

UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE PATENT TRIAL AND APPEAL BOARD

Apple Inc.
“Apple”
Petitioner

v.

Advanced Coding Technologies, LLC
“ACT”
Patent Owner

INTER PARTES REVIEW OF U.S. PATENT NO. 10,218,995

DECLARATION OF MR. DAVID B. LETT

I declare that all statements made in this declaration on my own knowledge are true and that all statements made on information and belief are believed to be true, and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Date: 6/13/2025

By: David B. Lett

David B. Lett

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I, David B. Lett, do hereby declare:

I. Introduction

1. My name is David Lett, and I have been retained by counsel for Apple Inc. (“Apple”) as an expert witness to assist in analyzing issues related to the patentability of certain claims of U.S. Patent No. 10,218,995, “the ’995 Patent.” I understand that Apple intends to submit this declaration in support of a second petition for *inter partes* review (“IPR”) of the ’995 Patent before the Patent Trial and Appeal Board (“PTAB”) of the United States Patent and Trademark Office (“USPTO”). I previously prepared another declaration that Apple submitted in support of a first petition for IPR of the ’995 Patent in IPR2025-00984, which addressed a different set of claims than the claims that I address in the present declaration.

2. I am being compensated for my work in this matter at my standard hourly rate. My compensation in no way depends on the outcome of this proceeding or the content of my testimony.

3. My analysis here is based on my years of education, research and experience, as well as my investigation and study of relevant materials, including those cited herein. I may rely upon these materials, my knowledge and experience, and/or additional materials to further explain and corroborate my analysis, and to

respond to any critiques of my analysis that may be raised during the course of the IPR proceeding in which this declaration is submitted.

II. Materials Considered

4. I have reviewed the IPR Petition that Apple is submitting to the PTAB to challenge claims 1, 5-6, and 8-10 of the '995 Patent. In fact, in preparing this declaration, I collaborated with counsel in developing the obviousness grounds set forth in the Petition. Based on my review, the Petition accurately portrays my opinions regarding the unpatentability of claims 1, 5-6, and 8-10 of the '995 Patent. I fully endorse the obviousness grounds, including the proposed combinations and mapping of those prior art combinations to the elements of claims 1, 5-6, and 8-10 as described in the Petition.

5. I also understand that an earlier IPR proceeding, IPR2024-00372, was instituted at the PTAB involving the '995 Patent, in which Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. (collectively, "Samsung") were the petitioners (the "Samsung IPR"). Dr. Clifford Reader submitted a declaration in the Samsung IPR that included an overview of the state of the art and an introduction to the technology described and claimed in the '995 Patent. Dr. Reader's discussion is relevant here and provides helpful context for understanding the technology described and claimed in the '995 Patent. Rather than repeat similar content here, I refer to Dr. Reader's discussion at Sections II and V of his '995

declaration from the Samsung IPR—submitted in this proceeding as exhibit APPLE-1078—for background information on the technology and state of the art of the '995 Patent.

6. In addition to the Petition and Sections II and V of Dr. Reader's declaration from the Samsung IPR, I reviewed the following additional material in the course of preparing this declaration on the '995 Patent:

APPLE-1001	U.S. Patent No. 10,218,995 to Sakazume ("the '995 Patent")
APPLE-1002	Excerpts from the Prosecution History of the '995 Patent ("the '995 Patent File History")
APPLE-1005	English Translation of Japanese Patent Publication No. 2007316161 A with Translation Certificate ("Phek")
APPLE-1006	Segall et al., <i>Spatial Scalability Within the H.264/AVC Scalable Video Coding Extension</i> ; IEEE Transactions on Circuits & Systems for Video Tech., Vol. 17, No. 9, September 2007 ("Segall")
APPLE-1007	Martins et al., <i>A Unified Approach to Restoration, Deinterlacing and Resolution Enhancement in Decoding MPEG-2 Video</i> , IEEE Transactions on Circuits & Systems for Video Tech., Vol. 12, No. 9, September 2002 ("Martins")
APPLE-1008	U.S. Patent Publication No.2008/0137753 ("He")
APPLE-1009	U.S. Patent No. 5,886,736 ("Chen")
APPLE-1010	Schwarz et al., <i>Overview of the Scalable Video Coding Extension of the H.264/AVC Standard</i> , IEEE Transactions on Circuits & Systems for Video Tech., Vol. 17, No. 9, September 2007 ("Schwarz")
APPLE-1011	U.S. Patent Publication No. 2009/0154567 ("Lei")

APPLE-1012	Park et al., <i>Super-Resolution Image Reconstruction: A Technical Overview</i> , IEEE Signal Processing Magazine, pp. 21-36, May 2003 (“Park”)
APPLE-1013	English Machine Translation of Japanese Patent Publication No. 2008053848 (“Hatanaka”)
APPLE-1014	U.S. Patent Publication No. 2010/0165077 (“Yin”)
APPLE-1015	U.S. Patent Publication No. 2009/0257664 (“Kao”)
APPLE-1016	U.S. Patent Publication No. 2009/0046995 (“K anumuri”)
APPLE-1017	U.S. Pat. 6,470,051 (“Campisano”)
APPLE-1018	U.S. Patent Publication No. 2006/0013306 (“Kim”)
APPLE-1019	Lu et al., Mechanisms of MPEG Stream Synchronization, ACM SIGCOMM Computer Communication Review, Vol. 24, Issue 1, pp. 57-67 (January 1994) (“Lu”)
APPLE-1020	U.S. Patent Publication No. 2003/0021345 (“Brusewitz”)
APPLE-1021	U.S. Patent Publication No. 2003/0021347 (“Lan”)
APPLE-1022	EE Times, <i>How Video Compression Works</i> (Aug. 6, 2007), available at https://www.eetimes.com/how-video-compression-works (retrieved Dec. 26, 2023) (“EETimes”)
APPLE-1023	Bier, <i>Introduction to Video Compression</i> , Berkeley Design Tech., Inc. (October 2005), available at https://www.bdti.com/MyBDTI/pubs/20051024_GSPx05_Video_Intro.pdf (retrieved Dec. 30, 2023) (“Bier”)
APPLE-1024	U.S. Patent No. 7,379,496 (“Holcomb”)
APPLE-1025	U.S. Patent Publication No. 2008/0043832 (“Barkley”)
APPLE-1026	U.S. Patent No. 6,173,013 (“Suzuki”)
APPLE-1030	Ely, <i>MPEG Video Coding: A Simple Introduction</i> , EBU Technical Review (Winter 1995) (“Ely”)

APPLE-1031	Japanese Patent Publication No. 2007316161 A with English Machine Translation (“Phek”)
APPLE-1032	ITU-T Recommendation H.264 (11/07)
APPLE-1033	Karczewicz et al., The SP- and SI-Frames Design for H.264/AVC, IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS FOR VIDEO TECHNOLOGY, v.13 (July 2003)
APPLE-1034	ISO/IEC 11172-2: 1993 (E) (MPEG1 Video)
APPLE-1035	ISO/IEC 13818-2: 2000 (E) (MPEG2/H.262 Video)
APPLE-1036	ITU-T Recommendation H.263 (02/98)
APPLE-1037	Reader, Intraframe and Interframe Adaptive Transform Coding, Efficient Transmission of Pictorial Information, SPIE v.66, 108 (1975)
APPLE-1038	Reader, MPEG4: Coding for Content, Interactivity, and Universal Accessibility, Optical Engineering 35(1), 104 (January 1996)
APPLE-1039	Reader, MPEG Patents, in MPEG Video Compression Standard, Chapter 16, at 357-362 (Mitchell et al ed.) (1996)
APPLE-1040	Radha et al., The MPEG-4 Fine-Grained Scalable Video Coding Method for Multimedia Streaming Over IP, IEEE Transactions on Multimedia, v.3, 53 (March 2001)
APPLE-1041	H.264 / MPEG-4 Part 10 White Paper, January 31, 2003 (downloaded from https://github.com/yistLin/H264-Encoder/blob/1cdaf090b63642932ed726b102ed2cf80908edbb/doc/H.264%20%3A%20MPEG-4%20Part%2010%20White%20Paper.pdf on Jan. 5, 2024)
APPLE-1042	ISO/IEC 14496-2: 2004 (MPEG4)
APPLE-1043	ISO/IEC 13818-2: 1996 (MPEG2)
APPLE-1046	U.S. Patent Publication No. 2001/0043751 (“Takahashi”)

- APPLE-1047 Peter J. Burt et al., *The Laplacian Pyramid as a Compact Image Code*, IEEE TRANSACTIONS ON COMMUNICATIONS, VOL. COM-31, NO. 4, APRIL 1983 (“Burt”)
- APPLE-1048 Michael Elad et al., *Restoration of a Single Superresolution Image from Several Blurred, Noisy, and Undersampled Measured Images*, IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 6, NO. 12, DECEMBER 1997 (“Elad”)
- APPLE-1049 Michal Irani et al., *Super resolution from image sequences*, [1990] Proceedings. 10th International Conference on Pattern Recognition, Atlantic City, NJ, USA, 1990, pp. 115-120 vol.2, doi: 10.1109/ICPR.1990.119340 (“Irani”)
- APPLE-1050 U.S. Patent Publication No. 2007/0160133 (“Bao”)
- APPLE-1051 U.S. Patent Publication No. 2004/0170330 (“Fogg”)
- APPLE-1052 U.S. Patent Publication No. 2006/0126952 (“Suzuki952”)
- APPLE-1053 U.S. Patent Publication No. 2004/0022318 (“Garrido”)
- APPLE-1054 U.S. Patent Publication No. 2005/0019000 (“Lim”)
- APPLE-1055 U.S. Patent Publication No. 2004/0156561 (“Yu-Chuan”)
- APPLE-1056 U.S. Patent Publication No. 2008/0018506 (“Raveendran”)
- APPLE-1057 Hunt B R, *Super-Resolution of Images- Algorithms, Principles, Performance*, Intl. Jnl. of Imaging Sys. and Technol., Vol. 6, pp. 297-304, Wiley, 1995, Oct. 1995 (“Hunt_Oct_1995”)
- APPLE-1058 Kramer P, O. Hadar, Benois-Pineau J, Domenger J-P, *Use of Motion Information in Super-Resolution Mosaicing*, ICIP, Oct. 2006 (“Kramer”)
- APPLE-1059 Patti A J, Sezan M I, Tekalp M, *Superresolution video reconstruction with arbitrary sampling lattices and nonzero aperture time*, IEEE Trans. on Im. Proc., Vol. 6, No. 8, pp. 10 (“Patti”)

APPLE-1060	Erickson K J, Schultz R R, <i>MPEG-1 super-resolution decoding for the analysis of video still images</i> , 4th IEEE Southwest Symp. on Im. Anal. and Interp., Apr. 2000 (“Erickson”)
APPLE-1061	Tsai R Y, Huang T S, <i>Multiframe image restoration and registration, Advances in Computer Vision and Image Processing</i> , Vol. 1, T. S. Huang, ed., Jai Press, pp. 317-319, 1984 (“Tsai”)
APPLE-1062	WIPO Patent Publication No. WO2008/057308A2 (“Kao308”)
APPLE-1063	U.S. Patent No. 5,606,369 (“Keesman”)
APPLE-1064	U.S. Patent Publication No. 2007/0201560 (“Segall560”)
APPLE-1065	U.S. Patent Publication No. 2004/0022518 (“Taga”)
APPLE-1066	U.S. Patent No. 6,510,177 (“DeBonet”)
APPLE-1067	U.S. Patent No. 6,023,535 (“Aoki”)
APPLE-1068	U.S. Patent Publication No. 2007/0160153 (“Sullivan”)
APPLE-1069	U.S. Patent Publication No. 2006/0222079 (“Park079”)
APPLE-1070	Exhibit SAMSUNG-1006 as submitted in IPR2024-00327
APPLE-1071	Exhibit SAMSUNG-1007 as submitted in IPR2024-00327
APPLE-1072	Exhibit SAMSUNG-1010 as submitted in IPR2024-00327
APPLE-1073	JP2009182776A and English Machine Translation (“Kuroda”)
APPLE-1074	U.S. Patent No. 8,023,561 (“Garrido561”)
APPLE-1075	U.S. Patent No. 6,580,754 (“Wan”)
APPLE-1076	U.S. Patent No. 5,408,270 (“Lim270”)
APPLE-1077	EP 1811786 (“Wang”)
APPLE-1078	Declaration of Dr. Clifford Reader from IPR2024-00372

III. Qualifications

A. Summary

7. I am a technical consultant and product development industry veteran with expertise in electronics, software, hardware, video, audio, and data communications (including wireless cellular and Bluetooth), having led product development organizations in cable, satellite, consumer electronics, asset tracking, remote tank logistics, and alarm industries. My current *curriculum vitae* is attached as Appendix A and some highlights follow.

8. I earned my B.S. in Electrical Engineering (1982) with high honors from the University of Tennessee in Knoxville, Tennessee. I also attended the Georgia Institute of Technology from 1986 to 1987, completing 40% of the required degree hours for the M.S. Electrical Engineering program.

9. From 1982 to 1985, I worked at Scientific Atlanta as an Electrical Engineer designing video, audio, and data communications equipment for the cable television industry. I designed software and hardware including addressable data transmitters, video sync suppression scramblers, transaction format converters, and data channel monitors for addressable Cable Television systems and Set Top Boxes.

10. From 1983 to 1985, while working at Scientific Atlanta, I also worked as an Assistant Professor at DeVry Institute of Technology, teaching courses in electronics and microprocessor hardware/software.

11. From 1985 to 1990, I worked at Wegener Communications as a Senior Electrical engineer, designing satellite communications equipment including forward error correction (FEC) coding systems, PSK modems, and analog control systems for RF modulators and PSK demodulators. I was promoted to the Hardware Engineering Manager, where I managed product development of video, audio, and data satellite receivers, modulators, graphics display systems, DSP-based companders, FSK and PSK satellite modems, multiplexers, forward error correction (FEC) codecs, RF upconverters and downconverters, and baseband analog and digital processing components.

12. In 1990, I returned to Scientific Atlanta, which was acquired by Cisco in 2006. I worked as Engineering Manager running the set top box engineering group where I was promoted to Director and Vice President during my tenure until 2011. I led the design of many cable set top boxes and systems through the evolution of analog video, addressability, downloadable software, electronic program guides, digital video, software applications, high-definition TV, DVR, DOCSIS, full spectrum tuners, and multiroom DVR. These systems implemented various technologies including DOCSIS 1/2/3 and hybrid gateways, 802.11, IPTV, DVR, cable modems, ADSL, VDSL, DVB-T/C/S, bootloaders, factory diagnostics, application frameworks, Nagra, DRMs, conditional access, secure microprocessors, device management, Android, Adobe Flash, Linux, DVD play/record, MPEG-4,

MPEG-2, H.264, NTSC, PAL, DAVIC, MoCA, high-performance CPUs, cablecards, network processors, HDMI, multiple video/audio display interfaces, 2D/3D graphics, and multiple RF tuners.

13. From 2011 to 2016, I worked for EchoStar Technologies, which served as the product development organization for sister company DISH Network. I served as Vice President of Engineering and was the Head of the Atlanta research and development center. I led the development of satellite set top boxes, consumer electronic equipment, and a home automation and security system. Technologies used included video/audio, IoT, H.265, HEVC, 3D, Satellite, wireless Zigbee, Z-Wave, Wi-Fi, Bluetooth, MoCA, transcoding, embedded C Linux applications, mobile applications (IOS and Android), SaaS, web applications (Javascript, HTML), BSS/OSS, AWS cloud storage, 2-way video/audio streaming, authentication, and VoIP.

14. In 2016, I started an independent consulting business in technology and intellectual property projects. I have consulted in various technology areas and industries including consumer electronics, cable, satellite, television, video/audio/image processing, multimedia content, networking, security, camera, online advertising, and Internet of Things (IoT).

15. From 2019 to 2022, I worked as Chief Technology Officer for Telular, an Ametek company. I was responsible for the development of Industrial IoT (IIoT)

recurring revenue solutions, combining wireless technologies (cellular, Bluetooth, sub-GHz, GPS, and satellite), purpose-built hardware, and SaaS in the commercial telematics, security and home automation markets and sold under the SkyBitz and Telguard Brands.

16. My record of professional service includes awards on products I designed and developed from several organizations in my field of expertise, including Best of Show, Technology Emmy, and Best of Innovations.

17. I am a named inventor on at least 118 issued patents and published patent applications corresponding to the areas of my professional work. The patents and published applications involving video and audio technologies include:

- U.S. Patent No. 9,615,139 titled “Determining Device That Performs Processing of Output Pictures”
- U.S. Patent No. 9,495,860 titled “False Alarm Identification”
- U.S. Patent No. 9,882,736 titled “Remote Sound Generation for a Home Automation System”
- European Patent No. EP 1,552,698 titled “Video transmission systems and methods for a home network”
- U.S. Patent Nos. 8,120,924, 7,240,217, 6,785,817, 6,564,324, 6,212,278 and 5,440,632 titled “Reprogrammable subscriber terminal”

- U.S. Patent Application No. US2015/0160635 titled “Multi-Tiered Feedback-Controlled Home Automation Notifications”
- U.S. Patent Application Publication No. 2015/0161882 titled “False alarm identification”
- U.S. Patent No. 8,549,567 titled “Media Content Sharing Over a Home Network”
- U.S. Patent Nos. 9,247,409 and 9,691,261 titled “Home Automation Communications”
- U.S. Patent No. 5,657,414 titled “Auxiliary device control for a subscriber terminal”
- PCT Patent Publication No. WO 2003/083606 titled “Exporting data from a digital home communication terminal to a client device”
- U.S. Patent No. 5,592,551 titled “Method and apparatus for providing interactive electronic programming guide”
- U.S. Patent No. 8,161,388 titled “Interactive discovery of display device characteristics”
- U.S. Patent No. 7,908,625 titled “Networked Multimedia System”
- U.S. Patent Nos. 7,861,272 and 7,849,486 titled “Networked subscriber television distribution”

- U.S. Patent Nos. 7,774,820 and 7,069,578 titled “Settop cable television control device and method including bootloader software and code version table for maintaining and updating settop receiver operating system software”
- U.S. Patent No. 5,715,515 titled “Method and apparatus for downloading on-screen graphics and captions to a television terminal”
- U.S. Patent No. 5,539,822 titled “System and Method for Subscriber Interactivity in a Television System”
- U.S. Patent Application Publication Nos. 2004/0068753 and 2008/0072272 titled “Video Transmission Systems and Methods for a Home Network”
- U.S. Patent No. 5,771,064 titled “Home communications terminal having an applications module”
- U.S. Patent Application Publication No. 2004/0133911 titled “Subscriber Network in a Satellite System”
- U.S. Patent No. 5,367,571 titled “Subscriber terminal with plug in expansion card”
- U.S. Patent No. 5,357,276 titled “Method of Providing Video On Demand with VCR Like Functions”

IV. Legal Standards

18. I have been asked to provide my opinions as to whether claims 1, 5-6, 8-10 of the '995 Patent would have been obvious to a person of ordinary skill in the art as of the earliest claimed priority date of the '995 patent (May 30, 2008) ("Critical Date").

19. I am an engineer by training and profession. The opinions I express in this declaration involve the application of my technical knowledge and experience to the evaluation of certain prior art with respect to the '995 Patent. In addition, I understand that the following legal principles apply.

20. It is my understanding that, in determining whether claims of the '995 patent are obvious in this proceeding, the claim terms are generally given their ordinary and customary meaning as understood by a person of ordinary skill in the relevant art. A person of ordinary skill in the art would read the claim terms in the context of the entire patent specification in which they appear, as well as the prosecution history of the patent.

21. It is my understanding that a claim is unpatentable under 35 U.S.C. § 103 if the claimed subject matter as a whole would have been obvious to a person of ordinary skill in the art at the time of the alleged invention. I also understand that an obviousness analysis takes into account the scope and content of the prior

art, the differences between the claimed subject matter and the prior art, and the level of ordinary skill in the art at the time of the invention.

22. In determining the scope and content of the prior art, it is my understanding that a reference is considered relevant prior art if it falls within the field of the inventor's endeavor. In addition, a reference is prior art if it is reasonably pertinent to the particular problem with which the inventor was involved. A reference is reasonably pertinent if it logically would have commended itself to an inventor's attention in considering his problem. If a reference relates to the same problem as the claimed invention, that supports use of the reference as prior art in an obviousness analysis.

23. To assess the differences between prior art and the claimed subject matter, it is my understanding that 35 U.S.C. § 103 requires the claimed invention to be considered as a whole. This "as a whole" assessment involves showing that one of ordinary skill in the art at the time of invention, confronted by the same problems as the inventor and with no knowledge of the claimed invention, would have selected the elements from the prior art and combined them in the claimed manner.

24. It is my further understanding that several rationales may be applied for combining references or modifying a reference to show obviousness of claimed subject matter. These rationales include: combining prior art elements according to

known methods to yield predictable results; simple substitution of one known element for another to obtain predictable results; a predictable use of prior art elements according to their established functions; applying a known technique to a known device (method or product) ready for improvement to yield predictable results; choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success; and some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify a prior art reference or to combine prior art teachings to arrive at the claimed invention.

V. Overview of the '995 Patent

A. Technical Background

25. The '995 Patent relates to video coding technology, including the use of “super-resolution” techniques to enhance pictures in a video coding system.

26. The '995 Patent discloses a predictable collection of conventional video coding features that were well known to a POSITA before the Critical Date. These features 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;

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

(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 information content (e.g., more detail) than any of the individual lower-resolution input pictures and a higher spatial resolution (e.g., higher pixel count¹) than the input pictures; and

(iv) **layered, hierarchical coding** in which two or more related video streams are encoded together to provide a base layer that can be decoded

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

independent of the other layers and one or more enhancement layers that are decoded in dependence on the base layer.²

27. For additional information on these and related video coding concepts, and the state of the art as of the Critical Date of the '995 Patent, I refer to Sections II and V of Dr. Reader's declaration from the Samsung IPR on the related '995 Patent that addresses these concepts in further detail.

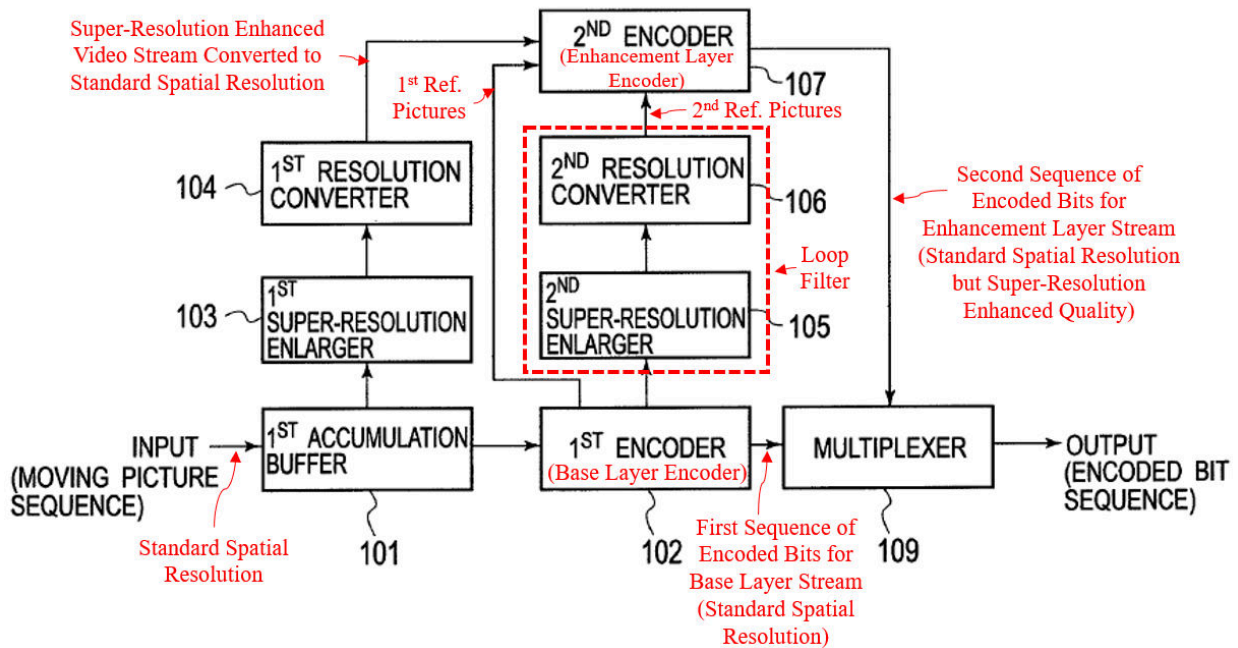
B. Brief Description

28. The '995 Patent describes layered or hierarchical video coding systems that apply conventional super-resolution techniques to enhance both (i) an original video stream that is provided as input to a video encoding/compression process and (ii) reference pictures used in a process for predicting pictures in the super-resolution enhanced video stream. The '995 Patent describes both encoding and decoding systems respectively configured to encode and decode such super-resolution enhanced video streams. An overview of the disclosed encoding and decoding architectures follows below.

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

Encoding Architecture Overview

FIG. 1



APPLE-1001, FIG. 1 (annotated)

29. As illustrated in FIG. 1, an example encoding system in the '995 Patent provides dual encoding paths for base- and enhancement-layer streams. APPLE-1001, 13:40–17:45. In the first path, a first encoder 102 processes a base-version of the input video that has not been super-resolution enhanced through an accumulation buffer 101, outputting a standard-resolution base-layer bitstream. Id., 13:46–14:9. In the second path, a super-resolution enlarger 103 performs super-resolution processing to increase both the spatial resolution and information density (e.g., quality) of the input video. A first resolution converter 104 then reduces the

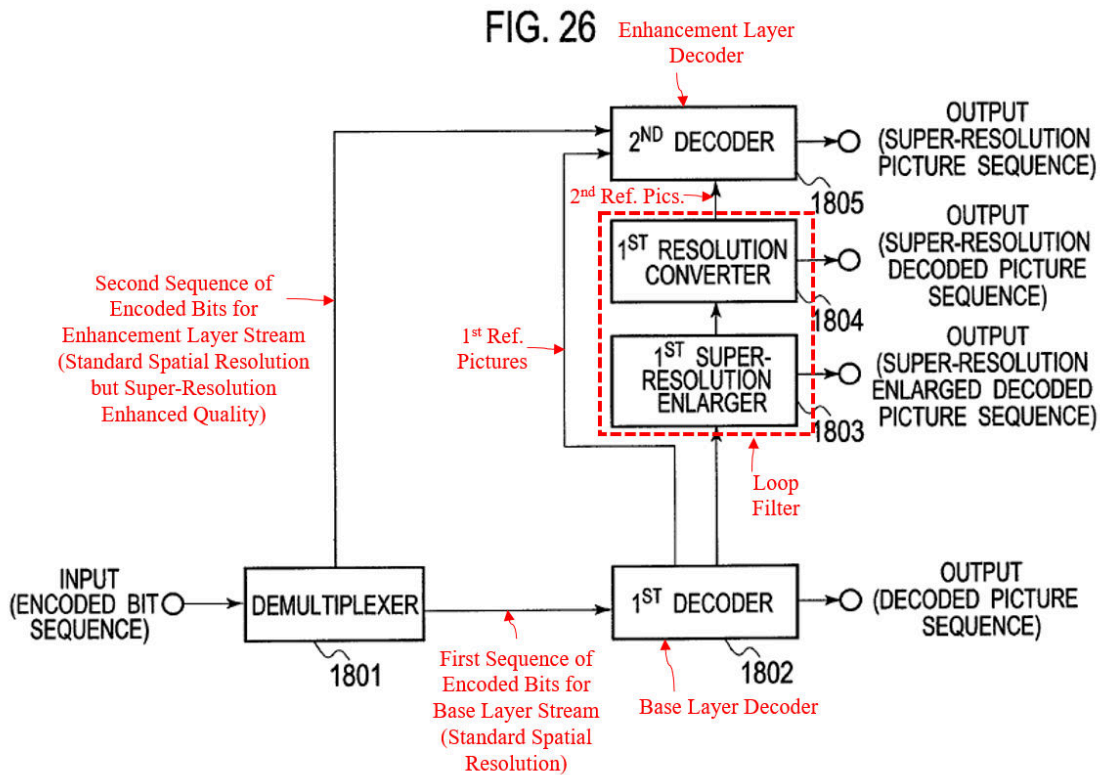
spatial resolution of the super-resolution enhanced version of the input video back to standard resolution, while retaining higher information density and thus providing higher quality than the original input video. *Id.*, 15:30-42, 14:10-48, 4:34-49.

30. The second encoder 107 implements inter-layer prediction techniques to exploit redundancies between base- and enhancement- layers streams. APPLE-1001, 15:30-64. In particular, the first encoder 102 encodes original (base) layer pictures from the input video and then decodes the encoded pictures. The decoded base layer pictures at the standard resolution are provided by the first encoder 102 to the second encoder 107 as a first set of reference pictures. *Id.* A second set of reference pictures is created by super-resolution enhancing the decoded base layer pictures at the second super-resolution enlarger 105 and then downscaling the enhanced decoded pictures to the standard resolution at the second resolution converter 106. *Id.*, 14:49-16:18. The super-resolution enlarger 105 and second-resolution converter 106 thus form a type of loop filter that enhances reference picture quality and reverts back to a standard resolution output. The second encoder 107 selects either non-enhanced base-layer reference pictures or super-resolution-enhanced reference pictures for predictive coding of the super-resolution enhanced video input stream. *Id.*, 14:49-16:18, 15:30-16:45. The encoded base and enhancement streams are then multiplexed into a single output, accompanied by

reference picture selection information, and transmitted to the decoding apparatus.

Id., 16:64-17:20, 16:46-63, 29:67-30:5, 59:62-60:20.

Decoding Architecture Overview



APPLE-1001, FIG. 26 (annotated)

31. FIG. 26 illustrates an example decoding system in the '995 Patent. As shown above, a demultiplexer 1801 parses the input encoded bit sequence to separate the first and second bitstreams corresponding to the base- and enhancement- layer video streams, respectively. APPLE-1001, 50:52-51:18; *see also id.*, 59:4-41, 50:39-54:6. 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 second decoder 1805 selects either non-super-resolution or super-resolution enhanced decoded base-layer pictures for inter-layer prediction, based on reference picture selection information from the encoding apparatus. *Id.*, 52:40-53:46.

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

33. For reference, I provide the following listing of challenged claim elements from the '995 Patent:

Claim 1	
[1.P]	A moving picture encoding system comprising:
[1.1]	a first encoder configured to work on a subsequence of a sequence of moving pictures with a standard resolution to implement a first combination of processes for an encoding and a decoding to create a first sequence of encoded bits and a set of decoded pictures with the standard resolution;
[1.2]	a first super-resolution enlarger configured to work on the subsequence of the sequence of moving pictures with the standard resolution to implement an interpolation of pixels with a first enlargement to create a set of super-resolution enlarged pictures with a first resolution higher than the standard resolution;

[1.3]	a first resolution converter configured to work on the set of super-resolution enlarged pictures to implement a process for a first resolution conversion to create a set of super-resolution enlarged and converted pictures with a standard resolution;
[1.4]	a second super-resolution enlarger configured to acquire the set of decoded pictures with the standard resolution from the first encoder to work on the sequence of decoded pictures to implement an interpolation of pixels with a second enlargement to create a set of super-resolution enlarged decoded pictures with a second resolution higher than the standard resolution;
[1.5]	a second resolution converter configured to work on the set of super-resolution enlarged decoded pictures to implement a process for a second resolution conversion to create a set of super-resolution enlarged and converted decoded pictures with a standard resolution; and
[1.6.i]	a second encoder configured to: have the set of super-resolution enlarged and converted pictures from the first resolution converter as a set of encoding target pictures, the set of decoded pictures from the first encoder as a set of first reference pictures, and the set of super-resolution enlarged and converted decoded pictures from the second resolution converter as a set of second reference pictures,
[1.6.ii]	select one of the set of first reference pictures and the set of second reference pictures to create reference picture selection information to identify the set of selected reference pictures to implement a second process for encoding to create a second sequence of encoded bits based on the set of encoding target pictures and the set of selected reference pictures, and implement a third process for encoding for the reference picture selection information to create a sequence of encoded bits of the reference picture selection information,
[1.7]	wherein the set of encoding target pictures, the set of first reference pictures, and the set of second reference pictures have the same value in spatial resolution.
Claim 5	
[5.1]	The moving picture encoding system according to claim 1, wherein the first super-resolution enlarger comprises: a positioner configured to work in a processing for superresolution enlargement, on a combination of a base picture constituting a base therein and one or

	more observation pictures to be based on, to make a positioning to pixel positions of a desirable high resolution, for an interval-unequal sampling to create nonhomogeneous high resolution pictures;
[5.2]	an interpolator configured to work on nonhomogeneous high resolution pictures created at the positioner, to implement a process for a prescribed nonhomogeneous interpolation to create interpolated pictures with a desirable high resolution;
[5.3]	an estimated picture creator configured to acquire interpolated pictures created at the interpolator, to implement thereon a process for a prescribed reconstruction to create estimated pictures with a desirable resolution; and
[5.4]	a repetition determiner configured to acquire a nonhomogeneous high resolution picture from the positioner and a nonhomogeneous estimated picture from the estimated picture creator, for employment of the acquired pictures to follow a prescribed determination method to determine whether or not a repetition of the processing for super-resolution enlargement is necessary, and work depending on a result thereof, to operate as the repetition is necessary, to provide the interpolator with information for a control to continue the processing, and operate as the repetition is unnecessary, to provide the estimated picture creator with information for a control to output a set of estimated pictures with a high resolution after super-resolution enlargement.
Claim 6	
[6]	The moving picture encoding system according to claim 1, further comprising a multiplexer configured to operate complying with a prescribed syntax structure to multiplex the first sequence of encoded bits from the first encoder, the second sequence of encoded bits from the second encoder, and information on encoding parameters of respective types used in the encoding at the first encoder and the encoding at the second encoder.
Claim 10	
[10]	The moving picture encoding system according to claim 1, wherein the second encoder divides an encoding target picture into a plurality of regions to select one of the set of first reference pictures and the set of second reference pictures for each divided region.
Claim 8	

[8.P]	8. A moving picture encoding method comprising:
[8.1]	a step of implementing a first combination of processes for an encoding and a decoding on a sequence of moving pictures with a standard resolution, creating a first sequence of encoded bits and a set of decoded pictures with the standard resolution;
[8.2]	a step of implementing an interpolation of pixels with a first enlargement on the sequence of moving pictures with the standard resolution, creating a set of super-resolution enlarged pictures with a first resolution higher than a standard resolution;
[8.3]	a step of implementing a process for a first resolution conversion on the set of super-resolution enlarged pictures, creating a set of super-resolution enlarged and converted pictures with a standard resolution;
[8.4]	a step of acquiring the set of decoded pictures with the standard resolution to work on the sequence of decoded pictures to implement an interpolation of pixels with a second enlargement to create a set of super-resolution enlarged decoded pictures with a second resolution higher than the standard resolution;
[8.5]	a step of working on the set of super-resolution enlarged decoded pictures to implement process for a second resolution conversion to create a set of super-resolution enlarged and converted decoded pictures with a standard resolution; and
[8.6.i]	a step of: having the set of super-resolution enlarged and converted pictures as a set of encoding target pictures, the set of decoded pictures as a set of first reference pictures, and the set of super-resolution enlarged and converted decoded pictures as a set of second reference pictures,
[8.6.ii]	selecting one of the set of first reference pictures and the set of second reference pictures to create reference picture selection information to identify the set of selected reference pictures to implement a second process for encoding to create a second sequence of encoded bits based on the set of encoding target pictures and the set of selected reference pictures, and implementing a third process for encoding for the reference picture selection information to create a sequence of encoded bits of the reference picture selection information,

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

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

C. Examination History

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

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

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

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

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

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

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

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

VI. Person of Ordinary Skill in the Art

40. It is my understanding that the patentability of the claims of the '995 Patent must be assessed from the perspective of a person of ordinary skill in the art

at the time of the alleged invention (“POSITA”). For purposes of my analysis in this declaration, I have taken the earliest claimed priority date of the ’995 Patent (May 30, 2008) as the date of the alleged invention (“Critical Date”). I understand that the factors considered in determining the ordinary level of skill in a field of art include the level of education and experience of persons working in the field; the types of problems encountered in the field; the teachings of the prior art, and the sophistication of the technology at the time of the alleged invention. I understand that a POSITA is not a specific real individual, but rather is a hypothetical individual having the qualities reflected by the factors above. I understand that a POSITA would also have knowledge from the teachings of the prior art, including the art cited below.

41. Taking these factors into consideration, it is my opinion that one of ordinary skill in the art in the field of digital video coding as of the Critical Date, would have had 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. Additional graduate education could substitute for professional experience, or additional professional experience could substitute for formal education.

42. I have possessed the qualifications of a POSITA since the Critical Date of the ’995 Patent, and long before.

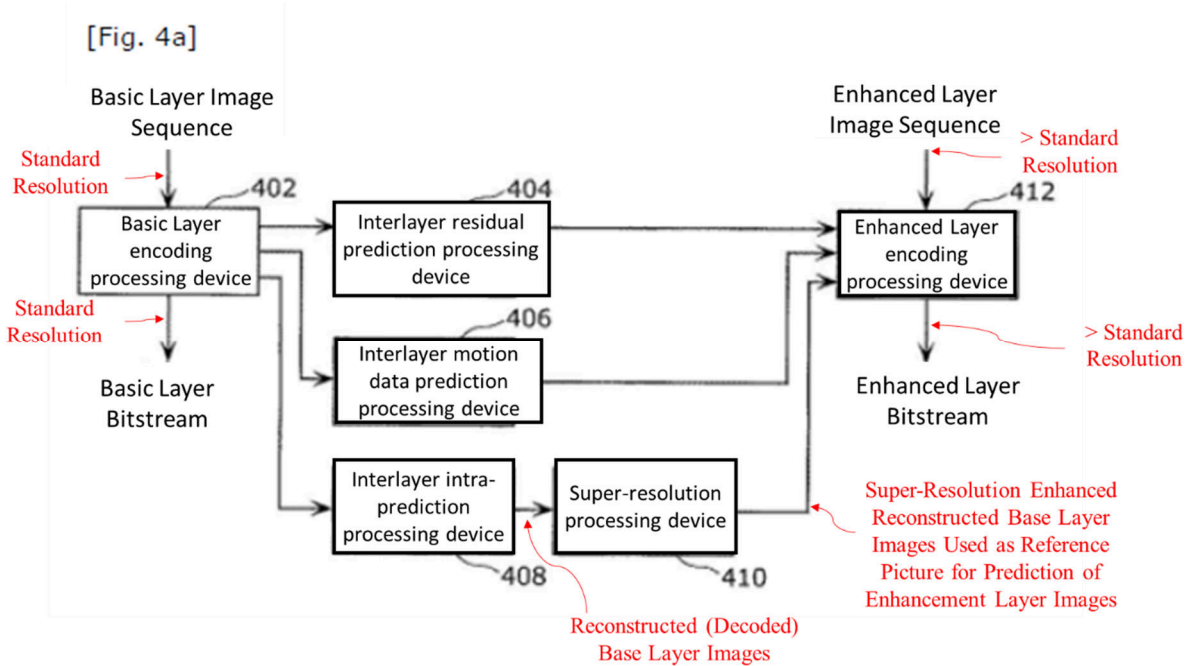
VII. Claim Construction

43. I have not been asked to opine on the special meanings of claim terms within the '995 patent. I have been informed that the claim terms should be afforded their ordinary meaning in view of the specification and file history. By addressing the relevance of the prior art to the various terms and limitations in claims 1, 5-6, and 8-10, I have not intended to formally construe any claim terms and I have not formed an opinion as to whether these terms are definite or supported by the specification of the '995 Patent.

VIII. Ground 1A – Obviousness based on Phek-YuChuan-He

A. Overview of Phek

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



APPLE-1005, FIG. 4a (modified and annotated).

B. Overview of YuChuan

45. YuChuan describes techniques for reconstructing “enhanced-resolution images” from multiple low-resolution images using an improved iterative “super-resolution algorithm.” APPLE-1055, Abstract, [0016], [0018]. YuChuan’s super-resolution enhancement technique involves (1) well-chosen initial interpolation, (2) robust image registration, and (3) automatic image selection, followed by optional post-processing for further image enhancement. APPLE-1055, Abstract, [0015], [0017].

46. YuChuan’s process begins by storing a set of M low-resolution images, from which one is selected as a prototype, and interpolating extra pixels based on a user-defined magnification factor to create an initial high-resolution (super-

resolution) estimate. APPLE-1055, [0019]-[0033]. YuChuan teaches creating a super-resolution image by employing interpolation techniques like third-order (cubic) interpolation during the initial guess phase to estimate high-resolution pixel values from neighboring low-resolution pixels, balancing computational complexity and reconstructed image quality. APPLE-1055, [0043]-[0046].

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

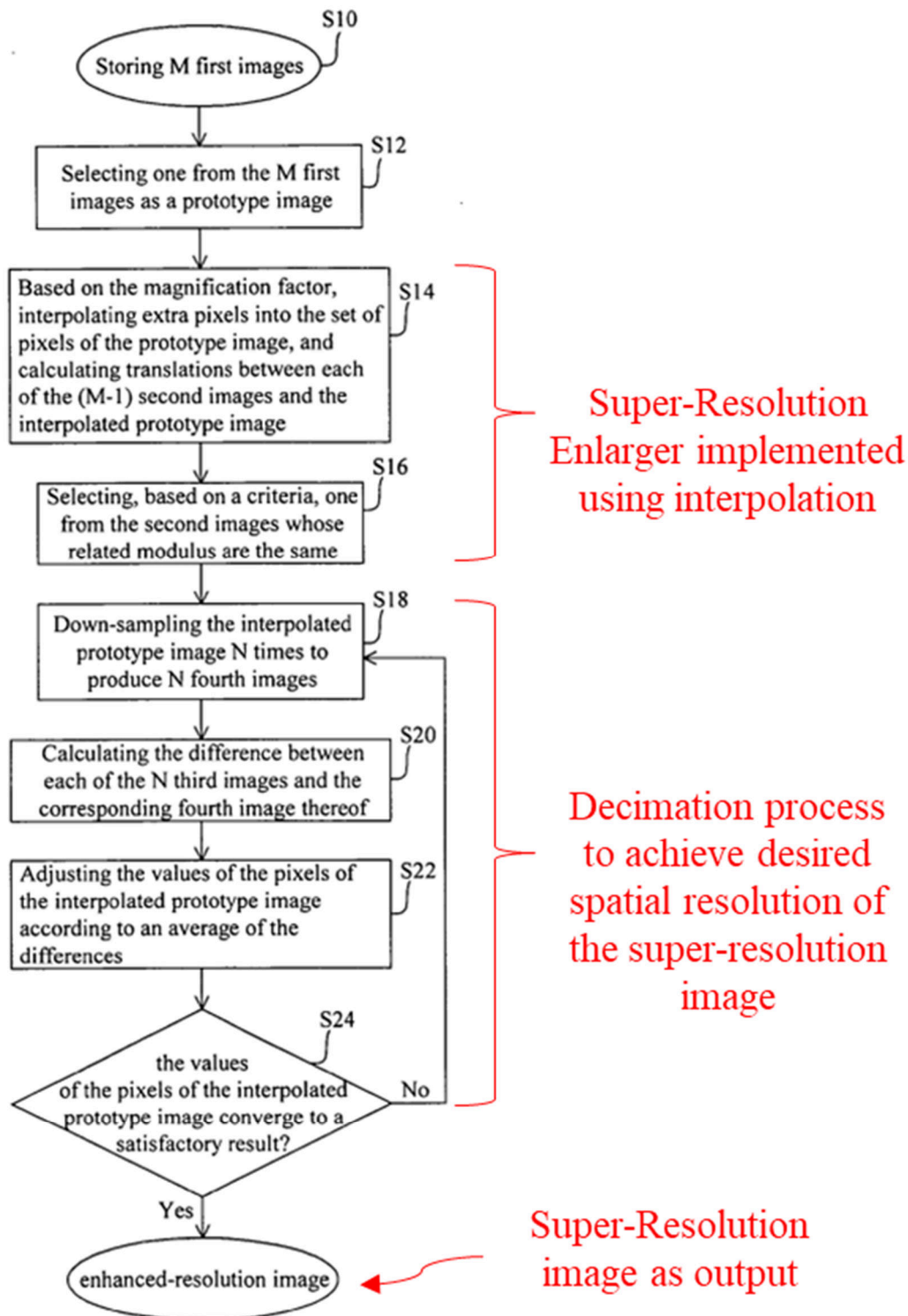


FIG. 1

APPLE-1055, FIG. 1 (annotated).

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



FIG. 5A



FIG. 5B



FIG. 5C



FIG. 5D

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

49. Third-order interpolation can be used for the initial guess, balancing computational efficiency and image quality. APPLE-1055, [0046]. YuChuan's method produces high-quality enhanced-resolution images, with significant

reductions in computation time when automatic image selection is used. APPLE-1055, [0067], [0070]-[0071].

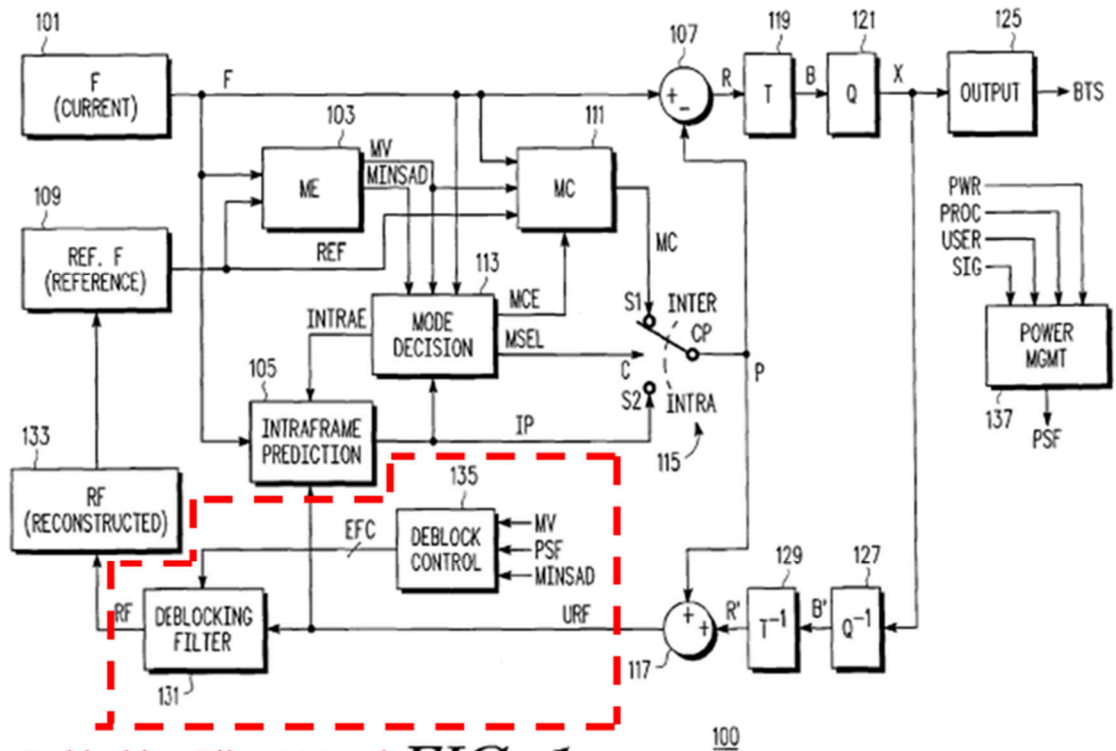
C. Overview of He

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

51. According to He, “[t]he deblocking filter enhances the decoded picture quality and increases the encoding efficiency by removing the block effects in the boundary of each 4x4, 8x8, and/or 16/16 block,” although “[t]he deblocking filter[] ... also consumes a significant amount of power and processing cycles.” APPLE-1008, [0006]. “Disabling the entire deblocking filter [] provides a significant reduction of computational complexity and power consumption, especially in the decoder of a video processing system.” *Id.*, [0028]. He thus proposes techniques for examining “the content of the video information ... to determine whether to disable the deblock filtering,” e.g., based on “a characteristic indicative of a relative amount of content complexity and/or a relative amount of motion of the video information” and “also based on power savings considerations.” *Id.*, [0028], [0037].

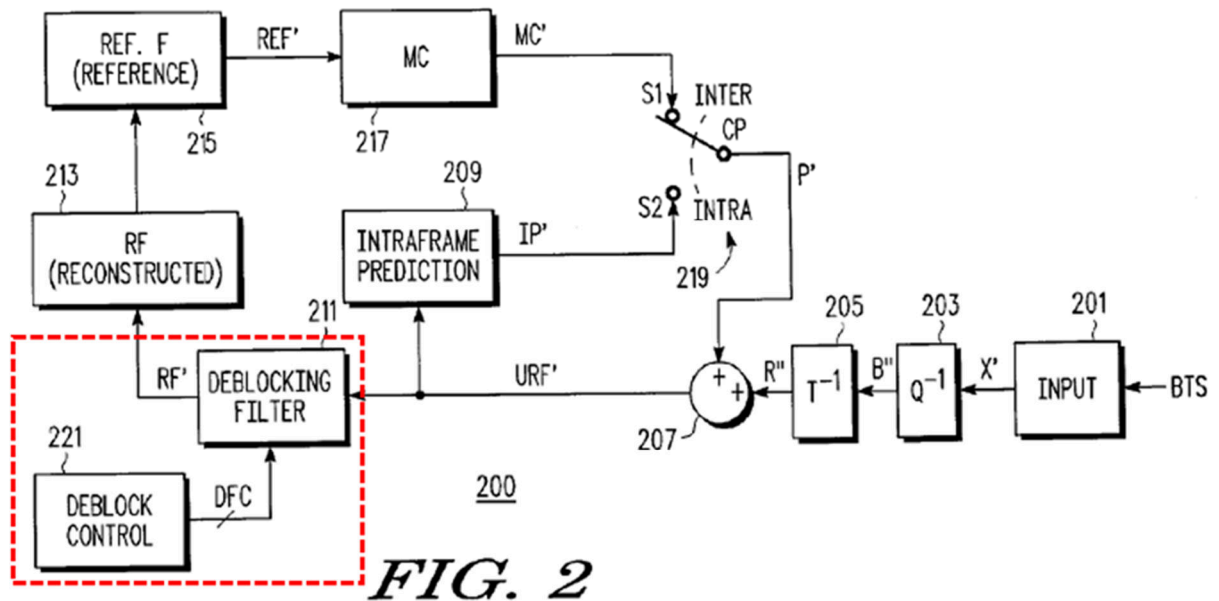
52. FIG. 2 (reproduced below) depicts a video decoder 200 configured to implement selective deblock filtering. APPLE-1008, [0032], FIG. 2. The decoder 200 receives a coded bitstream (BTS) and performs prediction and reconstruction operations to decode at least a portion of a picture, thereby generating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

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



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

APPLE-1008, FIG. 1 (annotated).



In-Loop Deblocking Filter 211 and
Control Circuit 221

APPLE-1008, FIG. 2 (annotated).

54. He thus represents one conventional option for selecting between reference pictures in a video coding prediction process. The coder can select to use an enhanced reference picture by activating the in-loop (deblocking) filter or can select to use a non-enhanced reference picture by disabling the in-loop (deblocking) filter. A POSITA would have understood that He's techniques are representative of a range of conventional solutions for selecting among different types of reference pictures to optimize coding efficiency and performance. APPLE-1046, [0131], [0253], FIGs. 6, 12, 15 (describing additional known techniques for selecting between different reference pictures in a hierarchical/scalable coding system).

D. Combination of Phek, YuChuan, and He

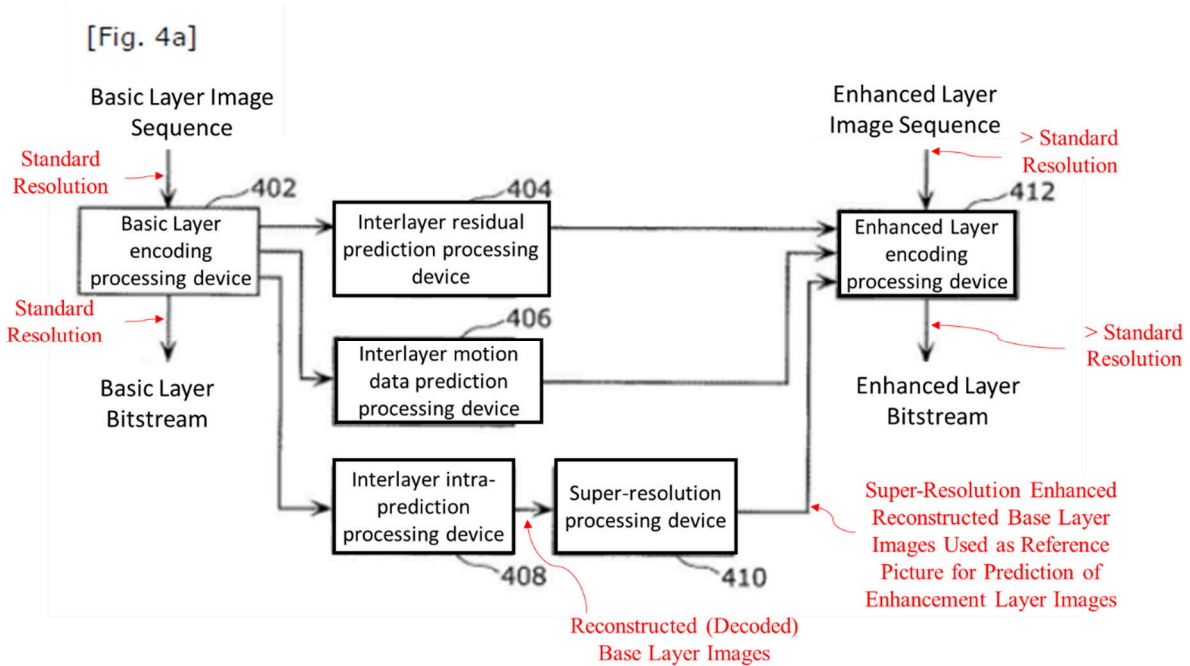
55. Like the '995 Patent, Phek discloses a layered video coding system that processes decoded base layer pictures to create reference pictures for the prediction of pictures in an enhancement layer. *Supra*, §§V.A, VIII.A. While Phek's disclosure focuses on details of a super-resolution algorithm used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

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

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

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

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



APPLE-1005, FIG. 4A.

58. To the extent Phek does not expressly describe how the enhanced layer image sequence encoded by enhanced layer encoding processing device 412 is formed, it would have been obvious for the enhanced layer image sequence to be formed by applying super-resolution processing to the base layer image sequence.⁴

⁴ Any conventional super-resolution processing technique would be suitable for this purpose, including Phek's super-resolution processing or Yu-Chuan's super-resolution processing. APPLE-1005, [0016]-[0020]; APPLE-1055, [0030]-[0071]; *cf.*, APPLE-1001, 22:38-23:21 ('995 Patent explaining that "any such super-resolution" process known in the art may be applied).

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

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

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

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

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

61. Third, a POSITA would have sought to form the enhanced layer image sequence by applying super-resolution processing to the base layer image sequence to produce an enhanced layer image sequence that is related to the base layer image sequence. The relationship between the two image sequences would have improved coding efficiency because the layered coding system removes significant redundancies between the base layer image sequence and the enhanced layer image sequence during coding. *Id.*; APPLE-1005 , [0014] (“Interlayer prediction is used for hierarchical encoding in order to improve encoding efficiency. ... The enhanced layer encoding processing device 412 uses interlayer prediction to reduce redundancy between the enhanced layer and the basic layer, thereby improving encoding efficiency compared to encoding performed using only an enhanced layer.”). Super-resolution processing also has the effect increasing the quality (e.g., information content, signal-to-noise ratio (SNR)) of an input image sequence, which is a characteristic of enhancement layer image sequences that are commonly

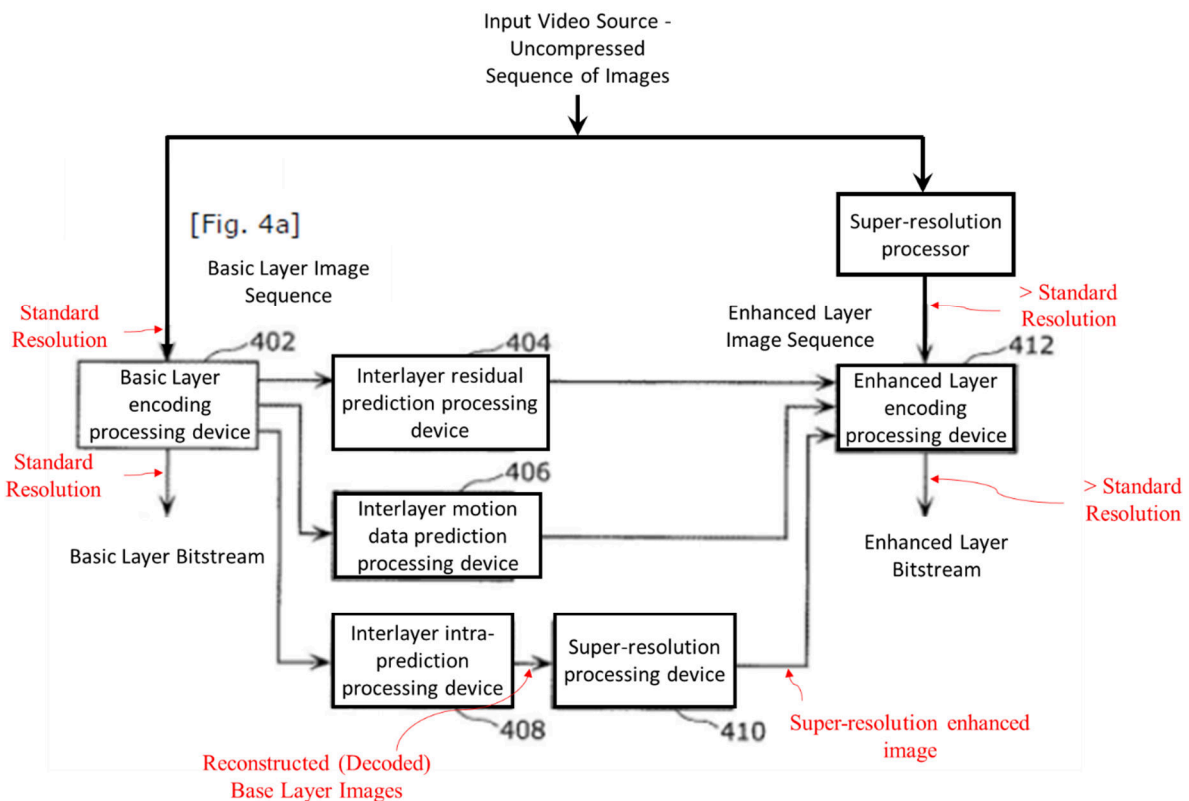
differentiated between layers of a scalable video coding system like that disclosed in Phek. APPLE-1005, (57), [0002]-[0004], [0011], [0013]; APPLE-1010, 1104 (“The usual modes of scalability are temporal, spatial, and *quality* scalability.”), 1103. A POSITA thus would have recognized super-resolution processing as a beneficial technique for generating an enhanced layer image sequence that could be suitably encoded by a layered/scalable coding system as taught in Phek.

62. Fourth, a POSITA would have sought to form the enhanced layer image sequence based on super-resolution processing to overcome limitations that may have suppressed the quality of the original input video (base layer image sequence). For example, the original input video may have been under-sampled or subject to movement or vibration that caused blurring or other quality degradations in the image sequence of the input video. Super-resolution processing would have been obvious and beneficial to enhance the quality of the original video such that the video could be later coded, decoded, and viewed with enhanced quality. APPLE-1055, [0012] (“Due to environmental constraints and resolution of image sensors, sometimes we can only get low-resolution images. In order to improve the image quality and resolution seen by human eyes, more than one input image is required. With image sequences, a blurring scene, a dim figure, or an unclear object of poor quality can be reconstructed to an enhanced-resolution output image and can then be easily observed and recognized.”); APPLE-1012, 2 (“In the process of recording

a digital image, there is a natural loss of spatial resolution caused by the optical distortions (out of focus, diffraction limit, etc.), motion blur due to limited shutter speed, noise that occurs within the sensor or during transmission, and insufficient sensor density Thus, the recorded image usually suffers from blur, noise, and aliasing effects. ... [T]he main concern of an SR algorithm is to reconstruct HR images from undersampled HR images,” while also “cover[ing] image restoration techniques that produce high quality images from noisy, blurred images.”). Moreover, by performing super-resolution at the encoding system before compression and storage or transmission of the video, the viewer’s device would beneficially be capable of reproducing the video at a higher quality simply by decoding the enhancement layer stream, without need to further apply super-resolution post-processing to a decoded version of the base layer image sequence at the receiver/viewing device. *Id.*; *see also* APPLE-1007, 804-805 (describing super-resolution post-processing performed at the receiver/viewing device).

63. Fifth, a POSITA would have found it obvious to generate Phek’s enhanced layer image sequence by applying super-resolution processing to the base layer image sequence because doing so merely entails the predictable application of known technique (e.g., super-resolution processing) to a known system (e.g., Phek’s layered coding system) to achieve predictable results. Here, Phek and the ’995 Patent both confirm that super-resolution processing was a

known technique and the implementation of such techniques was well within the capability of a POSITA. APPLE-1005, [0016]-[0020]; APPLE-1001, 22:38-23:21. A POSITA would have reasonably expected success using super-resolution to enhance image quality for the enhanced layer image sequence in Phek's system, especially since such super-resolution techniques were well known and commonly implemented by the Critical Date. *Id.*



First Intermediate Illustration of Proposed Combination (Phek)

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

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

65. While super-resolution processing can produce the dual benefits of enhanced quality and increased resolution images, it is in some cases desirable merely to enhance the quality of images without increasing their resolution. For example, a POSITA would have known from background knowledge of the art that

“[a] related problem to SR [super-resolution] techniques is image restoration, which is a well-established area in image processing applications The goal of image restoration is to recover a degraded (e.g., blurred, noisy) image, but it ***does not change the size of image.***” APPLE-1012, 2; *see also id.*, (“restoration and SR reconstruction are closely related theoretically, and SR reconstruction can be considered as a second-generation problem of image restoration”); APPLE-1067, 7:10-30 (describing super-resolution technique that produces “output[s] at least ***at the original resolution***” according to a “resolution factor” that is “predetermined or user-selected on the fly”), 1:12-51, 2:1-15. Indeed, the coder depicted in FIG. 4a of Phek is a scalable video coding apparatus, and a well-known form of scalable coding is “quality” scalability (also referred to as signal-to-noise ratio (SNR) scalability) that involves coding pictures at a higher quality in the enhancement layer than the base layer—but still coding the base and enhancement layer pictures at the same spatial resolution. APPLE-1010, 1104 (“With quality scalability, the substream ***provides the same spatio-temporal resolution*** as the complete bit stream, but with a lower fidelity.”); APPLE-1006, 1121 (“[T]he SVC extensions support . . . quality scalability (fidelity enhancement for pictures ***of the same resolution***).”).

66. A POSITA seeking to implement a form of quality/fidelity/SNR scalability in Phek’s system while maintaining the same resolution of images in

the base and enhancement layers would have turned to references such as YuChuan to understand how the increased resolution of a super-resolution enlarged image could be reduced to the original (standard) resolution of the base layer image. For example, YuChuan teaches that a super-resolution enlarged image (e.g., referred to as an interpolated or enhanced-resolution image) can be decreased by down-sampling the enlarged image. *See e.g.*, APPLE-1055, [0019] (“The interpolated prototype image is down-sampled N times according to the respective translations ...”), [0035] (“[S]tep S18 is performed to down-sample, according to the respective translation ..., the interpolated prototype image ...”), [0039]-[0042], FIGS. 1, 5A-5D. YuChuan’s down-sampling operation reduces the size or spatial resolution of the interpolated prototype image (i.e., a super-resolution enlarged image). YuChuan’s method is performed according to user-defined magnification factor. APPLE-1055, [0014], [0019], [0031], FIG. 1.

67. It would have been obvious to implement Phek’s hierarchical coding device to include a down-sampler as suggested by YuChuan or downscaling to reduce the resolution of the super-resolution enlarged base layer input image sequence when forming the enhancement layer input image sequence. A POSITA would have been motivated to implement this straightforward combination for multiple reasons. *Id.* For example, down-sampling the super-resolution enlarged base layer input image sequence would be beneficial to permit the base layer and

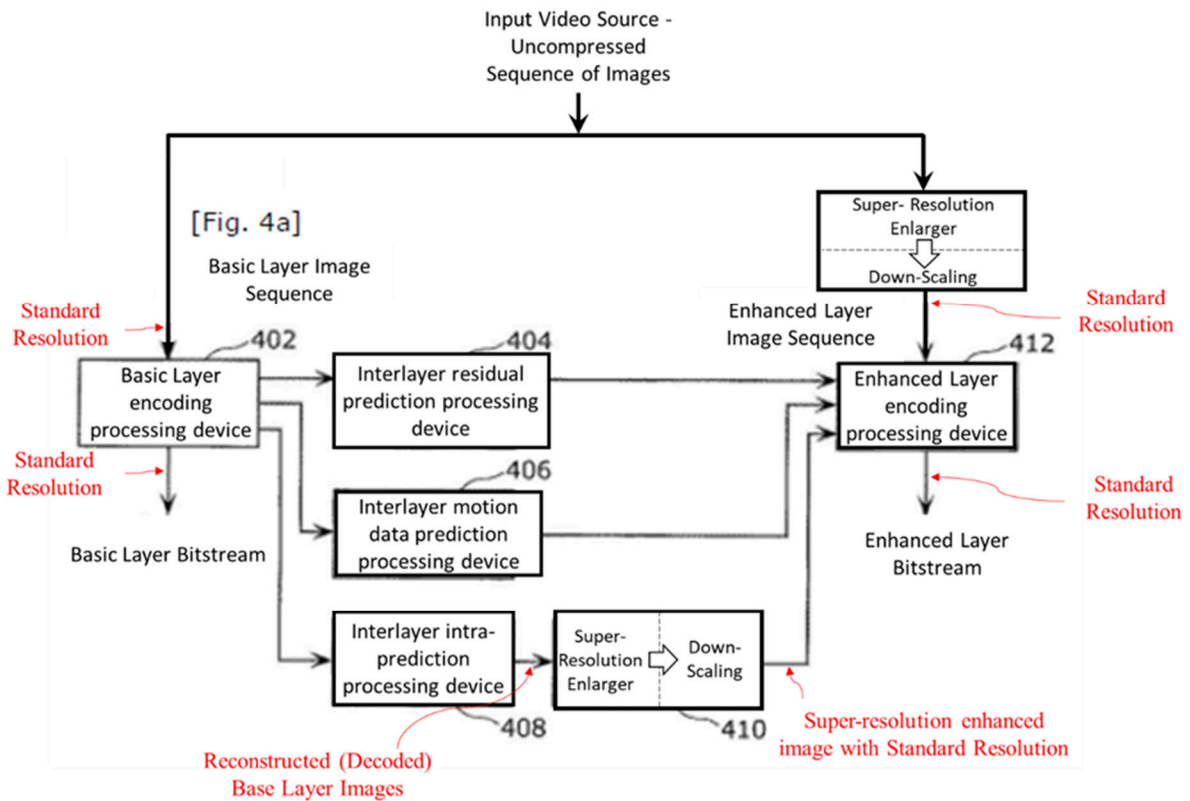
enhancement layer input image sequences to be encoded at the same spatial resolution. Thus, the base and enhancement layers would be differentiated by quality alone (rather than both quality and spatial resolution), which was a common form of scalable coding before the Critical Date. APPLE-1010, 1104;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

before the '995 Patent. *See, e.g.*, APPLE-1055, [0014], [0019], [0031], FIG. 1 (describing benefits of down-sampling to facilitate iterative super-resolution process); APPLE-1007, 2 (“the super-resolution picture is *decimated to the desired format*”), 6 (§IV), FIG. 2; APPLE-1068, [0085] (“Once the encoder has chosen a spatial resolution for a current picture or area within a current picture, *the encoder re-samples the original picture to the desired resolution before coding it.*”), [0082]-[0088], FIGS. 6, 8, 10.

68. Given that the enhancement layer in the Phek-YuChuan system is encoded at the same spatial resolution as the base layer, a POSITA also would have found it obvious to implement a downscaler at the output of Phek’s super-resolution processing device 410 so that the enhanced reference pictures produced by the super-resolution processing device 410 match the resolution of the base layer. A POSITA would have appreciated that reference pictures used in interlayer prediction are ordinarily scaled to the same size as images in the enhancement layer for which the reference pictures will be used to predict. *See, e.g.*, APPLE-1006, §II (“the width and height of the scaled regions of lower resolution and higher resolution pictures must have the same scaling ratio”); APPLE-1026, 25:27-37 (“the resolution converter 205 converts the resolution of the base layer image signal to the resolution corresponding to the enhancement image signal”); APPLE-1046, [0128] (“a resolution conversion circuit 3 for subjecting regenerated data ...

to resolution conversion in a way that its resolution becomes equal to that of the high-resolution image signal”); APPLE-1024, 9:30-35 (“the encoder sets the resolution for the reference frame (630) before setting the resolution for the current frame (620)”), 14:40-46 (“the one or more spatial resolution scaling factors are constrained to be identical to the one or more spatial resolution scaling factors for the reference”), FIG. 6; APPLE-1068, [0082]-[0088], FIGS. 6, 8, 10. It would have been obvious to downscale the super-resolution enlarged reference pictures from super-resolution processing device 410 to maintain the quality enhancements obtained from super-resolution processing while better facilitating interlayer prediction by setting the resolution of the reference picture to the resolution of the enhancement layer.

69. Finally, the implementation of down-samplers in Phek’s device to down-sample the super-resolution enlarged images would have been obvious because it merely involves the predictable application of a known technique (e.g., down-sampling / resolution conversion) to a known system (e.g., Phek’s layered coding system) to achieve predictable results. A POSITA would have reasonably expected success implementing the combination since down-sampling techniques were well known and commonly applied by the Critical Date.



Second Intermediate Illustration of Proposed Combination (Phek-YuChuan)

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

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

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

APPLE-1005, [0011]-[0015], FIGS. 3a-3b, 4a-4b; APPLE-1007, 1-2, 6; *supra*, §VIII.D.(a)-(b). A POSITA would have understood that the super-resolution and downscaling operations performed on reference pictures collectively function as a type of “loop filter,” which will be referred to as a “super-resolution and downscaling loop filter” (or simply an “SR-D filter”). Like other loop filters known in the art, the Phek-YuChuan-He SR-D loop filter enhances decoded frames before they are used as a reference for the prediction of frames in an enhancement layer. *Supra*, §II.A; APPLE-1078, §§II, V; APPLE-1022, 10-11; APPLE-1008, [0006]. A POSITA would have known that a wide range of loop filters were known in the art before the '995 Patent and the SR-D filter in the proposed combination similarly serves to enhance the quality of reference pictures consistent with other conventional loop filters. APPLE-1078, §II.F and *generally* §§II, V; *see also* APPLE-1008, [0006] (describing in-loop filter that “enhances the decoded picture quality and increases the encoding efficiency”); APPLE-1015, [0068] (explaining that in-loop filters “are placed in the coding loop (in-loop), so the filtered frames are used as referenced frames for motion compensation of subsequent coded frames”); APPLE-1011, [0022]-[0023] (“fidelity enhancement techniques can be performed on the processed data at a number of stages in the encoder”), FIGS. 2-5.

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

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

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

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

bypass SR-D filtering when super-resolution processing is too costly and/or the improvement in coded picture quality and compression efficiency achieved by SR-D filtering are too small to justify the additional processing expense for a given frame or slice.

75. A POSITA also would have known that super-resolution processing is often most effective to improve the quality of an image when “some relative scene motions ... exist from frame to frame.” APPLE-1012, 2. But in the absence of motion, or if the lower-resolution images from which the super-resolution image is constructed are merely “shifted by integer [pixel] units,” then “no new information can be used to reconstruct” a super-resolution image and super-resolution processing will be less effective. APPLE-1012, 2. YuChuan also teaches that super-resolution processing works effectively for “low-resolution image sequences associated with a moving object,” but can be less important for other content. APPLE-1055, [0070]-[0071] (“the object becomes more distinct” and “the edges of words are more discernible”), [0043]. Accordingly, when super-resolution processing does not improve the reference picture significantly, imposes an undue increase in computational load, and/or when the power consumption required for super-resolution processing is substantial, it would have been obvious to bypass SR-D filtering based on He’s teachings for selective in-loop filtering. For example, consistent with He’s teaching to use an unfiltered reference picture

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

76. The fact that selective loop filtering was standard in video coders before the '995 Patent, and that He specifically describes such techniques in a layered coding system like Phek's, underscores that a POSITA would have found the combination obvious, would have been motivated to make the combination, and would have reasonably expected success. Indeed, integration of selective loop filtering in the Phek-YuChuan-He combination involves no more than the predictable application of a known technique (e.g., selective in-loop filtering) to a conventional system having an in-loop filter (e.g., Phek-YuChuan's hierarchical encoder) to achieve predictable results. Moreover, a POSITA would have understood that He's techniques are representative of a range of conventional solutions for selecting among different types of reference pictures to optimize coding efficiency and performance. APPLE-1046, [0131], [0253], FIGs. 6, 12, 15 (describing additional known techniques for selecting between different reference pictures in a hierarchical/scalable coding system). Considering the advanced state

of the art at the time before the Critical Date of the '995 Patent, selectively applying SR-D filtering in the combination would have been an obvious and straightforward technique.

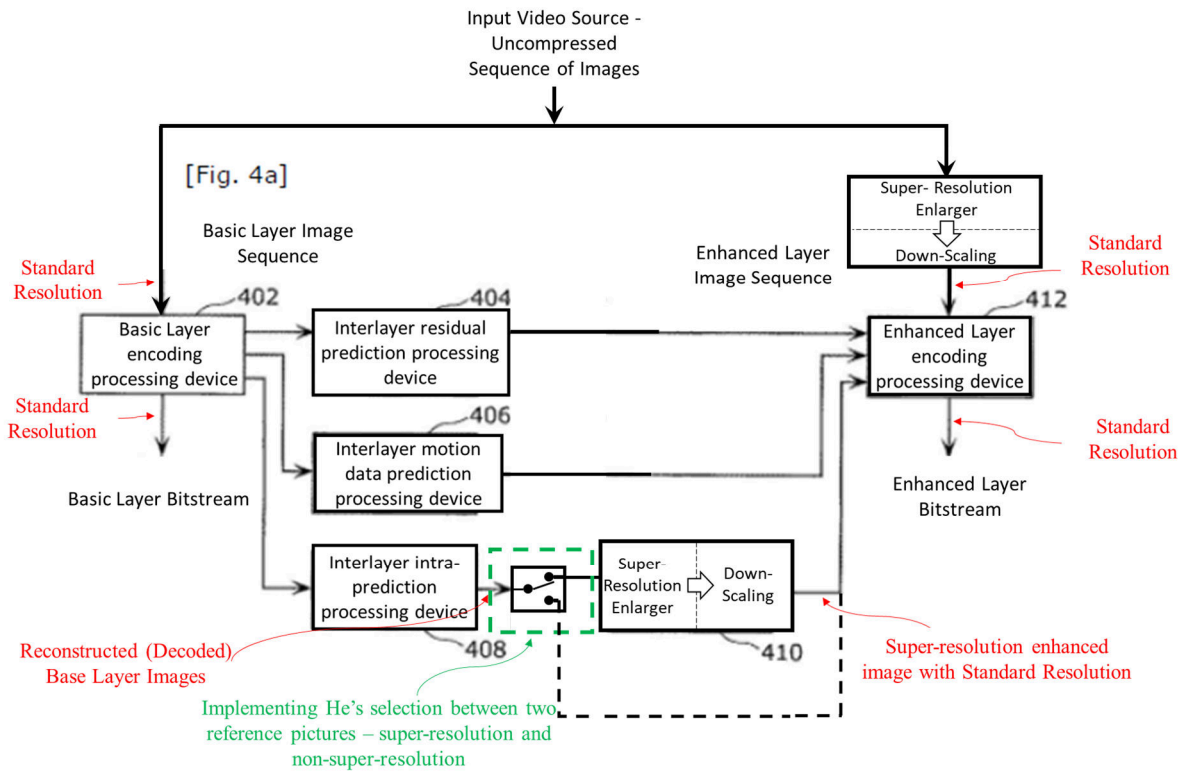


Illustration of Proposed Combination (Phek-YuChuan-He)

E. Analysis

77. As noted above, in preparing this declaration, I reviewed the IPR Petition that Apple is submitting to the PTAB to challenge claims 1, 5-6, and 8-10 of the '995 Patent. I collaborated with counsel in developing the grounds set forth in the Petition, and as such, the Petition itself reflects my analysis and opinions regarding the patentability of claims 1, 5-6, 8-10 of the '995 Patent. Based on my review, the Petition correctly describes why the proposed prior art combinations

would have been obvious to a POSITA and how the prior art combinations provide each element of claims 1, 6, 8-10. Below, I highlight certain aspects of the Phek-YuChuan-He combination as described above and their relevance to various elements of claims 1, 6, 8-10 of the '995 Patent obvious. Additional explanation is provided in the Petition.

78. The first encoder element of claim 1, corresponding to claim element [1.1], which operates on standard resolution moving pictures to create encoded bits and decoded pictures, finds correspondence in Phek's basic layer encoding processing device (402) alone or together with interlayer intra-prediction processing device (408) as illustrated in the proposed combination. A POSITA would have understood that Phek's basic layer encoder implements conventional encoding and decoding processes operating on standard resolution video to produce both a compressed bitstream and decoded pictures that provide a foundation for subsequent enhancement layer processing. The basic layer encoding processing device performs encoding and decoding operations on standard resolution video, generating both the first sequence of encoded bits according to its compression algorithm and the set of decoded pictures through a reconstruction process at the standard resolution.

79. The first super-resolution enlarger element, corresponding to claim element [1.2], which processes standard resolution moving pictures to create super-

resolution enlarged pictures with higher resolution, corresponds to the super-resolution processor positioned in the enhanced layer processing path of the proposed combination. As illustrated in the combination diagram, this super-resolution processor receives the input video source at the standard resolution and implements Phek's or YuChuan's super-resolution enlargement techniques to generate enhanced resolution pictures from the standard resolution input sequence. POSITA would have understood that this configuration represents a logical application of Phek's teachings, where super-resolution processing is applied to the original standard resolution video sequence to create higher resolution target pictures for enhanced layer encoding. The super-resolution processor operates on the input video stream to produce super-resolution enlarged pictures that serve as encoding targets for the enhanced layer.

80. The combination further integrates conventional resolution conversion techniques known to a POSITA to implement the first resolution converter, corresponding to claim element [1.3], which processes the super-resolution enlarged pictures to generate super-resolution enlarged and converted pictures with standard resolution. This resolution converter operates on the output of the first super-resolution enlarger, applying well-established resolution reduction techniques to return the enhanced pictures to standard resolution while preserving beneficial quality enhancements introduced by the super-resolution processing.

The resolution conversion process ensures that encoding target pictures ultimately used by the second encoder (enhanced layer encoding processing device 412) maintains compatibility with the standard resolution framework while benefiting from the intermediate super-resolution enhancement. This approach represents a natural extension of multi-resolution video processing techniques, where different resolution processing stages are combined to achieve optimal encoding performance. A POSITA would have readily understood that such resolution conversion operations are routine in video processing systems where multiple resolution domains must be reconciled for system compatibility.

81. Parallel to the encoding target processing path, the combination implements a second super-resolution enlarger corresponding to claim element [1.4] through Phek's super-resolution processing device (410). This component acquires the set of decoded pictures generated by the basic layer encoding processing device (402) and applies super-resolution enhancement to create super-resolution enlarged decoded pictures with resolution higher than standard resolution. The second super-resolution enlarger operates on the same fundamental principles as the first super-resolution enlarger but processes reconstructed pictures rather than original input pictures, thereby generating enhanced reference pictures that incorporate both encoding artifacts from the basic layer processing and enhancement characteristics from super-resolution

algorithms. A POSITA would have recognized that applying super-resolution processing to decoded pictures represents a logical approach to reference picture enhancement, where the goal is to provide improved prediction capabilities for subsequent encoding operations. This processing path creates an alternative set of reference pictures that benefit from super-resolution enhancement while maintaining the temporal and spatial characteristics of the reconstructed base layer content.

82. The combination incorporates conventional resolution conversion methods known to a POSITA to implement the second resolution converter of claim element [1.5], which processes the super-resolution enlarged decoded pictures to generate super-resolution enlarged and converted decoded pictures with standard resolution. Together, the super-resolution enlargement and downscaling by the second resolution converter form a super-resolution and downscaling (SR-D) in-loop filter for enhancing reference pictures used in the interlayer prediction process.

83. The enhanced layer encoding processing device (412) directly corresponds to the second encoder of claim elements [1.6.i] and [1.6.ii], configured to receive super-resolution enlarged and converted pictures from the first resolution converter as encoding target pictures. This enhanced layer encoder utilizes the decoded pictures from the basic layer encoder as first reference pictures

and the super-resolution enlarged and converted decoded pictures from the second resolution converter as second reference pictures. The enhanced layer encoder implements He's reference picture selection techniques, enabling it to select between the two sets of reference pictures based on content characteristics, prediction efficiency, or other encoding optimization criteria. This selection mechanism generates reference picture selection information that identifies which set of reference pictures is used for encoding each portion of the video sequence, directly addressing the requirement to "select one of the set of first reference pictures and the set of second reference pictures to create reference picture selection information." The selection process operates through He's taught switching mechanism that evaluates the prediction performance of each reference picture set and chooses the optimal configuration for each encoding decision, thereby maximizing coding efficiency while maintaining backward compatibility with standard resolution processing requirements.

84. Notably, all three sets of pictures—encoding target pictures, first reference pictures, and second reference pictures—maintain the same spatial resolution value. The proposed combination achieves this requirement through a natural and predictable placement of resolution conversion processes that ensure all pictures used by the second encoder operate at standard resolution. The first resolution converter processes super-resolution enlarged pictures back to standard

resolution for use as encoding targets, while the second resolution converter processes super-resolution enlarged decoded pictures back to standard resolution for use as second reference pictures. The first reference pictures naturally maintain standard resolution since they originate directly from the basic layer encoder's decoded output. This architectural design ensures resolution compatibility between all processing paths while maintaining the benefits of intermediate super-resolution enhancement throughout the encoding pipeline, creating a system where enhanced processing techniques improve encoding quality without compromising the fundamental resolution compatibility required for practical implementation.

85. The following figure illustrates an example implementation of the proposed Phek-YuChuan-He combination in which the selection switch is configured to select a set of reference pictures that have undergone super-resolution processing and downscaling (SR-D filtering):

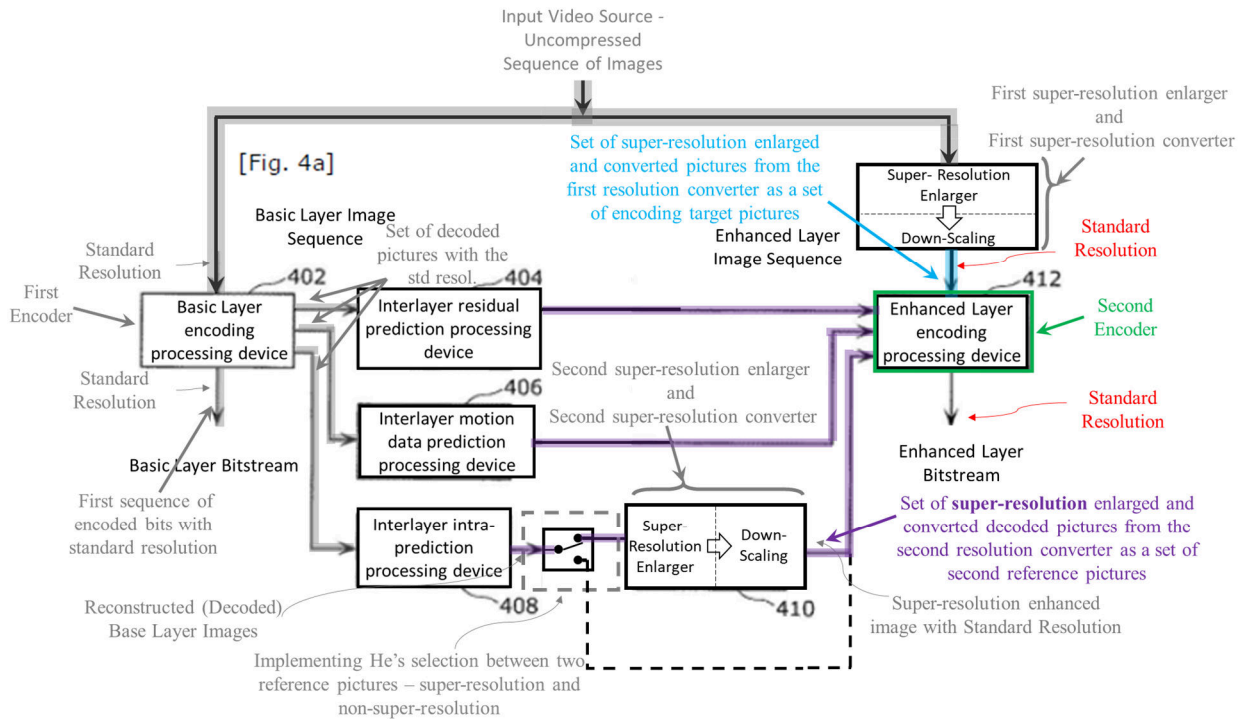


Illustration of Proposed Combination (Phek-YuChuan-He)

86. The following figure illustrates an example implementation of the proposed Phek-YuChuan-He combination in which the selection switch is configured to select a set of reference pictures that have not undergone SR-D filtering:

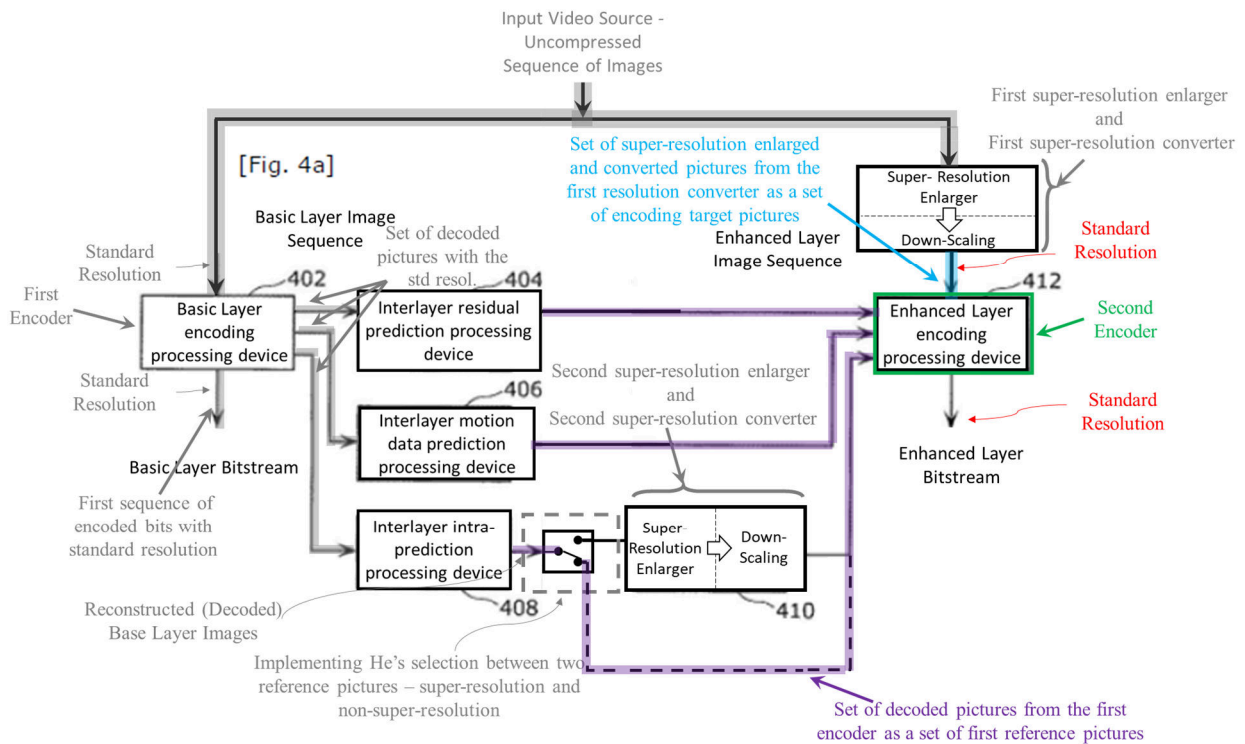


Illustration of Proposed Combination (Phek-YuChuan-He)

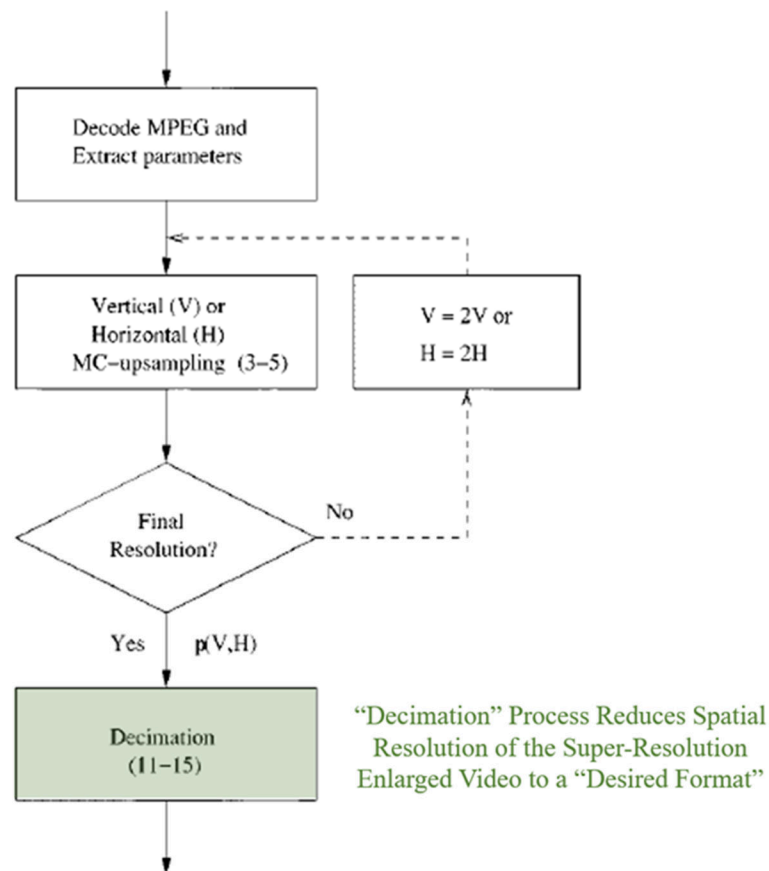
IX. Ground 1B – Obviousness based on Phek-YuChuan-Martins-He

A. Overview of Martins

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

“The algorithm is based on motion-compensated spatial upsampling from multiple images and decimation to the desired format.” *Id.*

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



APPLE-1007, FIG. 2 (annotated); see also id., p. 5, §IV (“DECIMATION”).

B. Analysis

89. Based on my review, the Phek-YuChuan-Martins-He combination would have rendered claims 1, 5-6, 8-10 of the '995 Patent obvious for each of the reasons described in the Petition.

X. Additional Remarks

90. I currently hold the opinions set expressed in this declaration. But my analysis may continue, and I may acquire additional information and/or attain supplemental insights that may result in added observations.

APPENDIX A

Expert Witness, CTO

Technology industry veteran with electronics/software/hardware/video/audio/data expertise.

IoT | Consumer Electronics | Telecommunications | Cable | Satellite | Broadband | Wireless

- Expert witness testimony (PTAB, ITC), technical consulting, and expert reports for renowned patent law firms such as Fish & Richardson and Banner Witcoff.
- 117 Patents and Patent publications. Served on corporate patent boards and as 30(b)(6) witness.
- Uniquely broad hardware/software/systems technical understanding.
- Award winning design and development including Best of Show, Technology Emmy, and Best of Innovations of over 100 million shipped products, responsible for \$1.3B annual revenue.
- Industries: Consumer Electronics, Cable, Satellite, Internet of Things (IoT), Telematics, Smart Truck Logistics, Transportation, Alarm Systems, Smart Tank monitoring & fulfillment, Smart Home, Television, Telecommunications, Video, Audio, Wireless, Broadband, OTT Video, IPTV, Payments
- Technical: hardware design, software design, systems design, mechanical design, embedded systems, cloud computing, AWS, Azure, Oracle Cloud Infrastructure (OCI), SaaS, edge computing, high speed digital, C, Java, Python, Linux, mobile applications (iOS, Android, cross-platform), web applications (Java, JavaScript, HTML), firmware, RTOS, user interfaces, UI/UX, video, audio, data, RF, DSP, communications, cybersecurity, encryption, error correction coding, real-time systems, cable, CATV, DOCSIS, broadband, satellite, satcom, IPTV, OTT video, video streaming, image processing, wireless, cellular, 3G, 4G, LTE, LTE-M, 5G, NB-IoT, Cat-M1, WiFi, ZigBee, Z-Wave, Bluetooth, BLE, LoRa, Internet of Things (IoT), IIoT, sensors, Machine-to-Machine (M2M), Telematics, AI, ML, networks, payments, consumer electronics, and telecommunications.

EXPERIENCE

Nov. 2016-present, **Expert Witness/CTO**, Independent Consultant

Technology, product development, organizational, & intellectual property consulting

- Expert Witness Reports and Testimony - Declarations, Opinions, PTAB Inter Partes Review (IPR) Petitions and Defense, Depositions
- Intellectual Property/Patent assistance, prosecution/defense strategy, search
- Technical Consulting

Jul. 2019 – June 2022, **Chief Technology Officer (CTO)**, **Telular**, an Ametek Company, Greater Atlanta Area

- Responsible for global engineering, corporate technical strategy, and technical representation.
- Developed SaaS, mobile, and hardware products for Industrial IoT (IIoT) businesses including transportation, tank monitoring, petroleum logistics, and facility alarm monitoring with 1.4M+ subscribers, sold under the SkyBitz and Telguard brands.
- Led the development of an IoT Toolkit (scalable platform and APIs) to extend the Telular IoT platform for all 60+ (and growing) AMETEK companies, enabling development of high- value IIoT recurring revenue web and mobile applications.
- SaaS, Cellular, 3G, 4G, LTE, LTE-M, 5G, NB-IoT, Cat-M1, BLE, Satellite, cloud, distributed systems, Azure, Oracle Cloud, IoT, telematics, AI, ML, M2M, hardware, GPS, solar, low-power design, broadband, firmware, software, systems, architecture, video, image processing, mobile apps, web apps.

Aug. 2011 – Oct. 2016, **Vice President of Engineering, Head of the Atlanta R & D Center, EchoStar Technologies**, Greater Atlanta Area (\$3B revenue, Engineering for Dish Network with a common controlling stockholder)

- Developed products for Dish Network and international customers including highest volume set-top boxes, H.265, HEVC, 3D, Satellite, MoCA, transcoding, Embedded C Linux applications, mobile applications (iOS and Android), SaaS, and web applications (Javascript, HTML). Provided product lifecycle support of contract manufacturers, test methodologies, customer service, QA, marketing, and sales.

- Led the architecture and global development of a huge end-to-end secure IoT cloud/fog/edge Platform for the consumer security & smart home market and other adjacent markets. Established the unique TV and mobile UI and MyLocal911 patented self-monitored security paradigm. System architecture consisted of 32 cloud systems and 24 CPE products. Systems included BSS/OSS, AWS cloud storage, 2-way video/audio streaming, authentication, provisioning, software download, command and control, customer service, online storefront, 911 emergency VoIP, logistics, CPE, and mobile applications. Represented the platform at trade shows.
- Functioned as a general manager in roles and responsibilities including vision, operations, business results, product management, program management, complex projects and services, hardware/software/systems product development of video, Internet of Things (IoT), and mobile application products.
- **Winner of the prestigious Best of Show award at the 2013 CES for the Hopper** because of the Hopper Transfers functionality and mobile applications.
- **Won 2015 CSI award “Best smart home product, technology or service”.**

Aug. 1990 – July 2011, **Vice President of Engineering, Cisco / Scientific Atlanta**, Greater Atlanta Area (\$35B / \$1.9B revenue companies respectively. Cisco acquired Scientific Atlanta Feb. 2006)

- Intellectual property – served on the corporate patent board, provided patent assistance, and testified in patent litigation cases including as a 30(b)(6) witness representing the corporation.
- Responsible for the hardware/firmware/software/mechanical/systems/architecture/ASIC requirements design and development of several generations of high volume set top boxes and other products with extensive data communications and multimedia capabilities and advanced features including DOCSIS 1/2/3 and hybrid gateways, 802.11, IPTV, DVR, cable modems, ADSL, VDSL, DVB-T/C/S, bootloaders, factory diagnostics, application frameworks, Nagra, DRMs, conditional access, secure microprocessors, device management, Android, Adobe Flash, Linux, DVD play/record, MPEG-4, MPEG-2, H.264, NTSC, PAL, DAVIC, MoCA, high-performance CPUs, cablecards, network processors, HDMI, multiple video/audio display interfaces, 2D/3D graphics, multiple RF tuners, and full spectrum tuners.
- Products developed supported worldwide video, audio, power supply, and regulatory standards.
- Developed products manufactured in company factories, contract manufacturers (CMs), Original Design Manufacturers (ODMs), and Joint Design Manufacturers (JDMs).
- Developed processes and practices to ensure success in high quality, high volume, low cost, and fast time-to-market product development.
- Architected Video-On-Demand (VOD) systems.
- Architected robust software download system to ensure network disaster recovery to avoid truck rolls. Received some of the **industries’ first downloadable software patents and an electronic program guide patent**. Developed the downloadable software system, enabling the applications software development business which evolved into a major corporate strategic business objective.
- Responsible for the total value proposition strategy internally in the organization through process design and externally facing customers to propose innovative solutions that add value and differentiate our offering.
- Established and managed department capex and opex budgets and manpower planning.
- Achieved unprecedented 3%/qtr product cost reductions for all products during the product lifecycle.
- Highly reliable products never had a field recall, which would have been disastrous to the business due to truck roll costs.
- Established software development department and software development practices including software processes, code reviews, networked version control and defect tracking, unit test teams, coding standards, and release processes.
- Reduced product development time to market for set top boxes from 14 months to 6 months through continuous process improvement
- Scaled organization from supporting \$10M to \$1.3B in sales
- Accounted for more than **70% of the revenues for Cisco’s Service Provider Video Technology Group and for Scientific Atlanta Corporation**.
- Award winning design and development of over 100 million shipped products
- **Winner of Technology Emmy in 2012 for Pioneering Development of Multi-Room DVR.**

- **Winner of 2006 CES "Best of Innovations" award for DVR/DVD Recorder/Player.**
- **Winner of Motorola/EE Times Excellence in Innovation Award** in 1994.

Nov. 1985 - July 1990, **Hardware Engineering Manager / Senior Engineer, Wegener Communications, Inc.,** Greater Atlanta Area

- Managed product development of video, audio, and data satellite receivers, modulators, graphics display systems, DSP-based companders, FSK and PSK satellite modems, multiplexers, forward error correction (FEC) codecs, RF upconverters and downconverters, and baseband analog and digital processing components. Disciplines managed included hardware, ASICs, FPGAs, RF, digital, microprocessors, analog, mechanical, and embedded software.
- Architected and designed forward error correction (FEC) coding systems, PSK modems, and analog control systems for RF modulators and PSK demodulators.

Mar. 1983 - June 1985 (while working at Scientific Atlanta), Assistant Professor, **DeVry Institute of Technology,** Greater Atlanta Area

- Taught evening school courses in microprocessor hardware/software and Electronics

June 1982 – Oct. 1985, **Scientific-Atlanta, Engineer II/Engineer I,** Greater Atlanta Area

- Designed software and hardware including addressable data transmitters, video sync suppression scramblers, transaction format converters, and data channel monitors for addressable Cable Television systems and Set Top Boxes.

EDUCATION

- MSEE course work in Electrical Engineering, Georgia Institute of Technology, Atlanta, Georgia
- BSEE, University of Tennessee, Knoxville, Tennessee, with High Honors. Specialization in Computer Engineering. GPA: 3.53/4.00.
- Georgia Institute of Technology Scrum Leadership Certificate, Certified Scrum Master (CSM), Certified Scrum Product Owner (CSPO), Certified Large Scale Scrum (LeSS) Practitioner
- Many short courses in business and engineering.