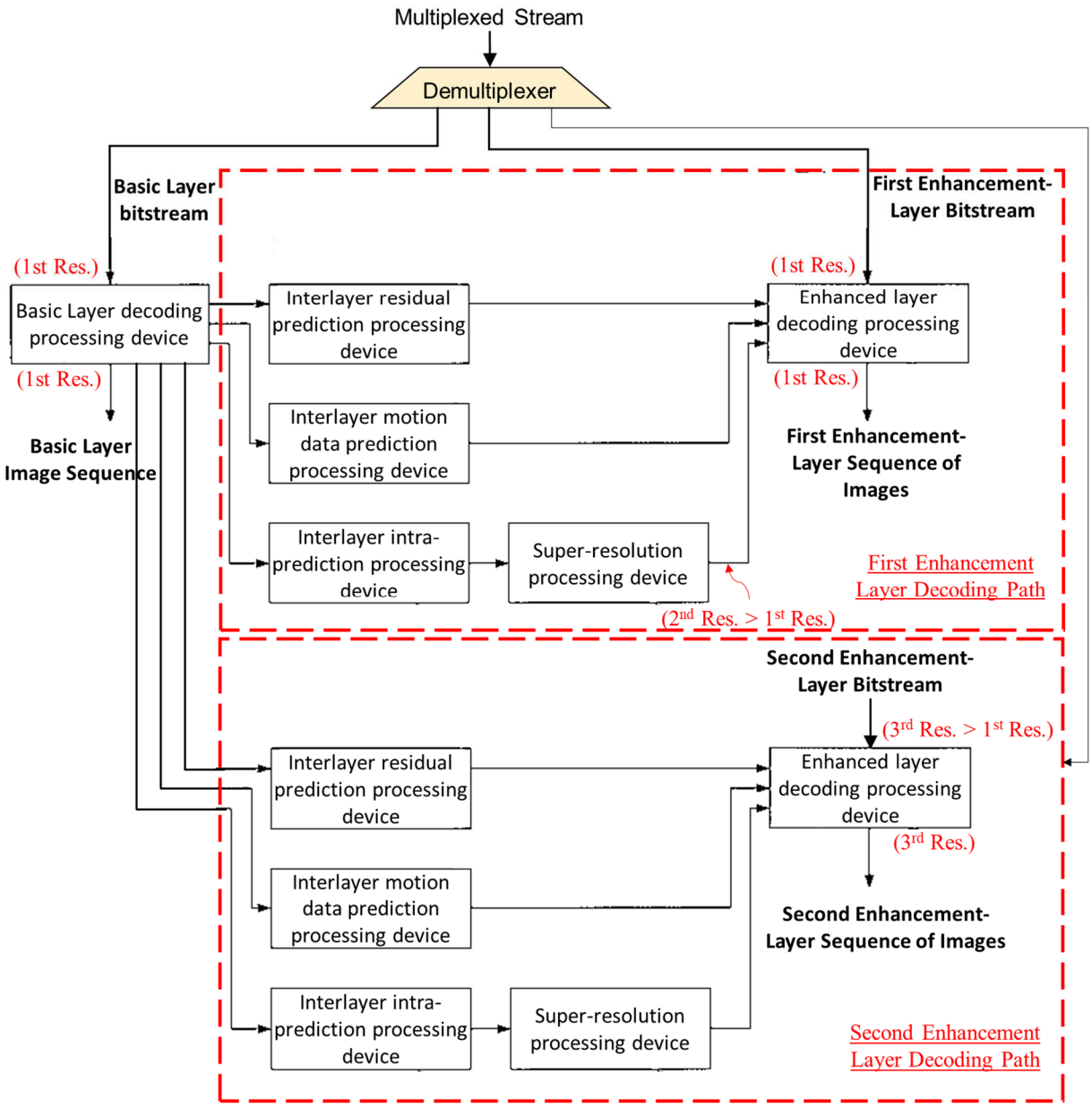
iii. Obvious based on Segall to Multiplex/Demultiplex Phek's Base and Enhancement Layer Bitstreams

Phek does not expressly disclose how the base-layer and enhancement-layer bitstreams are transmitted from the encoder to the decoder. It nonetheless would have been obvious to a POSITA to multiplex the respective bitstreams from the

base-, first-enhancement, and second-enhancement layers of the encoding apparatus in Phek-Segall-Martins-He combination into a single, composite bitstream for transmission. SAMSUNG-1003, ¶¶182-184. The hierarchical decoding device in the combination would then predictably include a demultiplexer to parse the separate basic and enhancement-layer bitstreams. *Id.* Multiplexing and demultiplexing bit streams in the layered coding system of the combination would have been obvious based on the teachings of Phek and Segall. *Id.*

For example, Phek itself describes a "video source [that] is separated from the other sources using an inverse multiplexer 202." SAMSUNG-1005, [0010], FIG. 2. Phek then discloses that its hierarchical video encoder (FIG. 4a) produces separate bitstreams for the base- and enhancement-layers, and that its hierarchical video decoder (FIG. 4b) separately processes the base-layer bitstream and the enhancement-layer bitstream. *Id.*, [0014]-[0015], FIGs. 4a-4b. Segall teaches that scalable video streams are treated "from a systems ***multiplex*** … perspective" in which "the data might often be handled … as distinct hierarchically related streams of content that are coordinated using decoding timestamps or other such mechanisms." SAMSUNG-1006, 3. A POSITA would have understood Segall as teaching multiplexing/demultiplexing of scalable or otherwise hierarchically coded bitstreams, which was common practice before the Critical Date. SAMSUNG-1003, ¶183 (citing SAMSUNG-1009, FIG. 12; SAMSUNG-1017, [0079], FIG. 10).

It would have been obvious and a POSITA would have been motivated to multiplex/demultiplex the base- and enhancement-layer streams in the combination to support transmission of the respective streams over a communication channel, while also facilitating synchronization of the streams by reference to common timing information in the multiplexed signal. SAMSUNG-1003, ¶184. A demultiplexer at the decoder also would have been obvious to separate the streams for processing of each layer by respective portions of the decoding device. *Id.* (citing SAMSUNG-1019, 1; SAMSUNG-1017, [0079]). Multiplexing/demultiplexing the layered streams in the combination also 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 multiplexing and demultiplexing layered bitstreams was commonly performed before the ’995 Patent. *KSR*, 550 U.S. at 417; SAMSUNG-1003, ¶184.



Third Intermediate Illustration of Proposed Combination (Phek-Segall)

iv. Obvious based on Martins to Downscale Phek's Super-Resolution Enlarged Reference Pictures

It next would have been obvious based on Martins to downscale the super-resolution enhanced reference pictures that Phek's first enhancement layer uses for prediction to the first (standard) resolution at which the images in the base- and

first enhancement layers are encoded and decoded. SAMSUNG-1003, ¶¶185-193.

Phek's decoding path for the first enhancement layer includes "a super-resolution processing device 430 [that] is used to improve the reference picture from the inter-layer intra-prediction processing device 428." SAMSUNG-1005, [0015]. 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 spatial resolution than the individual lower-resolution images. SAMSUNG-1005, [0002] ("Super-resolution processing is a technique for generating high-resolution images from a plurality of low-resolution images."). As described above, however, the base- and first enhancement-layer streams in the combination are both coded at the same spatial resolution. *Supra*, § III.A.5.i. Subjecting reference pictures to super-resolution processing naturally yields enlarged images whose spatial resolution is greater than the resolution of the decoding targets in the first enhancement layer stream. SAMSUNG-1005, FIG. 4b. In this context, it would have been obvious to apply a decimation technique like Martin's to revert Phek's super-resolution enlarged reference picture to the smaller spatial resolution of the base- and first enhancement-layer streams (while retaining gains in SNR or detail

resulting from the super-resolution enhancement). SAMSUNG-1003, ¶¶186-188; SAMSUNG-1007, § IV; *supra*, § III.A.3.

Multiple reasons would have prompted a POSITA to follow Martins' suggestion to downscale super-resolution images back to the original (standard) resolution such that the reference pictures that Phek's first enhancement layer uses for inter-layer prediction would be downscaled super-resolution images.[9] SAMSUNG-1003, ¶189.

First, a POSITA would have sought to downscale Phek's super-resolution reference images to reduce the computational expense and complexity of inter-layer predictions of images in the first enhancement layer. SAMSUNG-1003, ¶190. A POSITA would have known before the '995 Patent that decoding from

[9] In the combination, it would have been obvious for the super-resolution processor 430 in the first enhancement layer to generate super-resolution images according to the techniques described in either Phek or Martins. SAMSUNG-1003, FN10. Both references' super-resolution processes produce images of higher quality and higher resolution than the set of lower-resolution input images. *Id.* Each process likewise meets the claimed requirements for super-resolution enlargement. Post super-resolution downscaling can then be performed in any suitable manner including, for example, using a decimation process like that described in Martins. *Id.*

higher-resolution reference pictures generally require more processing time/resources and consumes more power than decoding with lower-resolution reference images—i.e., a fact that explains multiple prior art proposals for reducing reference image size before the Critical Date. A POSITA would have sought to downscale Phek's super-resolution reference images to obtain similar benefits. SAMSUNG-1003, ¶190 (citing SAMSUNG-1021, [0003], [0011], [0016]-[0029], Abstract, FIGS. 2-4; SAMSUNG-1020, Abstract, [0002], [0026], FIG. 4; SAMSUNG-1012, [0002]-[0003], [0006], [0026]-[0027]).

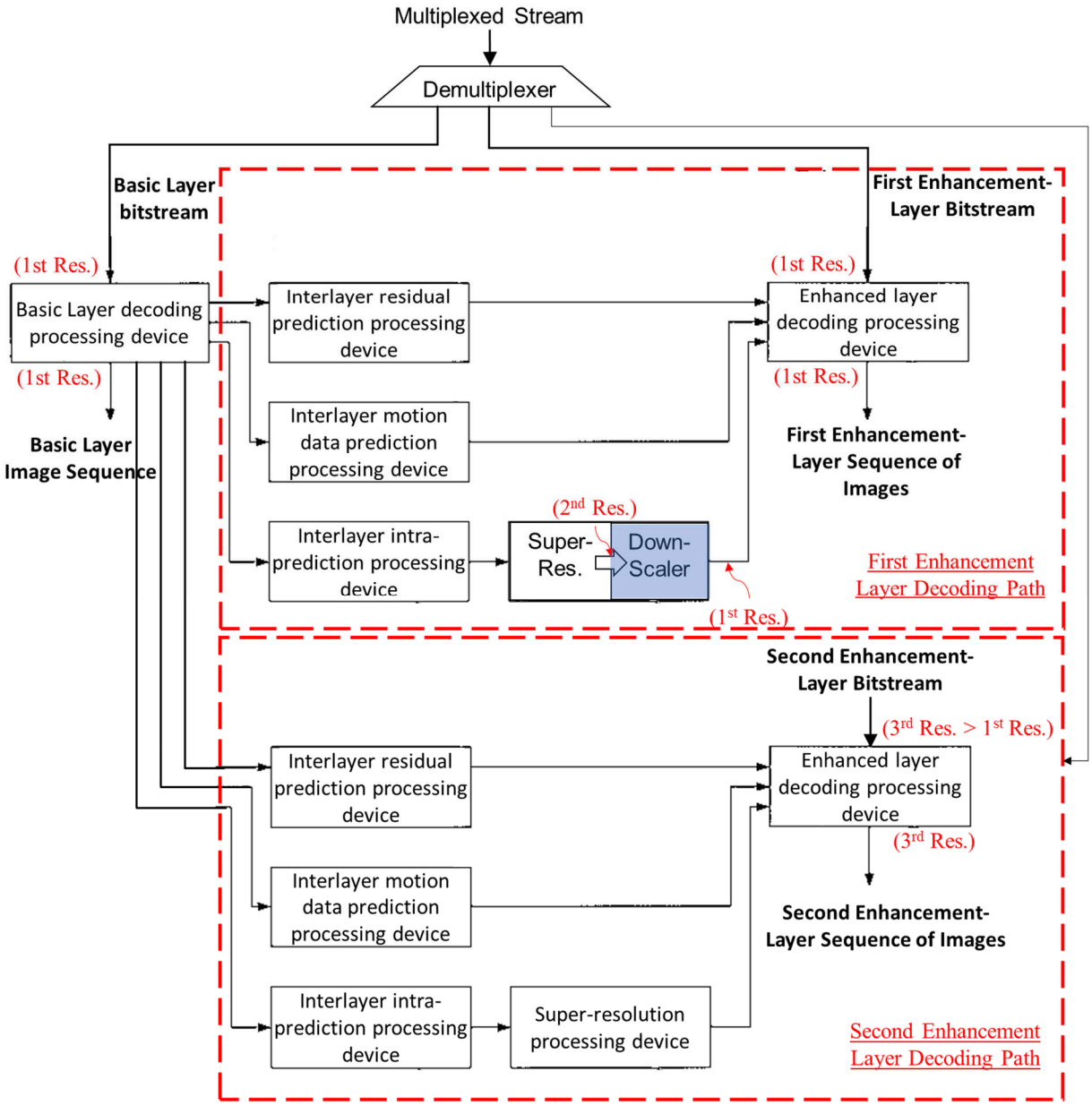
Second, a POSITA would have sought to downscale Phek's super-resolution reference images to reduce the amount of memory required to buffer or otherwise store the reference images for decoding. SAMSUNG-1003, ¶191. Before being applied in a prediction process such as motion compensation and estimation, reference images are commonly stored in a frame buffer where they are made available to the decoder for prediction of a downstream image. SAMSUNG-1003, ¶191; SAMSUNG-1008, FIG. 2 (buffers 213, 215). The size of the frame buffer is proportional to the size of the reference images and it would have been obvious that the buffer size could be reduced by reducing the resolution of the reference images before they are stored in the buffer. SAMSUNG-1003, ¶191. Indeed, frame buffer size was a well-known concern in the art before the '995 patent, especially since larger frame buffers generally require more expensive hardware, more processing,

and more power consumption to maintain than smaller frame buffers. SAMSUNG-1003, ¶191 (citing SAMSUNG-1009, 3:21-28).

Third, a POSITA would have sought to downscale Phek's super-resolution reference images to separately allow the base-layer stream to be outputted for display with an improved picture quality at the first (standard) spatial resolution that does not require a higher resolution, more expensive display device. SAMSUNG-1003, ¶192. Phek expressly notes that super-resolution images are not only usable as reference images in a decoding loop but can also be outputted for display. SAMSUNG-1005, [0002], [0012]-[0013]. Martins likewise describes how decimation can be applied to "obtain a sequence of higher fidelity … in the same format as the directly decoded one." SAMSUNG-1007, 1. Downscaling Phek's super-resolution images would have allowed for rendering of those images at a display device of lower resolution or even on devices that support higher resolutions during periods of time when the decoder is unable to obtain enhancement layer data due to degraded channel conditions or the like. SAMSUNG-1003, ¶192; SAMSUNG-1006, 1.

Fourth, downscaling the super-resolution picture enlarged 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 decimation and downscaling

techniques on super-resolution images before the '995 Patent. *KSR*, 550 U.S. at 417; SAMSUNG-1003, ¶193.



Fourth Intermediate Illustration of Proposed Combination (Phek-Segall-Martins)

v. Obvious based on He to Selectively Apply Phek's/Martin's Super-Resolution (and Downscaling) Loop Filter

A POSITA would have next found it obvious based on He to implement Phek's first enhancement layer decoder in the combination to selectively enable or disable super-resolution processing and downscaling of reference pictures in the first enhancement layer of the Phek-Segall-Martins-He combination. SAMSUNG-1003, ¶¶194-202.

As previously discussed, the teachings of Phek in view of Martins render obvious techniques for performing super-resolution processing and downscaling of reference images used for inter-layer prediction of images in the first enhancement layer. SAMSUNG-1005, [0011]-[0015], FIGS. 3a-3b, 4a-4b; SAMSUNG-1007, 1-2, 6; *supra*, § III.A.5.iv.

The super-resolution and downscaling operations performed on reference pictures in the first enhancement layer decoding path form a type of "loop filter," which the Petition will refer to as a "super-resolution and downscaling loop filter" (or simply an "SR-D filter"). SAMSUNG-1003, ¶196. Like other loop filters known in the art, the Phek-Segall-Martins-He SR-D loop filter enhances decoded frames before they are used as references for the prediction of frames in the first enhancement layer. *Supra*, §II.A; SAMSUNG-1022, 10-11; SAMSUNG-1008, [0006]. As Dr. Reader explains, a wide range of loop filters were known in the art before the '995 Patent and the SR-D filter in the proposed combination similarly serves to enhance the quality of reference pictures consistent with other known

loop filters. SAMSUNG-1003, ¶196 (citing SAMSUNG-1008, [0006]; SAMSUNG-1015, [0068]; SAMSUNG-1011, [0022]-[0023], FIGS. 2-5); *supra*, §II.A.

Phek does not explicitly disclose criteria or conditions for the use of super-resolution processing on reference pictures, nor does Martins explain when SR-D 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 decoded image quality and compression that would be realized by use of the loop filter, power consumption, and the like. *Supra*, § III.A.4; SAMSUNG-1003, ¶197. 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." SAMSUNG-1008, [0006]. "Disabling the entire deblocking filter, therefore, provides a significant reduction of power and processing complexity, especially in the decoder." *Id.* To maintain a "desired tradeoff between video quality and complexity reduction," He 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-Segall-Martins-He

combination to achieve benefits like those expressly described in He—including to reduce the power consumption and computational complexity of decoding frames in at least the first enhancement layer. SAMSUNG-1008, [0028], [0031], [0037], [0076], [0069]; SAMSUNG-1003, ¶199. In the combination, and based on He's teaching, control flags in frame or slice header(s) can predictably indicate whether an in-loop SR-D filter should be applied when decoding a given frame or slice in the first enhancement layer. *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-D filtering. SAMSUNG-1003, ¶200. Indeed, the same concerns that motivated He's use of selective "deblocking"-type loop-filters—including computational complexity and power consumption concerns—are similarly, if not more, applicable to SR-D filtering especially since SR-D filtering involves processing of more images and imposes an even greater computational burden than traditional deblocking filters. SAMSUNG-1003, ¶200; SAMSUNG-1007, 6 (describing need to "keep the algorithmic complexity down"); SAMSUNG-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." SAMSUNG-1011, 2; SAMSUNG-1003, ¶201. 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. SAMSUNG-1011, 2; SAMSUNG-1003, ¶201. 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-D filtering based on He's teachings for selective in-loop filtering. SAMSUNG-1003, ¶201. 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 first enhancement layer decoder in the combination to use a decoded base layer-frame that has not been SR-D filtered for inter-layer prediction of a corresponding frame in the first enhancement layer when the SR-D filter is disabled. *Id*.; SAMSUNG-1008, [0026] ("the unfiltered reconstructed frame information URF is passed as the reconstructed information RF" when loop filtering is disabled), FIG. 2.

The fact that selective loop filtering was standard in video coders before the '995 Patent and that He specifically describes such techniques in a layered coding system like Phek's underscores the obviousness of the combination and that a

POSITA would have had a reasonable expectation of success implementing selective SR-D loop filtering in the combination. SAMSUNG-1003, ¶202; *KSR*, 550 U.S. at 417.

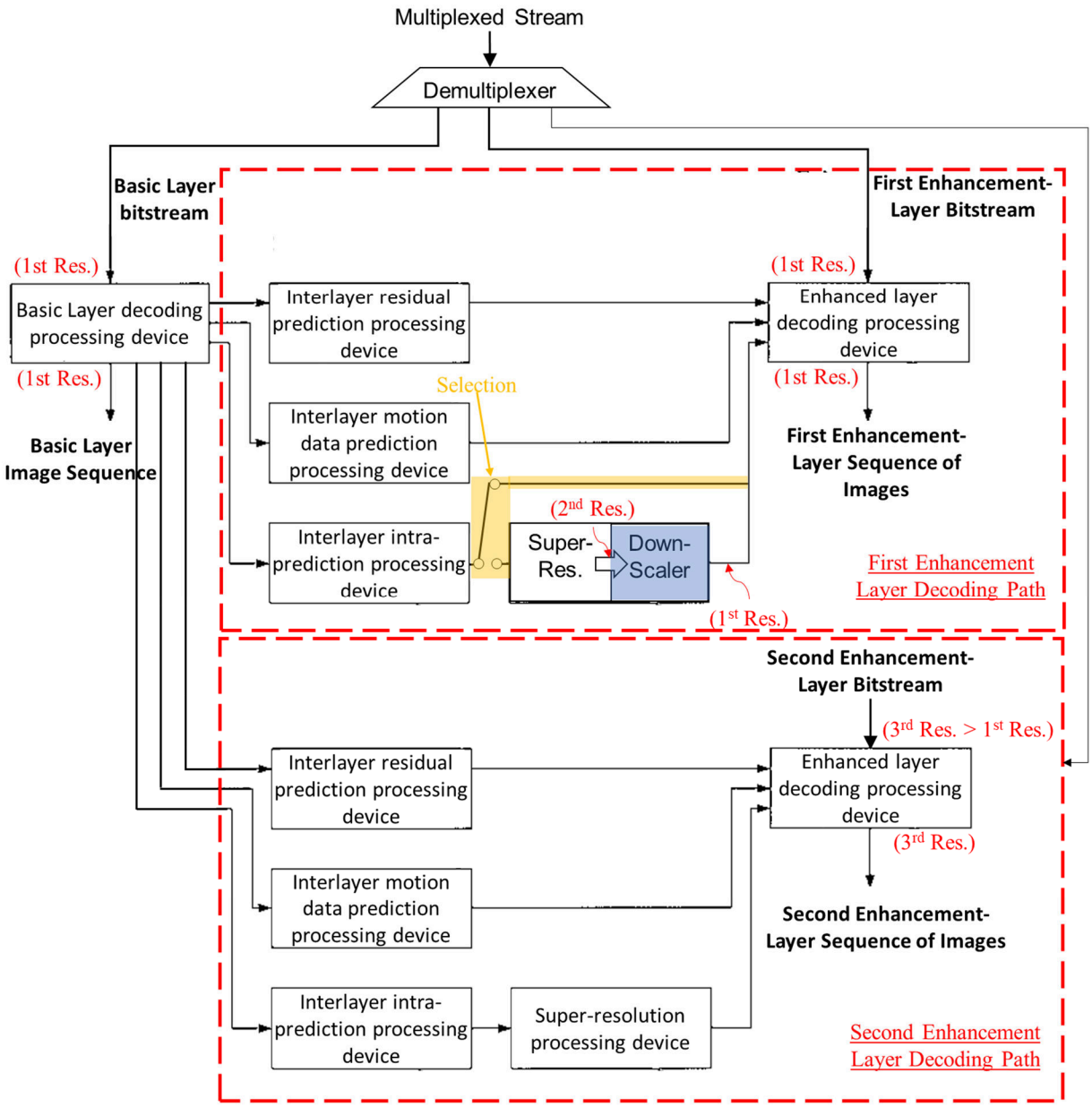


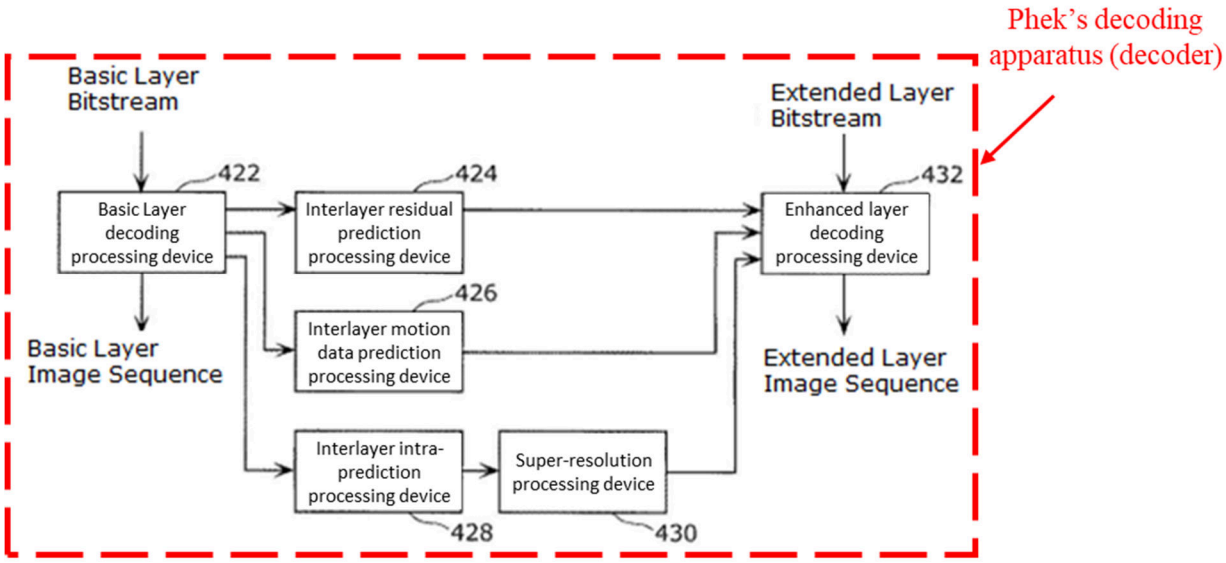
Illustration of Phek-Segall-Martins-He Combination

6. Analysis

(a) Claim 2

[2.P]

To the extent the preamble is limiting, the Phek-Segall-Martins-He combination renders obvious [2.P]. SAMSUNG-1003, ¶¶204-205. For example, with respect to FIG. 4b, Phek describes a "decoding device (decoder)" in an "[i]nterlayer predictive" coding system. SAMSUNG-1005, [0014], FIG. 4b; *see also id.*, [0011]-[0015], FIGs. 3a-3b, 4a. In a decoder, an "image sequence is reconstructed from the encoded video bitstream." SAMSUNG-1005, [0012].



SAMSUNG-1005, FIG. 4b (modified and annotated).

As shown in FIG. 4b, Phek's decoding device includes (i) a basic layer decoding processing device 422 that processes a basic-layer bitstream to decode a basic layer image sequence and (ii) an enhanced-layer decoding processing device

432 that processes an enhancement-layer bitstream to decode an enhancement-layer image sequence. SAMSUNG-1005, [0014]-[0015], FIG. 4b. The decoding device mirrors operations of the encoding device in "us[ing] interlayer prediction to reduce redundancy between the enhanced layer and the basic layer, thereby improving encoding efficiency compared to encoding performed using only an enhanced layer." *Id.*, [0014]; *see also supra*, §§III.A.1, III.A.5.(i)-(v); SAMSUNG-1003, ¶205.

[2.1]

The Phek-Segall-Martins-He combination renders obvious [2.1]. SAMSUNG-1003, ¶¶206-209. For example, Phek describes a "reverse multiplexer 202" (also referred to as an "inverse multiplexer" or a "demuxer") that receives an "input D252 [] composed of video and/or audio sources, etc." and that processes the input D252 to "separate[]" … "the video source … from the other sources." SAMSUNG-1005, [0010], FIG. 2.

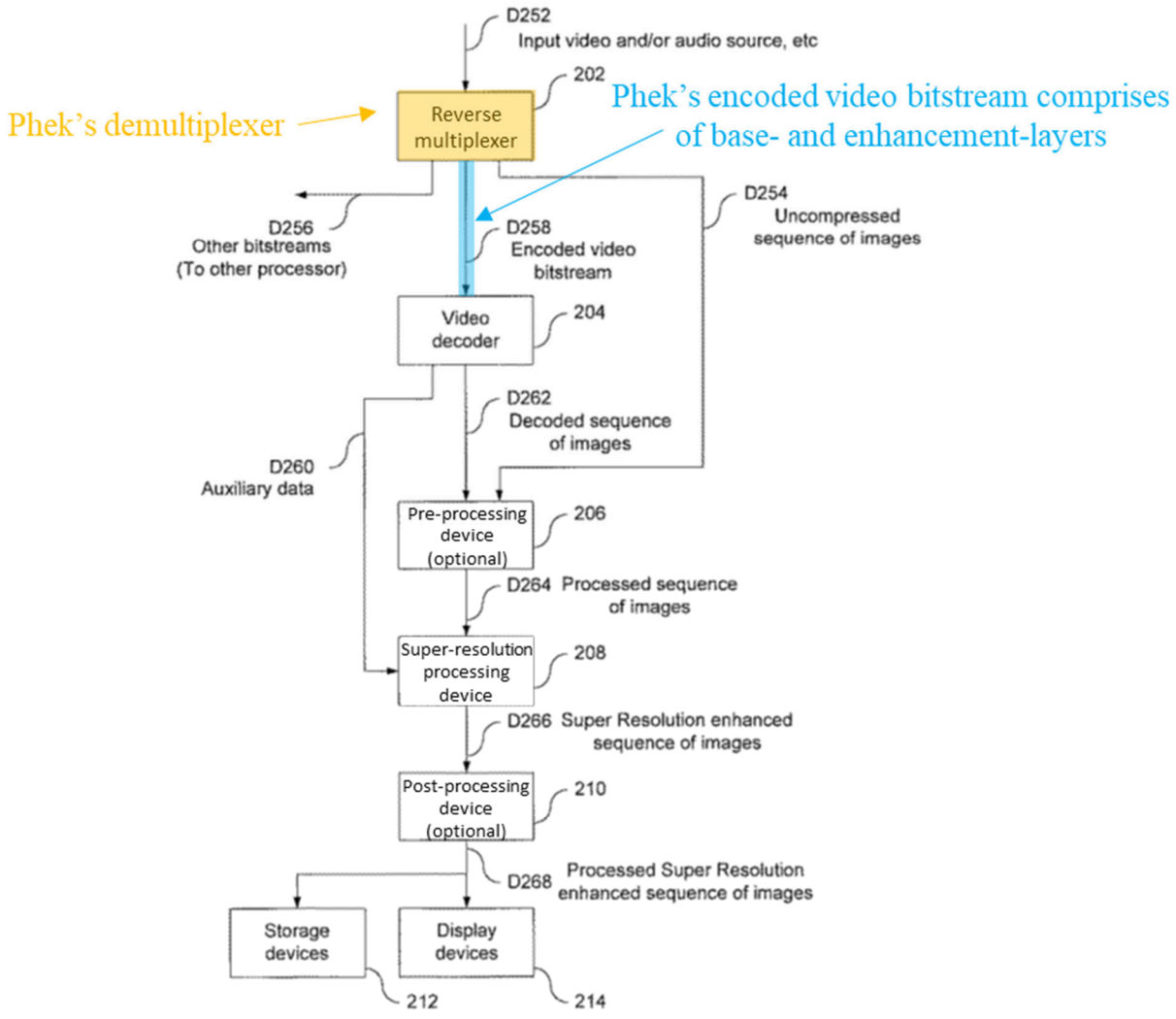


Fig. 2

SAMSUNG-1005, FIG. 2 (modified and annotated).

Further, Phek discloses that the encoder (FIG. 4a) encodes separate bit-streams for the basic- and enhancement layers, while the decoder (FIG. 4b) processes the basic-layer bitstream and the enhancement-layer bitstream in respective decoding paths. SAMSUNG-1005, [0014]-[0015], FIGS. 4a-4b. A POSITA thus would have understood and it would have been obvious that when implementing

layered hierarchical coding, Phek's encoded video bitstream D258 from FIG. 2 would include both the basic- and enhancement-layer bitstreams as shown in FIGs. 4a-4b. Phek does not expressly disclose that the basic- and enhancement-layer bitstreams are multiplexed, however. SAMSUNG-1003, ¶207.

Segall teaches that scalable video streams are treated "from a systems ***multiplex*** … perspective" in which "the data might often be handled … as distinct hierarchically related streams of content that are coordinated using decoding timestamps or other such mechanisms." SAMSUNG-1006, 3. As referenced in Segall, a POSITA would have known that scalable and hierarchical video bitstreams are commonly multiplexed into a composite signal for transmission and demultiplexed upon receipt at the decoder side. SAMSUNG-1003, ¶208 (citing SAMSUNG-1009, FIG. 12; SAMSUNG-1017, [0079], FIG. 10); *supra*, §III.A.5.iii.

In the combination, Phek's encoding device from FIG. 4a multiplexes the respective bitstreams from the basic- and (first) enhancement layers into a single composite signal for transmission, and further multiplexes a second enhancement-layer bitstream into the composite signal when a second enhancement layer is provided as described above. SAMSUNG-1003, ¶209; *supra*, §III.A.5.ii-iii. A demultiplexer akin to Phek's demultiplexer 202 implements a process for a pre-

scribed demultiplexing of the composite signal and outputs the respective bit-streams for processing by corresponding layers of the decoding device. *Id.* The basic layer bitstream constitutes a "***first sequence of encoded bits***" while the (first) enhancement layer bitstream constitutes a "***second sequence of encoded bits***." *Id.*

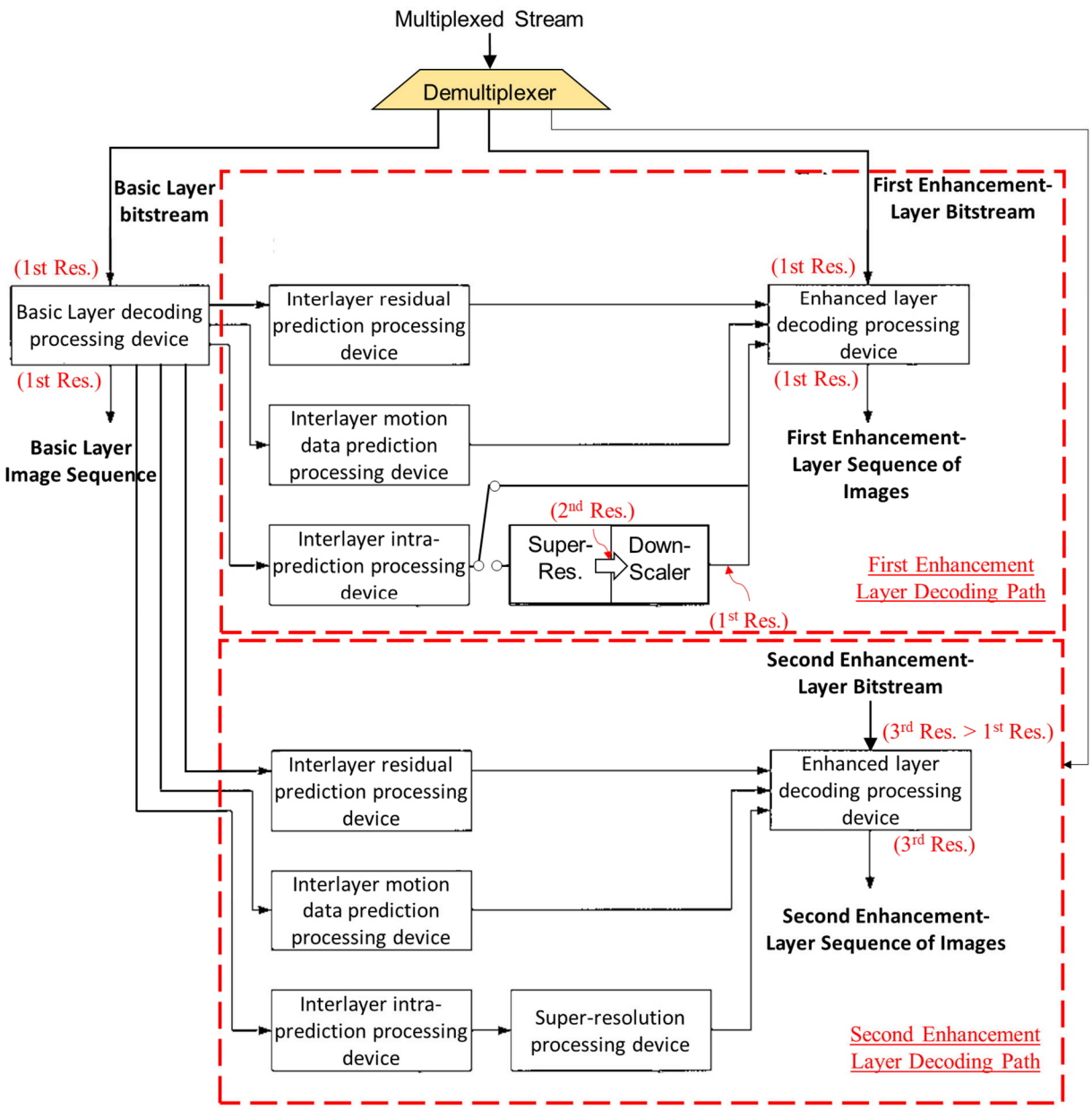


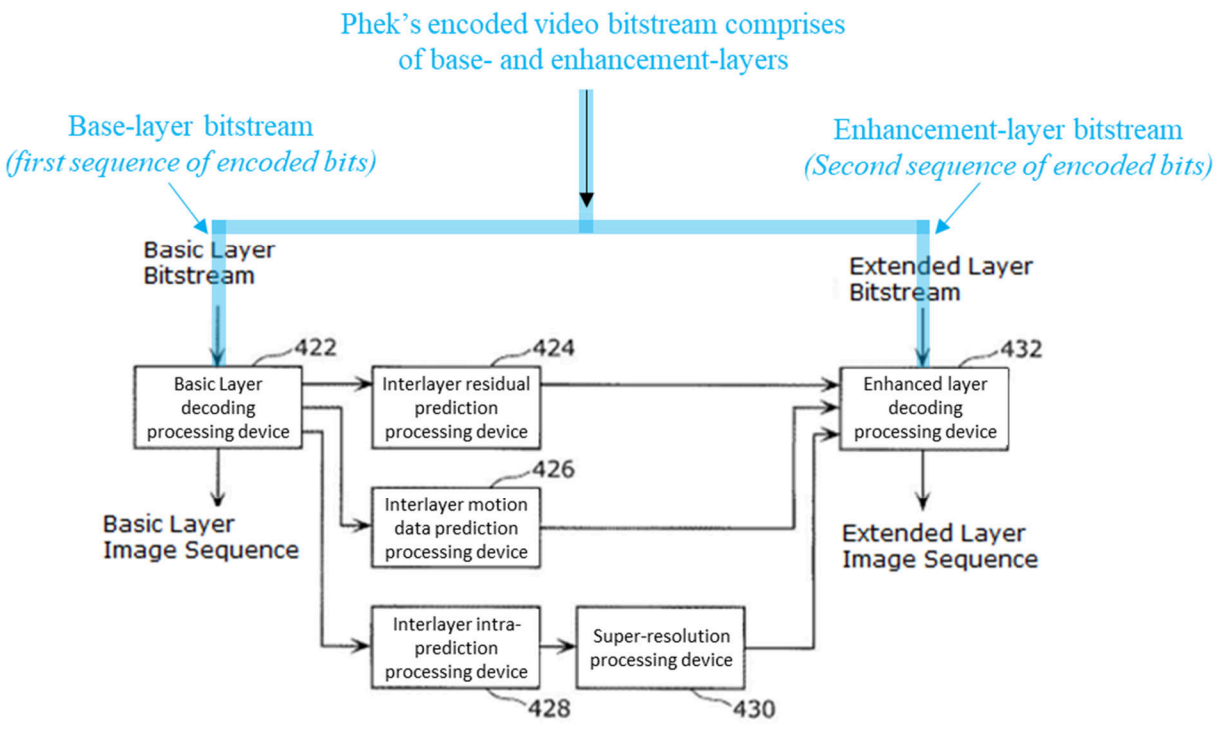
Illustration of Phek-Segall-Martins-He Combination

SAMSUNG-1003, ¶209.

[2.2]

The Phek-Segall-Martins-He combination renders obvious [2.2]. SAMSUNG-1003, ¶¶210-211. For example, with respect to FIG. 4b, Phek discloses a decoding device for hierarchically encoded video streams configured to decode image sequences from each of a basic-layer bitstream and an enhancement-layer bitstream. SAMSUNG-1005, [0014]-[0015], FIG. 4b. "In the decoder, the basic layer bitstream is decoded using a basic layer decoding processing device 422." *Id.*, [0015].

In the combination, consistent with Phek's and Segall's teachings, the basic layer decoding processing device 422 (***first decoder***) acquires the basic-layer bitstream (***first sequence of encoded bits***) from the demultiplexer to implement thereon a process for a prescribed first decoding to create a basic layer image sequence (***sequence of decoded pictures***). SAMSUNG-1003, ¶211; *supra*, § III.A.5. As explained above in the combination overview, the basic layer video stream is encoded and decoded with a first spatial resolution (***standard resolution***). *Supra*, § III.A.5.i; SAMSUNG-1003, ¶211.



SAMSUNG-1005, FIG. 4b (modified and annotated).

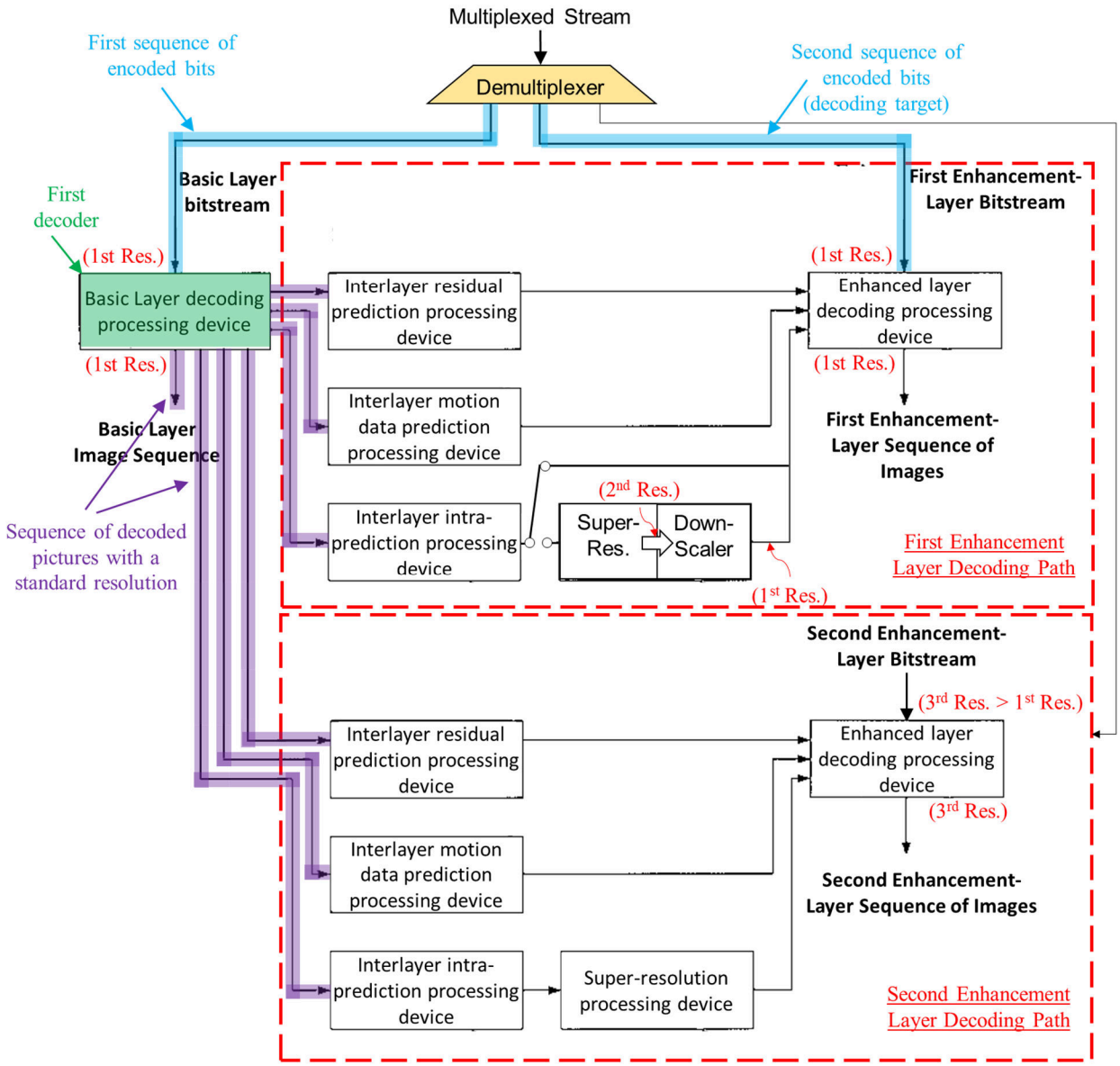


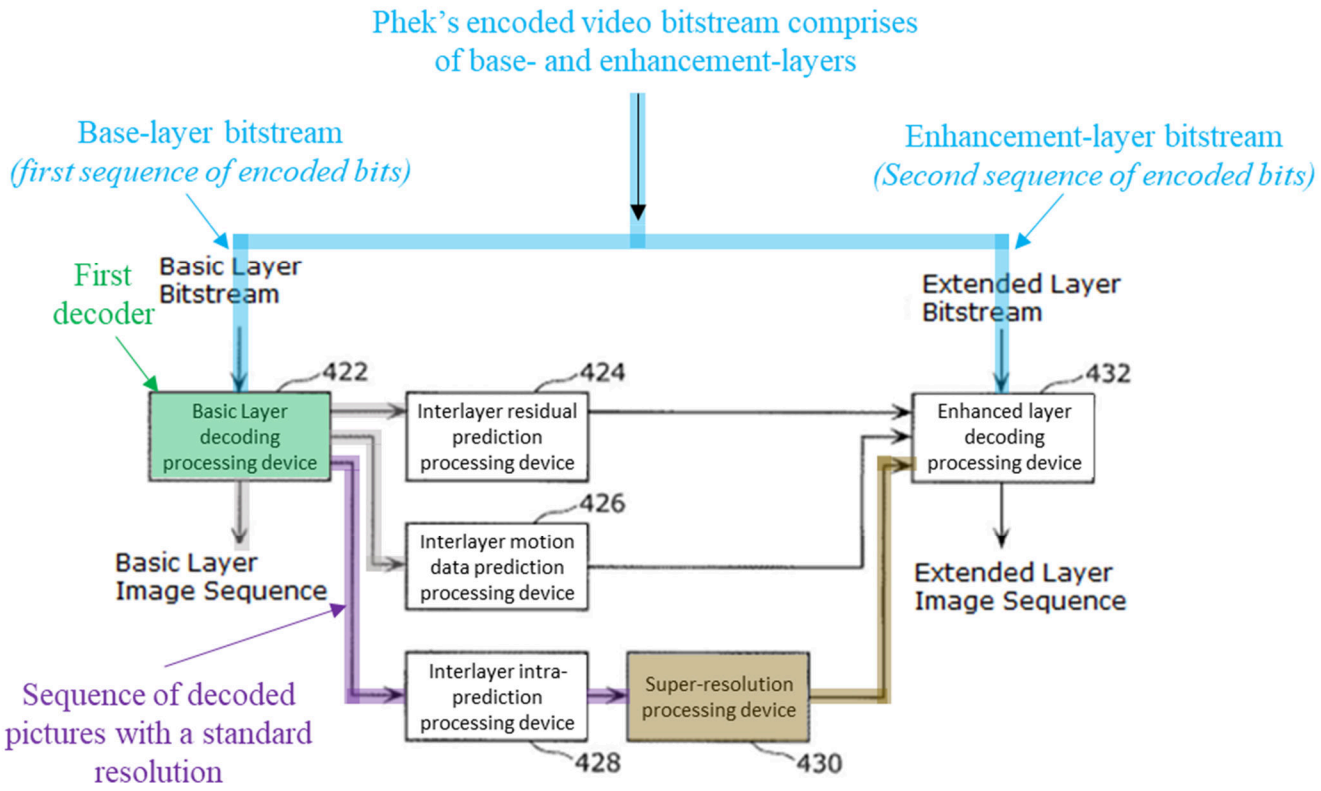
Illustration of Phek-Segall-Martins-He Combination

SAMSUNG-1003, ¶211.

[2.3]

The Phek-Segall-Martins-He combination renders obvious [2.3]. SAMSUNG-1003, ¶¶212-216. For example, with respect to FIG. 4b, Phek describes a

"super-resolution processing device 430 [that] is used to improve the reference picture from the inter-layer intra-prediction processing device 428" and that "performs residual interpolation." SAMSUNG-1005, [0015], FIG. 4b. SAMSUNG-1003, ¶212. Phek explains that "super-resolution processing … improve[s] encoding efficiency or picture quality by improving the reference frames used for motion detection, motion compensation prediction, and display." SAMSUNG-1005, [0013], [0014] ("uses an … a reconstructed image of the basic layer as an additional reference image for encoding the image of the enhanced layer"). The super-resolution processing device 430 thus constitutes a "***first super-resolution enlarger***" and is configured to acquire the basic layer image sequence (***sequence of decoded pictures created with a standard resolution***) at the basic layer decoding processing device 422 (***first decoder***) to work on the basic layer image sequence to implement an interpolation of pixels with a first enlargement to create a sequence of "***super-resolution enlarged decoded pictures with a first resolution higher than a standard resolution***." SAMSUNG-1003, ¶212.



SAMSUNG-1005, FIG. 4b (annotated and modified).

In more detail, Phek's super-resolution processing creates a super-resolution enlarged image from a sequence of lower-resolution images. The super-resolution enlarged image has both improved quality (e.g., more resolvable detail and higher SNR) and a higher spatial resolution (e.g., more pixels) than any of the individual lower-resolution images used as input to the super-resolution processing. SAMSUNG-1005, [0002] ("Super-resolution processing is a technique for generating high-resolution images from a plurality of low-resolution images. This technique can be used … to improve the resolution and quality of the inputted image sequences … ."); *supra*, §II.A; SAMSUNG-1003, ¶213.

In FIG. 1a, Phek illustrates "a block diagram showing the processing devices (functional blocks) in the super-resolution processing device." SAMSUNG-1005, [0016]. In the super-resolution processing device, an "interpolation processing device 110 interpolates frames subject to super-resolution" using "[w]ell-known interpolation methods" such as "bilinear interpolation, bicubic interpolation, and Lanczos interpolation." *Id.* Moreover, in Phek, there is a disclosure of "residual interpolation to prevent grid artifacts." *Id.*, [0006]. This is achieved "by adding smoothing constraints to high-resolution estimated images," thereby resulting in the generation of "sharper images." *Id.*, [0006], [0008]. SAMSUNG-1003, ¶214.

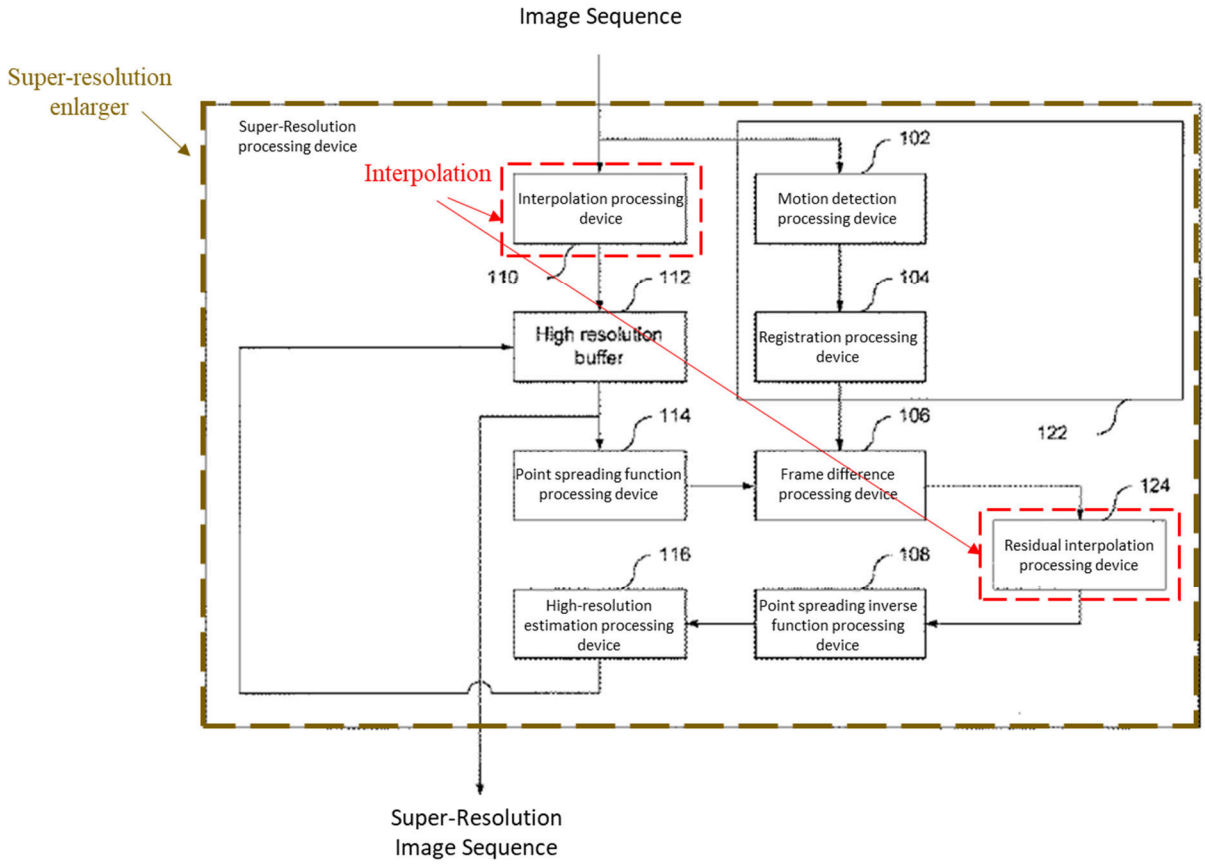


Fig. 1a

SAMSUNG-1005, FIG. 1a (modified and annotated); *see also id.*, FIG. 1b.

Martins also discloses super-resolution processing and enlargement techniques that would have been obvious to apply additionally or as an alternative to Phek's super-resolution algorithm in the context of the Phek-Segall-Martins-He combination. *Supra*, §§ III.A.3, III.A.5.iv. For example, in FIG. 2, Martins illustrates a super-resolution enlarger that enlarges an image using "spatial interpolation". SAMSUNG-1007, 5 and FIG. 2. 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 superresolution pictures obtained by simple spatial interpolation." *Id.* "The algorithm is based on motion-compensated spatial upsampling from multiple images and decimation to the desired format." *Id.*

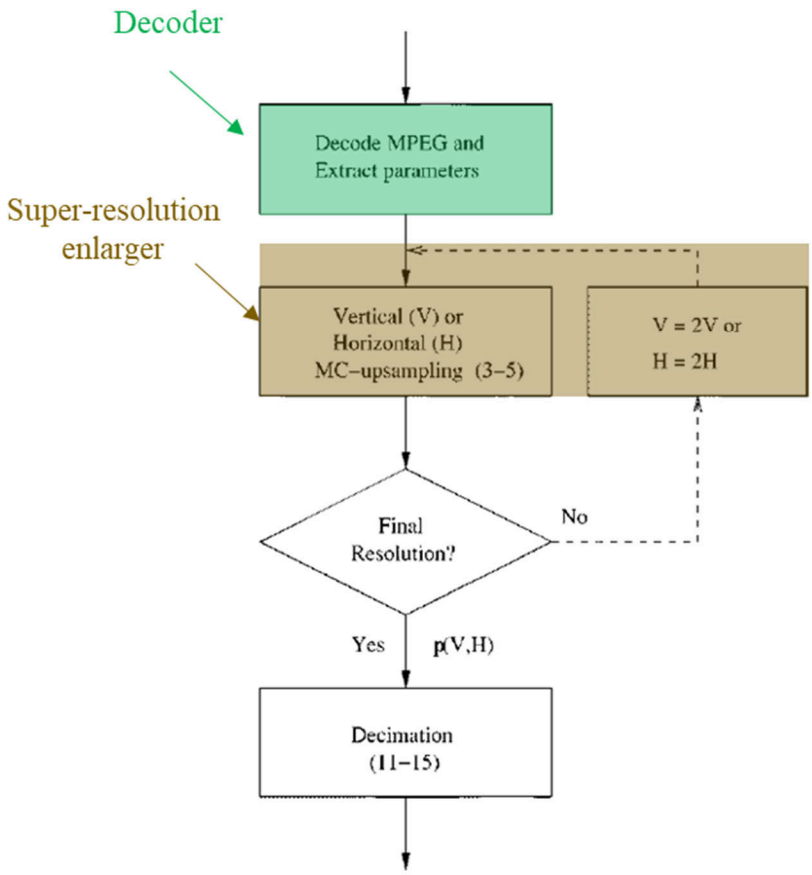


Fig. 2. Overview block diagram. MC upsampling alternates between doubling the resolution vertically and horizontally. Then final step is decimation to the desired format. Equation numbers are given in (). Dashed line marks control flow.

SAMSUNG-1007, FIG. 2 (annotated); SAMSUNG-1003, ¶215.

As illustrated below, the super-resolution processor in the first enhancement layer decoding path of the Phek-Segall-Martins-He decoding device corresponds to the recited "***first super-resolution enlarger***":

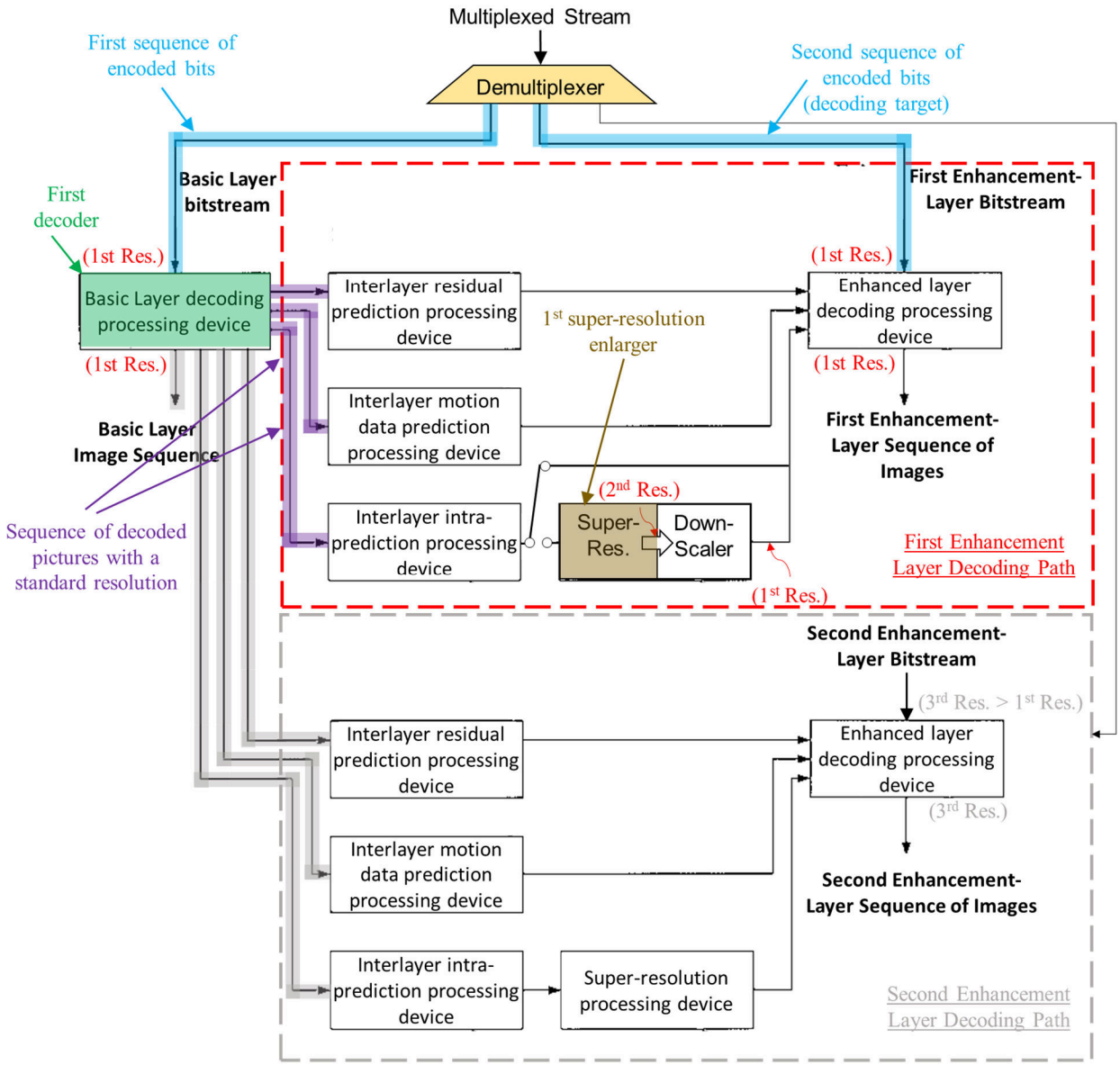


Illustration of Phek-Segall-Martins-He Combination

SAMSUNG-1003, ¶216; *supra* §III.A.5.iv.

[2.4]

The Phek-Segall-Martins-He combination renders obvious [2.4]. SAMSUNG-1003, ¶217-221. As discussed above, it would have been obvious to apply a decimation technique like Martins' to the sequence of super-resolution enlarged

decoded pictures generated by the first super-resolution enlarger, thereby reducing the size (spatial resolution) of the super-resolution enlarged reference pictures to the first (standard) resolution of the basic- and enhanced- layer pictures. SAMSUNG-1003, ¶217; SAMSUNG-1007, § IV; *supra*, §§ III.A.3, III.A.5.iv.

For example, FIG. 2 depicts operations in Martins' picture enhancement process, which specifically includes a "decimation" operation that downscales the super-resolution enlarged image to a lower spatial resolution. In other words, "the super-resolution picture is decimated to the desired format." SAMSUNG-1007, Abstract, 2; *see also id.*, 1 (""obtain a sequence of higher fidelity … in the same format as the directly decoded one"), 3, 9, §IV ("DECIMATION").

Martins teaches that different "degree[s] of decimation" can be applied depending on the context in which the system is operated, e.g. to perform image "restoration, chrominance upsampling, deinterlacing, or resolution enhancement[] …" SAMSUNG-1007, 2. Image restoration enhances decoding quality without changing the size of the restored image. *Id.*; SAMSUNG-1003, ¶218-219 (citing SAMSUNG-1011, 2 ("does not change the size")).

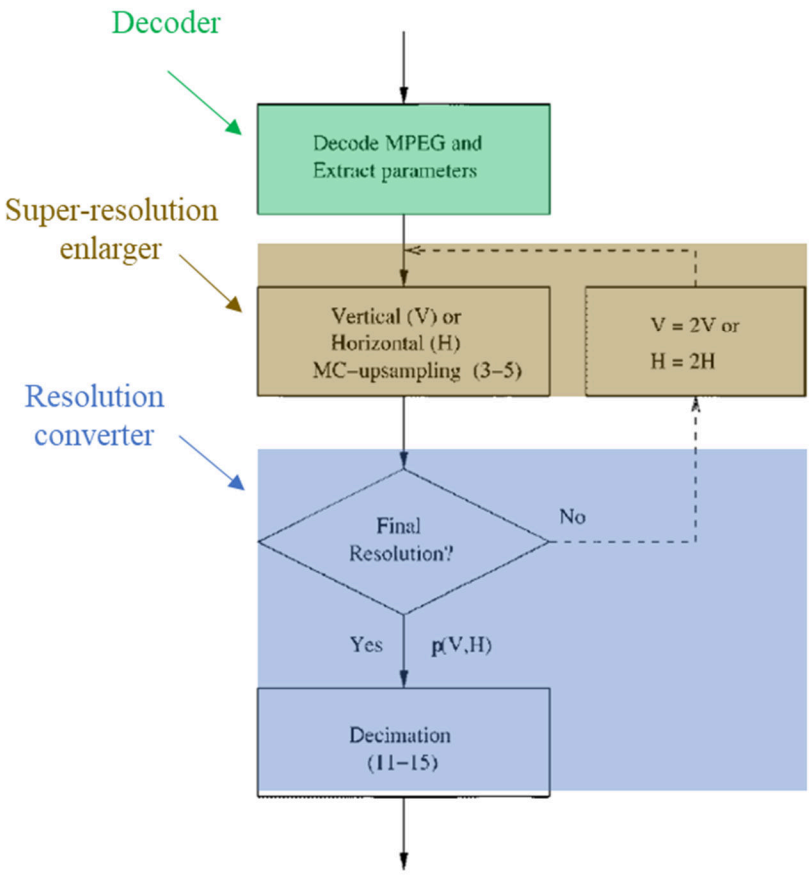


Fig. 2. Overview block diagram. MC upsampling alternates between doubling the resolution vertically and horizontally. Then final step is decimation to the desired format. Equation numbers are given in (). Dashed line marks control flow.

SAMSUNG-1007, FIG. 2 (annotated); §IV Decimation

Through FIGs. 11-12, Martins illustrates results of their super-resolution and decimation enhancement techniques. SAMSUNG-1007, 8-9. In FIG. 11, Martins illustrates "the result of using simple upsampling of a directly decoded sequence." *Id.*, 8-9. FIG. 12, by contrast, shows "the results of our enhancement to progressive SDTV … images[] … ." *Id.*, 8-9.

Standard Definition (SD)
(*standard resolution*)

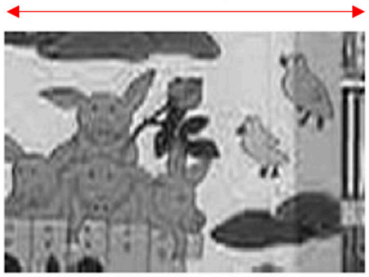


Fig. 11. Direct progressive SDTV. Mobcal at 5 Mbs/s. Part of the I-picture (frame 24, top field). PSNR = 28.5 dB.

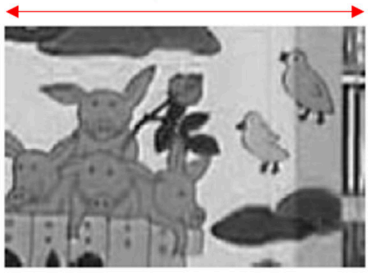


Fig. 12. Enhanced to progressive SDTV. Mobcal at 5 Mb/s. Part of the I-picture (frame 24, top field). PSNR = 30.1 dB.

Original picture

Enhanced picture created using Martins' algorithm

SAMSUNG-1007, FIGs. 11 and 12 (annotated).

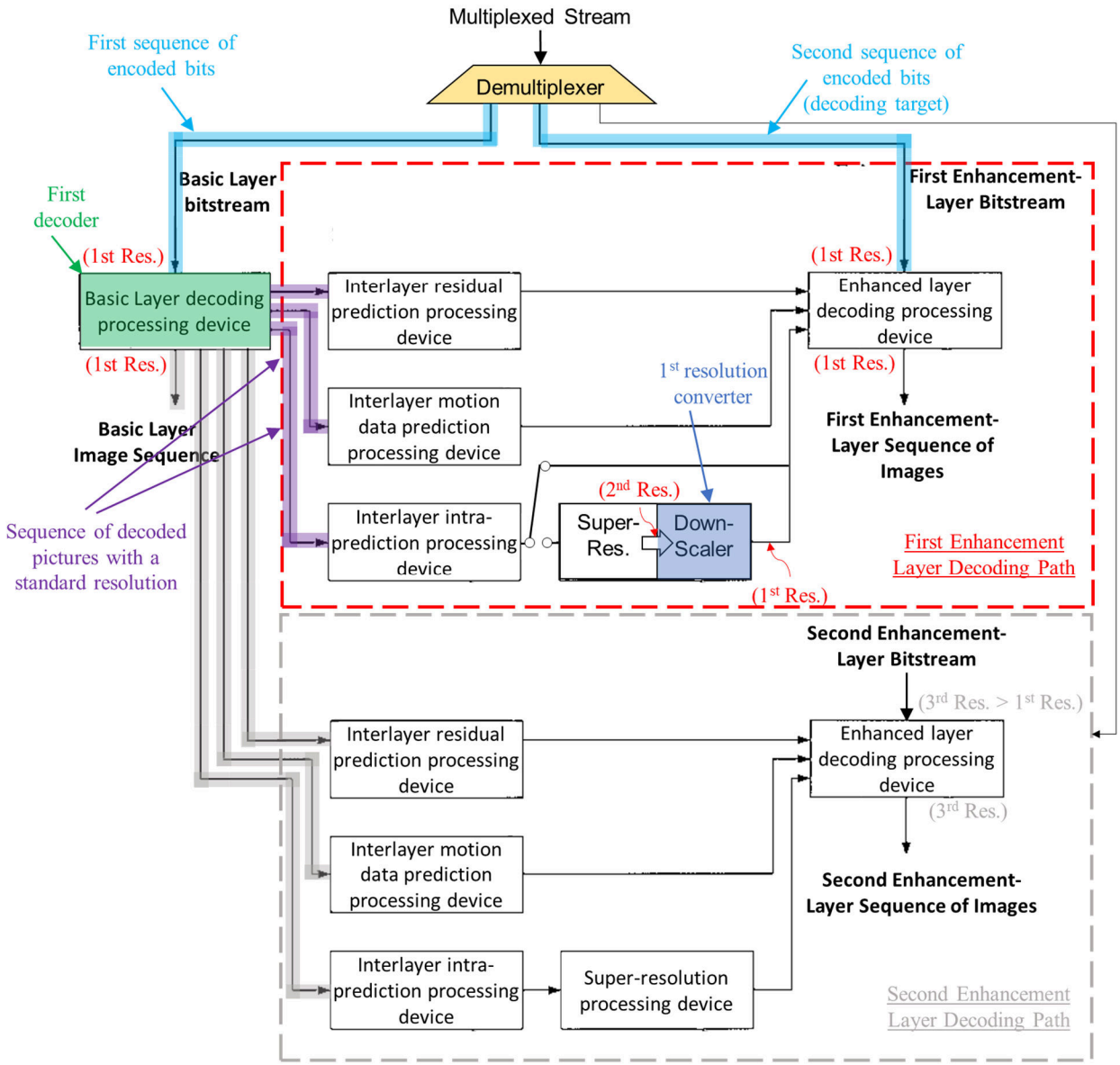


Illustration of Phek-Segall-Martins-He Combination

SAMSUNG-1003, ¶220.

As shown above, the Phek-Segall-Martins-He decoding device includes a decimation processor (***first resolution converter***) based on Martins that acquires the sequence of super-resolution enlarged decoded basic-layer pictures created at the super-resolution processor (***first super-resolution enlarger***) to work on these

pictures by decimating them down to the first (lower or standard) spatial resolution (***a process for a prescribed resolution conversion to create a sequence of super-resolution decoded pictures with a standard resolution***). *Supra*, §§ III.A.1, III.A.3, and III.A.5.iv; SAMSUNG-1003, ¶221.

[2.5.i]

The Phek-Segall-Martins-He combination renders obvious [2.5.i]. SAMSUNG-1003, ¶¶222-228. Phek discloses, and the combination includes, an enhanced layer decoding processing device 432, an interlayer residual prediction processing device 424, an interlayer motion data prediction processing device 426, and an interlayer intra-prediction processing device 428 that collectively provide a "***second decoder***" as claimed.[10] SAMSUNG-1005, [0014]-[0015], FIG. 4b. Each of the processing devices 424, 426, 428, and 432 facilitates decoding of the (first) enhancement layer bitstream apart from decoding of the basic layer bitstream and thus collectively provide a "***second decoder***." *Id.*, [0015] ("An enhanced layer decoding processing device 432 decodes the enhanced layer bitstream using an interlayer residual prediction processing device 424, interlayer motion data prediction

[10] The SR-D processors are also in the decoding loop and can optionally be considered part of the recited "***second decoder***." SAMSUNG-1003, ¶222.

processing device 426, and interlayer intra prediction processing device 428."); SAMSUNG-1003, ¶222.

In the combination, as taught by Phek, the first enhancement layer decoding processing device 432 acquires a first enhancement layer bitstream (***second sequence of encoded bits obtained with a standard resolution at the demultiplexer***). SAMSUNG-1005, [0014]-[0015], FIG. 4b; SAMSUNG-1003, ¶223. It would have been obvious for reasons addressed above for the first enhancement layer in the Phek-Martins-Segall-He combination to encode/decode the enhancement layer sequence of images at the same (standard) spatial resolution as the base layer sequence of images by implementing known forms of layered, hierarchical coding in which both the base and enhancement layers have the same spatial resolution (e.g., multiview coding, quality scalability, and/or temporal scalability). *Supra*, § III.A.5.i; SAMSUNG-1003, ¶223. The enhanced layer decoding processing device 432 acquires the first enhancement layer bitstream as "***a set of decoding targets***" that allow the second decoder to decode the enhancement layer stream (e.g., using residual values that represent differences between predicted pictures and target pictures in the enhancement stream). *Id.*, [0012], [0015]; *cf.*, SAMSUNG-1001, 15:30-54, 52:40-53:46 (describing similar decoding targets).

The teachings of Phek in view of Martins and He further render obvious that the components corresponding to the recited "***second decoder***" (i) acquire the sequence of decoded pictures created with the standard resolution from the basic layer decoding processing device 422 (***first decoder***) as a set of first reference pictures and (ii) acquire the sequence of super-resolution decoded pictures created with the standard resolution from the output of the decimation/downscaling processor (***first resolution converter***) as a set of second reference pictures. SAMSUNG-1003, ¶224; SAMSUNG-1005, [0014]-[0015], FIG. 4b; SAMSUNG-1007, §IV, FIG. 2; *supra*, §§III.A.5.iv-v. For example, Phek discloses that, at the encoder, an "interlayer intra-prediction processing device 408 uses an intra image of the basic layer or a reconstructed image of the basic layer as an additional reference image for encoding the image of the enhanced layer" and "[a] super-resolution processing device 410 is used to improve these additional reference images." SAMSUNG-1005, [0014]. On the decoding side, "[a]s in the encoder, a super-resolution processing device 430 is used to improve the reference picture from the inter-layer intra-prediction processing device 428." *Id.*, [0015]. Based on fundamental video decoding techniques known by the Critical Date, a POSITA would have recognized from Phek's disclosure, and it would have been obvious, that the inter-layer intra-prediction processing device 428 obtains decoded base layer images as refer-

ence pictures for the interlayer prediction of enhancement layer images. SAMSUNG-1003, ¶224; SAMSUNG-1007 ("uses … a reconstructed image of the basic layer as an additional reference image for encoding the image of the enhanced layer").

Further, in the combination, He teaches that the SR-D 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 (e.g., a scalable video coding system). SAMSUNG-1008, [0034]. See also, *id.*, [0006]-[0008], [0023]-[0035], [0086]-[0087], FIGs. 1-3, 7. *Supra*, §§ III.A.4, III.A.5.v. When SR-D filtering is applied to a sequence of images, the enhanced layer decoding processing device 432 acquires SR-D filtered versions of the decoded base layer sequence of images (***sequence of super-resolution decoded pictures created with the standard resolution at the first resolution converter***) as a set of second reference pictures. SAMSUNG-1005, [0014]-[0015], FIG. 4b; *supra*, § III.A.5.v. When SR-D filtering is not applied (bypassed) with respect to a sequence of images, the enhanced layer decoding processing device 432 uses the decoded base layer sequence of images (rather than SR-D filtered versions) acquired by the inter-layer intra-prediction processing device 428 as a set of first reference pictures. *Id.* The combination's "***second decoder***" thus acquires the SR-D filtered (second) set of reference pictures when SR-D filtering is enabled and

acquires the decoded base layer sequence of images as a set of first reference pictures both when SR-D filtering is enabled (as needed to perform the SR-D filtering) and when it is not. SAMSUNG-1003, ¶225.

He also teaches that loop filtering can be selectively applied to different images in a video stream such that both the first and second sets of reference pictures would be acquired by the first enhancement layer decoder to decode different sequences of images in the first enhancement layer stream. *Id.*; SAMSUNG-1008, [0027]-[0028], [0034]-[0037], [0053]-[0054]. Analogously, it would have been obvious to acquire both the first and second sets of reference pictures to decode different slices of enhancement layer images with reference to either SR-D filtered or non-SR-D filtered reference pictures as explained below. *Infra*, [11]; SAMSUNG-1003, ¶226.

The following figure illustrates use of the non-SR-D filtered version of the decoded base layer images as a set of first reference pictures when the SR-D filter is disabled:

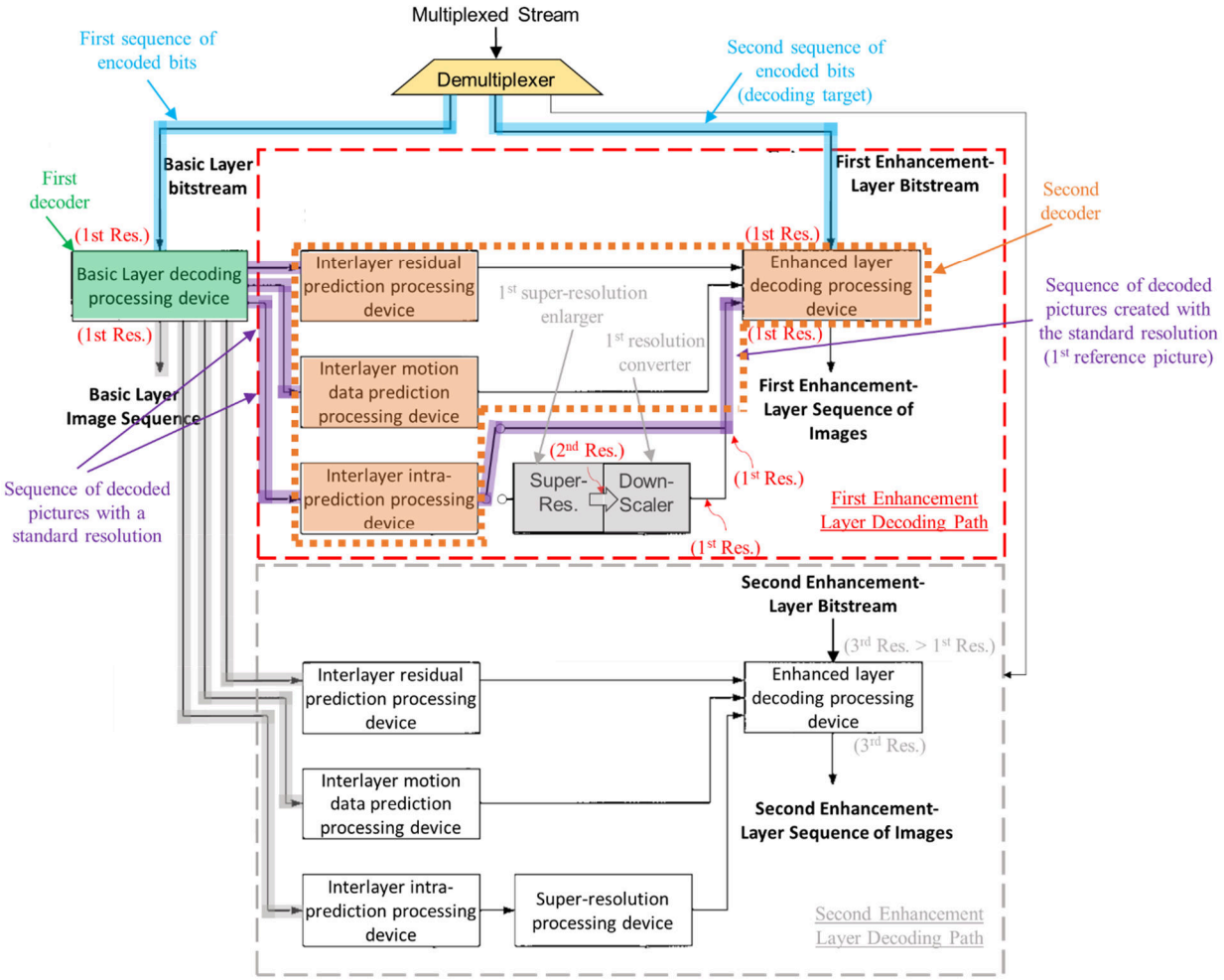


Illustration of Phek-Segall-Martins-He Combination

SAMSUNG-1003, ¶227.

By contrast, the following figure illustrates use of the SR-D filtered version of the decoded base layer images as a set of second reference pictures when the SR-D filter is enabled:

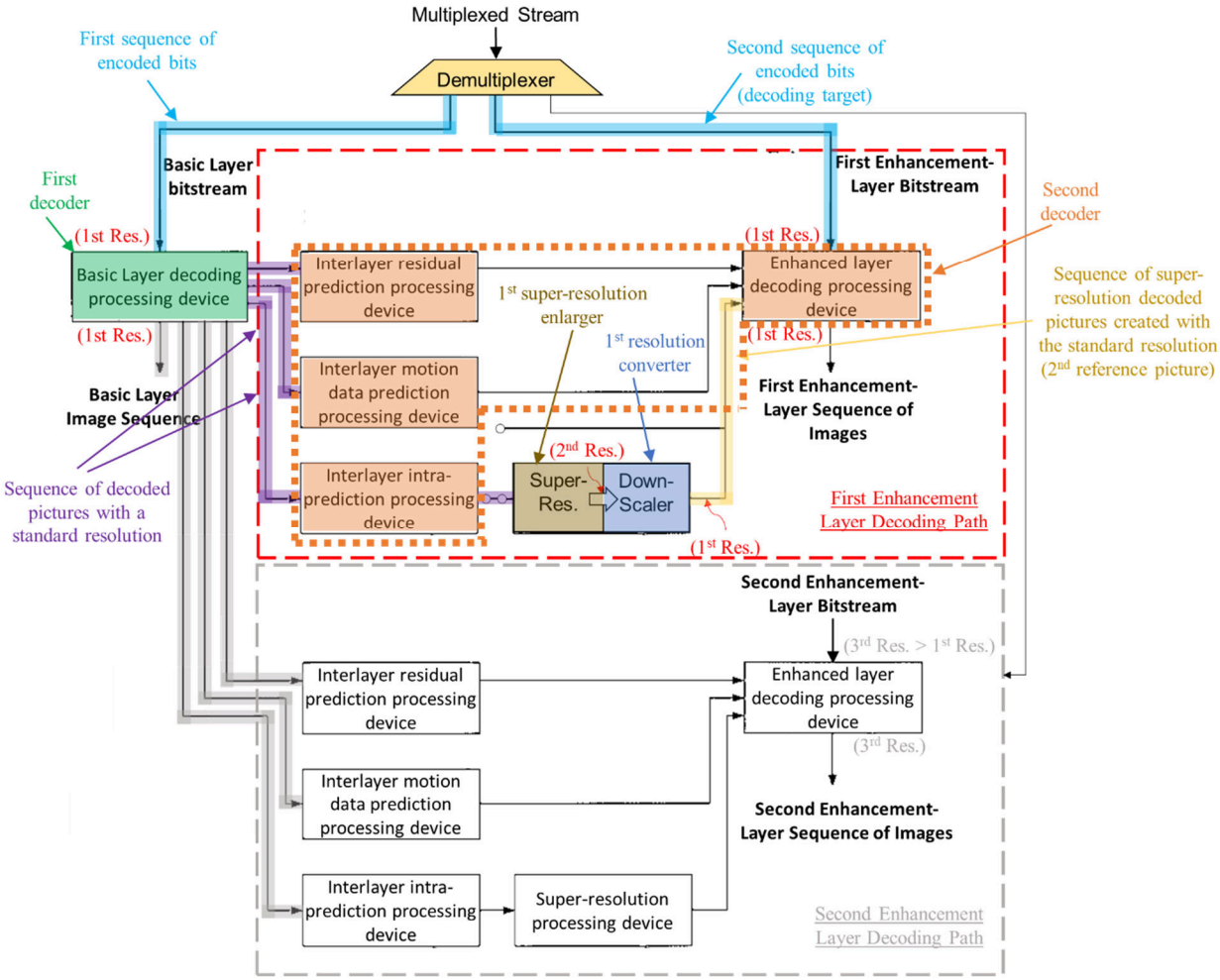


Illustration of Phek-Segall-Martins-He Combination

SAMSUNG-1003, ¶228.

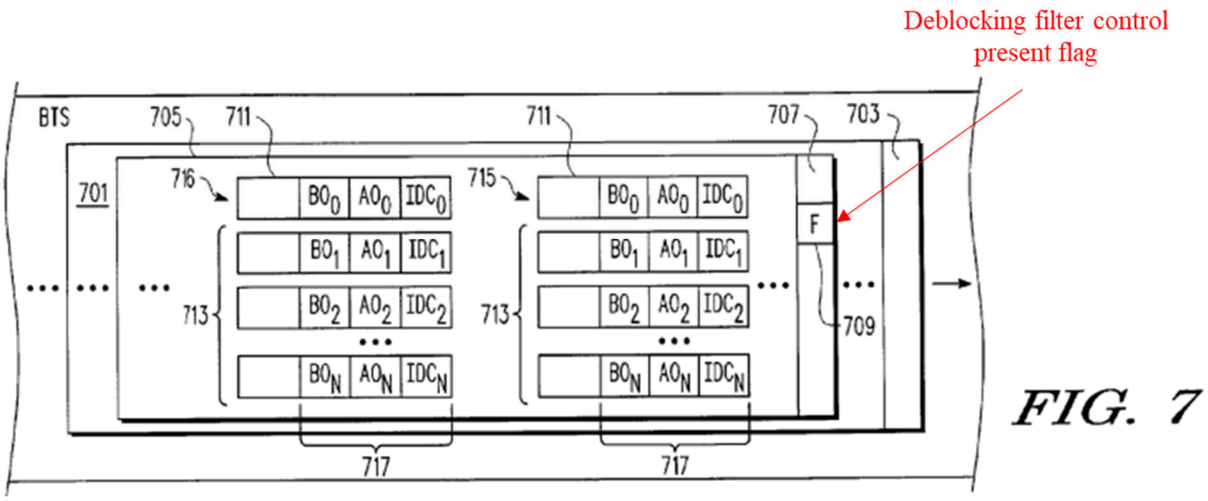
[2.5.ii]

The Phek-Segall-Martins-He combination renders obvious [2.5.ii]. *See also supra* §§[2.5.i], III.A.1, III.A.4, III.A.5.v; SAMSUNG-1003, ¶¶229-237. As discussed above (*supra*, [2.5.i]), in the combination, the enhancement layer decoding processing device 432 decodes pictures in the enhancement layer bitstream using either decoded base layer pictures that have not been enhanced/improved by SR-D

filtering (***first set of reference pictures***) or decoded base layer pictures that have been enhanced/improved by SR-D filtering (***second set of reference pictures***). SAMSUNG-1003, ¶229. The enhancement layer decoding processing device 432 (and/or other components in the first enhancement layer decoding path corresponding to the recited "***second decoder***") whether to use SR-D filtered or non-SR-D filtered reference pictures based on control information transmitted in the multiplexed signal from the encoder, based on the teachings of He. *Supra*, § III.A.5.v.

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

includes a deblocking filter control present flag 709, labeled "F"." SAMSUNG-1008, [0052]. SAMSUNG-1003, ¶230.



SAMSUNG-1008, FIG. 7 (annotated).

He discloses, in FIG. 2, a deblock control circuit 221. SAMSUNG-1008, FIG. 2. Based on the value of the deblocking control flag, the deblock control circuit 221 issues control signals to a deblocking filter 131 to selectively enable/disable the use of a deblock filter on reconstructed (decoded) frames. SAMSUNG-1008, [0006]-[0008]. When the deblock filter is enabled, the filtered (enhanced) reconstructed frame is used as a reference picture for prediction of a subsequent frame. When the deblock filter is disabled, the original (unfiltered or non-enhanced) reconstructed frame is used as the reference picture for prediction of a subsequent frame. *Id.*, [0034]. SAMSUNG-1003, ¶231.

He discloses that "the 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. As with the deblocking filter 131, 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." SAMSUNG-1008, [0034]. SAMSUNG-1003, ¶232.

Based on He's teachings, it would have been obvious to a POSITA to implement an analogous "control circuit" in the combination with Phek-Martins-Segall configured to selectively enable/disable SR-D filtering of base layer frames that are used for prediction of enhancement layer frames. SAMSUNG-1003, ¶233. In the combination, it would have been obvious for the control circuit to be configured to selectively enable/disable the super-resolution enlarger and downscaler circuits, which form a loop filter analogous to He's deblock filter. *Supra*, § III.A.5.v; SAMSUNG-1003, ¶233.

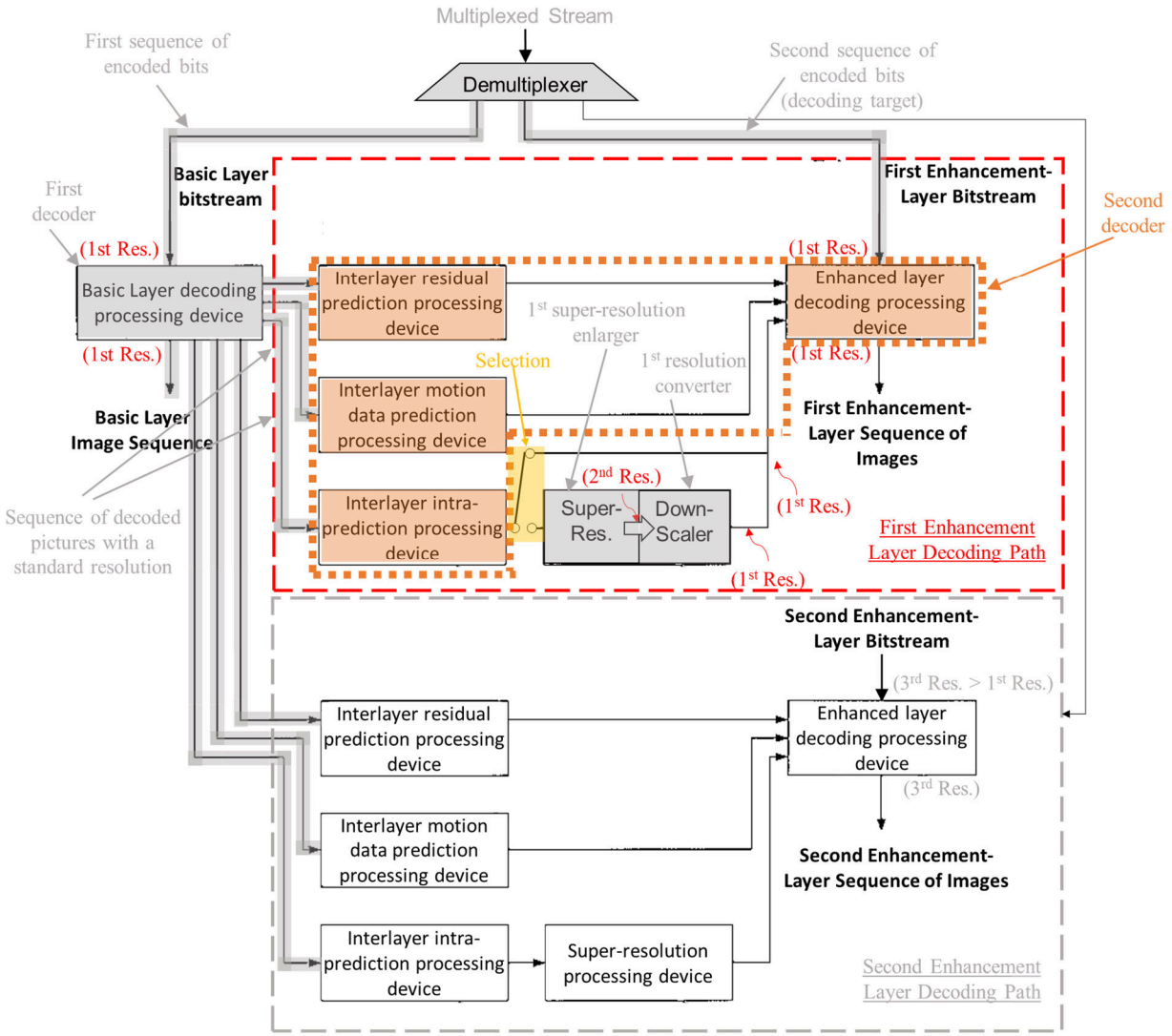


Illustration of Phek-Segall-Martins-He Combination

SAMSUNG-1003, ¶233. This figure illustrates selectivity of the SR-D filter.

Thus, as illustrated above, the "***second decoder***" as implemented in the Phek-Segall-Martins-He combination selects either the sequence of base-layer decoded pictures (when SR-D filter is disabled) as a set of first reference pictures or the sequence of super-resolution enhanced and downscaled base-layer decoded pictures (when SR-D filter is enabled) as the set of second reference pictures. Control

signals like those taught in He (e.g., analogous to He's "deblocking enable/disable parameter" and "deblocking control flag") would provide the first enhancement-layer decoding path with "***reference picture selection information***" as claimed. SAMSUNG-1003, ¶234.

Further, based on Phek's teachings, it would have been obvious for the enhancement layer decoding processing device 432 to implement a combination of processes for a prescribed prediction and a prescribed second decoding with an extension of the standard resolution to create a sequence of super-resolution pictures decoded with the standard resolution based on the set of decoding targets and the set of selected reference pictures. SAMSUNG-1003, ¶235. Phek discloses that super-resolution processing improves the "reference picture." SAMSUNG-1005, [0015]. A POSITA would have known and found obvious that a "reference picture" in video decoders is used for the prediction of at least a portion of another picture in the same or related video stream. *Supra*, §II.A; SAMSUNG-1008, FIG. 2 and [0033] (describing use of reference pictures for motion compensated predictions). Phek also renders obvious a prescribed second decoding with an extension of the standard resolution through its disclosure that the "enhanced layer decoding processing device 432 decodes the enhanced layer bitstream." SAMSUNG-1005, [0015]; *see also id.*, [0012]. A POSITA would have known that complete decod-

ing of a picture in a compressed video stream involves additional operations beyond prediction of the picture from a reference picture. SAMSUNG-1003, ¶235. Decoding additionally involves adding residual information to the predicted picture to correct differences between the predicted picture and the picture that is targeted for decoding. *Supra*, §II.A; SAMSUNG-1008, FIG. 2 and [0032] ("combiner 207 adds selected prediction information P' to R' to generate unfiltered reconstructed information").

It would have been obvious for the second decoder in the combination to decode and thus create a sequence of (first) enhancement layer pictures by further implementing a prescribed decoding to add residual information from the (first) enhancement layer bitstream ("***set of decoding targets***") to the pictures predicted from the selected set of reference pictures, consistent with ordinary video processing techniques like those identified in Phek. SAMSUNG-1003, ¶236. A POSITA would have been motivated to add residual information to the predicted pictures to improve the quality of the decoded pictures in the first enhancement layer stream. SAMSUNG-1003, ¶236. Moreover, as described above in the combination overview, it would have been obvious for the first enhancement layer to decode the first enhancement layer stream at the same, standard resolution as the base layer stream. *Supra*, §III.A.5.i. The first enhanced decoding processing de-

vice 432 thus decodes with an extension of the standard resolution and outputs picture with the standard spatial resolution as claimed, albeit with greater detail than the base layer stream as a result of the super-resolution processing. *Id.*; *supra*, §II.A. Further, the second decoder in the combination can select a set of either SR-D filtered or non-SR-D filtered reference pictures by fully enabling or disabling the loop filter as taught in He for sequences of pictures in the video stream, or by individually determining that each picture in a set of pictures should be predicted using SR-D or non-SR-D filtered references, thereby creating the claimed sequence of super-resolution pictures decoded with the standard resolution. SAMSUNG-1008, [0077], [0027]-[0028], [0037]-[0038]; SAMSUNG-1003, ¶¶236-237.

[2.6]

The Phek-Segall-Martins-He combination renders obvious [2.6]. SAMSUNG-1003, ¶¶238-240. For example, Phek discloses that its "Interlayer Predictive Encoding and Decoding Devices" can be implemented using "scalable" video coding techniques, and Segall teaches that a common type of scalable video coding before the '995 Patent was "spatial" scalability. SAMSUNG-1006, 1 ("provides a mechanism for reusing an encoded lower resolution version of an image sequence for the coding of a corresponding higher resolution sequence"), 2-3 ("The lowest resolution video data in a spatially scalable system is sometimes referred to as the

base layer …, and the higher resolution video data is often referred to as the *enhancement layer*. Processes that determine or predict the value of enhancement layer data from previously reconstructed data of a lower resolution layer at the same time instance are referred to as *inter-layer* prediction processes[] …"), FIG. 1. Segall explains that known scalable architectures before the Critical Date allowed for "multilayer scenarios" so that different enhancement layers could encode/decode video streams each with different spatial resolutions. *Id.*, 3.

As described above in the overview of the Phek-Segall-Martins-He combination, it would have been obvious to augment Phek's decoding device of FIG. 4b with a second enhancement layer implementing spatial scalability so that it would use decoded base layer pictures to predict higher resolution pictures encoded in a second enhancement layer stream. *Supra*, §III.A.5.ii; SAMSUNG-1003, ¶239. The second enhancement layer thus provides a "***second resolution converter***" configured to acquire the sequence of decoded pictures with the standard resolution from the basic layer decoding processing device 422 (***first decoder***) to work on the sequence of decoded pictures to implement an interpolation of pixels with a second enlargement to create a sequence of enlarged decoded pictures as the output of the second enhancement layer with a high resolution higher than the standard resolution. SAMSUNG-1006, 4 ("using up-sampling of the decoded lower resolution picture"), 4 ("lower resolution picture array to be up-sampled"), 6 ("interpolation

filter" and "interpolating kernel"), 7 ("bilinear interpolation"); SAMSUNG-1003, ¶-.

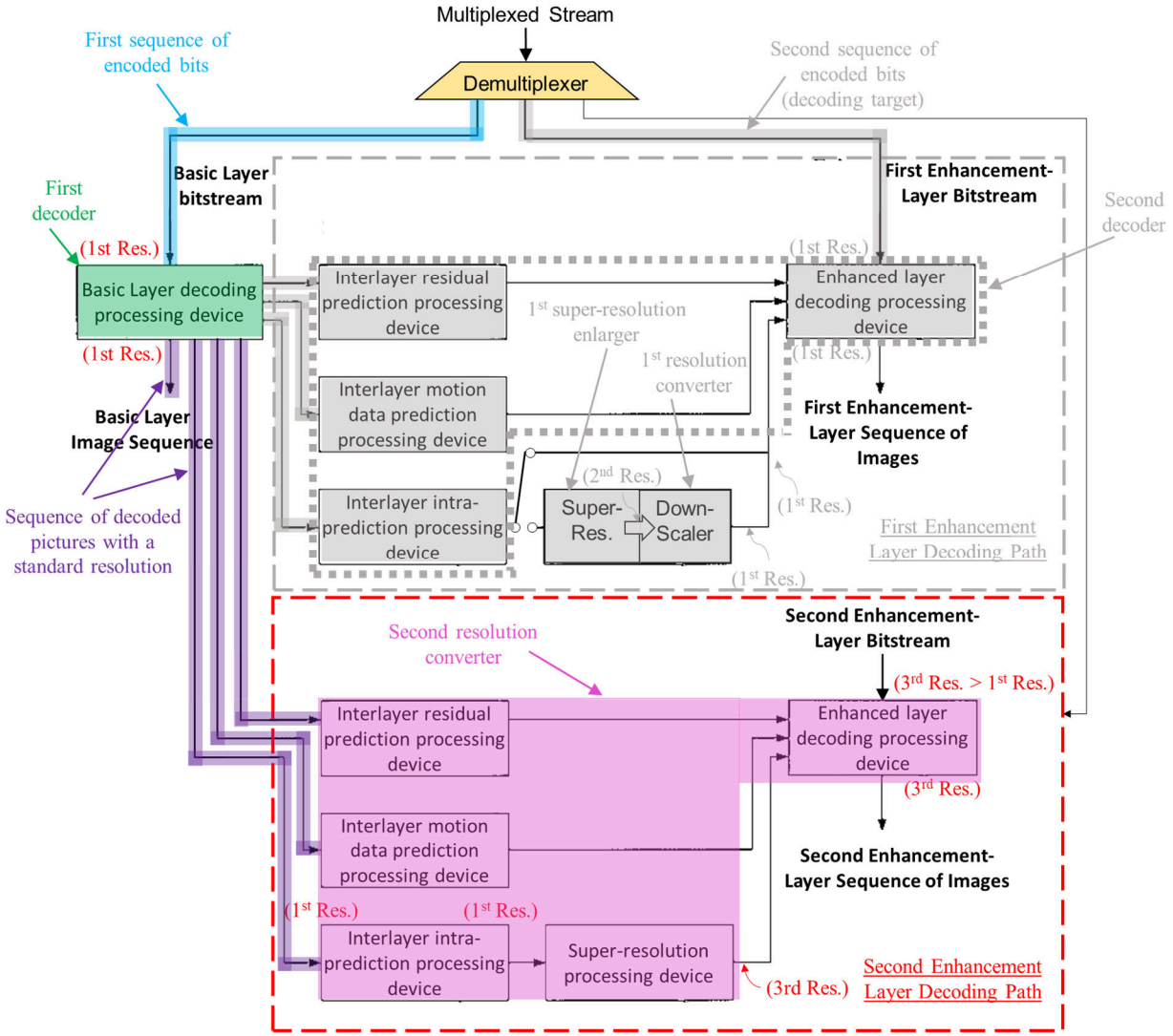


Illustration of Phek-Segall-Martins-He Combination

SAMSUNG-1003, ¶239. First mapping of the second resolution converter.

Moreover, Phek's super-resolution processing involves uses a set of lower-resolution images to generate a super-resolution image of higher quality and spatial resolution than the individual lower-resolution images. SAMSUNG-1005, [0002]-

[0003]. A super-resolution processing device 430 that implements super-resolution processing to enhance reference pictures in the second enhancement layer provides another structure that renders obvious the recited "***second resolution converter***" in the combination. SAMSUNG-1003, ¶240. This second super-resolution processing device 430 works on decoded base-layer pictures at the standard resolution to create a sequence of enlarged decoded pictures with a high resolution as a second resolution higher than the standard resolution. SAMSUNG-1005, [0014]-[0016], FIGS. 1a-1b, 4a-4b.

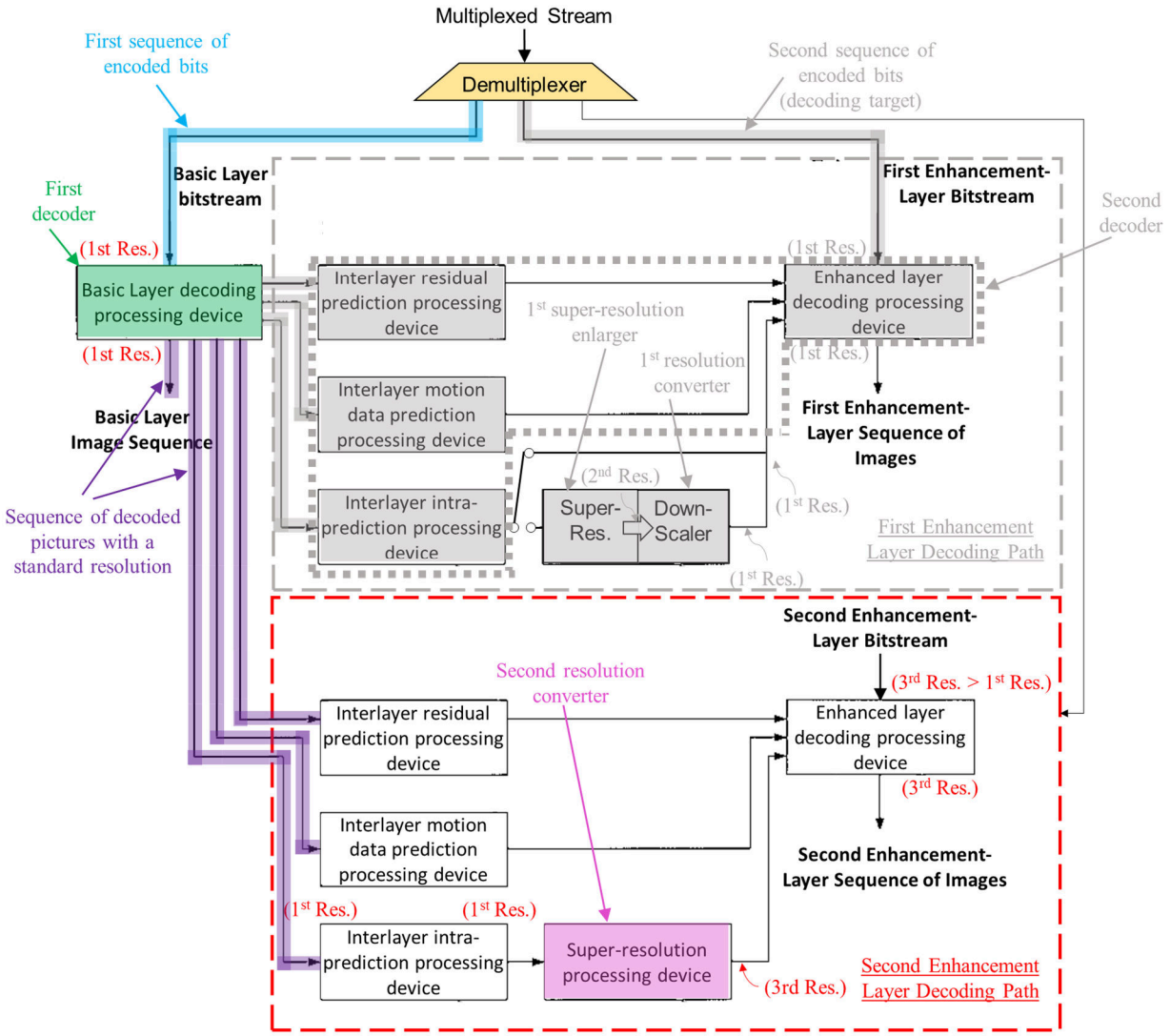


Illustration of Phek-Segall-Martins-He Combination

SAMSUNG-1003, ¶240. Second mapping of the second resolution converter.

[2.7]

As described above, it would have been obvious to implement the decoding device in the Phek-Segall-Martins-He combination such that the set of decoding targets in the first enhancement layer, the set of first reference pictures (e.g., decoded base layer pictures without SR-D filtering), and the set of second reference

pictures (e.g., decoded base layer pictures with SR-D filtering) have the same spatial resolution. *Supra*, §§III.A.5.i; SAMSUNG-1003, ¶241.

(b) Claim 3

[3.P]

Supra [2.P]. SAMSUNG-1003, ¶242.

[3.1]

Supra [2.1]. SAMSUNG-1003, ¶243.

[3.2]

Supra [2.2]. SAMSUNG-1003, ¶244.

[3.3]

Supra [2.3]. SAMSUNG-1003, ¶245.

[3.4]

Supra [2.4]. SAMSUNG-1003, ¶246.

[3.5.i]

Supra [2.5.i]. SAMSUNG-1003, ¶247.

[3.5.ii]

Supra [2.5.ii]. SAMSUNG-1003, ¶248.

[3.6]

Supra [2.6]. SAMSUNG-1003, ¶249.

[3.7]

Supra [2.7]. SAMSUNG-1003, ¶250.

(c) Claim 4

[4.P]

Supra [2.P]. SAMSUNG-1003, ¶251.

[4.1]

Supra [2.1]. SAMSUNG-1003, ¶252-.

[4.2]

Supra [2.2]. SAMSUNG-1003, ¶253.

[4.3]

Supra [2.3]. SAMSUNG-1003, ¶254.

[4.4]

Supra [2.4]. SAMSUNG-1003, ¶255.

[4.5.i]

Supra [2.5.i]. SAMSUNG-1003, ¶256.

[4.5.ii]

Supra [2.5.ii]. SAMSUNG-1003, ¶257.

[4.6]

Supra [2.6]. SAMSUNG-1003, ¶258.

[4.7]

Supra [2.6] and §III.A.5.i-ii. SAMSUNG-1003, ¶259.

[4.8]

Supra [2.6] and §III.A.5.i-ii. SAMSUNG-1003, ¶260.

[4.9]

Supra [2.7] and §III.A.5.i-ii. SAMSUNG-1003, ¶261.

(d) Claim 11

[11]

The Phek-Segall-Martins-He combination renders obvious [11]. *Supra* §III.A.5.v, [2.5.i] and [2.5.ii]. SAMSUNG-1003, ¶¶262-264. The additional features recited in [11] simply reflect the common practice of individually encoding and decoding different blocks or other regions of a picture in a video stream (e.g., rather than entire pictures as a whole). SAMSUNG-1003, ¶262; *see also* SAMSUNG-1030, 8 ("basic coding unit for spatial redundancy reduction in MPEG is based on an 8 x 8 block, motion-compensation is usually based on a 16 pixel by 16 line *macroblock*"); *supra*, §II.A. Phek itself teaches that enhancement layer pictures can be coded by macroblocks. SAMSUNG-1005, [0014] ("motion data include the partition size and type used of each macroblock, as well as the prediction direction and motion vector").

He likewise discloses that "[e]ach video frame is subdivided" into macroblock (MB) levels, "where each MB is a 16×16 block of pixels." SAMSUNG-1008, [0004], [0034], [0086]. "The video decoder 200 generally processes information one macroblock at a time." *Id.*, [0034]. He further teaches that separate loop filter (e.g., deblocking filter) controls can be applied to each "slice" in a coded video stream, where "each slice incorporates one or more macroblocks." *Id.*,

[0053]-[0054]. For instance, the loop filter can be selectively enabled or disabled for each slice. *Id.*

It would have been obvious to apply He's teachings regarding slice-level selective loop filtering in the Phek-Segall-Martins-He combination so that the second decoder (e.g., processors 424, 426, 428, 432) in the first enhancement layer would divide the decoding target in the first enhancement layer stream into a plurality of slices (regions) and select whether to use an SR-D filtered version or a non-SR-D filtered version of a reference picture for prediction of each divided region. SAMSUNG-1003, ¶264. A POSITA would have sought to implement slices in the combination in this manner to reduce the size of the coding unit and allow for more variance in the prediction processes applied to decode different regions of the target picture, which would allow for greater compression and improved prediction quality for individual slices. *Id.*; SAMSUNG-1030, 8. A POSITA would have had a reasonable expectation of success given that slices were commonly implemented in MPEG systems before the Critical Date and He already proposed selective loop filtering on a slice-by-slice basis. SAMSUNG-1003, ¶264.

IV. PTAB DISCRETION SHOULD NOT PRECLUDE INSTITUTION

A. 35 U.S.C. §325(d) – *Advanced Bionics*

Under 35 U.S.C. § 325(d), the Board applies a two-part framework in determining whether to exercise its discretion to deny institution. IPR2019-01469, Paper 6 at 8 (PTAB Feb. 13, 2020) (precedential) ("*Advanced Bionics*"). 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 of the framework 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 IPR2017-01586, Paper 8 (PTAB 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. Petitioner'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 ’995 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*, Section II.C. Indeed, the file history contains no indication that Segall, Martins, or He were addressed or even made available to the Examiner during original examination. *Id.*; *see also* SAMSUNG-1001, face. The Phek-Segall-Martins-He combination advanced in Ground 1of this Petition therefore is not cumulative of the prior art evaluated by the Office before issuance, especially considering the meaningful differences discussed below. IPR2022-01186, Paper 9 at 10-11 (PTAB Nov. 10, 2022) (finding part one not satisfied despite the Examiner’s earlier use of a prior art reference cited in the petition); PGR2022-00034, Paper 11 at 17-20 (PTAB Nov. 17, 2022) (part one not satisfied by petition’s new combination).

Indeed, the Phek-Segall-Martins-He combination presents teachings and obviousness rationales that are materially different and non-cumulative to either the teachings of the prior art addressed during original examination or the Examiner’s arguments made in support of the rejections applied during original examination. For example, as discussed above (*supra*, Section II.C), the Examiner relied on Barkley’s teachings “regarding a video decoder [that] selectively decode[s] video information from the base layer and one or more enhancement layers to playback or

reproduce the video information at a desired level of quality" to address then-pending limitations of the "second decoder" element of application claim 23 (issued claim 2) related to the use of multiple sets of reference pictures. SAMSUNG-1002, 91 (citing SAMSUNG-1025, [0005], FIGS. 1, 3, 5-8). In the final amendment before allowance, the applicant amended the claims to require that the second decoder "select one of the set of first reference pictures and the set of second reference pictures ***based on reference picture selection information***" and argued that Barkley fails to disclose "any such reference picture selection information to identify the selected reference picture." SAMSUNG-1002, 62 (emphasis added). These amendments apparently convinced the Examiner to allow the '995 Patent, but Ground 1 relies on teachings from He (in combination with Phek, Segall, and Martins) that are materially different from Barkley's to show that the claimed reference picture selection features of the Challenged Claims were obvious before the Critical Date.

As described in detail above with respect to [2.5.i], [2.5.ii], He demonstrates that reference picture selection information in the form of loop-filtering control signals were well-known and obvious before the Critical Date. *Supra*, [2.5.i], [2.5.ii], III.A.4. Unlike the Examiner's reliance on Barkley, Ground 1 does not rely on He to meet the reference picture selection features of the Challenged Claims based on differences in reference pictures applied *at different layers of a*

scalable coding system. SAMSUNG-1002, 91. Ground 1 instead shows that the implicated claim features were obvious based on application of He's *selective use of the super-resolution and downscaling ("SR-D") loop filter* in the Phek-Segall-Martins-He combination. *Supra*, [2.5.i], [2.5.ii]. The file history simply contains no indication that the Examiner ever considered teachings cumulative to He's in connection with these claim features.

He's teachings are also materially different from Barkley in that He selects between references pictures that have "the same value in spatial resolution" as claimed while Barkley does not. Neither the deblocking filtering disclosed in He nor the SR-D filter in the Phek-Segall-Martins-He combination changes the spatial resolution of the first set of reference pictures. *Supra*, §III.A.4. But the Examiner's identification of reference pictures selected at different layers of a spatially scalable video coding system does involve reference pictures of different spatial resolutions. SAMSUNG-1002, 91 (citing SAMSUNG-1025, [0005], FIGS. 1, 3, 5-8)).

Moreover, Ground 1 cites teachings from Martins for the "first resolution converter" limitations that are meaningfully different from the teachings of Holcomb relied upon by the Examiner. *E.g.*, SAMSUNG-1002, 89-90. Martins specifically describes techniques for performing a first resolution conversion by decimating a super-resolution enlarged picture in a video stream to convert the super-

resolution enlarged picture back to its original or standard spatial resolution. SAMSUNG-1007, § IV, FIG. 2; *supra*, [2.4]. Holcomb, by contrast, discloses "multi-resolution video coding" with no specific teaching cited for converting a super-resolution enlarged image to a standard spatial resolution of the image from before the super-resolution enlargement. SAMSUNG-1024, Abstract.

For each of these reasons, the first part of the *Advanced Bionics* framework is not satisfied. The *Advanced Bionics* analysis should therefore end with part 1, and the Board should not exercise its discretion to deny institution.

2. The Office Erred in Granting the '995 Patent

The Board need not reach part 2 of the *Advanced Bionics* framework since part 1 is not satisfied. But even if the Board evaluates part 2, *Becton* factors (c), (e), and (f) support institution.

As described in the preceding section, the file history contains no indication that the Examiner ever considered Phek in combination with Segall, Martins, and He as set forth in Ground 1 of this Petition. Segall, Martins, and He are not even cited on the face of the '995 Patent, and thus the extent of the Examiner's consideration of any teachings of the prior art cited in Ground 1 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 Segall, Martins, and He, the original examination

was infected with error because it failed to account for the relevant and non-cumulative teachings from these references cited in Ground 1. 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.

B. 35 U.S.C. §314(a) – *Fintiv*

In *Apple Inc. v. Fintiv, Inc.*, the Board enumerated six factors that it will assess in determining whether to exercise discretion to deny institution under §314(a) based on co-pending litigation. IPR2020-00019, Paper 11 at 2-3 (PTAB "precedential" Mar. 20, 2020) ("*Fintiv*"). In June 2022, the USPTO issued updated discretionary denial guidance in view of the *Fintiv* factors and expressly noted that ***the PTAB will not discretionarily deny institution if Petitioner presents a Sotera stipulation***. SAMSUNG-1027, 3, 7-8. Here, Petitioner has eliminated any risk of duplicated effort by voluntarily presenting a *Sotera* stipulation to Patent Owner. SAMSUNG-1028; *Sotera Wireless, Inc. v. Masimo Corp.*, IPR2020-01019, Paper 12 (PTAB Dec.

1, 2020). For at least this reason, and considering the compelling merits of Ground 1, the Board should not discretionarily deny this Petition.

V. CONCLUSION AND FEES

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

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

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

Samsung Electronics Co., Ltd. is the petitioner and real party-in-interest. Samsung Electronics America, Inc. is an additional real party-in-interest.

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

The ’995 Patent is the subject of the following civil actions: *Advanced Coding Technologies LLC v. Samsung Electronics Co., Ltd. et al.*, 2:22-cv-00499-JRG, E.D. Tex., filed December 30, 2022 (SAMSUNG-1004) and *Advanced Coding Technologies LLC v. LG Electronics, Inc. et al.*, 2:22-cv-00501-JRG, E.D. Tex., filed December 30, 2022.

Petitioner is not aware of any other disclaimers, reexamination certificates, or IPR petitions addressing the ’995 Patent.

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

Petitioner provides the following designation of counsel.

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D. Service Information

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

Petitioner consents to electronic service by email at IPR39843-0172IP1@fr.com (referencing No. 39843-0172IP1 and cc'ing PTABInbound@fr.com, axf-ptab@fr.com, jjm@fr.com, nstephens@fr.com, and rgupta@fr.com).

Respectfully submitted,

Dated 01/08/2024

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CERTIFICATION UNDER 37 CFR §42.24

Under the provisions of 37 CFR §42.24(d), the undersigned hereby certifies that the word count for the foregoing Petition for *Inter Partes* Review totals 13,935 words, which is less than the 14,000 allowed under 37 CFR §42.24.

Dated 01/08/2024

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CERTIFICATE OF SERVICE

Pursuant to 37 CFR §§ 42.6I(4)(i) *et seq.* and 42.105(b), the undersigned certifies that on January 8, 2024, a complete and entire copy of this Petition for *Inter Partes* Review, Power of Attorney, and all supporting exhibits were provided via Federal Express, to the Patent Owner, by serving the correspondence address of record as follows:

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