----------x

In the Matter of Investigation No. 337-TA-1373

CERTAIN ELECTRONIC DEVICES, INCLUDING SMARTPHONES, COMPUTERS, TABLET COMPUTERS, AND COMPONENTS THEREOF

----------x

OPEN SESSIONS

Pages: 306 through 569 (with excerpts)

Place: Washington, D.C.

Date: August 14, 2024

TCL-1067
TTE Technology Inc. d/b/a TCL North America v. InterDigital, Inc. IPR2026-00417
AMAZON-1067
Amazon v. InterDigital, IPR2026-00195

1 UNITED STATES INTERNATIONAL TRADE COMMISSION
2 Washington, D.C.
3 Before the Honorable MaryJoan McNamara
4 Administrative Law Judge
5 ----------x
6 In the Matter of Investigation No.
7 337-TA-1373
8 CERTAIN ELECTRONIC DEVICES,
9 INCLUDING SMARTPHONES, COMPUTERS,
10 TABLET COMPUTERS, AND COMPONENTS
11 THEREOF
12 ----------x
13
14 International Trade Commission
15 500 E Street, SW
16 Washington, D.C.
17
18 Evidentiary Hearing
19 Wednesday, August 14, 2024
20 Volume II
21
22 The parties met pursuant to notice of the
23 Administrative Law Judge at 9:30 a.m. Eastern.
24
25 Reported by: Linda S. Kinkade RDR CRR RMR RPR CSR

A P P E A R A N C E S:

Counsel for Complainants InterDigital Inc., InterDigital VC Holdings, Inc., InterDigital Patent Holdings, Inc., and InterDigital Madison Patent Holdings SAS:

ALSTON & BIRD LLP
950 F Street, NW
Washington, DC 20004
(202) 239-3300
M. Scott Stevens, Esq.

-and-

ALSTON & BIRD LLP
560 Mission Street, Suite 2100
San Francisco, California 94105
(415) 243-1000
Philip Ducker, Esq.
Katherine G. Rubschlager, Esq.

-and-

ALSTON & BIRD LLP
1201 West Peachtree Street
Atlanta, Georgia 30309
(404) 881-7000
Neal A. Larson, Esq.

A P P E A R A N C E S (continued):

-and-

Counsel for Complainants InterDigital Inc., InterDigital VC Holdings, Inc., InterDigital Patent Holdings, Inc., and InterDigital Madison Patent Holdings SAS:

ALSTON & BIRD LLP
555 Fayetteville Street
Raleigh, North Carolina 27601
(919) 862-2200
Jenny J. Wang, Esq.

-and-

ALSTON & BIRD LLP
90 Park Avenue
New York, New York 10023
(212) 210-9400
Ravi Shah, Esq.
Christopher L. McArdle, Esq.

CONTINUED ON FOLLOWING PAGE

A P P E A R A N C E S (continued):

Counsel for Respondents Lenovo PC HK Limited, Lenovo (United States) Inc., and Motorola Mobility LLC:

FISH & RICHARDSON P.C.
1000 Maine Avenue, SW, Suite 1000
Washington, DC 20024
(202) 783-5070

Adam R. Shartzer, Esq.
Michael J. McKeon, Esq.
Richard A. Sterba, Esq.
Linhong Zhang, Esq.
April Sunyoung Park, Esq.
John Thuermer, Esq.
Joshua Carrigan, Esq.
Daniel Lee, Esq.

CONTINUED ON FOLLOWING PAGE

A P P E A R A N C E S (continued):

-and-

Counsel for Respondents Counsel for Respondents Lenovo PC HK Limited, Lenovo (United States) Inc., and Motorola Mobility LLC:

FISH & RICHARDSON P.C.
500 Arguello Street
Redwood City, California 94063
(650) 839-5070
Leeron Kalay, Esq.

-and-

FISH & RICHARDSON P.C.
7 Times Square
New York, New York 10036
(212) 765-5070
Scott M. Flanz, Esq.

CONTINUED ON FOLLOWING PAGE

A P P E A R A N C E S (continued):

-and-

Counsel for Respondents Counsel for Respondents Lenovo PC HK Limited, Lenovo (United States) Inc., and Motorola Mobility LLC:

FISH & RICHARDSON P.C.
1180 Peachtree Street, NE, 21st Fl
Atlanta, Georgia 30309
(404) 892-5005
Brian P. Boyd, Esq.

Counsel for the Office of Unfair Import Investigations:

U.S. International Trade Commission
500 E Street, SW
Washington, DC 20436
(202) 205-2000
Jennifer Dienes, Esq.
Investigative Attorney
Jeffrey Hsu, Esq.
Supervisory Attorney

*** Index appears at end of transcript ***

P R O C E E D I N G S

(In session at 9:55 a.m.)

JUDGE MCNAMARA: Good morning, everyone.

Sorry for holding up the proceedings. Thank you everybody. I do have the timing, the timesheet, which I appreciate.

So is there anything you'd like me to address before we get started with Mr. Herrington and finish up this morning?

MR. MCKEON: Your Honor, we're all set to go on the domestic industry issue and final witness on that. But there are some issues with the slides for the next witness that Complainant is calling, Dr. Richardson. If we could take that up now, get it resolved now, or we could get the witness done and take it up after that.

JUDGE MCNAMARA: I think that makes sense to do. Let's do it that way. Thank you, Mr. McKeon.

I think you had a little more time left, Mr. Sterba?

MR. STERBA: Good morning, Your Honor. Richard Sterba. Yes, we do have a little bit more time left with Mr. Herrington.

JUDGE MCNAMARA: Mr. Herrington, good morning. My apologies for holding you up.

MR. STERBA: Your Honor, if anyone needs to

apologize to the witness, it's me.

JUDGE MCNAMARA: I'm not sure why you're saying that, but I'll take it.

RYAN N. HERRINGTON,

having been previously duly sworn or affirmed on his oath, was thereafter examined and testified further as follows:

MR. STERBA: Your Honor, one housekeeping matter before we resume the examination.

Counsel brings to my attention that in two of Mr. Herrington's answers yesterday he revealed some substance that could arguably be confidential business information.

And for that purpose, the parties have -- sorry if I didn't mention this to you specifically -- the private parties have discussed two answers that Mr. Herrington gave that we would like to redesignate as confidential, and I have those pages and line numbers.

Would that be okay with you?

MS. DIENES: That's fine with the Staff.

JUDGE MCNAMARA: I think that's great. You can -- have you talked to Ms. Kinkade yet or will you do that yet?

MR. STERBA: I have not talked to Ms. Kinkade yet, Your Honor. I wanted to bring it up to you first, and

my apologies to the Staff.

It is page 285, lines 9-18, and page 295:17 through 296:5.

JUDGE MCNAMARA: Very good. Thank you. And I guess the rushes came through last night so you can just redesignate them.

MR. STERBA: I apologize for the inconvenience, but thank you for your attention to that.

JUDGE MCNAMARA: That would be a good time, too, for each side to go through the transcript, and if there's anything that you see that you need to correct, you can take care of that, and that won't be as much of a burden for Ms. Kinkade that way.

CROSS-EXAMINATION (resumed)

BY MR. STERBA:

Q. Mr. Herrington, good morning. Welcome back.

A. Thank you, good morning.

Q. I would just like to remind you that we are on the public record. I intend for us to remain on the public record for the remainder of your examination.

And, again, I would offer the caution that if you think your answer is going to reveal any confidential information, that you would stop me and we can switch over to the confidential record and you can finish your answer. Okay?

A. I will try.

Q. Your counsel would have given you that similar admonition if they had been allowed to talk with you last night.

A. Of course.

(Whereupon, the hearing proceeded in confidential session.)

O P E N S E S S I O N

BY MR. STERBA:

Q. Still on the public record.

Until this past weekend, you did not have any mechanism other than a sales-based allocation to exclude research and development not directed to the domestic industry products, correct?

A. I don't think there was a need to exclude, but to the extent that someone wanted to try to exclude even based on these speculative numbers that did not come from the licensee, I don't think that had been done until the adjusted exhibits were presented based on, in my view, a request from Judge McNamara to do that.

Q. All right. Let me try this one more time.

Other than a sales-based allocation, you do not have any other mechanism to exclude research and development not directed to the domestic industry products, correct?

A. If you're asking did I only do a sales-based allocation, that is correct.

Q. And that's because at the time you believed you did not need to, correct?

A. I still believe you don't need to, based on all the evidence in the record and the way the Commission has ruled in the past.

Q. And you believe that even if the research and

development is directed to products without any sales, correct?

A. Well, again, it's in the ordinary course of business. Again, it's hard for me to answer without going on the confidential record, because this is unique and there's unique facts and circumstances in this case. So I cannot answer on the public record the way I want to answer.

Q. That's a perfectly appropriate response, sir. We're going to leave that right there.

A. Okay.

MS. RUBSCHLAGER: Your Honor, is it possible to go onto the confidential record? I'm seeing some hesitancy from Mr. Herrington to answer Mr. Sterba's questions, and I think at this point --

JUDGE MCNAMARA: Why don't we just do that.

MR. STERBA: Actually, let's just go to the deposition transcript, please, because this is --

MS. RUBSCHLAGER: Your Honor, he should be able to answer the questions freely, and we are talking about an economic prong which is usually discussed on the confidential record.

JUDGE MCNAMARA: Here is what we'll do. I think, so that he can testify freely, let's just go on the confidential record, leave it there. We can fix it later as need be, but let's just keep going so it's unfettered.

MR. STERBA: That would be fine. Thank you, Your Honor.

JUDGE MCNAMARA: And, by the way, we'll try to make up the time for which I was late this morning. I'll figure it out. We'll get it done.

(Whereupon, the hearing proceeded in confidential session.)

O P E N S E S S I O N

BY MR. STERBA:

Q. Earlier in your testimony I heard you refer to the sales-based allocation, I think, as, quote, the most used allocation method. Would that be fair?

A. Yes. I think it's generally the most used, based on my experience that I've seen at the ITC.

Q. But there are other allocation methods, yes?

A. Yes, I would agree with that.

Q. For example, there's an activity-based allocation?

A. I've seen that.

Q. And you did not use that in this investigation, right?

A. I saw no evidence that Apple tracks it in any way to be able to do it in that manner, correct, or Vizio.

Q. A headcount allocation is another way to do an allocation; is that right?

A. Again, if the information is available, that's certainly a way you can consider.

Q. And you did not perform a headcount allocation in this investigation, right?

A. Again, I didn't think it was necessary. What I did I thought was reasonable. I didn't see any evidence that would allow me to even consider that type of allocation

methodology.

Q. A unit-based allocation is yet another methodology, correct?

A. A unit-based is, and I actually performed that for one of the Respondents or one of the licensees and I didn't for the other, for reasons that I gave in my expert report.

Q. Okay. You've done a headcount-based allocation in the past, correct?

A. I'm sure I have, especially if the information is available and I think it's the most proficient for the facts and circumstances in that particular case.

Q. Okay. Then you would agree that a headcount-based allocation is a reasonable allocation method, right?

A. A headcount-based? Depending on the facts and circumstances, it may be reasonable, but it's something that you have to consider with those facts and circumstances of that case. It's certainly I think been accepted in the past.

Q. Have you ever criticized another expert for not having performed a headcount allocation?

A. I'm sure I may have, especially if the information is available.

Q. Okay. I do want to talk about your adjusted

numbers now, the changes you made, the new math. Okay?

A. (Nodding head up and down.)

Q. You effectively subtracted out $10 billion from the top line, correct?

A. Yes. I think I was trying to subtract out $2.5 billion per quarter.

Q. Ten billion over a year.

A. Yes.

Q. And you said you did that based on some information that was included in Mr. Clarke's rebuttal report; is that right?

A. Yes, I believe so.

Q. You don't actually know how much money Apple spends on R&D on products that are never sold, right?

A. I think no one knows. I think that's part of the issue, in the sense that that's why these numbers are speculative.

I think, again, now I feel like I've got to go back on the confidential record, Your Honor, to talk again about it.

(Whereupon, the hearing proceeded in confidential session.)

O P E N S E S S I O N

BY MR. STERBA:

Q. Thank you, sir. I want to talk about quickly in the process of being established and significance and unusual events. Okay?

A. Okay.

Q. The complaint in this investigation was filed on September 1st, 2023, correct?

A. That's correct, original.

Q. Thank you. And the iPhone 15 Pro was first available for sale on September 15th, 2023, correct?

A. I believe that's correct.

Q. Apple introduces a new iPhone once a year, right?

A. Yes, only once a year for their flagship product, correct.

Q. It's an annual event, correct?

A. I think I even said that on direct, it is an annual event.

Q. Mr. Stevens during his opening referred to it as a specific cadence. Do you recall that?

A. He may have used those terms. I don't recall exactly.

Q. Okay. It's your testimony that the introduction of the iPhone 15 Pro was significant because of the introduction of the A17 chipset; is that right?

A. I think that's, in part, what made it unusual. I think significant is, in part, because it's only one product that they are releasing once a year for their flagship product, and what, in part, made it unusual was this introduction of the A17 chip with the AV1 decoder.

Q. And you know that a year prior, Apple released the iPhone 14 Pro, correct?

A. That's reasonable. I don't know exactly, but, yeah, sounds right.

Q. The iPhone 14 Pro included an A16 chipset, correct?

A. That may have been true. I don't think it has the AV1 decoder.

Q. That may very well be true. New phone, new chipset, right?

A. Are you talking about the 14?

Q. iPhone 14 Pro A16 chipset, correct?

A. That may have been. I don't recall.

Q. Take a look at CX-1019, please, Mr. Lee, and page 4 of that document.

Mr. Herrington, CX-1019 includes a table showing the various iPhone products and their chipsets. Have you ever seen this before?

A. I don't recall off the top of my head.

Q. Do you see the reference to the iPhone 11 Pro Max

and the A13 Bionic chip about one-third of the way up from the bottom?

A. I see it highlighted, yes.

Q. Okay. You don't have any reason to dispute that the iPhone 11 Pro included an A13 Bionic chip, right?

A. Not as I sit here.

Q. Above that, the iPhone 12 is released with an A14 Bionic chip?

A. I see that.

Q. Above that, the iPhone 13 A15 Bionic chip?

A. I see that.

Q. 14 Pro Max A16 Bionic chip?

A. I see that.

Q. And then second from the top, the iPhone 15 Pro with an A17 Pro chipset.

Do you see that?

A. I do.

Q. That's five instances of Apple releasing a new iPhone product with a new chipset, correct?

A. That may be.

Q. You would agree with me now that Apple releasing a new phone with a new chipset is not unusual, correct?

A. Again, I think what I would define unusual, in the sense here, is what the chipset had in it, and specifically the AV1 decoder.

Q. You know other products included an AV1 decoder prior to the release of the iPhone 15 Pro, correct?

A. That may be true. I don't recall one way or the other.

Q. Would it be less significant if other products previously offered the AV1 decoder functionality?

A. Not to me, because the iPhone is their flagship product.

Q. During your direct examination you showed a video --

You can take that down, please.

During your direct examination you were showed a video, and, as I understand it, the purpose of the video was to show the significance of the release of the A17 chip; is that right?

A. I think the video just goes to show that Apple considered this a major advancement.

Q. Does Apple release videos for all the new chipsets that they release?

A. It wouldn't surprise me if they do, but I don't know one way or the other.

Q. If they did, would it make the release of the iPhone 15 and the A17 chipset less significant?

A. Not to me.

Q. Let's talk about significance. Are Apple's

investments so massive to be per se significant?

A. I don't think you ever look at something as -- on an absolute value. I think you put it into context. But I certainly think looking at the numbers and looking at their size is something that the Commission takes into account.

Q. You would agree that Complainant's domestic industry investments do not need to constitute 100 percent of their worldwide R&D expenditures to be significant, correct?

A. That Complainant's investments do not need to be 100 percent to be significant, I would agree with that. There is no bright-line test.

Q. You would agree that if 10 percent of the Complainant's R&D expenditures are invested domestically, that could constitute a significant investment for purposes of section 337, correct?

A. There's no bright-line test, so now you're asking me hypotheticals. I think it depends on the facts and circumstances of the case.

Q. In this investigation, without revealing the identity of the licensee or the analysis, I'm just going to ask you about a percentage.

If you can't answer, just say you can't answer.

But you testified in this investigation that a company's -- strike that.

You've testified in this investigation that 4.5 percent of a company's worldwide R&D spends are -- that are in the U.S., that's significant, correct, quantitatively significant?

MS. RUBSCHLAGER: Objection, Your Honor. I think we're getting on to the confidential record again with specific numbers.

JUDGE MCNAMARA: I think it's difficult for --

MR. STERBA: Okay.

JUDGE MCNAMARA: -- for this to be done without being on the confidential record.

(Whereupon, the hearing proceeded in confidential session.)

O P E N S E S S I O N

BY MR. STERBA:

Q. Mr. Herrington, at the end of your direct examination yesterday you testified about the veracity of the statement in Mr. McKeon's opening. Do you recall that?

A. I recall looking through the InterDigital 10-K and just reading numbers into the record. I don't recall exactly what I said about Mr. McKeon's statement.

Q. Well, specifically, you were asked about InterDigital's relative spend on patent litigation versus research and development, right?

A. Yes.

Q. And based on a few numbers that you looked at from InterDigital's 2023 10-K that were highlighted during your direct examination, you testified under oath that Mr. McKeon's statement, quote, would appear based on that document to be false.

You said that, right?

A. Yes, I believe I said that, based on the numbers that are in the document.

Q. You would agree that's a fairly serious accusation to make, right?

A. I am just pointing out what I saw in the document. I don't know how serious it is.

Q. I think telling the judge that a lawyer for the

Respondents made a false statement during his opening is a pretty serious accusation. You'd agree?

A. Not necessarily. This is what I do for a living, is that usually -- Mr. Clarke is getting up here and will say what I say is incorrect.

Q. So I have to tell you, Mr. Herrington, Mr. McKeon is my friend, and I was very surprised to hear you make that accusation against him. So I'm going to spend a few more minutes with you today, and I would like to revisit his statement and see what Mr. McKeon actually said and see how it compares to the evidence. Okay?

A. Sounds good.

Q. All right. So let's see what Mr. McKeon actually told the Court during his opening.

Let's look at RDX-1C, slide 6. This was the slide that Mr. McKeon showed during his opening.

If we can look at the hearing transcript, this is page 83, starting at line 25, Mr. McKeon says:

And, in fact, if you look in 2020 and 2021, $170 million in 2020, in 2021 $175 million, just in patent litigation and licensing. That's what they -- and if you look at their R&D budget, it pales in comparison to that, what they call R&D, which is essentially getting patents. That's their business. So we have to be clear here, and they filed, of course, the case that brought us here today

in 2023.

Do you remember that testimony from Mr. McKeon -- strike that.

Do you remember that statement in Mr. McKeon's opening?

A. Something to that effect.

Q. Well, let's take a look at it. This is worth doing. The hearing transcript at 83, please.

At the bottom, line 25, and the next page, 84.

Mr. McKeon is comparing InterDigital's spend on litigation and licensing to what they spend on their R&D budget, right?

A. Litigation and licensing, yes. And I think what I was pointing out was litigation.

Q. Oh. What you were talking about was something different from what Mr. McKeon was talking about, right?

A. Potentially. I was focused -- I think the numbers I read was litigation.

Q. So you would agree with me that in 2020 and 2021, InterDigital spent more money on litigation and licensing than on R&D, right?

A. Again, I don't know exactly where these numbers come from. I'm sure you could take me to their 10-K and try to show me these numbers. If you want to tell me that that's what it's going to say, then I can agree that that's

what the numbers are, similar to what I agreed on my direct to what the numbers were in the record.

Q. I am going to tell you what that's going to say, and I'm not sure I need to burden the Court with an entire walkthrough of this, but I do need the record to be clear on this.

A. Fair enough.

Q. I think Mr. McKeon's statement, the annual reports for 2020 and 2021 bear this out, based on that slide and what you've seen so far, you would not disagree with that, correct?

A. I have no -- as I sit here, I don't have any reason to disagree with that, that those numbers are inaccurate.

Q. Do you know whether Mr. McKeon's statement that he made in his opening is also true for 2022 and 2023?

A. I don't have any opinion one way or the other whether they are true or not.

Q. Well, I'll tell you, it's a little bit confusing, because InterDigital in 2022 does something a little clever. They reclassify certain expenses in their operating expense categories. Do you know about that?

A. Not as I sit here.

Q. You would agree with me that the optics of InterDigital spending more on litigation and licensing than

on research and development costs is not a very good look, right?

A. I don't think I can agree with that.

Q. You think it's okay to spend more on litigation and licensing than R&D?

A. I don't have an opinion one way or the other.

Q. Let's look at the 2022 Annual Report. This is Exhibit RX-857.

Mr. Herrington, this is the 2022 Annual Report. I'd like to direct you to page 70 of this. We see a discussion at the bottom there called Reclassifications. Okay?

A. Okay.

Q. And right about the middle there, we see language that reads, which resulted in reclassifying certain portfolio-related costs out of the licensing line, previously referred to as patent administration and licensing, and into research and portfolio development.

Do you see that?

A. I do.

Q. Okay. So in 2022, InterDigital combined its R&D costs and its litigation costs under a new category called research and portfolio development and separated out its licensing costs, right?

A. I think what it's saying is it's reclassifying

the licensing line into research and portfolio development.

Q. Okay. Let's look at page 56 of this Annual Report where we see the investments of InterDigital at the top in research and portfolio development of $185 million and licensing at $71 million. Do you see that?

A. Yes.

Q. Okay. You can take that down.

Let's take a look at the 2023 10-K now, which is the document that you were shown yesterday during your direct examination. Okay?

A. (Nodding head up and down.)

Q. That's CX-1013, please.

And if we could have page 56 of that document.

I'd like to direct your attention to the research and portfolio development and the licensing lines. Do you see those here, sir? $195 million in 2023, $185 million in 2022 for research and portfolio development, right?

A. I see that.

Q. And we know now that that includes their litigation costs, right?

A. I thought it said it was including licensing.

Q. Well, sir, licensing is a separate line item now starting in 2022, right?

A. I do see it as a separate line item.

Q. Right. And licensing expenses in 2023, $79

million, $71 million in 2022. Do you see that?

A. I do see that.

Q. Okay. And yesterday during your direct examination you testified regarding the research and development expenses for InterDigital, and you testified that in 2023, 2022, and 2021 the research and innovation costs were $78.3 million, $74.3 million, and $89.4 million respectively.

A. That sounds close to what I said, yes.

Q. And then you read into the record yesterday InterDigital's intellectual property enforcement costs for 2022, 2023, and 2021, correct?

A. I believe that's correct.

Q. And what you said was those litigation costs were just under 49 million in 2022 -- strike that.

And you can take this down, please.

Those litigation costs were just under $49 million in 2023 and nearly $44.5 million in 2022; is that correct?

A. I don't recall exactly, but that's probably close.

Q. Can we see yesterday's hearing transcript, page 274, please. We'll look at lines 3-8.

This is your testimony from yesterday. You were reading from the document, and you read the intellectual

property enforcement costs. Do you see that?

A. Yes.

Q. $48.8 million, $44.4 million, $34.3 million, right?

A. Yes.

Q. You can take that down, please.

Can we have the 2023 Annual Report back, please, page 56.

We saw those licensing costs being $79 million and $71 million, right?

A. I see that.

Q. So for 2023, InterDigital's combined litigation and licensing costs were roughly $128 million dollars, correct?

A. If that's what the math is, yes.

Q. And you would agree that in 2023, InterDigital's licensing and litigation costs were more than its R&D costs, correct?

A. Licensing and litigation?

Q. Yes, sir.

A. That may be so. I don't recall.

Q. Well, the licensing and litigation costs were $128 million, right?

A. Okay.

Q. And the R&D costs were $78 million, right?

A. Okay.

Q. And you would agree with me that $128 million is greater than $78 million, correct?

A. I agree with that.

Q. So in 2023, InterDigital's licensing and litigation costs were more than its R&D costs, right?

A. So, again, with the licensing included, okay, yes.

Q. And in 2022, InterDigital's combined litigation and licensing costs were approximately $115 million, correct?

A. Okay.

Q. And then in 2022, InterDigital's litigation and licensing costs were more than its R&D costs, right?

A. Okay.

Q. And we've already discussed that in both 2021 and in 2020, InterDigital's litigation and licensing costs were higher than its R&D costs, right?

A. Litigation and licensing, yes, which I think --

Q. Yes, sir, litigation and licensing, greater than R&D, right?

A. Yes. And I was looking yesterday at just litigation, correct.

Q. So now, as you sit here today, you would agree with me that Mr. McKeon's statement that InterDigital's

spend on litigation and licensing exceeded its spend on R&D in 2020. That was a true statement, correct?

A. If you include licensing, that may be true.

Q. Just listen to my question, please, Mr. Herrington. We're almost done, I promise.

You would agree with me now that Mr. McKeon's statement that InterDigital's spend on litigation and licensing exceeded its spend on R&D in 2020. That was a true statement, correct?

A. When you include licensing, that's true.

Q. And Mr. McKeon's statement would also be true for 2021, correct?

A. When you include licensing, I believe that's true.

Q. Mr. McKeon's statement would also be true for 2022, right?

A. When you include licensing, I believe the math is what it is.

Q. And Mr. McKeon's statement would also be true in 2023, right?

A. If you include licensing.

Q. Thank you, Mr. Herrington.

MR. STERBA: I pass the witness.

JUDGE MCNAMARA: Thank you, Mr. Sterba.

Ms. Dienes?

EXAMINATION BY COUNSEL FOR ITC STAFF

BY MS. DIENES:

Q. Good morning, Mr. Herrington.

A. Good morning.

Q. Yesterday you --

MS. DIENES: Your Honor, could we please go on the confidential record?

(Whereupon, the hearing proceeded in confidential session.)

O P E N S E S S I O N

REDIRECT EXAMINATION

BY MS. RUBSCHLAGER:

Q. Mr. Herrington, Mr. Sterba asked you a lot of questions about InterDigital's litigation and licensing spend. Do you recall that?

A. Yes.

Q. Did Apple take a license?

A. Apple did take a license.

Q. Did Vizio take a license?

A. Vizio did take a license.

Q. What about Lenovo?

A. As far as I know, Lenovo has not taken a license; otherwise, I don't think we would be here.

Q. And when did -- do you know when Lenovo contacted InterDigital about potentially taking a license in this case?

A. I believe, as we heard in the opening statement, it was after the complaint was filed, at least they reached out to a patent pool.

Q. Mr. Herrington, am I correct that you've been involved in many ITC litigations or cases before?

A. I have, over 60 at this point for ITC section 337 specific investigations.

Q. And would you agree with me that litigating cases

like this especially at the ITC are costly and expensive?

A. Yes, they are.

Q. Thank you, Mr. Herrington.

MS. RUBSCHLAGER: I have no further questions.

JUDGE MCNAMARA: All right. Thank you.

Mr. Sterba?

MR. STERBA: Your Honor, very brief. Richard Sterba.

RECROSS-EXAMINATION

BY MR. STERBA:

Q. You just testified that Lenovo doesn't have a license from InterDigital. Is that what I heard?

A. That's what I said, yes. I'm not aware of one.

Q. Are you aware of any license between InterDigital and Lenovo?

A. Oh, there may be. There may be licenses between them, but nothing related to the asserted patents.

Q. What's your basis for that statement, sir?

A. My basis? I assume if there was, we wouldn't be here.

Q. Okay. Fair enough.

MR. STERBA: I have no further questions, Your Honor.

JUDGE MCNAMARA: Thank you, Mr. Sterba.

Mr. Herrington, you may step down. Thank you

very much.

And I see you are not being called back, so your testimony has concluded. Thank you again.

THE WITNESS: Thank you, Your Honor.

MR. STERBA: Your Honor, at the risk of belaboring this point, Richard Sterba for Respondents, I lodged an objection yesterday to a video that was shown. There is ongoing discussion between the parties as to whether that video would be admissible for all purposes or admissible only for demonstrative purposes.

JUDGE MCNAMARA: Where are you right now?

MR. STERBA: Pardon me?

JUDGE MCNAMARA: On that issues, on that discussion, where are you on that discussion?

MR. STERBA: I think it wasn't clear, Your Honor, whether it's admitted merely for demonstrative purposes or for any purpose.

JUDGE MCNAMARA: I think there are two ways of looking at it. I was thinking about this last night going home. You could consider some of it an excited utterance, in a way, which would get around, of course, hearsay, but I think it should just come in for demonstrative purposes.

MR. STERBA: Thank you, Your Honor.

MS. RUBSCHLAGER: Thank you, Your Honor.

MR. BRADLEY: Good morning, Your Honor. Kirk

Bradley for Complainants. It's great to be here again. I was here in February for the Markman.

JUDGE MCNAMARA: Yes, you were.

MR. BRADLEY: Complainants call Dr. Iain Richardson.

MR. MCKEON: Your Honor, for this witness, we have some objections to slides. Do you want to take that up now to get that resolved?

JUDGE MCNAMARA: I think it makes sense to do it.

Dr. Richardson, you may still come up. And I'll administer the oath after they lodge their objection, after Mr. McKeon lodges his objection.

MR. FLANZ: Good morning, Your Honor. Scott Flanz on behalf of Respondents.

JUGE MCNAMARA: Yes. How are you?

MR. FLANZ: I'm doing well. It's a pleasure to be before you again.

Some disputes arose last night with the exchange of Dr. Richardson's demonstrative, specifically with respect to the '877 patent slides.

In our view, in Respondent's view, these are two entirely new theories, theories that were not in the prehearing brief, and, therefore, are in violation of your ground rules.

Should I pause?

JUDGE MCNAMARA: Since I have the deck slide in front of me, if you could direct me to the appropriate slides to which you object.

MR. FLANZ: Absolutely, Your Honor. There are a couple that I think are good examples, but we do have a full list. So should I direct you to the example first?

JUDGE MCNAMARA: Take them slowly. Ms. Kinkade and I will write them down.

MR. FLANZ: I would like to begin with slide 92, so that would be CDX-0005C.92.

JUDGE MCNAMARA: Ms. Dienes, were you in on this conversation?

MS. DIENES: Yes, Your Honor, I was part of the meet-and-confer.

JUDGE MCNAMARA: Thank you.

MR. FLANZ: Do you have that exhibit?

JUDGE MCNAMARA: Yes. Thank you.

MR. FLANZ: And I can show it on the ELMO in case that's helpful for everyone.

This is an excerpt from Complainant's prehearing brief right here on page 22. So, in our view, and as you heard from Mr. McKeon during opening, Complainant's position has always been that they didn't need to identify the MCIF and SCF filters. So here it is in black and white in their prehearing brief. InterDigital is arguing that Respondents

contend that InterDigital must identify these two filters, and InterDigital writes, not so.

So if we turn to slide 92 here, this is the first that we have seen from InterDigital showing that they believe the Subpel_Filters can be decomposed from GF into SCF and MCIF here. So this diagram looks to me like balloons. We've never seen this diagram before. We have never seen this decomposition before. Based on the prehearing brief, their argument we understood was they didn't even have to identify this, which is why they didn't.

And so, in our view, this slide -- and there are a number of other slides which I can list for you, that have the balloons on them as well -- we think all of those are inadmissible.

JUDGE MCNAMARA: I'm going to need to know each of the slides individually.

MR. FLANZ: Of course. So our list with respect to those are -- if I might just grab the binder.

JUDGE MCNAMARA: While you are getting those, who will be responding for InterDigital?

MR. BRADLEY: Kirk Bradley will, Your Honor.

JUDGE MCNAMARA: Okay. Good. Thank you.

MR. FLANZ: Your Honor, that would be slides 91 -- I believe it's 66 through 70.

JUDGE MCNAMARA: Just a minute. Okay.

MR. FLANZ: I'll show you, Your Honor, so we can all look at it.

JUDGE MCNAMARA: Is that the entirety of the list?

MR. FLANZ: No. The full list where we're objecting to new theories is 66 through 70, 81, 89, 91, 92, 98, and 90, 94, and 99.

JUDGE MCNAMARA: And what you're saying, if I understand correctly, is that none of these illustrations was used at any time in any -- in Dr. Richardson's report, during his deposition testimony, these were not used anywhere.

MR. FLANZ: Yes, Your Honor, with just a little bit more than that. So not only did they not use the illustrations, but they hadn't shown any way of decomposing the GF function into MCIF and SCF. So that's one argument, the new disclosure of decomposing GF into MCIF and SCF. The other argument is they are identifying a new GF, one that wasn't previously disclosed.

As you might recall from the opening, Mr. McKeon pointed to Round2 being an issue with their GF, and their new GF doesn't include Round2. And so, as an example for that one, I can point you to slide 94. I'll put that up.

JUDGE MCNAMARA: I guess while I have the entire list, I took down at 91, 92 being close to the order that

you provided them, 66 through 70, 81, 89, 91, 92, 98, 90, 94, and 99.

MR. FLANZ: That's correct. So, Your Honor, with respect to the second argument, this is a great example of such a slide where they are identifying a new GF.

JUDGE MCNAMARA: And you are on slide which again?

MR. FLANZ: I'm on slide 94. And I will confess this is my first time using the ELMO, so I'm going to try and zoom in.

And it looks like it's there, and you can see they have drawn this box around a portion of this function, and you see on the bottom outside the box is this Round2.

And so our argument would be, previously they pointed to the whole function. Now they are pointing to just a specific part of that function. They never previously said that they were going to point to such a specific part of that function as the single GF filter. And, in fact, Your Honor, they previously said that this Subpel_Filter function actually was multiple filters, not a single filter.

And so as an example of that argument, you can look to their prehearing brief at page 19, which I'll show.

JUDGE MCNAMARA: Let me pull it out. Go ahead.

MR. FLANZ: Yes, Your Honor. So if you look

here, I just put together the prehearing brief side by side with the cutout from slide 98 of Dr. Richardson's demonstratives, and so you can see on the left in the prehearing brief, InterDigital argued that each row in the array is a filter. So each row.

And on the right you can see this new demonstrative which has multiple rows and they are saying that it is a single filter.

JUDGE MCNAMARA: Okay. What page, again, are you on?

MR. FLANZ: So this is slide 98 and page 19 of the prehearing brief.

JUDGE MCNAMARA: Okay. I see.

MR. FLANZ: Again, I have highlighted here, you can see, again, InterDigital reiterated its position that they disagreed with us that they had -- that we had to find MCIF and SCF.

So we're happy to -- I'll proceed however you want, Your Honor, to walk through each slide, but, at a high level, our objections are, one, this is a totally new GF that wasn't in the prehearing brief and we think is contrary to it; and, two, they never identified how to decompose GF into the SC function and the MC function, which is, by the way, why Mr. McKeon presented that in opening.

And I will note that this morning, a few minutes

before you arrived, we heard some additional prehearing brief cites from InterDigital. So I've had a chance to look at them, and I don't believe that they solve the problem. That being said, I haven't heard their argument on it.

JUDGE MCNAMARA: Yes, and they do have a right to make that argument.

MR. FLANZ: Of course.

JUDGE MCNAMARA: So is there anything else you would like me to look at so that I'm thoroughly briefed and you're on the record?

MR. FLANZ: I don't think -- I think that that's our position, although I would like the chance to respond if they make an argument.

JUDGE MCNAMARA: Of course. Sure.

MR. BRADLEY: Kirk Bradley, for Complainants.

So there's actually three issues here. That's why Mr. Flanz grouped them the way he did. I'll be clearer about it.

So the first objection they have, as I understand it, is on slide 66 through 70. The second objection they have is on slides 81, 89, 91, 92, 98. I think those -- these sets rise and fall together, I believe. Their third objection is on 90, 94, and 99. That's why they go out of order, is because they should be grouped that way.

I will take them one at a time.

JUDGE MCNAMARA: Are you taking them as a group at a time?

MR. BRADLEY: I'm going to group them at a time. There's going to be three discussions here. The first discussion is on slide 66 through 70.

JUDGE MCNAMARA: Gotcha.

MR. BRADLEY: If we turn to slide 66, and, Your Honor, if it would be helpful, I could put it on the ELMO.

JUDGE MCNAMARA: I think it might be helpful for everyone.

MR. BRADLEY: So here is slide 66, which I think is fairly representative of 66 to 70. And what this slide says in the title is "Generating Additional Pixels." And we see here on the right side of the screen it has Fig. 8 from the patent, and all this does is show how you can take those pixels and then do an interpolation. This is a slide explaining interpolation.

And in our prehearing brief, on page 20, we address this precisely, and we say Fig. 8, again, the figure on the screen, depicts how pixels of a prediction block -- that's the last part of Fig. 8 on the bottom right -- our brief says Fig. 8 depicts how pixels of that prediction block are generated from the pixel S at coordinates Xref Yref by applying single filters to the rows and columns of

the reference block. The reference block is the one in the upper left of Fig. 8 on this slide.

What we've said in our prehearing brief is that Fig. 8 shows how to start with a reference block with individual pixels and from those perform interpolation to get down to the prediction block in the bottom right. That's what our prehearing brief says on page 20.

This slide titled Generating Additional Pixels explains how that works, how you go from individual pixels, perform interpolation. I'm happy to explain what it's showing, but that's what it's showing. And it says here how to do it between values, and that's exactly what interpolation is, how to get pixels between values.

That's what this debate is about, and I think it's clear that what this whole patent is about interpolation -- I won't comment further on their objection -- but this is interpolation. And Dr. Richardson, I expect, is going to walk us through what it means to interpolate. And these slides 66 to 70 show that.

I'm happy to move on to the second unless Your Honor has questions.

JUDGE MCNAMARA: Just a quick question, because I'm at page 20 of the prehearing brief and I do see that explanation. So I would understand that there would be, again, that it would be not unusual to use Fig. 8 as a

pictorial.

So I understand that's exactly what you were doing.

MR. BRADLEY: Great, Your Honor.

JUDGE MCNAMARA: At least with this.

MR. BRADLEY: Yes, Your Honor. I would like then to turn to their second issue, and, again, that's the one that begins with slide 81.

JUDGE MCNAMARA: Before we move on, since you were providing groups, would you say that 67 through 70 -- they have different headings, obviously, different descriptors, but at least one of them talks about generating additional pixels using the formulae.

So I guess my question is, there are different representations in 67 through 70. Are they also -- can you tag those also or correlate them with the prehearing brief?

MR. BRADLEY: It's the same point. It starts with a really easy example on 66 just to show a couple pixels, how you interpolate, and it builds from there. These are successive slides in the presentation, and it is just starting simple and then showing how it grows and grows in the context of the patent, of course, but it's just building on.

So it's the same thing. We have disclosed how you interpolate and so it's the same point.

JUDGE MCNAMARA: Okay. Also, at page 20 of the prehearing brief, you cite to a number of pages of Dr. Richardson's deposition, from what I can tell, or from one of his expert reports.

MR. BRADLEY: Yes, Your Honor. We certainly -- I don't believe the objection includes that this wasn't disclosed by Dr. Richardson. It's just whether it's in the prehearing brief. Certainly, and I can show Your Honor, but it's in paragraph 101 of his report where he explains interpolation. He uses the word "between," which is the exact word we see here, that we're generating pixels between values, for example, on slide 66.

I did -- I don't know if this helps Your Honor, but I did a search when I heard their objection over his report, and interpolation appears 469 times. These slides are dealing with interpolation.

JUDGE MCNAMARA: Okay. And so if I understand the objection that has been lodged, first of all, these exact pictorials of their theory had not been presented and now Respondents are claiming that this is an additional theory.

MR. BRADLEY: It's not a new theory. It's interpolation. It's a demonstrative to help elucidate Dr. Richardson 's testimony that I expect him to provide.

JUDGE MCNAMARA: Before we move on to the next

group, Ms. Dienes, where are you in this?

MS. DIENES: Your Honor, I largely agree with the Respondents that this information is not disclosed in the prehearing brief. I do not think it's a simple matter of, oh, it's a demonstrative of interpolation, and, therefore, it is fair game.

I don't think there is any problem with Complainants relying on Fig. 8, but if you had looked on slide 66, the figure to the left, that Complainants are claiming are merely a demonstrative, contains a lot of additional information, including additional numbers, different arrows pointing to things.

And then within this set, if you look at slide 68 through 70, there's an identification of specific portions that are SCF and MCIF filter that were not previously disclosed as well as a previous identification of a GF filter on slide 70.

So I think it's not simply a demonstrative of the interpolation, and to the extent it is, it was not previously disclosed, and it contains a lot of additional information that was not disclosed in your prehearing brief and would be contrary to your Ground Rule 7.2.

JUDGE MCNAMARA: So here's the thing about that too. There is a bit of a problem that I've thought about. There is a notice disclosure in the prehearing brief.

Obviously there have been hundreds and hundreds of pages of depositions taken. And so generally I don't expect in the prehearing brief to see just a replication of what's in expert reports, expert rebuttal reports, but enough tie-in of the actual evidence and a discussion of the issue so that both sides are clear what the theory is and how they are being explained across the evidence that we have.

The prehearing brief is supposed to give you the theories that are being relied upon and they are supposed to give you some of the reasoning, but, again, it can't be an exact replication.

So was any of this discussed in expert reports, in Dr. Richardson's expert reports, and was the theory clear to both sides as to what -- and what the prehearing brief was referencing?

MS. DIENES: Your Honor, from the Staff's perspective, and I willfully admit, I am one person so I tend to rely on the prehearing briefs for the parties to disclose their theory. I do not think that the information contained on the demonstratives was clearly disclosed, from my perspective.

Dr. Richardson's report is well over a thousand pages, so I do not think, even with the explanation as to the purpose behind Ground Rule 7.2, that this meets the intent and the purpose behind Ground Rule 7.2. I think it

goes beyond that.

And, again, I don't think it's a simple demonstrative of interpolation. If it was, I don't think we would be here. I think it goes far beyond that.

JUDGE MCNAMARA: Okay.

Do you have a response to that?

MR. BRADLEY: Yes, I do, Your Honor. Let me move on to slide 68, which, again, at 66 through, I believe 70. This is 68.

And this is, again, building on 66, which begins to introduce the concept of interpolation, and now here we see in the green, the light green bar at the top, all this is showing is that interpolation is occurring for the SCF filter, which is the resampling filter that's in the claim. And the bottom one that says MCIF, that "I" stands for interpolation.

And all we're doing -- there's no debate that these filters are doing interpolation. We're demonstrating through a demonstrative that the two filters are doing interpolation and we're mapping that out, building on that slide 66 that does interpolation.

Also, we gave them cites to Dr. Richardson's report last night, and they looked at that and their objection this morning does seem to be the brief. But any notion that this is not part of the prehearing brief doesn't

make sense to me, because this, again, is showing the two filters that are in the claim, SCF and MCIF, that everyone agrees, I believe, do interpolation. And we're elucidating and demonstrating in a little bit more detail gradually how they are doing interpolation.

I don't think there's disputes about how interpolation occurs, but it is an important concept to understand to see what these filters are doing. And that's all these slides do.

JUDGE MCNAMARA: Okay. Let's take the next grouping, and that would be -- well, is there any other response that you'd like to make?

MR. FLANZ: Your Honor, if I may, very briefly. I appreciate the description that we're hearing now from InterDigital. Again, we were discussing 66 and 70, but I want to discuss the issue that's most crucial to us, and I think it's the same topic. You see the same bubble diagrams here.

JUDGE MCNAMARA: Give me a slide number, please.

MR. FLANZ: This is slide 91. And I can show you that 92 is very similar. So these are the ones that we care most about, slides 91 and 92.

And I appreciate the response that there was a discussion of coefficients and that there was a discussion of interpolation with a word between. These images, this

analysis was never in the prehearing brief. It wasn't in the expert reports at all.

It's true that the patent has a figure and the patent talks about interpolation, but they never identified where this interpolation was happening, how it was happening. And so we were never able to look at and respond to where SCF was or where MCIF was.

This is very new. This is something we didn't have a chance to examine. That's why I wanted to direct you back to slides 91 and 92, which is kind of where the rubber meets the road.

JUDGE MCNAMARA: And so my understanding, if my understanding is correct, the earlier group of slides from 66 to 70 is essentially laying out the predicate of just how interpolation works. There is no theory other than a replication in some fashion of a discussion of the claim. Would that be accurate?

MR. FLANZ: So I think looking at 66 through 70, they are doing more than what they did before, and so I don't think that there was disclosure for that. But with respect to -- infringement is really --

JUDGE MCNAMARA: Sure. I'm trying to figure out how much of this is truly just a replication of a figure that explains something that everybody would be clear about with respect to the claim and when we're getting into

infringement and the variations and the argument, and that's not clear to me.

MR. FLANZ: Right.

JUDGE MCNAMARA: Unless you're now pointing me to slides 91 and 92.

MR. FLANZ: So 91 and 92 is definitely what we care most about. One more point with respect to Your Honor's question about 66 through 70.

Certainly we're not objecting to the figure in the patent, but I think that -- and it's true that the prehearing brief has coefficients listed, but they were never identified as SCF. There was no identification that, hey, this is what we're going to be looking at to prove our case that there's a composition of functions here. In fact, as I showed Your Honor, they didn't think that they needed to do that.

So I think our objection with respect to this group is going to center around 91 and 92, but I do feel like -- we do think that 66 through 70 sets the predicate for this inappropriate and undisclosed reasoning.

JUDGE MCNAMARA: So there are other slides as well. Again, they were grouped, as you provided, as 81, 89, 91, 92, 98. But now you're focusing just on 91 and 92.

MR. BRADLEY: Your Honor, Kirk Bradley. I would like to correct my grouping based on what Mr. Flanz has

shown. I misspoke. The groupings are 66 to 70, along with 91 and 92. I believe those all group together.

JUDGE MCNAMARA: Okay.

MR. BRADLEY: So then the second group would be just 81, 89, 98.

JUDGE MCNAMARA: Okay.

MR. BRADLEY: And the third group would be 90, 94, 99.

JUDGE MCNAMARA: Okay.

MR. BRADLEY: I'm sorry to introduce that confusion.

JUDGE MCNAMARA: That's fine. We want to get this clear on the record. That's more important than anything. And understand exactly what the objections are too, and what was disclosed and what wasn't.

So I now understand, again, that you're focusing, Mr. Flanz, on 91 and 92. What about 81, 89 and 98?

MR. FLANZ: Yes, Your Honor. So I will show you 98. This is slide 98. And --

JUDGE MCNAMARA: I've seen a variation of this.

MR. FLANZ: Exactly.

JUDGE MCNAMARA: If not this exact exhibit.

MR. FLANZ: Right. That's an excerpt, and it's zoomed in on the portion that we have an issue with. So rather than search for it, the problem here is that on their

slide they are identifying Subpel_Filters as being the single horizontal filter GFH. And so our view, and I think it's -- well, I'll let Staff respond, but our view is that never before was there an identification that Subpel_Filters is going to be satisfying the GF limitation in the claims.

In fact, to the contrary, as I showed Your Honor, the prehearing brief, which is here on the left --

JUDGE MCNAMARA: And again, we're on page 20.

MR. FLANZ: This is page 19 of the prehearing brief. And in this paragraph, InterDigital says that each row in the array is a filter, right?

So comparing the left to the right, in their prehearing brief they are arguing that each row is a filter. And now the argument that we presume Dr. Richardson is going to make is that the composition or some combination of all of them is a single filter. We view those as inconsistent.

JUDGE MCNAMARA: All right.

Can you please address that, Mr. Bradley?

MR. BRADLEY: So, Your Honor, addressing the demonstrative slides 81, 89 and 98, perhaps this will be better once we hear from Dr. Richardson, but I've put up on the ELMO the highlighting that Mr. Flanz has provided, but he skipped the very first sentence.

JUDGE MCNAMARA: Again, you have to reference --

MR. BRADLEY: I will, Your Honor. Thank you.

This is on page 19 of the Complainant's prehearing brief. And the first sentence in the paragraph that begins on that page, it's the one that is not highlighted up here, and it says, "An example of a filter coefficient array specified by the AV1 Specification's Subpel_Filters is shown at," and it gives the page cite for the AV1, where it has these Subpel_Filters.

When you look at in the CDX exhibits that they are complaining about, which are numbers 81, 89, and 98, those are all just as we see on the screen here, Subpel_Filters from AV1. And if we go back to Dr. Richardson's report, he goes into detail. I'm happy to put it on the ELMO.

JUDGE MCNAMARA: I think you should.

MR. BRADLEY: Okay. By the way, Your Honor, this is his report. This is double-sided. It's big. It's all in here.

I will flip to paragraph 1075. I'll show Your Honor, this is page 439 of Dr. Richardson's report. Just to show Your Honor, we are in claim element 1.3, which is this long one that talks about the GFv is a composition of the MCIF and SCF filters. And I'll show Your Honor -- I just wanted to show Your Honor we're in that section talking about that very claim limitation.

And we move on a few pages. Now I'm on page 443,

paragraph 1080, and here on the screen are Subpel_Filters. It goes on and on. This one right here in the middle of page 440 is the exact one that's on the demonstrative slide.

The prehearing brief refers to these in reference to the Subpel_Filters of AV1. Dr. Richardson's report goes into detail showing all of these, and on the demonstrative slides we hone in on this particular one.

There's other portions of his report that say the same thing.

JUDGE MCNAMARA: Right, but there is an issue that they have that this was not disclosed in the prehearing brief to the extent, and I think specific language was read, each row -- well, you can read it yourself, but it's at page 19 of the prehearing brief, and it was already read into the record -- each row in the array is a filter, and yStep, in parentheses, and xStep indicates how many of the filters are applied to the samples.

And it goes on from there, but the explanation of the objection that I heard was that previously not all the rows in combination or in any combination there constituted filters.

MR. BRADLEY: I see, Your Honor. I think that's a question for Dr. Richardson about what it shows. And if in real time they have an issue -- I'm hesitant to sit here and testify, because this is pretty complex stuff --

JUDGE MCNAMARA: It is very complex.

MR. BRADLEY: -- about what is and is not a filter or filter array --

JUDGE MCNAMARA: Mr. Bradley, as I understand it, they did not have notice of the exact theory of how, in fact, this Subpel_Filter worked, and it's clearly in his report. There is some language in the prehearing brief. But the other side is saying that there is a new theory about meeting the claim limitation and how that actually works.

MR. BRADLEY: Understood, Your Honor. So we're back here on page 19 of Complainant's prehearing brief. And I emphasized at the beginning the first sentence that refers to these Subpel_Filters, and then it says here that -- and it talks about it as an array, a filter coefficient array.

JUDGE MCNAMARA: Which is what you just showed us.

MR. BRADLEY: Correct. And then it says there that each row in the array is a filter, and that yStep and also xStep indicates how many of these filters are applied to the samples, and it goes on to talk about Multipel_Filters, like the Subpel_Filters -- which, again, is the focus of the slides -- contain two or more filtering coefficients, and it goes on from there.

Maybe I don't fully understand the objection, but

the notion of these Subpel_Filters and which ones are at issue and what they are, it's been the whole subject of this patent, and these two filters, and we were specifically referencing these Subpel_Filters earlier. A moment ago I said it was the middle one on page 443 of Dr. Richardson's report. They all look the same. It's on page 444. My point is otherwise the same. I just wanted to correct that. It's because these arrays of filters, much like we see this one example of, there's actually lots of those within Subpel_Filters.

JUDGE MCNAMARA: I've seen some of this. So let me look -- let's talk about, briefly, very briefly, the last block or the last numbers of the exhibits. That's 90, 94, and 99, or the last grouping.

MR. BRADLEY: Yes, the last objection. Should I speak to that or Mr. Flanz?

JUDGE MCNAMARA: I think Mr. Flanz should address that so that we're clear.

MR. FLANZ: Yes, Your Honor.

MS. DIENES: Your Honor, would you like to hear from me on the last --

JUDGE MCNAMARA: Sure.

MS. DIENES: I agree with Respondents. I believe this slide that we showed that compared the objected-to demonstrative and the contents of the prehearing brief shows

that they are actually somewhat contradictory, and that demonstrative -- that demonstrative slide does appear to show a new theory.

I certainly don't think I had notice of it from the prehearing brief, and that's a huge problem, to be suddenly putting in what seems to be new theories at trial.

JUDGE MCNAMARA: So for me the question is, is it a new theory or is it an explanation of what they already agreed upon. Again, I'm not sure.

MS. DIENES: Either way, I don't think it was appropriately disclosed in the prehearing brief.

JUDGE MCNAMARA: Okay. And I have some issues here for sure.

Go ahead. If you could address the last grouping, Mr. Flanz.

MR. FLANZ: Yes, Your Honor. So representative of the last problem is, I want to make sure the whole slide is on the screen, this is slide 99 of Dr. Richardson's proposed slides.

Our problem is that this is the first identification of just this portion as GFH. So you can see here on the slide that they have a blue box that's drawn around a portion of the code. It's just a few lines labeled GFH.

Now, I think you'll see that part of that is

Subpel_Filters, which we were just discussing, so it kind of goes hand in hand. But the notice issue here is that never before were we told just this portion is what GFH is. Their previous position was that, if you see here at the top, interfilter, the previous position, as we understood it, was that the whole thing is what they were best identifying as GFH. And that's why we were able to -- that was the motivation for one of our responses, which you heard in the opening, about the inappropriate inclusion of Round2, right? But now we're hearing that, oh, wait, it's just this portion. We didn't have notice of that, and we think that that's unfair.

JUDGE MCNAMARA: And so that is a change for sure.

MR. FLANZ: That's right.

JUDGE MCNAMARA: Yes. And, again, you're isolating from that group just slide 99, but also part of that grouping you identified 90 and 94. So how do they play in?

MR. FLANZ: Let me just switch --

JUDGE MCNAMARA: Or is that the same? 94 seems to have an overlay from the AV1 Specification, but it has the same focus.

MR. FLANZ: That's right.

JUDGE MCNAMARA: And 99 the same.

MR. FLANZ: What was that, Your Honor?

JUDGE MCNAMARA: I think 99 is the same. We've talked about 99. We talked about 94. They appear to be the same. And 90 again.

MR. FLANZ: Yes, Your Honor.

JUDGE MCNAMARA: Okay. All right.

Ms. Dienes?

MS. DIENES: Your Honor, the Staff agrees that this is a problem. Obviously I'm interested to see what Mr. Bradley points to, but from the information I got this morning, I do not see this identification in their prehearing brief such that there would be notice of it going into this hearing. So I agree with Respondents that this should be precluded.

JUDGE MCNAMARA: I know. I was receiving some of the MILs that it wasn't clear what the parties -- there was still some confusion about what I would say is lack of clarity in some of the theories.

Do you want to address this, Mr. Bradley, this last grouping, please?

MR. BRADLEY: I certainly do, Your Honor. Kirk Bradley.

Let me first describe what I understand to be going on in Mr. Richardson's demonstrative slides. What this is saying, if Your Honor looks with me on demonstrative

slide 99, which is the example they gave, we start here where my pen is with the for loop, which means it starts with for, and it loops. Here is just below that --

JUDGE MCNAMARA: Read the commentary, please, that would be helpful.

MR. BRADLEY: The first one says for (R = 0, and it goes on from there. Nested within that is a second for loop that says, for (c = 0, and it goes on from there, and a third nested for loop says for (t = 0, and it goes on from there.

And then after that for loop there is a line that says intermediate (r) c = Round2. It says Round2 function. That's the debate. And so that is what Dr. Richardson expects to elucidate.

Let me first refer to the deposition where Lenovo's counsel asked him about this exact point, and I've highlighted it. We're on Dr. Richardson's deposition at page 15. Right at the beginning of the deposition, they are asking him about this very nesting of three for loops, and I understand the word "for" to help recognize the grammar from the transcript, the question is three, three nests of for loops. That's right.

And within that -- the last of the nested for loops, the innermost for loop, there is the use of Round2. Do you see that? Intermediate (r (c = Round2 -- that's

paraphrased a little bit.

That's the question. And he says, do you see that? And the answer is, I see that, but it's not -- it meaning the Round2 function -- he says it's not in that for -- he says here -- in response he says, I see that text about the Round2 function, but it's not in that for loop.

They are talking about three nested for loops, and they asked Dr. Richardson the question, and he said that the Round2 function is not in that for loop.

The filter we're pointing to, to go back to this demonstrative slide using 99 as an example, shows these very same three nested for loops that were discussed at the deposition and how the Round2 function is outside the for loop we're pointing to for the filter. It was exactly addressed.

And if we go back to the deposition here on page 17 of the deposition just a little bit ahead, we're still talking about the Round2 function, and it's at his report at page 441 and actually continues on to 442. And when you go to his report at pages 441 and 442, it has these exact things. Here is 442. It's the exact one, the exact same series of for loops with Round2 outside of the for loop.

JUDGE MCNAMARA: I may not understand as well as you all do, but my understanding of the objection is that

that may all have been discussed but it wasn't exactly clear that that's what was explained.

MR. BRADLEY: I can address that as well.

MS. DIENES: Yes, Your Honor, that's exactly it. Nor do I think that the parties are required to retain an encyclopedic knowledge of everything that has happened in the case in order to be able to glean what the theories are in the prehearing brief.

JUDGE MCNAMARA: And you have to be explicit in your prehearing brief about what you're considering is to be infringement, relying, of course, on those, but you have to be really clear about that.

This is one of the statements that I do not see clearly as explaining that that was the theory. Okay? There are a couple of others here that I think are harmless, or more harmless, but this particular grouping especially I have a problem with.

MR. BRADLEY: Yes, Your Honor. I have not yet presented where this was in the prehearing brief. I was first showing how -- the background that led to this that shows that this was disclosed, and now let me show in the prehearing brief.

JUDGE MCNAMARA: Sure. Go ahead.

MR. BRADLEY: For purposes of showing the prehearing brief, I first want to remind Your Honor that

these for loops I was just showing on pages 441 and 442 of Dr. Richardson's report are found in the one that matters here, this one on page 442 of Dr. Richardson's report is -- this is page 442. The previous page is 441. And that's paragraph 1080 of Dr. Richardson's report, that's the key thing to remember for the moment, paragraph 1080 of his report.

When we go to the exact same portion of what I was discussing earlier, we're in the '877 patent, we talk about these arrays and the Subpel_Filters, and there we're citing directly to paragraph 1080 and 1081, just a two-paragraph citation. So there it's disclosed.

And also on page 22 of our prehearing brief we have a discussion here that I've highlighted, and here it's describing in the context of the claims that the claim is directed to a single filter GFH and GFv that perform the functions of the two composition filters, MCIF and SCF.

And Dr. Richardson has identified just that, and we cite his report at paragraphs 1075 through 98, which includes the 1080 and surrounding text to be complete.

So this was clearly in our prehearing brief in the very context of the '877 patent and the two single filters, GFv and GFH, and I've already ahead of time shown the key portions of that paragraph for the debate that they are raising, and I also showed how that generated from

Lenovo's own question at the deposition.

So that is our -- at least part of the support that I wanted to present to Your Honor. This is not a new theory. This is something we provided.

JUDGE MCNAMARA: Mr. Flanz?

I'm sorry. Were you finished, Mr. Bradley?

MR. BRADLEY: That's good enough, Your Honor.

JUDGE MCNAMARA: Mr. Flanz? And I think I know where I'm going to go from here.

MR. FLANZ: Thank you, Your Honor. Scott Flanz for Respondents.

I just want to close by saying that we saw the words that were in the deposition, three for loops, one, two, three, and nowhere in the deposition or anything he just showed is there an identification of where the GF is. There's a discussion of the code. There's no discussion of where is the GF. And I think that's the overarching problem with all three of these objections, that things have been discussed in general, but when it comes to the specifics, and particularly with this patent where there is an equal sign, the specifics matter.

There is no good identification of GF, SC, or MCI, and we think we're being surprised with this. It wasn't in the prehearing brief, and so it should be excluded.

JUDGE MCNAMARA: Okay.

Ms. Dienes?

MS. DIENES: Your Honor, I would just like to point you to your Ground Rule 7.2.1.

JUDGE MCNAMARA: I know what it is, Ms. Dienes.

MS. DIENES: Okay. It's the Staff's view that a mere citation to the expert's report does not comply with that Ground Rule, because they are supposed to provide reasoning and explanation behind that. So I would say that that disclosure has not been made.

Also, I don't think Complainants should be rewarded for providing unclear or the lack of disclosure in their prehearing brief because they have come and tried to fix it in their demonstratives here.

JUDGE MCNAMARA: Okay. Are there any of the demonstratives that you would consider harmless?

MS. DIENES: Your Honor, I don't think any of them are harmless, because I think they all go to the heart of the infringement allegations in this case. So I don't know that I would be comfortable saying that it's okay, just let it in, because of the nature of the allegations in this case.

JUDGE MCNAMARA: Are there any --

Thank you, Ms. Dienes.

Are there any that you consider to be harmless,

Mr. Flanz?

MR. FLANZ: Scott Flanz on behalf of Lenovo.

I think that we're in agreement with the Staff. We don't see it as harmless, but we do think there are certain ones that are more important. The ones that are the most important are the slides resembling 99, which we discussed, I believe it was 99 and 98, and then also 91 and 92, which have the bubble diagrams.

JUDGE MCNAMARA: Right.

So you're not objecting to the illustration of Fig. 8 that includes just essentially the way in which Fig. 8 operates?

MR. FLANZ: That's right, Your Honor. They are backgrounds. To the extent that it opens the door into inappropriate infringement analysis, we would object to that, but the -- we don't want to belabor the point. The core is infringement and we don't think they should surprise us with it.

JUDGE MCNAMARA: So what you're saying is, what you would really like to see out is 91, 92, 95 and 98.

MR. FLANZ: Can you say those again?

JUDGE MCNAMARA: 91, 92, 95, and 98.

MR. FLANZ: And 99, Your Honor.

JUDGE MCNAMARA: Okay.

Here is what I'm going to do. There is clearly

an issue here about notice and the extent of the notice, and I think there is a clear problem between what's presented in the prehearing brief as being a clear-cut theory of infringement.

So I'm going to allow the other demonstratives to which the Respondents do not have the same level of objection, if you will, and if they are used for illustration purposes only of a point, but they can't be used specifically for noninfringement.

The other slides will be disallowed at this point, but the Complainant can make an offer of proof, and there will be response to it. And I will give you a briefing schedule on that at the end of the week.

MR. FLANZ: Yes, Your Honor. Thank you.

JUDGE MCNAMARA: Okay. I think this is where the precision of language becomes so important and a precision of being very clear of why there is infringement or not infringement, why there is or isn't invalidity and the reasoning for it.

Again, it's not just enough to cite to exhibits. And I've run into this before. And sometimes, again, some of these demonstratives are pretty harmless, they are just illustrations. So that's where we're going to go.

MR. BRADLEY: Kirk Bradley for Complainants.

We jotted down what we understood to be the

ruling, which we heard it as 91, 92, 99, and 98. I think the 99 should be a 95?

JUDGE MCNAMARA: I heard -- let's clarify to be sure. I had written down 91, 92, 95, 98, and 99 was added. So is that correct, Mr. Flanz?

MS. DIENES: Your Honor, should it be 94 instead of 95?

MR. FLANZ: Your Honor, Scott Flanz on behalf of Lenovo. I think it should be 94 instead of 95.

JUDGE MCNAMARA: Okay. So let me repeat it so that we're all on the same page: 91, 92, 94, 98, and 99.

MR. FLANZ: Yes, Your Honor.

JUDGE MCNAMARA: Ms. Dienes, is that your understanding?

MS. DIENES: Yes, Your Honor.

JUDGE MCNAMARA: Okay. And that's your understanding, Mr. Bradley?

MR. BRADLEY: I've written them down, yes, Your Honor.

JUDGE MCNAMARA: Okay. Good. And, again, those are out and you can make an offer of proof.

MR. BRADLEY: Your Honor, just so I'm clear with them being out but we can make an offer of proof, may I --

JUDGE MCNAMARA: They cannot be presented here during this hearing. I'm sorry, they cannot be presented

during the hearing. You can make an offer of proof following a standard method by which you make an offer of proof with your evidence and so forth.

MR. BRADLEY: Understood, Your Honor. Just to be clear, because they do flow in context, would we pause and make an offer of proof at the time?

JUDGE MCNAMARA: Just mention that you are going to be making an offer of proof consistent with the ruling to preserve your appeal ruling.

MR. BRADLEY: Understood, Your Honor. Thank you.

MR. MCKEON: Your Honor, before we begin, would it be a good time for our morning break?

JUDGE MCNAMARA: Let's take 15 minutes and then we'll start again, and we'll try and make up time, and I will help you with that.

(Whereupon, the proceedings recessed at 11:34 a.m.)

(In session at 11:50 a.m.)

JUDGE MCNAMARA: Thank you, everyone. Please be seated.

I think at this point we're finally ready for Dr. Richardson. We're going to try to make up time. I'm going to take a quick consensus.

Shall we shave ten minutes off lunch today, ten minutes tomorrow, ten minutes Friday, and that should cover

it?

Ms. Dienes, are you okay with that?

MS. DIENES: That's fine with Staff, Your Honor.

JUDGE MCNAMARA: Okay.

MR. BRADLEY: Kirk Bradley. That's fine with Complainants, Your Honor.

MR. MCKEON: Fine with Respondents, Your Honor. Thank you.

JUDGE MCNAMARA: We'll figure out if we need to do more than that.

MR. MCKEON: Thank you, Your Honor.

JUDGE MCNAMARA: Okay. Dr. Richardson, you haven't been given the oath yet, so would you kindly raise your right hand.

IAIN RICHARDSON,

having been first duly sworn or affirmed on his oath, was thereafter examined and testified as follows:

JUDGE MCNAMARA: Please state your full name.

THE WITNESS: Iain Edward Richardson.

JUDGE MCNAMARA: Thank you very much. You may be seated.

DIRECT EXAMINATION

BY MR. BRADLEY:

Q. Good morning, Dr. Richardson.

First of all, Kirk Bradley for Complainants.

JUDGE MCNAMARA: Thank you.

Q. Good morning, sir. I know you've testified before Her Honor before, but would you please introduce yourself?

A. It's nice to meet you in person this time, Your Honor. I'm Iain Richardson.

JUDGE MCNAMARA: Yes. I think it was during the pandemic.

A. Yes, on Zoom, yes.

Q. Did that Zoom meeting involve video coding and decoding?

A. That Zoom meeting used video coding and decoding to send and receive the pictures, yes.

Q. Let's turn to CX-2366 in your witness binder.

And do you recognize that as your CV? You can look on the screen.

A. Yes, that looks like a copy of my CV.

Q. Did you work with counsel to prepare a series of demonstrative slides to help you elucidate your testimony here today?

A. I did yes.

Q. Did you create a demonstrative that summarizes your experience and education, and is that Exhibit CDX-5C.2?

A. I did.

Q. Please briefly describe your educational

background and work history at least as it relates to your testimony here today.

A. I received my undergraduate, degree which is actually a master of engineering degree, in 1990. I completed my Ph.D. on the topic of video compression in 1999.

And then my experience that I think is relevant to what we're discussing today, I was a professor, first a lecturer, then a reader and then a professor, full professor, at the Robert Gordon University in Aberdeen, Scotland, for over 15 years, and I taught courses relating to imaging video processing and compression. I carried out research on those topics. I wrote a lot of research papers. I founded an image compression technology laboratory at that university.

I have worked as a founder of actually three companies, but two are listed here, so I cofounded a company called 4i2i Communications in the 1990s. As part of my role there I was developing and implementing video codecs. I founded two companies, OneCodec Limited and Vcodex Limited, and in my work with those companies I've been engaged with research, development, and implementation of video codecs.

Q. Is it safe to say you have been working in video coding and decoding technologies for the last 30-plus years?

A. That would be correct. Around 1993 was the -- my

first, I think the first research paper that I wrote.

Q. Have you designed video coding technologies?

A. Yes, I designed and implemented my first software video codec in around 1993, before anyone had heard of video codec. So outside of my specialist field. And over the years I've designed, implemented, and also managed the implementation of a number of video codecs.

One that always sort of sticks with me is in the 1990s I developed a hardware video codec with that first company I founded, 4i2i. I then left the company and didn't know sort of much about what they had done with the technology.

And towards 2010 I got a phone call from NASA saying can you help us fix your video codec. And so that was news to me. And it turned out that the hardware that I had developed ended up in the international space station and had been working for a number of years, and they had a problem and they saw my name in the source code, and so they looked me up and got in touch. So, yeah.

Q. As part of your work, have you developed video coding software?

A. Yes, I have, yes.

Q. And have you published peer-reviewed papers on video coding and decoding?

A. I have. In fact, a number of the, I think it's

80-plus papers that I've published, a number of them focus very specifically on the challenges and potential solutions when implementing video codecs in software and in hardware. So I've always been particularly focused on the implementation of these technologies.

Q. Do you have experience with the process of testing for conformance to video coding specifications?

A. Yes, I'm experienced with the process. I've done it myself, and I've written about it.

Q. Have you given invited lectures on topics related to video coding and streaming?

A. Yes, I've given a number of invited talks over the years.

Relevant to the local area, I've been invited to speak at the Smithsonian Institution. It was a joint talk with technical staff from there and the Library of Congress on the topic of video compression.

And I've given eight or nine invited lectures to Examiners at the U.S. Patent and Trademark Office as part of their ongoing program to keep the Examiners up to date with the latest developments. So, basically, every year for the last 10 or 12 years, they have asked me if I have the time to give a talk on video compression to the Examiners, and that's sort of -- that's worked out around eight or nine times.

Q. Turning to CDX-5C.3, do you understand that the parties have agreed on the level of skill that a person of skill in the art of these three patents would have for the purposes of this investigation?

A. Yes.

Q. And do you recognize that level of skill as what's written on this demonstrative slide?

A. I believe so, yes.

Q. As of the priority dates of the three asserted patents dating back to, I believe, 2006, did you satisfy this definition?

A. Yes.

Q. When you were forming your opinions in this case, did you apply them and look at it through the lens of a person that has this level of experience?

A. Yes, I did.

Q. Do you consider yourself an expert in the field of video encoding and decoding?

A. Yes.

Q. And do you consider yourself an expert in the subject matter of the '556, '877, and '859 patents?

A. I do, because I think, as we've already heard, all three relate to the coding and compression of signals such as images and video, and that's been my area of specialty for over 30 years, so yes.

MR. BRADLEY: Your Honor, Complainants proffer Dr. Richardson as an expert in the field of video encoding and decoding and the subject matter of the '556, '877, and '859 patents.

MR. MCKEON: No objection, Your Honor. Michael McKeon for Respondents.

MS. DIENES: No objection from Staff.

JUDGE MCNAMARA: Then Dr. Richardson is accepted as an expert on the subject matter for which he has been called to testify without objection.

MR. BRADLEY: Thank you, Your Honor.

Q. Dr. Richardson, I've turned to CDX-5C.4.

What were you asked to do in this investigation?

A. So as this slide I think summarizes, I've been asked to give my opinion or render an opinion as to whether certain accused products that can decode AV1 encoded bitstreams infringe the asserted claims of the three patents at issue. And --

Q. And --

A. I'm sorry.

Q. Go ahead, sir.

A. I was going to say I was also asked to reach an opinion or provide an opinion on whether certain domestic industry products that can decode AV1 encoded bitstreams practice the asserted claims of the three patents at issue.

Q. Did you form an opinion about Lenovo's infringement of the '556, '877, and '859 patents?

A. So with respect to certain computers, phones and tablets sold by Lenovo and/or Motorola, then I did reach an opinion, yes.

Q. And we'll look at those products, but what's your opinion on that issue?

A. So for those products my opinion is that they infringe the asserted claims of the three patents.

Q. And did you also reach an opinion about the domestic industry products that -- we'll identify those here in a moment, but did you analyze whether they practice the asserted claims of all three patents?

A. So for the domestic industry products that I think we'll be talking about, it's my opinion that those products all practice the asserted claims of the three patents at issue.

Q. In reaching your opinions, did you analyze the AV1 Specification that's been marked as CX-247?

A. Yes, I did.

Q. Did you also analyze third-party source code and technical documentation?

A. I did, yes.

Q. If we turn to CDX-5C.5, is this a demonstrative slide you've prepared that compiles the CX numbers for the

source code and technical documentation that you considered in reaching your opinions?

A. Yes, that's my recollection, yes.

MR. BRADLEY: Your Honor, if I may, the parties, I believe, are in agreement that, rather than have me read these all out, we'll just provide them to Ms. Kinkade soon enough.

JUDGE MCNAMARA: That's correct. That works well. And just so that you know, my set of slides starts at page 18.

MR. BRADLEY: May we approach?

JUDGE MCNAMARA: Yes. Thank you.

MR. BRADLEY: Your Honor, we'll start with that set, and then, as you probably deduced, we'll work our way into the next set.

Q. In addition to the source code and documents that we see here on this slide, did you also perform testing, either tests you did yourself, or that you reviewed from InterDigital's expert, Dr. Xiong?

A. I did both. I performed testing myself and I reviewed testing and the results of testing that Dr. Xiong had performed.

Q. And did you review and rely on signed declarations from Google, MediaTek, and Advanced Micro Devices, sometimes called AMD?

A. That's my recollection, yes.

Q. If you look in your binder at CX-514C or maybe we can put it on the screen, just the cover page of it.

Do you recognize this declaration as the MediaTek declaration that you considered?

A. I do, yes.

Q. For Mr. Don Chen, is that correct?

A. Yes, that's my recollection that I considered this declaration.

Q. Let's turn to CX-519.

Is this the Google declaration that you relied on from Mr. Thomas Hodge of Google?

A. I recall reviewing and relying on this declaration, yes.

Q. And then one more, if we can pull up CX-1600C just the cover page.

I'll ask, is this the AMD declaration you provided signed by Mr. Kevin Murray on behalf of AMD?

A. I think you might have misspoken in your question.

Q. Perhaps I did. Let me restate it.

Is CX-1600C the AMD declaration that you relied on in forming your opinions, the declaration of Mr. Kevin Murray?

A. I recall reviewing this declaration, and I relied

on this declaration in forming my opinions.

Q. Okay. We can pull that down.

Moving over to CDX-5C.6.

Dr. Richardson, have you formed an opinion about representative products in this investigation so that we don't have to go through every single one?

A. I have, yes.

Q. And what do we see here on this slide, CDX-5C.6?

A. So this is a list of eight products that, in my opinion, are representative of the functionality we are discussing in this matter.

Q. For the accused products; is that right?

A. Yes, sorry, the representative for the accused products. So these are all products sold, as I understand, by Lenovo and/or Motorola.

Q. Do all of these products, in your opinion, comply with the AV1 Specification?

A. Yes, they do. I'm sorry. I might just extend that answer slightly.

In my opinion all of these products are capable of decoding video that has been encoded according to the AV1 Specification.

Q. And does the decoding also occur according to the AV1 Specification?

A. Yes, in my opinion, yes.

Q. So on the screen now, CDX-5C.7.

What do we see here?

A. So this is an illustration of, if I recall correctly, one of these products, the Tab P11 Pro Generation 2, and I'm also highlighting what, in my opinion, is a representative chip or chipset that is present -- chip or chipset that is representative of the chipset in that product.

MR. BRADLEY: Your Honor, I'll pause for a moment and say here that, with the MediaTek chip that Dr. Richardson just mentioned, the parties have reached a stipulation as concerns the MediaTek chips. And I believe we're going to be filing it soon enough, but just for the sake of the record at the moment, the stipulation, as I understand it, is that the MediaTek 6891, including the Z and CZA versions, as well as the MediaTek 5586 and the MediaTek 8797 that we see here on the screen are all representative of each other. Any of those can be representative of any of the others. And, also, that the MediaTek 5583, 56 -- 5583 is the first one, then 5691 and then 5695, and 9S and 195S, I believe it is, are representative of each other. And we'll be filing that stipulation soon enough.

Q. Dr. Richardson, in your opinion, with the MediaTek chips, do they all decode AV1 video in materially

the same way?

A. For the chips or chipsets that I analyzed, yes, they do in my opinion.

Q. Moving ahead to CDX-5C.9.

What do we see on the screen here?

A. So this is an illustration of another Lenovo product, the ThinkPad X1, which has an Intel chip or chipset. And I've also highlighted that, in my opinion, the specific Intel CPU chip with integrated graphics is representative of the chips or chipsets in this product.

Q. And are you referring to the Intel Core i7-1355U with integrated Xe graphics?

A. Yes, I am.

Q. In your opinion, what chips is that one I just referenced representative of with respect to AV1?

A. It's representative of Intel chips that are capable of decoding AV1 video, which the similar proviso that decoding AV1 video means, broadly, capable of decoding a bitstream that is encoded according to the AV1 Specification and that satisfies the decoding process of the AV1 Specification.

Q. And do the products that use the Intel Core i7-1355U with integrated Xe graphics chip, do those products all decode AV1 video in materially the same way?

A. In my opinion they do.

Q. Let's turn and look at AMD on CDX-5C.10.
What do we see here?
A. So this is an illustration of two Lenovo products, ThinkPad X13 and the ThinkPad T16. Both of them have AMD processors or CPUs. And I've called out two representative chips or two chips that, in my view, are representative, an AMD Ryzen 5 PRO 7540U with integrated graphics, and also an AMD Ryzen 7 PRO 6850U CPU with integrated graphics.
Q. And does the AMD Ryzen 5 PRO 7540U, does that operate with VCN 4.0 source code?
A. So the VCN 4.0 source code, that's a reference to -- it's an AMD code name for video coding source code that I understand, and I think if I recall, I understand from the AMD corporate representative that that source code is representative of the source code that is instantiated or present in that particular AMD CPU.
Q. Understood. And I see the one on the right references the VCN 3.0 source code, and that's in reference to the AMD Ryzen 7 PRO 6850U.
And is the answer the same for the VCN 3.0 source code?
A. Yes, it is. So the VCN 3.0 source code is, or is representative of the source code that is implemented in that AMD Ryzen 7 PRO CPU.

Q. Are these two products we've been referencing in connection with CDX-5C.10, are those, in your opinion, representative of all Lenovo products with VCN 3.0 or VCN 4.0 source code with respect to how they decode 81 bitstreams?

A. Yes. So in my opinion all of the products, AMD products or Lenovo products with AMD chipsets that I've analyzed, that one or the other of these chipsets would be representative of them.

Q. And did you review the AMD source code and document production in connection with forming that opinion?

A. I reviewed portions of the VCN 4.0 source code and portions of the VCN 3.0 source code.

Q. And did you rely on testing in connection with these products in assessing their representativeness?

A. I did, and I personally tested these products, and I also considered and relied upon Dr. Xiong's testing of these products.

Q. And did you also rely on the declaration from the AMD gentleman that we referenced just a moment ago?

A. I did, yes.

Q. And do the products that use the Intel core -- strike that.

Do the products that use the VCN 3.0 source code and VCN 4.0 source code decode AV1 video in materially the

same way?

A. In my opinion they do, at least for the purposes of my analysis in this matter.

Q. Let's turn to Qualcomm and CDX-5C.11.

What does this one show?

A. So this is an illustration of a Motorola handset, the Motorola Edge+ 2023, and I've also highlighted that the CPU of this device is a Qualcomm CPU, Snapdragon 8 Generation 2 mobile platform with the identifier SM8550, and, as I understand it, the code name Kailua.

Q. And this has the Snapdragon 8 Gen 2 mobile platform CPU; is that right?

A. Yes.

Q. Do you know, are there other Qualcomm chips capable of decoding AV1 bitstreams, or is it this one?

A. My recollection, yeah, my understanding is that this is the only Qualcomm chip, at least that I was aware of at the time, that is capable of decoding AV1 video on the chip itself.

Q. On CDX-5C.12, what do we see here?

A. This is an illustration of the Lenovo product, the IdeaPad Pro 5i, and, as I've highlighted, this product has an Nvidia GPU, graphics processing unit, and that's the Nvidia GeForce RTX 4050.

Q. Is this product that you just mentioned

representative of all Lenovo products with an Nvidia chip having a NVDEC 5.0 and 5.2 source code?

A. Yes.

Q. And that's -- in your opinion do they all decode AV1 video in materially the same way as concerns the subject matter at issue in this investigation?

A. For the devices with these Nvidia chipsets or GPUs, yes.

Q. Let's talk about Google Chrome for a second.

On CDX-5C.13, are these the products you reviewed with the Google Chrome browser?

A. Yes. So I think at least two of them we've seen already, so these are the Tab P11 Pro, the Tab P12, the Moto G 5G 2023, and the Motorola Edge+ 2023. And as I recall, all of these have the Google Chrome browser, and all of them are, as I recall, capable of decoding and playing AV1 video via the Google Chrome browser.

Q. And do they all do so in materially the same way?

A. For the purposes of my analysis in this investigation, then I would say yes.

Q. If we turn to CDX-5C.14, this is an excerpt from the Google declaration that you referenced earlier, CX-506.

What are we seeing here? What are you showing us?

A. So on the left is, as I recall, the front page of

that declaration. On the right I've called out two sections. The first one I've highlighted "Google responds to the links to the library of open-source code relating to VP9 and AV1 are," and then there are four web links, and I've highlighted two of them at the bottom of the screen. The first one ending in libgav1 and the second one ending in libaom. And the reason I highlighted these two web links is that these relate specifically to the Google code's functionality relating to AV1.

Q. So in addition to CX-506 that we see an excerpt of here on the screen, do you recall, the Google declaration CX-519 that we referenced a moment ago, do you recall that it identified these same links?

A. That's my recollection, yes.

Q. Turning to CDX-5C.15, and I want to talk to you for a moment about the domestic industry products. Sometimes I refer to those as the DI products.

Do you understand that convention?

A. I'll try and remember that. I've heard it before, yes.

Q. You're welcome to refer however you would like. Sometimes I might say DI products.

Did you also consider representative products for your analyses relating to the domestic industry products in this investigation?

A. I did. I considered Apple and Vizio products.

Q. And is the source code and documents you relied on in forming those opinions summarized here on CDX-5C.15?

A. It is with respect to my opinions relating to the domestic industry products.

Q. And just for the record, I will -- we will provide this summary later, but this is another one where there are quite a few CX numbers.

Dr. Richardson, let's discuss the Vizio products first.

If we turn to CDX-5C.16, what do we see here on the screen?

A. So this is an illustration of two products or product series: the Vizio 32-inch D-Series and the Vizio 43-inch V-Series. These are both television sets. And with each one I've called out what I consider to be a representative chip, both MediaTek chips, and the first one is MT5583, and the second one is MT5691.

Q. Do the Vizio M-Series, P-Series, D-Series, and V-Series all use one of the two chips, the MT5538 and the MT5691?

A. That's my recollection, yes.

Q. And do all of those products that use those two chips decode AV1 video in materially the same way for purposes of this investigation?

A. In my opinion, yes.

Q. And is the same true for the Vizio OLED TVs, do they also use one or the other of these two chips and materially decode AV1 video in materially the same way?

A. That's my recollection, yes.

Q. And did you verify that these chips are operable to decode AV1 video by performing testing?

A. I did. I tested at least -- at least two Vizio televisions, at least one containing each of these chips, according to the documents that I've already referred to, and in both cases I confirmed that the products were capable of successfully decoding and playing AV1 bitstreams.

Q. One more. Let's talk about the Apple products.

Turning to CDX-5C.17, which Apple products did you consider for your representativeness analysis?

A. So as this slide illustrates, I considered the iPhone 15 Pro and the iPhone 15 Pro Max, both manufactured by Apple.

Q. And what chip do these two products use?

A. So both of these products use and incorporate the Apple A17 Pro Chip.

Q. And in your opinion do all Apple products that use the A17 Pro Chip decode AV1 video in materially the same way for purposes of this investigation?

A. Yes.

Q. Did you verify that the A17 Pro Chip is operable to decode AV1 video by performing product testing?

A. So I tested each of these devices or one of each of these devices, which both -- both devices I understand to contain the A17 Pro Chip, and I confirmed for both of the devices that they were capable of decoding and playing AV1 video.

Q. I want to turn then to the patented technologies.

Before we turn to the first patent that we'll talk about, which is the '556 patent, I would just like to understand, do the patents generally relate to certain aspects of video encoding and decoding?

A. Yes, they do.

Q. And just generally, what is video encoding and decoding? You're welcome to put it in the context of AV1 or just more generally, but just to provide some background.

A. I think I'd like to put it more generally to start with, Your Honor.

So video encoding is the process of going from source video to a bitstream, a compressed or encoded bitstream. Video decoding is the process of going from an encoded bitstream back to some representation of video.

I think we're all familiar with the use of this. So, for example, when Your Honor and I met a few years ago via Zoom, I think it was at least on two occasions, my

camera on my device is capturing my video when that's happening. A video encoder in my device is encoding and compressing video into a bitstream. The bitstream is being sent over the internet as a series of packets, and at your end those packets are being received. The bitstream is being decoded, and the result is video on your screen.

And one of the most important aspects of all of that is that the encoding process reduces the amount of data that's required to be sent over the network, and the decoding process expands -- expands it back again.

And the reason we need to do that, or the reason that I've spent the last 30 years working on this, is that there's a lot of data, particularly as we're moving to high-definition and now 4K videos, it is quite common, and so there is a lot of data, network capacity is limited, storage space on, for example, mobile devices, like the ones I was just showing you, is limited, and so compressing as efficiently as possible is really important.

Q. Is efficient coding and decoding important in this field?

A. Yes. So efficient can mean a number of things, but there's maybe three main dimensions, I think, that are really helpful to remember.

One is the quality. We want video quality that's good enough or, in fact, as good as possible given other

limitations. We want the compression to be as good as possible given practical limitations. And we also want the computation to be as small as -- as low as possible given practical considerations. And these three dimensions are sort of in opposition to each other or we're trading them off.

So, for example, we can usually get smaller video files if we compress the data more, but that might result in poorer video quality, which we're going to be talking about, I think, today. We might also apply more processing power or perhaps and/or more memory, which I think we're going to be talking about today, in order to, again, improve compression, reduce the file size.

And over the years I think we'll come on to this, but over the 30 years I've been involved in the field, a number of video codec specifications and standards have been published, and each one sets out a certain, if you like, scope of ways of doing this. And I've written about quite a number of these standards and specifications in the past.

Q. You've mentioned codecs a few times.

Can you just provide a little bit of context or background on what a video codec is, and perhaps touch on what an encoder is and what a decoder and how that relates to a codec?

A. Okay. I'll stick with the Zoom example. I think

I already mentioned this, but the thing or the process or the piece of your device, or whatever it is, it can be implemented in a number of ways. The process that takes the input video and produces a compressed bitstream, that's the video encoder. The process that takes video bitstream and produces output video, that's a video decoder. You put the two together, you get the acronym codec. And so in my field we'll often use codec to describe as a sort of a shorthand for encoder and decoder.

They do tend to work in pairs. So if we're talking over Zoom, then both ends have a codec, and my codec is sending -- is encoding video and decoding at the same time, if it's a two-way conversation.

If I'm watching streaming service at home, then, on a TV such as the ones we've been talking about, so my TV at home, I can't remember, it's not a Vizio, but I think it's another model, it has a decoder in it, and the provider of the streaming service, such as Netflix, they are, at some point, encoding the video, so it's their encoder and my decoder.

And one of the purposes, in my mind anyway, of these standards and specifications I mentioned is that they tend to be written so that one encoder can talk to another decoder as long as they are both, loosely speaking, making use of the same specification or standard.

Q. One example that's particularly relevant here is the AV1 Specification, is that your view?

A. Yes. So my general understanding is that AV1 as a specification is intended for that type of purpose, to provide some sort of a reference so that an encoder that encodes video according to the specification and a decoder that decodes video according to the specification, that they can interoperate with each other, basically, the decoder can encode what the -- the decoder can decode what the encoder produced.

Q. And does that allow devices from different companies to be able to speak to each other and encode and decode video correctly because they are following the same specification?

A. Absolutely. So, again, at a high level, I've just been talking about chipsets from different manufacturers, Qualcomm, AMD, Nvidia and so on. If those chipsets all follow the same decoder specification, then one encoder, such as, I'm just making up a name, a Netflix encoder that uses AV1 encoding, all of those chipsets should be able to decode that same source material, even though they are, I guess, developed by different manufacturers, maybe the teams that develop them -- developed each one didn't even talk to each other, but they are all following the same specification. That's the general idea of a

specification such as this one.

Q. With particular reference here, I'll mention with decoders, can those come in different types, hardware, software, et cetera?

A. They can, and it can get quite complicated. You can have an AV1 decoder that does absolutely -- or the same for others -- for other specifications, such as the H.264 standard or the HEVC standard, whatever -- an implementation of that can come entirely in hardware or it can be what I might call dedicate hardware, and implementation might be entirely in software, so everything is being done by software instructions executing on a processor.

What you also see quite a lot of is a mixture of the two. So it's possible, for example, for part of the operation of something like AV1 decoding to happen in software and part of it to happen in hardware. And sometimes we do that in my field in order to put the most computationally intensive parts into hardware and some other parts into software.

Q. Is Google Chrome an example of a software decoder?

A. So Google -- the Google Chrome browser has functionality, and one of those functions, as I understand it, is to be capable of decoding certain types of video. So when that browser is decoding AV1 video, it's my

understanding that it's doing -- it is doing the operations in software.

I think if you look inside the Google software, there are versions of certain functions that are optimized for certain types of processor, but all of the steps are set out in the software.

Q. You talked about efficiency and computations.

Does memory come into play?

A. Memory is very important. So, for example, I read a book about the H.264 standard, and in that standard there is a specification of essentially how much memory a decoder needs to decode a certain class of video, such as high-definition video, using the H.264 standard.

So for that example, if I want to manufacture an H.264 decoder that is capable of decoding high-definition video, I can work out, as a manufacturer, exactly how much memory I need for that decoding process. I can implement it in a number of ways, but the ceiling on the memory is part of the specification of that standard.

Q. To summarize a little bit what we've been talking about for the last bit, are all of the accused products and the domestic industry products in this case, are they all able to decode AV1 bitstreams according to the AV1 Specification?

A. In my opinion they are, and I've explained, I

1 think, or summarized how I reached that opinion.
2 Q. So when we walk through the patents, and we're
3 about to start here in a moment, if I refer to the accused
4 products and the domestic industry products together as the
5 AV1 products, will you understand what I'm referring to?
6 A. I'm happy to keep that in mind, yes.
7 Q. Okay. Let's put CDX-5C back on the screen and
8 turn particularly to 5C.18, Mr. Campos.
9 Dr. Richardson, do you recognize this patent, the
10 JX-3?
11 A. So, yes, this appears to be extracts from a
12 U.S. Patent, I would call it the '556 patent, so it is the
13 Patent U.S. 9,674,556.
14 Q. And there in the center top of the screen, do you
15 see the title of the patent? What is it?
16 A. Methods and apparatus for in-loop de-artifact
17 filtering.
18 Q. And, generally, generally, what is in-loop
19 de-artifact filtering? What are we talking about here?
20 A. Probably a good idea to break it down a little
21 bit, so there are three phrases there: in-loop,
22 de-artifact, filtering. Artifact -- artifacts are -- I
23 mentioned earlier this tradeoff between, for example,
24 compression and image quality.
25 So I think we're probably all familiar with it.

When we turn the compression up to, you know, to the point where the image is visibly distorted, those distortions are sometimes called artifacts. In this patent, the patentees also call them noise or content noise.

And so artifacts in this context are disturbances introduced by the compression process itself such that, when the data is decompressed, the disturbances are visible or somehow present in the decoded images.

So that's artifact. And so de-artifacting, as the name suggests, is the process of trying to remove or reduce those artifacts.

Filtering is, at a really high level, a way that one can do that. So a filter modifies something, and in this context, so de-artifact filtering generally, I would say, covers filtering processes that remove or attempt to remove or reduce artifacts due to the processes I've been talking about.

And then the third phrase is in-loop. That's a little bit more complicated. There is a loop shown in Fig. 4 of the patent. There's a lot going on in it. My shorthand for what it means to be in-loop is that it's something that's done in both the encoder and the decoder. And one of the characteristics is that the filtered data ends up being stored in the decoder so that the decoder can make further predictions.

1 May I unpack that a little bit?
2 Q. Yes, please do.
3 A. Sure. So the encoder compresses data, the
4 decoder decompresses data. I've talked about that. One of
5 the ways -- and I think you heard it yesterday actually --
6 one of the ways in which a video encoder can compress data
7 is to make predictions, and it does those typically a block
8 at a time, a block being a small region of pixels. And it
9 makes those or can make those predictions based on
10 previously decoded frames.
11 Again, I think there were some good examples
12 yesterday. I can't remember the exact details. I think
13 there might have been a car moving along.
14 And the idea is that, for a given block of pixels
15 in the current frame, I can probably find a similar block of
16 pixels in a previous frame, such as the frame immediately
17 before. Often due to things that are moving from one frame
18 to the next.
19 So to do that, at the decoder, to make that
20 prediction, I need to store at least something, some part of
21 that previous frame, maybe the whole frame, maybe part of
22 it. I need to store that previous frame, that previously
23 decoded frame.
24 And I'll draw Your Honor's attention in Fig. 4,
25 the bottom center of that figure there's a reference picture

buffer. Again, I think you're going to hear -- well, you might hear more about today, depending on which slides I'm showing, but that reference picture buffer, generally in this context, that is memory that's going to be storing previously decoded frames.

So that was quite long-winded, but the point I'm trying to get to, with an in-loop filter, the output of the filter, the result of the filter goes into that buffer. And a benefit of that is that, when the decoder makes predictions from that buffer, it's making predictions from something that is being hopefully improved.

If the filter has done a good job, the amount of -- the level of artifacts or noise has been reduced in what's stored in that buffer, and, conceptually, I think hopefully you'll agree that, if I've got a cleaner image in that buffer, I can make a better prediction.

So one of the main purposes, in my mind anyway, of an in-loop filter is to improve that whole prediction process. It might have a side effect or another benefit that artifacts are reduced, so the image might look better to us as humans watching the video, but actually a key purpose of an in-loop filter is to improve that prediction process.

And so if, for example, I saw a de-artifact filter that wasn't in-loop, it might improve the quality for

the observer, for the viewer, but it wouldn't necessarily improve that process.

So that was quite a long answer, but I think these are topics that are going to be coming up again and again, so it's probably pretty important.

Q. In Fig. 4 on this slide, CDX-5C.18, I see in the bottom right a deblocking filter, a box labeled "sparsity denoising."

Actually, before I ask you about those, let me ask you, what problem was the '556 patent trying to solve?

A. So generally the '556 patent is trying to solve, in general, how to make a better in-loop de-artifact filter.

So I've explained why in-loop de-artifacting filtering can be very useful, and it can actually have quite a critical effect overall -- I'm not talking about the patent -- it could have a critical effect on the performance of this prediction process in video codecs.

Actually, I talked quite a lot a moment ago, I had forgotten I had some slides to illustrate this.

Q. I've shifted us to CDX-5C.19, and I realize you've described some of this, but to put it in context of what we're seeing here on the slide.

A. So I mentioned artifacts a few moments ago, these distortions or quantization noise that are due to compression. The patent talks about several types of

artifacts, and there's one that is really well-known.

I think if you've ever watched, like I have, streaming services, at some point, when your internet connection has gone a little bit ropey, a little bit bad, you've probably seen something like this. So it's a very characteristic artifact, not just of AV1, but of any video compression method that uses block-based coding in a certain way.

And this is called a blocking artifact. So I've illustrated it here with a close-up of an image, and it's got this sort of character -- to me it looks like looking through sort of glass tiles that are arranged on a grid. And this grid is actually the block grid. So it kind of gives you a clue to how this image was encoded. I can actually look at that and say these are 8x8 pixel blocks. I don't know if you can see, there's 8 pixels, I think, within each one of them.

So in the boundaries between these blocks, particularly when we have turned the compression up so the data is really reduced, we tend to see, at the decoder, we tend to see these -- they are basically discontinuities that show up. They are really visible. They are problematic from -- for us as humans, because, as somebody said yesterday, we tend to notice edges. They tend to kind of draw our attention. But they are also problematic for this

prediction process, because you can imagine, if you're trying to predict from this, you don't have a good starting point for the next video frame. So these are blocking artifacts.

Q. Does the '556 patent provide a solution that deals with artifacts that result from video coding?

A. It does. And to sort of cut to the punch line, it talks about at least a two-stage process, and one of those stages is to remove or reduce these blocking artifacts.

Q. And just briefly, what does the second stage do?

A. So the second stage is to use a sparse or sparsity denoising filter, which I think we're going to discuss a lot, and that's a second type of filter, or a second filter, it has a specific or -- it has a particular type. It's a sparsity denoising filter or a sparse denoising filter. And its purpose, according to the patentees, is to reduce or remove noise, quantization noise or artifacts, that haven't been removed or reduced fully by the deblocking filter.

So I think of it as a second pass, the deblocking filter goes first, does its job as best as it can, whatever is left can be reduced further, and that's what the patent is contemplating.

Q. Do you understand or recall that the asserted

claims of the '556 patent are independent claims 1 and 5 and dependent claims 3 and 7?

A. That's my recollection.

Q. Let's dive right in. Here we see on the screen CDX-5.20.

Is this the claim language of claim 5 broken down by its elements?

A. Yes.

Q. And you referenced it a moment ago, but in the context of the claim that we now see, it looks like claim 5 talks about two successive filters, first a deblocking filter and, second, an adaptive sparse denoising filter.

Are those the filters you were referring to a moment ago?

A. Broadly, yes. I was referring to the patent in general, but I think that's consistent with what we see here when we look at a specific claim.

Q. What, in this context of the claim language, what's meant by successive filtering?

A. I would understand that to mean, in the context of the patent, that one filter is happening after the other. And it's saying here, for example, in element 5.c, I'm paraphrasing, a deblocking filter for performing a first pass, and then in 5.d, an adaptive sparse denoising filter for performing a second pass, and they are described as

being performed successively.

And if you remember that diagram I showed you a moment ago, you saw -- I think we saw two filters, two boxes there, first a deblocking filter and then an arrow to a sparse or sparsity denoising filter.

Q. So is the output of the first filter the input of the second filter --

A. That's --

Q. -- for successive filters?

A. That's my understanding of how one should read this claim in the context of the patent.

Q. Is that your opinion of how it should be read?

A. That's my opinion, yes.

Q. Let's turn to CDX-5C.21. And we have here some of the claim language alongside Fig. 4 of the patent that's been highlighted some.

What are we seeing here?

A. So I'm putting pieces together from the last few slides that we saw.

So on the right-hand side here is that Fig. 4 again, and I've color-coded two of the boxes, the deblocking filter 465 and the sparsity denoising filter 444.

And on the left I'm extracting three of the claim elements. The first element on this slide, 5.b, recites two filters for successively performing in-loop-filtering. And

I'm just paraphrasing somewhat here. The second element corresponds to, in my opinion, to the first of those highlighted filter blocks, 465, and that's the deblocking filter for performing a first pass to reduce blocking artifacts. And the second -- so the final element I've listed, 5.d, corresponds, in my opinion, to the sparsity denoising block 444 in Fig. 4, and that's performing the second pass to reduce noise.

Q. For that phrase there in 5.d, the quote, "sparse denoising filter," closed quote, are you aware that the parties submitted competing claim construction positions on that term?

And you can see them here, I believe, on CDX-5C.22.

A. I'm aware that three proposed constructions were submitted for this term, yes.

Q. And what is the, just to recap, what is the meaning that the Complainants and Staff proposed for that term?

A. So the meaning is a filter that reduces noise based on a sparse representation of the signal.

Q. And there in the middle right column, do we see the Respondents' proposed constructions for this term?

A. Yes. And I understand -- I see that there are two constructions. The first one is a sparse denoising

filter for performing a second pass to reduce noise, which is not a deringing filter.

And a second construction, alternatively, a filter which exploits a sparse image model using an overcomplete set of linear transforms and hard thresholding, which is not a deringing filter.

Q. So perhaps setting aside one of those claim construction of -- argument about the alleged disclaimer of deringing filters, do any of your opinions change depending on which construction Her Honor ultimately gives to the phrase "sparse denoising filter" in these claims?

A. No. My opinions with respect to this patent and its asserted claims and the AV1 products, my opinions do not change.

Q. Let me ask you, when you formed your opinions of infringement by the accused products and practicing by the domestic industry products, did you review the patent and its specification and its prosecution history in the Patent Office for each of the three patents? Was that part of your analysis?

A. Yes, it was.

Q. And shifting just back to the '556 patent, you may have said earlier, but have you formed an opinion regarding whether the AV1 products infringe or practice the asserted claims of the '556 patent?

A. Yes.

Q. And what is that?

A. I have. In my opinion, the AV1 products, which we've discussed include those two categories, practice the asserted claims of this patent.

Q. So the Lenovo products infringe, and the DI products practice; is that your opinion?

A. The Lenovo and/or Motorola products infringe, the domestic industry products practice.

Q. Thank you for that clarification.

Let's jump into the element-by-element analysis.

When you rendered your opinions, did you look at all the elements to determine whether all of them were satisfied?

A. So this is claim 5. I considered all of the elements of claim 5 to determine whether they were satisfied.

Q. And you considered all the elements of all the claims. We're just using 5 as our walkthrough.

Is that right?

A. Yes.

Q. Let me ask you, does -- I'll turn to 5C.24. You can see it on the screen.

Does Lenovo dispute all the elements or just some of them?

A. My understanding is that in this matter Lenovo does not dispute at least the first four elements here, that's element 5 preamble -- or the preamble, as I understand it, element 5.a, element 5.b, and element 5.c.

Q. You understand that there is a dispute at least as to parts of 5.d and 5.e?

A. Yes.

Q. And do you understand that -- well, let me ask you this.

In the AV1 Specification, what is your opinion that -- what thing in the AV1 Specification is the sparse denoising filter that's required in the claims?

A. In my opinion the filter known as CDEF, the Constrained Directional Enhancement Filter in AV1, in my opinion, satisfies the element -- the requirement here for an adaptive sparse denoising filter that satisfies elements 5.d and 5.e.

Q. Do you understand in the context of element 5.d that the dispute is whether CDEF in AV1 is or is not a sparse denoising filter? Do you understand that to be a core dispute between the parties?

A. I understand that to be a core dispute, and I'm not actually aware of any other disputes over element 5.d.

Q. And, in 5.e, do you understand that the parties' dispute is whether or not CDEF in AV1 is or is not, quote,

"selectively enabled or disabled," closed quote, according to element 5.e? Do you understand that to be the core dispute on the second issue?

A. Yes. With the proviso that I understand, as I said, that the Respondents dispute that CDEF and AV1 is an adaptive sparse denoising filter.

Q. Correct. On 5.e, we continue that first dispute, but the separate additional dispute, the second dispute in 5.e, is over whether CDEF is selectively enabled or disabled, is that your understanding?

A. That's broadly my understanding, yes.

Q. Okay.

MR. BRADLEY: Your Honor, I'm about to start walking through starting with the preamble. I'm happy to continue. It's almost 1:00. It's a transition point. I'm happy to continue.

JUDGE MCNAMARA: Let's break for lunch. It does seem like a good time to break.

So it is now 12:57. So I will see you back here in 50 minutes. We'll take off ten minutes. Thank you.

(Whereupon, the proceedings recessed at 12:57 p.m.)

AFTERNOON SESSION

(In session at 1:50 p.m.)

JUDGE MCNAMARA: Thank you. Please be seated, everyone.

Anytime you're ready, Mr. Bradley.

BY MR. BRADLEY:

Q. Thank you. Kirk Bradley for the Complainants.

Dr. Richardson, I want to step back and ask you one more question that I probably meant to ask, if I didn't.

Talking about the Intel representative accused products, do all the Intel accused products decode AV1 video in materially the same way as the representative ThinkPad X1 that has the core i7-1355U with integrated Xe graphics?

A. In my opinion, yes.

Q. We're on CDX-5.25.

Looking at the preamble, I think you said earlier, there is no dispute about the preamble; is that correct?

A. I'm not aware of a dispute, no.

Q. And did you review documents and testimony provided by Lenovo in forming an opinion about whether 5.pre, the preamble, is satisfied or not?

A. I did yes.

Q. And what did those documents and testimony tell you about whether the AV1 products infringe or practice this

requirement, if indeed it is a requirement, it's the preamble?

A. So those documents and testimony and also my testing of the physical accused products confirm to me that each of those products is an apparatus comprising at least memory and one or more processors, which are configured to do certain tasks.

Q. Those processors contain memory; is that right?

A. Well, the apparatus, apparatuses, what is the plural, the apparatuses do contain memory and processors.

Q. If we look at CDX-5.28, have you checked off that claim 5 preamble?

A. Yes.

Q. And the next limitation is 5.a, and it just says, decode an image region.

Did you analyze that?

A. I did, and for the reasons that I've discussed earlier, in my review of AV1, my review of the products themselves, and the documentation, in my opinion that element is also satisfied.

Q. And here on the screen is CDX-5C.30, which is a couple portions from the AV1 Specification.

Is that what we see here?

A. Yes.

Q. And is it sections 7 and 2 that you've provided

excerpts from?

A. Yes. So there's a bit of AV1 terminology here.

OBU stands for open bitstream, bitstream unit. And it's quite hard to summarize this document, because there's a lot in it and it's quite technical, of course, but what it's saying here is that, for the general decoding mode of AV1, the input is a sequence of OBUs, and that, in my understanding, is a sequence of these data units, these open bitstream units, and each one of them contains the coded data, the coded bitstream for -- I think it's a frame or a portion of a frame, a video frame, that is, and it says, general decoding, input is a sequence of OBUs, so that's an encoded bitstream, output is decoded frames, so that is a decoded video sequence.

So this summary confirms what the AV1 Specification describes in a lot of detail, which is that the AV1 products each decode an image region.

Q. And turning to CDX-5.31, what was your conclusion for the AV1 products relative to the requirement that they decode an image region?

A. So my conclusion is that all of the AV1 products do decode an image region.

Q. Moving right along, we have element 5.b, which says that the one or more processors including at least two filters for successively performing in-loop-filtering to

reduce at least a first and a second type of coding artifact.

And I know we talked some about this earlier, but did you analyze this question relative to the AV1 products?

A. I did, yes.

Q. And did you decide or determine whether these -- whether this requirement is met by the AV1 products?

A. In my opinion it is indeed met.

Q. We see here on CDX-5C.33 section -- or an excerpt of section 7.4 from the AV1 process.

What does this tell us about the two filters, two successive filters, in AV1?

A. So, once again, I've picked out a short excerpt here of a very long document, but I've reviewed the entire document, went through it, and I can confirm that, in my opinion, what I'm about to describe does indeed happen in AV1 decoder.

And so this is part of the frame "wrapup" process. As the name kind of alludes, at the end of decoding the data of the frame, that's all the pixel data, an AV1 decoder goes through a wrapup process, a process that happens at the end of decoding one frame and before decoding a further frame.

And it says, on this extract here, if certain things are met, the process first performs -- and the

process here is the decode frame wrapup process, first performs any postprocessing filtering by the following ordered steps, and the first of those steps is described as a loop filter process and that is a deblocking filter that's specified in AV1, and the second of those processes is a CDEF process, and that is the constrained directional enhancement filter of AV1, which I mentioned earlier.

So two filter processes, they are happening in succession at the end of decoding a frame. The first of those processes is a deblocking filter, which, as I think we'll see, reduces or removes blocking artifacts, and the second process is the CDEF, which, in my opinion, is the sparse denoising filter, which, again, we'll look at further.

Q. So if we go to CDX-5C.34, what do we see here?

I'll mention I believe it's a graphic that largely mimics or mirrors a graphic from CX-2105, but explain what we see here on the screen, please.

A. So the document that you just mentioned is, if I recall correctly, a technical overview of AV1 written by some of the developers or designers of AV1. And what I've done here is I've taken one of the figures of that document, which is everything in, basically, in white or light blue, I've added the yellow boxes pointing to the deblocking filter and the CDEF. And this kind of does two things.

First of all, if you exclude those two boxes, and if you were to look at the original document, you would see that this is how the designers of AV1 describe or explain their processes. A decoded frame is filtered in those two passes, and then other things happen after that.

And the other thing that this is showing is I'm just illustrating what I just said, that, in my opinion, the first filter there, the first filter of the claims is satisfied by the deblocking filter, the second, which is also known in AV1 as the loop filter, even though there are other loop filters, the second filter of the claims is satisfied by AV1's CDEF.

Q. And, Mr. Campos, if you could please pull up CX-2105.19. And then zoom in on the image on that page, please, on the top right.

We're looking at the actual paper now, CX-2105.

Dr. Richardson, is this the figure from the AV1 paper you were just describing?

A. Yes, it is.

Q. Okay. And does it show the things you just described?

A. So it doesn't have those two boxes labeled filter 1 and filter 2, those were my boxes, but it shows everything else that my diagram, my slide described.

Q. Great. Thank you.

If we go forward to CDX-5C.35, what is this describing for us?

A. So, once again, this is my attempt to excerpt something from this big, complicated document that just explains or summarizes the first part of that, a loop filter, which is the deblocking filter.

Q. And --

A. Sorry. No, carry on, I was just collecting my thoughts.

And at a high level, I think it's quite useful to focus on the first two sentences, I've highlighted the second sentence, the input is the array of reconstructed samples, the output is a modified array of deblocked samples. So the output CurrFrame, C-U-R-R-F-R-A-M-E, is an array containing deblocked samples.

So once this process is -- this filter process has been applied, we have a version of CurrFrame, which has been deblocked where the filter has attempted to remove or reduce the blocking artifacts in the frame, if there are any.

Q. So you're referring here to section 7.14 of AV1, is that what this is?

A. Yes.

Q. And if the output from here is CurrFrame, C-U-R-R-F-R-A-M-E, if we go to the next slide, CDX-5C.36,

what does section 7.15 say is the input to CDEF?

A. So the first sentence there explains that the input to CDEF is this same array CurrFrame, and when I say "same array," that's the array that was modified by the deblocking process.

And, again, I'm just excerpting and summarizing here, but if -- it's actually not too difficult to do, particularly we have a searchable version -- if you go through that specification, you can search on where CurrFrame appears and you can look at the order that the specification states things should happen in, and you will see that at the end of the loop filter, the deblocking filter, the very next thing that happens is this process here, which takes the output of the loop filter and applies CDEF, and then the second sentence says the output is the array CDEF frame containing deringed samples.

Q. Do the loop filter and CDEF that you've been describing, do those reduce different kinds of artifacts during the process?

A. They do. The first of those filters, specifically is designed to and operates to reduce blocking artifacts, and the second filter operates on what's left, and it reduces other types of artifacts, including ringing artifacts and, in my opinion, other types of coding noise or quantization noise.

Q. So in your opinion do the AV1 products infringe or practice element 5.b of the '556 patent?

A. Yes, they do.

Q. If we go to the next limitation, 5.c, which, again, is in the list of ones that are not disputed, it says here that at least two filters including -- include a deblocking filter for performing a first pass to reduce blocking artifacts.

Does the loop filter that you've described, does the first filter -- is it a deblocking filter for performing a first pass to reduce blocking artifacts?

A. It is, yes.

Q. How do you know that?

A. Well, I know that from my own testing. I know that from -- actually primarily from reviewing the AV1 Specification, from reviewing documents such as the overview paper that I just mentioned, which actually describes the operation of this in a little bit more detail, and just from the -- from what's in the actual specification.

Q. So in your opinion do the AV1 products infringe or practice the element 5.c?

A. In my opinion the AV1 products all practice element 5.c.

Q. And the accused products infringe, correct?

A. And -- well, because the accused products

practice, in my opinion, all of the elements, they infringe.

Q. Great. So let's turn to where the first dispute is, and that's here in element 5.d, which says that an adaptive sparse denoising filter for performing a second pass to reduce noise.

You've already described a little bit, but what is a denoising filter in the context of the '556 patent?

A. So a denoising filter, as the name suggests, reduces noise. The '556 patent explains in quite a lot of detail what it means by that. It talks about quantization noise as, I think it uses that term, if I can recollect, to describe all coding artifacts, it describes blocking artifacts, as a first type of quantization noise, and the patentee says that, once you've applied the deblocking filter in a general video coding system, once you've applied a deblocking filter, what is left, according to the patentee, is quite similar to uniform noise.

And so that was, as I understand it, one of the motivations of the patented invention or the approach of the invention was to use denoising filters or a -- propose a denoising filter to attempt to reduce what's left after applying the deblocking filter.

Q. I have an easy one for you.

Is ringing noise a type of noise?

A. It is a type of noise. It's a type of creating

artifact and it's a type of quantization noise.

Q. What types of noise does CDEF in AV1 produce?

A. In my opinion, and based on my analysis and also on testing that I carried out, it reduces or removes ringing noise, it reduces or removes uniform noise or noise that does not necessarily have a ringing characteristic.

Q. Now in element 5.d, that we've talked already a little bit, and we're about to talk a lot more about sparse denoising filter, but I see here the word adaptive, adaptive sparse denoising filter.

Is there any dispute about whether CDEF is adaptive?

A. I don't believe there is a dispute over whether this -- that filter in AV1 is adaptive, meaning generally, as I recall, that its behavior changes depending on the content or depending on what it's filtering.

Q. And if we turn here to CDX-5C.41, we have an excerpt from CX-1608.

What do we see here, and particularly relevant to this term adaptive?

A. So this is an extract from or two extracts from a technical paper by, as I understand it, two of the authors or developers of the CDEF process itself. It's titled "The AV1 Constrained Directional Enhancement Filter (CDEF)."

And then in the second extract, I'm highlighting

that CDEF works, according to the authors, by, and I'll paraphrase, adaptively filtering.

So that supports my opinion that CDEF adaptively filters.

Q. Let's move on to sparse and sparse representation.

I'm on CDX-5C.42. We see the Manhattan skyline that's already been the subject of a fair amount of discussion.

In the context of the '556 patent, and the context of a sparse denoising filter, what does this skyline representation tell us?

A. So we had at least one, maybe two, explanations yesterday, that -- or illustrations that focused on these images, and I think it was well-put yesterday, so I don't want to repeat too much territory for Your Honor, but the concept here is that we have the same data, the Manhattan, basically the buildings of Manhattan, and we're looking at it here in two different representations, or the analogy here is that these viewpoints are each a representation.

And a sparse representation, in my opinion, is one that allows us to view or process the data in such a way that we can begin to discriminate between things, if it's filtering, we can discriminate between things that we want to filter and things that we do not want to filter.

Q. And with the slides that are on the screen, which come from RX-650, if you're trying to analyze a sparse representation, what does the right side image tell you that the left side image does not?

A. So, again, it was summarized yesterday.

In this illustration, if your purpose or what you want to do relates to the height of the skyscrapers, for example, identifying skyscrapers or buildings above a certain height, then the representation on the right, the viewpoint on the right in this illustration, allows you to do that more effectively than the one on the left.

The one on the left, as we heard yesterday, is really hard, absent other information, to distinguish exactly which buildings here are the skyscrapers, which are the lower buildings. By adopting a different -- putting the same data into a different representation, we can begin to discriminate between the two.

Q. And did Lenovo's expert, Dr. Orchard, or former expert, I guess, did he present this very image as a sparse representation of the Manhattan skyline?

A. My understanding is that he did.

Q. Let's turn to CDX-5C.43 so we can start to walk through an example. We'll have a few slides here. It is an important point, and we need to walk through it.

What do we see here on 5C.43 to start this

walkthrough of the sparse representation?

A. So I'm showing a simplistic image, but it's representative, if you like, of a image that might appear in a video.

So I'll suggest that this is representative of a typical single frame of a video sequence.

Q. And if we turn to CDX-5C.44, I see you have drawn out a red and blue square with a clear edge between them.

What are we showing here?

A. So this goes back to something I mentioned earlier. I think I mentioned blocks -- yeah, I did, in respect of deblocking -- and I mentioned that a video codec typically processes a scene a block at a time, and AV1 does that. It processes the scene a block at a time.

In the case of CDEF, it processes 8x8 pixels at a time. So I'm picking out one 8x8 block in this image. And, yeah, you've moved on. Sorry.

Q. If we move to CDX-5C.45, do you show that 8x8 block of the red and blue edge of the car and sky?

A. Exactly. And, again, I think we saw this yesterday. On the right-hand side here I'm calling out or illustrating the actual 64 pixels that make up that block, and I've moved the illustration into monochrome because I think that's going to be easier to cover, something similar can happen for color information, but one of the things CDEF

does is it processes the monochrome component of video, so I think this is a reasonable illustration.

Q. So if we move to CDX-5C.46, we've taken that monochrome 8x8 block with the darker on top, lighter on the bottom, and you've had added a whole bunch of numbers here to the right.

What is this representing?

A. So we're seeing a block on the screen. Inside the computer that is driving this screen, or the screens that we're all looking at, there is computer stuff, the software and hardware, and in there, the pixels on the screen are represented as numbers, and color pixels is more numbers per pixels, but if we just stick to monochrome to keep it simpler, in monochrome each pixel is represented with one number.

The value of that number, the magnitude of that number, tells you something about the brightness of the pixel. So in this case a lower number is a darker pixel, a brighter number -- a larger number, sorry, is a brighter pixel.

Q. And I see here the top three rows of numbers are all numbered 102, meaning a little darker, and the bottom five rows are all 136, meaning a little brighter in the luminescence, is that what you're representing here?

A. That's basically it. And I've deliberately

chosen or, in this case, generated a block which starts off quite simple -- flat, dark gray at the top, flat, lighter gray at the bottom.

Q. So I realize we're working through an example to show, but it seems unlikely they would all be pure 102 in the first three rows and pure 136 on the bottom five rows.

So if we move to CDX-5C.47, what are you showing here?

A. Okay. I know I'm not supposed to disagree with you, but they might be all the same values. So that you could certainly get -- like on my screen, for instance, the background, the light background, that's all the same pixel value, but in video and images, very often we have variation, and it might be variation that was in there from the start, or it might be variation due to the coding process itself.

So, basically, variation that you don't want generally is what we call noise, and I've added some noise here to my original clean, flat block to make a noisier block on the right. So noise in this respect, what I've actually done is added small random positive and negative variations.

Q. And did you run all this in testing through MATLAB scripts that you prepared, like CX-2058, for example?

A. I did. So to generate these numbers and then to

introduce the noise, and then to do further steps, which I'll talk about, I wrote basically a program, a software program, in an environment called MATLAB, which is quite good for rapidly or easily testing things out like this, generating diagrams and so on.

Q. So if we move to CDX-5C.48, I see that the top three rows that were all 102s and the bottom five rows that were all 136s have now changed some.

What are you showing here?

A. Yes. So every pixel value has had noise added to it. Interesting, or I think it's interesting, some of the pixels haven't changed, because that's the nature of randomly occurring noise, is that sometimes things don't change, but most of the pixel values have changed. And the way they have changed I think is relevant. They have shifted up or shifted down. They have got slightly brighter or slightly darker, so the numbers have got slightly larger or slightly smaller.

So when we look at the block, we can actually really quickly see it still has a light part and a dark part, but we look at the numbers, it's a little bit harder to see that, but if you look at the numbers you can probably convince yourself that the top part still has generally smaller numbers and the lower part still has generally larger numbers, because the starting point was a dark or a

light block.

Q. If we move to CDX-5C.49, I see you have the same slide we just had, but now there's a red box around 101 towards the upper left.

What are you going to show here? What does this represent?

A. So what I'm going to represent -- I'm going to pick out one pixel position, one of those 64 pixels, and just look at how CDEF works for that pixel.

And I'd like to just add something here. I did this for a lot of blocks, a lot of different noise characteristics, and a lot of different pixel values, and I submitted all of that in the testing exhibits that you mentioned earlier. But I'm just picking out one here.

The reason I'm saying that is that this will illustrate some aspects of how CDEF works, but if you wanted to look at other pixels, things behave differently, but the general principles, in my view, remain the same.

Q. CDEF would work the same. It's just the pixels it's filtering may change depending on what you're looking at, whether you're looking at a big white part of the wall over here or looking at the edge between the white and the brown rail; is that what you're saying?

A. Almost. So I mentioned that CDEF is adaptive. So CDEF is specified in AV1, and for any of those different

types of blocks, it will go through the same process every single time.

What it does to the block will depend partly on what's in the block. As we'll see in a moment, what it does to this pixel value depends on -- could we just go back one please -- depends on what's going on in the block.

For example, the fact that this block has a strong -- what I would call a strong horizontal feature, if you look at this, clearly there's something going on horizontally. That will affect how CDEF works.

A block that has something going on vertically will affect -- will -- CDEF will process that in a different way, but it will still follow the same process that's specified here.

I hope that's clear.

Q. So are you going to show us what CDEF does with the pixel using this 101 pixel as an example?

A. I am, yes.

Q. Okay. Let's move to CDX-5C.50.

And I see on the left side you have the 101 in the middle with the red box.

What are we seeing here?

A. Yeah, there's quite a lot going on on this slide, so I'll just take a moment.

Just focusing on the left-hand side of this

slide, the numbers that you see here are the same numbers you saw a couple of slides ago or for the last two slides. It's the top left part of that bigger block.

The reason I've just zoomed in on the top left part is that CDEF, for every pixel, it looks at a 5x5 pixel region. So that's why I've shown the 25 pixels on the left. That's the top left. 5x5 region of that larger block, that's the first thing.

The second thing that's going on is that there's some color-coding in the block on the left. There's a line of pixels color-coded green, and then there's two diagonal lines of pixels color-coded yellow. So there's 12 pixels color-coded apart from the original pixel in the middle.

So CDEF basically picks out -- chooses 13 pixel positions and does things to those positions. For every pixel 101, for every pixel that it's processing, it looks at 13 pixel positions or considers them, if you like, and does some processes, based on what's in those boxes.

So in this case it's processing pixel 101, and this is like at a high level, it's processing pixel 101 based on what's in the green and the yellow boxes, and based on what's in 101 -- 101 itself.

And just before I move away from that left-hand image, if the feature in the image was vertical, the feature in the block was vertical, all of this would be rotated 90

degrees, so it would be lined up. So the green line there is attempting to line up with the dominant feature in the block, which in this case is our boundary between the dark and the light pixels.

Moving on to the one on the right, CDEF goes through a number of steps, the first step is actually to do what I just described, to find the direction or the dominant direction and line up this pattern, this sort of -- it is like an asterisk, I think, if you sort of squint at it -- to line up this pattern based on that direction.

The next thing it does is illustrated on the right. It takes each of the 12 yellow and green positions and it subtracts from each of those the center position. So it's creating or calculating difference values. And you can see that if you move to the left of the 101 you've got a block that -- a pixel that is 102.

The difference between 102 and 101 is plus 1. Move one left again, you've got a value that is 97. 97 take away 101 gives you minus 4.

If I point to this one, does that help? So for each of these positions, we're looking at what's the difference between the pixel position over here and the center pixel. And if you do that for every one of the 12, you end up with 12 difference values.

And I'll just draw your attention to one more,

which is the difference value on the right in the green. And you'll see that the original pixel value over there was 101. Our center pixel also happened to be 101. That's just because of the random variation. So the difference is zero.

So this is the differencing step. And I've called this in the title "difference domain," and this is my opinion, but, in my opinion, this is -- what we see on the right is a transformation of what was on the left, a representation in a difference -- in a different domain, which is this difference domain.

Q. So when we think back to the Manhattan skyline photos, and thinking that you have the top-down bird's-eye view versus the East River view that you can actually see the height of the buildings, that transformed into a different viewpoint, how does that relate or not to what's CDEF does with, as you say here, transforming the values into the difference domain? Is it looking at it from a different perspective like the Manhattan skyline?

A. It is doing exactly that. It is taking all of the data that I highlighted on the left and representing it in a different viewpoint or a different way of looking at that data in what I'm showing on the right.

And it's all still there, which might require a bit of explaining, but we've moved -- we've shifted, from the processing point of view, we've shifted the way that we

look at the data and, therefore, the way that we process the data by calculating these difference values, and that, in my view, is analogous, directly analogous, to shifting the viewpoint from bird's-eye view of Manhattan to a sideways view of Manhattan.

Q. And that's what CDEF does, is that your opinion?

A. This is one of the things that CDEF does. And it's not just my opinion. It's in the process in AV1, and these are the results that I didn't just kind of make up, I calculated them by applying the CDEF process in my test simulation, my MATLAB software.

Q. And we'll look in just a moment what we do next with this information, but first let me ask you two questions.

One, if I use the pointer on the screen, still looking at CDX-5C.50, if we look at this negative 4 value here, relative to the 101 pixel value of interest, can you get back to the original dataset, meaning, is this difference domain calculation, is that reversible?

A. It's completely --

(Clarification requested by the court reporter.)

A. -- completely reversible, and that's really, really important. Sorry. It is completely reversible.

So you can step through quite straightforward, I think. If you start with minus 4 and add 101, you get 97.

So you can quite literally work backwards. You can work backwards from minus 4 and 101 to 97. If you start with the next one, plus 1, you can work backwards from plus 1 and 101, add them together, you get 1.

So if I wanted -- I don't know why I want to -- but if I wished, if I had the data on the right and I knew how it was generated, I could reverse that process and get back to the original data. And, again, by analogy, I haven't leveled any buildings in Manhattan, I haven't touched the buildings, I've just moved my viewpoint of the buildings. All of that information is still there, but it's in a different domain or a different representation.

Q. And I said we're going to look at what happens next in this process, and I had two questions. That was the first one.

The second question I had for you is: Does CDEF use an overcomplete set of linear transforms?

A. In my view it does. So a linear transform is a transform that is, among other things, reversible. Overcomplete, and these are kind of quite big concepts, but overcomplete, as the name suggests, is more transforms than you need.

So in the example that I've just sort of walked you through, I can get back to the original data with just one of these pairs, but if we look at it another way, I can

get to 101 with any one of these difference values and the original value. Because it works that way as well.

So if I go through all 12 of these, I can get back to 101 by adding 4 to 97, I can get back to 101 by subtracting 1 from 102, by adding 5 to 96, or by adding 0 to 101. So any one of these four gets me back to the original value.

So in my view, that is an overcomplete representation. Each one of those differences is a simple linear transform. We don't actually need all 12 to get back to the original data. We can get back to it from any one of the 12. So in my view that makes this set overcomplete.

Q. So if we pick up on the slides where we were, we have what you've called the difference domain on the right, so let me move to CDX-5C.51, and it looks like we're picking up with the process. I see that difference domain on the left.

What's going on here?

A. Okay. In retrospect, I should have maybe broken this down, because there is quite a lot going on in here. We'll focus on it one piece at a time.

The difference domain, I think I've walked through in quite a lot of detail, that's the one on the top left of this slide.

The other two pieces of this slide are

illustrating what happens next in CDEF. And I'm trying to illustrate a process that's implemented in software or hardware. But I'm just trying to illustrate what happens next.

So what happens next, once we have the values in the difference domain, for all of those values except for the middle one, so for all of those color-coded yellow and green values -- by the way, I'm going to introduce a term, offsets, offset locations. I should have done that earlier.

So I'm going to say that all of the yellow and green highlighted values on the left are offset locations, 12 -- always 12 locations with CDEF.

So what CDEF does next is it looks at what is in those offset locations. And if the numbers in those locations, if the scale of those numbers is above a certain level, it ignores them. If the scale is below a certain level, it uses them in the final step.

And I've illustrated that in the middle diagram with the X's. So in the middle you'll see -- well, let's go to the left. You'll see that some of the numbers are larger, 39, 36, 32, 36, and the magnitude of those numbers, whether they are positive or negative, they are a long way from zero.

Other numbers are much closer to zero, the magnitude of those numbers is smaller. So CDEF makes a

decision based on the magnitude of those numbers.

If the magnitudes are above a certain level, such as in this case 32, 36, or 39, I've put X's through those values to illustrate that CDEF ignores those values from this point on.

Q. Let me ask you, if I may, just to break this down a little bit before you keep going with what's shown here, because there's a lot on this slide.

First of all, in the difference domain that you've shown, the far left side that we see here on slide CDX-5C.51, is that difference domain a sparse representation?

A. In my view the difference domain is a sparse representation. It's a different viewpoint or a different representation of the data, and it has made it possible for this filter to discriminate between data that it wants to take into account when filtering and data that it wants to ignore when filtering. And -- sorry.

Q. Were you here yesterday -- you were here yesterday for the openings, right?

A. I was.

Q. I don't have a slide on it, but do you recall the piano chord that was played, three large spikes for the notes, and then much smaller near zero values for the audience members that were murmuring in the background?

A. Yes, and those yellow smaller values, as I recall, were representing noise, background -- audio noise in that example.

Q. And let me ask you, are there instances there where perhaps you're interested in discerning those three large values and getting rid of the noise in the crowd?

A. Yes, and like I think -- it was a good illustration yesterday where you might have a recording of that concert, or you might be streaming it live, and you want to try and make the piano sound better and try and reduce the noise. And that is something that you do in audio processing. You can try and reduce the noise and keep the dominant components, which in this case are -- would be the frequencies of the piano chord that's being played.

Q. Could you or would you apply a threshold and, for example, get rid of all the noise below the threshold, just leaving the three dominant?

A. You could, and I think that was explained yesterday. Again, I think that's a good illustration of, in a different but related context, how you can use filtering such as a threshold to remove noise and keep the things that you don't want to filter. So in that example you're filtering the noise, you're not filtering the large dominant values, you're leaving them unchanged.

Q. And kind of the inverse of that same example with

the piano, I think yesterday was mentioned that perhaps the FBI would want to hear some plot going on in the crowd, and try to remove the piano, the dominant piano sounds.

So could that threshold be applied and, for example, filter out the large values and leave just the smaller, near-zero values?

A. You could do that, yes, in the example that was given, that would be a different type of filter, but it would be -- still be using that representation, that viewpoint of the data, the frequency domain in that example, it would be using the representation as a tool to filter one thing and leave the other thing, and it depends on what you -- again, you can do that with the audio. You have filters that will basically turn up the noise and squash the signal.

Q. With those concepts in mind and perhaps with reference to CDX-5C.51, why does CDEF in AV1 put data in the difference domain? Why does it do that? What's the point?

A. So the point, and it's taken a little while to get here, but the point is to -- is to try and get a good effect on that pixel in the middle. The point is to filter that pixel in the middle.

And what's happened here is the result of the filter, the final step, and I'll cut to the punch line, it's made that pixel value slightly lower. So if you remember

our kind of brightness values, the brightness of this pixel has got slightly less. It's gone a little bit darker.

How it's done that, by going through this process, it's ignored those values that I put crosses through, and what's left are the values that are small negative and positive values up here, and the filter -- this is exactly -- actually what it does -- it uses those values and then it tries to adjust the middle position based on those values. And what it's doing here is adjusting that middle position to make it more similar to those values.

Could we actually go back one slide? I think that might be helpful, just briefly.

Q. Yes, back on CDX-5C.50. Please continue.

A. So going back to our original block, you look at the 101, look at the yellow and green values that are not ignored, the ones on the same row and the ones above, and just try and focus on those 1, 2, 3, 4 -- eight values round about it. Most of those values are slightly lower. Most of them are in the 90's.

So when we just consider that part of the data, if we're trying to reduce the noise with just that data in mind, then we want to make 101 slightly smaller. And the result of that is that it gets a little bit more similar to those other values.

Two things going on here. One is that, if you

1 think about doing that for every single pixel, then those
2 pixels are going to get a little bit more similar to each
3 other, and that is what CDEF does. It reduces the noise.
4 It reduces those random variations. It makes them a little
5 bit more similar to each other.
6 The reason, though, that we had to exclude the
7 pixels at the bottom, so one more, please --
8 Q. Yes, sir.
9 A. -- 4 pixels at the bottom that we excluded, if
10 you look at the numbers there, they are quite large. So if
11 we haven't excluded those numbers, they would actually
12 result in the opposite effect to the one we want. They
13 would make 101 larger.
14 So if we go on, Kirk.
15 Q. If you would, just continue that same thought. I
16 think it's helpful, perhaps, in reference to the middle part
17 with the X's, the middle and right.
18 A. Okay. So, yes, again, we've picked our window,
19 we've picked our offsets, and then we're going to consider
20 those offsets, exclude the ones whose values are
21 particularly large, or I could have shown it the other way
22 around, CDEF will also exclude values that are particularly
23 low in the negative regions and leave behind everything
24 that's quite close to zero, small, plus or minus values.
25 And then filter that middle value based on those

small plus or minus values. The effect of that is to bring all of those unexcluded values closer together.

Again, what would happen if we didn't have this difference domain constraint before doing that filtering, those big values, those large values, they would influence the filtering. They would make 101 get larger. Visually that would actually make our edge get fuzzy. Hopefully you can see that this was the darker part of the edge, and we want to make it similar in the dark region, we want to reduce the noise in that region. What we don't want to do is actually have this unwanted effect of a little bit of the light region bleeding into the dark region.

So if you think of this as really hard to do without kind of a video and stepping through many blocks and pixels, but hopefully you can get this general idea that, if we didn't do this constraint in the CDEF, the filtering would not have this effect of smoothing out the small variations and leaving that edge or that feature, it would actually -- it might smooth out the variations, it might get it wrong for the reasons I discussed, and quite crucially that edge would no longer be an edge, it would be kind of a blurred line.

And then one more thing, and then I'll let you go on, sorry, one more thing is, remember we're using this for prediction. The whole point is to improve the prediction.

So if we have that edge of the car in the next frame, if we can keep that edge and smooth out the noise, we're going to get a good prediction of that edge wherever it is in the next frame.

Q. And on the bottom of the slide is the -- what is that?

A. Okay. Unless you're in my world, that's quite scary, even for me, the first time I saw it, it took me a while. That is a big equation.

The CDEF paper that I referred you to a few minutes ago, that describes the CDEF process. It describes overlay of three or four pages of step-by-step text. And then it says, and I'm paraphrasing, this equation represents the whole thing. So that equation is a mathematical representation of the whole CDEF process. Actually the process after we've found our direction and we've picked our -- we've picked our offset values.

Just quickly, because this might be relevant later on, I've color-coded the equation to try and match it up to what you just heard. So I'm not going to go through the maths, but I will go through -- nothing up my sleeve -- this equation is explaining -- what I've explained is basically what this equation tells us.

And with an equation like this, you start in the middle and work outwards, or that's the way I'm going to do

it, in the middle is xi plus m minus xi. m is the offset, a shorthand for going sideways in the green or up diagonally in the yellow.

So what that middle part is saying is basically the first part that I showed you. Put it into the difference domain. So when you do that for all of the offsets, you end up with the 12 offset positions that I showed you.

So m is basically one of 12, and this happens for all 12 positions. So you end up with all of those 12 difference domain values.

Going out, this is like a Russian doll, I'm going to unpack the doll, the next layer of the doll is a function called f, and you see it's got an open parentheses and at the end of the line it's got a closed parentheses. So everything inside those parentheses is f. F, according to the CDEF paper, also the AV1 Specification, is a constraint function.

And what f does is the piece in the middle. It excludes large positive or small negative differences. And by small I mean like minus, in this case, let's say, anything below minus 30, anything below minus 40 is excluded. So large magnitude differences are excluded by f.

Q. And this equation is from CX-1608, the paper; is that right?

A. Absolutely. Absolutely. I'll just very quickly go through two other pieces.

There is a weight here, which is -- I think that's meant to be an orange color-coding, but it doesn't really show up very well. And so the weight is applied to the output of f, so to everything that's not excluded, there is a summation here, which means adding things up mathematically showing, basically, if I can paraphrase, take the remaining values, multiply each of them by some sort of a factor, and then add them all together. And that has the effect, in this example, of coming up with a negative value, which is finally added to our actual pixel. And that's what you saw.

We came up with a negative value from the offsets, because, overall, they are negative. We added a negative value, subtracted something from the center value, and we ended up making the output, that's the 99 here, slightly smaller, and that's the filter. That's how this complicated-looking equation works.

Q. Thank you for that, Dr. Richardson.

You've described now in quite a lot of detail the CDEF and its operations.

With the filter, and the way you've described it, and putting the values into the difference domain, which you said is a sparse representation, in your opinion is CDEF and

AV1, is that an adaptive sparse denoising filter for purposes of the '556 patent claims?

A. Yes. And I can explain or remind you very quickly, based on this one slide, it's adaptive at least because this pattern changes direction based on what's in the block. It's a sparse denoising filter, because it's reducing the noise, the variation, and it's using or basing that on the difference domain, which is a sparse representation. And it's a denoising filter, because the result of using that difference domain is a filtered pixel, which has the effect of reducing that noise variation.

And I didn't mention constraint in my answer, but, without the constraint part in the middle, we wouldn't have excluded the pixels. So we need to get into the difference domain and then do something, and that -- or to something. The first one is to exclude some values and the second one is to calculate a filtered output.

Q. Now you've described CDEF in this example with the pixel value of 101, but does CDEF do the operations you've described of putting the information into the difference domain, which is sparse representation, does it do that as it's tasked regardless of which pixel it's actually operating on?

A. It does. And I've -- I'll be honor here, I've deliberately chosen an example where things are being

excluded, because that helps you to get the general idea.

The same process will be applied to other parts of the image, which might not have anything to exclude. All of the difference domain values might be small, positive and negative. It's still a sparse representation. It's still using that to control its operation and to reduce noise.

Q. I wanted to ask you about that very point, because yesterday during the openings there was a suggestion, not by us, that CDEF might not be a sparse denoising filter depending on the pixels being filtered, meaning that sometimes the representation might be sparse and sometimes not, depending on what the pixel values are.

Is that right, or is CDEF doing its job regardless of which pixels it comes across?

A. In my opinion that's a completely incorrect interpretation, because CDEF is always going through this process, whether or not there's big edges or big discontinuities to exclude, it's still going through the same process.

If I might make an analogy to the piano and the removal of noise in the background, if I'm the engineer setting that up, I'm going to set up my filter to remove noise. If the audience is really, really quiet, my filter is still a denoising filter. It's still working to reduce noise, even if the noise isn't there.

Another little analogy is the deblocking filter. Sometimes there are blocks where there are no discontinuities to remove. It's still a deblocking filter. It's just that it basically does nothing if there's nothing for it to deal with. Just like here, if there are no edges to exclude, it doesn't exclude edges, but it's still going through this process, it's still, in my view, a sparse denoising filter for the reasons that I suggested.

Q. Let me turn to one other thing I heard yesterday, and I think we'll hear from Lenovo going forward.

Are you aware of an argument where they say that CDEF does not qualify as a sparse denoising filter because it does not generate 12 difference values all at one time? Are you aware they argue that?

A. I recall that argument, yes.

Q. And I believe they rely on the pseudocode for that theory.

Do you recall that?

A. I do, yes.

Q. Let me move forward to CDX-5C.52.

What do we see here on this slide?

And this is from CX-247.337.

A. So actually this is really quite -- it's another representation of what I just showed you. You remember that scary-looking function, the things highlighted here is, I

think, if I remember correctly, another way of looking at that function.

This is pseudocode. Pseudocode is not software. Pseudocode is, in this case, a set of logical statements. This pseudocode comes from the AV1 Specification.

A quick step back. AV1 specifies as completely as it can a decoding process. And part of that is written in text. Sometimes the authors go into pseudocode or use pseudocode when it's, in their view, I guess, more compact to just specify a series of logical steps.

To a person of skill in the art, this looks like software, but it's not software. So to run CDEF in software, you have to implement source code in software or in hardware based on this, that follows these logical steps. Because that actually, at a high level, the specification says you have to do this, you have to follow these logical steps, it doesn't say how you put it into software or hardware.

So this is pseudocode. This is not the actual software.

Q. And did you review the actual source code?

A. I did, for all of the source code that I listed earlier, I reviewed the actual software or hardware source code that carried out the CDEF operation.

Q. So when they are relying on the pseudocode and

you looked at the actual code, who did you decide is right about this issue?

A. The question, as I understand it, is what the products do, not what the pseudocode does, and if there is a dispute or if we disagree about the functionality, and it actually depends on how the software or hardware implements this functionality, then I would say the software or the hardware itself is the thing to look at and to rely on.

And I based all my opinions that I've given you on the software and the hardware, not purely on the pseudocode.

Q. If we move to CDX-5C.53, does this slide summarize the actual code that you've relied on relative to the products?

And I'm speaking specifically about CX-1604C, CX-1967C, CX-1674C, and CX-2021C.

A. It does with respect to the products containing Nvidia chipsets, the products containing Intel chipsets, the products containing MediaTek chipsets, and the top one, AMD, I forget whether that's version 3.0 or 4.0, but I've reviewed the relevant hardware source code for both those versions and relied on it upon my review for both those versions.

Q. Sir, you've described how CDEF is an adaptive sparse denoising filter, and you've explained why my friends

here are wrong in those theories.

What did you ultimately conclude regarding claim element 5.d of the '556 patent?

A. So in my opinion this element is satisfied by all of the AV1 products. When they decode video according to the AV1 Specification, they go through the steps that I've showed you, and for the reasons that I've explained, in my opinion, they satisfy an adaptive sparse denoising filter for performing a second pass to reduce noise.

Q. Let's move on to the last limitation of claim 5, which we said earlier the debate is over whether CDEF is selectively enabled or disabled.

Did you form an opinion on that issue?

A. I did.

Q. And what happens in AV1? Is CDEF selectively enabled and disabled -- enabled or disabled?

A. CDEF is selectively enabled or disabled in AV1.

Q. And how do you know that?

A. So, for example, the AV1 Specification, I think we might have it on the next slide -- I can't remember -- if not, I can just sort of summarize.

The AV1 Specification tells us that certain elements or certain parameters in the bitstream itself can enable or disable CDEF. What I mean by that is that if certain flags or values are set to a certain value, CDEF is

applied by the decoder. If these values are set to a different value, CDEF is not applied by the decoder.

Q. Does the claim say what selectively enables or disables CDEF, or does the claims say that the sparse denoising filter is selectively enabled or disabled?

A. Well, the plain language of the claim, as I see it, is that the claim element 5.e says that the adaptive sparse denoising filter is selectively enabled or disabled. It doesn't say which portion of the system needs to do that.

Q. And I think my friends here say that, of course it's selectively enabled or disabled, but they say it's done by the encoder, and they say this is a decoder claim.

What do you say to that?

A. I agree with the first part. So the selective enabling and disabling is done by the encoder. And I know that because the AV1 bitstream says that the bitstream is produced by an AV1 encoder, and that's actually how it defines the encoding process, the thing that produces the bitstream.

I disagree with the second part, and my reading of the claim is that the claim -- the other claim elements after the first one talk about what the apparatus does -- decode an image region, perform in-loop filtering, perform a first pass, perform a second pass. Element 5.e says something about whether or not the filter is enabled or

disabled.

So it's a different way of using the language, and so I disagree that the decoder has to be the one doing element 5.e.

Q. So, sir, have you walked us through the entirety of claim 5?

A. I have.

Q. In your opinion, do all the AV1 products satisfy claim 5?

A. Yes, for the reasons I've explained.

MR. BRADLEY: Before I move on, I do want to go on the confidential record. I wanted to cabin it to one part.

(Whereupon, the hearing proceeded in confidential session.)

O P E N S E S S I O N

JUDGE MCNAMARA: Thank you.

MR. BRADLEY: I apologize.

JUDGE MCNAMARA: Thank you.

BY MR. BRADLEY:

Q. Thank you for that indulgence, sir. I was asking what is the '877 patent generally directed to.

Please proceed.

A. It is generally directed to video coding, video compression and decompression.

Q. Does it talk about specific ways to perform prediction and reconstruction of frames?

A. It does. And, Your Honor might see a little bit of a connection here. We were talking, when I talked about the previous patent, I was talking about predicting blocks, and so this patent is -- the previous patent was talking about filtering, which had an influence on prediction. This patent is, in my view, talking about an aspect of the prediction process itself.

And, in particular, it's talking about how the decoder creates that prediction block. So, again, reminding everyone of the context, the context was that we want to efficiently encode and compress one block of a current frame, and it was well-known before this patent to do that coding, involving making a prediction from a previously

coded frame, it could be the immediately preceding frame, it could be another frame, but it's one that's already been decoded. And this patent is about ways of making that prediction block.

Q. So if we turn to CDX-5C.61, it's a slide entitled "Adaptive Resolution."

Just briefly, what are we seeing here and how does it relate to the technology and the invention of the '556 -- of the '877 patent?

A. So adaptive resolution is a technique in video coding that has certain advantages or can have certain advantages, and I think this set of images was explained to you yesterday. I created them, so I'm happy -- I'll quickly explain them again.

Again, something that we're all quite familiar with, we're having a Zoom call and the internet doesn't cut off, but the speeds of the internet or the bandwidth goes down, it happens to us all, I think.

And at that time you might find that these blocks appear. We talked about the blocks. The compression has got, if you like, gone overboard and the image becomes very blocky-looking, for the same kind of reasons I discussed with respect to the '556 patent.

One solution to that is adaptive resolution. So the top three images show the example of the middle image is

representing part of the video that has had this -- has suffered this problem. The bottom three images are representing sort of an overall solution or potential solution to that problem, which is that, when you get into the period when your internet connection is not very good, that's the middle picture, reduce the resolution of the image.

So at the encoder you could do that by -- words you will hear a lot -- downsampling, resampling the image, reducing, which generally means reducing the numbers of pixels in the image. So if we started off in high-definition, cut it down to standard definition or smaller. And then when the internet gets better, bring the resolution back up.

You might not notice it as the viewer because the screen might kind of fill the screen either way, but the actual resolution, the sharpness, the number of pixels in the image goes down in the middle part.

So that sounds good as an idea, but it creates certain potential problems with the whole prediction process.

So this patent, in my view, makes this process practically feasible and makes it better by improving the prediction process.

Q. So just to make sure I'm following along, what we

see here on the screen, slide 61, is the top row is a problem, the bottom row is a solution.

Is the '556 patent -- excuse me -- is the '877 patent a solution to what we see on the bottom here?

A. It's a way of making what we see on the bottom practical in a way that wasn't available before, because what we have on the bottom looks like a good idea, but it has certain consequences. And before the '877 patent there wasn't a good solution to those consequences.

Q. So if we move forward, here we're looking at CDX-5C.62, and we have the '877 patent, Fig. 3, and an excerpt.

What are you showing here with the '877 patent problem that they identified?

A. So if you look at the text that I've highlighted at the top right, this is from the patent, when they're talking about the adaptive resolution method, so that's this kind of concept I illustrated in the previous slide, that you change the resolution of your images, we would say on the fly, as you're going along, the encoder changes the resolution.

But this text is identifying a problem or a problem with that concept, which is that at the time of this patent the only way that people, I would say, knew how to do that was to save lots of versions of the previous frame.

So that's kind of illustrated in Fig. 3. It's not the most user-friendly figure, but it's all in there. I'll use the pointer again.

So the top of figure 3, there's a line of illustrations of video frames or coded video frames, 0, 1, 2, 3, 4, 5. This is quite close to that previous slide of mine. 0 and 1 are at full resolution; 2 and 3, the encoder wants to reduce the resolution, like we discussed; 4 and 5 have gone back up to a larger resolution.

The problem occurs when you think about frame 4, for example, how does the decoder make these prediction blocks for claim 4, where does it get those blocks from.

Because for frame 4, frame 4 is at full resolution, but the previous frame was actually a lot smaller. And before this, the way we did things, the way people in the industry did things was to try and predict from frame 3 by making a bigger version of frame 3 in the decoder. And that's called an upsampled reconstructed image or reconstructed reference image.

I should have said below the line is showing reference images in the DPB. We saw the DPB earlier, the decoded picture buffer. That's where the decoder stores a frame that it's decoded so that it can be used for later predictions.

So the patent is kind of looking at what ends up

in the DPB, is it a problem, it is, according to the inventors, how do we solve that problem.

And so to predict frame 4, we need a full-scale version of frame 3, and that's shown as 3 prime, at the bottom of the column headed with 4.

So imagine a block at frame 4 is predicted from a block in the immediate preceding frame, frame 3. What this is saying is that the prior art method was to take the decoded frame 3 that we had already decoded, that's in the reference picture buffer, in white, and also create an upsampled version of that frame, a bigger version, store that in the DPB, the decoded picture buffer as well.

Slight complication I haven't introduced yet in my earlier discussions is that, in many modern-day video codex, including AV1, frame 4 can be predicted or blocks in frame 4 can be predicted not just from frame 3 but from earlier frames as well, maybe two frames in the past.

So we want to predict blocks of frame 4 also from frame 2, which happened two frames ago. Sometimes there are good reasons for that depending on the way things change from one frame to the next.

So now the decoder, to decode frame 4 has to store original size frame 2, that's the small version in this example, bigger size version of frame 2, original frame 3, and bigger version of frame 3.

So you can see there is a lot more requiring to be stored in this decoded picture buffer. And that works for all of these frames.

It's actually worse than this figure shows, because as the patentee explains, if you have not just two possible resolutions but, say, 16, you need to decode -- you need to upsample and store all of those in the decoded picture buffer, and that's actually what the patent says. For as many versions as we have -- we have to store as many versions as we have possible resolutions.

Q. Thank you for that. I've shifted to CDX-5C.63, which, using your soccer or football, perhaps, example, it shows the prior art method.

Can you just kind of put your discussion you just gave into the context of these pictures to help make it a little less abstract?

A. Sure. And I hope Your Honor will allow me to call this football, because this is the Scotland women's team, so I think football is the right word to use.

So I've illustrated this prior art, the problem of the prior art. There's a reference frame, which I've shown at the top left here, that was the small resolution one that I talked about. So, I'm sorry, reference frame, that's a frame that has been decoded previously, it's been decoded and stored in the decoded picture buffer, and we

call that -- AV1 I think calls it a reference frame.

So that's at a lower resolution than the current frame, which is the one on the right.

And so what the decoder wants to do, block by block, for the yellow block, which conveniently contains the ball, very important, where's the ball, the yellow block contains the ball, the decoder wants to make a prediction for that block.

It wants to create that prediction from the reference frame. But the reference frame was the wrong size. So the decoder, according to the prior art method, blows up the whole frame, resamples the whole frame, upsamples it, and saves that version in the DPB. And now the decoder can do the job it wants to do. It can take the large version of the ball, the scaled-up version of the square with the ball, use that for prediction, and predict the current frame.

I would just like to point out one thing, and this is going to go all the way through, and it is actually quite relevant, I think, to some of the questions Your Honor might be having to address.

That prediction block, that's not the ball. That's a prediction of the ball. And the ball is still there. These are a few frames apart, but the same principle applies. It's the same ball, of course. It's the same game

of football. It's like a few frames, one frame or a few frames in the past, but it's not the same image. The images have changed. So this is a prediction block. It's different from the block of the current frame.

But we try and find the best prediction, it might not be perfect, it's not perfect, but it's something that matches the current ball.

I'll say one other thing. Those two blue arrows here, these are both, once again, these are filters. These are different filters. Going to talk about filters, but these are doing a different job.

The patent talks about two filters involved in this process. The first one is called a resampling filter, and the claim and the patent uses the terminology SCF. And the second filter is called an interpolation filter, and the claim uses and the patent uses the acronym MCIF, motion compensated interpolation filter. I'll say that again. Motion compensated interpolation filter.

I want to try and go through my explanations without getting too much into why and how we do that, but I think it's enough to know that part of the motion compensation process, which I don't think I really explained much earlier, the process of finding the ball and then shifting that so that it overlaps the current one as closely as possible, which I think opposing counsel actually

explained pretty well yesterday. So I'm glad they did that job for me.

That process of shifting motion compensation process typically involves interpolation. And I'll try and explain that in the next few slides, but, basically, we don't know where that ball came from, it's probably not moved an exact number of pixels, and we can often get a better prediction if we can interpolate, generate half pixels and quarter pixels that don't actually exist and point our offset to those positions, which always sounds a little bit counterintuitive, but it does improve the prediction.

Q. So on this slide 63 that shows the prior art method, I see in the bottom left you've shown here that the resampled version is stored in the DPB memory. If we move forward to the next slide, CDX-5C.64, I see it says, no resampled version is stored in the DPB memory, and the title is that it's the patent's improved method.

What's going on here?

A. So the invention of this patent, I think, is extremely elegant and it solves several problems at once.

In the previous slide we had two separate filter steps. We had a resampling filter and an interpolation filter. The invention of the patent, as I understand it, combines those filters into a single step, the acronym is

GF, I think it's grouped filter, and that GF does resampling and motion compensation -- motion compensated interpolation -- in one step.

So in terms of generating our prediction block, the starting point overall is the same. We're finding the position of the ball in the previous frame. But we're finding it in this example a smaller frame. So everything is kind of zoomed out a bit.

And then instead of resampling first and then interpolating, the patent proposes to do resampling and interpolation in a single filtering step. So we end up with the same prediction block that we had in the previous slide, but now we've done two things. The first thing is we've combined the filters. That saves a filter step. That saves processing, among other things. And the second thing is that there is now no need to store a resampled version of this reference frame in the DPB memory.

The reason for that is that the frame is always there, and if we are resampling it as we need it for the current frame, if we need to resample by 2, we resample by 2 and we interpolate it. If we need to resample by 4, we resample or scale up by 4 and interpolate. Because we do that in a single step, pointing -- in a way we're cutting out the middle man, we're pointing straight to the original-sized reference picture. We don't have to store

the same amount of data in the buffer. And we don't have to do two filters; we can do just one.

Q. In the method and apparatus of the '877 patent where no resampled version is stored in the DPB memory, is that a big deal? Is storage space in the DPB memory at a premium or doesn't matter much? What's your opinion?

A. In my opinion, Your Honor, it's a really big deal. So a little bit of context.

Each standard, I mentioned the H.264. In the standard it specifies how much memory a decoder needs. That, in turn, affects the size of chips, the cost of chips, the power consumption of chips.

And remember that I said a couple of slides ago that, without this, if you have 16 different resolutions, you need to store 16 different extra versions of this reference frame in the DPB. So the size of the DPB, everything else becoming equal, is increased by a very substantial amount.

I mean, you can do the sums, and it depends on the number of -- but, again, a different Russian-doll analogy. Instead of storing one Russian doll, I've got to unpack it into all the different sizes and put all of those. If you wanted to put that in your cupboard, you need a much bigger cupboard basically.

So, yes, it's a big deal. Memory, working within

limited memory sizes is one of the big constraints of video codec design and chip design for video codecs, and these chips are in so many consumer devices, as we've seen. So if we can save that much memory, that's a big deal in my view.

MR. BRADLEY: Your Honor, I'm at a point where the next bit of questioning might take a little while. Is now a good time for an afternoon break?

JUDGE MCNAMARA: Sure. So it's 3:57 now. I'll see you back here in 15 minutes.

(Whereupon, the proceedings recessed at 3:57 p.m.)

(In session at 4:13 p.m.)

JUDGE MCNAMARA: All right. Thank you, everybody.

Anytime, Mr. Bradley.

MR. BRADLEY: Thank you, Your Honor.

BY MR. BRADLEY:

Q. Dr. Richardson, I've turned to CDX-5C.65 titled "Single Filters Are Applied Successively to Reference Block," and it shows Fig. 8 of the patent.

What are we looking at here? What does this tell us?

A. So on the right-hand side of the slide I have taken Fig. 8 of the patent and I've taken the liberty of graying out some pieces, but I don't believe that changes

the meaning of what I've left behind.

And what Fig. 8 is showing in the pieces that I have effectively highlighted is a reference block at the top left, and if I can just orient Your Honor, I was talking about 8x8 pixel blocks earlier, so what the patent here is illustrating is consistent with the 4x4 block.

So it's a smaller, four along, four down, but video codecs, such as AV1, or other video codecs, can use in some instances smaller or bigger block sizes, and 4x4 is one of the block sizes that we might have in a reference block -- a reference frame, sorry.

And then the patent talks about GF, the grouped filter that I mentioned earlier. And I sort of simplified things somewhat, because the patent does describe in detail that one of the things you can do with a filter, the filter GF overall, its job is to process a block in two dimensions, horizontally and vertically, and with the right choice of filter you can split those tasks up into a horizontal filtering step and a vertical filtering step.

And I think I might be kind of extrapolating here, but I think the patent says that you can do them in either order. I think one of ordinary skill in the art would understand that this type of so-called separable filter, you can do the horizontal first and then the vertical. If you switch the order, you can still do that.

So here it's showing horizontal first and then vertical. So it's showing one of these GF filters or it's G in the diagram. And, first of all, the reference block is filtered horizontally. And if I could just use the laser pointer again, what that means is that the first horizontal filter operates on these four pixel values, which are still in black here, and fills in values in between.

And so, as a result of that, if we do that for all four rows of pixels in the block, the pixel has four rows, we do that for all four rows, we end up with a temporary block here, that is the same height as the original, but is now twice as wide or more or less twice as wide, because we filled in those pixels.

The patent then discloses that, if we do the same thing in the vertical direction with the vertical filter, now we're taking this temporary or intermediate block as the input, and the end result is that the vertical pixels get filled in so we get more pixels in the vertical direction.

So by doing first applying GF and then applying GV or GF -- sorry -- first applying GFH and then applying GFv, as the patent says, the result is that the prediction block, the upsampled or resampled or filtered prediction block has been generated.

Q. On this slide it shows an excerpt from the '877 patent specification that says, the filters GFH and GFv are

then successively applied as shown in Fig. 8 to determine the prediction block, which is the prediction in the bottom right of the Fig. 8.

What is that showing about the filters GFH and GFv being successively applied?

A. This is the excerpt from the patent specification, the text that I've highlighted, that's explaining what it means in the context of the patent to successively apply horizontal and vertical filters, it means as shown in the Fig. 8.

So in a situation where you start with an original block, the reference, you generate an intermediate or temporary block with the first filter, and then the second filter is applied on that intermediate or temporary block or supplied to that intermediate or temporary block to create the prediction block. That's the final version in the lower right.

Q. So if we move to CDX-5C.66, earlier you mentioned creating in between values, and I see that here on this slide. What is this showing?

A. So the question or what I'm trying to illustrate here is how this type of filter, which, again, I'll remind you is a different type of filter than the ones we've discussed with respect to the '556 patent, just how this type of filter can generate these new values, which are

illustrated in the figure with white dots or dots with white in the middle.

JUDGE MCNAMARA: And you're referring to the temporary block?

A. I'm referring at the start to the temporary block. The same explanation would apply to going from the temporary to the prediction block.

So I have shown what I would describe as a pair of filters here. And I'll just take a little bit of time to show you what I'm showing in this image at the top left.

I'm showing two original pixel values, and I've given them numbers, 8 and 4. Again, we've been through this, pixels can have numbers. I've chosen small numbers to make the sums easier.

So we have two original values. And I'm showing a way of generating missing or an intermediate or in between value. And I'm showing that diagrammatically with these arrows and red blobs or red circles. And the arrows represent a filtering operation, and 8 in this example is just copied. The pixel is not changed.

So the arrow goes from the 8 at the top to the 8 at the bottom. And the weight or multiplier -- these things are all kind of synonymous -- the weight of the multiplier or the coefficient of that filter is just a 1.

The next value, the 6, which I've highlighted in

blue to show that it's a created value and in between value, that's generated with in this case with a filter that has multipliers or weights or coefficients of one half and one half.

And the reason it's got 2 is it depends on 2 pixels. So the 8 is multiplied by a half, the 4 is multiplied by a half. Not too difficult to do that -- 8 times a half is 4, 4 times a half is 2, and then those two are added together. And that's multiply and add.

We actually saw a little bit of that in the '556 patent, that sum with the weights, so this is a weighted sum, if you like, of 8 and 4 to give us 6.

And then the third pixel at the bottom, the 4, is just copied again, so that has a filter that has a weight or a coefficient to a multiplier of 1.

Q. Are you just explaining how to generate those in between values, for example, we'll call them the white dots in the temp and in the prediction, Fig. 8?

A. That's right. So if you followed, accept what I've said so far, if I do that for every pair of pixels along the first of those horizontal lines, as in the filter will have generated the first row of white values. So that's why I zoomed in -- I should probably have zoomed in on the bottom part. I don't know if I've done that in a blowup of the slide.

But I took two pixels here and generated one in the middle. If I do the same thing moving along, I take 2 pixels and generate an extra one. If I do that all the way along, every line, I end up with a temp array.

Q. If we move to CDX-5C.67, what do we see here on the right side of the screen? And you don't need to walk through the details, but what is that showing?

A. Okay. So the '877 patent is yet another quite complicated patent with a lot of equations in it.

What I'm trying to show here is that my simple but I would say accurate example is a version of filters similar to those that are expressed in the patent.

So I've picked out two filters that are actually disclosed in the patent. And the first one, and this is maybe a little bit difficult to follow, but let's concentrate on the first one, and imagine that first line was just a 64 divided by 64.

Do you see what I've highlighted there? 006400 and then all of that divided by 64.

So if we ignore the zeros -- and I'm not going into territory we discussed earlier; I'm just asking for the purpose of following this through -- then what we have is 64 divided by 64, and that's just 1. So that top filter, I would suggest, is a copy filter, just like the one I had shown here on the left.

I ignored the zeros and I just put the 1 in brackets. In the patent it has this extended notation. What that notation means to a person of ordinary skill in the art reading this patent is that, when I'm applying that filter, conceptually I could take into account 5 pixels, that's why there are five entries in that array, but it's saying ignore four of them and just use 1 pixel and copy it.

Q. I think that -- is there more you wanted to say about that?

A. Just that the second line is a more complicated filter, but it's the same general idea. I've deliberately chosen for simplicity a simple, what's known as a bilinear filter, for that middle step where we're generating a new pixel.

Q. Let's move to CDX-5C.68, which I see is "Prior Art Resampling." I guess it shows the SCF, which is the resampling filter on the top, and the MCIF on the bottom, and it looks like you've highlighted in green the SCF.

What are you showing here?

A. So if you recall, before the break I showed you a slide where we had a smaller source image, a smaller reference image rather, and a larger resampled reference image, which we're going to use for prediction. And there was a first filter, and that first filter was labeled SCF, and it stands for -- actually, yeah, sampling something

filter. I can't remember at this time of the day.

But so this is showing how we can use that simple filter I showed you, the bilinear filter, on a row of pixels, so this could be the top row of that reference block, and we generate or the filter generates a new row of pixels with the in-between values filled in. So that is an upsampled row of pixels.

So this is representing for one line of pixels in one block of that reference image in my previous slide how this filter would generate an upsampled version of that line, and that line would ultimately be stored in the decoded picture buffer.

So if you can imagine that previous image and one little line of pixels, this is what that prior art method does to that line of pixels. It applies this filter or these filters over and over again.

JUDGE MCNAMARA: I'm sorry. When you're describing, so it's clear in the record, rather than saying "here" or "there" --

A. Oh, I apologize, Your Honor.

JUDGE MCNAMARA: -- give us the color coding or however you want to describe it as long as there are references.

A. Thank you for the reminder, Your Honor.

So I've highlighted part of this diagram, my

diagram, in green, and I'm using that to represent the SCF, the first stage sampling filter. And within that highlighted box you'll see a whole series of these filters I introduced a slide or two ago.

So pixel 8 is copied, because the multiplier or coefficient is 1. Pixel 6 highlighted in blue is generated by multiplying 8 by a half and 4 by a half and adding them together. Pixel 4 is just copied. The pixel with value 8 is generated by multiplying 4 by a half, 12 by a half, adding them together. Again, half of 4 is 2, half of 12 is 6, add them together you get 8. And if you keep doing that across the line you get a resampled version of that line of pixels.

Q. So if we go to the next slide, the same slide, but now you've highlighted in green the MCIF. Is MCIF doing the same type of operation that you just described in relation to SCF, the scaling filter?

A. It is. And I've actually chosen to use the same filters here. They don't have to be the same. It could use different, more complicated filters, for example, but I'm choosing, again, the simple bilinear filter and copy filter.

And what this is illustrating, this green highlighted area, MCIF, this is illustrating the second stage of filtering in the prior art, and this does a slightly different job that looks very similar. It's

generating the yellow pixels in the bottom line to fill in half-pixel positions. It's increasing the density of the pixels, if you like. So it's doing a slightly different job even though I'm using the same filter structure in this example.

And, again, the pixels we generated previously are copied, so that white 8 is copied to the white 8 at the very bottom. The blue 6 is copied to the blue 6 at the very bottom. In between them we're generating another sample value, half-pixel position, and we're doing the same operation, but this time with 8 and 6. So the white 8 and the blue 6 on the left in the middle line are each multiplied by a half and then added together. 8 times a half is 4, 6 times a half is 3, add them together you get 7.

And if you do that for every position, we end up with another line of pixel values or interpolated values at the bottom of the screen.

So in two stages we've gone from the pixel values 8, 4, 12 and 4, to the new or the pixel values 8, 7, 6, 5, 4, and so on. So this is illustrating, for one line of pixels in our reference image, how we get to the resampled version and then the motion compensated interpolated version using two stages of filters.

Q. So with these two stages, and the next slide we're going to look at the invention relative to what we're

looking at now, this is the prior art, and you've described it as two stages with a C in the middle that says resampled version stored in the DPB.

Is that the same thing you were describing earlier about the prior art?

A. It's the same thing. The only thing I'm not showing is the vertical version of this, because we have to do all of this horizontally and all of it vertically, but I'm describing simple filters that correspond or illustrate the prior art method.

Q. Okay. So let's compare what we're looking at here on slide 69, which is the prior art, where you have two stages and a resampled version stored in the DPB.

Let's go to slide CDX-5C.70 entitled "'877 Patent's Grouped Filter," and what do we see here including that text on the left?

A. So I'm now showing a GF that does the same job in a single stage as those two stages of filters in the previous slide.

And I'll spoil the plot by telling you that the line of pixels at the bottom is identical, but we got there or the filter got there in a slightly different way.

And it's probably easiest if I just step through, once again. I'll start with the pixel 8 at the left. The pixel 8 is copied. It's got a 1 in that circle. If we look

at the pixel 7 next to it, which is highlighted in yellow, that has two input sources, 8 and 4, but now we've changed or now the filter has different coefficients or weights. The weight coming from 8 is three quarters, the weight coming from 4 is one quarter. 8 times 3 quarters is 6, four times a quarter is 1, 6 plus 117.

The next one, the blue weights of one half and one half. Half of 8 is 4, half of 4 is 2, 4 plus 2 is 6.

And then the next pixel along moving to the right is a yellow 5, and the weights are one quarter and three quarters. One quarter of 8 is 2, three quarters of 4 is 3, 3 plus 2 is 5. And then the pixel 4, we just use a single input of 1, so 4 is just copied.

So what this filter has done in a single step is generate the same output values but without having to go through the intermediate step. So even though the numbers at the bottom are the same, what's happening to get there is not the same. We don't generate the numbers in the middle. We don't need to store the numbers in the middle. And so this represents or, in fact, this is a simple illustration of the GF combined filter of the patent.

I'll just point out one more thing, is that, if you look along the diagram and follow the arrows and the circles and so on, you'll see that there are four unique sets of operations. You can copy with a 1, you can multiply

and add with three quarters and one quarter, you can multiply and add with a half and a half, or you can multiply and add with one quarter and three quarters. And then you go back and just repeat.

And I've illustrated those four filtering operations, which is -- this is what they are -- with the numbers in parentheses on the right. 1 is just sitting on its own. The next possibility is three quarters, comma, one quarter. The next possibility is one half, comma, one half. And the final possibility in this example is one quarter, comma, three quarter. And each of these is a filtering operation applied to 2 pixels or 1 or 2 pixels, rather, to generate an output pixel.

Q. So is it correct to say that the group filter of the invention combines the two-stage filters into single and doesn't require saving the resampled version in the DPB?

A. That's exactly correct. There are two benefits from this I see at least. One is that we've done the filtering in a single step so that can be a computational saving, and the second one there is no intermediate value, nothing needs to be stored in the DPB.

Q. If we move to CDX-5C.72, do you recall that claims 1 and 7 are asserted in this investigation?

A. Claims 1 and 7 of the '877 patent, yes.

Q. And claim 1 is a method claim and claim 7 is a

device claim; is that right?

A. That's my understanding, yes.

Q. And you've analyzed these claims and considered infringement and whether the domestic industry products practice; is that right?

A. I have indeed.

Q. And what was your conclusion?

A. My opinion is that the accused AV1 products and the domestic industry AV1 products infringe or practice respectively all elements of each of these two claims.

Q. And I know you studied these claims. Is the there any material differences between them apart from being a method or a device?

A. As far as the analysis I went through to reach my opinions, there is no difference.

Q. Is that also true for the disputes between the parties, no difference as between the two claims to your understanding?

A. It's my understanding that any differences in language between the two frames, two claims, sorry, does not affect -- does not affect any of the disputes between the parties about these claims.

Q. Okay. Let's walk through claim 1. We have here on the screen on slide CDX-5C.73. We have the preamble -- we have the whole claim -- but we have the preamble

highlighted. Do you understand the preamble is not disputed by the parties?

A. I understand that, yes.

Q. And let's walk through it rather quickly.

I've moved to slide 5C.74, CDX-5C.74. What is this showing in connection with part of the preamble language?

A. So I've included part of the preamble language at the top right of this image, this slide, sorry, said reconstructed reference image stored in a decoded picture buffer.

I have extracted and highlighted part of the AV1 Specification below that. And I've identified part of the specification that calls out seven different reference frames. So reference frame -- sorry -- ref frame is a structure described in AV1, the AV1 Specification. There are seven of these structures -- sorry -- eight of these structures, and each of these can contain a reconstructed reference image stored in a decoded picture buffer.

And at the foot of the lower right of this slide I've, again, highlighted part of the AV1 Specification. A variable ref specifying the reference frame contents is set as follows, and in context that's talking about the reference frame that is going to be used to decode or predict and decode the current block.

And at the lower right it says that ref in certain situations is set equal to FrameStore (RefIdx). And in AV1, in my opinion, FrameStore is the decoded picture buffer. RefIdx is an index that identifies one reference frame within the decoded picture buffer in the AV1 Specification.

Q. Let's move on to CDX-5C.73. This addresses another part of the preamble language that says, quote, "from a reference block of a reference image reconstructed at a different size from the size of said current image," closed quote.

What are you showing here with AV1 section 7.11.3.3?

A. So with respect to that text from the preamble of the claim, I am showing an extract from section 7.11.3.3 of AV1 titled "Motion Vector Scaling Process."

As the highlighted text at the bottom points out, the sampling locations are also adjusted to compensate for any difference in the size of the reference frame compared to the current frame.

So if you look at this section and go through the whole of the section, it is describing generating prediction samples using motion compensated interpolation, but as part of that process (excuse me) the sampling locations are adjusted to compensate for size differences.

So that's basically summarizing the fact that this process is doing both motion compensated interpolation and any rescaling of the reference frame in the way that I described earlier.

Q. And it says here from AV1 that it does this to, quote, "compensate for any difference in the size of the reference frame compared to the current frame," closed quote.

Did I read that correctly?

A. Yes.

Q. And if we move to the next slide, CDX-5C.76, I see you have section 7.12.3. It says "Reconstruct Process."

What are you showing here in reference to the preamble phrase "reconstruct a current block of a current image"?

A. I'm showing here that there is a process in AV1 that reconstructs a block of a current image or current block of a current image, and down at the foot of this extract it says the outputs of this process, that's the reconstruct process, are reconstructed samples in the current frame CurrFrame, and this is done for each transformed block.

So this process is basically describing reconstructing a current block of a current image and putting that reconstructed block into CurrFrame. And we

actually saw CurrFrame earlier, Your Honor. That is the reconstructed current image after decoding that then gets processed by the loop filter and CDEF.

Q. So on CDX-5C.77, I see there's a checkmark next to the preamble. Did you analyze the entirety of the preamble language and compare it to the accused products and the domestic industry products and reach a conclusion?

A. I did, and my conclusion is that the preamble of claim 1 of the '877 patent is satisfied for the AV1 products.

Q. Let's move to CDX-5C.78, which highlights in bold claim language -- claim element 1.1, "Motion Compensating Said Reference Block," and it goes on from there.

Did you analyze this, sir?

A. I did.

Q. If we go to CDX-5C.79, what are you showing here with AV1 section 7.11.3.4?

A. So this section is the block inter prediction process, and I've highlighted that this process takes as inputs a variable that specifies which reference frame to use, the locations of a block, single block, of that -- of the reference image, and produces as its output an array, a two-dimensional array, that's a block, of called pred, which contains inter predicted samples. So this is a prediction block that is used in the reconstruction step that I

mentioned a few minutes ago.

Sorry. To summarize, this is summarizing and the specification is describing in detail motion compensating a reference block or the reference block of the reference image that was discussed -- I discussed a few minutes ago.

Q. If we move to CDX-5C.80, I see this pertains to the claim language saying, "motion compensating said reference block of said reference image," and it has AV1 section 7.11.3.3.

What are you showing here?

A. So I've shown this section before. This is summarizing the actual motion compensation that's done to produce that reference block that I just mentioned, and that's the process that I explained a few moments ago where samples in the reference frame are computed based on the motion vector, and the sampling locations are adjusted to compensate for any difference in size of the reference frame compared to the current frame, and the result is the locations of that -- of the block in the reference frame that we're going to use to generate our prediction block.

Q. If we turn to CDX-5C.81, which your slide is entitled "AV1 Subpel_Filters," how do you know that the AV1 Specification describes applying a single horizontal filter GFH and a single vertical filter GFv successively on the lines and on the columns of pixels of the reference block?

A. So the detail of the AV1 Specification describes just that. I've highlighted at the lower right here a part of the, if I recall, the descriptive -- a descriptive part of the specification.

It says, when talking about constructing a prediction block, first a horizontal filter is used to build up a temporary array, and then this array is vertically filtered to obtain the final prediction (excuse me).

And in the AV1 Specification it describes exactly how these horizontal and vertical filters are to be used and applied. And I'm highlighting in the center here an extract from an array specified in the standard, a very large array called Subpel_Filters. And each line of that array that I've highlighted here, that, in my opinion, specifies one filtering operation.

Q. Is there a particular name of the filter shown on 5C.81, which is from CX-247.278 or .275?

A. The filters are specified by the array Subpel_Filters.

Q. Does the '877 patent describe how its single filters are applied and what they're applied to? And I'll turn to CDX-5C.82.

A. It does, and we've seen this modified or annotated figure before. The '877 patent describes that, starting with a reference block, filters GFH and GFv are

successively applied as shown in Fig. 8 to determine the prediction block, bP.

Q. Are you aware that Lenovo has a different understanding of how the '877 patent's claimed filters are applied?

A. I have seen a different interpretation, yes.

Q. And my understanding of their position is that the horizontal and vertical filters must both be applied to the same block, the reference block, both of them going back to that same block.

Is that what Fig. 8 shows?

A. So that's also broadly my understanding of a position that I believe Lenovo has put forward. That's not what Fig. 8 shows. That's not what the text accompanying Fig. 8 shows.

The figure and the text state that what the patent means by successively applying these two filters is as shown in Fig. 8, i.e., applying a first filter to a reference block to generate a temporary block shown in the figure, applying a second figure -- second filter to the temporary block to generate a prediction block also as shown in the figure.

Q. And does element 1.1 of the '877 patent refer to applying a single horizontal filter, GFH, and a single vertical filter, GFv, successively on the lines and on the

columns of pixels of said reference block?

A. Yes.

Q. And just to be clear, does that mean each one is independently applied to the reference block or is it -- are they successively applied starting with the reference block?

A. So the claim language, it uses the word "successively," and my understanding, as a nonpatent lawyer, is that one should read the claims in the context of the specification. The specification says exactly what in my view the inventors meant by "successively applied" in this instance.

Q. I've pulled up CDX-5C.83, which -- what are you showing here?

A. So I'm trying to illustrate here what, as I understand it, Lenovo are suggesting with this particular position. As I understand -- if I understand it, I think they're suggesting that the claim is saying apply GH to the reference block, for example, to generate a horizontally filtered block like the one I've highlighted as temp here, and also to apply GV to that same reference block, which I would imagine would generate a separate vertically filtered block like the one I've illustrated in red on the left of this slide.

Q. Now they say, well, the claim says successively apply them on the lines and on the columns of pixels of said

reference block. If you read the patent claims in light of the specification, is it talking about what's shown here with their theory, or is it talking about what Fig. 8 actually shows?

JUDGE MCNAMARA: Pardon me. When you say "here," you have to be specific about what you're referencing.

MR. BRADLEY: Thank you, Your Honor. I'll start the question over.

Q. Dr. Richardson, the claim's element 1.1 says that the two filters are applied successively on the lines and on the columns of pixels of said reference block.

Does that mean you apply each of the filters separately to the reference block, as Lenovo says, or does it mean you apply them successively as Fig. 8 shows?

A. I believe it means you apply them successively, and I believe that's consistent with Fig. 8 and with the specification of the patent.

Q. And that's your opinion; is that correct?

A. That's my opinion.

Sorry, Your Honor. Could I just take one minute to clear my throat?

JUDGE MCNAMARA: Sure. Do you need a break?

THE WITNESS: No, that's fine.

(Brief interruption.)

MR. BRADLEY: That was the quietest, most polite

throat-clearing I've ever heard.

Q. Dr. Richardson, what was your ultimate conclusion about element 1.1 of the '877 patent?

A. In my opinion, for the reasons I've explained, element 1.1 of the '877 patent is satisfied and is infringed by the accused products and practiced by the domestic industry products.

Q. Let's go quickly through element 1.2 of the '877 patent. Do you understand this one is not disputed?

A. That's my understanding.

Q. Let's look at it very briefly anyway. If we go to slide CDX-5C.86, we have an excerpt from the AV1 Specification, section 7.12.3, what is this showing us about the reconstruction process?

A. So I've highlighted language from the claim or included language from the claim at the top of this slide. This is an excerpt of the reconstruct process of AV1.

And perhaps if we just skip to the bottom of this slide, there is an equation -- this is an example of an equation, a relationship, that is set out in English language words rather than a strict mathematical equation, but it's saying a relationship, it's saying the CurrFrame, and then it specifies a block within the frame using the y plus y,y, x plus x,x language, if you like, it is saying that that is set equal to.

And then there's a few things happening, but the most important ones are another CurrFrame and plus a residual, and that CurrFrame on the right, just to be confusing -- but this is in AV1; this is the way it specifies it -- that's a portion of the prediction that's being created, it's a prediction. It's CurrFrame, again, y plus y,y, x plus x,x. So that's a prediction block for the current block. The residual is the difference between that prediction and the actual block that we want to decode.

On the left-hand side of the whole relationship is another CurrFrame, but this is basically taking a prediction block, taking a residual block, and putting them back into CurrFrame to create a decoded block. So that satisfies in my view the claim element we're talking about.

Q. And that's element 1.2; is that correct?

A. Yes.

Q. If we move to CDX-5C.88, we see element 1.3, which starts off by saying, "wherein said single vertical filter GFv," and it goes on from there.

Do you see that?

A. I do.

Q. In your opinion do the AV1 products have a single vertical filter, GFv, that's recited here in element 1.3?

A. Yes, they do, in my opinion.

Q. Let's turn to CDX-5C.89.

What does this show us about the AV1 Subpel_Filters being a single filter?

A. So Subpel_Filters I've mentioned before. It's defined in the part of the AV1 spec that specifies this process of -- that applies motion compensated interpolation with a factor to account for any difference in frame scale.

It uses filters from the large Subpel_Filters array, and it applies those -- it applies filters from this array horizontally and it applies filters from this array vertically to the block of pixels that are being processed -- sorry -- to the block of residual samples that are being -- sorry.

I do apologize, Your Honor. I've been talking for a few hours now.

These filters are applied in the horizontal direction and in the vertical direction to a block of pixels in a reconstructed reference frame to create a prediction block, and I think I've explained all of that earlier. The single vertical filter in the example here, again, in AV1 would be a single line of this filter array.

So, for example, at the very top line, 0001280000, that is one example of a single vertical filter that is applied in AV1. Each of the other lines are also examples. And depending on the filter, depending on the pixel position that's being generated, one of these lines

will be selected or is selected by AV1, and the filtering is applied in the vertical direction.

Q. When it says here on slide 89, you have a notation in relation to the Subpel_Filters from AV1, you have a notation that says, "GFv is embedded in the bilinear filter."

Can you just explain a little bit more what that's referring to?

A. So I'll unpack that a little bit. AV1 specifies, I think, is it seven or eight different possible filter sets. I'll call this a filter set. So just to explain what I mean by that, this array here, this has a total of 16 lines in it. You can count them, if you like. Each one of those is a filter.

And this set of filters is a set of filters that is used for bilinear filtering. Bilinear filtering is an option that is transmitted in the AV1 bitstream, it's one of the filter types. The AV1 encoder can choose one of these filter types. This is one of them.

So when I said GF -- I think I said this in my expert report, I can't remember -- where I said GFv is embedded in the bilinear filter, what I mean by that is, when AV1 uses this particular filter, the bilinear filter or the set of bilinear filters, the decoder for each pixel position uses one of these filters, one of these lines to

filter pixels from the reference block to produce upsampled motion compensated interpolated filters of the prediction block.

Q. And is the bilinear filter of the AV1 Specification one of the options of Subpel_Filters?

A. It is indeed. It's one of seven or eight options.

Q. And earlier you described in your testimony the bilinear filters and how the -- it works to create the additional pixel values, the interpolated values; is that correct?

A. I did, yes.

Q. And that was for the bilinear filters as shown here, for example, that's part of AV1?

A. My testimony earlier was for my example filters with coefficients or multipliers of 1, a half, one quarter, three quarters, and so on.

It's my opinion that -- and those are bilinear filters -- it's my opinion that, as the AV1 Specification states, these are also bilinear filters, and, in fact, these are filters of the same form as the ones I described earlier, but the numbers are larger.

Q. If we go to CDX-5C.90, it's titled "Block Inter Prediction Uses Subpel_Filters," and I see you have some, I guess it's the pseudocode on the screen. Is that what we

see here?

A. This is an extract of AV1. Once again, this is a portion of pseudocode, so this is another part of the specification where it's describing the logical steps that a decoder should take and it's describing them in this pseudocode.

Q. I see here a reference in the middle of the pseudocode to yStep and to Subpel_Filters.

Can you just explain a little bit more what we're seeing there, what those mean?

A. YStep -- there is quite a lot going on here. At the very top it's saying select one of the Subpel_Filter sets that I talked about, interp filter. And then once we got down to this code, this is now talking about a single pixel position that we want to create in the upsampled motion compensated prediction block. That position is basically identified by yStep.

Now if you think of x and y as horizontal and vertical axes, yStep tells the decoder which pixel position in the vertical direction that it's going to apply this filter to. And yStep, as we did see a little while ago, as it says here, is set equal to a version of yScale, and yScale specifies the vertical size of the reference frame relative to the current frame.

So a lot going on here, but there is this link at

the bottom of the page to the changing of size of the block depending on the reference frame size relative to the current frame, so that's our scaling.

yStep also takes into account our motion compensated interpolation, and then Subpel_Filters, which I've highlighted in the pseudocode, is used to create for that pixel position an upsampled motion compensated interpolated prediction sample.

Q. I don't have it here on the screen, I think it's in the next section, but is there also similar pseudocode in AV1 for xStep, for the horizontal direction?

A. There is. So this pseudocode, I should have said, is looking at the vertical direction of filtering. There is filtering in the vertical direction and there's filtering in the horizontal direction.

This is the vertical filtering code -- the pseudocode, sorry -- the horizontal filtering pseudocode looks very similar, but it's just -- everything is aligned in the horizontal direction to filter across a line of pixels rather than to filter up and down a vertical column of pixels.

Q. Does this pseudocode and the corresponding pseudocode for xStep, do those indicate to you that AV1 will perform both motion compensated interpolation and resampling?

A. Yes. These filters indicate that motion compensated interpolation and resampling is being performed in AV1 in the horizontal and vertical direction, and in each case it's being performed in a single filtering step, which is basically the calculation of based on Subpel_Filters that I've highlighted here.

Q. Looking back at the top of this slide, CDX-5C.90, some of the claim language is quoted there, and it quotes, is such that GFv(S) = MCIFv(SCFv(S)) where MCIFv is a vertical motion compensation interpolation filter and SCFv is a vertical resampling filter.

Do you see that?

A. I do.

Q. What does that first expression, GFv = MCIFv (SCFv), what does that expression mean in the context of the claims of the '877 patent?

JUDGE MCNAMARA: Pardon me. Before you answer, just reading the realtime script, I think you left out of the MCIF -- I'm sorry -- left out of the SCF script the H.

MR. BRADLEY: I did, Your Honor, because I believe that H on the screen is a typo.

JUDGE MCNAMARA: Okay. I just want to be sure.

MR. BRADLEY: That's why I paused and I fixed in my head. Thank you very much for calling that out. I apologize. I think we have a typo on the slide.

So it does end with vertical motion compensation interpolation filter, and SCFv is a vertical resampling filter.

Q. Dr. Richardson, what does that expression mean in the context of the claims of the '877 patent?

A. Sorry, just to clarify, do you mean the expression that looks like an equation?

Q. Yes, sir, that one.

A. Okay. So, Your Honor, yet another equation. It's not my fault.

So this is a -- this is set out as an equation. The patent actually explains -- the patentee explains what they mean by this type of equation. They call it a composition, and they call it a composition of two filters, SCFv and MCIFv.

And in my opinion what this expression that looks like an equation actually means is it means -- it means that the two filters -- sorry. Let me pause for a second. I don't want to -- because I think this is quite important.

It means that GFv carries out the functions of two filters: SCFv and MCIFv.

Q. Earlier when you were walking us through the bilinear filter, you explained how the MCIF filter would work and the SCF filter would work, and you described the invention of the GF filter.

Is that, in your opinion, is that what's being represented here by this equation, if you will?

A. To put it the other way around, my example where I walked through an SCF filter, a simple bilinear filter, followed by an MCIF filter, another bilinear filter, with an intermediate row in between the two, and then I showed you another slide where I showed you a single filter that in a single step carries out the job of both of those filters, that is entirely consistent in my view with this expression or equation here that begins GFv(S).

Q. And through your analysis have you shown and satisfied yourself that the result of the GFv filter is the same as when SCFv and MCIFv are combined?

A. Just so I'm clear, are you referring to my example that I provided earlier?

Q. Referring to the claim.

JUDGE MCNAMARA: Just a moment.

MR. MCKEON: I think that question goes a little too far. We don't have support in the expert report on that one.

JUDGE MCNAMARA: He has already testified with respect to slide -- I just matched up slide 69, which he also was showing us an illustration of how the filters work and essentially what the patent does, as I understand, the changes it made.

MR. MCKEON: I thought, Your Honor, we had a new question.

JUDGE MCNAMARA: I'm sorry?

MR. MCKEON: The question that was just asked --

JUDGE MCNAMARA: I know. All he is doing is tying this equation to what he has already provided previously.

MR. MCKEON: Okay. We'll see where it goes, Your Honor.

JUDGE MCNAMARA: That's what I'm hearing is that he is just taking the equation and the language of the patent and tying it to the earlier explanation that's already in evidence where he showed the GF, if that's correct, on slide 70, and showed again the changes from the prior art.

MR. MCKEON: Okay. We will proceed, Your Honor, and we'll see where we go here.

JUDGE MCNAMARA: Is that what you were doing, Mr. Bradley?

MR. BRADLEY: Yes, Your Honor.

JUDGE MCNAMARA: Okay. Thank you.

Q. Continuing looking at CDX-5C.90, do you see near the bottom of the pseudocode there is a line that says --

(Clarification requested by the court reporter.)

Q. -- pred [r] [c] = Round2 (S, enter Round 1).

Dr. Richardson, do you see that?

A. I do, yes.

Q. What is that referring to?

A. If I could go a couple of lines above, I think we might have heard this earlier, I'm not sure, something that I would call a for loop, there's a line that begins for (T = 0, T is less than 8, T++ -- ++ means keep increasing T -- and that's immediately followed by a line that begins S+ =. And a POSITA reading this source code would understand that this logical description says do the S+ line 8 times.

So to answer your question, immediately before that, as I read this pseudocode, the S+ line is carried out 8 times and each one -- each time the variable S is having a pixel value multiplied by a weight from Subpel_Filters and added to the total S.

Once all of that is done and S -- the total of S is complete, then there is this line that you asked me about, and Round2 is a function that's defined in the AV1 Specification, and it does two things to its inputs. It changes the magnitude of the input and it rounds the result, as I recall, to an integer number.

Q. Let me back up just a moment. Before we were talking about the Round2 function, when counsel objected, I realize I didn't get an answer to the question I had posed.

So let me back up. Is that okay, sir?

A. Sure.

Q. Through your analysis, have you shown and satisfied yourself that the result of the GFv filter is the same as when SCFv and MCIFv are combined?

A. So in the example that I walked Your Honor through earlier, I think I showed exactly that for filters SCF and MCIF. And I showed you that there was a combined filter GF or a filter that combined the operations of both of those filters and produced exactly the same result.

Q. And that's true for both the vertical side and the horizontal; is that right?

A. That would be true. I could go through the same or similar examples in the vertical direction or in the horizontal direction and we would get to the same result.

JUDGE MCNAMARA: And those were in slides or the examples that were provided, that Dr. Richardson explained, were to be found in CDX-5C, slide 69 and 70, correct?

MR. BRADLEY: Yes, Your Honor. CDX-5C.68, 69, and 70.

Q. Shifting back to the Round2 function that you were just describing, does the Round2 function ensure that the filter outputs remain within computer hardware constraints?

A. Yes. An operation such as the Round2 function specified in AV1 ensures that the magnitude -- that's the

possible minimum and maximum values of S in this case -- remain within a certain range, and we need to do that in computer implementations to make sure that numbers don't get too large for the particular hardware to handle.

Q. Does the single horizontal and single vertical filters of the AV1 Specifications block inter prediction process result in a prediction or motion compensated reference image that has been motion compensated, interpolated and resampled as claimed regardless of rounding?

A. In my opinion, yes.

Q. Does the pseudocode you've referenced in AV1 confirm that for you?

A. It does, yes.

Q. Is the Round2 function inside of or outside of the third nested for loop that you've been discussing?

MR. MCKEON: Now we're getting, Your Honor, into what was excluded this morning. We're getting into defining the filter in a very specific way, whether it includes Round2 or not, and that's not in his report. It's never been disclosed to us.

So what he is doing here is going to the slides that were excluded and just going right through them without the slide on the screen.

JUDGE MCNAMARA: Mr. Bradley, you're not doing

that now, are you?

MR. BRADLEY: Correct, Your Honor, I'm not. I'm asking him about the Round2 function.

JUDGE MCNAMARA: What he has already done did not get into the Round2 function, and the slides that were already in evidence were being explained, as I understood it, by the slide to which, ultimately, there was no issue with, but he can't go any further.

MR. MCKEON: Yes, Your Honor, I agree with that. The question here we have now is the slide that was excluded this morning, the box about what was in the function and what was not in the function. Remember --

JUDGE MCNAMARA: I do, that's why I'm saying, that's not what he is doing at this point, Mr. McKeon.

MR. MCKEON: I think that question, Your Honor, is exactly what he is doing.

JUDGE MCNAMARA: You stood up and objected, and my response to Mr. Bradley was you're not going to go into slide 91 or any of the excluded slides that contain the information that was excluded and that's subject to an offer of proof.

MR. MCKEON: Okay. If that's what's happening here, Your Honor, then I submit to that. I was unclear about the question. It seemed like he was asking the very question that was --

JUDGE MCNAMARA: I think he was about to, but he stopped. That's why I asked him, Mr. McKeon, are you going into questioning that's been excluded because of the exclusion of the slides this morning that will be subject to an offer of proof.

MR. MCKEON: Understood, Your Honor. Yes, if this is part of the offer of proof, then we can proceed on that basis.

JUDGE MCNAMARA: Well, this morning what I said to you is that, for today, slides 90 -- this is what everybody agreed upon, where I ruled on this morning, and I don't want to keep doing this --

MR. MCKEON: Sorry, Your Honor.

JUDGE MCNAMARA: Slides 91, 92, 94, 98, and 99, we agreed those were the slides that were objected to this morning, and then what I said was that they would be subject to an offer of proof.

So the offer of proof, if you want to spend the time now, my understanding the way these offers of proof have been done in the past, they can be done two ways procedurally. One is to offer the proof today and bound it as an offer of proof, and the other is to actually to do it in writing, which is what I was expecting to be done.

MR. MCKEON: Yes, Your Honor. Believe me, I'm not asking that we do this offer of proof here. My

objection is that the slide that was excluded, the reason we excluded it is because there was no opinion in this case about --

JUDGE MCNAMARA: That's why there is going to be an offer of proof, Mr. McKeon, not right now, and he is not going to be permitted to go into any of the information that is on the slides that were excluded this morning and would be part of an offer of proof.

MR. MCKEON: Okay. Let me hear the question again, Your Honor, and see what we got on that.

MR. BRADLEY: Your Honor, on point, I conferred with my team at the break and actually we don't need those slides. It's not a big deal. We're making the proofs and getting the evidence we need regardless. So I appreciate so much Your Honor's offer to let us make an offer of proof. I'm just previewing that I don't think we're going to need one. I don't expect that we're going to file it at the end.

MR. MCKEON: Your Honor, this makes my point, though. What was excluded was a matter of disclosure in the case, and now we're getting into --

JUDGE MCNAMARA: Mr. McKeon, where are you going? He has already been told he can't proceed.

MR. MCKEON: Okay. Okay. If we're done with that line of questioning, Your Honor, I'll sit down. I'm sorry. I thought there was a question here about Round2.

JUDGE MCNAMARA: He has not been allowed to answer it. Again, Mr. Bradley, he is not going down the road that was precluded this morning, unless it's made an offer of proof, and that's where we are.

MR. MCKEON: Okay. Your Honor, I'm sorry. I wanted to just make clear that the question is being withdrawn, as I understand your order here.

JUDGE MCNAMARA: Mr. Bradley, are you ready to proceed? Do you understand what I have instructed?

MR. BRADLEY: I am, Your Honor. I think this is much ado without nothing. I'm moving on.

JUDGE MCNAMARA: That's right.

Q. So skipping the slides that have been excluded, let's move on to CDX-5C.95.

What is this, Dr. Richardson? What are we looking at? And I see it references CX-2112 specifically at 1 to 2.

A. So I recognize this as a technical paper written by authors who include developers who, as I understand it, were involved with the development of the AV1 Specification. The title of the paper is "In Loop Frame Super-Resolution in AV1." And I've highlighted a few sentences. And these go directly to some of the issues that I've been talking through with respect to the '877 patent.

The first highlighting is, and this is talking

about AV1, any inter frame could be predicted from references that are at different resolutions. And my understanding is that's talking about at a high level this idea of having a reference frame at a different resolution predicting blocks of a current frame from that differently sized reference frame.

The second highlighting is it would be more compute efficient to combine such rescaling with subpel interpolation for motion compensation, and that is what AV1 does.

And then the final highlighting, the interpolation for scaled prediction can be implemented simply as separable filtering in each dimension.

So the second and third highlighted extracts there are, in my view, both describing what AV1 does, which is to combine rescaling for this purpose with sub-pixel interpolation for this purpose in order to generate samples of a predicted block.

Q. Let me ask you a few follow-up just to make sure some of the key points are on the record.

You said "this paper," excuse me, CX-2112, is by several of the developers of AV1 at Google; is that right?

A. Yes. I recognize at least three of the names -- Joshi, Mukherjee, and Grange. I certainly recognize those three as being involved in the AV1 development effort.

Q. So this paper, this is not InterDigital talking; it's not Lenovo talking; it's the developers of AV1. Is that right?

A. That's my understanding, yes, based on the names and the context.

Q. And just to highlight in particular the middle quote here from the paper, it says, quote, from the Google folks, quote, "It would be more compute efficient to combine such rescaling with Subpel interpolation for motion compensation," and that is what AV1 does. That's what they wrote?

A. That's what they wrote. And, again, as I recall and understand it, they are describing the combination of rescaling of a reference picture or blocks of a reference picture, combining that with subpixel interpolation, both of which I described earlier, and saying that it would be more compute efficient, which I interpret as more computationally efficient, to combine those two processes into a single step.

Q. Sir, what is your opinion about whether the AV1 products practice or infringe the element 1.3 of the '877 patent?

A. In my opinion they do.

Q. And 1.3 is for the -- on the vertical side of the two filters; is that right?

A. Yes. Everything in 1.3 refers to the vertical dimension as you can see for the -- by the subscript v.

Q. And moving to CDX-5C.97, now we're on element 1.4.

Sir, is that the same limitation but now written for the horizontal direction instead of the vertical direction?

A. So apart from the fact that 1.4 refers to the horizontal direction, the rest of the limitation is essentially the same.

Q. So your testimony and explanations and documents you relied on, the sections of AV1 that you pointed us to for the vertical GF, does that apply equally to the horizontal GF filter of the patent?

A. Yes, with the proviso that the pseudocode that I showed Your Honor a few slides ago, the portion of pseudocode that I relied on for this piece is a different portion, but it is almost identical.

I don't know if we need to show it or not, but it's almost identical. And certainly in respect of calculating the positions, selecting a Subpel_Filter from those arrays and applying that filter, the steps are the same.

Q. The pseudocode -- earlier you showed us the yStep pseudocode for the vertical direction, but I think you might

have said, I want to make sure, there's similar pseudocode for the xStep horizontal; is that right?

A. For the x direction or the horizontal direction, yes, there is, Your Honor.

Q. And, sir, is it your opinion that the AV1 products practice or infringe element 1.4 of the '877 patent?

A. It is, yes.

Q. Now let's turn to the last limitation of the '877 patent, and this one, we've already talked a lot about it, but it says, "wherein no resampled version of said reconstructed reference image is stored in the decoded picture buffer."

Have you already described that?

A. I have described the concept, yes.

Q. Okay. And, sir, do the AV1 products store a resampled version of the reconstructed reference image in the decoded picture buffer?

A. They do not. Specifically the products, as I've explained and as my analysis has shown, the AV1 products do not change the scale of the reference image. They leave the reference image at its original decoded scale, and then one block at a time they identify a block of pixels in that reference image and scale and motion compensated interpolate those pixels in a single step without generating or storing

any intermediate resampled version of that reference frame.

Q. Moving to CDX-5C.102, which is an excerpt of the AV1 Specification section 7.20, I see the title here that says, "Only Decoded Images Are Saved to the DPB."

What are you showing hear?

A. So I'm extracting and highlighting a couple of pieces from the AV1 Specification. So these are from section 7.20, "Reference Frame Update Process."

Your Honor might be delighted to note the first sentence. This process is invoked as the final step in decoding a frame. So we have reached the end of the loop. This is the end of the decoding loop. And it says the inputs to this process are the decoded samples for the current frame LrFrame. And LrFrame is basically that CurrFrame that we mentioned, modified by the loop filter that we mentioned a long time ago, modified by the CDEF filter that we also mentioned earlier, modified by one more step called the loop restoration filter, hence the subscript -- or hence the title "LrFrame."

So we've reached the end of the decoded process. And what this says is, further down in the second extract, FrameStore, and I'll paraphrase slightly, is set equal to LrFrame. And if you read all of the subscripts in those two statements that I've highlighted in the lower part of the slide, what it is actually saying in this logical language

is that that LrFrame, that reconstructed decoded frame, is placed into FrameStore. And FrameStore is AV1's terminology for the decoded picture buffer.

So this is where in AV1, after we've gone through all of the steps of decoding the frame, we put it into the decoded picture buffer, FrameStore, so that it can be reused the next time we go around or the decoder goes around the decoding loop.

Q. A few more questions on this term. So I think you showed a number of times in the background and in the earlier discussions about the prior art method that saved the resampled version in the DPB and how the patented invention does not. Do you recall that generally?

A. Yes.

Q. Okay. And this requirement of the claim says, quote, "wherein no resampled version of said reconstructed reference image is stored in the DPB," right?

A. Yes.

Q. Okay. And is it your opinion that, indeed, no resampled version of the reconstructed reference image is stored in the DPB in all the AV1 products?

A. That is absolutely my opinion, yes.

Q. Now let me ask you this. So when we look at the final step and you get the decoded image, is that stored in the DPB?

A. Yes.

Q. Okay. Has that been both resampled and motion compensated interpolated MCIF?

A. Well, actually that decoded image is made up of blocks. Each block in that decoded image was predicted from an upsampled motion compensated interpolated block from a reference picture, but each block is predicted potentially in a different way from a different reference picture.

So it's not -- it doesn't come from one reference picture anyway, and it's decoded, which means the residual has been decoded and added to all of those prediction blocks to make up the decoded frame.

Q. Is the core point captured by this limitation, is it that none of that intermediate resampled version is stored in the DPB, isn't that the whole point?

A. Well, that's the -- a key purpose, as I see it, of the proposed invention is that those -- a resampled -- those resampled versions in gray, you remember from a few hours ago, they are not generated, they are not stored in the DPB.

Q. Just two more slides on this patent. We see CDX-5C.103 titled "Decoded Frames Are Not Resampled Versions of Reference Frames."

What are you showing here?

A. I'm showing at the top an illustration of the

prior art as a reference frame. It is resampled using horizontal and vertical filters. You can see I've illustrated that stretching and then upsampling that we talked about before. A resampled version is generated. It's stored in the DPB. And in the prior art one version was stored for every single possible resolution change.

And then in the prior art, from that resampled version of the reference frame, motion compensated interpolated prediction blocks are generated in the horizontal and vertical direction.

And actually that MCIF step is done a block at a time. I've perhaps oversimplified it here showing it for the complete frame.

Q. And on the bottom of this slide 103 you have an excerpt from column 6 of the '877 patent and I'll read the excerpt. It says, quote, "No resampled reference image, i.e., over or subsample, is stored in the DPB memory in addition to the reconstructed reference image," closed quote.

What is that describing?

A. It's describing, basically, that, according to the patent and the method of the patent and the claimed invention, that red arrow in the middle showing the prior art's generating and storing a resampled version of a reference frame, that does not happen.

Q. And I think you said earlier in your testimony in this patent, but is that a big deal, to save that storage space in the DPB?

A. It's a big deal. For example, if my opinion is correct, and I think it is, AV1, outside of this, has 16 different resolutions. So according to the prior art method, to use this approach a decoder would have to store all 16 resolutions. They would have to be available for every decoded frame.

Q. Moving to CDX-5C.105, I see here a checkmark in element 1.5. Is that your opinion that the element 1.5 is satisfied by all the AV1 products?

A. It is. And I'll just, just to be totally clear, AV1 specifies exactly what you can and can't do with FrameStore. It says in the specification what data can be written into FrameStore and when it can be written. And the only thing that's written is that decoded reconstructed reference frame in the portion that I highlighted.

So a decoder operating according to this spec can't write other things into that buffer because then it would not be decoding in accordance with the AV1 Specification.

Q. One last question, which I think is the same place we began. In your opinion do all the AV1 products infringe both claims that are asserted of the '877 patent?

A. They do.

Q. Let's shift gears.

Yes, ma'am.

JUDGE MCNAMARA: It is past 5:30 now, Mr. Bradley. Do I have that right?

MR. BRADLEY: You do, Your Honor. I'm just surprised. Time flies.

JUDGE MCNAMARA: I think it's time that we stop for the evening and we'll pick up tomorrow where we are. We'll pick up some time. So just make sure when you are submitting the time for this evening, please, again, you calculate what each side has used. I read your stipulation beforehand. Apparently you are ascribing to the side who loses a particular objection time and you're deducting from their time. You decided this. That's not in my realm. That's what you decided. So I'm sure I will hear a dispute about that -- or I may, I'm hoping not.

So we'll pick up here tomorrow. Let me know what time remains or what you have calculated as time remaining as of the close of the day and if we have to pick up a little more time.

MR. MCKEON: I think we're doing pretty well. We're going to not call Mr. Clarke, who was a domestic industry expert. So we're not going to call him. So we will pick up some time there. We didn't allocate a lot of

time for his testimony, but we'll pick up time in light of that.

So I think -- and, of course, after Dr. Richardson, we have Dr. Schonfeld will be our witness. So I think, despite the long days here, and I appreciate Your Honor going over, I think we're on track to get this trial completed in time.

JUDGE MCNAMARA: Okay. Good to know. Again, it's up to you who you call and who you don't call. I'm not --

MR. MCKEON: Of course. I realize that, Your Honor. I just wanted to give notice to the Court to have an idea where we're headed here.

MR. STEVENS: That's right, I completely agree with Mr. McKeon on this, I think we're on good course.

We did not receive an order from Your Honor before the trial setting time allocation, so we don't actually have that. Obviously we can count up, but we can't tell you how much we have left because we don't have that set.

JUDGE MCNAMARA: Normally what the parties do is the parties themselves determine how much time is allocated. I give you the number of days. Typically the calculation is, say, reduced by lunch hours and reduced by the 15 minutes we take each day morning and afternoon.

MR. MCKEON: Six and a half hours a day.

JUDGE MCNAMARA: Pretty much.

MR. MCKEON: And we calculate from there. That's what we normally do, Your Honor.

JUDGE MCNAMARA: That's exactly right. I never set the time limits on each side except once.

MR. STEVENS: It must have been one of my trials.

JUDGE MCNAMARA: No, no, this is long before your time, Mr. Stevens, on this, and it was where I made a mistake, and I think the parties halfway through realized that they had misallocated time and the Respondents needed more time to be fair, and I added a day on and I said blame me. And it all worked out, what can I tell you, it all worked out.

MR. STEVENS: Thank you, Your Honor.

MR. MCKEON: Thank you, Your Honor.

JUDGE MCNAMARA: All right. Everybody, have a good evening, and I'll see you tomorrow morning.

//

(Whereupon, at 5:42 p.m., the proceedings adjourned, to reconvene the following day, August 15, 2024, at 9:30 a.m.)

C O N T E N T S

INDEX OF WITNESSES

WITNESS	DIRECT	CROSS	RE-DIRECT	RE-CROSS	STAFF
RYAN N. HERRINGTON.....	314	352	353	349	
IAIN RICHARDSON.....391					

OPENING STATEMENTS

AFTERNOON SESSION.....432

CONFIDENTIAL SESSION.....316 - 317

CONFIDENTIAL SESSION.....321 - 323

CONFIDENTIAL SESSION.....327 - 330

CONFIDENTIAL SESSION.....337 - 338

CONFIDENTIAL SESSION.....350 - 351

CONFIDENTIAL SESSION.....475 - 501

C E R T I F I C A T E

TITLE: CERTAIN ELECTRONIC DEVICES, INCLUDING SMARTPHONES, COMPUTERS, TABLET COMPUTERS, AND COMPONENTS THEREOF

INVESTIGATION NO.: 337-TA-1337

HEARING DATE: August 14, 2024

LOCATION: Courtroom A

NATURE OF HEARING: Evidentiary Hearing

I hereby certify that the foregoing/attached transcript is a true, correct and complete record of the above-referenced proceedings of the U.S. International Trade Commission.

Date: August 19, 2024
Signed: LaShonne Robinson
ss//

~~Signature of the Contractor or the~~ Authorized Contractor's Representative

I hereby certify that I am not the court reporter and that I have proofread the above-referenced transcript of the proceedings of the U.S. International Trade Commission against the aforementioned court reporter's notes and recordings for accuracy in transcription in the spelling, hyphenation, punctuation and speaker identification and did not make any changes of a substantive nature. The foregoing/attached transcript is a true, correct and complete transcription of the proceedings.

Signed: David Sisson
ss//

I hereby certify that I reported the above-referenced proceedings of the U.S. International Trade Commission and caused to be prepared from my record media and notes of the proceedings a true, correct and complete verbatim recording of the proceedings.

Signed: August 16, 2024
ss// _____