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Transcript of Jeremy R. Cooperstock, Ph.D.

Date: October 11, 2024

Case: Peloton Interactive, Inc. -v- NEC Corporation (PTAB)

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Conducted on October 11, 2024

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1 UNITED STATES PATENT AND TRADEMARK OFFICE 2 BEFORE THE PATENT TRIAL AND APPEAL BOARD 3 4 PELOTON INTERACTIVE, INC.,) 5 Petitioner,) 6 VS.) Case IPR2023-01239 7 NEC CORPORATION,) U.S. Patent 8 Patent Owner.) No. 8,752,101 9 ----- 10 11 12 13 REMOTE DEPOSITION OF 14 JEREMY R. COOPERSTOCK, PH.D. 15 FRIDAY, OCTOBER 11, 2024 16 17 18 19 20 21 22 23 STENOGRAPHIC REPORTER: CHRISTA YAN, CSR NO. 14316, RPR 24 ----- 25	1 INDEX OF EXAMINATIONS 2 PAGE 3 MR. PAUL 5 4 5 --oOo-- 6 7 8 Witness's Changes or Corrections 98 9 Reporter's Certificate 100 10 11 12 --oOo-- 13 14 E X H I B I T S 15 EXHIBIT FOR IDENTIFICATION PAGE 16 Exhibit 1004 - Patent Application Publication 11 17 US 2006/0143678 A1 18 Exhibit 2016 - Supplemental Declaration of 16 19 Dr. Jeremy Cooperstock 20 Exhibit 1040 - Supplemental Declaration of 88 21 Clifford Reader, Ph.D. 22 23 24 --oOo-- 25
1 REMOTE APPEARANCES: 2 FOR PETITIONER: 3 COVINGTON & BURLING LLP 4 BY: RAJESH PAUL, ATTORNEY-AT-LAW 5 ANUPAM SHARMA, ATTORNEY-AT-LAW 6 850 10th Street NW 7 Washington, DC 20001 8 (202) 662-6000 9 rpaul@cov.com 10 11 12 13 14 FOR PATENT OWNER: 15 BAKER BOTTS LLP 16 BY: MICHAEL KNIERIM, ATTORNEY-AT-LAW 17 30 Rockefeller Plaza 18 New York, New York 10112 19 (212) 408-2500 20 steven.liquori@bakerbotts.com 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 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Conducted on October 11, 2024

5 1 THE TECHNICIAN: Thank you to everyone for attending 2 this proceeding remotely which we anticipate will run 3 smoothly. Please remember to speak slowly and do your 4 best not to talk over one another. Please be aware that 5 we are recording this proceeding for backup purposes. Any 6 off-the-record discussions should be had away from the 7 computer. Please remember to mute your mic for those 8 conversations. Please have your video enabled to help the 9 reporter identify who is speaking. If you are unable to 10 connect with video and are connected via phone, please 11 identify yourself each time before speaking. 12 We will provide a complimentary, unedited 13 recording of this deposition with the purchase of a 14 transcript. I apologize in advance for any 15 technical-related interruptions, thank you. 16 JEREMY R. COOPERSTOCK, PH.D., 17 the Witness, called on behalf of the Petitioner, being 18 duly sworn to state the truth, the whole truth, and 19 nothing but the truth, testified on oath as follows: 20 EXAMINATION 21 BY MR. PAUL: 22 Q So I'll just introduce myself. I'm Raj Paul, of 23 Covington & Burling on behalf of petitioner Peloton, and 24 with me today is Anupam Sharma, also of Covington & 25 Burling also on behalf of petitioner Peloton, and Janice	7 1 Q Do you have anything else with you? 2 A That's all. 3 Q Okay. And so we may electronically reference 4 those at times. And you could, you know, look on the 5 screen or reference your -- any material that you prefer. 6 A Actually, did I say that I had a copy of Chou, 7 the Exhibit 104, as well? My apologies. 8 Q Thank you for clarifying. 9 So how did you prepare for today's deposition? 10 A I reviewed my declaration as well as that of 11 Dr. Reader. I skimmed over the relevant portions of the 12 Chou reference that I referenced and met with counsel. 13 Q And just to clarify, your declaration you're 14 referring to Exhibit 2016? 15 A I don't believe I have the number on the file. I 16 just have it in mind as -- in my files as IPR 239, and 17 then parentheses, '101 patent, Sup Cooperstock Decl PDF. 18 Q Is that an electronic version that you're 19 referring to? 20 A That is correct. 21 Q Okay. 22 A I'll just see if it has the number on the title, 23 but I don't believe it does. No, it doesn't have an 24 exhibit number on the title. 25 Q And you mentioned you reviewed Dr. Cooperstock --
6 1 Jabido, also on behalf of Peloton. 2 Good morning, Dr. Cooperstock. 3 A Good morning, Mr. Paul. 4 Q You've been previously deposed so I'll just lay 5 out a few reminders. I'll be asking the questions. If 6 your lawyer objects, you can go ahead and answer the 7 question unless you're instructed not to answer; is that 8 fair? 9 A Yes. And, Mr. Paul, just to point out that the 10 camera angle is such that you're often cut off or we're 11 only seeing the top of your head at times. So I don't 12 know if you want to adjust the camera so we get better 13 view just to assist in understanding. 14 Q Okay. (Indicating.) I'll try to manage. 15 So if you need -- yeah, and I'll try to elevate 16 my voice, but if you have trouble hearing or understanding 17 me, just let me know. I'll try to rephrase my questions. 18 And if you need a break at any point, that's 19 fine. I'll just ask that if a question is pending, you go 20 ahead and answer before we take a break; is that fair? 21 A That's fair. 22 Q Do you have any materials with you today? 23 A I have copies of my declaration, Dr. Reader's 24 declaration, a copy of the '101 patent, and my original 25 25 declaration in the '101.	8 1 sorry, Dr. Reader's declaration? 2 A That's correct. 3 Q That's Exhibit 1040? 4 A That's correct. 5 Q And can you briefly explain the process for 6 constructing your supplemental declaration? 7 MR. KNIERIM: I'm just going to caution the witness 8 not to reveal the contents of any communications he may 9 have had with attorneys. If you can answer that question 10 without doing so, go ahead. 11 THE WITNESS: Yes, I reviewed Dr. Reader's 12 supplemental declaration, read through that, and the 13 substance of Chou that he was referencing. I discussed my 14 opinions and comments on Dr. Reader's positions with 15 counsel, and we went through in a similar manner as per 16 the preparation of the original declaration, back and 17 forth, in drafting the contents and revising until 18 arriving at the final version that was submitted. 19 BY MR. PAUL: 20 Q Did you personally draft every section of the 21 declaration? 22 A I did not write every word in the declaration. 23 It was a collaborative effort much like all the other 24 declarations that I've been involved in. There is back 25 and forth in terms of writing and commenting. But all the

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Conducted on October 11, 2024

9 1 positions that are in the declaration are my opinions, and 2 I support and agree with all the positions. Those are my 3 positions that I hold. 4 Q Approximately how long did it take you to 5 construct your declaration? 6 A I expect it somewhere in the order of 15 to 7 20 hours. 8 Q Okay. And without getting into the substance of 9 any privileged discussions you had with your attorneys, 10 can you explain what you understood to be the purpose of 11 submitting the -- this supplemental declaration? 12 MR. KNIERIM: I'll issue the same caution I issued 13 earlier. If you can answer that question without 14 revealing the contents of communications with the 15 attorneys, you can do so. 16 BY MR. PAUL: 17 Q Dr. Cooperstock? 18 A Yes, so I refer to paragraph 3 of my supplemental 19 declaration, that sort of states my understanding of the 20 reason why I prepared the supplemental declaration. And 21 that was my understanding that Dr. Reader had provided a 22 supplemental declaration in support of petitioner's reply. 23 And as such, I was providing the supplemental declaration 24 or the surreply to address those (indiscernible utterance) 25 new arguments that had been raised by Dr. Reader and	11 1 contents of the supplemental declaration that had been 2 provided by petitioner all relate to one limitation of 3 Claim 1. I considered that limitation as it relates to 4 the positions that I had expressed in my original 5 declaration, and I considered the Chou reference, the Chou 6 patent, that petitioner is citing. 7 Q Okay. So if we could please pull up 8 Exhibit 1004. Which I'll refer to as the Chou reference. 9 THE STENOGRAPHIC REPORTER: Are we marking this, 10 Counsel? 11 MR. PAUL: Yes. 12 (Whereupon Deposition Exhibit 1004 13 was marked for identification.) 14 THE TECHNICIAN: Okay, I'm getting that it in the chat 15 and pulled up right now. 16 THE STENOGRAPHIC REPORTER: So we're marking it as 17 1004? 18 MR. PAUL: Yes. 19 THE STENOGRAPHIC REPORTER: Thank you. 20 THE TECHNICIAN: (Indicating.) 21 BY MR. PAUL: 22 Q And, Dr. Cooperstock, you recognize this to be 23 the Chou reference? 24 A I do. 25 Q Okay. And if we can please go to page 9. I'm
10 1 petitioner. 2 THE STENOGRAPHIC REPORTER: I'm sorry, Doctor, you 3 said to raise those what? 4 THE WITNESS: To address the new arguments that were 5 raised -- 6 THE STENOGRAPHIC REPORTER: Thank you. 7 THE WITNESS: -- by petitioner and Dr. Reader. 8 THE STENOGRAPHIC REPORTER: Thank you. 9 BY MR. PAUL: 10 Q And you reviewed Dr. Reader's supplemental 11 declaration, Exhibit 1040, in its entirety? 12 A I did. 13 Q What else did you -- 14 A And, Mr. Paul -- sorry, Mr. Paul, just to remind 15 you that you're oftentimes dropping below the camera in 16 terms of your face. Right now I see you, but when you're 17 looking down, I see the top of your head. 18 Q Okay. I think I was able to get it the way you 19 like. Is that better? 20 A That is better, yes, thank you. 21 Q Okay. What else did you consider in making your 22 declaration? 23 A I considered the substance of the '101 patent 24 with regard to limitations. And I believe that the 25 contents of the surreply all relate to -- sorry, the	12 1 sorry, it would have -- I think it's further down. It 2 would have... page 19, actually, of the PDF. 3 And if we could zoom in on where it says, 4 Equation 18, the lower left corner. I think that's good. 5 And so, Dr. Cooperstock, you take the position 6 that Equation 18 is what is used by the Chou system to 7 update the code rate $rc(n)$? 8 MR. KNIERIM: Objection; form. 9 THE WITNESS: That is not my position. 10 BY MR. PAUL: 11 Q So could you describe what your position is with 12 respect to Equation 18? 13 A Well Equation 18, I mean, speaks for itself. 14 It's describing the update of $tb(n)$, T, lowercase b, as in 15 bravo, which is the buffer tube, upper bound. And it's 16 doing so for frame N on the basis of the upper bound of 17 frame $(n-1)$. It's adding to that, the ratio of the coding 18 rate rc of frame N, divided by $f(n)$, which is a -- 19 described, I believe, as the period or the time duration 20 over which the -- just go back to the definition. 21 So Equation 4 provides the definition for $f(n)$ 22 which is the 1 over the difference in media time between 23 frame $(n+1)$ and frame N. And... the -- so the denominator 24 I should say of the added term there is the, once again, 25 the code rate $rc(n)$ divided by the $f(n)$. And let me group

Conducted on October 11, 2024

13 1 those in parentheses so we have clarity on the denominator 2 because I realize this is being stored as text on a 3 transcript. 4 So the update to the buffer tube upper bound, 5 $tb(n)$, is being assigned the value of that same variable, 6 the buffer tube upper bound at frame $(n-1)$, plus the 7 fraction with the numerator $rc(n)$, the code rate, divided 8 by, and then the denominator, there is a product, two 9 terms. $F(n)$, which as I said is the defined in 10 Equation 4. And the $r\tilde{t}(n)$, which I believe is 11 described as a moving average of the previous values of 12 the code rate $ra(n)$. 13 And an additional term is added to that fraction 14 which is $w(n-1)$, where $w(n-1)$ is defined in Equation 19. 15 Q Okay. And so as to the $w(n-1)$, that's described 16 as an error term that captures variations around a locally 17 constant arrival rate, did I read that right? 18 A That is the description that Chou provides 19 following Equation 19. 20 THE STENOGRAPHIC REPORTER: I'm sorry, Mr. Paul, you 21 said error term? 22 MR. PAUL: Error, e-r-r-o-r. 23 THE STENOGRAPHIC REPORTER: Thank you. 24 BY MR. PAUL: 25 Q Okay. And so Equation 19 provides that error	15 1 By regulating the coding bit rate, it is 2 attempted to control the buffer tube upper bound so that 3 it tracks the target schedule. Did I read that 4 accurately, Dr. Cooperstock? 5 A You did. 6 Q Okay. And so is this consistent with your 7 understanding that the goal of Chou is to attempt to track 8 the buffer tube upper bound to the target schedule? 9 MR. KNIERIM: Object to form. 10 THE WITNESS: Yeah, as Chou reads, it is attempted to 11 control the upper tube -- sorry, to control the buffer 12 tube upper bound so that it tracks the target schedule. 13 BY MR. PAUL: 14 Q Okay. And Equation 18 doesn't factor in the 15 playback deadline $td(n)$, right? 16 A Equation 18 uses as variables the coding rate 17 $rc(n)$, the $f(n)$ defined in Equation 4, the moving average 18 code rate $ra(n)$, and the terms in W or the elements that 19 make up $w(n-1)$. Nowhere in there is the deadline or the 20 target deadline being used. 21 Q So Equation 18 doesn't factor in the playback 22 deadline, $td(n)$, right? 23 A $Td(n)$ does not appear in Equation 18 or in 24 Equation 19. 25 Q Okay. Thank you.
14 1 term $w(n-1)$ as a function of $g(n-1)$, right? 2 A $G(n-1)$ is one of the parameters or the terms that 3 are used in computing $w(n-1)$. 4 Q Okay. And so through Equation 19, Equation 18 5 uses $g(n-1)$ as an input, right? 6 A Equation 18 that makes use of $w(n-1)$ is therefore 7 making use of $g(n-1)$. 8 Q Okay. And so just taking a step back. 9 Chou discloses that in regulating the coding bit 10 rate, its goal is to attempt to track the buffer tube 11 upper bound to the target schedule. Is that a fair 12 assessment? 13 A Just so I have clarity on the wording, if you 14 just point me to the paragraph in Chou so I'm... 15 Q Sure. 16 Why don't we go, if we could impend upward so he 17 can we can see paragraph 70. That's fine. Thank you. 18 And so I'll just read here for the record 19 briefly, begins, With the state transition equation 20 defined in Equation 18, uninterrupted playback can be 21 achieved by regulating the coding bit rate so that the 22 client buffer does not underflow. To introduce a margin 23 of safety that increases over time, a target schedule is 24 introduced as illustrated in Figure 5, whose distance from 25 the playback deadline grows slowly over time.	16 1 And just for clarity, I think you said this, but 2 the Equation 18 also does not factor in the target 3 schedule $tt(n)$; is that right? 4 A That is correct. $Tt(n)$ does not appear in 5 Equation 18 or 19. 6 Q And those two factors, the playback deadline and 7 the target schedule, are what Chou describes as providing 8 the margin of safety as referenced in paragraph 70; is 9 that fair? 10 A That -- Chou describes the target schedule that 11 is introduced to provide a margin of safety. 12 Q Okay. And it says that the distance of that 13 target schedule from the playback deadline grows over 14 time. Right? 15 A It says, the -- referring to the target schedule, 16 Whose distance from the playback deadline grows slowly 17 over time. 18 Q Okay. Thank you. 19 If we could switch gears and I can mark as 20 Exhibit 2016, we can pull that up as well. 21 (Whereupon Deposition Exhibit 2016 22 was marked for identification.) 23 BY MR. PAUL: 24 Q This is your supplemental declaration, 25 Dr. Cooperstock.

Conducted on October 11, 2024

17 1 A And since you're bringing up my supplemental 2 declaration, I should perhaps at this point, just note a 3 typo in paragraph 11. 4 Q Okay. 5 A On the third line, where I reference the Chou 6 exhibit, Exhibit 1004, paragraph 24, that should be a 7 reference to paragraph 25, where the quotation is taken 8 from. 9 Q Thank you for clarifying that. 10 MR. KNIERIM: I'm sorry, can we get the marked 11 exhibits dropped in the chat at some point? I have copies 12 here as well. So it's not urgent, but whenever you get a 13 chance, if you could drop those -- 14 THE TECHNICIAN: Oh, I'm sorry, they were going to 15 just Janice. I'll add those again. 16 BY MR. PAUL: 17 Q So if we -- Dr. Cooperstock, do you recognize 18 this to be your supplemental declaration? 19 A I recognize that to be the title page of my 20 supplemental declaration, yes. 21 Q Okay. And if we could go to paragraph 8, which I 22 believe is on page 6. So in this subsection, 23 Dr. Cooperstock, you take the position that Chou discloses 24 the gap $g(n-1)$ and gap $g(n)$ are encoder side variables, 25 not decoder side variables; is that accurate?	19 1 reference. And to paragraph 66. Right there. And if we 2 could zoom in. Thank you very much. That's perfect. 3 So here, it references, I think as you were 4 referring to the gap $g(n)$ at frame N between the buffer 5 tube upper bound and the coding schedule is considered as 6 depicted in Figure 4, right? 7 A That's correct. 8 Q And in the next sentence, it says, That decoder 9 buffer fullness, $Fd(n)$, can be expressed as a function of 10 $g(n)$ referring to Equation 10. Right? 11 MR. KNIERIM: Objection to form. 12 THE WITNESS: Paragraph 66 provides the high-level 13 explanation that the decoder buffer fullness $Fd(n)=B$, the 14 encoder side buffer size, minus $Fe(n)$, the encoder buffer 15 fullness. And then Equation 10 provides an equivalent 16 expression which is that $Fe(n)=B(n)$, the number of bits, I 17 believe, that are added. Make sure it's bits, speaking 18 correctly. 19 Yes. $B(n)$, the number of bits dumped into the 20 leaky bucket on the encoder side at time tau of N. And 21 added to that is the gap $g(n)$, again, on the encoder side. 22 BY MR. PAUL: 23 Q And so Equation 10 expresses that the coder 24 buffer fullness as a function of $g(n)$, right? 25 A The decoder buffer fullness is expressed as
18 1 A In this paragraph I don't believe I've explicitly 2 stated not decoder side variable, but throughout my 3 supplemental declaration, that is the point that I keep 4 trying to emphasize. Which is in Chou, $g(n)$ is referring 5 to the gap at the encoder side. It is the gap as is 6 stated in the quotation part way through that paragraph. 7 The gap $g(n)$ at frame N between the buffer tube 8 upper bound and the coding schedule, this is something 9 that is an encoder side variable. 10 Q Okay. And just for clarity, I was reading the 11 opening sentence of your paragraph 8. 12 A Oh, I apologize. I missed -- yes, I missed the 13 very opening sentence where I do say not decoder's side 14 variable. Thank you. 15 Q Okay. So Chou discloses the gap $g(n-1)$ and gap 16 $g(n)$ are encoder side variables, not decoder side 17 variables, is that your opinion? 18 A That is correct. 19 Q Okay. In connection with that opinion, you cite 20 to several paragraphs throughout the Chou disclosure, 21 right? 22 A That is correct. 23 Q Okay. So why don't we take a few of these in -- 24 First, we can go to paragraph 66. And if we 25 could go to -- go back to Exhibit 1004, the Chou	20 1 $B(n)+g(n)$. 2 Q Okay. And Equation 10 also expresses the decoder 3 buffer fullness as a function, right? 4 A Well, the decoder buffer fullness is given as a 5 function in the text of the paragraph 66 itself and in the 6 context of Equation 10. 7 Q Right. And then in the context of Equation 10, 8 the decoder buffer fullness is also given as a function of 9 $g(n-1)$, right? 10 A The decoder buffer fullness is expressed 11 equivalently in Equation 10 as being the gap $g(n-1)$ at the 12 encoder side, plus the fraction of the coding rate $rc(n)$ 13 divided by $f(n)$. 14 Q Okay. And just for clarity, do you see anywhere 15 in paragraph 66 where either $g(n)$ or $g(n-1)$ is referenced 16 as encoder side? 17 A Well, $g(n)$ is described in numerous paragraphs 18 previous. And I cite to those in my declaration in 19 explaining the meaning of $g(n)$ in Chou. And how the 20 descriptions that are provided for the leaky bucket which 21 this is describing the model that Chou is adopting are a 22 model for what is taking place on the encoder side. 23 So I can point you not in paragraph 66 -- 24 Q Okay. 25 A If we go above where $g(n)$ is introduced in...

Conducted on October 11, 2024

21 1 yes. So paragraph 61 is perhaps the best place to start 2 for that. Where, as I was explaining, the leaky bucket or 3 a leaky bucket is a metaphor for the encoder buffer. 4 And... then in paragraph 69, using Equation 16, and I 5 realize this is pointing out to a later equation, but here 6 Chou is getting into further detail, The client can 7 compute the upper bound $tb(n-1)$ from the measured arrival 8 time $ta(n-1)$, the estimated arrival rate are $\tilde{ra}$ 9 $(n-1)$ and $g(n-1)$. And then here we have the elaboration 10 that is very helpful for understanding. 11 In parentheses, referring to $g(n-1)$, which can be 12 transmitted to the client along with the data in frame $n-1$ 13 or computed at the client as described in Section V-E. So 14 paragraph 69 of Chou is being explicit as to the fact that 15 the variable $g(n)$ or $g(n-1)$ is something that is 16 transmitted to the client. 17 Q Okay. 18 A Or computed as per the description that comes 19 later in Chou. 20 Q Okay. So just for clarity, my question is not 21 about paragraph 69. We can get to that in a bit. 22 But if we can go back to paragraph 66. And 23 actually, before that, you mentioned paragraph 61. If we 24 can pan upward there. $G(n)$ or $g(n-1)$ neither of those 25 gaps are referenced in paragraph 61 at all, right?	23 1 something that is an encoder side variable. 2 BY MR. PAUL: 3 Q Okay. So paragraph 66 does not explicitly 4 reference the gap $g(n)$ or the gap $g(n-1)$ as being encoder 5 side variables; is that fair? 6 MR. KNIERIM: Objection to form, asked and answered. 7 THE WITNESS: As I've stated, the decoder side 8 variable in paragraph 66 is $fd(n)$, which Chou describes as 9 the decoder buffer fullness. 10 BY MR. PAUL: 11 Q I'll move to strike that as nonresponsive. 12 I'm asking about paragraph 66 specifically, 13 Dr. Cooperstock. Do you see anywhere in that paragraph 14 where it's referencing $g(n)$ or $g(n-1)$ as an encoder side 15 variable? 16 MR. KNIERIM: Objection to form, asked and answered. 17 THE WITNESS: As I've answered, I am also referring to 18 paragraph 66, and I'm telling you what paragraph 66 does 19 describe as the decoder side variable, and that's $fd(n)$. 20 $G(n)$ and $g(n-1)$ are used in the equation, and they are 21 described when you get to paragraph 69, as a variable that 22 is sent from the encoder to the client or computed 23 according to the formulation or the description that is 24 provided in Section V-E. 25
22 1 A Paragraph 61 is explaining that the teachings of 2 Chou regarding the leaky bucket relate to things taking 3 place at the encoder. The encoder is the leaky bucket, or 4 the leaky bucket is a metaphor for the encoder buffer. 5 And thus, when Chou is talking about the variables that 6 relate to the buffer, those variables relate to the buffer 7 in the encoder side. 8 Q So paragraph 61 does not explicitly mention $g(n)$ 9 or $g(n-1)$, right? 10 A That is correct. Paragraph 61 is giving the 11 framing for the overall metaphor of the leaky bucket. 12 Q So if we go to paragraph 66, if we can pan down 13 just a little bit. Paragraph 66 doesn't reference either 14 the gap of $g(n)$ or the gap $g(n-1)$ as being an encoder side 15 variable, right? 16 MR. KNIERIM: Objection to form. 17 THE WITNESS: So as I explained previously, those 18 details are provided explicitly when we get to 19 paragraph 69. But if we're referring to the equations in 20 paragraph 66, or the two forms within Equation 10, we see 21 that the decoder buffer fullness is -- there's a variable 22 for that. 23 It's $fd(n)$. That's the decoder buffer fullness 24 that Chou is describing. And that decoder buffer fullness 25 is expressed as a function of other variables. $G(n)$ is	24 1 BY MR. PAUL: 2 Q Okay. And so paragraph 66 is referencing the gap 3 $g(n)$ as we discussed earlier. And notes that that is 4 depicted in Figure 4. Right? 5 A That -- the gap $g(n)$ is depicted in Figure 4. 6 Q Okay. So why don't we contextualize this. If we 7 can go to Figure 4, please. Thank you. 8 And I believe you mentioned this earlier, 9 Dr. Cooperstock. The staircase pattern seen in Figure 4 10 is the coding schedule; is that right? 11 A I don't use the term staircase in my supplemental 12 declaration. But I've discussed it in the previous 13 deposition. 14 Q Okay. Could you help orient us, looking at 15 Figure 4, where we can find the coding schedule there. 16 A So if you go back to Figure 2, just to situate 17 what's happening there. 18 Q Okay. 19 A The output of the encoder into the encoder buffer 20 is the timing of that, is illustrated what's labeled as A, 21 in Figure 2. That's when the encoder is outputting a 22 number of bits that refer to some content of media into 23 the buffer. And the timing of that is the coding 24 schedule. And that we see depicted in Figure 3, as the 25 staircase A.

Conducted on October 11, 2024

25 1 Now, there's an equivalent schedule, which is the 2 decoding schedule. And that appears as label D, the 3 output of the decoder buffer into the decoder in Figure 2. 4 And we see that staircase D in Figure 3 as well. And 5 Figure 4 in describing this abstraction, this idealized 6 model where various assumptions are made to simplify the 7 description of the leaky bucket metaphor, treats either 8 staircase A or staircase D as something that can be 9 inserted within the buffer tube. And that's what we see 10 depicted in Figure 4. 11 Q Okay. Thank you for that explanation. 12 So if we can pan back down to Figure 4. Okay. 13 So you understand that when I say staircase 14 pattern, I'm referring to the pattern that appears between 15 the two parallel, diagonal lines? 16 A I see the staircase pattern that I've described 17 as appearing between the two diagonal lines that represent 18 the buffer tube. 19 Q Okay. And you understand that staircase pattern 20 to be the -- what Chou refers to as the coding schedule, 21 right? And specifically the coding schedule referenced in 22 paragraph 66 of Chou, if that's helpful. 23 A Yes. And in fact, I refer to this in paragraph 8 24 of my declaration where referring to paragraph 66, I quote 25 from Chou that the gap $g(n)$ at frame N between the buffer	27 1 MR. KNIERIM: Objection -- objection to form. 2 THE WITNESS: $G(n)$ depicted in Figure 4 is a span that 3 corresponds to the y-axis which is a measure in bits. 4 BY MR. PAUL: 5 Q Okay. And Figure 4 also has $g(n-1)$, do you see 6 that? 7 A I see that. 8 Q And likewise, $g(n-1)$ in Figure 4 is also denoted 9 in bits, right? 10 A That is correct. 11 Q And you mentioned that Figure 4 shows the buffer 12 tube? 13 A That is correct. 14 Q What does the buffer tube represent? 15 A So the buffer tube, as Chou describes, bounds the 16 coding schedule between an upper bound and a lower bound. 17 Q Okay. And that coding schedule upper bound and 18 lower bound correspond by way of the y-axis to bits, 19 right? 20 A Well, it's a bits at a particular point in media 21 time as expressed in Figure 4. 22 Q Okay. Thank you. 23 This might be a good time to take a short break. 24 I'm going to switch to a different topic. Do 10 minutes, 25 5 minutes.
26 1 tube upper bound and the coding schedule. 2 Q Okay. And in Figure 4, the y-axis is given in 3 bits, right? 4 A That is correct. 5 Q And on the far right, we see $F_d(n)$ which we -- as 6 we discussed, is the decoder buffer fullness, right? 7 A That is correct. 8 Q And the decoder buffer fullness as indicated here 9 has two components, $b(n)$ and also $g(n)$, right? 10 A That is consistent with equation... Equation 10, 11 as contained within paragraph 66 of Chou. 12 Q And so as indicated in Figure 4, that gap $g(n)$ is 13 a gap in terms of bits, right? 14 A Yes. In paragraph 24 of Chou, the text starting 15 on the fourth line reads, This upper bound gap is defined 16 as the number of data bits that the server's encoder 17 buffer can contain over the bits currently contained 18 therein after a just-generated frame is fully input into 19 the buffer. 20 Q Okay. And I'm not asking about paragraph 24 just 21 yet. I'm just referring to Figure 4 as shown on the 22 screen. There in Figure 4, $g(n)$ is denoted in bits, 23 right? 24 A $G(n)$ is -- 25 Sorry.	28 1 A Sure. I'll just note that in approximately 2 35 minutes, I'd like to take an early lunch. Because of a 3 holiday that starts this evening, I have a shifted 4 schedule. 5 Q Okay. So why don't we do 5 minutes, then. 6 A Okay. 7 Q Okay. 8 THE STENOGRAPHIC REPORTER: Okay. Off the record. 9 (Recess taken.) 10 BY MR. PAUL: 11 Q So if we go back to paragraph 8 of your 12 declaration, Exhibit 2016. And there, you also cite 13 paragraphs 24 and 25. 14 A Paragraph 18 of my declaration? 15 Q I'm sorry, paragraph 8. 16 A 8, okay. 17 Q Yeah, which is on the screen. 18 Okay. And my question is just pointing to the 19 fact that you've cited 24 and 25, paragraphs 24 and 25 of 20 Chou. Right? 21 A That's correct. 22 Q Okay. So if we can go back to Exhibit 1004, 23 paragraph 24, would you take a look at that. Thank you. 24 And so at the top here, there's reference in paragraph 24 25 to the initial encoder buffer parameters and upper bound

Conducted on October 11, 2024

29 1 gap that is computed by the server. Do you see that? 2 A Yes. 3 Q Okay. And it defines that upper bound gap as, 4 The number of data bits that the server's encoder buffer 5 can contain over the bits currently contained therein 6 after a just-generated frame is fully input into the 7 buffer. Did I read that right? 8 A You did. 9 Q And it continues, More particularly, the upper 10 bound gap for each frame is computed as the difference 11 between the encoder buffer size and the last computed 12 value for an encoder buffer fullness after insertion of 13 the just-generated frame. I read that right? 14 A So far, so good. 15 Q Okay. Thank you. 16 And if we jump to the end -- toward the end of 17 the paragraph where it says, In one embodiment. Do you 18 see that? 19 A I do. 20 Q In one embodiment, the server provides the upper 21 bound gap computed for the first frame of a sequence of 22 frames generated after a change in the coding rate to the 23 client along with an indication of the coding bit rate 24 associated with the sequence of frames as part of the data 25 associated with the first frame of the sequence. In	31 1 A So far, still so good. 2 Q Thus, an alternate embodiment where the server is 3 not configured to compute and provide the gap values on an 4 ongoing basis, the client computer can still compute them 5 on its own. Did I read that right? 6 A You read that correctly. 7 Q So where the client computer performs the 8 calculations for the upper bound gap value, Chou discloses 9 that as an alternative embodiment where the one where the 10 server calculates the upper bound gap value; is that fair? 11 A As is described throughout the paragraph, when 12 the client computer is computing the gap value, it is 13 computing an estimate for the gap value that would be on 14 the encoder side. 15 Q Okay. So where the client computer performs the 16 calculations for the upper bound gap value, as indicated 17 at the end of paragraph 25, Chou discloses that as an 18 alternative embodiment to the one where the server 19 calculates the upper bound gap value. 20 MR. KNIERIM: Objection to form, asked and answered. 21 THE WITNESS: No. As it's explained in the sentence 22 prior to the one you just read, it is possible for the 23 client to estimate the upper bound gap values for every 24 frame received. 25 So the client is computing an estimate of the gap
30 1 another embodiment, the server provides the gap value with 2 every frame generated. 3 Did I read that right? 4 A That is correct. 5 Q Okay. So I was providing some context there. 6 And if we continue to paragraph 25, which as we saw, you 7 also cited. There, Chou states that the client employs 8 the encoder buffer parameters and the upper bound gap 9 values to determine on a frame-by-frame basis, the coding 10 bit rate that will reduce a difference between the 11 estimated latest anticipated arrival time of a frame under 12 consideration and a prescribed target arrival time of that 13 frame in order to keep the client buffer at approximately 14 the desired duration level. 15 Did I read that right? 16 A You did. 17 Q Next, it explains, In cases where the upper bound 18 gap is only provided with the first frame after the change 19 in the coding bit rate, the client estimates the upper 20 bound gap for the frames that do not include a gap value. 21 It is also noted that given the aforementioned initial 22 encoder buffer conditions, it is possible for the client 23 to estimate the upper bound gap values for every frame 24 received. 25 Did I read that right?	32 1 that exists at the encoder's side. Chou is not advancing 2 this as the client computing something that is related to 3 its own side. It's an alternative for the server sending 4 the server's gap value. The client can instead estimate 5 it. 6 BY MR. PAUL: 7 Q My apologies. For some reason I got logged off 8 for like five seconds. 9 Let me ask that again. So where the client 10 computer performs the calculations for the upper bound gap 11 value as referenced toward the end of paragraph 25 of 12 Chou, Chou discloses that as an alternative embodiment to 13 the one where the server calculates the upper bound gap 14 value; is that right? 15 MR. KNIERIM: Objection; form, asked and answered. 16 THE WITNESS: Yeah, as I answered probably while you 17 were disconnected, this is with reference to the previous 18 sentence in that paragraph where it is possible for the 19 client to estimate the upper bound gap values for every 20 frame received. 21 So this is where the client, not being provided 22 directly by the server with the server side or the 23 encoder's side gap value, the client can instead estimate 24 it. And this is what I was alluding to earlier in the 25 deposition, it's described in more detail in Section V-E

Conducted on October 11, 2024

33 1 of Chou, how the client performs his estimation of the 2 encoder's side gap. 3 BY MR. PAUL: 4 Q If we can step backward to being shown on the 5 screen, paragraph 22, paragraph 22 explains that, The 6 client computes the coding bit rate that will provide the 7 desired results on an ongoing basis using the 8 aforementioned linear quadratic optimal control technique. 9 This coding bit rate computation involves determining on a 10 frame-by-frame basis a coding bit rate that reduces a 11 difference between the estimated latest anticipated 12 arrival time of the frame under consideration and a 13 prescribed target arrival time while, at the same time 14 reducing the change in the coding bit rate to a prescribed 15 degree. 16 Did I read that accurately? 17 A Not quite accurately. You substituted a the for 18 the article a. So in the, This coding bit rate 19 computation involves determining on a frame-by-frame 20 basis, a coding rate, not the coding bit rate. But 21 otherwise, you read that correctly. 22 Q Okay. So this coding bit rate computation 23 involves determining on a frame-by-frame basis a coding 24 bit rate that reduces a difference between the estimated 25 latest anticipated arrival time of the frame under	35 1 parameters, right? 2 A Well, if you just go back one paragraph to 3 paragraph 21, there's mention there in the – essentially 4 from the beginning. A server generating a streaming media 5 data stream that exhibits one of the number of coding bit 6 rates supported by the server. Initially, the server 7 chooses the coding bit rate during the start-up period. 8 So you have already in paragraph 21, mention of 9 encoder's side parameters. 10 Q What are the encoder side parameters that you 11 contend or reference in paragraph 21? 12 A The coding bit rate. 13 Q Okay. So going back to paragraph 22, the first 14 time encoder buffer parameters in paragraph 22 are 15 referenced is after the clause starting, In one embodiment 16 involving the aforementioned leaky bucket model, right? 17 A That is correct. 18 Q And specifically, with respect to that, In one 19 embodiment, that's where Chou makes mention of parameters 20 indicative of this state of the encoder buffer? 21 MR. KNIERIM: Objection to form. 22 BY MR. PAUL: 23 Q Right? 24 A To be clear, in this section of paragraph 22, 25 Chou states, In one embodiment involving the
34 1 consideration and a prescribed target arrival time while 2 at the same time reducing the change in the coding bit 3 rate to a prescribed degree. 4 Did I read that accurately? 5 A No. You made a different mistake this time. You 6 substituted the word the for an in the third line of that 7 section. So it should read, This coding bit rate 8 computation involves determining on a frame-by-frame basis 9 a coding bit rate that reduces a difference between an 10 estimated latest anticipated arrival time of the frame 11 under consideration and a prescribed target arrival time. 12 While at the same time, reducing the change in the coding 13 bit rate to a prescribed degree. 14 Q Thank you for that. 15 And then it continues, In one embodiment 16 involving the aforementioned leaky bucket model, the 17 coding bit rate computations are based on parameters 18 indicative of the state of the encoder buffer of the 19 server. These parameters are computed by the server and 20 provided to the client along with the streaming media 21 data. Did I read that accurately? 22 A You did. 23 Q Okay. And so prior to this statement in one 24 embodiment involving the aforementioned leaky bucket 25 model, Chou doesn't make any mention of encoder buffer	36 1 aforementioned leaky bucket model, the coding bit rate 2 computations are based on parameters indicative of the 3 state of the encoder buffer of the server. 4 Q Right. 5 A These parameters are computed by the server and 6 provided to the client along with the streaming media 7 data. 8 Q Okay. And if we just again, looking at the 9 screen, revisit paragraph 25. Where it says, The client 10 employs encoder buffer parameters and the upper bound gap 11 values to determine on a frame-by-frame basis the coding 12 bit rate that will reduce the difference between the 13 estimated latest anticipated arrival time of a frame under 14 consideration and a prescribed target arrival time of that 15 frame in order to keep the client buffer at approximately 16 the desired duration level. Right? 17 A That is what is stated there. 18 Q Okay. Whereas looking to the left on 19 paragraph 22, it says, the second sentence, This coding 20 bit rate computation involves determining on a 21 frame-by-frame basis a coding bit rate that reduces a 22 difference between an estimated latest anticipated arrival 23 time of the frame under consideration and a prescribed 24 target arrival time, while at the same time reducing the 25 change in the coding bit rate to a prescribed degree.

Conducted on October 11, 2024

37 1 Right? 2 A That is what the beginning of paragraph 22 3 states. 4 Q So in paragraph 22, with respect to the 5 computation reference there, Chou doesn't say that encoder 6 buffer parameters are used to make that computation, 7 right? 8 A As I read paragraph 22, Chou introduces or Chou 9 introduce the concept and then provides an elaboration of 10 that concept as you get towards the two-thirds of the way 11 through the paragraph, in which Chou describes in one 12 embodiment involving the aforementioned leaky bucket model 13 the coding bit rate computations are based on parameters 14 indicative of the state of the encoder buffer of the 15 server. 16 And as we know and as we've been speaking about 17 previously, the leaky bucket model is a metaphor for the 18 encoder. 19 Q Okay. And in the statement that you just 20 provided where Chou describes in paragraph 22, 21 computations being based on parameters indicative of the 22 state of the encoder buffer of the server, that 23 description is qualified as being in one embodiment of 24 that aforementioned leaky bucket model. That's what it 25 says, right?	39 1 BY MR. PAUL: 2 Q And so Chou in paragraph 22 that computation 3 referenced in the second paragraph of... sorry, strike 4 that. 5 The computation referenced in the second sentence 6 of paragraph 22, Chou doesn't foreclose that computation 7 as being done using something other than encoder buffer 8 parameters. Right? It says that, In one embodiment, 9 encoder buffer parameters can be used. Is that -- 10 A Sorry, as I've stated already, the beginning part 11 of paragraph 22 is introducing the general concept. As to 12 how it's done, that comes later in paragraph 22. And if 13 we go later in Chou, we have further details provided 14 about that. 15 We saw in two instances in Chou, where the 16 encoder can transmit along with the stream media data, the 17 parameters of the encoder buffer. Or the client can 18 estimate those as, we saw referenced in section -- or 19 pointer, to Section V-E. So the beginning part, once 20 again, of paragraph 22, is introducing a high-level 21 concept. 22 And then as we drill down further, Chou provides 23 further details. 24 Q Do you have an understanding, Dr. Cooperstock, 25 one way or the other as to whether the parameters
38 1 A It says, part way through paragraph 22, In one 2 embodiment involving the aforementioned leaky bucket 3 model, the coding bit rate computations are based on 4 parameters indicative of the state of the encoder buffer 5 of the server. 6 Q Okay. And so Chou doesn't foreclose that the 7 computation -- with respect to the computation -- strike 8 that. 9 Earlier in paragraph 22, when Chou mentions this 10 coding bit rate computation, are you with me so far? 11 A This coding bit rate computation, I'm with you. 12 Q Chou doesn't foreclose that that computation 13 referenced here in paragraph 22 can be done using 14 something other than encoder buffer parameters, right? 15 MR. KNIERIM: Objection to form. 16 THE WITNESS: As I stated previously, in the beginning 17 of paragraph 22, Chou is introducing the general idea. 18 And then later in paragraph 22, Chou elaborates on that 19 idea providing the detail of the one embodiment involving 20 the aforementioned leaky bucket model in which the coding 21 bit rate computations are based on parameters indicative 22 of the state of the encoder buffer of the server. 23 And goes on, These parameters are computed by the 24 server and provided to the client along with the streaming 25 media data.	40 1 indicative of the state of the encoder buffer referenced 2 toward the end of paragraph 22, whether that is used in -- 3 strike that. 4 MR. KNIERIM: Sorry, before we proceed with your 5 question, Counsel, you keep saying strike that. I'm 6 assuming you mean withdrawn and not that you're requesting 7 that the reporter strike that portion of the question from 8 the record, correct? 9 MR. PAUL: Yes, I withdraw that. 10 BY MR. PAUL: 11 Q So is it your testimony, Dr. Cooperstock, that 12 Chou discloses that every embodiment uses parameters 13 indicative of the state of the encoder buffer to make the 14 coding bit rate computations, or is it just one embodiment 15 in which the parameters indicative of the state of the 16 encoder buffer are used to perform that computations? 17 A You've asked quite a multipart question there. 18 But let me explain again. 19 Chou is starting off in paragraph 22, explaining 20 the high-level concept. That is, that the client computes 21 the coding rate -- coding bit rate, that will provide the 22 desired results. And this is all related to the central 23 theme of Chou, using the quadratic -- linear quadratic 24 optimal control technique. It does so using the leaky 25 bucket model, which as explained earlier in Chou, is a

Conducted on October 11, 2024

41 1 metaphor for the encoder. 2 Then, as we go later in paragraph 22, Chou 3 elaborates on this high-level, general concept and 4 explains in one embodiment involving this -- the same, the 5 aforementioned leaky bucket model, the coding bit rate 6 computations are based on parameters indicative of the 7 state of the encoder buffer of the server. 8 Q Okay. So let me ask it this way. As to the 9 elaboration that you mentioned toward the end of 10 paragraph 22, is it your understanding that that is the 11 only embodiment, or is that simply one embodiment? 12 A As I explained, the encoder can transmit the 13 results of its own determination of the size of its 14 buffer, or the gap value that the encoder determines. Or 15 where the encoder is not transmitting that value on every 16 frame, the client can estimate it as we've seen pointed 17 to. We'd have to dig up the paragraph, but we know that 18 there are pointers to the details in Section V-E. 19 Q Okay. So we can agree that prior to the -- that 20 elaboration or in paragraph 22, where it starts with, in 21 one embodiment, earlier in paragraph 22 there's no 22 reference to encoder buffer parameters, right? 23 MR. KNIERIM: Objection; form-- objection; form. 24 THE WITNESS: As I explained previously in 25 paragraph 21, we already have reference to encoder	43 1 start small and then grow slowly over time. 2 Did I read that accurately? 3 A You did. 4 Q And in the last sentence there, it says, Thus 5 client buffer management is a key element affecting the 6 performance of streaming media systems. Did I read that 7 right? 8 A You did. 9 Q So Chou is, in paragraph 20, explaining that by 10 adjusting the target level, the client buffer size can be 11 controlled over time. Is that fair? 12 A Could you point me to -- oh, just a minute. 13 So by adjusting the client buffer target level to 14 start small and then grow slowly over time, that is what 15 Chou is describing with respect to the -- the startup. 16 Q Okay. And specifically, it says here that by 17 adjusting that target level, the client buffer size can be 18 controlled over time. Right? 19 A That is a synopsis, not a direct quote. Is that 20 correct? 21 Q Dr. Cooperstock, you didn't cite to paragraph 20 22 in your declaration, Exhibit 2016, right? 23 A That's correct. I do not have citation to 24 paragraph 20 of Chou. 25 Q So you didn't consider paragraph 20 in rendering
42 1 parameters. 2 BY MR. PAUL: 3 Q Okay. And that's not in paragraph 22, right? 4 A The contents of paragraph 21 are not the same as 5 the contents that are found in paragraph 22. They're 6 separate paragraphs. 7 Q Okay. So why don't we pan upward a little bit to 8 paragraph 20. 9 This paragraph begins, Preventing the client 10 buffer from underflowing, while keeping the average coding 11 bit rate close to the average transmission bit rate of the 12 network meets two of the aforementioned user expectations. 13 Namely, if the buffer never underflows it allows for 14 continuous playback. 15 In addition, keeping the average coding bit rate 16 close to the average transmission bit rate of the network 17 means the data is played back with the highest possible 18 quality given the average communication bandwidth 19 available. Did I read that accurately? 20 A So far, so good. 21 Q And then it continues, This leaves the remaining 22 issue of startup delay. This issue is resolved in the 23 present system and process by controlling the size of the 24 client buffer over time. More particularly, the 25 aforementioned client buffer target level is adjusted to	44 1 your opinions regarding Chou's description of the summary 2 of the invention? 3 A I considered all of Chou. I did not see anything 4 in paragraph 20 that conflicts with the opinions I've 5 expressed in my declaration or my supplemental 6 declaration. 7 Mr. Paul, I will want to take a lunch break 8 fairly soon. So I -- no problem going for another 5, 9 10 minutes maximum on this round. Or if you'd like to 10 break now, if this is a good time, that would be fine as 11 well. 12 Q Sorry, I'm just... just a follow-up to 13 paragraph 20 of Chou. Once again, I think you had 14 mentioned it's a synopsis. I just wanted to clarify here. 15 At 093127 in the transcript, that is a synopsis, not a 16 direct quote; that's correct? Is that -- 17 A Yeah, I was trying to match the wording that you 18 were using with the content of the paragraph. And I 19 wasn't finding the exact quotation. So I was assuming and 20 trying to verify with you that what you had just stated to 21 me was your synopsis of the contents of the relevant 22 section of that paragraph. 23 Q Okay. So you would agree with the synopsis that 24 in paragraph 20, Chou says that by adjusting the target 25 level, the client buffer size can be controlled over time;

Conducted on October 11, 2024

45 1 is that fair? 2 MR. KNIERIM: Objection; outside the scope. 3 THE WITNESS: What I see in paragraph 20 of specific 4 reference to what you've just stated is where Chou states, 5 This leaves the remaining issue of startup delay. This 6 issue is resolved in the present system and process by 7 controlling the size of the client buffer over time. 8 BY MR. PAUL: 9 Q And then the next sentence after that, it says, 10 More particularly, the aforementioned client buffer target 11 level is adjusted to start small and then grow slowly over 12 time. Right? 13 A That is stated in paragraph 20. 14 Q And so by -- is it a fair synopsis that by 15 adjusting the client buffer target level, the Chou system 16 and process is enabled to control the client buffer size 17 over time. 18 A I believe you're asking me to opine on sections 19 of paragraph 20 beyond the words stated there directly. 20 And I don't believe I've offered any opinions about this, 21 this section of Chou. 22 So all I can do here is repeat for you what Chou 23 states, which is with regard to the issue of start-up 24 delay, Chou says, This issue is resolved in the present 25 system and process by controlling the size of the client	47 1 A I did not. 2 Q Okay. Thank you. 3 So you can go back to paragraph 8 of your 4 declaration, Exhibit 2016. You also cite paragraph 110 5 and 112 of Chou. Right? 6 A Oh, yes, there. 7 Q And you include parentheticals there referencing 8 what's referred to in those paragraphs as the current gap 9 gnew(n). Is that right? 10 A That's correct. 11 Q So let's take a closer look at that, if we can go 12 to Exhibit 1004, paragraph 110. And if we can pan up just 13 a little bit. Yeah, okay. 14 And so paragraph 110 is under section -- 15 Subsection B titled, Leaky Bucket Computations at the 16 Sender. Right? 17 A Correct. 18 Q And if we can just zoom in just a little bit more 19 to paragraph 110 now, that's fine. 20 And this paragraph is discussing stream 21 switching, right? 22 A Well, that's the latter roughly third of the 23 paragraph. Prior to that, it's discussing setup that is 24 not specific to stream switching. 25 Q Okay. Thank you.
46 1 buffer over time. 2 And I can read the rest of the paragraph, but 3 that's -- I mean, it says what it says. 4 Q Okay. So Chou's system facilitates the 5 controlling the client buffer size over time. Is that 6 fair? 7 A Once again, I can only read for you what Chou 8 states here, and I haven't opined on the details there of 9 paragraph 20. But paragraph 20 states that with regard to 10 the issue of startup delay, This issue is resolved in the 11 present system and process by controlling the size of the 12 client buffer over time. 13 Q Thank you. 14 A And I can read the rest if you would like. 15 Q So why don't we break for lunch. You said -- you 16 said 30 minutes is... 17 A 30 minutes is more than enough, yeah. 18 Q Okay. So why don't we -- yeah, we'll do 19 30 minutes. 20 A Okay. 21 THE STENOGRAPHIC REPORTER: Okay, thank you. 22 (Recess taken.) 23 BY MR. PAUL: 24 Q Dr. Cooperstock, did you discuss the substance of 25 your testimony with counsel during the lunch break?	48 1 So as to the part where it starts to discuss 2 stream switching in the latter part, it reads, On a stream 3 switch, i.e., $r\text{-hat}(n)$ not equal to $r\text{-hat}(n-1)$, the gap 4 $gnew(n)$ for the new stream is transmitted to the client 5 along with $\Delta g(n-1) = gnew(n-1) - gold(n-1)$ as described 6 below. Right? 7 A That is what is stated there. 8 Q Okay. And then similarly if we can go to 9 paragraph 112. And this is now under the Subsection D 10 titled, Code Bit Rate Switching. I see that in your 11 declaration, you call attention to this sentence beginning 12 with, If the sender. Do you see that second sentence? 13 A I do, I do. 14 Q Okay. And that reads, If the sender finds a 15 suitable coding bit rate and makes the switch at frame n, 16 it will transmit three values to the client along with the 17 frame. The new coding bit rate, $r\text{-hat}new(n)$ the current 18 gap through the upper bound $gnew(n)$ and the shift $\Delta g(n-1) = gnew(n-1) - gold(n-1)$. Did I read that right? 19 A Correct. 20 Q And it continues, With this information the 21 client can properly adjust its control target schedule as 22 well as its upper bound, right? 23 A That is what is stated. 24 Q And did you see, Dr. Cooperstock, where the Chou

Conducted on October 11, 2024

49 1 reference first introduce the term $g_{new}(n)$? 2 A I'm not sure which paragraph in Chou first 3 introduces the notation of the g_{new}. I'm just trying to 4 search, but my search tool doesn't locate the superscript 5 text. 6 Q No problem. 7 So for context, I referenced in the Subsections C 8 and D, and these are, if you go to paragraph 106, 9 indicates right above that, that these are under Section 5 10 called, Implementation Details. Do you see that? 11 A I see that. 12 Q Okay. So why don't we go to paragraph 97. And 13 this is under Subsection D called, Choosing a Stream Given 14 a Coding Bit Rate. Do you see that? 15 A I do. 16 Q And this Subsection D is under Section 4, if you 17 look right above paragraph 89. Section 4 is called, 18 Practical Issues with Streaming. Do you see that? 19 A Which paragraph? 20 Q That heading is above paragraph 89, Section 4, 21 Practical Issues with Streaming. 22 A Okay. 23 Q So we can go back to paragraph 97. Just wanted 24 to contextualize this. And so there, Chou explains, When 25 the client requests a coding bit rate $rc(n)$, the server	51 1 be too large to allow switching to the stream without risk 2 of client buffer underflow. In fact, whenever the stream 3 switches, there is generally a discontinuity in the upper 4 bound which may be either positive or negative. A 5 positive shift in the upper bound is illustrated in the 6 graph in Figure 10, which if large, could cause the client 7 buffer to underflow, either immediately or eventually. 8 Did I read that right? 9 A You did. 10 Q And so here, Chou is explaining how its disclosed 11 system selects coding rate in order to prevent client 12 buffer from underflowing, right? 13 MR. KNIERIM: Objection to form, and also as to scope, 14 outside the scope of the supplemental declaration. 15 THE WITNESS: Yeah, so my read of what Chou is stating 16 here is that this is a second reason why the encoder or 17 the server may not be able to provide a coding bit rate 18 $rc -- r\text{-hat}$, sorry, $r\text{-hate}(n)$ that is identical to that 19 requested by the client. 20 And as explained in the second reason, is that 21 even if there is an exact match, that is there is a stream 22 in the media file with the average coding bit rate exactly 23 equal to $rc(n)$, there is a risk because of the size of the 24 buffer tube, that switching to that stream may result, as 25 it says, the buffer tube for the stream may be too large
50 1 complies by choosing a stream, or sub-stream, of a 2 scalable stream having a coding bit rate $r\text{-hate}(n)$ 3 approximately equal to $rc(n)$. 4 There are several reasons that $r\text{-hate}(n)$ may 5 differ from $rc(n)$. Did I read that right? 6 A You did. 7 Q And then it provides multiple reasons for why 8 there may be a difference between $r\text{-hate}(n)$ and $rc(n)$. 9 Right? 10 A I see two reasons that it provides. 11 Q And for context, those are reasons for why 12 $r\text{-hate}(n)$ provided by the server may be different from 13 $rc(n)$ which is chosen by the client. Right? 14 A As is stated, the $rc(n)$ is a coding bit rate that 15 is requested by the client. 16 Q Okay. 17 A That the $r\text{-hate}(n)$ is the server's choice of the 18 corresponding coding bit rate. 19 Q Okay. So I want to draw attention to the 20 sentence beginning with, The second reason. Do you see 21 that? 22 A I do. 23 Q It says, The second reason is that even if there 24 is a stream in the media file with average coding bit rate 25 exactly equal to $rc(n)$, the buffer tube for the stream may	52 1 to allow switching to the stream without risk of client 2 buffer overflow. 3 BY MR. PAUL: 4 Q Thank you. 5 And just for context, Dr. Cooperstock, did you 6 read the entirety of the Chou reference in formulating 7 your opinions in this matter? 8 A I did go through the entirety of Chou. But the 9 sections that I have cited, I've gone over many times. 10 The -- Chou as a total document, is more than a handful of 11 pages. And I haven't memorized Chou, and I cannot 12 reproduce for you the word-for-word recitation of what's 13 in there. 14 Q Thank you for that. 15 So putting aside memorization, you've read 16 paragraph -- paragraphs 97 and 98 in formulating your 17 opinions in this matter? 18 A I did read them, yes. 19 Q Okay. And so again, paragraph 97, is it your 20 understanding that Chou is explaining here how its 21 disclose system entails selecting coding rate in order to 22 prevent underflow from occurring; is that fair? 23 MR. KNIERIM: Standing objection as to scope for all 24 questions related to paragraph 97. 25 THE WITNESS: Yeah, that's -- that's not what Chou has

Conducted on October 11, 2024

53 1 stated. Chou is providing multiple reasons why the server 2 may not provide a stream with a coding rate $r\text{-hatc}(n)$ that 3 is equal to the coding rate requested by the client. And 4 the second reason that you focused on states that even if 5 there is a stream in the media file with average coding 6 bit rate exactly equal to $rc(n)$, the buffer tube for the 7 stream may be too large to allow switching to the stream 8 without risk of client buffer underflow. 9 BY MR. PAUL: 10 Q Okay. So this is an example in which underflow 11 is a consideration in making the code rate determination? 12 A As I've stated already, the description that Chou 13 is providing for the choice of the coding bit rate by the 14 server, there are several reasons, as this paragraph 15 states, that that choice by the server may differ from the 16 coding bit rate requested by the client. 17 And the second reason, as I've read to you, is 18 that even if there is a stream in the media file with 19 average coding bit rate exactly equal to $rc(n)$, the buffer 20 tube for the stream may be too large to allow switching to 21 the stream without risk of client buffer underflow. 22 Q Okay. Let's continue to paragraph 98. There, 23 Chou explains, if you zoom in just a little bit, this -- 24 Thus, the server must choose a stream that causes the 25 upper bound to shift up no more than some amount	55 1 MR. KNIERIM: Standing objection as to all questions 2 related to paragraph 98, which is not discussed in either 3 Dr. Cooperstock's supplemental declaration or Dr. Reader's 4 supplemental declaration. 5 THE WITNESS: So I see here in paragraph 98, that Chou 6 states that, The server must choose a stream that causes 7 the upper bound to shift up by no more than some amount 8 $\text{deltamaxg}(n-1)$ supplied to it by the client. So I agree 9 that is a value or variable that the client supplies to 10 the server. 11 BY MR. PAUL: 12 Q Okay. 13 A The client supplies $\text{deltamaxg}(n-1)$ to the server 14 in its feedback along with $rc(n)$ which also suggests that 15 $rc(n)$ is something provided or supplied by the client. 16 Q And so paragraphs 98 and 97 of Chou state that 17 the term $g\text{new}(n)$, which you've cited to in paragraph 8 of 18 your declaration, that that term is illustrated in 19 Figure 10 of Chou, right? 20 A Can you point me to the paragraph of my 21 declaration where I... 22 Q Okay. So let's go to your declaration. 23 Exhibit... yeah. And so there's multiple references to 24 $g\text{new}(n)$ with citations to paragraph 110 and 112. 25 A You're talking about paragraph 8 of my
54 1 $\text{deltamaxg}(n-1)$ supplied to it by the client. The client 2 supplies $\text{deltamaxg}(n-1)$ to the server in its feedback along 3 with $rc(n)$, shortly after client time $ta(n-2)$ after frame 4 $(n-1)$ has already begun streaming. 5 Did I read that right so far? 6 A You did. 7 Q Upon receiving the feedback, the server selects a 8 stream with coding bit rate $r\text{-hatc}(n)$ as high as possible, 9 such that $r\text{-hatc}(n)$ less than or equal to $rc(n)$ and if 10 $r\text{-hatc}(n) > r\text{-hatc}(n-1)$, i.e., if it is a switch up in rate, 11 then $g\text{new}(n-1) - \text{gold}(n-1)$ less than or equal to 12 $\text{deltamaxg}(n-1)$ where $g\text{new}(n-1)$ and $\text{gold}(n-1)$ are illustrated 13 in Figure 10. 14 Did I read that right? 15 A You did. 16 Q And finally, it concludes, The constraint given 17 by $\text{deltamaxg}(n-1)$ is not applied if it is a switch down in 18 rate, right? 19 A That is what it says. 20 Q And so this makes clear that the client supplies 21 two things to the server and its feedback, delta g-- let 22 me withdraw that. 23 Paragraph 98 specifies that the client supplies 24 two things to the server. The first is $\text{deltamaxg}(n-1)$ and 25 the second is the $rc(n)$. Right?	56 1 declaration? 2 Q Correct. 3 A Okay. 4 Q Paragraph 8 of your declaration cites the term 5 $g\text{new}(n)$ in Chou, right? So, Dr. Cooperstock, I'm simply 6 referring to the fact that paragraph 8 of your 7 declaration, Exhibit 2016, references $g\text{new}(n)$ multiple 8 times. Is that accurate? 9 A Yes. I refer to $g\text{new}(n)$ on I believe two 10 occasions in paragraph 8. 11 Q Okay. And so going back to my question, with 12 respect to paragraphs 97 and 98 of Chou, if you can bring 13 that back up, Exhibit 1004. Thank you. 14 Paragraphs 97 and 98 indicate that that term 15 $g\text{new}(n)$ is illustrated in Figure 10. Right? 16 A Well, I see mention of $g\text{new}(n-1)$, illustrated in 17 Figure 10. 18 Q Okay. So why don't we go to Figure 10. Thank 19 you. 20 And Figure 10, as you indicated, shows the gap 21 $g\text{new}(n-1)$. Right? 22 A It does. 23 Q And that would be with respect to frame $(n-1)$, 24 right? 25 A $G\text{new}(n-1)$ would be with respect to frame $(n-1)$.

Conducted on October 11, 2024

57 1 Q Okay. And it also shows a gap gold(n-1). Right? 2 A It does show gold(n-1). 3 Q And Figure 10 shows a staircase pattern, do you 4 see that? 5 A I do. 6 Q And that staircase pattern in Figure 10 is an 7 arrival schedule. Right? 8 A You'll have to point me to where it's described 9 as such. 10 Q Do you have an understanding -- first of all, did 11 you review Figure 10 in formulating your opinions? 12 A As I said, I read through all of Chou in the 13 opinions that I've expressed in my supplemental 14 declaration. I don't believe I made any reference to 15 Figure 10. So I've only reviewed this as an initial 16 readthrough. 17 Q And so sitting here today, you don't have an 18 understanding of whether the staircase in Figure 10 is an 19 arrival schedule? 20 A I'm happy to take a look and give you an answer 21 to that, but I cannot just off the top of my head. As I 22 said, I haven't memorized Chou. I'd have to go back and 23 take the time to refresh my memory. 24 Q Okay. Why don't we go to Figure 5 of Chou. 25 Dr. Cooperstock, do you recall this figure?	59 1 example, to denote? 2 A That would be the arrival time of frame(n-1). 3 Q Okay. So referring back to the staircase pattern 4 in Figure 10, does that scaling on the y-axis help you to 5 understand the staircase as being an arrival schedule as 6 opposed to something else? 7 A Again, without reading through Chou and making 8 sure that I'm correctly understanding what is being 9 illustrated in Figure 10, I would not want to just guess 10 and presume that Figure 10 is illustrating a staircase 11 pattern that illustrates something, just on the basis of 12 similar appearance in a previous figure for which Chou was 13 explicit as to the meaning. If you like, I can take the 14 time to go and read through Chou dealing with that figure. 15 Q Okay. Let's -- let me ask you this. So what is 16 your understanding of what $g_{new}(n-1)$ represents? 17 A So my understanding of g_{new} is, as we were reading 18 from paragraph 98, this is related to a choice of stream, 19 as per the heading of that section, Choosing the Stream 20 Giving the Coding Bit Rate. Where there may be an old gap 21 and a new gap for a particular frame. 22 And the new gap is, as described in 23 paragraph 112, is that -- I should say the $g_{new}(n)$, as 24 described in 112, is the current gap to the upper bound 25 for a frame. So we have the calculation being done in
58 1 A I do. 2 Q And Figure 5 also has a staircase pattern, right? 3 A It does. 4 Q And for reference, the y-axis of Figure 5 is 5 indicated in client time, right? 6 A That is correct. 7 Q And it has labeled here that the staircase 8 pattern, I believe, you can see that it's indicated as 9 being an arrival schedule, right? 10 A That is also correct. 11 Q So does Figure 5 help you to understand whether 12 or not the staircase pattern in Figure 10 -- if we can go 13 back to Figure 10. Figure 10, whose y-axis also has been 14 given in client time, would that staircase pattern also be 15 an arrival schedule, yes or no? 16 A I'm not finding anything as I'm skimming through 17 Chou, where Chou describes the staircase pattern shown in 18 Figure 10. So without taking further time to read through 19 that section entirely that deals with that, I would 20 hesitate to offer an opinion without -- being careful to 21 be accurate. 22 Q Okay. You see how the y-axis has certain 23 indications there? 24 A The y-axis has labels of $ta(n-2)$ through $ta(n)$. 25 Q And so what do you understand $ta(n-1)$, for	60 1 terms of looking at the differences between the current 2 gap, $g_{new}(n)$, and the previous gap to the upper bound, 3 $gold(n)$. And that's computed for -- in computing the delta 4 of $g(n-1)$. It's the difference between those two values 5 on frame (n-1). 6 Q Okay. And so we mentioned earlier that the -- 7 and as shown in Figure 10, the y-axis is in client time, 8 right? 9 A That is correct. 10 Q And so therefore, the gaps shown here in 11 Figure 10, $g_{new}(n-1)$ and $gold(n-1)$, those gaps are denoted 12 in time, right? 13 MR. KNIERIM: Objection to form. 14 THE WITNESS: I'm not sure about that. While I 15 haven't gone through the details of Figure 10 in my 16 declaration. I do see in paragraph 101, when Chou is 17 describing the shift in the control target schedule, it 18 describes this as being a shift that is the difference 19 between $g_{new}(n-1)$ and $gold(n-1)$ as being the actual shift in 20 the upper bound in bits at frame (n-1) computed at the 21 server, as illustrated in Figure 10. 22 So I'm reluctant to agree with you that the 23 expression of $g_{new}(n-1)$ is in time as opposed to being 24 measured in bits. 25

Conducted on October 11, 2024

61 1 BY MR. PAUL: 2 Q Okay. As shown in Figure 10, you see that the 3 y-axis is in client time, right? 4 A I see the y-axis in client time. 5 Q And you see the gold(n-1) and gnew(n-1), you see 6 those gaps indicated in Figure 10, right? 7 A I see the indications of gold (n-1) and gnew(n-1). 8 Q And with respect to frame (n-1), if you trace 9 those back to the y-axis, for either one of those gaps, 10 the lower bound is ta(n-1). Right? 11 MR. KNIERIM: Objection to form. 12 THE WITNESS: It appears to me on Figure 10, that the 13 lower portion of the span that is indicated by the arrows 14 representing the vertical extent of gold and gnew, that that 15 traced across horizontally would seem to align with 16 ta(n-1). 17 BY MR. PAUL: 18 Q And would a person of ordinary skill in the art 19 understand that the lower bound of gold(n-1) and gnew(n-1), 20 as shown in Figure 10, the lower bound would be ta(n-1)? 21 MR. KNIERIM: Objection to form, outside the scope. 22 THE WITNESS: As before, I'm not sure how to answer 23 that without going through in detail, the description that 24 Chou is providing for Figure 10. As I noted previously in 25 paragraph 101, the description here is discussing the	63 1 that figure. 2 BY MR. PAUL: 3 Q Okay. So your testimony is you can't tell one 4 way or another by looking at Figure 10 whether the 5 gnew(n-1) or gold(n-1) is given in time? 6 MR. KNIERIM: Objection to form. 7 THE WITNESS: In the end I would want to read the 8 corresponding description of Figure 10 to be able to 9 answer that question correctly. 10 BY MR. PAUL: 11 Q Dr. Cooperstock, you said you've read the 12 entirety of Chou in formulating your opinions, right? 13 A I did. 14 Q And as we've indicated -- as we've seen, your 15 opinions cite to multiple times in a given paragraph 16 gnew(n), right? 17 A That is correct. 18 Q So your testimony is that you had not 19 sufficiently reviewed the figures associated with that 20 term, in order to understand whether or not that term 21 gnew(n) is a gap denoted in time rather than bits? 22 MR. KNIERIM: Objection to form. 23 THE WITNESS: What I'm discussing here is the 24 representation that is shown in Figure 10. And I have not 25 opined on that representation there. I've opined on, as
62 1 delta between gnew(n-1) and gold(n-1) as being the actual 2 shift in the upper bound in bits. Bits is not time. 3 So there may be another location where Chou 4 describes it otherwise, but as I'm on the fly as I'm 5 standing here right now trying to offer you a response to 6 your question, I'm not able to go beyond what I can read 7 clearly articulated in Chou. 8 BY MR. PAUL: 9 Q Okay. Dr. Cooperstock, is it your testimony that 10 a person of ordinary skill in the art would not know 11 whether or not the lower bound of gold(n-1) or gnew(n-1) as 12 shown in Figure 10, is ta(n-1), is that -- 13 MR. KNIERIM: Objection to form, outside the scope. 14 THE WITNESS: Yeah, I would suggest that a person of 15 ordinary skill would look at Figure 10 and seek 16 description in the text of Chou to have a full 17 understanding of what Figure 10 is representing. And as I 18 have done now, looking at paragraph 101, I'm not able to 19 agree with you that the lower portion of the vertical 20 extent of the arrows representing gold(n-1) or gnew(n-1) is 21 a measure in time as opposed to a measure in bits. 22 Again, I think I would expect a POSITA to want to 23 read through the description in full to make sure that 24 they understood, just as I would want to make sure that I 25 understood correctly by reading in full the description of	64 1 you've noted in paragraph 8 of my declaration, the 2 citations to Chou that talks about where that value gnew(n) 3 is coming from. And I've cited, for example, 4 paragraph 113 of Chou that says -- sorry, that said g(n), 5 paragraph 110 of Chou that talks about, The sender 6 computes g(n)... The gap gnew(n) for the new stream is 7 transmitted to the client. 8 And further in paragraph 112, If the sender finds 9 a suitable coding bit rate and makes a switch at frame N, 10 it will transmit three values to the client along with the 11 frame: The new coding bit rate rnew(n), the current gap 12 to the upper bound gnew(n), et cetera. 13 So I've cited to gnew(n) in terms of how that 14 value or where that value is determined, who sends it 15 where. I haven't opined on or had to look through Chou to 16 determine what the content of gnew(n) was or gnew(n-1). And 17 certainly not with respect to Figure 10, to which I've not 18 cited. 19 BY MR. PAUL: 20 Q So your opinions in your supplemental declaration 21 do not entail having had to look through to determine what 22 the content of gnew(n-1) is; is that fair? 23 A When I was formulating my opinions, I was 24 concerned with the question of where gnew(n) or gnew(n-1) is 25 determined. Who sends it? That was the question that I

Conducted on October 11, 2024

65 1 was considering. I was not considering the question of 2 what is the data or what are the data, represented by 3 gnew(n-1), whether that be a time measurement or a bit 4 measurement. 5 Q Would understanding what the gap gnew(n-1) is, 6 would that have been helpful in understanding whether that 7 is sent by the server or the client? 8 A I don't think so. This is, again, not something 9 that I've considered but in formulating my opinions as 10 expressed in the declaration. But given that gnew is 11 calculated at the encoder, at the server side, the server 12 and map between the bits and the time associated, by 13 dividing by the rate, the coding rate. 14 So for the encoder side, given that's where G of 15 new is determined, it doesn't matter whether it's 16 expressed in bits or in time. 17 Q Okay. If we can go to Figure 4, and we saw this 18 earlier, Dr. Cooperstock. And we mentioned there that in 19 Figure 4, the y-axis is given in bits, right? 20 A That is correct. 21 Q And there is a reference to g(n) and g(n-1) in 22 Figure 4, right? 23 A There is g(n) and there are g(n-1) both appearing 24 in Figure 4. 25 Q And so if we can go back to Figure 10, and y-axis	67 1 response to the opinions that Dr. Reader had expressed. I 2 don't recall Dr. Reader raising questions as to whether 3 gnew(n-1) or gold(n-1) were expressed in bits or in time. 4 And as such, I wasn't concerned with that 5 particular question that you're posing to me now. 6 Q Okay. You can go to paragraphs 126 -- sorry, 7 I'll withdraw that. If you go to paragraph 17 of your 8 declaration. Thank you. 9 And so here, you reference and cite to -- 10 actually, I'll withdraw that. 11 Let's go back to Figure 10, please. And just for 12 clarity, Dr. Cooperstock, I'd asked you previously about 13 whether you had an understanding of what the lower bounds 14 of either gold(n-1) or gnew(n-1) correspond to. Do you 15 recall those questions? 16 A I do. 17 Q Okay. And you didn't have an understanding as to 18 what those lower bounds correspond to, right? 19 MR. KNIERIM: Objection to form. 20 THE WITNESS: As I stated, I have not gone through the 21 detailed explanation of Figure 10 carefully to be able to 22 answer that question accurately. 23 BY MR. PAUL: 24 Q Okay. 25 A And I'm happy to do so if you want me to take the
66 1 is in client time, right? 2 A The y-axis shown here appears to be in client 3 time. 4 Q And so if gnew(n) and gold(n) are given in time, 5 those gaps would be different than the gaps shown in 6 Figure 4, right? 7 MR. KNIERIM: Objection to form. 8 THE WITNESS: I really do not have enough information 9 in front of me to -- well, I do have the information. I 10 just would have to take the time to go through and compare 11 the discussion of what is illustrated in Figure 4 with 12 what is illustrated in Figure 10. Given that Figure 10 is 13 dealing with a potential change in stream, we're dealing 14 with different content here. 15 And given the representation in Figure 10 is, as 16 you've noted several times, expressed in client time, 17 whereas the graph in Figure 4 is illustrated with respect 18 to bits, again I would want to be very certain of the 19 comparison or the mapping over of information displayed in 20 one figure than the other. 21 BY MR. PAUL: 22 Q And you hadn't conducted that comparison prior to 23 formulating the opinions in your supplemental declaration? 24 A As I've stated, the opinions that I expressed and 25 formulated in my supplemental declaration were directly in	68 1 time now to review that section. I can try to give you an 2 answer, but I haven't considered that question in 3 formulating my declaration. 4 Q Thank you. 5 And just for clarity, the upper bound of 6 gold(n-1), do you see that gold(n-1) has an upper bound in 7 Figure 10? 8 A I do. 9 Q Do you have an understanding one way or another 10 of what that upper bound corresponds to? 11 A In my brief perusal here of Chou's description of 12 Figure 10, I do not get a detailed explanation about that 13 span. I can only go back to the description where the 14 gap, the regular gap, g(n) as shown in Figure 4 is 15 described, and as Chou explains that is the gap between 16 the buffer tube upper bound and the coding schedule. 17 So for Figure 4, we have a clear explanation as 18 to what g(n) is. As to whether Chou intends the same for 19 gnew and gold, for the corresponding previous frame (n-1), I 20 would want to read through again carefully to be sure 21 before giving you an answer. 22 Q Okay. So it's possible that the gnew(n-1) is 23 different from the gap shown in Figure 4, where the y-axis 24 is given in bits, rather than client time. Is that fair? 25 A My read of things here from the quick scan of the

Conducted on October 11, 2024

69 1 paragraphs under Section D, choosing a stream giving a 2 coding bit rate, appears to suggest that the gap that we 3 see in Figure 10 is similarly, as described previously, 4 with respect to the gap between the buffer tube upper 5 bound and the coding schedule. 6 Q Your testimony is that the staircase pattern 7 shown in Figure 10 is a coding schedule? 8 MR. KNIERIM: Objection to form. 9 THE WITNESS: What I've stated is that the gap that 10 was described earlier for Figure 4, as being the gap at 11 frame -- well, the gap $g(n)$ at frame N, this is in 12 paragraph 66, between the buffer tube upper bound and the 13 coding schedule. 14 That's what's described in Figure 4. When I look 15 at the description in Chou, under Section D of -- sorry, 16 Subsection D of Section 5, Roman V, Implementation 17 Details, Coding Bit Rate Switching, we have the upper 18 bound, a current gap to the upper bound $g_{new}(n)$. Which 19 seems to be a similar description. 20 BY MR. PAUL: 21 Q Okay. So putting aside the similarities in the 22 description, you can't say for sure whether the gap shown 23 in Figure 4 is the same as the gap shown in Figure 10; is 24 that fair? 25 A As I've stated, they're dealing with different	71 1 are illustrating different things. Figure 4 is related to 2 the general concept. Figure 10 is related to the coding 3 bit rate switching. And that's why you have notations in 4 Figure 10 of g_{new} and g_{old} that do not appear in Figure 4 5 because Figure 4 is not dealing with a change between two 6 coding bit rates. 7 Q So the gap in Figure 4 and the gaps in Figure 10 8 are different gaps? 9 A The gaps shown in Figure 10 are a new gap, which 10 is the current value as described in figure -- in 11 paragraph 112 of Chou, and the old is presumably the 12 previous value prior to the switch. 13 Q Right. And those gaps are different than the gap 14 shown in Figure 4, which describes a different 15 functionality as you testified just a minute ago? 16 A I don't believe I suggested that Figure 4 is 17 dealing with different functionality. Rather, if I did, I 18 may have misspoken. What I'm trying to explain is that 19 Figure 4 is dealing with the general model of the leaky 20 bucket and its operation. Whereas Figure 10 is dealing 21 with a specific aspect to that functionality. Which is 22 what happens when there is a change in coding rate, coding 23 bit rate. 24 Q Can we pan up to Figure 5, please. 25 Here once again, this Figure 5, as we talked
70 1 things. Figure 4 is a general description starting off, 2 the overall algorithm, and Figure 10 is specifically 3 related to Roman V, Subsection D, Coding Bit Rate 4 Switching. 5 And the notation is no longer just $g(n)$. It's 6 g_{new} and $g_{old}(n)$. They're dealing with descriptions of a 7 similar measure, a similar variable, but dealing with a 8 different functionality or a different aspect of the leaky 9 bucket model that Chou is describing. Moreover it's 10 describing in Figure 10, that for $(n-1)$, rather than for 11 frame N, and the graph is expressed in Figure 10 in client 12 time, rather than in bits. 13 So there are a number of discrepancies to deal 14 with, but the overall description of the G, the $g(n)$ or 15 the $g(n-1)$ relative to G of old or G of new has the 16 similarities. They both seem to be talking about the gap 17 between the upper bound. In paragraph 112, it's upper 18 bound in bits, upper bound... the current gap to the upper 19 bound and then the old gap to the upper bound. 20 Q Okay. So to summarize, there may be similarities 21 in the variable used in the gap in Figure 4 and the gap in 22 Figure 10. But those gaps deal with different 23 functionalities or different aspects of the leaky bucket 24 model as you described; is that fair? 25 A No, that's not what I said. I said the figures	72 1 about briefly earlier, Dr. Cooperstock, shows a staircase 2 pattern of arrival schedule. Right? 3 A That is correct. 4 Q And the y-axis in Figure 5 is client time, right? 5 A That is correct. 6 Q And as we saw, the y-axis in Figure 10 is also 7 client time, right? 8 A That is correct. 9 Q And Figure 5 shows that -- indicates a lower 10 bound of the gap between the staircase and the upper 11 bound. That lower bound -- 12 A Okay. 13 Q That lower bound is labeled $t_a(n)$. Do you see 14 $t_a(n)$ on Figure 5? 15 A I do. 16 Q With respect to frame N? 17 A I see $t_a(n)$. I don't see a label of a gap 18 though. 19 Q Correct. 20 And you see that the -- or that frame N, where it 21 meets the upper bound of that tube, do you see that? 22 A Where... you mean the intersection of the dashed 23 line representing $\tau D(n)$ in media time intersects the 24 upper bound of the tube? 25 Q Correct.

Conducted on October 11, 2024

73 1 A Okay. 2 Q And that is labeled $tb(n)$. Right? 3 A That is correct. 4 Q What do you understand $tb(n)$ to represent? 5 A Sorry, was somebody else speaking? 6 MR. KNIERIM: I just didn't catch the letter that was 7 used just for a clear record. Was it B, as in boy? 8 MR. PAUL: Yes. I'm asking about $tb(n)$, B, as in boy. 9 THE WITNESS: Yes, so $tb(n)$ is the upper bound of the 10 buffer tube for frame N. 11 BY MR. PAUL: 12 Q And that is an upper bound with respect to what? 13 It's an upper bound in terms of time; is that fair? 14 A With respect to Figure 5, the upper bound is -- 15 appears to be with respect to time, as per paragraph 70 of 16 Chou. 17 Q Okay. If we can go back to Figure 10, please. 18 And there, we talk about there is explicit 19 labelling of a gap $gold(n-1)$, right? 20 A There is a label of $gold(n-1)$. 21 Q Do you have an understanding that the upper bound 22 of that gap $gold(n-1)$ is an upper bound in time? 23 MR. KNIERIM: Objection to form, scope. 24 THE WITNESS: Well, reading paragraph 101, where Chou 25 talks about -- this is about two-thirds of the way down,	75 1 schedule. 2 Q What is that upper bound that you just mentioned? 3 A The upper bound would similarly be the upper 4 bound to whatever the staircase is representing. If it's 5 encoder side, then that's the coding schedule. 6 Q Okay. The upper bound, it could also be a 7 decoder schedule. Is that what you're saying? 8 A With respect to Figure 10, I'd have to go through 9 the text again to see whether Chou's description is 10 dealing with the possible complementarity in the idealized 11 assumptions that were made earlier in introducing the 12 leaky bucket model. 13 But I -- well, without going through that text 14 carefully and seeing the lead up to it, I would hesitate 15 to speculate. 16 Q Okay. 17 A Now, Mr. Paul, we've been going for about an hour 18 and 20 minutes. So would this be a good time to take a 19 break? 20 Q Yeah, we can do 10 minutes. 21 A Sure. 22 Q Thank you. 23 (Recess taken.) 24 BY MR. PAUL: 25 Q Dr. Cooperstock, just a couple of follow-up
74 1 One solution is to introduce a simultaneous shift in the 2 control target schedule equal $\delta g(n-1)/R$ tilde or the 3 moving average of that coding rate, where δ 4 $g(n-1) = g_{new}(n-1) - gold(n-1)$ is the actual shift in the upper 5 bound, brackets, in bits, closed brackets, at frame $(n-1)$ 6 computed at the server, as illustrated in Figure 10. 7 So this description as provided here is talking 8 about a computation done at the server in bits. I don't 9 disagree that Figure 10 is labelling the y-axis in client 10 time. And as I stated earlier, given that the computation 11 is being done at the server side, the translation between 12 time and bits is simply a matter of dividing by rate. And 13 that may explain the discrepancy between the y-axis label 14 of time, and the discussion in some of the text 15 surrounding Figure 10 or associated with Figure 10 as 16 referring to these gaps being in bits. 17 BY MR. PAUL: 18 Q So what is your understanding of the upper bound 19 of that gap shown in Figure 10, $gold(n-1)$? 20 A Assuming that we are dealing with the two 21 diagonal lines representing the buffer tube in which the 22 upper line represents the upper bound, the lower line 23 represents the lower bound, that would be the lower bound 24 to whatever is taking place in the staircase. 25 If it's on the encoder side, then it's the coding	76 1 questions. If we can go back to 1004. Let's take a look 2 at Figure 5. 3 You mentioned that upper bound $tb(n)$, right? 4 A Yes. 5 Q And do you understand that to be an upper bound 6 for when the packets arrive? 7 A So with respect to the view of Figure 5 as being 8 the transformation of Figure 4 converting bits into client 9 time, which as Chou describes in paragraph 67, Dividing 10 the vertical scale of the schedules in Figure 4 by r_a, the 11 schedules are obtained in terms of client time, rather 12 than bits, as shown in the graph of Figure 5. 13 Q Right. 14 A And the coding schedule divided by r_a becomes the 15 arrival schedule in which case the upper bound is the 16 upper bound of the arrival of the bits. 17 Q Okay. And in paragraph 67, even more 18 specifically, says that, For each N, the time $tb(n)$ by 19 which frame N is guaranteed to arrive, right? 20 A The buffer tube upper bound in bits divided by r_a 21 becomes the buffer tube upper bound in time, which 22 provides for each N the time $tb(n)$ by which frame N is 23 guaranteed to arrive. 24 Q Okay. Thank you. 25 So if we go back to Figure 10, and we talked

Conducted on October 11, 2024

77 1 about the upper bound shown in Figure 10, right? 2 A Assuming that it's an upper bound. I'm basing it 3 on the sort of parallels. 4 Q Okay. So Figure 10 has an upper bound, which 5 would be the time by which frame any given frame N, (n-1), 6 (n-2) would be guaranteed to arrive; is that fair? 7 MR. KNIERIM: Objection to form 8 THE WITNESS: I don't know if that's fair given that 9 what seems to be described in Figure 10 is calculations 10 taking place on the encoder side. 11 BY MR. PAUL: 12 Q What do you understand the buffer tube upper 13 bound in Figure 10 is the upper bound do? In other words, 14 the upper bound to what? 15 A Okay. It looks like, from what I'm seeing here 16 in the summary from paragraphs 97 and 98, that this is the 17 server choosing a -- using these values to determine which 18 coding bit rate to pick, based on arrival of frames or 19 anticipated arrival times of frames of the client. 20 So that -- that seems to indicate, again, this 21 is -- this is just going on what I'm reading at present, 22 that the -- the server is choosing a stream that causes 23 the upper bound to shift up from paragraph 98, No more 24 than some amount $\text{deltamaxg}(n-1)$ supplied to it by the 25 client.	79 1 Q Do you see that rc_old and rc_new are annotated on 2 what correspond to the upper bounds in Figure 10? 3 A I'm sorry, I didn't understand your question. 4 Q Okay. Let's take this one at a time. So rc_old 5 on Figure 10 is labeled along the upper bound of the 6 buffer tube, right? 7 MR. KNIERIM: Objection to form. 8 THE WITNESS: If you could point me to the description 9 in Chou that relates to those labels, I'd be happy to 10 consider your question, but I'm not finding it in my quick 11 skim here. 12 BY MR. PAUL: 13 Q Okay. Why don't we go back to... you mentioned 14 paragraph 67 of Chou when we were talking a moment ago 15 about the buffer tube upper bound -- 16 A Sorry, I found it now in paragraph 125, Chou does 17 describe the old coding bit rate rcold and the new coding 18 bit rate rcnew, but that's with reference to Figure 12, not 19 Figure 10. 20 Q Okay. Why don't we go to paragraph 67. And we 21 can zoom in just a little bit. Thank you. 22 And here, we talked about this a few minutes ago, 23 how you get from Figure 4 to Figure 5 in Chou, right? 24 A Yeah, Dividing the vertical scale of the 25 schedules in Figure 4 by ra, the schedules are obtained in
78 1 Q So that upper bound referenced in paragraph 98 2 and shown in Figure 10 is an upper bound for the arrival 3 of those frames; is that fair? 4 A That seems to be the case given that the server 5 is choosing rates with awareness that it has to ensure 6 that the arrival of frames do not result in underflow at 7 the client side. 8 Q Okay. What do you understand rc_old, do you see 9 that on Figure 10? 10 A I do see that. But I have not considered rc_old 11 in forming my opinions. 12 Q You don't have an understanding of what rc_old 13 denotes in Figure 10; is that fair? 14 A As I stated -- 15 MR. KNIERIM: Object to form -- 16 THE WITNESS: Sorry, I was speaking over Mike. 17 MR. KNIERIM: Yeah, objection to form, scope. 18 THE WITNESS: So, as I stated, I have not considered 19 rc_old in forming my opinions. 20 BY MR. PAUL: 21 Q And just to close the gap here, rc_new, did you 22 consider or have an understanding of what rc_new is in 23 formulating your opinions? 24 A I was not expressing opinions on either rc_new or 25 rc_old as I prepared my deposition -- my declaration.	80 1 terms of client time, rather than bits as shown in the 2 graph in Figure 5. 3 Q Okay. And then in paragraph 67, Chou goes on to 4 explain that, In the same plot, the playback deadline is 5 shown, which is the time $\text{td}(n)$ at which frame N is 6 scheduled to be played after instantaneous coding. Thus 7 the gap between the frames arrival time and its playback 8 deadline is the client buffer duration at the time of the 9 frame arrival. Right? 10 A No. You made two mistakes in reading that 11 section. 12 Q It says, In the same plot that playback deadline 13 is shown, that plot being Figure 5, right? 14 A Fair enough. 15 Q And that playback deadline is the time $\text{td}(n)$ at 16 which the frame N is scheduled to be played after 17 instantaneous decoding, right? 18 A Correct. 19 Q And it goes on to say, Thus, the gap between a 20 frame's arrival time and its playback deadline is the 21 client buffer duration at the time of the frame arrival, 22 right? 23 A Now you've read it correctly. 24 Q Okay. And so who is keeping track of the 25 playback deadline, client or server?

Conducted on October 11, 2024

81 1 A The playback deadline, what I expect, would have 2 to be maintained at the client side. The client is 3 ultimately the party that determines when it is playing 4 back content. 5 Q And similarly, who keeps track of the target 6 schedule, client or server? 7 Dr. Cooperstock, in the interest of time, this 8 question's been pending for several minutes now. Do you 9 have an understanding of who keeps track of the target 10 schedule client or server? 11 A I'm searching for challenge, trying to see if 12 there's anything definitive that Chou provides with regard 13 to whether the client could be the one to be involved in 14 that determination or whether it would strictly be a 15 function of the leaky bucket model where the encoder is 16 responsible for setting the target schedule. 17 And I'm not finding a definitive statement to 18 that effect, and I haven't considered the question as to 19 where that parameter would be determined. 20 Q Okay. Let me go on to -- let's go to 21 paragraph 113. Sorry, actually, let's go back to -- let's 22 put up Figure 5. 23 Okay. And I asked you about playback deadline 24 and target schedule. Just to close the loop, who provides 25 the $tb(n)$?	83 1 buffer tube upper bound in bits divided by r_a becomes a 2 buffer tube upper bound in time which provides for each N, 3 the time $tb(n)$ by which frame N is guaranteed to arrive. 4 But that doesn't specify who's responsible for 5 that value. 6 Q Let's go to paragraph 113. 7 And this is under Section 5E, which is 8 implement -- Section 5 being, Implementation Details and 9 Subsection E being, Optimal Rate Control at the Client. 10 Right? 11 A That is correct. 12 Q And you've cited paragraph 113 in your 13 declaration... let me withdraw that. 14 You cited paragraph 113 in paragraph 8 of your 15 declaration, right? 16 A Correct. 17 Q Okay. Do you see anywhere in paragraph 113, 18 Section 5E that Chou discloses calculating $g(n-1)$? 19 A Oh, paragraph 113 only discusses the client 20 receiving the value, $g(n)$ along with the new frame. And 21 states that, The values of $g(n)$ for successive frames 22 could be then inferred by the client itself based on the 23 coding bit rate $r\text{-hat}(n)$ and the frame size $b(n)$. So 24 that's where the client can estimate or infer what the 25 $g(n)$ is for successive frames.
82 1 A So Chou describes in paragraph 25, that the upper 2 bound gap is provided by the encoder. And goes on to 3 state that, In cases where the upper bound gap is only 4 provided for -- with the first frame after a change in the 5 coding bit rate, the client estimates the upper bound gap 6 for the frames that do not include a gap value -- I'm 7 sorry, that's the gap... 8 Q So my question is with respect to Figure 5. Do 9 you have an understanding of who keeps track of the upper 10 and lower bounds, shown in Figure 5? 11 A I'm trying to see just like for the target 12 schedule, whether that would be anything other than the 13 encoder's responsibility. 14 So we have in paragraph 69 in Chou, reference to, 15 Using Equation 16, the client can compute $tb(n-1)$, the 16 upper bound for frame $(n-1)$ from the measured arrival time 17 $ta(n-1)$, the estimated arrival rate $r\text{-tilde}(n-1)$ and 18 $g(n-1)$ which can be transmitted to the client along with 19 the data, et cetera, et cetera. 20 So the client can compute the upper bound. 21 Q Okay. 22 A Who is in charge of it? That's a different 23 question. And I'm not seeing Chou state here who is 24 responsible, ultimately, for that value. It just states 25 that the client can compute it. And in paragraph 67, The	84 1 And you could presumably apply that logic 2 substituting n with $(n-1)$ to have the same result. 3 Q Paragraph 113 itself doesn't explicitly disclose 4 calculating $g(n-1)$, right? 5 A No. Paragraph 113 is with reference to $g(n)$. 6 Q Okay. If we can go to -- you've mentioned that 7 paragraph 101 earlier in -- and I just wanted to draw 8 attention, right above it, paragraph 100, which begins, It 9 is noted that in an alternate embodiment. Do you see 10 that? 11 A I do. 12 Q And it reads, In an alternate embodiment, 13 information as to what coding bit rates the server 14 supports can be provided to the client ahead of time, and 15 the client can be responsible for performing the foregoing 16 analysis. In this case, the client would only request 17 coding bit rates that are supported by the server, and 18 there would be no need to provide the $\Delta_{\max} g(n-1)$ to 19 the server with the request. 20 Do you see that? 21 A I do. 22 Q And so paragraph 100 of Chou, illustrates an 23 alternate embodiment in which the client can perform 24 computations; is that fair? 25 MR. KNIERIM: Objection to form, scope.

Conducted on October 11, 2024

85 1 THE WITNESS: What paragraph 100 describes, with 2 regard to the... coding bit rates or the information, as 3 to the coding bit rates the server supports, that that is 4 information that can be provided to the client ahead of 5 time. So the server doesn't need to, in real time, make 6 determinations as to coding rates that are suitable and 7 the client requests them. Here, the client would already 8 know which coding rates the server supports. 9 BY MR. PAUL: 10 Q So in this example, embodiment all work is being 11 done at the client, right? 12 MR. KNIERIM: Same objections. 13 THE WITNESS: All that is said here is that in 14 paragraph 100, that the client would only request coding 15 bit rates that are supported by the server. And there 16 would be no need to provide the $\Delta_{max}(n-1)$ to the 17 server with the request. 18 So this is eliminating the requirement for the 19 client and server to have to negotiate in a sense where 20 the client is requesting one code rate, the server might 21 not support. In paragraph 100, we see that being in a 22 sense, short-circuited by the server providing a priority, 23 a list of rates that it supports to the client. Thus 24 facilitating the client making the request of a coding bit 25 rate that it knows the server can support.	87 1 Q Thank you. 2 So I was going to 126 and 127, and you start with 3 126. These are cited in paragraph 17 of your declaration. 4 I think we started to look at that, right? 5 Well, why don't we go to paragraph 17 of our 6 declaration, 2016. 7 A Okay. 8 Q And there you mentioned, Chou discloses a 9 technique for the client to estimate the gap $g(n)$ of the 10 encoder buffer when the server is unable to simulate the 11 leaky buckets and cannot send $g_{new}(n)$ to the client, right? 12 A That's correct. 13 Q And to that proposition, you cite paragraphs 126 14 to 128 of Chou, right? 15 A Correct. 16 Q And if we go to -- back to Chou. So in the 17 middle of paragraph 26, it says that, The client continues 18 to update $g(n)$ for the new coding bit rate by running its 19 own leaky bucket simulator with a new coding bit rate. 20 Right? 21 A Correct. 22 Q So Chou's leaky bucket model entails that both 23 the client and the server each run its own leaky bucket 24 simulator, right? 25 MR. KNIERIM: Objection to form.
86 1 BY MR. PAUL: 2 Q Okay. If we go back to paragraph 112, in this 3 you cited -- we looked at it earlier. It was cited in 4 your declaration, right? 5 A That's correct. 6 Q And as of the sentence that you cited, If the 7 sender finds a suitable coding bit rate and makes a switch 8 at frame N, it will transmit three values to the client 9 along with the frame, the new coding bit rate $r_{new}(n)$, 10 the current gap to the upper bound $g_{new}(n)$ and the shift 11 $\Delta(n-1) = g_{new}(n-1) - g(n-1)$, right? 12 A That is correct. 13 Q Those parameters are not used to calculate a new 14 code rate, which has already been calculated, right? 15 A As you read, the new coding bit rate $r_{new}(n)$ 16 is something that has already been determined and is 17 transmitted from the sender to the client. 18 Q Okay. If you go to paragraphs 126 and 127. 19 A Just -- sorry, before you do, I do note a 20 reference to an earlier question, later in this same 21 paragraph 112, we have, With this information, the client 22 can properly adjust its control target schedule as well as 23 its upper bound. 24 So here, at least, we have the client presumably 25 being responsible for controlling its upper bound.	88 1 THE WITNESS: The leaky bucket is the control 2 mechanism or the metaphor that is employed by the server. 3 And the client can try to simulate what is going on on the 4 server, on the encoder. But it only has knowledge of what 5 is taking place or has taken place based on whatever 6 information the server sends. 7 So the client runs the simulator, or the client 8 can -- yeah, can run its own simulator. But the server is 9 not running the simulator. The server is implementing the 10 paradigm of the leaky bucket. 11 BY MR. PAUL: 12 Q Okay. If we can pull up Exhibit 1040. And I'll 13 mark Exhibit 1040 into the record as well. 14 (Whereupon Deposition Exhibit 1040 15 was marked for identification.) 16 BY MR. PAUL: 17 Q And if we can -- first of all, Dr. Cooperstock, 18 do you recognize Exhibit 1040 to be Dr. Reader's 19 supplemental declaration? 20 A Based on the cover page, it looks identical to 21 what I have in front of me. 22 Q Okay. And at the beginning you noted that the 23 purpose of your supplemental declaration was to respond to 24 the opinions provided by Dr. Reader in this declaration, 25 right?

Conducted on October 11, 2024

89 1 A That is correct. 2 Q Okay. If we can go to paragraph 16. Here, 3 Dr. Reader begins that, Chou mentions that the calculation 4 of the frame rate must account for transmission delay when 5 providing feedback from the client to server. Right? 6 A No. You've inserted a the where one does not 7 exist, and you've dropped the, the where it did exist. 8 Q Okay. Let me read that again. 9 At paragraph 16, Dr. Chou -- withdrawn. 10 In paragraph 16 Dr. Reader states, Chou mentions 11 that the calculation of frame rate must account for 12 transmission delay when providing feedback from the client 13 to the server. Did I read that right? 14 A You did. 15 Q And over the course of today's deposition, we've 16 seen various portions of the Chou reference discussing the 17 feedback from the client to the server, right? 18 A You'll have to remind me of which specific 19 paragraphs we were dealing with where the client is 20 providing feedback. 21 Q Sure. 22 Why don't we go to Exhibit 1004, Chou 23 paragraph 69. Here, it states that the -- last sentence 24 of paragraph 69, From this perspective Equation 18 can be 25 regarded as the state transition equation of a feedback	91 1 coding bit rate in Chou's system, right? 2 MR. KNIERIM: Objection; scope. 3 THE WITNESS: What I read in the first sentence of 4 paragraph 81 is that, As each frame arrives at the client, 5 a feedback loop can send a message to the server to adjust 6 the coding bit rate. 7 BY MR. PAUL: 8 Q Thank you. 9 And similarly, the concluding sentence of 10 paragraph 81, after discussing the one-frame delay in this 11 paragraph, states that, This one-frame delay in the 12 feedback loop must be explicitly accounted for, right? 13 MR. KNIERIM: Objection; scope. 14 THE WITNESS: That is the final sentence of the 15 paragraph. 16 BY MR. PAUL: 17 Q Okay. And as we saw Dr. Reader, in his 18 Declaration 1040, paragraph 16, references this feedback 19 loop, right? 20 MR. KNIERIM: Objection; scope, only outside the scope 21 out of Dr. Cooperstock's supplemental declaration. 22 BY MR. PAUL: 23 Q We can go to 1040. 24 And as we discussed earlier, a couple of minutes 25 ago, Dr. Reader here is making mention of the feedback
90 1 control system, and it is thus possible to use a 2 control-theoretic approach to regulate the coding bit 3 rate, right? 4 A Okay. So yes, by requesting a different code 5 rate, that is feedback that the client is providing to the 6 sender. 7 Q And if we go to... one moment. 8 If we go to paragraph 81 of Chou. And you recall 9 citing paragraph 81 of Chou in your first declaration? 10 A I believe so. 11 MR. KNIERIM: Objection; scope. (Indiscernible 12 utterance) and I'll just note for the record that 13 Dr. Cooperstock's supplemental declaration was submitted 14 in accordance with -- 15 THE STENOGRAPHIC REPORTER: I'm sorry, Mike, you cut 16 off a bit. You cut off. I couldn't hear you. 17 MR. KNIERIM: Sure, sure. 18 So objection is to scope. And I want to note for 19 the record that Dr. Cooperstock's supplemental declaration 20 was submitted pursuant from the order -- pursuant to the 21 order from the board that limited the topics that he could 22 opine on. 23 BY MR. PAUL: 24 Q And so, Dr. Cooperstock, paragraph 81 of Chou 25 also discusses the feedback loop entailed in regulating	92 1 from client to server, right? 2 MR. KNIERIM: Same objection. 3 THE WITNESS: Dr. Reader states in paragraph 16 that, 4 Chou mentions that the calculation of frame rate must 5 account for transmission delay when providing feedback 6 from the client to the server. 7 BY MR. PAUL: 8 Q Okay. And in your supplemental declaration, 9 Exhibit 2016, you don't make any mention to the feedback 10 in Chou's system, right? 11 MR. KNIERIM: Objection; scope. 12 THE WITNESS: What Dr. Reader is discussing here in 13 paragraph 16 is the fact that the time at which a 14 calculation can be carried out to determine code rate for 15 frame N is at time frame (n+2). 16 That's what I read as being the point that 17 Dr. Reader is making in paragraph 16. And I've no dispute 18 that the time at which the client has the ability to 19 determine or to -- what the language from paragraph 81, 20 the time a ta(n), the time of arrival of frame N, that is 21 the time at which the controller's job must be to choose 22 the coding rate rc(n+2). 23 This one-frame delay in the feedback group must 24 be explicitly accounted for. That's the point that 25 Dr. Reader is making. That's one of the few instances

Conducted on October 11, 2024

93 1 where I think Dr. Reader's description is accurate. That 2 is -- that is indeed the time at which the controller 3 chooses the frame rate, or the coding rate for N frame 4 (n+2). 5 BY MR. PAUL: 6 Q Dr. Cooperstock, my question was slightly 7 different. My question was, in your supplemental 8 declaration, Exhibit 2016, you don't make any mention of 9 the feedback in Chou's system, right? 10 MR. KNIERIM: Objection; scope. 11 THE WITNESS: Again, as I read the discussion from 12 paragraph 16 of Dr. Reader, the discussion here pertains 13 to the time at which the client can calculate the code 14 rate for frame N. That's what element of the feedback 15 loop is being discussed here. 16 BY MR. PAUL: 17 Q Okay. So putting aside for a second, 18 Dr. Reader's declaration, you don't make any reference to 19 the feedback in Chou's system in your declaration, right? 20 A My declaration is in response to Dr. Reader's 21 supplemental declaration and the petition or the reply of 22 the petitioner, that is supported by Dr. Reader's 23 supplemental declaration. And in -- 24 Q Okay. 25 A Sorry?	95 1 MR. PAUL: I completely disagree with that. It's 2 clearly within the scope of what he intended to do with 3 his -- what Dr. Cooperstock said he did in preparation in 4 the purpose of his declaration. So we can disagree on 5 that. 6 MR. KNIERIM: We can disagree. I just want to read 7 into the record the request was to submit a supplemental 8 declaration responsive to Section 383, 3C1, Exhibit 1040 9 and paragraph 6 of 15, 28 through 29, not paragraph 16. 10 But you can proceed. 11 BY MR. PAUL: 12 Q Okay. Dr. Cooperstock, did you see anywhere in 13 Dr. Reader's supplemental declaration where he cited to 14 paragraphs 110, 112, or 126 of Chou? 15 A Sorry, can you give me the paragraph numbers 16 again? 17 Q Paragraphs 110, 112, or 126 of Chou are not cited 18 in Dr. Reader's supplemental declaration, Exhibit 1040, 19 right? 20 A From my quick search right now, I'm not seeing 21 those paragraph numbers listed other than reference to my 22 own original declaration. 23 Q Okay. And your citation to paragraphs 110, 112, 24 and 126 in your supplemental declaration, you believe were 25 nonetheless responsive to his supplemental declaration; is
94 1 Q Please. 2 A Oh, okay. 3 And the discussion in this supplemental 4 declaration by Dr. Reader is not dealing with questions 5 about the way the feedback loop operates and so forth. 6 It's only to describe the time at which the determination 7 of the code rate is carried out. And as per the last 8 sentence shown here on the page of the paragraph 16, When 9 frame (n-2) arrives at the decoder, the client buffer 10 duration will be the difference between playback deadline 11 T -- let's see that in a larger font -- $td(n-2)$ and 12 arrival schedule $ta(n-2)$ citing to Chou paragraph 67. 13 So there was really nothing for me to discuss in 14 terms of the feedback loop given that what Dr. Reader is 15 discussing here, is simply the time at which that 16 calculation is being carried out. 17 MR. KNIERIM: And again, I just want to state for a 18 very clear record here, the board authorized a 19 supplemental declaration from Dr. Cooperstock providing 20 certain paragraphs of Dr. Reader's declaration that's in 21 our email and the order the board issued. And this is not 22 one of them. So just so we have a clear record here. I 23 think it's inappropriate to ask questions about this 24 paragraph given that Dr. Cooperstock, by order of the 25 board, did not have an opportunity to opine on it.	96 1 that fair? 2 MR. KNIERIM: Objection to form. 3 THE WITNESS: Well, if we take, for example, 4 Dr. Reader's -- let me find the paragraph. 5 In paragraph 14 of Dr. Reader's supplemental 6 declaration, he concludes by claiming that accordingly, a 7 POSITA would have understood that when the Equation 18 8 accounts for the, quote, Playback deadline, end quote, 9 Target schedule, closed quote, of Figure 5, it would 10 factor in the client buffer size according to this model. 11 And what I've done in paragraph 22 of my 12 supplemental declaration responding to that is noting that 13 Chou teaches determining the code rate based on the coder 14 buffer parameters. And I've cited to paragraph 110 of 15 Chou as an example of that. Where Chou in paragraph 110, 16 talks about, about halfway down, Once all the data units 17 in a frame are read from the media file, the sender 18 computes $g(n) = B_{min}(R_{avg}) - B_e(n)$ for each of the virtually 19 streams, et cetera, et cetera. 20 And then the gap $g_{new}(n)$ for the new stream is 21 transmitted to the client along with $\Delta g(n-1)$, et 22 cetera, et cetera. These are all, as I've noted here, 23 determining the code rate based on the encoder buffer 24 parameters. That's why I've cited to that paragraph in 25 Chou as an example to illustrate in response to

Conducted on October 11, 2024

97	1 Dr. Reader's contention that a POSITA would have 2 understood that when the Equation 18 accounts for the 3 playback deadline and target schedule, it would factor in 4 the client buffer size according to this model. 5 I'm illustrating that that's not the case. 6 MR. PAUL: I don't have any further questions for now. 7 MR. KNIERIM: All right, let's take a short break. 8 (Recess taken.) 9 MR. KNIERIM: I have no questions for the witness. So 10 I think we are concluded. 11 MR. PAUL: Thank you, Dr. Cooperstock. 12 (WHEREUPON THE DEPOSITION WAS 13 CONCLUDED AT 12:58 P.M.) 14 15 16 17 18 19 20 21 22 23 24 25	99
98	1 WITNESS'S CHANGES OR CORRECTIONS 2 3 NOTE: If you are adding to your testimony, print 4 the exact words you want to add. If you are 5 deleting from your testimony, print the exact 6 words you want to delete. Specify with "Add" 7 or "Delete" and sign this form. 8 9 Deposition of: JEREMY R. COOPERSTOCK, PH.D. 10 Case Title: PELOTON V. NEC 11 Date of Deposition: OCTOBER 11, 2024 12 13 I, _____ have 14 the following corrections to make to my deposition: 15 PageLine Change/Add/Delete 16 _____ 17 _____ 18 _____ 19 _____ 20 _____ 21 _____ 22 _____ 23 _____ 24 _____ 25 _____	100
98	1 Please be advised I have read the 2 foregoing deposition, pages 1 through 3 100, inclusive. 4 I hereby state there are: 5 6 (Check one) _____ no corrections 7 _____ corrections per attached 8 _____ 9 10 JEREMY R. COOPERSTOCK, PH.D. 11 12 13 14 15 16 17 18 19 --oOo-- 20 21 22 23 24 25	100
98	1 CERTIFICATE OF SHORTHAND REPORTER/STENOGRAPHER 2 3 I, Christa Yan, Certified Shorthand/Stenographic 4 Reporter within and for the State of California do hereby 5 certify: 6 That Jeremy Cooperstock, Ph.D., the Witness whose 7 deposition is hereinbefore set forth, was duly sworn by me 8 before the commencement of such deposition and that such 9 deposition was taken before me and is a true record of the 10 testimony given by such witness. 11 12 I further certify that each party was represented by 13 counsel at the deposition. 14 15 I further certify that the deposition of Jeremy 16 Cooperstock, Ph.D. occurred remotely on October 11, 2024, 17 commencing at 8:06 a.m., to 12:58 p.m., Pacific Standard 18 Time. 19 20 I further certify that I am not related to any of the 21 parties to this action by blood or marriage, I am not 22 employed by or an attorney to any of the parties to this 23 action, and that I am in no way interested, financially or 24 otherwise, in the outcome of this matter. 25 WITNESS my hand this 17th day of October 2024. _____ Christa Yan, CSR NO. 14316	100

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PELOTON EX. 1042 - 26/57

A			
a1	15:4, 33:16,	affecting	21:25, 40:22,
3:17	33:17, 34:4,	43:5	44:3, 45:22,
ability	34:21, 42:19,	aforementioned	52:23, 55:1,
92:18	43:2, 67:22	30:21, 33:8,	57:10, 57:12,
able	achieved	34:16, 34:24,	85:10, 85:13,
10:18, 51:17,	14:21	35:16, 36:1,	88:17, 96:16,
62:6, 62:18,	across	37:12, 37:24,	96:22, 97:7
63:8, 67:21	61:15	38:2, 38:20,	allow
about	action	41:5, 42:12,	51:1, 52:1,
21:21, 22:5,	100:23, 100:25	42:25, 45:10	53:7, 53:20
23:12, 26:20,	actual	after	allows
37:16, 39:14,	60:19, 62:1,	26:18, 29:6,	42:13
45:20, 55:25,	74:4	29:12, 29:22,	alluding
60:14, 64:2,	actually	30:18, 35:15,	32:24
64:5, 67:12,	7:6, 12:2,	45:9, 54:3,	along
68:12, 70:16,	21:23, 67:10,	80:6, 80:16,	21:12, 29:23,
72:1, 73:8,	81:21	82:4, 91:10	34:20, 36:6,
73:18, 73:25,	add	again	38:24, 39:16,
74:8, 75:17,	17:15, 99:4,	12:24, 17:15,	48:5, 48:16,
77:1, 79:15,	99:6, 99:15	19:21, 32:9,	54:2, 55:14,
79:22, 81:23,	added	36:8, 39:20,	64:10, 79:5,
94:5, 94:23,	12:24, 13:13,	40:18, 44:13,	82:18, 83:20,
96:16	19:17, 19:21	46:7, 52:19,	86:9, 96:21
above	adding	59:7, 62:22,	already
20:25, 49:9,	12:17, 99:3	65:8, 66:18,	35:8, 39:10,
49:17, 49:20,	addition	68:20, 71:25,	41:25, 53:12,
84:8	42:15	75:9, 77:20,	54:4, 85:7,
abstraction	additional	89:8, 93:11,	86:14, 86:16
25:5	13:13	94:17, 95:16	also
accordance	address	ago	2:21, 5:24,
4:7, 90:14	9:24, 10:4	71:15, 79:14,	5:25, 6:1, 16:2,
according	adjust	79:22, 91:25	20:2, 20:8,
23:23, 96:10,	6:12, 48:22,	agree	23:17, 26:9,
97:4	86:22, 91:5	9:2, 41:19,	27:5, 27:8,
accordingly	adjusted	44:23, 55:8,	28:12, 30:7,
96:6	42:25, 45:11	60:22, 62:19	30:21, 47:4,
account	adjusting	ahead	51:13, 55:14,
89:4, 89:11,	43:10, 43:13,	6:6, 6:20,	57:1, 58:2,
92:5	43:17, 44:24,	8:10, 84:14,	58:10, 58:13,
accounted	45:15	85:4	58:14, 72:6,
91:12, 92:24	adopting	algorithm	75:6, 90:25
accounts	20:21	70:2	alternate
96:8, 97:2	advance	align	31:2, 84:9,
accurate	5:14	61:15	84:12, 84:23
17:25, 56:8,	advancing	all	alternative
58:21, 93:1	32:1	7:2, 8:23,	31:9, 31:18,
	advised	8:25, 9:2,	32:3, 32:12
	98:1	10:25, 11:2,	amount
			53:25, 55:7,

77:24 analysis 84:16 angle 6:10 annotated 79:1 another 5:4, 30:1, 44:8, 62:3, 63:4, 68:9 answer 6:6, 6:7, 6:20, 8:9, 9:13, 57:20, 61:22, 63:9, 67:22, 68:2, 68:21 answered 23:6, 23:16, 23:17, 31:20, 32:15, 32:16 anticipate 5:2 anticipated 30:11, 33:11, 33:25, 34:10, 36:13, 36:22, 77:19 anupam 2:5, 5:24 any 5:5, 5:14, 6:18, 6:22, 7:5, 8:8, 9:9, 34:25, 45:20, 57:14, 77:5, 92:9, 93:8, 93:18, 97:6, 100:22, 100:24 anything 7:1, 44:3, 58:16, 81:12, 82:12 anywhere 20:14, 23:13, 83:17, 95:12 apologies 7:7, 32:7	apologize 5:14, 18:12 appeal 1:2 appear 15:23, 16:4, 71:4 appearance 59:12 appearances 2:1 appeared 4:5 appearing 25:17, 65:23 appears 25:2, 25:14, 61:12, 66:2, 69:2, 73:15 application 3:16 applied 54:17 apply 84:1 approach 90:2 approximately 9:4, 28:1, 30:13, 36:15, 50:3 arguments 9:25, 10:4 around 13:16 arrival 13:17, 21:7, 21:8, 30:11, 30:12, 33:12, 33:13, 33:25, 34:1, 34:10, 34:11, 36:13, 36:14, 36:22, 36:24, 57:7, 57:19, 58:9, 58:15, 59:2, 59:5, 72:2, 76:15, 76:16,	77:18, 77:19, 78:2, 78:6, 80:7, 80:9, 80:20, 80:21, 82:16, 82:17, 92:20, 94:12 arrive 76:6, 76:19, 76:23, 77:6, 83:3 arrives 91:4, 94:9 arriving 8:18 arrows 61:13, 62:20 art 61:18, 62:10 article 33:18 articulated 62:7 aside 52:15, 69:21, 93:17 asked 23:6, 23:16, 31:20, 32:15, 40:17, 67:12, 81:23 asking 6:5, 23:12, 26:20, 45:18, 73:8 aspect 70:8, 71:21 aspects 70:23 assessment 14:12 assigned 13:5 assist 6:13 associated 29:24, 29:25, 63:19, 65:12, 74:15	assuming 40:6, 44:19, 74:20, 77:2 assumptions 25:6, 75:11 attached 98:10 attempt 14:10, 15:7 attempted 15:2, 15:10 attending 5:1 attention 48:11, 50:19, 84:8 attorney 100:24 attorney-at-law 2:4, 2:5, 2:13 attorneys 8:9, 9:9, 9:15 authorized 94:18 available 42:19 average 13:11, 15:17, 42:10, 42:11, 42:15, 42:16, 42:18, 50:24, 51:22, 53:5, 53:19, 74:3 aware 5:4 awareness 78:5 away 5:6 B b(n) 19:19, 26:9, 83:23 b(n)+g(n) 20:1 back 8:16, 8:24,
---	---	--	--

12:20, 14:8, 18:25, 21:22, 24:16, 25:12, 28:11, 28:22, 35:2, 35:13, 42:17, 47:3, 49:23, 56:11, 56:13, 57:22, 58:13, 59:3, 61:9, 65:25, 67:11, 68:13, 73:17, 76:1, 76:25, 79:13, 81:4, 81:21, 86:2, 87:16 backup 5:5 backward 33:4 baker 2:12 bandwidth 42:18 based 34:17, 36:2, 37:13, 37:21, 38:3, 38:21, 41:6, 77:18, 83:22, 88:5, 88:20, 96:13, 96:23 basing 77:2 basis 12:16, 30:9, 31:4, 33:7, 33:10, 33:20, 33:23, 34:8, 36:11, 36:21, 59:11 because 13:2, 28:2, 51:23, 71:5 becomes 76:14, 76:21, 83:1 been 6:4, 8:24,	9:25, 11:1, 37:16, 58:13, 65:6, 75:17, 81:8, 86:14, 86:16 before 1:2, 4:3, 5:11, 6:20, 21:23, 40:4, 61:22, 68:21, 86:19, 100:9, 100:10 beginning 35:4, 37:2, 38:16, 39:10, 39:19, 48:11, 50:20, 88:22 begins 14:19, 42:9, 84:8, 89:3 begun 54:4 behalf 5:17, 5:23, 5:25, 6:1 being 5:17, 13:2, 13:5, 15:20, 20:11, 21:14, 22:14, 23:4, 32:21, 33:4, 37:21, 37:23, 39:7, 58:9, 58:20, 59:5, 59:8, 59:25, 60:18, 60:19, 60:23, 62:1, 69:10, 74:11, 74:16, 76:7, 80:13, 83:8, 83:9, 85:10, 85:21, 86:25, 92:16, 93:15, 94:16 believe 7:15, 7:23, 10:24, 12:19, 13:10, 17:22, 18:1, 19:17,	24:8, 45:18, 45:20, 56:9, 57:14, 58:8, 71:16, 90:10, 95:24 below 10:15, 48:6 best 5:4, 21:1 better 6:12, 10:19, 10:20 between 12:22, 18:7, 19:4, 25:14, 25:17, 25:25, 27:16, 29:11, 30:10, 33:11, 33:24, 34:9, 36:12, 36:22, 50:8, 60:1, 60:4, 60:19, 62:1, 65:12, 68:15, 69:4, 69:12, 70:17, 71:5, 72:10, 74:11, 74:13, 80:7, 80:19, 94:10 beyond 45:19, 62:6 bit 14:9, 14:21, 15:1, 21:21, 22:13, 29:23, 30:10, 30:19, 33:6, 33:9, 33:10, 33:14, 33:18, 33:20, 33:22, 33:24, 34:2, 34:7, 34:9, 34:13, 34:17, 35:5, 35:7, 35:12, 36:1, 36:12, 36:20, 36:21, 36:25, 37:13, 38:3, 38:10,	38:11, 38:21, 40:14, 40:21, 41:5, 42:7, 42:11, 42:15, 42:16, 47:13, 47:18, 48:10, 48:15, 48:17, 49:14, 49:25, 50:2, 50:14, 50:18, 50:24, 51:17, 51:22, 53:6, 53:13, 53:16, 53:19, 53:23, 54:8, 59:20, 64:9, 64:11, 65:3, 69:2, 69:17, 70:3, 71:3, 71:6, 71:23, 77:18, 79:17, 79:18, 79:21, 82:5, 83:23, 84:13, 84:17, 85:2, 85:3, 85:15, 85:24, 86:7, 86:9, 86:15, 87:18, 87:19, 90:2, 90:16, 91:1, 91:6 bits 19:16, 19:17, 19:19, 24:22, 26:3, 26:13, 26:16, 26:17, 26:22, 27:3, 27:9, 27:18, 27:20, 29:4, 29:5, 60:20, 60:24, 62:2, 62:21, 63:21, 65:12, 65:16, 65:19, 66:18, 67:3, 68:24, 70:12, 70:18, 74:5, 74:8, 74:12, 74:16, 76:8, 76:12,
--	--	--	---

76:16, 76:20, 80:1, 83:1 blood 100:23 board 1:2, 90:21, 94:18, 94:21, 94:25 both 65:23, 70:16, 87:22 botts 2:12 bounds 27:15, 67:13, 67:18, 79:2, 82:10 boy 73:7, 73:8 brackets 74:5 bravo 12:15 break 6:18, 6:20, 27:23, 44:7, 44:10, 46:15, 46:25, 75:19, 97:7 brief 68:11 briefly 8:5, 14:19, 72:1 bring 56:12 bringing 17:1 bucket 19:20, 20:20, 21:2, 21:3, 22:2, 22:3, 22:4, 22:11, 25:7, 34:16, 34:24, 35:16, 36:1, 37:12, 37:17, 37:24, 38:2, 38:20,	40:25, 41:5, 47:15, 70:9, 70:23, 71:20, 75:12, 81:15, 87:19, 87:22, 87:23, 88:1, 88:10 buckets 87:11 burling 2:3, 5:23, 5:25 C calculate 86:13, 93:13 calculated 65:11, 86:14 calculates 31:10, 31:19, 32:13 calculating 83:18, 84:4 calculation 59:25, 89:3, 89:11, 92:4, 92:14, 94:16 calculations 31:8, 31:16, 32:10, 77:9 california 4:4, 4:7, 100:4 call 48:11 called 5:17, 49:10, 49:13, 49:17 camera 6:10, 6:12, 10:15 can't 63:3, 69:22 cannot 52:11, 57:21, 87:11 captures 13:16 careful 58:20	carefully 67:21, 68:20, 75:14 carried 92:14, 94:7, 94:16 case 1:8, 76:15, 78:4, 84:16, 97:5, 99:10 cases 30:17, 82:3 catch 73:6 cause 4:6, 51:6 causes 53:24, 55:6, 77:22 caution 8:7, 9:12 central 40:22 certain 58:22, 66:18, 94:20 certainly 64:17 certificate 3:9, 100:1 certified 4:4, 100:3 certify 100:5, 100:13, 100:16, 100:22 cetera 64:12, 82:19, 96:19, 96:22 challenge 81:11 chance 17:13 change 29:22, 30:18, 33:14, 34:2, 34:12, 36:25, 66:13, 71:5, 71:22, 82:4,	99:15 changes 3:8, 99:1 charge 82:22 chat 11:14, 17:11 check 98:8 choice 50:17, 53:13, 53:15, 59:18 choose 53:24, 55:6, 92:21 chooses 35:7, 93:3 choosing 49:13, 50:1, 59:19, 69:1, 77:17, 77:22, 78:5 chosen 50:13 chou's 44:1, 46:4, 68:11, 75:9, 87:22, 91:1, 92:10, 93:9, 93:19 christa 1:31, 4:3, 100:3, 100:34 citation 43:23, 95:23 citations 55:24, 64:2 cite 18:19, 20:18, 28:12, 43:21, 47:4, 63:15, 67:9, 87:13 cited 28:19, 30:7, 52:9, 55:17, 64:3, 64:13, 64:18, 83:12, 83:14, 86:3,
---	---	---	--

86:6, 87:3, 95:13, 95:17, 96:14, 96:24 cites 56:4 citing 11:6, 90:9, 94:12 claim 11:3 claiming 96:6 clarify 7:13, 44:14 clarifying 7:8, 17:9 clarity 13:1, 14:13, 16:1, 18:10, 20:14, 21:20, 67:12, 68:5 clause 35:15 clear 35:24, 54:20, 68:17, 73:7, 94:18, 94:22 clearly 62:7, 95:2 clifford 3:21 close 42:11, 42:16, 78:21, 81:24 closed 74:5, 96:9 closer 47:11 code 4:7, 12:7, 12:25, 13:7, 13:12, 15:18, 48:10, 53:11, 85:20, 86:14, 90:4, 92:14, 93:13, 94:7, 96:13, 96:23 coder 19:23, 96:13	collaborative 8:23 com 2:9, 2:17 comes 21:18, 39:12 coming 64:3 commencement 100:9 commencing 100:18 commenting 8:25 comments 8:14 communication 42:18 communications 8:8, 9:14 compare 66:10 comparison 66:19, 66:22 complementarity 75:10 completely 95:1 complies 50:1 complimentary 5:12 components 26:9 computation 33:9, 33:19, 33:22, 34:8, 36:20, 37:5, 37:6, 38:7, 38:10, 38:11, 38:12, 39:2, 39:5, 39:6, 74:8, 74:10 computations 34:17, 36:2, 37:13, 37:21, 38:3, 38:21, 40:14, 40:16,	41:6, 47:15, 84:24 compute 21:7, 31:3, 31:4, 82:15, 82:20, 82:25 computed 21:13, 21:18, 23:22, 29:1, 29:10, 29:11, 29:21, 34:19, 36:5, 38:23, 60:3, 60:20, 74:6 computer 5:7, 31:4, 31:7, 31:12, 31:15, 32:10 computes 33:6, 40:20, 64:6, 96:18 computing 14:3, 31:12, 31:13, 31:25, 32:2, 60:3 concept 37:9, 37:10, 39:11, 39:21, 40:20, 41:3, 71:2 concerned 64:24, 67:4 concluded 97:10, 97:13 concludes 54:16, 96:6 concluding 91:9 conditions 30:22 conducted 66:22 configured 31:3 conflicts 44:4 connect 5:10	connected 5:10 connection 18:19 consider 10:21, 43:25, 78:22, 79:10 consideration 30:12, 33:12, 34:1, 34:11, 36:14, 36:23, 53:11 considered 10:23, 11:3, 11:5, 19:5, 44:3, 65:9, 68:2, 78:10, 78:18, 81:18 considering 65:1 consistent 15:6, 26:10 constant 13:17 constraint 54:16 construct 9:5 constructing 8:6 contain 26:17, 29:5 contained 26:11, 26:17, 29:5 contend 35:11 content 24:22, 44:18, 64:16, 64:22, 66:14, 81:4 contention 97:1 contents 8:8, 8:17, 9:14, 10:25, 11:1, 42:4, 42:5, 44:21
---	---	--	---

context 20:6, 20:7, 30:5, 49:7, 50:11, 52:5 contextualize 24:6, 49:24 continue 30:6, 53:22 continues 29:9, 34:15, 42:21, 48:21, 87:17 continuous 42:14 control 15:2, 15:11, 33:8, 40:24, 45:16, 48:22, 60:17, 74:2, 83:9, 86:22, 88:1, 90:1 control-theoretic 90:2 controlled 43:11, 43:18, 44:25 controller 93:2 controller's 92:21 controlling 42:23, 45:7, 45:25, 46:5, 46:11, 86:25 conversations 5:8 converting 76:8 cooperstock 1:20, 3:19, 4:5, 5:16, 6:2, 7:17, 7:25, 9:17, 11:22, 12:5, 15:4, 16:25, 17:17, 17:23, 23:13, 24:9, 39:24, 40:11, 43:21,	46:24, 48:25, 52:5, 56:5, 57:25, 62:9, 63:11, 65:18, 67:12, 72:1, 75:25, 81:7, 88:17, 90:24, 93:6, 94:19, 94:24, 95:3, 95:12, 97:11, 98:15, 99:9, 100:7, 100:17 cooperstock's 55:3, 90:13, 90:19, 91:21 copies 6:23, 17:11 copy 6:24, 7:6 corner 12:4 corporation 1:10 correct 7:20, 8:2, 8:4, 16:4, 18:18, 18:22, 19:7, 22:10, 26:4, 26:7, 27:10, 27:13, 28:21, 30:4, 35:17, 40:8, 43:20, 43:23, 44:16, 47:10, 47:17, 48:20, 56:2, 58:6, 58:10, 60:9, 63:17, 65:20, 72:3, 72:5, 72:8, 72:19, 72:25, 73:3, 80:18, 83:11, 83:16, 86:5, 86:12, 87:12, 87:15, 87:21, 89:1 corrections 3:8, 98:8, 98:10, 99:1,	99:14 correctly 19:18, 31:6, 33:21, 59:8, 62:25, 63:9, 80:23 correspond 27:18, 67:14, 67:18, 79:2 corresponding 50:18, 63:8, 68:19 corresponds 27:3, 68:10 could 7:4, 11:7, 12:3, 12:11, 14:16, 16:19, 17:13, 17:21, 18:25, 19:2, 24:14, 43:12, 51:6, 75:6, 79:8, 81:13, 83:22, 84:1, 90:21 couldn't 90:16 counsel 7:12, 8:15, 11:10, 40:5, 46:25, 100:14 couple 75:25, 91:24 course 89:15 cover 88:20 covington 2:3, 5:23, 5:24 csr 1:31, 100:34 current 47:8, 48:17, 59:24, 60:1, 64:11, 69:18, 70:18, 71:10, 86:10 currently 26:17, 29:5	cut 6:10, 90:15, 90:16 D d(n 72:23 dashed 72:22 data 21:12, 26:16, 29:4, 29:24, 34:21, 35:5, 36:7, 38:25, 39:16, 42:17, 65:2, 82:19, 96:16 date 99:11 day 4:1, 4:3, 100:30 dc 2:7 deadline 14:25, 15:15, 15:19, 15:20, 15:22, 16:6, 16:13, 16:16, 80:4, 80:8, 80:12, 80:15, 80:20, 80:25, 81:1, 81:23, 94:10, 96:8, 97:3 deal 70:13, 70:22 dealing 59:14, 66:13, 69:25, 70:6, 70:7, 71:5, 71:17, 71:19, 71:20, 74:20, 75:10, 89:19, 94:4 deals 58:19 decl 7:17
--	--	---	---

declaration 3:18, 3:20, 6:23, 6:24, 6:25, 7:10, 7:13, 8:1, 8:6, 8:12, 8:16, 8:21, 8:22, 9:1, 9:5, 9:11, 9:19, 9:20, 9:22, 9:23, 10:11, 10:22, 11:1, 11:5, 16:24, 17:2, 17:18, 17:20, 18:3, 20:18, 24:12, 25:24, 28:12, 28:14, 43:22, 44:5, 44:6, 47:4, 48:11, 51:14, 55:3, 55:4, 55:18, 55:21, 55:22, 56:1, 56:4, 56:7, 57:14, 60:16, 64:1, 64:20, 65:10, 66:23, 66:25, 67:8, 68:3, 78:25, 83:13, 83:15, 86:4, 87:3, 87:6, 88:19, 88:23, 88:24, 90:9, 90:13, 90:19, 91:18, 91:21, 92:8, 93:8, 93:18, 93:19, 93:20, 93:21, 93:23, 94:4, 94:19, 94:20, 95:4, 95:8, 95:13, 95:18, 95:22, 95:24, 95:25, 96:6, 96:12 declarations 8:24 decoder 17:25, 18:2,	18:16, 19:8, 19:13, 19:25, 20:2, 20:4, 20:8, 20:10, 22:21, 22:23, 22:24, 23:7, 23:9, 23:19, 25:3, 26:6, 26:8, 75:7, 94:9 decoder's 18:13 decoding 25:2, 80:17 defined 13:9, 13:14, 14:20, 15:17, 26:15 defines 29:3 definition 12:20, 12:21 definitive 81:12, 81:17 degree 33:15, 34:3, 34:13, 36:25 delay 42:22, 45:5, 45:24, 46:10, 89:4, 89:12, 91:10, 91:11, 92:5, 92:23 delete 99:6, 99:7, 99:15 deleting 99:5 delta 48:5, 48:18, 54:21, 60:3, 62:1, 74:2, 74:3, 86:11, 96:21 deltamax 84:18, 85:16 deltamaxg(n-1 54:2, 54:12, 54:17, 54:24,	55:8, 55:13, 77:24 deltamaxg(n-1) su- plied 54:1 denominator 12:23, 13:1, 13:8 denote 59:1 denoted 26:22, 27:8, 60:11, 63:21 denotes 78:13 depicted 19:6, 24:4, 24:5, 24:24, 25:10, 27:2 deposed 6:4 deposition 1:19, 5:13, 7:9, 11:12, 16:21, 24:13, 32:25, 78:25, 88:14, 89:15, 97:12, 98:2, 99:9, 99:11, 99:14, 100:8, 100:9, 100:10, 100:14, 100:16 describe 12:11, 23:19, 79:17, 94:6 described 12:19, 13:11, 13:15, 20:17, 21:13, 23:21, 25:16, 31:11, 32:25, 48:5, 57:8, 59:22, 59:24, 68:15, 69:3, 69:10, 69:14, 70:24, 71:10, 77:9 describes 16:7, 16:10,	23:8, 27:15, 37:11, 37:20, 58:17, 60:18, 62:4, 71:14, 76:9, 82:1, 85:1 describing 12:14, 20:21, 22:24, 25:5, 43:15, 60:17, 70:9, 70:10 description 13:18, 21:18, 23:23, 25:7, 37:23, 44:1, 53:12, 61:23, 61:25, 62:16, 62:23, 62:25, 63:8, 68:11, 68:13, 69:15, 69:19, 69:22, 70:1, 70:14, 74:7, 75:9, 79:8, 93:1 descriptions 20:20, 70:6 desired 30:14, 33:7, 36:16, 40:22 detail 21:6, 32:25, 38:19, 61:23 detailed 67:21, 68:12 details 22:18, 39:13, 39:23, 41:18, 46:8, 49:10, 60:15, 69:17, 83:8 determination 41:13, 53:11, 81:14, 94:6 determinations 85:6 determine 30:9, 36:11, 64:16, 64:21, 77:17, 92:14,
---	---	---	---

92:19 determined 64:14, 64:25, 65:15, 81:19, 86:16 determines 41:14, 81:3 determining 33:9, 33:19, 33:23, 34:8, 36:20, 96:13, 96:23 diagonal 25:15, 25:17, 74:21 differ 50:5, 53:15 difference 12:22, 29:10, 30:10, 33:11, 33:24, 34:9, 36:12, 36:22, 50:8, 60:4, 60:18, 94:10 differences 60:1 different 27:24, 34:5, 50:12, 66:5, 66:14, 68:23, 69:25, 70:8, 70:22, 70:23, 71:1, 71:8, 71:13, 71:14, 71:17, 82:22, 90:4, 93:7 dig 41:17 direct 43:19, 44:16 directly 32:22, 45:19, 66:25 disagree 74:9, 95:1, 95:4, 95:6 disclose 52:21, 84:3	disclosed 51:10 discloses 14:9, 17:23, 18:15, 31:8, 31:17, 32:12, 40:12, 83:18, 87:8 disclosure 18:20 disconnected 32:17 discontinuity 51:3 discrepancies 70:13 discrepancy 74:13 discuss 46:24, 48:1, 94:13 discussed 8:13, 24:3, 24:12, 26:6, 55:2, 91:24, 93:15 discusses 83:19, 90:25 discussing 47:20, 47:23, 61:25, 63:23, 89:16, 91:10, 92:12, 94:15 discussion 66:11, 74:14, 93:11, 93:12, 94:3 discussions 5:6, 9:9 displayed 66:19 dispute 92:17 distance 14:24, 16:12, 16:16 divided 12:18, 12:25,	13:7, 20:13, 76:14, 76:20, 83:1 dividing 65:13, 74:12, 76:9, 79:24 doctor 10:2 document 52:10 doing 8:10, 12:16 done 38:13, 39:7, 39:12, 59:25, 62:18, 74:8, 74:11, 85:11, 96:11 down 10:17, 12:1, 22:12, 25:12, 39:22, 54:17, 73:25, 96:16 dr 3:19, 6:2, 6:23, 7:11, 7:25, 8:1, 8:11, 8:14, 9:17, 9:21, 9:25, 10:7, 10:10, 11:22, 12:5, 15:4, 16:25, 17:17, 17:23, 23:13, 24:9, 39:24, 40:11, 43:21, 46:24, 48:25, 52:5, 55:3, 56:5, 57:25, 62:9, 63:11, 65:18, 67:1, 67:2, 67:12, 72:1, 75:25, 81:7, 88:17, 88:18, 88:24, 89:3, 89:9, 89:10, 90:13, 90:19, 90:24, 91:17,	91:21, 91:25, 92:3, 92:12, 92:17, 92:25, 93:1, 93:6, 93:12, 93:18, 93:20, 93:22, 94:4, 94:14, 94:19, 94:20, 94:24, 95:3, 95:12, 95:13, 95:18, 96:4, 96:5, 97:1, 97:11 draft 8:20 drafting 8:17 draw 50:19, 84:7 drill 39:22 drop 17:13 dropped 17:11, 89:7 dropping 10:15 duly 5:18, 100:8 dumped 19:19 duration 12:19, 30:14, 36:16, 80:8, 80:21, 94:10 during 35:7, 46:25 E e-r-r-o-r 13:22 each 5:11, 29:10, 76:18, 76:22, 83:2, 87:23, 91:4, 96:18, 100:13 earlier 9:13, 24:3,
---	---	--	---

24:8, 32:24, 38:9, 40:25, 41:21, 60:6, 65:18, 69:10, 72:1, 74:10, 75:11, 84:7, 86:3, 86:20, 91:24 early 28:2 effect 81:18 effort 8:23 either 20:15, 22:13, 25:7, 51:4, 51:7, 55:2, 61:9, 67:14, 78:24 elaborates 38:18, 41:3 elaboration 21:9, 37:9, 41:9, 41:20 electronic 7:18 electronically 7:3 element 43:5, 93:14 elements 15:18 elevate 6:15 eliminating 85:18 else 7:1, 10:13, 10:21, 59:6, 73:5 email 94:21 embodiment 29:17, 29:20, 30:1, 31:2, 31:9, 31:18, 32:12, 34:15,	34:24, 35:15, 35:19, 35:25, 37:12, 37:23, 38:2, 38:19, 39:8, 40:12, 40:14, 41:4, 41:11, 41:21, 84:9, 84:12, 84:23, 85:10 emphasize 18:4 employed 88:2, 100:24 employs 30:7, 36:10 enabled 5:8, 45:16 encoder 17:24, 18:5, 18:9, 18:16, 19:14, 19:20, 19:21, 20:12, 20:16, 20:22, 21:3, 22:3, 22:4, 22:7, 22:14, 23:1, 23:4, 23:14, 23:22, 24:19, 24:21, 26:16, 28:25, 29:4, 29:11, 29:12, 30:8, 30:22, 31:14, 34:18, 34:25, 35:10, 35:14, 35:20, 36:3, 36:10, 37:5, 37:14, 37:18, 37:22, 38:4, 38:14, 38:22, 39:7, 39:9, 39:16, 39:17, 40:1, 40:13, 40:16, 41:1, 41:7, 41:12, 41:14, 41:15, 41:22, 41:25, 51:16, 65:11, 65:14,	74:25, 75:5, 77:10, 81:15, 82:2, 87:10, 88:4, 96:23 encoder's 32:1, 32:23, 33:2, 35:9, 82:13 end 29:16, 31:17, 32:11, 40:2, 41:9, 63:7, 96:8 enough 46:17, 66:8, 80:14 ensure 78:5 entail 64:21 entailed 90:25 entails 52:21, 87:22 entirely 58:19 entirety 10:11, 52:6, 52:8, 63:12 equal 48:3, 50:3, 50:25, 51:23, 53:3, 53:6, 53:19, 54:9, 54:11, 74:2 equation 12:4, 12:6, 12:12, 12:13, 12:21, 13:10, 13:14, 13:19, 13:25, 14:4, 14:6, 14:19, 14:20, 15:14, 15:16, 15:17, 15:21, 15:23, 15:24, 16:2, 16:5, 19:10, 19:15, 19:23, 20:2, 20:6,	20:7, 20:11, 21:4, 21:5, 22:20, 23:20, 26:10, 82:15, 89:24, 89:25, 96:7, 97:2 equations 22:19 equivalent 19:15, 25:1 equivalently 20:11 error 13:16, 13:21, 13:22, 13:25 essentially 35:3 estimate 30:23, 31:13, 31:23, 31:25, 32:4, 32:19, 32:23, 39:18, 41:16, 83:24, 87:9 estimated 21:8, 30:11, 33:11, 33:24, 34:10, 36:13, 36:22, 82:17 estimates 30:19, 82:5 estimation 33:1 et 64:12, 82:19, 96:19, 96:21, 96:22 even 50:23, 51:21, 53:4, 53:18, 76:17 evening 28:3 eventually 51:7 every 8:20, 8:22, 30:2, 30:23,
--	--	--	--

31:23, 32:19, 40:12, 41:15 everyone 5:1 exact 44:19, 51:21, 99:4, 99:5 exactly 50:25, 51:22, 53:6, 53:19 examination 5:20 examinations 3:1 examined 4:6 example 53:10, 59:1, 64:3, 85:10, 96:3, 96:15, 96:25 exhibit 3:15, 3:16, 3:18, 3:20, 7:7, 7:14, 7:24, 8:3, 10:11, 11:8, 11:12, 16:20, 16:21, 17:6, 18:25, 28:12, 28:22, 43:22, 47:4, 47:12, 55:23, 56:7, 56:13, 88:12, 88:13, 88:14, 88:18, 89:22, 92:9, 93:8, 95:8, 95:18 exhibits 17:11, 35:5 exist 89:7 exists 32:1 expect 9:6, 62:22, 81:1 expectations 42:12	explain 8:5, 9:10, 40:18, 71:18, 74:13, 80:4 explained 22:17, 31:21, 40:25, 41:12, 41:24, 51:20 explaining 20:19, 21:2, 22:1, 40:19, 43:9, 51:10, 52:20 explains 30:17, 33:5, 41:4, 49:24, 53:23, 68:15 explanation 19:13, 25:11, 67:21, 68:12, 68:17 explicit 21:14, 59:13, 73:18 explicitly 18:1, 22:8, 22:18, 23:3, 84:3, 91:12, 92:24 expressed 11:4, 19:9, 19:25, 20:10, 22:25, 27:21, 44:5, 57:13, 65:10, 65:16, 66:16, 66:24, 67:1, 67:3, 70:11 expresses 19:23, 20:2 expressing 78:24 expression 19:16, 60:23 extent 61:14, 62:20 F f(n) 12:18, 12:21,	12:25, 13:9, 15:17, 20:13 face 10:16 facilitates 46:4 facilitating 85:24 fact 21:14, 25:23, 28:19, 51:2, 56:6, 92:13 factor 15:14, 15:21, 16:2, 96:10, 97:3 factors 16:6 fair 6:8, 6:20, 6:21, 14:11, 16:9, 23:5, 31:10, 43:11, 45:1, 45:14, 46:6, 52:22, 64:22, 68:24, 69:24, 70:24, 73:13, 77:6, 77:8, 78:3, 78:13, 80:14, 84:24, 96:1 fairly 44:8 far 26:5, 29:14, 31:1, 38:10, 42:20, 54:5 fd(n) 19:9, 22:23, 23:8, 23:19, 26:5 fd(n)=b 19:13 fe(n) 19:14 fe(n)=b(n) 19:16 feedback 54:2, 54:7,	54:21, 55:14, 89:5, 89:12, 89:17, 89:20, 89:25, 90:5, 90:25, 91:5, 91:12, 91:18, 91:25, 92:5, 92:9, 92:23, 93:9, 93:14, 93:19, 94:5, 94:14 few 6:5, 18:23, 79:22, 92:25 figures 63:19, 70:25 file 7:15, 50:24, 51:22, 53:5, 53:18, 96:17 files 7:16 final 8:18, 91:14 finally 54:16 financially 100:25 find 24:15, 96:4 finding 44:19, 58:16, 79:10, 81:17 finds 48:14, 64:8, 86:7 fine 6:19, 14:17, 44:10, 47:19 first 18:24, 29:21, 29:25, 30:18, 35:13, 49:1, 49:2, 54:24, 57:10, 82:4, 88:17, 90:9, 91:3 five 32:8
---	---	---	---

fly 62:4 focused 53:4 follow-up 44:12, 75:25 following 13:19, 99:14 follows 5:19 font 94:11 foreclose 38:6, 38:12, 39:6 foregoing 84:15, 98:2 form 12:8, 15:9, 19:11, 22:16, 23:6, 23:16, 27:1, 31:20, 32:15, 35:21, 38:15, 41:23, 51:13, 60:13, 61:11, 61:21, 62:13, 63:6, 63:22, 66:7, 67:19, 69:8, 73:23, 77:7, 78:15, 78:17, 79:7, 84:25, 87:25, 96:2, 99:7 format 4:7 forming 78:11, 78:19 forms 22:20 formulated 66:25 formulating 52:6, 52:16, 57:11, 63:12, 64:23, 65:9, 66:23, 68:3, 78:23	formulation 23:23 forth 8:17, 8:25, 94:5, 100:8 found 42:5, 79:16 fourth 26:15 fraction 13:7, 13:13, 20:12 frame 12:16, 12:17, 12:18, 12:23, 13:6, 18:7, 19:4, 21:12, 25:25, 26:18, 29:6, 29:10, 29:13, 29:21, 29:25, 30:2, 30:11, 30:13, 30:18, 30:23, 31:24, 32:20, 33:12, 33:25, 34:10, 36:13, 36:15, 36:23, 41:16, 48:15, 48:17, 54:3, 56:23, 56:25, 59:21, 59:25, 60:5, 60:20, 61:8, 64:9, 64:11, 68:19, 69:11, 70:11, 72:16, 72:20, 73:10, 74:5, 76:19, 76:22, 77:5, 80:5, 80:9, 80:16, 80:21, 82:4, 82:16, 83:3, 83:20, 83:23, 86:8, 86:9, 89:4, 89:11, 91:4, 92:4, 92:15, 92:20, 93:3, 93:14,	94:9, 96:17 frame's 80:20 frame(n-1 59:2 frame-by-frame 30:9, 33:10, 33:19, 33:23, 34:8, 36:11, 36:21 frames 29:22, 29:24, 30:20, 77:18, 77:19, 78:3, 78:6, 80:7, 82:6, 83:21, 83:25 framing 22:11 friday 1:21, 4:1 front 66:9, 88:21 full 62:16, 62:23, 62:25 fullness 19:9, 19:13, 19:15, 19:24, 19:25, 20:3, 20:4, 20:8, 20:10, 22:21, 22:23, 22:24, 23:9, 26:6, 26:8, 29:12 fully 26:18, 29:6 function 14:1, 19:9, 19:24, 20:3, 20:5, 20:8, 22:25, 81:15 functionalities 70:23 functionality 70:8, 71:15, 71:17, 71:21 further 12:1, 21:6,	39:13, 39:22, 39:23, 58:18, 64:8, 97:6, 100:13, 100:16, 100:22 G g(n 17:24, 18:4, 18:7, 18:16, 19:4, 19:10, 19:21, 19:24, 20:15, 20:17, 20:19, 20:25, 21:15, 21:24, 22:8, 22:14, 22:25, 23:4, 23:14, 23:20, 24:3, 24:5, 25:25, 26:9, 26:12, 26:22, 26:24, 27:2, 64:4, 64:6, 65:23, 68:14, 68:18, 69:11, 70:5, 70:14, 83:20, 83:21, 83:25, 84:5, 87:9, 87:18 g(n)=bmin(ravg) -- be(n 96:18 g(n) and 65:21 g(n-1 14:1, 14:2, 14:5, 14:7, 17:24, 18:15, 20:9, 20:11, 20:15, 21:9, 21:11, 21:15, 21:24, 22:9, 22:14, 23:4, 23:14, 23:20, 27:5, 27:8, 60:4, 65:21, 65:23, 70:15, 74:2, 82:18,
--	--	--	--

83:18, 84:4, 84:18, 85:16, 96:21 g(n-1)=gnew 48:5 g(n-1)=gnew(n-1) - -gold(n-1 48:19, 74:4, 86:11 g- 54:21 gap 17:24, 18:5, 18:7, 18:15, 19:4, 19:21, 20:11, 22:14, 23:4, 24:2, 24:5, 25:25, 26:12, 26:13, 26:15, 29:1, 29:3, 29:10, 29:21, 30:1, 30:8, 30:18, 30:20, 30:23, 31:3, 31:8, 31:10, 31:12, 31:13, 31:16, 31:19, 31:23, 31:25, 32:4, 32:10, 32:13, 32:19, 32:23, 33:2, 36:10, 41:14, 47:8, 48:3, 48:18, 56:20, 57:1, 59:20, 59:21, 59:22, 59:24, 60:2, 63:21, 64:6, 64:11, 65:5, 68:14, 68:15, 68:23, 69:2, 69:4, 69:9, 69:10, 69:11, 69:18, 69:22, 69:23, 70:16, 70:18, 70:19, 70:21, 71:7, 71:9,	71:13, 72:10, 72:17, 73:19, 73:22, 74:19, 78:21, 80:7, 80:19, 82:2, 82:3, 82:5, 82:6, 82:7, 86:10, 87:9, 96:20 gaps 21:25, 60:10, 60:11, 61:6, 61:9, 66:5, 70:22, 71:7, 71:8, 71:9, 71:13, 74:16 gears 16:19 general 38:17, 39:11, 41:3, 70:1, 71:2, 71:19 generally 51:3 generated 29:22, 30:2 generating 35:4 getting 9:8, 11:14, 21:6 give 57:20, 68:1, 95:15 given 20:4, 20:8, 26:2, 30:21, 42:18, 49:13, 54:16, 58:14, 63:5, 63:15, 65:10, 65:14, 65:19, 66:4, 66:12, 66:15, 68:24, 74:10, 77:5, 77:8, 78:4, 94:14, 94:24, 100:11 giving 22:10, 59:20,	68:21, 69:1 gnew 47:9, 49:3, 59:17, 61:14, 65:10, 68:19, 70:6, 71:4 gnew(n 48:4, 48:18, 49:1, 55:17, 55:24, 56:5, 56:7, 56:9, 56:15, 59:23, 60:2, 63:16, 63:21, 64:2, 64:6, 64:12, 64:13, 64:16, 64:24, 66:4, 69:18, 86:10, 87:11, 96:20 gnew(n-1 54:12, 56:16, 56:21, 56:25, 59:16, 60:11, 60:19, 60:23, 61:5, 61:7, 61:19, 62:1, 62:11, 62:20, 63:5, 64:16, 64:22, 64:24, 65:3, 65:5, 67:3, 67:14, 68:22 gnew(n-1) 54:11 go 6:6, 6:19, 8:10, 11:25, 12:20, 14:16, 17:21, 18:24, 18:25, 20:25, 21:22, 22:12, 24:7, 24:16, 28:11, 28:22, 35:2, 39:13, 41:2, 47:3, 47:11, 48:8, 49:8, 49:12, 49:23, 52:8,	55:22, 56:18, 57:22, 57:24, 58:12, 59:14, 62:6, 65:17, 65:25, 66:10, 67:6, 67:7, 67:11, 68:13, 73:17, 75:8, 76:1, 76:25, 79:13, 79:20, 81:20, 81:21, 83:6, 84:6, 86:2, 86:18, 87:5, 87:16, 89:2, 89:22, 90:7, 90:8, 91:23 goal 14:10, 15:7 goes 38:23, 80:3, 80:19, 82:2 going 8:7, 17:14, 27:24, 35:13, 44:8, 56:11, 61:23, 75:13, 75:17, 77:21, 87:2, 88:3 gold 61:7, 61:14, 68:19, 71:4 gold(n 60:3, 66:4, 70:6 gold(n-1 54:11, 54:12, 57:1, 57:2, 60:11, 60:19, 61:5, 61:19, 62:1, 62:11, 62:20, 63:5, 67:3, 67:14, 68:6, 73:19, 73:20, 73:22, 74:19 gone 52:9, 60:15,
---	---	--	--

67:20 good 6:2, 6:3, 12:4, 27:23, 29:14, 31:1, 42:20, 44:10, 75:18 graph 51:6, 66:17, 70:11, 76:12, 80:2 group 12:25, 92:23 grow 43:1, 43:14, 45:11 grows 14:25, 16:13, 16:16 guaranteed 76:19, 76:23, 77:6, 83:3 guess 59:9	58:11, 59:4 helpful 21:10, 25:22, 65:6 here 14:18, 17:12, 19:3, 21:5, 21:9, 26:8, 28:24, 38:13, 43:16, 44:14, 45:22, 46:8, 51:10, 51:16, 52:20, 55:5, 57:17, 58:7, 60:10, 61:25, 62:5, 63:23, 66:2, 66:14, 67:9, 68:11, 68:25, 71:25, 74:7, 77:15, 78:21, 79:11, 79:22, 82:23, 85:7, 85:13, 86:24, 89:2, 89:23, 91:25, 92:12, 93:12, 93:15, 94:8, 94:15, 94:18, 94:22, 96:22 hereby 98:4, 100:4 hereinbefore 100:8 hesitate 58:20, 75:14 high 54:8 high-level 19:12, 39:20, 40:20, 41:3 highest 42:17 hold 9:3 holiday 28:3 horizontally 61:15	hour 4:2, 75:17 hours 9:7	82:6 inclusive 98:3 increases 14:23 indeed 93:2 index 3:1 indicate 56:14, 77:20 indicated 26:8, 26:12, 31:16, 56:20, 58:5, 58:8, 61:6, 61:13, 63:14 indicates 49:9, 72:9 indicating 6:14, 11:20 indication 29:23 indications 58:23, 61:7 indicative 34:18, 35:20, 36:2, 37:14, 37:21, 38:4, 38:21, 40:1, 40:13, 40:15, 41:6 infer 83:24 inferred 83:22 information 48:21, 66:8, 66:9, 66:19, 84:13, 85:2, 85:4, 86:21, 88:6 initial 28:25, 30:21, 57:15 initially 35:6 input 14:5, 26:18,
H		I	
halfway 96:16 hand 100:30 handful 52:10 happening 24:17 happens 71:22 happy 57:20, 67:25, 79:9 head 6:11, 10:17, 57:21 heading 49:20, 59:19 hear 90:16 hearing 6:16 help 5:8, 24:14,		idea 38:17, 38:19 idealized 25:5, 75:10 identical 51:18, 88:20 identification 3:15, 11:13, 16:22, 88:15 identify 5:9, 5:11 illustrate 96:25 illustrated 14:24, 24:20, 51:5, 54:12, 55:18, 56:15, 56:16, 59:9, 60:21, 66:11, 66:12, 66:17, 74:6 illustrates 59:11, 84:22 illustrating 59:10, 71:1, 97:5 immediately 51:7 impend 14:16 implement 83:8 implementation 49:10, 69:16, 83:8 implementing 88:9 inappropriate 94:23 inc 1:4 include 30:20, 47:7,	

29:6 inserted 25:9, 89:6 insertion 29:12 instances 39:15, 92:25 instantaneous 80:6, 80:17 instead 32:4, 32:23 instructed 6:7 intended 95:2 intends 68:18 interactive 1:4 interest 81:7 interested 100:25 interruptions 5:15 intersection 72:22 intersects 72:23 introduce 5:22, 14:22, 37:9, 49:1, 74:1 introduced 14:24, 16:11, 20:25 introduces 37:8, 49:3 introducing 38:17, 39:11, 39:20, 75:11 invention 44:2 involved 8:24, 81:13 involves 33:9, 33:19, 33:23, 34:8, 36:20	involving 34:16, 34:24, 35:16, 35:25, 37:12, 38:2, 38:19, 41:4 ipr 1:8, 7:16 issue 9:12, 42:22, 45:5, 45:6, 45:23, 45:24, 46:10 issued 9:12, 94:21 issues 49:18, 49:21 itself 12:13, 20:5, 83:22, 84:3 J jabido 2:22, 6:1 janice 2:22, 5:25, 17:15 jeremy 1:20, 3:19, 4:5, 5:16, 98:15, 99:9, 100:7, 100:16 job 92:21 jump 29:16 just-generated 26:18, 29:6, 29:13 K keep 18:3, 30:13, 36:15, 40:5 keeping 42:10, 42:15, 80:24 keeps 81:5, 81:9,	82:9 key 43:5 kieran 2:23 knierim 2:13, 8:7, 9:12, 12:8, 15:9, 17:10, 19:11, 22:16, 23:6, 23:16, 27:1, 31:20, 32:15, 35:21, 38:15, 40:4, 41:23, 45:2, 51:13, 52:23, 55:1, 60:13, 61:11, 61:21, 62:13, 63:6, 63:22, 66:7, 67:19, 69:8, 73:6, 73:23, 77:7, 78:15, 78:17, 79:7, 84:25, 85:12, 87:25, 90:11, 90:17, 91:2, 91:13, 91:20, 92:2, 92:11, 93:10, 94:17, 95:6, 96:2, 97:7, 97:9 know 6:12, 6:17, 7:4, 37:16, 41:17, 62:10, 77:8, 85:8 knowledge 88:4 knows 85:25 L label 25:2, 72:17, 73:20, 74:13 labeled 24:20, 58:7,	72:13, 73:2, 79:5 labelling 73:19, 74:9 labels 58:24, 79:9 language 92:19 large 51:1, 51:6, 51:25, 53:7, 53:20 larger 94:11 last 29:11, 43:4, 89:23, 94:7 later 21:5, 21:19, 38:18, 39:12, 39:13, 41:2, 86:20 latest 30:11, 33:11, 33:25, 34:10, 36:13, 36:22 latter 47:22, 48:2 lawyer 6:6 lay 6:4 lead 75:14 leaky 19:20, 20:20, 21:2, 21:3, 22:2, 22:3, 22:4, 22:11, 25:7, 34:16, 34:24, 35:16, 36:1, 37:12, 37:17, 37:24, 38:2, 38:20, 40:24, 41:5, 47:15, 70:8, 70:23, 71:19, 75:12, 81:15,
--	--	--	--

87:11, 87:19, 87:22, 87:23, 88:1, 88:10 least 86:24 leaves 42:21, 45:5 left 12:4, 36:18 less 54:9, 54:11 let's 47:11, 53:22, 55:22, 59:15, 67:11, 76:1, 79:4, 81:20, 81:21, 83:6, 94:11, 97:7 letter 73:6 level 30:14, 36:16, 42:25, 43:10, 43:13, 43:17, 44:25, 45:11, 45:15 likewise 27:8 limitation 11:2, 11:3 limitations 10:24 limited 90:21 line 17:5, 26:15, 34:6, 72:23, 74:22 linear 33:8, 40:23 lines 25:15, 25:17, 74:21 liquori@bakerbot- ts 2:17 list 85:23	listed 95:21 little 22:13, 42:7, 47:13, 47:18, 53:23, 79:21 llp 2:3, 2:12 locally 13:16 locate 49:4 location 62:3 logged 32:7 logic 84:1 long 9:4 longer 70:5 look 7:4, 28:23, 47:11, 49:17, 57:20, 62:15, 64:15, 64:21, 69:14, 76:1, 87:4 looked 86:3 looking 10:17, 24:14, 36:8, 36:18, 60:1, 62:18, 63:4 looks 77:15, 88:20 loop 81:24, 90:25, 91:5, 91:12, 91:19, 93:15, 94:5, 94:14 lower 12:4, 27:16, 27:18, 61:10, 61:13, 61:19, 61:20, 62:11,	62:19, 67:13, 67:18, 72:9, 72:11, 72:13, 74:22, 74:23, 82:10 lowercase 12:14 lunch 28:2, 44:7, 46:15, 46:25 M made 25:6, 34:5, 57:14, 75:11, 80:10 maintained 81:2 make 15:19, 19:17, 34:25, 37:6, 40:13, 62:23, 62:24, 85:5, 92:9, 93:8, 93:18, 99:14 makes 14:6, 35:19, 48:15, 54:20, 64:9, 86:7 making 10:21, 14:7, 53:11, 59:7, 85:24, 91:25, 92:17, 92:25 manage 6:14 management 43:5 manner 8:15 many 52:9 map 65:12 mapping 66:19 margin 14:22, 16:8,	16:11 mark 16:19, 88:13 marked 11:13, 16:22, 17:10, 88:15 marking 11:9, 11:16 marriage 100:23 match 44:17, 51:21 material 7:5 materials 6:22 matter 52:7, 52:17, 65:15, 74:12, 100:26 maximum 44:9 mean 12:13, 40:6, 46:3, 72:22 meaning 20:19, 59:13 means 42:17 measure 27:3, 62:21, 70:7 measured 21:7, 60:24, 82:16 measurement 65:3, 65:4 mechanism 88:2 media 12:22, 24:22, 27:20, 34:20, 35:4, 36:6, 38:25, 39:16, 43:6, 50:24, 51:22, 53:5, 53:18, 72:23, 96:17
--	--	--	---

meets 42:12, 72:21 memorization 52:15 memorized 52:11, 57:22 memory 57:23 mention 22:8, 34:25, 35:3, 35:8, 35:19, 56:16, 91:25, 92:9, 93:8 mentioned 7:25, 21:23, 24:8, 27:11, 41:9, 44:14, 60:6, 65:18, 75:2, 76:3, 79:13, 84:6, 87:8 mentions 38:9, 89:3, 89:10, 92:4 message 91:5 met 7:12 metaphor 21:3, 22:4, 22:11, 25:7, 37:17, 41:1, 88:2 mic 5:7 michael 2:13 middle 87:17 might 27:23, 85:20 mike 78:16, 90:15 mind 7:16 minus 19:14	minute 43:12, 71:15 minutes 27:24, 27:25, 28:2, 28:5, 44:9, 46:16, 46:17, 46:19, 75:18, 75:20, 79:22, 81:8, 91:24 missed 18:12 misspoken 71:18 mistake 34:5 mistakes 80:10 model 20:21, 20:22, 25:6, 34:16, 34:25, 35:16, 36:1, 37:12, 37:17, 37:24, 38:3, 38:20, 40:25, 41:5, 70:9, 70:24, 71:19, 75:12, 81:15, 87:22, 96:10, 97:4 moment 79:14, 90:7 more 29:9, 32:25, 42:24, 45:10, 46:17, 47:18, 52:10, 53:25, 55:7, 76:17, 77:23 moreover 70:9 morning 6:2, 6:3 morrison 2:23 move 23:11 moving 13:11, 15:17,	74:3 much 8:23, 19:2 multipart 40:17 multiple 50:7, 53:1, 55:23, 56:7, 63:15 must 53:24, 55:6, 89:4, 89:11, 91:12, 92:4, 92:21, 92:23 mute 5:7 myself 5:22	85:16 negative 51:4 negotiate 85:19 neither 21:24 network 42:12, 42:16 never 42:13 new 2:15, 9:25, 10:4, 48:4, 48:17, 59:21, 59:22, 64:6, 64:11, 65:15, 70:15, 71:9, 79:17, 83:20, 86:9, 86:13, 86:15, 87:18, 87:19, 96:20 next 19:8, 30:17, 45:9 nonetheless 95:25 nonresponsive 23:11 notation 49:3, 70:5 notations 71:3 note 17:2, 28:1, 86:19, 90:12, 90:18, 99:3 noted 30:21, 61:24, 64:1, 66:16, 84:9, 88:22, 96:22 notes 24:3 nothing 5:19, 94:13 noting 96:12
		N n 47:9 n+1 12:23 n+2 92:15, 93:4 n-1 12:17, 13:6, 21:7, 21:8, 21:9, 21:12, 48:5, 54:4, 56:23, 56:25, 60:5, 60:20, 61:7, 61:8, 68:19, 70:10, 74:5, 77:5, 82:16, 84:2 n-1)-gold 48:5 n-2 77:6, 94:9 namely 42:13 nec 1:10, 99:10 need 6:15, 6:18, 84:18, 85:5,	

nowhere 15:19 number 7:15, 7:22, 7:24, 19:16, 19:19, 24:22, 26:16, 29:4, 35:5, 70:13 numbers 95:15, 95:21 numerator 13:7 numerous 20:17 nw 2:6 O oath 5:19 object 15:9, 78:15 objection 12:8, 19:11, 22:16, 23:6, 23:16, 27:1, 31:20, 32:15, 35:21, 38:15, 41:23, 45:2, 51:13, 52:23, 55:1, 60:13, 61:11, 61:21, 62:13, 63:6, 63:22, 66:7, 67:19, 69:8, 73:23, 77:7, 78:17, 79:7, 84:25, 87:25, 90:11, 90:18, 91:2, 91:13, 91:20, 92:2, 92:11, 93:10, 96:2 objections 85:12 objects 6:6 obtained 76:11, 79:25	occasions 56:10 occurred 100:17 occurring 52:22 october 1:21, 4:2, 99:11, 100:17, 100:30 off-the-record 5:6 offer 58:20, 62:5 offered 45:20 office 1:1 often 6:10 oftentimes 10:15 oh 17:14, 18:12, 43:12, 47:6, 83:19, 94:2 old 59:20, 70:15, 70:19, 71:11, 79:17 once 12:24, 39:19, 44:13, 46:7, 71:25, 96:16 one 5:4, 11:2, 14:2, 29:17, 29:20, 31:9, 31:18, 31:22, 32:13, 34:15, 34:23, 35:2, 35:5, 35:15, 35:18, 35:25, 37:11, 37:23, 38:1, 38:19, 39:8, 39:25, 40:14, 41:4, 41:11, 41:21, 61:9, 63:3, 66:20, 68:9, 74:1, 79:4, 81:13, 85:20, 89:6, 90:7, 92:25, 94:22 one) _____ 98:8 one-frame 91:10, 91:11, 92:23 ongoing 31:4, 33:7 only 6:11, 30:18, 41:11, 46:7, 57:15, 68:13, 82:3, 83:19, 84:16, 85:14, 88:4, 91:20, 94:6 opening 18:11, 18:13 operates 94:5 operation 71:20 opine 45:18, 90:22, 94:25 opined 46:8, 63:25, 64:15 opinion 18:17, 18:19, 58:20 opinions 8:14, 9:1, 44:1, 44:4, 45:20, 52:7, 52:17, 57:11, 57:13, 63:12, 63:15, 64:20, 64:23, 65:9, 66:23, 66:24, 67:1, 78:11, 78:19, 78:23, 78:24, 88:24	opportunity 94:25 opposed 59:6, 60:23, 62:21 optimal 33:8, 40:24, 83:9 order 9:6, 30:13, 36:15, 51:11, 52:21, 63:20, 90:20, 90:21, 94:21, 94:24 ordinary 61:18, 62:10, 62:15 orient 24:14 original 6:24, 8:16, 11:4, 95:22 other 8:23, 22:25, 38:14, 39:7, 39:25, 66:20, 77:13, 82:12, 95:21 otherwise 33:21, 62:4, 100:26 out 6:5, 6:9, 21:5, 91:21, 92:14, 94:7, 94:16 outcome 100:26 output 24:19, 25:3 outputting 24:21 outside 45:2, 51:14, 61:21, 62:13, 91:20 over 5:4, 7:11, 12:20, 12:22,
---	---	--

14:23, 14:25, 16:13, 16:17, 26:17, 29:5, 42:24, 43:1, 43:11, 43:14, 43:18, 44:25, 45:7, 45:11, 45:17, 46:1, 46:5, 46:12, 52:9, 66:19, 78:16, 89:15 overall 22:11, 70:2, 70:14 overflow 52:2 own 31:5, 32:3, 41:13, 87:19, 87:23, 88:8, 95:22 owner 1:12, 2:11 P pacific 4:2, 100:18 packets 76:6 page 3:2, 3:15, 11:25, 12:2, 17:19, 17:22, 88:20, 94:8 pageline 99:15 pages 52:11, 98:2 pan 21:24, 22:12, 25:12, 42:7, 47:12, 71:24 paradigm 88:10 paragraphs 18:20, 20:17, 28:13, 28:19, 42:6, 47:8,	52:16, 55:16, 56:12, 56:14, 67:6, 69:1, 77:16, 86:18, 87:13, 89:19, 94:20, 95:14, 95:17, 95:23 parallel 25:15 parallels 77:3 parameter 81:19 parameters 14:2, 28:25, 30:8, 34:17, 34:19, 35:1, 35:9, 35:10, 35:14, 35:19, 36:2, 36:5, 36:10, 37:6, 37:13, 37:21, 38:4, 38:14, 38:21, 38:23, 39:8, 39:9, 39:17, 39:25, 40:12, 40:15, 41:6, 41:22, 42:1, 86:13, 96:14, 96:24 parentheses 7:17, 13:1, 21:11 parentheticals 47:7 part 18:6, 29:24, 38:1, 39:10, 39:19, 48:1, 48:2 particular 27:20, 59:21, 67:5 particularly 29:9, 42:24, 45:10 parties 100:23, 100:24	party 81:3, 100:13 patent 1:1, 1:2, 1:9, 1:12, 2:11, 3:16, 6:24, 7:17, 10:23, 11:6 pattern 24:9, 25:14, 25:16, 25:19, 57:3, 57:6, 58:2, 58:8, 58:12, 58:14, 58:17, 59:3, 59:11, 69:6, 72:2 paul 2:4, 3:3, 5:21, 5:22, 6:3, 6:9, 8:19, 9:16, 10:9, 10:14, 11:11, 11:18, 11:21, 12:10, 13:20, 13:22, 13:24, 15:13, 16:23, 17:16, 19:22, 23:2, 23:10, 24:1, 27:4, 28:10, 32:6, 33:3, 35:22, 39:1, 40:9, 40:10, 42:2, 44:7, 45:8, 46:23, 52:3, 53:9, 55:11, 61:1, 61:17, 62:8, 63:2, 63:10, 64:19, 66:21, 67:23, 69:20, 73:8, 73:11, 74:17, 75:17, 75:24, 77:11, 78:20, 79:12, 85:9, 86:1, 88:11, 88:16, 90:23, 91:7,	91:16, 91:22, 92:7, 93:5, 93:16, 95:1, 95:11, 97:6, 97:11 pdf 7:17, 12:2 peloton 1:4, 2:22, 5:23, 5:25, 6:1, 99:10 pending 6:19, 81:8 perfect 19:2 perform 40:16, 84:23 performance 43:6 performing 84:15 performs 31:7, 31:15, 32:10, 33:1 perhaps 17:2, 21:1 period 12:19, 35:7 person 61:18, 62:10, 62:14 personally 8:20 perspective 89:24 pertains 93:12 perusal 68:11 petition 93:21 petitioner 1:6, 2:2, 5:17, 5:23, 5:25, 10:1, 10:7, 11:2, 11:6, 93:22 petitioner's 9:22
---	---	--	---

ph 1:20, 3:21, 4:5, 5:16, 98:15, 99:9, 100:7, 100:17 phone 5:10 pick 77:18 place 20:22, 21:1, 22:3, 74:24, 77:10, 88:5 playback 14:20, 14:25, 15:15, 15:21, 16:6, 16:13, 16:16, 42:14, 80:4, 80:7, 80:12, 80:15, 80:20, 80:25, 81:1, 81:23, 94:10, 96:8, 97:3 played 42:17, 80:6, 80:16 playing 81:3 plaza 2:14 please 5:3, 5:4, 5:7, 5:8, 5:10, 11:7, 11:25, 24:7, 67:11, 71:24, 73:17, 94:1, 98:1 plot 80:4, 80:12, 80:13 plus 13:6, 20:12 point 6:9, 6:18, 14:14, 17:2, 17:11, 18:3, 20:23, 27:20,	43:12, 55:20, 57:8, 79:8, 92:16, 92:24 pointed 41:16 pointer 39:19 pointers 41:18 pointing 21:5, 28:18 portion 40:7, 61:13, 62:19 portions 7:11, 89:16 posing 67:5 posita 62:22, 96:7, 97:1 position 12:5, 12:9, 12:11, 17:23 positions 8:14, 9:1, 9:2, 9:3, 11:4 positive 51:4, 51:5 possible 30:22, 31:22, 32:18, 42:17, 54:8, 68:22, 75:10, 90:1 potential 66:13 practical 49:18, 49:21 prefer 7:5 preparation 8:16, 95:3 prepare 7:9 prepared 4:7, 9:20, 78:25 prescribed 30:12, 33:13,	33:14, 34:1, 34:3, 34:11, 34:13, 36:14, 36:23, 36:25 present 2:21, 42:23, 45:6, 45:24, 46:11, 77:21 presumably 71:11, 84:1, 86:24 presume 59:10 prevent 51:11, 52:22 preventing 42:9 previous 13:11, 20:18, 24:12, 32:17, 59:12, 60:2, 68:19, 71:12 previously 6:4, 22:17, 37:17, 38:16, 41:24, 61:24, 67:12, 69:3 print 99:3, 99:5 prior 31:22, 34:23, 41:19, 47:23, 66:22, 71:12 priority 85:22 privileged 9:9 probably 32:16 problem 44:8, 49:6 proceed 40:4, 95:10 proceeding 5:2, 5:5 process 8:5, 42:23, 45:6, 45:16,	45:25, 46:11 product 13:8 properly 48:22, 86:22 proposition 87:13 provide 5:12, 16:11, 31:3, 33:6, 40:21, 51:17, 53:2, 84:18, 85:16 provided 9:21, 11:2, 20:20, 22:18, 23:24, 30:18, 32:21, 34:20, 36:6, 37:20, 38:24, 39:13, 50:12, 55:15, 74:7, 82:2, 82:4, 84:14, 85:4, 88:24 provides 12:21, 13:18, 13:25, 19:12, 19:15, 29:20, 30:1, 37:9, 39:22, 50:7, 50:10, 76:22, 81:12, 81:24, 83:2 providing 9:23, 16:7, 30:5, 38:19, 53:1, 53:13, 61:24, 85:22, 89:5, 89:12, 89:20, 90:5, 92:5, 94:19 publication 3:16 pull 11:7, 16:20, 88:12 pulled 11:15
---	--	--	--

purchase 5:13 purpose 9:10, 88:23, 95:4 purposes 5:5 pursuant 90:20 put 81:22 putting 52:15, 69:21, 93:17 Q quadratic 33:8, 40:23 qualified 37:23 quality 42:18 question 6:7, 6:19, 8:9, 9:13, 21:20, 28:18, 40:5, 40:7, 40:17, 56:11, 62:6, 63:9, 64:24, 64:25, 65:1, 67:5, 67:22, 68:2, 79:3, 79:10, 81:18, 82:8, 82:23, 86:20, 93:6, 93:7 question's 81:8 questions 6:5, 6:17, 52:24, 55:1, 67:2, 67:15, 76:1, 94:4, 94:23, 97:6, 97:9 quick 68:25, 79:10, 95:20	quite 33:17, 40:17 quotation 17:7, 18:6, 44:19 quote 25:24, 43:19, 44:16, 96:8, 96:9 R r-hat 51:18 r-hatc(n) 48:3, 50:2, 50:4, 50:8, 50:12, 50:17, 51:18, 53:2, 54:8, 54:9, 83:23 r-hatc(n)>r-hatc- (n-1) 54:10 r-hatc(n-1) 48:3 r-hatcnew(n) 48:17, 86:9, 86:15 ra 21:8, 76:10, 76:14, 76:20, 79:25, 83:1 ra(n) 13:12, 15:18 raise 10:3 raised 9:25, 10:5 raising 67:2 raj 5:22 rajesh 2:4 rates 35:6, 71:6, 78:5, 84:13, 84:17, 85:2,	85:3, 85:6, 85:8, 85:15, 85:23 rather 63:21, 68:24, 70:10, 70:12, 71:17, 76:11, 80:1 ratio 12:17 rc 12:18, 51:18 rc(n) 12:7, 12:25, 13:7, 15:17, 20:12, 49:25, 50:3, 50:5, 50:8, 50:13, 50:14, 50:25, 51:23, 53:6, 53:19, 54:3, 54:9, 54:25, 55:14, 55:15 rc(n+2) 92:22 rc_new 78:21, 78:22, 78:24, 79:1 rc_old 78:8, 78:10, 78:12, 78:19, 78:25, 79:1, 79:4 rcnew 79:18 rcnew(n) 64:11 rcold 79:17 read 8:12, 13:17, 14:18, 15:3, 29:7, 29:13, 30:3, 30:15, 30:25, 31:5, 31:6, 31:22, 33:16, 33:21, 34:4, 34:7,	34:21, 37:8, 42:19, 43:2, 43:6, 46:2, 46:7, 46:14, 48:19, 50:5, 51:8, 51:15, 52:6, 52:15, 52:18, 53:17, 54:5, 54:14, 57:12, 58:18, 59:14, 62:6, 62:23, 63:7, 63:11, 68:20, 68:25, 80:23, 86:15, 89:8, 89:13, 91:3, 92:16, 93:11, 95:6, 96:17, 98:1 reader 3:21, 7:11, 9:21, 9:25, 10:7, 67:1, 67:2, 88:24, 89:3, 89:10, 91:17, 91:25, 92:3, 92:12, 92:17, 92:25, 93:12, 94:4, 94:14 reader's 6:23, 8:1, 8:11, 8:14, 10:10, 55:3, 88:18, 93:1, 93:18, 93:20, 93:22, 94:20, 95:13, 95:18, 96:4, 96:5, 97:1 reading 18:10, 59:7, 59:17, 62:25, 73:24, 77:21, 80:10 reads 15:10, 26:15, 48:2, 48:14, 84:12
---	--	---	---

readthrough 57:16 real 85:5 realize 13:2, 21:5 really 66:8, 94:13 reason 9:20, 32:7, 50:20, 50:23, 51:16, 51:20, 53:4, 53:17 reasons 50:4, 50:7, 50:10, 50:11, 53:1, 53:14 recall 57:25, 67:2, 67:15, 90:8 received 30:24, 31:24, 32:20 receiving 54:7, 83:20 recess 28:9, 46:22, 75:23, 97:8 recitation 52:12 recognize 11:22, 17:17, 17:19, 88:18 record 14:18, 28:8, 40:8, 73:7, 88:13, 90:12, 90:19, 94:18, 94:22, 95:7, 100:10 recording 5:5, 5:13 reduce 30:10, 36:12 reduces 33:10, 33:24, 34:9, 36:21 reducing 33:14, 34:2,	34:12, 36:24 refer 9:18, 11:8, 24:22, 25:23, 56:9 reference 7:3, 7:5, 7:12, 11:5, 11:8, 11:23, 17:5, 17:7, 19:1, 22:13, 23:4, 28:24, 32:17, 35:11, 37:5, 41:22, 41:25, 45:4, 49:1, 52:6, 57:14, 58:4, 65:21, 67:9, 79:18, 82:14, 84:5, 86:20, 89:16, 93:18, 95:21 referenced 7:12, 16:8, 20:15, 21:25, 25:21, 32:11, 35:15, 38:13, 39:3, 39:5, 39:18, 40:1, 49:7, 78:1 references 19:3, 55:23, 56:7, 91:18 referencing 8:13, 23:14, 24:2, 47:7 referred 47:8 referring 7:14, 7:19, 16:15, 18:4, 19:4, 19:10, 21:11, 22:19, 23:17, 25:14, 25:24, 26:21, 56:6, 59:3, 74:16 refers 25:20	refresh 57:23 regard 10:24, 45:23, 46:9, 81:12, 85:2 regarded 89:25 regarding 22:2, 44:1 regular 68:14 regulate 90:2 regulating 14:9, 14:21, 15:1, 90:25 regulations 4:8 relate 10:25, 11:2, 22:2, 22:6 related 32:2, 40:22, 52:24, 55:2, 59:18, 70:3, 71:1, 71:2, 100:22 relates 11:3, 79:9 relative 70:15 relevant 7:11, 44:21 reluctant 60:22 remaining 42:21, 45:5 remember 5:3, 5:7 remembered 4:1 remind 10:14, 89:18 reminders 6:5 remote 1:19, 2:1	remotely 2:21, 4:3, 4:5, 5:2, 100:17 rendering 43:25 repeat 45:22 rephrase 6:17 reply 9:22, 93:21 reporter 1:31, 4:4, 5:9, 10:2, 10:6, 10:8, 11:9, 11:16, 11:19, 13:20, 13:23, 28:8, 40:7, 46:21, 90:15, 100:1, 100:4 reporter's 3:9 represent 25:17, 27:14, 73:4 representation 63:24, 63:25, 66:15 represented 65:2, 100:13 representing 61:14, 62:17, 62:20, 72:23, 74:21, 75:4 represents 59:16, 74:22, 74:23 reproduce 52:12 request 84:16, 84:19, 85:14, 85:17, 85:24, 95:7 requested 50:15, 51:19, 53:3, 53:16 requesting 40:6, 85:20,
--	--	---	--

90:4 requests 49:25, 85:7 requirement 85:18 resolved 42:22, 45:6, 45:24, 46:10 respect 12:12, 35:18, 37:4, 38:7, 43:15, 56:12, 56:23, 56:25, 61:8, 64:17, 66:17, 69:4, 72:16, 73:12, 73:14, 73:15, 75:8, 76:7, 82:8 respond 88:23 responding 96:12 response 62:5, 67:1, 93:20, 96:25 responsibility 82:13 responsible 81:16, 82:24, 83:4, 84:15, 86:25 responsive 95:8, 95:25 rest 46:2, 46:14 result 51:24, 78:6, 84:2 results 33:7, 40:22, 41:13 reveal 8:8 revealing 9:14 review 57:11, 68:1 reviewed 7:10, 7:25,	8:11, 10:10, 57:15, 63:19 revising 8:17 revisit 36:9 risk 51:1, 51:23, 52:1, 53:8, 53:21 rockefeller 2:14 roman 69:16, 70:3 roughly 47:22 round 44:9 rpaul@cov 2:9 rpr 1:31 run 5:2, 87:23, 88:8 running 87:18, 88:9 runs 88:7 S safety 14:23, 16:8, 16:11 said 4:3, 4:6, 10:3, 13:9, 13:21, 16:1, 46:15, 46:16, 57:12, 57:22, 63:11, 64:4, 70:25, 85:13, 95:3 same 9:12, 13:5, 33:13, 34:2, 34:12, 36:24, 41:4, 42:4, 68:18, 69:23,	80:4, 80:12, 84:2, 85:12, 86:20, 92:2 saw 30:6, 39:15, 39:18, 65:17, 72:6, 91:17 say 7:6, 12:24, 18:13, 25:13, 37:5, 59:23, 69:22, 80:19 saying 40:5, 75:7 says 12:3, 16:12, 16:15, 19:8, 29:17, 36:9, 36:19, 37:25, 38:1, 39:8, 43:4, 43:16, 44:24, 45:9, 45:24, 46:3, 50:23, 51:25, 54:19, 64:4, 76:18, 80:12, 87:17 scalable 50:2 scale 76:10, 79:24 scaling 59:4 scan 68:25 schedule 14:11, 14:23, 15:3, 15:8, 15:12, 16:3, 16:7, 16:10, 16:13, 16:15, 18:8, 19:5, 24:10, 24:15, 24:24, 25:1, 25:2, 25:20, 25:21, 26:1, 27:16, 27:17, 28:4, 48:22,	57:7, 57:19, 58:9, 58:15, 59:5, 60:17, 68:16, 69:5, 69:7, 69:13, 72:2, 74:2, 75:1, 75:5, 75:7, 76:14, 76:15, 81:6, 81:10, 81:16, 81:24, 82:12, 86:22, 94:12, 96:9, 97:3 scheduled 80:6, 80:16 schedules 76:10, 76:11, 79:25 scope 45:2, 51:13, 51:14, 52:23, 61:21, 62:13, 73:23, 78:17, 84:25, 90:11, 90:18, 91:2, 91:13, 91:20, 92:11, 93:10, 95:2 screen 7:5, 26:22, 28:17, 33:5, 36:9 search 49:4, 95:20 searching 81:11 second 36:19, 39:3, 39:5, 48:12, 50:20, 50:23, 51:16, 51:20, 53:4, 53:17, 54:25, 93:17 seconds 32:8 section 4:8, 8:20, 21:13, 23:24,
---	---	--	---

32:25, 34:7, 35:24, 39:18, 39:19, 41:18, 44:22, 45:21, 47:14, 49:9, 49:16, 49:17, 49:20, 58:19, 59:19, 68:1, 69:1, 69:15, 69:16, 80:11, 83:7, 83:8, 83:18, 95:8 sections 45:18, 52:9 see 7:22, 10:16, 10:17, 14:17, 20:14, 22:20, 23:13, 24:24, 25:4, 25:9, 25:16, 26:5, 27:5, 27:7, 29:1, 29:18, 44:3, 45:3, 48:10, 48:12, 48:25, 49:10, 49:11, 49:14, 49:18, 50:10, 50:20, 55:5, 56:16, 57:4, 58:8, 58:22, 60:16, 61:2, 61:4, 61:5, 61:7, 68:6, 69:3, 72:13, 72:17, 72:20, 72:21, 75:9, 78:8, 78:10, 79:1, 81:11, 82:11, 83:17, 84:9, 84:20, 85:21, 94:11, 95:12 seeing 6:11, 75:14, 77:15, 82:23, 95:20 seek 62:15	seem 61:15, 70:16 seems 69:19, 77:9, 77:20, 78:4 seen 24:9, 41:16, 63:14, 89:16 selecting 52:21 selects 51:11, 54:7 send 87:11, 91:5 sender 47:16, 48:12, 48:14, 64:5, 64:8, 86:7, 86:17, 90:6, 96:17 sending 32:3 sends 64:14, 64:25, 88:6 sense 85:19, 85:22 sent 23:22, 65:7 sentence 18:11, 18:13, 19:8, 31:21, 32:18, 36:19, 39:5, 43:4, 45:9, 48:11, 48:12, 50:20, 86:6, 89:23, 91:3, 91:9, 91:14, 94:8 separate 42:6 sequence 29:21, 29:24, 29:25 server 29:1, 29:20, 30:1, 31:2, 31:10, 31:18,	32:3, 32:13, 32:22, 34:19, 35:4, 35:6, 36:3, 36:5, 37:15, 37:22, 38:5, 38:22, 38:24, 41:7, 49:25, 50:12, 51:17, 53:1, 53:14, 53:15, 53:24, 54:2, 54:7, 54:21, 54:24, 55:6, 55:10, 55:13, 60:21, 65:7, 65:11, 74:6, 74:8, 74:11, 77:17, 77:22, 78:4, 80:25, 81:6, 81:10, 84:13, 84:17, 84:19, 85:3, 85:5, 85:8, 85:15, 85:17, 85:19, 85:20, 85:22, 85:25, 87:10, 87:23, 88:2, 88:4, 88:6, 88:8, 88:9, 89:5, 89:13, 89:17, 91:5, 92:1, 92:6 server's 26:16, 29:4, 32:4, 50:17 set 100:8 setting 81:16 setup 47:23 several 18:20, 50:4, 53:14, 66:16, 81:8 sharma 2:5, 5:24 shift 48:18, 51:5,	53:25, 55:7, 60:17, 60:18, 60:19, 62:2, 74:1, 74:4, 77:23, 86:10 shifted 28:3 short 27:23, 97:7 short-circuited 85:22 shorthand 4:4, 100:1, 100:3 shortly 54:3 should 5:6, 12:24, 17:2, 17:6, 34:7, 59:23 show 57:2 shown 26:21, 33:4, 58:17, 60:7, 60:10, 61:2, 61:20, 62:12, 63:24, 66:2, 66:5, 68:14, 68:23, 69:7, 69:22, 69:23, 71:9, 71:14, 74:19, 76:12, 77:1, 78:2, 80:1, 80:5, 80:13, 82:10, 94:8 shows 27:11, 56:20, 57:1, 57:3, 72:1, 72:9 side 17:24, 17:25, 18:2, 18:5, 18:9, 18:13, 18:16, 19:14, 19:20, 19:21, 20:12, 20:16,
---	--	--	---

20:22, 22:7, 22:14, 23:1, 23:5, 23:7, 23:14, 23:19, 31:14, 32:1, 32:3, 32:22, 32:23, 33:2, 35:9, 35:10, 65:11, 65:14, 74:11, 74:25, 75:5, 77:10, 78:7, 81:2 sign 99:7 signature-plkal 100:32 similar 8:15, 59:12, 69:19, 70:7 similarities 69:21, 70:16, 70:20 similarly 48:8, 69:3, 75:3, 81:5, 91:9 simplify 25:6 simply 41:11, 56:5, 74:12, 94:15 simulate 87:10, 88:3 simulator 87:19, 87:24, 88:7, 88:8, 88:9 simultaneous 74:1 since 17:1 sitting 57:17 situate 24:16 size 19:14, 29:11, 41:13, 42:23, 43:10, 43:17, 44:25, 45:7,	45:16, 45:25, 46:5, 46:11, 51:23, 83:23, 96:10, 97:4 skill 61:18, 62:10, 62:15 skim 79:11 skimmed 7:11 skimming 58:16 slightly 93:6 slowly 5:3, 14:25, 16:16, 43:1, 43:14, 45:11 small 43:1, 43:14, 45:11 smoothly 5:3 solution 74:1 some 17:11, 24:22, 30:5, 32:7, 53:25, 55:7, 74:14, 77:24 somebody 73:5 something 18:8, 21:15, 23:1, 25:8, 32:2, 38:14, 39:7, 55:15, 59:6, 59:11, 65:8, 86:16 somewhere 9:6 soon 44:8 sorry 8:1, 10:2, 10:14, 10:25, 12:1, 13:20,	15:11, 17:10, 17:14, 26:25, 28:15, 39:3, 39:10, 40:4, 44:12, 51:18, 64:4, 67:6, 69:15, 73:5, 78:16, 79:3, 79:16, 81:21, 82:7, 86:19, 90:15, 93:25, 95:15 sort 9:19, 77:3 span 27:2, 61:13, 68:13 speak 5:3 speaking 5:9, 5:11, 19:17, 37:16, 73:5, 78:16 speaks 12:13 specific 45:3, 47:24, 71:21, 89:18 specifically 23:12, 25:21, 35:18, 43:16, 70:2, 76:18 specifies 54:23 specify 83:4, 99:6 speculate 75:15 staircase 24:9, 24:11, 24:25, 25:4, 25:8, 25:13, 25:16, 25:19, 57:3, 57:6, 57:18, 58:2, 58:7, 58:12, 58:14, 58:17, 59:3, 59:5,	59:10, 69:6, 72:1, 72:10, 74:24, 75:4 standard 4:2, 100:18 standing 52:23, 55:1, 62:5 start 21:1, 43:1, 43:14, 45:11, 87:2 start-up 35:7, 45:23 started 87:4 starting 26:14, 35:15, 40:19, 70:1 starts 28:3, 41:20, 48:1 startup 42:22, 43:15, 45:5, 46:10 state 4:4, 5:18, 14:19, 34:18, 35:20, 36:3, 37:14, 37:22, 38:4, 38:22, 40:1, 40:13, 40:15, 41:7, 55:16, 82:3, 82:23, 89:25, 94:17, 98:4, 100:4 stated 18:2, 18:6, 23:7, 36:17, 38:16, 39:10, 44:20, 45:4, 45:13, 45:19, 48:7, 48:24, 50:14, 53:1, 53:12, 66:24, 67:20, 69:9, 69:25, 74:10,
--	---	---	--

78:14, 78:18 statement 34:23, 37:19, 81:17 states 1:1, 9:19, 30:7, 35:25, 37:3, 45:4, 45:23, 46:8, 46:9, 53:4, 53:15, 55:6, 82:24, 83:21, 89:10, 89:23, 91:11, 92:3 stating 51:15 stenographer 100:1 stenographic 1:31, 10:2, 10:6, 10:8, 11:9, 11:16, 11:19, 13:20, 13:23, 28:8, 46:21, 90:15, 100:3 step 14:8, 33:4 steven 2:17 still 31:1, 31:4 stored 13:2 stream 35:5, 39:16, 47:20, 47:24, 48:2, 48:4, 49:13, 50:1, 50:2, 50:24, 50:25, 51:1, 51:2, 51:21, 51:24, 51:25, 52:1, 53:2, 53:5, 53:7, 53:18, 53:20, 53:21, 53:24, 54:8, 55:6,	59:18, 59:19, 64:6, 66:13, 69:1, 77:22, 96:20 streaming 34:20, 35:4, 36:6, 38:24, 43:6, 49:18, 49:21, 54:4 streams 96:19 street 2:6 strictly 81:14 strike 23:11, 38:7, 39:3, 40:3, 40:5, 40:7 sub-stream 50:1 submit 95:7 submitted 8:18, 90:13, 90:20 submitting 9:11 subsection 17:22, 47:15, 48:9, 49:13, 49:16, 69:16, 70:3, 83:9 subsections 49:7 substance 8:13, 9:8, 10:23, 46:24 substituted 33:17, 34:6 substituting 84:2 successive 83:21, 83:25 sufficiently 63:19 suggest 62:14, 69:2	suggested 71:16 suggests 55:14 suitable 48:15, 64:9, 85:6, 86:7 summarize 70:20 summary 44:1, 77:16 sup 7:17 superscript 49:4 supplemental 3:18, 3:20, 8:6, 8:12, 9:11, 9:18, 9:20, 9:22, 9:23, 10:10, 11:1, 16:24, 17:1, 17:18, 17:20, 18:3, 24:11, 44:5, 51:14, 55:3, 55:4, 57:13, 64:20, 66:23, 66:25, 88:19, 88:23, 90:13, 90:19, 91:21, 92:8, 93:7, 93:21, 93:23, 94:3, 94:19, 95:7, 95:13, 95:18, 95:24, 95:25, 96:5, 96:12 supplied 55:8, 55:15, 77:24 supplies 54:2, 54:20, 54:23, 55:9, 55:13 support 9:2, 9:22, 85:21, 85:25 supported 35:6, 84:17,	85:15, 93:22 supports 84:14, 85:3, 85:8, 85:23 sure 14:15, 19:17, 28:1, 49:2, 59:8, 60:14, 61:22, 62:23, 62:24, 68:20, 69:22, 75:21, 89:21, 90:17 surreply 9:24, 10:25 surrounding 74:15 switch 16:19, 27:24, 48:3, 48:15, 54:10, 54:17, 64:9, 71:12, 86:7 switches 51:3 switching 47:21, 47:24, 48:2, 48:10, 51:1, 51:24, 52:1, 53:7, 53:20, 69:17, 70:4, 71:3 sworn 5:18, 100:8 synopsis 43:19, 44:14, 44:15, 44:21, 44:23, 45:14 system 12:6, 42:23, 45:6, 45:15, 45:25, 46:4, 46:11, 51:11, 52:21, 90:1, 91:1, 92:10, 93:9, 93:19 systems 43:6 T ta 21:8
---	---	---	---

ta(n 58:24, 72:13, 72:14, 72:17, 92:20 ta(n-1 58:25, 61:10, 61:16, 61:20, 62:12, 82:17 ta(n-2 54:3, 58:24, 94:12 take 6:20, 9:4, 12:5, 17:23, 18:23, 27:23, 28:2, 28:23, 44:7, 47:11, 57:20, 57:23, 59:13, 66:10, 67:25, 75:18, 76:1, 79:4, 96:3, 97:7 taken 17:7, 28:9, 46:22, 75:23, 88:5, 97:8, 100:10 taking 14:8, 20:22, 22:2, 58:18, 74:24, 77:10, 88:5 talk 5:4, 73:18 talked 71:25, 76:25, 79:22 talking 22:5, 55:25, 70:16, 74:7, 79:14 talks 64:2, 64:5, 73:25, 96:16 target 14:11, 14:23, 15:3, 15:8, 15:12, 15:20,	16:2, 16:7, 16:10, 16:13, 16:15, 30:12, 33:13, 34:1, 34:11, 36:14, 36:24, 42:25, 43:10, 43:13, 43:17, 44:24, 45:10, 45:15, 48:22, 60:17, 74:2, 81:5, 81:9, 81:16, 81:24, 82:11, 86:22, 96:9, 97:3 tau 19:20, 72:23 tb 21:7 tb(n 12:14, 13:5, 73:2, 73:4, 73:8, 73:9, 76:3, 76:18, 76:22, 81:25, 83:3 tb(n-1 82:15 td(n 15:15, 15:22, 15:23, 80:5, 80:15 td(n-2 94:11 teaches 96:13 teachings 22:1 technical-related 5:15 technician 2:23, 5:1, 11:14, 11:20, 17:14 technique 33:8, 40:24, 87:9 tell 63:3	telling 23:18 term 12:24, 13:13, 13:16, 13:21, 14:1, 24:11, 49:1, 55:17, 55:18, 56:4, 56:14, 63:20 terms 8:25, 10:16, 13:9, 14:2, 15:18, 26:13, 60:1, 64:13, 73:13, 76:11, 80:1, 94:14 testified 5:19, 71:15 testimony 40:11, 46:25, 62:9, 63:3, 63:18, 69:6, 99:3, 99:5, 100:11 text 13:2, 20:5, 26:14, 49:5, 62:16, 74:14, 75:9, 75:13 th 2:6, 4:1, 100:30 thank 5:1, 5:15, 7:8, 10:6, 10:8, 10:20, 11:19, 13:23, 14:17, 15:25, 16:18, 17:9, 18:14, 19:2, 24:7, 25:11, 27:22, 28:23, 29:15, 34:14, 46:13, 46:21, 47:2, 47:25, 52:4, 52:14, 56:13, 56:18, 67:8, 68:4, 75:22,	76:24, 79:21, 87:1, 91:8, 97:11 theme 40:23 therefore 14:6, 60:10 therein 26:18, 29:5 things 22:2, 54:21, 54:24, 68:25, 70:1, 71:1 think 10:18, 12:1, 12:4, 16:1, 19:3, 44:13, 62:22, 65:8, 87:4, 93:1, 94:23, 97:10 third 17:5, 34:6, 47:22 three 48:16, 64:10, 86:8 through 8:12, 8:15, 14:4, 18:6, 37:11, 38:1, 48:18, 52:8, 57:12, 58:16, 58:18, 58:24, 59:7, 59:14, 60:15, 61:23, 62:23, 64:15, 64:21, 66:10, 67:20, 68:20, 75:8, 75:13, 95:9, 98:2 throughout 18:2, 18:20, 31:11 tilde 21:8 tildea 74:2 tildea(n 13:10
--	--	--	--

tildea (n-1 82:17 times 6:11, 7:4, 52:9, 56:8, 63:15, 66:16, 77:19 timing 24:20, 24:23 title 7:22, 7:24, 17:19, 99:10 titled 47:15, 48:10 today 5:24, 6:22, 57:17 today's 7:9, 89:15 tool 49:4 top 6:11, 10:17, 28:24, 57:21 topic 27:24 topics 90:21 total 52:10 toward 29:16, 32:11, 40:2, 41:9 towards 37:10 trace 61:8 traced 61:15 track 14:10, 15:7, 80:24, 81:5, 81:9, 82:9 tracks 15:3, 15:12 trademark 1:1 transcript 4:6, 5:14,	13:3, 44:15 transformation 76:8 transition 14:19, 89:25 translation 74:11 transmission 42:11, 42:16, 89:4, 89:12, 92:5 transmit 39:16, 41:12, 48:16, 64:10, 86:8 transmitted 21:12, 21:16, 48:4, 64:7, 82:18, 86:17, 96:21 transmitting 41:15 treats 25:7 trial 1:2 trouble 6:16 true 100:10 truth 5:18, 5:19 try 6:14, 6:15, 6:17, 68:1, 88:3 trying 18:4, 44:17, 44:20, 49:3, 62:5, 71:18, 81:11, 82:11 tt (n 16:4 tt (n) 16:3 tube 12:15, 13:4, 13:6, 14:10, 15:2, 15:8,	15:11, 15:12, 18:7, 19:5, 25:9, 25:18, 26:1, 27:12, 27:14, 27:15, 50:25, 51:24, 51:25, 53:6, 53:20, 68:16, 69:4, 69:12, 72:21, 72:24, 73:10, 74:21, 76:20, 76:21, 77:12, 79:6, 79:15, 83:1, 83:2 two 13:8, 16:6, 22:20, 25:15, 25:17, 26:9, 39:15, 42:12, 50:10, 54:21, 54:24, 56:9, 60:4, 71:5, 74:20, 80:10 two-thirds 37:10, 73:25 typo 17:3 U ultimately 81:3, 82:24 unable 5:9, 87:10 under 30:11, 33:12, 33:25, 34:11, 36:13, 36:23, 47:14, 48:9, 49:9, 49:13, 49:16, 69:1, 69:15, 83:7 underflow 14:22, 51:2, 51:7, 52:22, 53:8, 53:10, 53:21, 78:6 underflowing 42:10, 51:12	underflows 42:13 understand 25:13, 25:19, 58:11, 58:25, 59:5, 61:19, 63:20, 73:4, 76:5, 77:12, 78:8, 79:3 understanding 6:13, 6:16, 9:19, 9:21, 15:7, 21:10, 39:24, 41:10, 52:20, 57:10, 57:18, 59:8, 59:16, 59:17, 62:17, 65:5, 65:6, 67:13, 67:17, 68:9, 73:21, 74:18, 78:12, 78:22, 81:9, 82:9 understood 9:10, 62:24, 62:25, 96:7, 97:2 unedited 5:12 uninterrupted 14:20 united 1:1 units 96:16 unless 6:7 until 8:17 update 12:7, 12:14, 13:4, 87:18 upper 12:15, 12:16, 13:4, 13:6, 14:11, 15:2, 15:8, 15:11, 15:12, 18:8,
---	---	---	--

19:5, 21:7, 26:1, 26:15, 27:16, 27:17, 28:25, 29:3, 29:9, 29:20, 30:8, 30:17, 30:19, 30:23, 31:8, 31:10, 31:16, 31:19, 31:23, 32:10, 32:13, 32:19, 36:10, 48:18, 48:23, 51:3, 51:5, 53:25, 55:7, 59:24, 60:2, 60:20, 62:2, 64:12, 68:5, 68:6, 68:10, 68:16, 69:4, 69:12, 69:17, 69:18, 70:17, 70:18, 70:19, 72:10, 72:21, 72:24, 73:9, 73:12, 73:13, 73:14, 73:21, 73:22, 74:4, 74:18, 74:22, 75:2, 75:3, 75:6, 76:3, 76:5, 76:15, 76:16, 76:20, 76:21, 77:1, 77:2, 77:4, 77:12, 77:13, 77:14, 77:23, 78:1, 78:2, 79:2, 79:5, 79:15, 82:1, 82:3, 82:5, 82:9, 82:16, 82:20, 83:1, 83:2, 86:10, 86:23, 86:25 upward 14:16, 21:24, 42:7	urgent 17:12 use 14:6, 14:7, 24:11, 90:1 user 42:12 uses 14:5, 15:16, 40:12 using 21:4, 33:7, 38:13, 39:7, 40:23, 40:24, 44:18, 77:17, 82:15 utterance 9:24, 90:12 V v-e 21:13, 23:24, 32:25, 39:19, 41:18 value 13:5, 29:12, 30:1, 30:20, 31:8, 31:10, 31:12, 31:13, 31:16, 31:19, 32:4, 32:11, 32:14, 32:23, 41:14, 41:15, 55:9, 64:2, 64:14, 71:10, 71:12, 82:6, 82:24, 83:5, 83:20 values 13:11, 30:9, 30:23, 31:3, 31:23, 32:19, 36:11, 48:16, 60:4, 64:10, 77:17, 83:21, 86:8 variable 13:5, 18:2,	18:9, 18:14, 21:15, 22:15, 22:21, 23:1, 23:8, 23:15, 23:19, 23:21, 55:9, 70:7, 70:21 variables 15:16, 17:24, 17:25, 18:16, 18:17, 22:5, 22:6, 22:25, 23:5 variations 13:16 various 25:6, 89:16 verify 44:20 version 7:18, 8:18 vertical 61:14, 62:19, 76:10, 79:24 via 5:10 video 5:8, 5:10 view 6:13, 76:7 virtually 96:18 voice 6:16 vs 1:8 W w(n-1 13:14, 13:15, 14:1, 14:3, 14:6, 15:19 want 6:12, 44:7, 50:19, 59:9, 62:22, 62:24, 63:7, 66:18, 67:25, 68:20,	90:18, 94:17, 95:6, 99:4, 99:6 wanted 44:14, 49:23, 84:7 washington 2:7 way 10:18, 18:6, 27:18, 37:10, 38:1, 39:25, 41:8, 63:4, 68:9, 73:25, 94:5, 100:25 we'll 46:18 we're 6:10, 11:16, 22:19, 66:13 we've 37:16, 41:16, 63:14, 75:17, 89:15 went 8:15 whatever 74:24, 75:4, 88:5 whenever 17:12, 51:2 whereas 36:18, 66:17, 71:20 whereupon 11:12, 16:21, 88:14, 97:12 whether 39:25, 40:2, 57:18, 58:11, 62:11, 63:4, 63:20, 65:3, 65:6, 65:15, 67:2, 67:13, 68:18, 69:22, 75:9, 81:13, 81:14, 82:12 whole 5:18
--	--	--	--

withdraw 40:9, 54:22, 67:7, 67:10, 83:13 withdrawn 40:6, 89:9 within 22:20, 25:9, 26:11, 95:2, 100:4 without 8:10, 9:8, 9:13, 51:1, 52:1, 53:8, 53:21, 58:18, 58:20, 59:7, 61:23, 75:13 witness 4:6, 5:17, 8:7, 8:11, 10:4, 10:7, 12:9, 15:10, 19:12, 22:17, 23:7, 23:17, 27:2, 31:21, 32:16, 38:16, 41:24, 45:3, 51:15, 52:25, 55:5, 60:14, 61:12, 61:22, 62:14, 63:7, 63:23, 66:8, 67:20, 69:9, 73:9, 73:24, 77:8, 78:16, 78:18, 79:8, 85:1, 85:13, 88:1, 91:3, 91:14, 92:3, 92:12, 93:11, 96:3, 97:9, 100:7, 100:11, 100:30 witness's 3:8, 99:1 word 8:22, 34:6 word-for-word 52:12	wording 14:13, 44:17 words 45:19, 77:13, 99:4, 99:6 work 85:10 write 8:22 writing 8:25 Y y-axis 26:2, 27:3, 27:18, 58:4, 58:13, 58:22, 58:24, 59:4, 60:7, 61:3, 61:4, 61:9, 65:19, 65:25, 66:2, 68:23, 72:4, 72:6, 74:9, 74:13 yan 1:31, 4:3, 100:3, 100:34 yeah 6:15, 15:10, 28:17, 32:16, 44:17, 46:17, 46:18, 47:13, 51:15, 52:25, 55:23, 62:14, 75:20, 78:17, 79:24, 88:8 york 2:15 yourself 5:11 Z zoom 12:3, 19:2, 47:18, 53:23, 79:21 0 01239 1:8	0143678 3:17 06 4:2, 100:18 093127 44:15 1 10 2:6, 19:10, 19:15, 19:23, 20:2, 20:6, 20:7, 20:11, 22:20, 26:10, 27:24, 44:9, 51:6, 54:13, 55:19, 56:15, 56:17, 56:18, 56:20, 57:3, 57:6, 57:11, 57:15, 57:18, 58:12, 58:13, 58:18, 59:4, 59:9, 59:10, 60:7, 60:11, 60:15, 60:21, 61:2, 61:6, 61:12, 61:20, 61:24, 62:12, 62:15, 62:17, 63:4, 63:8, 63:24, 64:17, 65:25, 66:12, 66:15, 67:11, 67:21, 68:7, 68:12, 69:3, 69:7, 69:23, 70:2, 70:10, 70:11, 70:22, 71:2, 71:4, 71:7, 71:9, 71:20, 72:6, 73:17, 74:6, 74:9, 74:15, 74:19, 75:8, 75:20, 76:25, 77:1, 77:4, 77:9, 77:13, 78:2, 78:9, 78:13, 79:2, 79:5, 79:19 100 3:9, 84:8, 84:22, 85:1, 85:14, 85:21, 98:3 1004 3:16, 11:8, 11:12, 11:17, 17:6, 18:25, 28:22, 47:12, 56:13, 76:1, 89:22 101 6:24, 6:25, 7:17, 10:23, 60:16, 61:25, 62:18, 73:24, 84:7 10112 2:15 104 7:7 1040 3:20, 8:3, 10:11, 88:12, 88:13, 88:14, 88:18, 91:18, 91:23, 95:8, 95:18 106 49:8 11 1:21, 3:16, 4:1, 17:3, 99:11, 100:17 110 47:4, 47:12, 47:14, 47:19, 55:24, 64:5, 95:14, 95:17, 95:23, 96:14, 96:15 112 47:5, 48:9, 55:24, 59:23,
---	---	---

59:24, 64:8, 70:17, 71:11, 86:2, 86:21, 95:14, 95:17, 95:23 113 64:4, 81:21, 83:6, 83:12, 83:14, 83:17, 83:19, 84:3, 84:5 12 79:18, 97:13, 100:18 125 79:16 126 67:6, 86:18, 87:2, 87:3, 87:13, 95:14, 95:17, 95:24 127 86:18, 87:2 128 87:14 14 96:5 14316 1:31, 100:34 15 9:6, 95:9 16 3:18, 21:4, 82:15, 89:2, 89:9, 89:10, 91:18, 92:3, 92:13, 92:17, 93:12, 94:8, 95:9 17 67:7, 87:3, 87:5, 100:30 18 12:4, 12:6, 12:12, 12:13, 14:4, 14:6, 14:20, 15:14, 15:16, 15:21,	15:23, 16:2, 16:5, 28:14, 89:24, 96:7, 97:2 19 12:2, 13:14, 13:19, 13:25, 14:4, 15:24, 16:5 2 20 9:7, 42:8, 43:9, 43:21, 43:24, 43:25, 44:4, 44:13, 44:24, 45:3, 45:13, 45:19, 46:9, 75:18 20001 2:7 2006 3:17 2016 3:18, 7:14, 16:20, 16:21, 28:12, 43:22, 47:4, 56:7, 87:6, 92:9, 93:8 202 2:8 2023 1:8 2024 1:21, 4:2, 99:11, 100:17, 100:30 21 35:3, 35:8, 35:11, 41:25, 42:4 212 2:16 22 33:5, 35:13, 35:14, 35:24, 36:19, 37:2, 37:4, 37:8,	37:20, 38:1, 38:9, 38:13, 38:17, 38:18, 39:2, 39:6, 39:11, 39:12, 39:20, 40:2, 40:19, 41:2, 41:10, 41:20, 41:21, 42:3, 42:5, 96:11 239 7:16 24 17:6, 26:14, 26:20, 28:13, 28:19, 28:23, 28:24 2473 4:8 25 17:7, 28:13, 28:19, 30:6, 31:17, 32:11, 36:9, 82:1 2500 2:16 26 87:17 28 95:9 29 95:9 3 30 2:14, 46:16, 46:17, 46:19 35 28:2 383 95:8 3c1 95:8 4 408 2:16 5 58 97:13, 100:18	5e 83:7, 83:18 6 6000 2:8 61 21:1, 21:23, 21:25, 22:1, 22:8, 22:10 66 18:24, 19:1, 19:12, 20:5, 20:15, 20:23, 21:22, 22:12, 22:13, 22:20, 23:3, 23:8, 23:12, 23:18, 24:2, 25:22, 25:24, 26:11, 69:12 662 2:8 67 76:9, 76:17, 79:14, 79:20, 80:3, 82:25, 94:12 69 21:4, 21:14, 21:21, 22:19, 23:21, 82:14, 89:23, 89:24 7 70 14:17, 16:8, 73:15 8 8 4:2, 100:18 8,752,101 1:10 81 90:8, 90:9, 90:24, 91:4, 91:10, 92:19
---	---	--	--

850 2:6 88 3:20 89 49:17, 49:20 9 97 49:12, 49:23, 52:16, 52:19, 52:24, 55:16, 56:12, 56:14, 77:16 98 3:8, 52:16, 53:22, 54:23, 55:2, 55:5, 55:16, 56:12, 56:14, 59:18, 77:16, 77:23, 78:1	
---	--