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| | | |
|---|---|---|
| 1 | you see where it says at Line 7: | 11:45:45 |
| 2 | "Such an accumulator may be considered | 11:45:49 |
| 3 | a block coder whose input block X sub one | 11:45:51 |
| 4 | through X sub N and output block Y sub one | 11:45:55 |
| 5 | through Y sub N are related by the | 11:45:59 |
| 6 | formula," and then it provides a formula? | 11:46:02 |
| 7 | A.        I see that. | 11:46:04 |
| 8 | Q.        That's the same description as Divsalar on | 11:46:04 |
| 9 | Page 5 where it says: | 11:46:08 |
| 10 | "The accumulator can be viewed as a | 11:46:09 |
| 11 | truncated rate-1 recursive convolutional | 11:46:12 |
| 12 | encoder with a transfer function, one over | 11:46:14 |
| 13 | one plus N, but we prefer to think of it | 11:46:17 |
| 14 | as a block code whose input block X sub | 11:46:21 |
| 15 | one through X sub N and output block Y sub | 11:46:24 |
| 16 | one through Y sub N are related by the | 11:46:28 |
| 17 | formula," and it provides a formula, | 11:46:31 |
| 18 | right? | 11:46:33 |
| 19 | MR. GLASS:  Same objection.  Outside the | 11:46:33 |
| 20 | scope.  Calls for a legal conclusion. | 11:46:34 |
| 21 | THE WITNESS:  There is some similarities | 11:46:35 |
| 22 | in language, some similarities in words, yes. | 11:46:37 |
| 23 | BY MR. DOWD: | 11:46:41 |
| 24 | Q.        And the code -- the formula that's written | 11:46:41 |
| 25 | there is the same formula, right? | 11:46:43 |

| | | |
|---|---|---|
| 1 | MR. GLASS: Same objections. | 11:46:45 |
| 2 | THE WITNESS: It doesn't have exactly the | 11:46:46 |
| 3 | same formula. | 11:46:48 |
| 4 | BY MR. DOWD: | 11:46:50 |
| 5 | Q. Other than in Divsalar, the plus sign does | 11:46:50 |
| 6 | not have a circle around it and in the '781 patent | 11:46:55 |
| 7 | the plus sign has a circle, is there any other | 11:47:00 |
| 8 | difference that you can identify? | 11:47:03 |
| 9 | MR. GLASS: Same objection. Outside the | 11:47:04 |
| 10 | scope. | 11:47:06 |
| 11 | THE WITNESS: I have not studied that in | 11:47:06 |
| 12 | detail. I feel uncomfortable making on-the-spot | 11:47:06 |
| 13 | judgements about the -- | 11:47:06 |
| 14 | THE REPORTER: Wait. You're going to have | 11:47:06 |
| 15 | to slow down for me. Repeat your answer. | 11:47:12 |
| 16 | THE WITNESS: I have not made an in-depth | 11:47:12 |
| 17 | analysis of that. I feel uncomfortable making an | 11:47:14 |
| 18 | on-spot judgment about the exact differences in | 11:47:18 |
| 19 | these two paragraphs. | 11:47:20 |
| 20 | BY MR. DOWD: | 11:47:21 |
| 21 | Q. Well, sitting here today, can you identify | 11:47:22 |
| 22 | any difference between the formula in Divsalar and | 11:47:25 |
| 23 | the formula at Column 3 of the '781 patent? | 11:47:28 |
| 24 | MR. GLASS: Same objections. | 11:47:31 |
| 25 | THE WITNESS: As I said, they are | 11:47:32 |

| | | |
|---|---|---|
| 1 | certainly not the same.  One are plus signs; the | 11:47:33 |
| 2 | other ones are symbols that perhaps are X or | 11:47:36 |
| 3 | symbols. | 11:47:40 |
| 4 | BY MR. DOWD: | 11:47:41 |
| 5 | Q.        Do you see at Line 24 it says: | 11:47:41 |
| 6 |             "Where the plus with a circle denotes | 11:47:43 |
| 7 |             mod 2 or exclusive OR addition"? | 11:47:43 |
| 8 |             THE REPORTER:  "Where the plus" -- | 11:47:43 |
| 9 |             MR. DOWD:  "With a circle around it." | 11:47:43 |
| 10 |             THE REPORTER:  Start there, please. | 11:47:43 |
| 11 |             MR. DOWD:  I will. | 11:47:49 |
| 12 | BY MR. DOWD: | 11:47:49 |
| 13 | Q.        "Where the plus with a circle around it | 11:47:51 |
| 14 | denotes mod 2 or exclusive OR addition"? | 11:47:53 |
| 15 | A.        I see that. | 11:47:57 |
| 16 | Q.        All right.  So if the plus in Divsalar is | 11:47:59 |
| 17 | an exclusive OR addition, we can agree that the | 11:48:02 |
| 18 | formula is the same in both documents, right? | 11:48:05 |
| 19 |             MR. GLASS:  Outside the scope. | 11:48:07 |
| 20 |             THE WITNESS:  As I said, if, you know, | 11:48:08 |
| 21 | that was an opinion that would be asked from me, I | 11:48:11 |
| 22 | would like to actually study that question in detail | 11:48:13 |
| 23 | and then come to a conclusion after a thoughtful | 11:48:16 |
| 24 | process. | 11:48:19 |
| 25 | /// | |

| | | |
|---|---|---|
| 1 | BY MR. DOWD: | 11:48:20 |
| 2 | Q.      Okay.  "Yes," "no," or "I don't know," | 11:48:20 |
| 3 | sitting here today the two formulas are the same? | 11:48:25 |
| 4 | MR. GLASS:  Same objections. | 11:48:28 |
| 5 | THE WITNESS:  I don't know. | 11:48:29 |
| 6 | BY MR. DOWD: | 11:48:30 |
| 7 | Q.      Okay.  Let's go back to Divsalar. | 11:48:35 |
| 8 | Am I correct that information bit X1 is | 11:48:42 |
| 9 | going to appear in every one of the subsets from Y1 | 11:48:48 |
| 10 | down to YN? | 11:48:54 |
| 11 | MR. GLASS:  Outside the scope. | 11:48:57 |
| 12 | THE WITNESS:  In formula 5.1, I see a | 11:48:57 |
| 13 | symbol X1 appearing on the right-hand side. | 11:49:01 |
| 14 | BY MR. DOWD: | 11:49:04 |
| 15 | Q.      And that appears for every subset Y1 | 11:49:04 |
| 16 | through YN, right? | 11:49:07 |
| 17 | MR. GLASS:  Same objections. | 11:49:07 |
| 18 | THE WITNESS:  It appears for those lines | 11:49:08 |
| 19 | that are visible, yes. | 11:49:10 |
| 20 | BY MR. DOWD: | 11:49:12 |
| 21 | Q.      And then there's a second information bit | 11:49:12 |
| 22 | X2 that appears in subsets Y2, Y3, down through YN, | 11:49:15 |
| 23 | right? | 11:49:20 |
| 24 | A.      I see a symbol X2 appearing on the | 11:49:21 |
| 25 | right-hand side. | 11:49:24 |

| | | |
|---|---|---|
| 1 | Q.        Uh-huh.  And it appears in each of the | 11:49:25 |
| 2 | subsets Y2 down the YN, right? | 11:49:28 |
| 3 | MR. GLASS:  Same objections. | 11:49:31 |
| 4 | THE WITNESS:  As I said, I have not | 11:49:32 |
| 5 | studied this.  It appears in three places.  This may | 11:49:34 |
| 6 | or may not mean what you are implying. | 11:49:38 |
| 7 | BY MR. DOWD: | 11:49:41 |
| 8 | Q.        Well, can you -- withdrawn. | 11:49:41 |
| 9 | Am I correct that the number of subsets in | 11:49:43 |
| 10 | which the information bit appears varies from bit X1 | 11:49:46 |
| 11 | to bit X2? | 11:49:50 |
| 12 | A.        An accumulator accumulates the past. | 11:49:55 |
| 13 | Simply at any point in time a bit comes in or | 11:49:58 |
| 14 | whatever the number is, it will add it to the | 11:50:02 |
| 15 | current running sum.  That's what an accumulator | 11:50:05 |
| 16 | does. | 11:50:07 |
| 17 | Q.        Okay.  So in the first recursive operation | 11:50:08 |
| 18 | you only have one bit, right, X1? | 11:50:11 |
| 19 | A.        This is simply the state of the system. | 11:50:14 |
| 20 | The state of the system stays there.  At any point | 11:50:17 |
| 21 | in time the state of the system is updated.  That's | 11:50:20 |
| 22 | what it is. | 11:50:22 |
| 23 | Q.        All right.  And let's just talk about how | 11:50:23 |
| 24 | an accumulator operates for a second. | 11:50:25 |
| 25 | So in the first clockcycle, you have one | 11:50:27 |

| | | |
|---|---|---|
| 1 | bit in, right? | 11:50:33 |
| 2 | A.        At every clockcycle you have one bit in. | 11:50:33 |
| 3 | Q.        Right.  And so I'm starting with the first | 11:50:36 |
| 4 | clockcycle; so far I only have one bit, right? | 11:50:40 |
| 5 | A.        You start with the first bit that appears. | 11:50:43 |
| 6 | You have -- you have a certain basic state that you | 11:50:43 |
| 7 | have.  You -- | 11:50:43 |
| 8 | THE REPORTER:  Wait.  Wait.  Wait.  Slow | 11:50:43 |
| 9 | down and start your answer again, please. | 11:50:51 |
| 10 | THE WITNESS:  The accumulator will be in a | 11:50:51 |
| 11 | particular state.  As soon as a bit arrives, the | 11:50:54 |
| 12 | state will be updated by whatever the incoming bit | 11:50:56 |
| 13 | is. | 11:51:01 |
| 14 | BY MR. DOWD: | 11:51:01 |
| 15 | Q.        Okay.  So let's, for the sake of my | 11:51:01 |
| 16 | example, assume that the initialization state of the | 11:51:04 |
| 17 | accumulator is 0, okay? | 11:51:07 |
| 18 | A.        Correct. | 11:51:09 |
| 19 | Q.        And the first bit that's presented is a 1, | 11:51:10 |
| 20 | okay?  Am I correct that what happens is that you | 11:51:15 |
| 21 | combine the 0 with the incoming one and it is the | 11:51:18 |
| 22 | result of that combination that gets, then, written | 11:51:22 |
| 23 | to the accumulator? | 11:51:25 |
| 24 | A.        That's correct. | 11:51:26 |
| 25 | Q.        And the result of that combination is | 11:51:27 |

| | | |
|---|---|---|
| 1 | neither the 1 or the 0 but the product of combining | 11:51:31 |
| 2 | them? | 11:51:36 |
| 3 | A.          It's the sum of combining these two. | 11:51:37 |
| 4 | it's -- it's -- it's taking the sum of the current | 11:51:40 |
| 5 | state with whatever's coming in.  That's going to be | 11:51:42 |
| 6 | the output; that's going to be the new state. | 11:51:46 |
| 7 | Q.          Okay.  And that new state is a bit that is | 11:51:49 |
| 8 | created by performing the summing? | 11:51:54 |
| 9 | MR. GLASS:  Objection.  Vague. | 11:51:58 |
| 10 | THE WITNESS:  It's the state.  It's simply | 11:51:58 |
| 11 | a state.  It's not a bit.  It's the state, and the | 11:52:00 |
| 12 | state could have -- be binary as it's in this form. | 11:52:03 |
| 13 | It could be a higher dimension.  It could be over a | 11:52:07 |
| 14 | bigger field, for example.  It's whatever the state | 11:52:10 |
| 15 | is at that point. | 11:52:12 |
| 16 | BY MR. DOWD: | 11:52:13 |
| 17 | Q.          Okay.  I'm -- I'm just doing a simple | 11:52:13 |
| 18 | accumulation -- | 11:52:15 |
| 19 | A.          Sure. | 11:52:16 |
| 20 | Q.          -- where we only have -- it can be a one 1 | 11:52:17 |
| 21 | or a 0. | 11:52:19 |
| 22 | A.          Okay.  So if the state is binary, then | 11:52:20 |
| 23 | there will be a binary state and it will have a | 11:52:20 |
| 24 | value in the state and -- | 11:52:20 |
| 25 | THE REPORTER:  I'm sorry, state your | 11:52:20 |

1    answer again, please.                           11:52:25

2              THE WITNESS:  Sure.  So if the state is    11:52:25

3    indeed binary, then it will take whatever state that  11:52:28

4    was before it.  It will add the current bit to the    11:52:33

5    state.  This will give you a new state, and the size  11:52:36

6    of the state doesn't change, so it will still be      11:52:40

7    binary.                                               11:52:43

8    BY MR. DOWD:                                          11:52:45

9    Q.        Okay.  And as each new bit comes in, a new  11:52:45

10   state is created by combining the -- the current      11:52:50

11   state in the accumulator with the new bit, correct?   11:52:58

12   A.        According to the description that I gave     11:53:02

13   before, if the state at any point is updated and      11:53:05

14   changed according to the value of the new incoming    11:53:08

15   bit, that is correct.                                 11:53:13

16   Q.        And that's done -- am I correct that        11:53:15

17   that's done using mod 2 addition?                     11:53:17

18   A.        That's done according to addition in the    11:53:20

19   field GF(2).                                          11:53:23

20   Q.        Okay.  Just so I make sure I understand     11:53:24

21   what that is, what is GF(2)?                          11:53:27

22   A.        GF(2) is the Galois field that contains     11:53:29

23   two elements.                                         11:53:33

24   Q.        Is the addition the same as ordinary        11:53:35

25   arithmetic, with the exception that one plus one      11:53:40

| | | |
|---|---|---|
| 1 | equals 0 in that case? | 11:53:44 |
| 2 | A.          There's -- it's -- it's whatever the | 11:53:46 |
| 3 | addition is over GF(2).  So that has a well-defined | 11:53:48 |
| 4 | mathematical concept and that is the addition. | 11:53:53 |
| 5 | Q.          Okay.  Let me -- let me try it another | 11:53:56 |
| 6 | way. | 11:53:58 |
| 7 |           Would the truth table for that addition be | 11:53:58 |
| 8 | one plus one equals 0, one plus 0 equals one, one -- | 11:54:01 |
| 9 | I'm sorry, 0 plus one equals one, 0 plus 0 equals 0? | 11:54:06 |
| 10 | A.          That's correct. | 11:54:11 |
| 11 | Q.          Okay.  Have you ever heard that called mod | 11:54:12 |
| 12 | 2 addition before? | 11:54:20 |
| 13 | A.          I certainly am aware of the mod 2 | 11:54:20 |
| 14 | addition. | 11:54:24 |
| 15 | Q.          Okay.  That's all the truth table for mod | 11:54:24 |
| 16 | 2 addition, right? | 11:54:27 |
| 17 | A.          That might very well be also the truth | 11:54:28 |
| 18 | table of mod 2 addition. | 11:54:39 |
| 19 | Q.          When you say:  "It might very well be," is | |
| 20 | that a guess or -- | |
| 21 |           THE REPORTER:  Hold on.  Hold on. | |
| 22 |             "That very well might be the" -- | |
| 23 |           THE WITNESS:  The truth table of mod 2 | |
| 24 | addition. | 11:54:43 |
| 25 | /// | |

| | | |
|---|---|---|
| 1 | BY MR. DOWD: | 11:54:43 |
| 2 | Q.          Well, is it or isn't it? | 11:54:44 |
| 3 | MR. GLASS:  Outside the scope. | 11:54:45 |
| 4 | THE WITNESS:  This is not what my expert | 11:54:46 |
| 5 | report is about. | 11:54:48 |
| 6 | BY MR. DOWD: | 11:54:49 |
| 7 | Q.          Irrespective of whether it's in your | 11:54:49 |
| 8 | expert report, is it true? | 11:54:51 |
| 9 | MR. GLASS:  Same objection. | 11:54:52 |
| 10 | THE WITNESS:  There are many things that | 11:54:59 |
| 11 | might be true, but I've been called for -- | 11:55:01 |
| 12 | THE REPORTER:  Wait.  I'm sorry.  Did you | 11:55:01 |
| 13 | say an objection? | 11:55:01 |
| 14 | MR. GLASS:  I said:  "Same objection." | 11:55:01 |
| 15 | THE WITNESS:  There are many things that | 11:55:01 |
| 16 | might be true, but I've been called for a | 11:55:01 |
| 17 | specific -- a specific purpose and that's my -- | 11:55:03 |
| 18 | whatever is -- is written in my expert report. | 11:55:06 |
| 19 | BY MR. DOWD: | 11:55:06 |
| 20 | Q.          Well -- | 11:55:11 |
| 21 | THE REPORTER:  Hold on.  I need to go off | 11:55:11 |
| 22 | the record. | 11:55:13 |
| 23 | MR. DOWD:  All right.  Let's go off the | 11:55:13 |
| 24 | record. | 11:55:13 |
| 25 | THE VIDEOGRAPHER:  This marks the end of | 11:55:13 |

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| | | |
|---|---|---|
| 1 | Video No. I in the deposition of | 11:55:15 |
| 2 | Dr. Rüdiger Urbanke.  We are off the record at | 11:55:19 |
| 3 | 11:55 a.m. | 11:55:22 |
| 4 | (Recess taken at 11:55 a.m.) | 11:55:22 |
| 5 | THE VIDEOGRAPHER:  Here begins Video No. 2 | 12:07:59 |
| 6 | in the deposition of Dr. Rüdiger Urbanke.  We are | 12:08:01 |
| 7 | back on the record at 12:08 p.m. | 12:08:04 |
| 8 | BY MR. DOWD: | 12:08:09 |
| 9 | Q.      Dr. Urbanke, before the break I was asking | 12:08:11 |
| 10 | you whether the truth table of a mod 2 addition is | 12:08:14 |
| 11 | the same as the GF(2) truth table that you told me | 12:08:20 |
| 12 | about; do you recall that? | 12:08:25 |
| 13 | A.      Yes. | 12:08:27 |
| 14 | Q.      And your answer was:  There are many | 12:08:28 |
| 15 | things that may be true but you're only going to | 12:08:30 |
| 16 | tell me what's in your report; do you recall that? | 12:08:34 |
| 17 | MR. GLASS:  Objection.  Mischaracterizes | 12:08:37 |
| 18 | testimony. | 12:08:39 |
| 19 | THE WITNESS:  I recall in a sense that you | 12:08:39 |
| 20 | asked me about whether or not these two things were | 12:08:42 |
| 21 | true.  Since I have not studied the exact | 12:08:45 |
| 22 | definitions of how these terms are defined, either | 12:08:48 |
| 23 | in the patents or on the paper, I prefer not to give | 12:08:50 |
| 24 | an ad hoc opinion on these. | 12:08:53 |
| 25 | /// | |

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| | | |
|---|---|---|
| 1 | BY MR. DOWD: | 12:08:56 |
| 2 | Q. Well, do you recall at the outset today | 12:08:56 |
| 3 | you swore to tell the truth, the whole truth and | 12:08:58 |
| 4 | nothing but the truth? | 12:09:01 |
| 5 | A. Absolutely. | 12:09:02 |
| 6 | Q. So is it true that the truth table of mod | 12:09:03 |
| 7 | 2 addition is one plus one equals 0, one plus 0 | 12:09:10 |
| 8 | equals one, 0 plus one equals one, one plus one | 12:09:14 |
| 9 | equals 0? | 12:09:19 |
| 10 | A. If you define the mod 2 addition in terms | 12:09:21 |
| 11 | of this truth table, then indeed that's what the | 12:09:23 |
| 12 | truth table is, but that's a tautology. So unless | 12:09:26 |
| 13 | you have given me a definition of what mod 2 is and | 12:09:28 |
| 14 | I have not looked in the patents exactly how this is | 12:09:32 |
| 15 | defined, I cannot answer this question. | 12:09:35 |
| 16 | Q. So you can't explain what mod 2 addition | 12:09:36 |
| 17 | is? | 12:09:39 |
| 18 | A. I have some definition of a mod 2, but I | 12:09:39 |
| 19 | don't know if in these patents it's exactly the same | 12:09:42 |
| 20 | definition that's used. | 12:09:45 |
| 21 | Q. Well, irrespective of the patents, what is | 12:09:46 |
| 22 | your definition of mod 2 addition? | 12:09:49 |
| 23 | A. One definition of mod 2, it would be | 12:09:50 |
| 24 | exactly the truth table that you mentioned. | 12:09:54 |
| 25 | Q. Okay. Now, if we go back to the two | 12:10:05 |

| | | |
|---|---|---|
| 1 | formula, the Divsalar formula 5.1 and the formula of | 12:10:08 |
| 2 | the '781 patent, Column 10 through Column 3 -- | 12:10:13 |
| 3 | sorry, Line 10 through about Line 23, those two | 12:10:17 |
| 4 | formulae show the same form of accumulation, right? | 12:10:23 |
| 5 | MR. GLASS: Objection. Outside the scope. | 12:10:27 |
| 6 | THE WITNESS: Those two formulae show a | 12:10:28 |
| 7 | certain mathematical relationship between some | 12:10:31 |
| 8 | sequence X and some sequence Y. | 12:10:34 |
| 9 | BY MR. DOWD: | 12:10:36 |
| 10 | Q.      And it's the same relationship, right? | 12:10:36 |
| 11 | MR. GLASS: Same objections. | 12:10:38 |
| 12 | THE WITNESS: I don't know how XOR in this | 12:10:39 |
| 13 | case is defined. I cannot answer this question to | 12:10:41 |
| 14 | you. | 12:10:46 |
| 15 | BY MR. DOWD: | 12:10:46 |
| 16 | Q.      Okay. If it is defined in the same way | 12:10:46 |
| 17 | that we've been discussing, the mod 2 addition, then | 12:10:48 |
| 18 | it would be the same? | 12:10:50 |
| 19 | MR. GLASS: Same objection. | 12:10:51 |
| 20 | THE WITNESS: I don't know the subtleties | 12:10:52 |
| 21 | of the exact definition. As I said, I didn't study | 12:10:54 |
| 22 | the patents, the exact claims to that extent. I | 12:10:57 |
| 23 | don't know if there are any subtle issues of how | 12:11:00 |
| 24 | these things are defined. | 12:11:02 |
| 25 | /// | |

| | | |
|---|---|---|
| 1 | BY MR. DOWD: | 12:11:07 |
| 2 | Q.          Now, let's go back to Figure 3 that you | 12:11:07 |
| 3 | reproduced in your report, there's an output from | 12:11:10 |
| 4 | the accumulator qN, right? | 12:11:13 |
| 5 | A.          That's correct. | 12:11:15 |
| 6 | Q.          And that output is the code word produced | 12:11:15 |
| 7 | by the encoder, right? | 12:11:19 |
| 8 | A.          Whatever comes out of this construction is | 12:11:23 |
| 9 | indeed what is considered the code word | 12:11:26 |
| 10 | corresponding to whatever the input is. | 12:11:29 |
| 11 | Q.          And that code word would include what are | 12:11:30 |
| 12 | called "parity bits," right? | 12:11:34 |
| 13 | A.          That code word is simply the output. | 12:11:36 |
| 14 | Unless you can give me an exact definition what you | 12:11:43 |
| 15 | mean with "parity bits," it's not possible for me to | 12:11:46 |
| 16 | decide whether or not that fits that definition. | 12:11:49 |
| 17 | Q.          Have you heard the term "parity bits" | 12:11:51 |
| 18 | before? | 12:11:54 |
| 19 | A.          Certainly. | 12:11:54 |
| 20 | Q.          What do you understand "parity bits" to | 12:11:54 |
| 21 | mean? | 12:11:58 |
| 22 | A.          Parity bits are -- would be bits that | 12:11:58 |
| 23 | depend on information bits and would -- may or may | 12:12:04 |
| 24 | not be part of a code word. | 12:12:14 |
| 25 | THE REPORTER:  "Be part of" -- | 12:12:14 |

1    THE WITNESS:  A code word.                        12:12:14

2    THE REPORTER:  Thank you.                         12:12:20

3  BY MR. DOWD:                                         12:12:20

4  Q.       Now, using that definition of parity bits, 12:12:21

5  am I correct that the output of an RA encoder, the   12:12:28

6  code word output by an RA encoder like that shown in 12:12:36

7  Figure 3 would include parity bits?                  12:12:41

8  A.       In this case, if that's your definition,    12:12:42

9  you would say that actually all the output bits are  12:12:44

10  parity bits, using the particular definition that I  12:12:48

11  mentioned.                                           12:12:50

12  Q.       Okay.  Now, are you familiar with --        12:12:52

13  withdrawn.                                           12:12:52

14           Are you familiar with systematic codes?    12:13:02

15  A.       Yes.                                        12:13:08

16  Q.       What is a systematic code?                  12:13:08

17  A.       A systematic code would be a code in which  12:13:10

18  the actual data that is to be encoded in an          12:13:14

19  unaltered form appears as part of the code word.     12:13:19

20  Q.       So in a systematic code, the code word      12:13:23

21  includes both the original information bits and the  12:13:26

22  parity bits, correct?                                12:13:30

23  A.       Indeed, it -- it includes the original      12:13:35

24  bits plus some additional bits which one might       12:13:38

25  characterize as parity bits.                         12:13:42

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| | | |
|---|---|---|
| 1 | Q. Okay. And systematic codes were known | 12:13:43 |
| 2 | before 1998, right? | 12:13:46 |
| 3 | A. In principle you can take a code -- you | 12:13:49 |
| 4 | know, this depends now very much on the world in -- | 12:13:52 |
| 5 | in the turbo coding world -- | 12:13:52 |
| 6 | THE REPORTER: What? | 12:13:58 |
| 7 | THE WITNESS: Sorry. Okay. In the turbo | 12:13:58 |
| 8 | code world, this distinction between systematic and | 12:14:00 |
| 9 | parity bits is a very natural one, because the | 12:14:05 |
| 10 | viewpoint is one of an actual encoder in which the | 12:14:07 |
| 11 | bits are being taken. The bits are being | 12:14:13 |
| 12 | transformed in some way and then these bits are | 12:14:15 |
| 13 | being output and perhaps there's a direct branch in | 12:14:18 |
| 14 | which the information bits are also seen. | 12:14:21 |
| 15 | So there's a very natural representation | 12:14:23 |
| 16 | between information bits or the actual systematic | 12:14:26 |
| 17 | bits and the parity bits. | 12:14:29 |
| 18 | Q. Okay. | 12:14:30 |
| 19 | A. But if you look at the world of LDPC codes | 12:14:30 |
| 20 | and you look at a standard representation, like a | 12:14:35 |
| 21 | Gallagher representation, there's no a priori notion | 12:14:38 |
| 22 | unless you do something specific which of the bits | 12:14:42 |
| 23 | would be parity bits or systematic bits. | 12:14:45 |
| 24 | MR. DOWD: Let's mark as Exhibit 7 a copy | 12:14:48 |
| 25 | of the Figure 3. | 12:14:51 |

| | | |
|---|---|---|
| 1 | Q. Actually, before I do that, you mentioned | 12:14:57 |
| 2 | in your explanation that there might be a direct | 12:15:00 |
| 3 | branch of the original information bits; do you | 12:15:03 |
| 4 | recall that? | 12:15:05 |
| 5 | A. So -- so one way of indicating in a | 12:15:05 |
| 6 | systems point of view that they're systematic bits | 12:15:09 |
| 7 | would be to draw a direct line from the input to the | 12:15:13 |
| 8 | output. | 12:15:16 |
| 9 | MR. DOWD: Okay. So let me show you what | 12:15:16 |
| 10 | I've created as Exhibit 7, please. | 12:15:18 |
| 11 | (Urbanke Exhibit 7 was marked for | 12:15:21 |
| 12 | identification and attached to the | 12:15:21 |
| 13 | transcript.) | 12:15:50 |
| 14 | BY MR. DOWD: | 12:15:50 |
| 15 | Q. Do you have Exhibit 7? | 12:15:51 |
| 16 | A. Yes. | 12:15:52 |
| 17 | Q. Do you see what I've added is a direct | 12:15:52 |
| 18 | branch from the original information bits to the | 12:15:55 |
| 19 | output? | 12:15:57 |
| 20 | A. Yes. | 12:15:57 |
| 21 | Q. That's shown in red? | 12:15:58 |
| 22 | A. Yes. | 12:15:59 |
| 23 | Q. And if I wanted to make the RA encoder of | 12:16:00 |
| 24 | Figure 3 a systematic code, Exhibit 7 shows how to | 12:16:06 |
| 25 | do that, right? | 12:16:10 |

| | | |
|---|---|---|
| 1 | MR. GLASS: Objection. Vague. Outside | 12:16:12 |
| 2 | the scope. | 12:16:14 |
| 3 | THE WITNESS: That might be one of the | 12:16:14 |
| 4 | ways of creating a systematic code. | 12:16:15 |
| 5 | BY MR. DOWD: | 12:16:19 |
| 6 | Q. Okay. And a person of ordinary skill in | 12:16:19 |
| 7 | the field in 1998 or 1999 would have known how to do | 12:16:22 |
| 8 | what I've shown in Exhibit 7, right? | 12:16:26 |
| 9 | MR. GLASS: Objection. Vague. Outside | 12:16:28 |
| 10 | the scope. | 12:16:30 |
| 11 | THE WITNESS: As I mentioned, there are | 12:16:30 |
| 12 | many ways of taking a code word. And if you're | 12:16:33 |
| 13 | actually having a code which is defined as a set of | 12:16:37 |
| 14 | code words, there's no a priori definition of what | 12:16:40 |
| 15 | systematic bits and the parity bits are. | 12:16:44 |
| 16 | So even though in this representation the | 12:16:45 |
| 17 | output bits in your original presentation in | 12:16:48 |
| 18 | Figure 3, in the paper we talked about, the output | 12:16:51 |
| 19 | bits in some interpretation can naturally be defined | 12:16:55 |
| 20 | as parity bits. | 12:17:01 |
| 21 | You might very well go back and decide | 12:17:01 |
| 22 | that some of these bits are actually information | 12:17:04 |
| 23 | bits and some are parity bits and even make a | 12:17:07 |
| 24 | definition from a nonsystematic code as to one and | 12:17:10 |
| 25 | revert it to a systematic one in a very different | 12:17:15 |

| | | |
|---|---|---|
| 1 | way from what you have drawn here.  So there's one | 12:17:18 |
| 2 | way to do it as it's drawn here, but that's | 12:17:18 |
| 3 | not -- | 12:17:18 |
| 4 | THE REPORTER:  Wait.  Slow down.  Slow | 12:17:18 |
| 5 | down.  Start again with: | 12:17:18 |
| 6 | "So there's one way" -- | 12:17:25 |
| 7 | THE WITNESS:  So there's one way to do it | 12:17:25 |
| 8 | and that's the way you show it.  But that's not | 12:17:27 |
| 9 | necessarily the only way you can create a systematic | 12:17:29 |
| 10 | code. | 12:17:32 |
| 11 | BY MR. DOWD: | 12:17:33 |
| 12 | Q.        Fair enough.  Let's -- let's break that | 12:17:33 |
| 13 | down, though, a little bit. | 12:17:34 |
| 14 | Understanding there may be other ways that | 12:17:35 |
| 15 | you could implement Divsalar Figure 3 as a | 12:17:39 |
| 16 | systematic code, one way to do that would be the way | 12:17:43 |
| 17 | shown in Exhibit 7, correct? | 12:17:45 |
| 18 | MR. GLASS:  Objection.  Outside the scope | 12:17:47 |
| 19 | of the expert report. | 12:17:48 |
| 20 | THE WITNESS:  You could create a | 12:17:50 |
| 21 | systematic code in that way, yes. | 12:17:52 |
| 22 | BY MR. DOWD: | 12:17:54 |
| 23 | Q.        Okay. | 12:17:55 |
| 24 | MR. DOWD:  And let's mark as Exhibit 8 a | 12:17:55 |
| 25 | further kind of refinement of what that would look | 12:18:03 |

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| | | |
|---|---|---|
| 1 | like. | 12:18:06 |
| 2 | (Urbanke Exhibit 8 was marked for | 12:18:07 |
| 3 | identification and attached to the | 12:18:07 |
| 4 | transcript.) | 12:18:07 |
| 5 | BY MR. DOWD: | 12:18:07 |
| 6 | Q. So do you have Exhibit 8? | 12:18:31 |
| 7 | A. Yes. | 12:18:33 |
| 8 | Q. And so in Exhibit 8, I'm -- the only thing | 12:18:33 |
| 9 | I'm really adding is showing what the code word is | 12:18:36 |
| 10 | at the bottom. Can we agree that Exhibit 8 shows | 12:18:41 |
| 11 | one way that you could create a systematic code word | 12:18:45 |
| 12 | from the Figure 3 RA code? | 12:18:49 |
| 13 | MR. GLASS: Outside the scope of the | 12:18:52 |
| 14 | expert report. | 12:18:54 |
| 15 | THE WITNESS: So what this figure -- | 12:18:58 |
| 16 | there's some interpretation of this figure that | 12:19:00 |
| 17 | might show a systematic code. | 12:19:03 |
| 18 | BY MR. DOWD: | 12:19:03 |
| 19 | Q. Okay. And so you've got the direct branch | 12:19:05 |
| 20 | from the original information bits shown in red, | 12:19:08 |
| 21 | contributing N information bits to the code word; do | 12:19:12 |
| 22 | you see that? | 12:19:16 |
| 23 | A. I see N information bits appearing | 12:19:16 |
| 24 | somewhere -- | 12:19:19 |
| 25 | Q. And -- | 12:19:19 |

| | | |
|---|---|---|
| 1 | A.        -- and labeled: | 12:19:20 |
| 2 | "N information bits." | 12:19:21 |
| 3 | Q.        Right.  And then you've got the qN parity | 12:19:22 |
| 4 | bits from the output of the accumulator, and they're | 12:19:26 |
| 5 | contributing those qN parity bits to the code word; | 12:19:32 |
| 6 | do you see that there? | 12:19:37 |
| 7 | A.        I see a gray box labeled:  "Parity bits," | 12:19:37 |
| 8 | yes. | 12:19:41 |
| 9 | Q.        Okay.  And am I correct that Exhibit 8 | 12:19:41 |
| 10 | shows one way in which you could implement the RA | 12:19:44 |
| 11 | code of Figure 3 as a systematic code? | 12:19:47 |
| 12 | MR. GLASS:  Objection.  Outside the scope | 12:19:50 |
| 13 | of the expert report. | 12:19:51 |
| 14 | THE WITNESS:  If you wanted to create a | 12:19:52 |
| 15 | systematic RA code, that might be one of the ways | 12:19:59 |
| 16 | that you could do it. | 12:20:02 |
| 17 | BY MR. DOWD: | 12:20:03 |
| 18 | Q.        Okay.  And that would have been within the | 12:20:03 |
| 19 | skill -- within the toolbox of a person working in | 12:20:06 |
| 20 | this field in 1998, correct? | 12:20:10 |
| 21 | MR. GLASS:  Objection.  Vague.  And | 12:20:11 |
| 22 | outside the scope of the expert report. | 12:20:12 |
| 23 | THE WITNESS:  I don't have formed a | 12:20:14 |
| 24 | particular opinion on that. | 12:20:19 |
| 25 | /// | |

| | | |
|---|---|---|
| 1 | BY MR. DOWD: | 12:20:21 |
| 2 | Q.        What -- what is your best understanding? | 12:20:21 |
| 3 | MR. GLASS:  Same objection. | 12:20:23 |
| 4 | THE WITNESS:  I don't know.  I have not | 12:20:23 |
| 5 | studied -- | 12:20:23 |
| 6 | THE REPORTER:  Wait.  Wait.  Wait.  You | 12:20:23 |
| 7 | have to hold on. | 12:20:23 |
| 8 | Objection, please? | 12:20:27 |
| 9 | MR. GLASS:  Same objection.  Outside the | 12:20:27 |
| 10 | scope. | 12:20:30 |
| 11 | THE WITNESS:  I have not been asked to | 12:20:30 |
| 12 | form an opinion in my expert report and I'd rather | 12:20:33 |
| 13 | not do this in an ad hoc fashion. | 12:20:37 |
| 14 | BY MR. DOWD: | 12:20:40 |
| 15 | Q.        If you asked a Ph.D. in information theory | 12:20:40 |
| 16 | with two- to three-years' experience in encoding as | 12:20:43 |
| 17 | of 1999, I'd like you to implement the RA code of | 12:20:48 |
| 18 | Figure 3 as a systematic code, that person would be | 12:20:53 |
| 19 | able to create what we have here on Exhibit 8, | 12:20:56 |
| 20 | correct? | 12:21:00 |
| 21 | MR. GLASS:  Same objection. | 12:21:00 |
| 22 | THE WITNESS:  That person might be able to | 12:21:00 |
| 23 | create a systematic code.  Whether or not it would | 12:21:03 |
| 24 | look like that is anyone's guess. | 12:21:05 |
| 25 | /// | |

| | | |
|---|---|---|
| 1 | BY MR. DOWD: | 12:21:08 |
| 2 | Q.          Okay.  But one of the -- one of the ways | 12:21:08 |
| 3 | you could implement exhibit -- withdrawn. | 12:21:10 |
| 4 |          One of the ways you could implement | 12:21:12 |
| 5 | Figure 3 as a systematic code is as shown in | 12:21:15 |
| 6 | Exhibit 8, right? | 12:21:18 |
| 7 |          MR. GLASS:  Same objection.  Outside the | 12:21:18 |
| 8 | scope. | 12:21:20 |
| 9 |          THE WITNESS:  That might be true that that | 12:21:20 |
| 10 | is one of the ways that you could create a | 12:21:24 |
| 11 | systematic code might have been related to the | 12:21:26 |
| 12 | figure that you've shown me. | 12:21:29 |
| 13 |          MR. DOWD:  Let's mark as Exhibit 9 a copy | 12:21:52 |
| 14 | of the Luby '97 reference. | 12:21:54 |
| 15 |               (Urbanke Exhibit 9 was marked for | 12:21:57 |
| 16 |               identification and attached to the | 12:21:57 |
| 17 |               transcript.) | 12:22:21 |
| 18 |          (Discussion off the record.) | 12:22:21 |
| 19 | BY MR. DOWD: | 12:22:22 |
| 20 | Q.          Do you have Exhibit 9? | 12:22:27 |
| 21 | A.          Yes. | 12:22:28 |
| 22 | Q.          Did you recognize it? | 12:22:28 |
| 23 | A.          Yes.  It appears to be the Luby '97 paper. | 12:22:30 |
| 24 | Q.          Okay.  If you could, turn to Page 152. | 12:22:34 |
| 25 | A.          Yes. | 12:22:45 |

| | | | |
|---|---|---|---|
| 1 | Q. | And there's a heading there: | 12:22:45 |
| 2 | | "Terminology?" | 12:22:47 |
| 3 | | Do you see that? | 12:22:49 |
| 4 | A. | Yes. | 12:22:50 |
| 5 | Q. | The second sentence reads: | 12:22:50 |
| 6 | | "In a systematic code, the transmitted | 12:22:53 |
| 7 | | symbols can be divided into message | 12:22:56 |
| 8 | | symbols and check symbols." | 12:22:58 |
| 9 | | Do you see that? | 12:22:59 |
| 10 | A. | Yes. | 12:23:00 |
| 11 | Q. | And if we compare that to Exhibit 8, the | 12:23:02 |
| 12 | | code word at the bottom has both message symbols, | 12:23:09 |
| 13 | | which would be the information bits, and check | 12:23:17 |
| 14 | | symbols, which would be the parity bits, right? | 12:23:21 |
| 15 | | MR. GLASS: Objection. Vague. Outside | 12:23:23 |
| 16 | | the scope. | 12:23:25 |
| 17 | | THE WITNESS: Yeah, I don't know what he | 12:23:25 |
| 18 | | has defined here as message symbols and check | 12:23:31 |
| 19 | | symbols. | 12:23:34 |
| 20 | BY MR. DOWD: | | 12:23:35 |
| 21 | Q. | So when you read Luby, you didn't know | 12:23:35 |
| 22 | | what a message symbol was? | 12:23:38 |
| 23 | A. | There might be a specific definition what | 12:23:40 |
| 24 | | he defines here as a message and check symbol. The | 12:23:42 |
| 25 | | main scope of this paper is not systematic versus | 12:23:46 |

| | | |
|---|---|---|
| 1 | nonsystematic.  The main scope of this paper is to | 12:23:51 |
| 2 | come up with coding schemes that are linear time | 12:23:51 |
| 3 | encodable and linear time -- | 12:23:51 |
| 4 | THE REPORTER:  Wait.  Hold on.  You've got | 12:23:51 |
| 5 | to slow down.  I just can't keep up with you.  Okay? | 12:24:00 |
| 6 | THE WITNESS:  Sorry.  The main scope of | 12:24:00 |
| 7 | that paper is to define as coding is come up with a | 12:24:01 |
| 8 | coding scheme that is linear time encodable, linear | 12:24:05 |
| 9 | time decodable and to come up with a particular | 12:24:10 |
| 10 | analysis for how these various components could be | 12:24:16 |
| 11 | chosen. | 12:24:18 |
| 12 | What they came up with is a scheme that | 12:24:20 |
| 13 | resembles a hierarchical scheme component that look | 12:24:24 |
| 14 | like LDPC components but are much more complicated. | 12:24:28 |
| 15 | That's what the main scope of the paper is about. | 12:24:33 |
| 16 | MR. DOWD:  Move to strike as | 12:24:36 |
| 17 | nonresponsive. | 12:24:38 |
| 18 | BY MR. DOWD; | 12:24:38 |
| 19 | Q.      My question, sir, is -- | 12:24:38 |
| 20 | MR. GLASS:  Objection to that -- that | 12:24:38 |
| 21 | motion. | 12:24:40 |
| 22 | BY MR. DOWD: | 12:24:41 |
| 23 | Q.      When you read Luby, did you know what Luby | 12:24:42 |
| 24 | meant by "message symbols"? | 12:24:45 |
| 25 | A.      There is some interpretation in which I | 12:24:47 |

| | | |
|---|---|---|
| 1 | can assume what he means on this thing by "message | 12:24:51 |
| 2 | symbols," yes. | 12:24:53 |
| 3 | Q.      What do you understand Luby to mean by | 12:24:53 |
| 4 | "message symbols"? | 12:24:56 |
| 5 | A.      A -- one possible interpretation is that | 12:24:57 |
| 6 | these are symbols that represent the data. | 12:25:00 |
| 7 | Q.      And by "the data," you're referring to | 12:25:02 |
| 8 | information bits to be encoded? | 12:25:06 |
| 9 | A.      Yes. | 12:25:08 |
| 10 | Q.      And what did you understand Luby to mean | 12:25:08 |
| 11 | by "check symbols"? | 12:25:11 |
| 12 | A.      One possible interpretation is that these | 12:25:13 |
| 13 | are parity check symbols. | 12:25:16 |
| 14 | Q.      Okay.  And so the check symbols would be | 12:25:19 |
| 15 | the -- like the parity bits that we've been | 12:25:22 |
| 16 | discussing, right? | 12:25:24 |
| 17 |          MR. GLASS:  Outside the scope. | 12:25:25 |
| 18 |          THE WITNESS:  They could be these symbols. | 12:25:27 |
| 19 | BY MR. DOWD: | 12:25:29 |
| 20 | Q.      Okay.  Now, Luby is in 1997, right? | 12:25:29 |
| 21 | A.      Yes, that's correct. | 12:25:33 |
| 22 | Q.      And that's the year before Divsalar in | 12:25:35 |
| 23 | 1998, right? | 12:25:39 |
| 24 | A.      That is correct. | 12:25:42 |
| 25 | Q.      So before Divsalar people knew about | 12:25:42 |

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| | | |
|---|---|---|
| 1 | systematic codes, right? | 12:25:45 |
| 2 | A.          Certainly a definition of systematic code | 12:25:46 |
| 3 | was known beforehand, yes. | 12:25:48 |
| 4 | Q.          And they knew that you could produce a | 12:25:50 |
| 5 | code word that had information bits followed by | 12:25:55 |
| 6 | parity bits, right? | 12:25:58 |
| 7 | A.          That is correct. | 12:25:59 |
| 8 | Q.          And so if somebody looking at the Divsalar | 12:26:02 |
| 9 | Figure 3 wanted to implement it as a systematic code | 12:26:07 |
| 10 | as described on Page 152 of Luby '97, one way to do | 12:26:11 |
| 11 | that is shown in Exhibit 8. | 12:26:19 |
| 12 | A.          Sorry.  Can you please repeat the last | 12:26:21 |
| 13 | sentence? | 12:26:25 |
| 14 | Q.          Yeah, sure.  Let me do it a step at a | 12:26:25 |
| 15 | time. | 12:26:28 |
| 16 |           If somebody looking at the Divsalar | 12:26:28 |
| 17 | Figure 3 wanted to implement it as a systematic code | 12:26:30 |
| 18 | as described on Page 152 of Luby '97, one way to do | 12:26:33 |
| 19 | so is shown in Exhibit 8, correct? | 12:26:39 |
| 20 |           MR. GLASS:  Objection.  Outside the scope. | 12:26:42 |
| 21 |           THE WITNESS:  If we take a definition of | 12:26:44 |
| 22 | systematic code that has -- that is my understanding | 12:26:50 |
| 23 | of systematic codes but that does not refer | 12:26:53 |
| 24 | particularly to the Luby one, then this picture that | 12:26:56 |
| 25 | you drew might be one way of, perhaps, getting to a | 12:27:00 |

| | | |
|---|---|---|
| 1 | systematic code. | 12:27:04 |
| 2 | BY MR. DOWD: | 12:27:05 |
| 3 | Q.      Okay. | 12:27:05 |
| 4 | A.      Now, whether or not in Luby he has exactly | 12:27:05 |
| 5 | the same definition or exactly the same objective, | 12:27:09 |
| 6 | that I would have to study further. | 12:27:13 |
| 7 | Q.      Okay.  We'll -- we'll come back to that | 12:27:14 |
| 8 | piece. | 12:27:17 |
| 9 | MR. DOWD:  Why don't we take that lunch | 12:27:25 |
| 10 | break; I'm about to move to something new. | 12:27:27 |
| 11 | MR. GLASS:  Sure. | 12:27:30 |
| 12 | THE VIDEOGRAPHER:  Going off the record. | 12:27:31 |
| 13 | The time is 12:27 p.m. | 12:27:32 |
| 14 | (Lunch recess taken at 12:27 p.m.) | 12:27:34 |
| 15 | THE VIDEOGRAPHER:  We are back on the | 01:18:00 |
| 16 | record.  The time is 1:18 p.m. | 01:18:02 |
| 17 | BY MR. DOWD: | 01:18:07 |
| 18 | Q.      Before the break we talked about how an | 01:18:08 |
| 19 | accumulator operates by combining bits; do you | 01:18:10 |
| 20 | recall that? | 01:18:13 |
| 21 | A.      Exactly. | 01:18:13 |
| 22 | Q.      What is the difference between how an | 01:18:15 |
| 23 | accumulator operates and how a repeater operates? | 01:18:17 |
| 24 | A.      An accumulator adds information or adds | 01:18:20 |
| 25 | bits or adds numbers.  A repeater repeats bits. | 01:18:23 |

| | | |
|---|---|---|
| 1 | Q. And what does that mean? | 01:18:31 |
| 2 | A. It might in one version prior | 01:18:33 |
| 3 | copy-and-paste or it might reuse bits, you know, in | 01:18:38 |
| 4 | a number of times, whatever the factor is that the | 01:18:41 |
| 5 | repetition claims. | 01:18:46 |
| 6 | Q. Okay. Are you familiar with Tanner | 01:18:58 |
| 7 | graphs? | 01:19:01 |
| 8 | A. Yes. | 01:19:02 |
| 9 | MR. DOWD: Let me show you what's been | 01:19:17 |
| 10 | marked as Exhibit 10, a copy of a Tanner graph. | 01:19:18 |
| 11 | (Urbanke Exhibit 10 was marked for | 01:19:26 |
| 12 | identification and attached to the | 01:19:26 |
| 13 | transcript.) | 01:19:27 |
| 14 | BY MR. DOWD: | 01:19:27 |
| 15 | Q. Do you have Exhibit 10? | 01:19:27 |
| 16 | A. Yes, thank you. | 01:19:28 |
| 17 | Q. Exhibit 10 is the Tanner graph for a | 01:19:29 |
| 18 | regular repeat-accumulate code, correct? | 01:19:35 |
| 19 | A. Yes. These days, in 2015, that would be | 01:19:38 |
| 20 | how we interpret that. | 01:19:40 |
| 21 | Q. Okay. Now, if I wanted to make this an | 01:19:43 |
| 22 | irregular repeat, one way to do that would be to add | 01:19:48 |
| 23 | an additional edge from one of the information nodes | 01:19:55 |
| 24 | at the top down to the random permutation box, | 01:20:02 |
| 25 | right? | 01:20:06 |

| | | |
|---|---|---|
| 1 | MR. GLASS: Objection. Outside the scope. | 01:20:06 |
| 2 | THE WITNESS: There are many ways of | 01:20:07 |
| 3 | taking a code and making it irregular. What you | 01:20:09 |
| 4 | claim is one particular way. | 01:20:11 |
| 5 | But there is a very, very large number of | 01:20:13 |
| 6 | ways of making a code irregular. | 01:20:16 |
| 7 | MR. DOWD: Okay. So let me show you what | 01:20:19 |
| 8 | I'll mark as Exhibit 11. | 01:20:22 |
| 9 | (Urbanke Exhibit 11 was marked for | 01:20:35 |
| 10 | identification and attached to the | 01:20:35 |
| 11 | transcript.) | 01:20:40 |
| 12 | BY MR. DOWD: | 01:20:40 |
| 13 | Q. Do you have Exhibit 11? | 01:20:40 |
| 14 | A. Yes. | 01:20:42 |
| 15 | Q. And do you see that what I've done between | 01:20:44 |
| 16 | Exhibit 10 and Exhibit 11 is I've added one line in | 01:20:49 |
| 17 | red at the top right. Do you see that? | 01:20:52 |
| 18 | A. That is correct. | 01:20:55 |
| 19 | Q. And that -- the addition of that | 01:20:56 |
| 20 | additional edge makes Exhibit 11 an irregular | 01:20:59 |
| 21 | repeat-accumulate code, correct? | 01:21:05 |
| 22 | MR. GLASS: That's outside the scope. | 01:21:06 |
| 23 | THE WITNESS: Let me first remark that | 01:21:07 |
| 24 | that code is extremely small and that adding a | 01:21:09 |
| 25 | single edge to any code would not have any | 01:21:13 |

| | | |
|---|---|---|
| 1 | noticeable performance difference.  So it means you | 01:21:15 |
| 2 | might do that in -- perhaps in some particular | 01:21:18 |
| 3 | version of definition you might be able to interpret | 01:21:20 |
| 4 | it as irregular, but it would have no effect on the | 01:21:22 |
| 5 | actual performance of the code. | 01:21:25 |
| 6 | BY MR. DOWD: | 01:21:27 |
| 7 | Q.        Okay.  So I wanted to break that down.  I | 01:21:27 |
| 8 | was going to come to the performance difference in a | 01:21:27 |
| 9 | moment, but -- | 01:21:27 |
| 10 | THE REPORTER:  Slow down, again.  Start | 01:21:27 |
| 11 | over. | 01:21:30 |
| 12 | BY MR. DOWD: | 01:21:30 |
| 13 | Q.        Let's break that down.  I'll come to the | 01:21:31 |
| 14 | performance difference between the two in a moment. | 01:21:35 |
| 15 | But just as a matter of first principles, the | 01:21:38 |
| 16 | addition of the additional edge at the top right | 01:21:42 |
| 17 | shown in red makes the code of Exhibit 11 an | 01:21:46 |
| 18 | irregular repeat-accumulate code, correct? | 01:21:50 |
| 19 | MR. GLASS:  Same objection. | 01:21:53 |
| 20 | THE WITNESS:  It's a particular version of | 01:21:54 |
| 21 | making it irregular out of a very large number of | 01:21:56 |
| 22 | ways of making it irregular. | 01:21:59 |
| 23 | BY MR. DOWD: | 01:22:01 |
| 24 | Q.        Okay.  Now, the code of Exhibit 11, | 01:22:01 |
| 25 | because it's an irregular repeat-accumulate code, | 01:22:15 |

| | | |
|---|---|---|
| 1 | that would be covered by the claims of the asserted | 01:22:18 |
| 2 | patents, right? | 01:22:22 |
| 3 |      MR. GLASS: Objection. Outside the scope. | 01:22:22 |
| 4 | Calls -- calls for a legal conclusion. | 01:22:23 |
| 5 |      THE WITNESS: I did not study the patents | 01:22:25 |
| 6 | or the claims or how they relate to the papers in | 01:22:27 |
| 7 | here. | 01:22:29 |
| 8 | BY MR. DOWD: | 01:22:30 |
| 9 | Q.     Okay. So you -- you can't tell me one way | 01:22:30 |
| 10 | or the other? | 01:22:34 |
| 11 | A.     No. | 01:22:34 |
| 12 | Q.     The irregular repeat-accumulate code of | 01:22:35 |
| 13 | Exhibit 11, that would be an IRA code as you have | 01:22:39 |
| 14 | described it in your report, correct? | 01:22:46 |
| 15 | A.     You're saying what is -- what is shown in | 01:22:50 |
| 16 | Exhibit 11, that that would be -- qualify as an IRA | 01:22:53 |
| 17 | code that is irregular? | 01:22:57 |
| 18 | Q.     Yes, that's my question. | 01:22:58 |
| 19 | A.     That is the question? | 01:22:59 |
| 20 |      Yes, but just to repeat, if you take a | 01:23:02 |
| 21 | code -- first of all, this code is a ridiculously | 01:23:07 |
| 22 | small code, it's a toy example so it would not be of | 01:23:09 |
| 23 | any practical use. | 01:23:12 |
| 24 |      And in, you know, in any real application | 01:23:14 |
| 25 | in any -- and -- and to get any benefit, this would | 01:23:18 |

| | | |
|---|---|---|
| 1 | not be something that is usable in an actual world | 01:23:21 |
| 2 | because what you have to do is you have to actually | 01:23:25 |
| 3 | change a fraction of the bits to make them | 01:23:29 |
| 4 | irregular. Otherwise, it's simply a -- you know, a | 01:23:32 |
| 5 | mathematical coincidence, perhaps, that you can call | 01:23:35 |
| 6 | that item as irregular depending on how exactly that | 01:23:40 |
| 7 | the definition is -- | 01:23:44 |
| 8 | THE REPORTER: Wait. Hold on. | 01:23:44 |
| 9 | "...you can call that item..." | 01:23:44 |
| 10 | Start there and slow down. | 01:23:52 |
| 11 | THE WITNESS: If you could just please | 01:23:52 |
| 12 | read back to me. | 01:23:52 |
| 13 | THE REPORTER: | 01:23:52 |
| 14 | "...a mathematical coincidence, | 01:23:35 |
| 15 | perhaps, that you can call that item..." | 01:23:38 |
| 16 | THE WITNESS: That item, an irregular | 01:23:53 |
| 17 | repeat-accumulate code, depending on how your | 01:23:55 |
| 18 | definition is set. But it would have no difference | 01:23:58 |
| 19 | and could act in essentially exactly the same as a | 01:24:01 |
| 20 | regular accumulate code. | 01:24:04 |
| 21 | BY MR. DOWD: | 01:24:07 |
| 22 | Q. Okay. So let's take that step by step. | 01:24:07 |
| 23 | The code that we have as Exhibit 11, that | 01:24:09 |
| 24 | code -- the performance of that code would not | 01:24:14 |
| 25 | approach the Shannon limit, correct? | 01:24:18 |

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| | | |
|---|---|---|
| 1 | A.       For several reasons it would not even get | 01:24:20 |
| 2 | close.  Number one, it's a code that has extremely | 01:24:23 |
| 3 | small length.  So a code that has such short length | 01:24:26 |
| 4 | could not approach the Shannon limit. | 01:24:30 |
| 5 |          Number two, it has essentially no | 01:24:32 |
| 6 | irregularity. | 01:24:34 |
| 7 | Q.       Well, it does have one irregularity, | 01:24:34 |
| 8 | right? | 01:24:39 |
| 9 | A.       If that's your definition, "irregularity," | 01:24:39 |
| 10 | even the regular IRA code is already irregular. | 01:24:41 |
| 11 | Q.       Well, you testified a moment ago that | 01:24:45 |
| 12 | Exhibit 11 is an irregular repeat-accumulate code, | 01:24:47 |
| 13 | right? | 01:24:51 |
| 14 | A.       That is true according to some definition. | 01:24:51 |
| 15 | I just claimed that even -- | 01:24:53 |
| 16 | Q.       Okay. | 01:24:53 |
| 17 | A.       -- Exhibit 10 might also qualify as an | 01:24:55 |
| 18 | irregular one. | 01:24:58 |
| 19 | Q.       Okay.  Well, in Exhibit 10 all of the | 01:24:59 |
| 20 | information nodes are repeated the same number of | 01:25:02 |
| 21 | times. | 01:25:04 |
| 22 | A.       That's not the definition of -- | 01:25:04 |
| 23 |          THE REPORTER:  Wait.  Wait.  You cut him | 01:25:04 |
| 24 | off at the end.  Please wait for him to finish. | 01:25:04 |
| 25 |          THE WITNESS:  Sorry. | 01:25:10 |

| | | |
|---|---|---|
| 1 | BY MR. DOWD: | 01:25:10 |
| 2 | Q. So my question is, in Exhibit 10, all of | 01:25:10 |
| 3 | the information bits are repeated the same number of | 01:25:15 |
| 4 | times, correct? | 01:25:17 |
| 5 | A. That is correct. But that's not -- | 01:25:18 |
| 6 | Q. Okay. | 01:25:20 |
| 7 | A. That is not the definition of an irregular | 01:25:21 |
| 8 | code. | 01:25:23 |
| 9 | Q. Well, let's take it a step at a time. | 01:25:23 |
| 10 | You're answering questions that I haven't asked. | 01:25:26 |
| 11 | In Exhibit 11, some number of information | 01:25:29 |
| 12 | nodes have a degree sequence three and one has a | 01:25:37 |
| 13 | degree sequence four, right? | 01:25:42 |
| 14 | A. That is correct. | 01:25:43 |
| 15 | Q. Okay. Now, the performance of some IRA | 01:25:45 |
| 16 | codes is better than other IRA codes, right? | 01:25:53 |
| 17 | A. That is correct. | 01:25:56 |
| 18 | Q. And Exhibit 11 is an example of a poorly | 01:25:56 |
| 19 | performing IRA code, right? | 01:26:00 |
| 20 | A. That I don't know. I have not checked it | 01:26:02 |
| 21 | out. I don't know whether this code performance | 01:26:04 |
| 22 | good or well. Depends -- you have to make sure that | 01:26:07 |
| 23 | the code is corresponding to its length and not | |
| 24 | corresponding to -- | |
| 25 | THE REPORTER: Wait. Slow down. | |

1    "You have to..."

2        Start there.

3        THE WITNESS:  I cannot assert that.  It    01:26:14

4   depends on your definition of what a -- a bad code    01:26:16

5   is.  Clearly, the code is very short, so it will    01:26:20

6   never be an absolute scale it could code.  But if    01:26:23

7   you compare it to the shortest length, I don't know    01:26:27

8   how good this code could be.    01:26:30

9   BY MR. DOWD:    01:26:32

10  Q.        Okay.    01:26:32

11  A.        You cannot say that without closer    01:26:32

12  analysis.    01:26:35

13  Q.        Well, can we agree that the patents cover    01:26:35

14  bad IRA codes as well as they do good IRA codes?    01:26:38

15        MR. GLASS:  Objection.  Outside the scope    01:26:42

16  of the expert report.  Calls for a legal conclusion.    01:26:43

17        THE WITNESS:  That I don't know.  I've not    01:26:45

18  studied the patents.    01:26:47

19  BY MR. DOWD:    01:26:47

20  Q.        You can't tell me one way or the other?    01:26:48

21  A.        No.    01:26:50

22  Q.        Okay.    01:26:54

23        MR. DOWD:  Let's mark as Exhibit 12    01:27:04

24  another copy of what I had previously marked as    01:27:07

25  Exhibit 10, but I'm going to make one change.    01:27:10

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| | | |
|---|---|---|
| 1 | (Urbanke Exhibit 12 was marked for | 01:27:13 |
| 2 | identification and attached to the | 01:27:13 |
| 3 | transcript.) | 01:27:45 |
| 4 | BY MR. DOWD: | 01:27:45 |
| 5 | Q.        Do you have Exhibit 12? | 01:27:45 |
| 6 | A.        Yes. | 01:27:46 |
| 7 | Q.        And let me explain what I'm intending by | 01:27:46 |
| 8 | the change that I just made. | 01:27:49 |
| 9 | Now, instead of only having one of the | 01:27:50 |
| 10 | information nodes repeated four and all the rest | 01:27:54 |
| 11 | three, now one-half of the information nodes are | 01:27:57 |
| 12 | degree three, the other half are degree four. | 01:28:04 |
| 13 | A.        I understand. | 01:28:07 |
| 14 | Q.        And you can have any number of information | 01:28:07 |
| 15 | nodes so you can get it long. | 01:28:09 |
| 16 | A.        I understand. | 01:28:12 |
| 17 | Q.        Exhibit 12 is an IRA code, right? | 01:28:14 |
| 18 | A.        Yes, I agree. | 01:28:17 |
| 19 | Q.        It's an IRA code as you would describe it | 01:28:19 |
| 20 | in your report, right? | 01:28:22 |
| 21 | A.        Yes, I agree. | 01:28:23 |
| 22 | Q.        And this IRA code would have a fine | 01:28:24 |
| 23 | performance, right? | 01:28:28 |
| 24 | MR. GLASS:  Objection.  Vague. | 01:28:30 |
| 25 | THE WITNESS:  I don't know.  This is not | 01:28:31 |

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| | | |
|---|---|---|
| 1 | possible to tell simply from looking at a graph. | 01:28:32 |
| 2 | BY MR. DOWD: | 01:28:35 |
| 3 | Q.        Okay.  This IRA code in Exhibit 12 would | 01:28:36 |
| 4 | be within the scope of the claims of the patent, | 01:28:39 |
| 5 | correct? | 01:28:41 |
| 6 | MR. GLASS:  Objection.  Outside the scope | 01:28:41 |
| 7 | of the expert report.  Calls for a legal conclusion. | 01:28:43 |
| 8 | Go ahead. | 01:28:45 |
| 9 | THE WITNESS:  I have not -- as I mentioned | 01:28:46 |
| 10 | before, I have not looked at the actual patent | 01:28:48 |
| 11 | claims.  So I cannot determine this. | 01:28:52 |
| 12 | BY MR. DOWD: | 01:28:54 |
| 13 | Q.        Okay.  But the change to get from an RA | 01:28:54 |
| 14 | code of Exhibit 10 to the IRA code of Exhibit 12 is | 01:29:01 |
| 15 | you allow for any number of information nodes and | 01:29:06 |
| 16 | you divide them into two groups, one with a first | 01:29:10 |
| 17 | degree sequence, the other with a different degree | 01:29:14 |
| 18 | sequence, right? | 01:29:18 |
| 19 | MR. GLASS:  Objection.  Vague. | 01:29:18 |
| 20 | THE WITNESS:  This is your construction. | 01:29:19 |
| 21 | So it's your definition. | 01:29:20 |
| 22 | BY MR. DOWD: | 01:29:22 |
| 23 | Q.        Okay.  But if I -- if I make those changes | 01:29:22 |
| 24 | and none other, that gets me an IRA code, right? | 01:29:25 |
| 25 | A.        As I mentioned, Exhibit 10 already shows | 01:29:29 |

| # | | Time |
|---|---|------|
| 1 | an IRA code. | 01:29:31 |
| 2 | Q. Well -- | 01:29:31 |
| 3 | A. With your definition. | 01:29:33 |
| 4 | Q. Can you tell me how it is that you | 01:29:35 |
| 5 | testified when I first showed you Exhibit 10 that it | 01:29:38 |
| 6 | was an RA code? | 01:29:41 |
| 7 | A. It is an RA code, but it can also be -- | 01:29:41 |
| 8 | with your definition of what irregularity means, | 01:29:45 |
| 9 | it's also already an irregular code. | 01:29:47 |
| 10 | Q. Why is that? | 01:29:50 |
| 11 | A. Because the nodes on the bottom have not | 01:29:51 |
| 12 | the same degree sequence than the nodes on the top. | 01:29:53 |
| 13 | Q. The nodes on the bottom do not have the | 01:29:56 |
| 14 | same degree sequence? | 01:29:58 |
| 15 | A. They have degree two versus on top have | 01:29:59 |
| 16 | degree three. | 01:30:03 |
| 17 | Q. Why is that? | 01:30:03 |
| 18 | A. That's how it is drawn. | 01:30:04 |
| 19 | Q. Where do you see the degree two to the -- | 01:30:05 |
| 20 | you're talking about the black nodes at the bottom? | 01:30:07 |
| 21 | A. No, I'm talking about the black circular | 01:30:10 |
| 22 | but white inside nodes on the bottom. | 01:30:13 |
| 23 | Q. Okay. So the very bottom nodes? | 01:30:15 |
| 24 | A. Exactly. | 01:30:18 |
| 25 | Q. Okay. Let me ask you this. | 01:30:19 |

| | | |
|---|---|---|
| 1 | A. But let me also mention that these are | 01:30:36 |
| 2 | irregular, according to definition, but they're not | 01:30:39 |
| 3 | irregular repeat codes. So your definition simply | 01:30:42 |
| 4 | doesn't imply repetition. Your definition of | 01:30:45 |
| 5 | irregularity has nothing to do with repetition. | 01:30:48 |
| 6 | Q. Well, what I mean to say is, is Exhibit 10 | 01:30:50 |
| 7 | an irregular repeat-accumulate code? | 01:30:54 |
| 8 | A. That is true. But according to the expert | 01:30:56 |
| 9 | report of Dr. Frey to which I respond, the | 01:31:02 |
| 10 | definition of irregularity that he uses is not one | 01:31:05 |
| 11 | that was commonly used and is not one that, you | 01:31:08 |
| 12 | know, is the standard definition of irregularity in | 01:31:10 |
| 13 | the realm of Tanner graph or LDPC codes. | 01:31:13 |
| 14 | Q. Well, let me ask you this, in Exhibit 10 | 01:31:18 |
| 15 | you agree that the repetition is regular, not | 01:31:21 |
| 16 | irregular? | 01:31:24 |
| 17 | A. If you're talking about repetitions, yes. | 01:31:25 |
| 18 | Q. Okay. And let's focus on irregular | 01:31:29 |
| 19 | repeat-accumulate codes where it's the repetition | 01:31:32 |
| 20 | step that is irregular, okay? | 01:31:34 |
| 21 | A. This is not the definition that's used in | 01:31:39 |
| 22 | the expert report. | 01:31:41 |
| 23 | Q. Whether that's what Dr. Frey meant or not, | 01:31:42 |
| 24 | can you have that in mind? | 01:31:46 |
| 25 | A. I -- my reaction is to whatever the expert | 01:31:47 |

| | | |
|---|---|---|
| 1 | report is, that's what I was asked to react, and my | 01:31:50 |
| 2 | claim is that the definition of irregularity in | 01:31:55 |
| 3 | there used is not the correct definition. It's not | 01:31:57 |
| 4 | the definition that was used in time. | 01:32:00 |
| 5 | It's a definition that's perhaps suitable | 01:32:01 |
| 6 | for the particular purpose of showing whatever he | 01:32:04 |
| 7 | wanted to show. But it's not a valid definition. | 01:32:07 |
| 8 | Q. What's the definition that's correct? | 01:32:09 |
| 9 | A. The standard definition in a round of LDPC | 01:32:11 |
| 10 | codes is the definition that a regular code would be | 01:32:14 |
| 11 | one in which all the variable nodes would be -- | 01:32:23 |
| 12 | THE REPORTER: Wait. I'm sorry. | 01:32:23 |
| 13 | "A regular code"? | 01:32:23 |
| 14 | THE WITNESS: A regular code would be one | 01:32:26 |
| 15 | in which all the nodes would have one particular | 01:32:28 |
| 16 | degree and all the check nodes would have one | 01:32:30 |
| 17 | particular degree. | 01:32:30 |
| 18 | BY MR. DOWD: | 01:32:30 |
| 19 | Q. And do those degrees have to be the same? | 01:32:30 |
| 20 | A. No. | 01:32:33 |
| 21 | MR. DOWD: Okay. So why don't we -- why | 01:32:48 |
| 22 | don't we do this, first let's mark as Exhibit 13 | 01:32:50 |
| 23 | a -- another Tanner graph. | 01:33:12 |
| 24 | /// | |
| 25 | /// | |

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| | | |
|---|---|---|
| 1 | (Urbanke Exhibit 13 was marked for | 01:33:16 |
| 2 | identification and attached to the | 01:33:16 |
| 3 | transcript.) | 01:33:22 |
| 4 | BY MR. DOWD: | 01:33:23 |
| 5 | Q.      Do you have Exhibit 13? | 01:33:24 |
| 6 | A.      Yes. | 01:33:25 |
| 7 | Q.      Is Exhibit 13 using your understanding of | 01:33:25 |
| 8 | what a -- an irregular repeat-accumulate code is for | 01:33:33 |
| 9 | purposes of this case?  Is it -- is Exhibit 13 an | 01:33:35 |
| 10 | IRA code or an RA code? | 01:33:41 |
| 11 | A.      Exhibit 13, if I see this correctly, and | 01:33:45 |
| 12 | all the -- so simply seeing that itself, okay, would | 01:33:50 |
| 13 | require a lot of interpretation.  It's not obvious | 01:33:54 |
| 14 | from the pictures, so let me just explain a little | 01:33:57 |
| 15 | bit.  I'm not trying to nitpick here but explain | 01:34:00 |
| 16 | why. | 01:34:02 |
| 17 | Q.      Sure. | 01:34:04 |
| 18 | A.      Standard way of representing RA codes at | 01:34:05 |
| 19 | the time was not that picture.  So to getting from | 01:34:08 |
| 20 | the original representation, a representation | 01:34:08 |
| 21 | that -- | 01:34:11 |
| 22 | THE REPORTER:  Wait.  Wait.  We're going | 01:34:14 |
| 23 | to start again, and you're going to go slower this | 01:34:14 |
| 24 | time. | 01:34:15 |
| 25 | THE WITNESS:  The standard representation | 01:34:15 |

| | | |
|---|---|---|
| 1 | of RA codes at that time is not according to this | 01:34:17 |
| 2 | picture.  The standard representation of RA codes at | 01:34:21 |
| 3 | that time used the system's point of view, the one | 01:34:25 |
| 4 | that we had talked about beforehand in Exhibit 6 -- | 01:34:28 |
| 5 | no, 7, I believe, and 8. | 01:34:35 |
| 6 | BY MR. DOWD: | 01:34:38 |
| 7 | Q.        So if it I can just pause there to | 01:34:38 |
| 8 | understand the difference you're drawing. | 01:34:40 |
| 9 | You're saying that at the time you would | 01:34:42 |
| 10 | use a figure like Figure 3 of Divsalar, not a Tanner | 01:34:44 |
| 11 | graph like what I've marked as Exhibit 13? | 01:34:47 |
| 12 | A.        Exactly.  Yes. | 01:34:50 |
| 13 | Q.        Okay.  With that, setting that aside, is | 01:34:52 |
| 14 | Exhibit 13 a regular or irregular repeat-accumulate | 01:34:56 |
| 15 | code? | 01:34:59 |
| 16 | A.        So if you'd just allow me a little bit to | 01:35:00 |
| 17 | elaborate on the point. | 01:35:04 |
| 18 | Whether or not that corresponds to an IRA | 01:35:06 |
| 19 | code, it's one interpretation that it could be an RA | 01:35:09 |
| 20 | code or IRA code.  But there are many other possible | 01:35:12 |
| 21 | representations in the realm of LDPC codes.  So this | 01:35:15 |
| 22 | is not one particular code. | 01:35:18 |
| 23 | What it requires would be a certain | 01:35:19 |
| 24 | interpretation of what these nodes actually mean. | 01:35:22 |
| 25 | So, for example, it would require that I interpret | 01:35:24 |

| | | |
|---|---|---|
| 1 | the top nodes as information bits and the bottom | 01:35:26 |
| 2 | nodes as parity bits, but this is not actually on | 01:35:30 |
| 3 | the figure. | 01:35:33 |
| 4 | Q.        Okay. | 01:35:33 |
| 5 | A.        No one tells me that that is. | 01:35:33 |
| 6 | Q.        Assume that that's true, assume that in | 01:35:36 |
| 7 | each of the figures that I've handed you, like from | 01:35:38 |
| 8 | Exhibit 10 through 13, the top open circles are | 01:35:43 |
| 9 | information nodes, the bottom open circles are -- | 01:35:46 |
| 10 | let me make sure I have it right -- parity nodes, | 01:36:00 |
| 11 | and the filled in circles in between are check | 01:36:13 |
| 12 | nodes, okay? | 01:36:16 |
| 13 | A.        Yes. | 01:36:18 |
| 14 | Q.        So with that, in Exhibit 13, is this an | 01:36:19 |
| 15 | irregular repeat-accumulate code or a regular | 01:36:27 |
| 16 | repeat-accumulate code? | 01:36:30 |
| 17 | A.        So just to make sure.  This requires a lot | 01:36:32 |
| 18 | of interpretation.  So more than half the terms | 01:36:35 |
| 19 | that, you know, require me to give you an answer are | 01:36:38 |
| 20 | actually not on that picture.  So, you know, with | 01:36:40 |
| 21 | this kind of interpretation, with these Luby | 01:36:45 |
| 22 | interpretation, I could claim that this is quite a | 01:36:49 |
| 23 | few different code structures.  I could claim, for | 01:36:51 |
| 24 | example, it was an LDPC code if you allow me to | 01:36:55 |
| 25 | interpret the various nodes in a particular way. | 01:36:57 |

| | | |
|---|---|---|
| 1 | And there might be many other codes that I | 01:36:59 |
| 2 | can interpret like this. So there is one particular | 01:37:02 |
| 3 | way that I can interpret this -- | 01:37:02 |
| 4 | THE REPORTER: Hold on. Slow down. Start | 01:37:02 |
| 5 | again. | 01:37:08 |
| 6 | THE WITNESS: There is -- there is a way | 01:37:08 |
| 7 | that I can interpret that as an RA code, but it | 01:37:09 |
| 8 | requires many, many jumps from the original | 01:37:12 |
| 9 | representation. It would require me to know that | 01:37:15 |
| 10 | the original system's point of view can be connected | 01:37:19 |
| 11 | or can be represented in this way. It would require | 01:37:21 |
| 12 | me to understand what the roles of the various nodes | 01:37:24 |
| 13 | are, and it would require to understand exactly what | 01:37:28 |
| 14 | the relationship between the two are. | 01:37:32 |
| 15 | These are fairly giant steps to be done in | 01:37:34 |
| 16 | order to come to this interpretation. And if you | 01:37:38 |
| 17 | allow me that degrees of freedom, there are many, | 01:37:40 |
| 18 | many interpretations I can give you of this picture. | 01:37:43 |
| 19 | MR. DOWD: Well, why don't we set | 01:37:46 |
| 20 | Exhibit 13 aside, and we can go back to Exhibit -- | 01:37:49 |
| 21 | Exhibits 10 and 12, okay. | 01:37:51 |
| 22 | Q. And I'd like to, for the purposes of the | 01:37:59 |
| 23 | next series of questions, just assume that in order | 01:38:03 |
| 24 | to be an irregular repeat-accumulate code, the | 01:38:06 |
| 25 | repetition has to be -- you have to have different | 01:38:12 |

| | | |
|---|---|---|
| 1 | degrees for different subsets of bits, okay? | 01:38:15 |
| 2 | A.        Sure. | 01:38:19 |
| 3 | Q.        Under -- under that understanding, we can | 01:38:20 |
| 4 | agree that Exhibit 10 is regular, right? | 01:38:24 |
| 5 | A.        So with an additional -- with the | 01:38:27 |
| 6 | additional interpretation of what these nodes | 01:38:31 |
| 7 | actually mean, that the top nodes would be -- would | 01:38:33 |
| 8 | have to be interpreted as information bits, that the | 01:38:37 |
| 9 | black nodes would have to be interpreted as parity | 01:38:41 |
| 10 | bits, and that the bottom bits would have to be | 01:38:44 |
| 11 | interpreted as parity -- sort of parity checks, and | 01:38:47 |
| 12 | the bottom one as parity bits.  Then a valid | 01:38:51 |
| 13 | interpretation of that graph would be of an RA code. | 01:38:55 |
| 14 | Q.        And if we go to Exhibit 12, to change | 01:38:58 |
| 15 | Exhibit 10 to an irregular repeat-accumulate code, | 01:39:07 |
| 16 | you would simply make half of the information nodes | 01:39:11 |
| 17 | have a different degree than the other half, right? | 01:39:17 |
| 18 | A.        It depends what your definition of | 01:39:20 |
| 19 | irregular RA code is.  If your definition is what | 01:39:22 |
| 20 | the expert, Dr. Frey, was irregularity -- | 01:39:26 |
| 21 | THE REPORTER:  Wait.  Wait. | 01:39:29 |
| 22 | "...what the expert..." | 01:39:29 |
| 23 | Slow down, please. | 01:39:29 |
| 24 | THE WITNESS:  If the definition is | 01:39:31 |
| 25 | according to what, you know, Dr. Frey said, into -- | 01:39:32 |

| | | |
|---|---|---|
| 1 | a very particular definition of irregularity which | 01:39:37 |
| 2 | is not the standard definition so that you have very | 01:39:41 |
| 3 | strict restrictions of how you have to interpret | 01:39:43 |
| 4 | those nodes, then you could interpret that has an RA | 01:39:45 |
| 5 | code. | 01:39:48 |
| 6 | But if you didn't have that in place, | 01:39:48 |
| 7 | there would be many ways to interpret that. | 01:39:52 |
| 8 | BY MR. DOWD: | 01:39:54 |
| 9 | Q. Okay. Before I began this set of | 01:39:54 |
| 10 | questions, I said: Assume with me that for these | 01:39:56 |
| 11 | questions an irregular repeat-accumulate code, the | 01:40:00 |
| 12 | irregular is of the repetition, okay? Do you recall | 01:40:06 |
| 13 | that? | 01:40:09 |
| 14 | A. Uh-huh. | 01:40:09 |
| 15 | Q. So with that in mind, Exhibit 12 shows | 01:40:10 |
| 16 | what you need to do to make an RA code an IRA code, | 01:40:14 |
| 17 | right? | 01:40:23 |
| 18 | A. It shows that if you assume that you have | 01:40:23 |
| 19 | Picture 10, that you interpret that as an RA Code, | 01:40:26 |
| 20 | which is not the standard, you know, definition at | 01:40:29 |
| 21 | the time, and it's not the standard view. It's the | 01:40:31 |
| 22 | view now, in 2015, in hindsight, you can interpret | 01:40:34 |
| 23 | going from Picture 10 to Picture 12 in adding these | 01:40:38 |
| 24 | irregularity, I agree. | 01:40:42 |
| 25 | Q. Okay. Okay. Now, I think you've just | 01:40:44 |

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| | | |
|---|---|---|
| 1 | been getting at this, but if we turn to your report | 01:41:19 |
| 2 | at Paragraph 152.  Just let me know when you have | 01:41:22 |
| 3 | that. | 01:41:28 |
| 4 | A.      Yes. | 01:41:34 |
| 5 | Q.      Now, there you say that: | 01:41:34 |
| 6 | "Turbo codes and LDPC codes were | 01:41:37 |
| 7 | described using very different language | 01:41:40 |
| 8 | and representations prior to the | 01:41:41 |
| 9 | invention." | 01:41:43 |
| 10 | Do you see that there? | 01:41:44 |
| 11 | A.      Yes. | 01:41:45 |
| 12 | Q.      And then if we go back to Paragraph 28, | 01:41:45 |
| 13 | you're describing different groups of researchers | 01:41:59 |
| 14 | working on codes.  You say there's a traditional | 01:42:05 |
| 15 | coding theorist's group and a group of researchers | 01:42:08 |
| 16 | with computer science, physics, and mathematics | 01:42:11 |
| 17 | backgrounds, right? | 01:42:15 |
| 18 | A.      Yes. | 01:42:16 |
| 19 | Q.      And then you say in Paragraph 29 that: | 01:42:16 |
| 20 | "Although these researchers all had a | 01:42:21 |
| 21 | common goal, different groups branched off | 01:42:24 |
| 22 | in different directions and there was not | 01:42:26 |
| 23 | much interaction between these different | 01:42:28 |
| 24 | research branches." | 01:42:31 |
| 25 | Right? | 01:42:34 |

1  A.      Yes.                                      01:42:34

2  Q.      Did you base the opinions expressed in   01:42:35

3  your report on the belief that a researcher in one  01:42:40

4  of these groups would have been unaware of the   01:42:43

5  publications from researchers in the other group?  01:42:46

6  A.      It's much more than unaware of           01:42:51

7  application.  You have to imagine that the way these  01:42:55

8  papers were written, they were written in an     01:42:57

9  entirely different language.                     01:43:00

10         So even though, perhaps, you know, you   01:43:01

11  would have one sentence that expresses exactly the  01:43:05

12  same facts, there might not be a single word that  01:43:08

13  actually is common, you know, in these sentences.  01:43:10

14         So it's essentially as if you came in a  01:43:13

15  room where you would have people of all kinds of  01:43:16

16  languages.  They might all have a similar aim in  01:43:19

17  mind and they might all talk about -- at the end  01:43:22

18  about the same aim, about the same kind of objects.  01:43:25

19         But if someone speaks Spanish, the second  01:43:28

20  person speaks, let's say, Chinese, and the first one  01:43:32

21  speaks German, it is quite difficult to actually do  01:43:36

22  the translation.                                 01:43:40

23         So this is not just something whether or  01:43:40

24  not you have something in -- you know, in front of  01:43:43

25  you.  But it would be very difficult to interpret  01:43:45

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| | | |
|---|---|---|
| 1 | whatever you have seen in your language seeing | 01:43:48 |
| 2 | something in a different language. | 01:43:50 |
| 3 | MR. DOWD: Okay. Let's -- let's break | 01:43:53 |
| 4 | that down because I'm going to move to strike as | 01:43:53 |
| 5 | nonresponsive. | 01:43:57 |
| 6 | MR. GLASS: And object if you do move to | 01:43:58 |
| 7 | strike. | 01:44:00 |
| 8 | BY MR. DOWD: | 01:44:01 |
| 9 | Q. My question was, is it your -- withdrawn. | 01:44:02 |
| 10 | Did you base the opinions in your report | 01:44:06 |
| 11 | on a belief that the researcher in one group would | 01:44:08 |
| 12 | not have known about the publication of a researcher | 01:44:11 |
| 13 | in another group? | 01:44:15 |
| 14 | A. No. | 01:44:17 |
| 15 | Q. Okay. All of Divsalar, Luby '97, | 01:44:18 |
| 16 | Luby '98, Richardson '99, the Frey '99 paper, they | 01:44:22 |
| 17 | were all actually written in the English language, | 01:44:30 |
| 18 | right? | 01:44:32 |
| 19 | A. English is language that was actually used | 01:44:32 |
| 20 | to express it. | 01:44:35 |
| 21 | Q. Okay. | 01:44:36 |
| 22 | A. But the -- no, this is not the same thing. | 01:44:36 |
| 23 | You -- I can give you easily examples of a sentence | 01:44:39 |
| 24 | where one in the same sentence would express exactly | 01:44:43 |
| 25 | the same thing and they might share essentially no | 01:44:46 |

| | | |
|---|---|---|
| 1 | words. | 01:44:49 |
| 2 | Q. And is it your position that a Ph.D. in | 01:44:50 |
| 3 | this field with two to three years of experience | 01:44:57 |
| 4 | with error correction codes would be unable to | 01:44:59 |
| 5 | understand what was said in one of these papers if | 01:45:04 |
| 6 | it was published by a person of an opposite group? | 01:45:07 |
| 7 | A. I can tell you that studying in 1999, | 01:45:12 |
| 8 | 2000, we had a sequence of workshops trying exactly | 01:45:17 |
| 9 | to bring these kind of groups together. It has | 01:45:21 |
| 10 | taken essentially about 10 years until people in the | 01:45:25 |
| 11 | various groups can comfortably talk to each other. | 01:45:28 |
| 12 | So this is not a trivial effort that is undertaking. | 01:45:31 |
| 13 | It's not something -- imagine like learning another | 01:45:35 |
| 14 | language. | 01:45:37 |
| 15 | You know, perhaps some people are more | 01:45:37 |
| 16 | gifted, some people are less gifted, but it's not a | 01:45:40 |
| 17 | trivial effort of simply plugging in something and | 01:45:44 |
| 18 | simply having a dictionary or something like that. | 01:45:46 |
| 19 | It's a serious effort that is required. | 01:45:49 |
| 20 | Q. My question is, is it your position that a | 01:45:51 |
| 21 | traditional coding theorist reading a publication | 01:45:56 |
| 22 | such as Luby which came from the computer science | 01:46:00 |
| 23 | group would not be able to understand what Luby was | 01:46:03 |
| 24 | saying? | 01:46:05 |
| 25 | A. It's my position that to start with a | 01:46:05 |

| | | |
|---|---|---|
| 1 | person in coding theory would have not even been | 01:46:07 |
| 2 | able to judge at that point whatever was written in | 01:46:13 |
| 3 | Luby was actually of interest to him or her. | 01:46:16 |
| 4 | Because the way things were represented | 01:46:19 |
| 5 | were so different that, you know, the -- the kind of | 01:46:21 |
| 6 | objective, if they were done, the standard pictures | 01:46:24 |
| 7 | that were done to prove that these things were good | 01:46:28 |
| 8 | were so different that it was far from obvious that | 01:46:32 |
| 9 | whatever was written in this paper was relevant to | 01:46:34 |
| 10 | potentially their problem. | 01:46:37 |
| 11 | Q.      Well, my question is not would they have | 01:46:39 |
| 12 | been able to judge whether it was of interest or | 01:46:46 |
| 13 | whether it was good. | 01:46:48 |
| 14 | My question is, if they read the words in | 01:46:49 |
| 15 | English, would they be able to understand what the | 01:46:53 |
| 16 | words meant? | 01:46:55 |
| 17 | A.      They might have to read several papers to | 01:46:58 |
| 18 | understand them.  They might have to go back to, you | 01:47:01 |
| 19 | know, other literature to understand, perhaps, what | 01:47:05 |
| 20 | is written in there. | 01:47:07 |
| 21 | Q.      Okay.  But they could read the English | 01:47:08 |
| 22 | language and they could understand what it meant, | 01:47:11 |
| 23 | correct? | 01:47:15 |
| 24 | A.      If a physicist, for example, talks about a | 01:47:15 |
| 25 | long code, he's talking about -- you know, in a | 01:47:18 |

| | | |
|---|---|---|
| 1 | completely different way. Now, you know, this is a | 01:47:22 |
| 2 | single word that he's using, we are using, let's | 01:47:26 |
| 3 | say, a symptotic, right, they -- | 01:47:26 |
| 4 | THE REPORTER: Wait. | 01:47:26 |
| 5 | "We are using..." | 01:47:41 |
| 6 | THE WITNESS: For example, in our -- in | 01:47:41 |
| 7 | EE, people would be talking about the symptotic | |
| 8 | limit. Physicists would talk -- | |
| 9 | THE REPORTER: Wait. Wait. I'm -- I'm | |
| 10 | not understanding you. You're going to have to slow | |
| 11 | down and repeat yourself, please. | |
| 12 | THE WITNESS: For example, to give you one | 01:47:43 |
| 13 | trivial example, if people in E talking about long | 01:47:44 |
| 14 | codes, they were talking about, let's say, a | 01:47:47 |
| 15 | symptotically long codes, a physicist would be | 01:47:50 |
| 16 | talking about the thermodynamic limit. It's far | 01:47:53 |
| 17 | from obvious that these two things even relate to | 01:47:57 |
| 18 | each other. And you would need a person to get | 01:48:00 |
| 19 | started to tell you which of these terms indeed at | 01:48:02 |
| 20 | first relate to each other in order to get started. | 01:48:07 |
| 21 | I'm not claiming that it is impossible to | 01:48:09 |
| 22 | learn. People have learned it. But it is a serious | 01:48:11 |
| 23 | effort to do and it's by far not obvious to do. | 01:48:14 |
| 24 | MR. DOWD: Let's mark as Exhibit 14, a | 01:48:33 |
| 25 | copy of the thesis of Dr. Khandekar. | 01:48:36 |

| | | |
|---|---|---|
| 1 | (Urbanke Exhibit 14 was marked for | 01:48:42 |
| 2 | identification and attached to the | 01:48:42 |
| 3 | transcript.) | 01:48:53 |
| 4 | BY MR. DOWD: | 01:48:53 |
| 5 | Q. Do you have Exhibit 14? | 01:48:53 |
| 6 | A. Yes. | 01:48:54 |
| 7 | Q. Do you recognize it? | 01:48:55 |
| 8 | A. It says: | 01:48:57 |
| 9 | "Graph-based Codes in Iterative | 01:48:58 |
| 10 | Decoding, Theis by Aamod Khandekar." | 01:49:00 |
| 11 | Q. So Exhibit 14 is the Ph.D. thesis that | 01:49:03 |
| 12 | Dr. Khandekar submitted, right? | 01:49:09 |
| 13 | A. That's what it says on the page. | 01:49:11 |
| 14 | Q. Have you reviewed Dr. Khandekar's thesis | 01:49:13 |
| 15 | before? | 01:49:16 |
| 16 | A. I must have leafed through it but not in | 01:49:17 |
| 17 | any detail. | 01:49:20 |
| 18 | Q. Now, before Dr. Khandekar had been awarded | 01:49:21 |
| 19 | his Ph.D.; in other words, at the time he was | 01:49:29 |
| 20 | writing this document, he did not have a Ph.D., | 01:49:31 |
| 21 | right? | 01:49:36 |
| 22 | A. Presumably not. | 01:49:36 |
| 23 | Q. He had not been working in the field for | 01:49:44 |
| 24 | two to three years, right? | 01:49:46 |
| 25 | A. I don't know exactly his employment | 01:49:48 |

| | | |
|---|---|---|
| 1 | history.  I don't know how long he actually studied. | 01:49:50 |
| 2 | He might have very well started on a master's level. | 01:49:52 |
| 3 | Q.       Turn to Page 3311.  Now, on this page, | 01:49:56 |
| 4 | Dr. Khandekar shows a -- an example of the | 01:50:13 |
| 5 | repeat-accumulate codes introduced in 15; do you see | 01:50:27 |
| 6 | that? | 01:50:31 |
| 7 | A.       I see a picture, yes. | 01:50:31 |
| 8 | Q.       And there's a representation of a | 01:50:33 |
| 9 | repeat-accumulate code like the one we saw in | 01:50:39 |
| 10 | Figure 3 of Divsalar, right? | 01:50:41 |
| 11 | A.       The figure heading says:  "A small Tanner | 01:50:42 |
| 12 | graph." | 01:50:42 |
| 13 | THE REPORTER:  Wait.  I'm sorry, I didn't | 01:50:42 |
| 14 | hear that part.  Please repeat. | 01:50:46 |
| 15 | THE WITNESS:  The figure heading says:  "A | 01:50:46 |
| 16 | small Tanner graph." | 01:50:48 |
| 17 | BY MR. DOWD: | 01:50:49 |
| 18 | Q.       You're on Page 3311? | 01:50:49 |
| 19 | A.       Oh, sorry, 3312, sorry.  Okay. | 01:50:51 |
| 20 | Q.       So on Page 3311 there's Figure 1.4, a | 01:50:56 |
| 21 | repeat-accumulate code, right? | 01:51:01 |
| 22 | A.       Figure -- you're talking about Figure 13? | 01:51:02 |
| 23 | Q.       1.4 in the middle of the page. | 01:51:05 |
| 24 | A.       1.4, the heading says:  "A | 01:51:08 |
| 25 | repeat-accumulate code."  Yes. | 01:51:12 |

| | | | |
|---|---|---|---|
| 1 | Q. | And in the paragraph right above that he | 01:51:12 |
| 2 | says: | | 01:51:15 |
| 3 | | "One example of the SCCC case is the | 01:51:16 |
| 4 | | ensemble of repeat-accumulate (RA) codes | 01:51:20 |
| 5 | | introduced in 15." | 01:51:25 |
| 6 | | Right? | 01:51:26 |
| 7 | A. | I see that, yes. | 01:51:27 |
| 8 | Q. | And if you turn to Page 3400, near the | 01:51:28 |
| 9 | back. | | 01:51:37 |
| 10 | A. | Yes. | 01:51:44 |
| 11 | Q. | We see that Reference 15 is the Divsalar | 01:51:45 |
| 12 | 1998 RA codes paper that we've been discussing, | | 01:51:48 |
| 13 | right? | | 01:51:54 |
| 14 | A. | Okay. | 01:51:54 |
| 15 | Q. | Do you see that there? | 01:51:55 |
| 16 | A. | I see Reference Number 15, yes. | 01:51:56 |
| 17 | Q. | And that's the Divsalar RA codes paper, | 01:51:58 |
| 18 | right? | | 01:52:02 |
| 19 | A. | Yes. | 01:52:02 |
| 20 | Q. | So Dr. Khandekar was aware of the Divsalar | 01:52:04 |
| 21 | RA codes paper, right? | | 01:52:08 |
| 22 | | MR. GLASS: Objection. Outside the scope. | 01:52:10 |
| 23 | | THE WITNESS: Dr. Khandekar, as far as I | 01:52:11 |
| 24 | know, was a Ph.D. student of Dr. -- or | | 01:52:14 |
| 25 | Professor MacKay. | | 01:52:20 |

| | | |
|---|---|---|
| 1 | BY MR. DOWD: | 01:52:20 |
| 2 | Q.        My question was, Dr. Khandekar, as | 01:52:20 |
| 3 | demonstrated by his thesis, he was aware of the | 01:52:24 |
| 4 | Divsalar paper, right? | 01:52:26 |
| 5 | MR. GLASS:  Same objection. | 01:52:28 |
| 6 | THE WITNESS:  It was a paper written by | 01:52:28 |
| 7 | his advisor. | 01:52:30 |
| 8 | BY MR. DOWD: | 01:52:32 |
| 9 | Q.        So he was aware of it, right? | 01:52:32 |
| 10 | MR. GLASS:  Same objection. | 01:52:34 |
| 11 | THE WITNESS:  A student is aware of a | 01:52:35 |
| 12 | paper by his advisor. | 01:52:37 |
| 13 | BY MR. DOWD: | 01:52:39 |
| 14 | Q.        Okay.  Now, if we go back to Page 3311, he | 01:52:40 |
| 15 | uses the Divsalar paper to explain the operation of | 01:52:48 |
| 16 | an RA code, right? | 01:52:50 |
| 17 | MR. GLASS:  Objection.  Beyond the scope | 01:52:51 |
| 18 | of the expert report. | 01:52:52 |
| 19 | THE WITNESS:  I don't know.  I have not | 01:52:53 |
| 20 | looked at that thesis in that detail and so I'm not | 01:52:54 |
| 21 | prepared to answer that. | 01:52:57 |
| 22 | BY MR. DOWD: | 01:52:57 |
| 23 | Q.        You can't say one way or the other? | 01:52:58 |
| 24 | A.        It is not what my expert report is about. | 01:53:00 |
| 25 | And so this thesis is not something that I reviewed | 01:53:02 |

| | | |
|---|---|---|
| 1 | in detail in accordance with my expert report. | 01:53:06 |
| 2 | Q.        Well, if we go to Page 3315, you see | 01:53:10 |
| 3 | there's a Figure 1.6? | 01:53:13 |
| 4 | A.        Yes. | 01:53:16 |
| 5 | Q.        And that figure is labeled:  "The Tanner | 01:53:18 |
| 6 | Graph of an RA Code."  Right? | 01:53:22 |
| 7 | A.        That is what the figure heading says. | 01:53:25 |
| 8 | Q.        And so at least Dr. Khandekar was aware | 01:53:29 |
| 9 | that the RA codes could be represented as Tanner | 01:53:34 |
| 10 | graphs, right? | 01:53:39 |
| 11 | MR. GLASS:  Same objection. | 01:53:39 |
| 12 | THE WITNESS:  As far as I read, the thesis | 01:53:40 |
| 13 | was published in 2002. | 01:53:42 |
| 14 | BY MR. DOWD: | 01:53:44 |
| 15 | Q.        My question is, Dr. Khandekar was aware | 01:53:44 |
| 16 | that RA codes could be represented as Tanner graphs, | 01:53:48 |
| 17 | right? | 01:53:52 |
| 18 | MR. GLASS:  Same objection. | 01:53:52 |
| 19 | THE WITNESS:  That's something I think you | 01:53:52 |
| 20 | would have to ask him.  And the only thing I know is | 01:53:53 |
| 21 | that the thesis was published in 2002. | 01:53:56 |
| 22 | BY MR. DOWD: | 01:54:00 |
| 23 | Q.        All right.  Well, let's go back to | 01:54:00 |
| 24 | Page 3293.  Do you have the abstract there? | 01:54:04 |
| 25 | A.        Yes. | 01:54:17 |

| | | | |
|---|---|---|---|
| 1 | Q. | Now, in the third paragraph, that | 01:54:18 |
| 2 | paragraph starts: | | 01:54:21 |
| 3 | | "We also introduce a new class of | 01:54:22 |
| 4 | | codes called irregular repeat-accumulate | 01:54:25 |
| 5 | | (IRA) codes which are adapted from the | 01:54:31 |
| 6 | | previously known class of | 01:54:35 |
| 7 | | repeat-accumulate codes." | 01:54:37 |
| 8 | | Do you see that? | 01:54:38 |
| 9 | A. | Yes. | 01:54:39 |
| 10 | Q. | And Dr. Khandekar is correct that IRA | 01:54:40 |
| 11 | codes are adapted from RA codes, right? | | 01:54:48 |
| 12 | A. | I don't know the history of how they came | 01:54:53 |
| 13 | about it; but if he says so, then I trust him. | | 01:54:55 |
| 14 | Q. | Okay.  So you have no reason to disagree | 01:54:59 |
| 15 | with that statement, right? | | 01:55:01 |
| 16 | A. | No. | 01:55:02 |
| 17 | Q. | And then he goes on, in the next sentence, | 01:55:03 |
| 18 | to describe irregular LDPC codes, which he says are: | | 01:55:07 |
| 19 | | Quote, arguably the best class of | 01:55:14 |
| 20 | | codes known today, at least for long | 01:55:16 |
| 21 | | locked lengths. | 01:55:20 |
| 22 | | Right? | 01:55:22 |
| 23 | A. | Yes, I see that sentence. | 01:55:22 |
| 24 | Q. | So Dr. Khandekar was also aware of | 01:55:24 |
| 25 | irregular LDPC codes, right? | | 01:55:29 |

| | | |
|---|---|---|
| 1 | MR. GLASS: Objection. Outside the scope. | 01:55:31 |
| 2 | THE WITNESS: That, I think, is best posed | 01:55:33 |
| 3 | to him. I wouldn't know. I know that, you know, | 01:55:35 |
| 4 | what I can see here, and I know the thesis is | 01:55:37 |
| 5 | titled -- is dated 2002. | 01:55:41 |
| 6 | BY MR. DOWD: | 01:55:42 |
| 7 | Q. Okay. Well, let's turn to Page 3354 -- | 01:55:42 |
| 8 | sorry, 3345. You see there's a Chapter 3 that | 01:55:57 |
| 9 | begins there on irregular repeat-accumulate codes? | 01:56:08 |
| 10 | A. Yes. | 01:56:12 |
| 11 | Q. And one of the first things that he talks | 01:56:13 |
| 12 | about in the middle of the second paragraph are | 01:56:15 |
| 13 | irregular LDPC codes by Luby, right? | 01:56:19 |
| 14 | A. I see a sentence there, yes. | 01:56:24 |
| 15 | Q. And the two references that he cites are | 01:56:26 |
| 16 | Luby '97 and Luby '98, right? | 01:56:30 |
| 17 | A. Let me check that. That seems to be | 01:56:32 |
| 18 | correct. | 01:56:46 |
| 19 | Q. So at least Dr. Khandekar thought that | 01:56:47 |
| 20 | Luby 7 -- '97 and Luby '98 were relevant to his | 01:56:52 |
| 21 | irregular repeat-accumulate codes, right? | 01:56:57 |
| 22 | MR. GLASS: Objection. Outside the scope | 01:56:59 |
| 23 | of the expert report. | 01:57:00 |
| 24 | THE WITNESS: I would not know what he | 01:57:01 |
| 25 | thought at that point in time. Again, this was in | 01:57:02 |

| | | |
|---|---|---|
| 1 | 2002.  What he thought, I think it's best to pose | 01:57:05 |
| 2 | the question to him. | 01:57:09 |
| 3 | BY MR. DOWD: | 01:57:11 |
| 4 | Q.        So you have no opinion on that? | 01:57:11 |
| 5 | A.        How would I know what he thought at that | 01:57:12 |
| 6 | time? | 01:57:15 |
| 7 | Q.        Well, in a Chapter 3 entitled:  "Irregular | 01:57:15 |
| 8 | Repeat Accumulate Codes," the first two cited | 01:57:18 |
| 9 | references are Luby '97 and Luby '98. | 01:57:21 |
| 10 | Do you see that? | 01:57:24 |
| 11 | A.        I see that. | 01:57:24 |
| 12 | Q.        And you can't tell me one way or the other | 01:57:25 |
| 13 | whether that indicates that Dr. Khandekar believed | 01:57:28 |
| 14 | Luby '97 and Luby '98 were relevant to irregular | 01:57:35 |
| 15 | repeat-accumulate codes? | 01:57:38 |
| 16 | A.        I have absolutely no idea, you know, what | 01:57:39 |
| 17 | his motivation were where to put it.  I have not | 01:57:41 |
| 18 | read the thesis in that detail.  I have not been | 01:57:44 |
| 19 | asked to make a -- you know, a detailed opinion | 01:57:47 |
| 20 | about this thing.  I think this is best posed the | 01:57:50 |
| 21 | question to him and that could -- he could clarify | 01:57:52 |
| 22 | the question, what was he thinking and at what point | 01:57:55 |
| 23 | was he thinking that. | 01:57:58 |
| 24 | Q.        Okay.  So respect to the question of how | 01:58:01 |
| 25 | Luby '97 and Luby '98 related to Dr. Khandekar's IRA | 01:58:06 |

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| | | |
|---|---|---|
| 1 | codes discussion, you can't help us answer that | 01:58:11 |
| 2 | question? | 01:58:13 |
| 3 | A.        I cannot help you in why exactly he put | 01:58:15 |
| 4 | that particular line at, you know, Line, let's say, | 01:58:18 |
| 5 | 10 in his thesis, Chapter 3, I don't know. | 01:58:22 |
| 6 | Q.        Okay.  So you do see that Dr. Luby | 01:58:26 |
| 7 | called -- I'm sorry -- withdrawn. | 01:58:31 |
| 8 |          You do see that Dr. Khandekar called | 01:58:35 |
| 9 | Luby '97 and '98 a, quote, major breakthrough, close | 01:58:39 |
| 10 | quote, right? | 01:58:43 |
| 11 | A.        Yes. | 01:58:43 |
| 12 | Q.        And it is true that Luby '97 and Luby '98 | 01:58:43 |
| 13 | were a major breakthrough, right? | 01:58:46 |
| 14 | A.        Luby '97 and Luby '98 brought the | 01:58:49 |
| 15 | state-of-the-art, the theoretical state-of-the-art | 01:58:53 |
| 16 | forward in terms of the analysis.  They were the | 01:58:56 |
| 17 | first ones for a very particular channel model, the | 01:59:01 |
| 18 | BC, which is very particular and what was not | 01:59:05 |
| 19 | thought about at that point in time to be relevant. | 01:59:10 |
| 20 | Only in hindsight did it turn out that it was to a | 01:59:13 |
| 21 | new state-of-the-art. | 01:59:17 |
| 22 | Q.        Well, Luby '97 and Luby '98 -- let's take | 01:59:19 |
| 23 | it a step at a time. | 01:59:23 |
| 24 |          Luby '97 and Luby '98 did advance the | 01:59:25 |
| 25 | state-of-the-art, correct? | 01:59:29 |

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| | | | |
|---|---|---|---|
| 1 | A. | Yes. | 01:59:32 |
| 2 | Q. | And in that sense they were a major | 01:59:32 |
| 3 | breakthrough, as Dr. Khandekar states here, right? | | 01:59:36 |
| 4 | A. | Both papers were theoretically very | 01:59:39 |
| 5 | important. | | 01:59:43 |
| 6 | Q. | Okay.  The next cited paper in this same | 01:59:43 |
| 7 | section on irregular repeat-accumulate codes is your | | 01:59:52 |
| 8 | Richardson '99 paper, right? | | 01:59:58 |
| 9 | A. | Let me check the reference, but I believe | 02:00:00 |
| 10 | yes.  Yes, that seems to be the case. | | 02:00:03 |
| 11 | Q. | And that is also a paper on irregular LDPC | 02:00:15 |
| 12 | codes, right? | | 02:00:24 |
| 13 | A. | Just to correct, you know, what I said, it | 02:00:24 |
| 14 | refers to the 2001 paper. | | 02:00:26 |
| 15 | Q. | I apologize.  So it refers to the 2001 | 02:00:28 |
| 16 | version? | | 02:00:31 |
| 17 | A. | Yes. | 02:00:32 |
| 18 | Q. | I see. | 02:00:32 |
| 19 | | But that paper, both in its 1999 preprint | 02:00:35 |
| 20 | version and in the 2001 version, relates to | | 02:00:42 |
| 21 | irregular LDPC codes, right? | | 02:00:46 |
| 22 | A. | It relates to irregular LDPC codes but has | 02:00:49 |
| 23 | some significant differences. | | 02:00:53 |
| 24 | Q. | Okay.  We'll get to those. | 02:00:54 |
| 25 | | Now, in your report you do not provide an | 02:01:22 |

| # | | Time |
|---|---|---|
| 1 | opinion on why Dr. Khandekar chose not to disclose | 02:01:24 |
| 2 | Luby '97, Luby '98, or Richardson '99 to the | 02:01:28 |
| 3 | Patent Office, right? | 02:01:31 |
| 4 | A.      No. | 02:01:32 |
| 5 | Q.      So that -- you've not performed any | 02:01:33 |
| 6 | opinion on that question? | 02:01:36 |
| 7 | A.      No.  I would have no idea. | 02:01:37 |
| 8 | Q.      Okay.  Now, is it your position that a | 02:01:41 |
| 9 | person of ordinary skill would not have considered | 02:01:49 |
| 10 | Divsalar, the two Luby references, and Richardson | 02:01:52 |
| 11 | 1999 together? | 02:01:56 |
| 12 | MR. GLASS:  Objection.  Vague. | 02:02:03 |
| 13 | Go ahead. | 02:02:04 |
| 14 | THE WITNESS:  If you could, perhaps, | 02:02:04 |
| 15 | please specify a little bit more what "together" | 02:02:06 |
| 16 | means. | 02:02:08 |
| 17 | BY MR. DOWD: | 02:02:09 |
| 18 | Q.      I mean, is it your position that -- well, | 02:02:11 |
| 19 | let's take them by groups. | 02:02:15 |
| 20 | A person of ordinary skill would not have | 02:02:16 |
| 21 | considered Divsalar -- the work of Divsalar and | 02:02:19 |
| 22 | the -- the Luby 1997 paper in the 1999 time frame? | 02:02:22 |
| 23 | MR. GLASS:  Objection.  Vague. | 02:02:29 |
| 24 | THE WITNESS:  So what I looked at in | 02:02:34 |
| 25 | particular in my report, are the Luby '97, Luby '98, | 02:02:37 |

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| | | |
|---|---|---|
| 1 | and the Richardson/Urbanke paper. | 02:02:42 |
| 2 | BY MR. DOWD: | 02:02:48 |
| 3 | Q.　　　　Okay. | 02:02:48 |
| 4 | A.　　　　These are the ones that I consider and | 02:02:48 |
| 5 | have my opinion on. | 02:02:52 |
| 6 | Q.　　　　Okay.　So with respect to what a person of | 02:02:53 |
| 7 | ordinary skill would understand from reading | 02:02:55 |
| 8 | Divsalar together with Luby '97, you've not provided | 02:02:59 |
| 9 | an opinion on that; is that correct? | 02:03:04 |
| 10 | A.　　　　I have -- you're talking about the | 02:03:07 |
| 11 | Divsalar '98 RA code paper? | 02:03:13 |
| 12 | Q.　　　　Yes. | 02:03:15 |
| 13 | A.　　　　And the second one was the Luby... | 02:03:16 |
| 14 | Q.　　　　'97. | 02:03:20 |
| 15 | A.　　　　I have a very small comment on Page 27 of | 02:04:19 |
| 16 | my report which relates to the Richardson '99 in | 02:04:22 |
| 17 | which I opinion that to use the technique that was | 02:04:31 |
| 18 | introduced in Richardson '99 to -- other than what | 02:04:37 |
| 19 | in '99 was actually considered in the paper, | 02:04:43 |
| 20 | low-density parity check codes -- to consider the | 02:04:50 |
| 21 | technique in the density evolution to schemes other | 02:04:53 |
| 22 | than low-density parity check codes, that at the | 02:04:58 |
| 23 | point of time that we -- or the time period that we | 02:05:02 |
| 24 | are talking about, that that had not been published | 02:05:03 |
| 25 | or done. | 02:05:07 |

| # | | | Time |
|---|---|---|---|
| 1 | | And I there refer in particular here to 12 | 02:05:08 |
| 2 | | where, you know, later on we get to the Divsalar | 02:05:14 |
| 3 | | paper.  But I'm sorry, I guess this was -- you were | 02:05:19 |
| 4 | | not referring to the Divsalar paper, 2001 paper, you | 02:05:21 |
| 5 | | were referring to the '98 paper, correct? | 02:05:25 |
| 6 | Q. | Correct. | 02:05:28 |
| 7 | A. | I'm sorry.  Okay.  So I... | 02:05:28 |
| 8 | | Sorry. | 02:05:29 |
| 9 | Q. | So let's just break that down. | 02:05:29 |
| 10 | | First, your testimony just now was talking | 02:05:32 |
| 11 | | about Paragraph 135 and the Footnote 12, right? | 02:05:33 |
| 12 | A. | Right. | 02:05:38 |
| 13 | Q. | Okay. | 02:05:38 |
| 14 | A. | But I'm -- | 02:05:39 |
| 15 | Q. | And let me give you my question again | 02:05:39 |
| 16 | | because I was -- | 02:05:41 |
| 17 | A. | Right. | 02:05:41 |
| 18 | Q. | -- asking a somewhat different question. | 02:05:42 |
| 19 | A. | Okay. | 02:05:44 |
| 20 | Q. | My question is, you have not offered an | 02:05:44 |
| 21 | | opinion about what a person of ordinary skill in the | 02:05:46 |
| 22 | | art would understand from reading the Divsalar '98 | 02:05:49 |
| 23 | | RA codes paper together with the Luby '97 paper, | 02:05:58 |
| 24 | | correct? | 02:06:04 |
| 25 | A. | There is, in my report, I believe no | 02:06:04 |

| | | |
|---|---|---|
| 1 | bigger section that talks about it. | 02:06:10 |
| 2 | Q.        Okay. | 02:06:13 |
| 3 | A.        I have to check now whether or not | 02:06:13 |
| 4 | somewhere I might mention in passing something, but | 02:06:16 |
| 5 | I don't believe so. | 02:06:19 |
| 6 | Q.        Okay.  And the same is true for Divsalar | 02:06:20 |
| 7 | plus Luby '98, right? | 02:06:23 |
| 8 | A.        Yes, I look at -- I look at the Luby '97, | 02:06:25 |
| 9 | Luby '98, and the -- the Richardson '99 paper. | 02:06:34 |
| 10 | Q.        And -- and my question is, there's no | 02:06:40 |
| 11 | opinion in your report about what a person of | 02:06:43 |
| 12 | ordinary skill would understand from reading | 02:06:47 |
| 13 | Divsalar '98 together with Luby '98, correct? | 02:06:50 |
| 14 | A.        I -- I do have -- I -- I do not mention in | 02:06:54 |
| 15 | particular the paper.  So in that sense, I don't | 02:06:58 |
| 16 | have that. | 02:07:01 |
| 17 | Q.        Okay. | 02:07:01 |
| 18 | A.        But I do mention RA codes in these | 02:07:01 |
| 19 | paragraphs.  And my argument is that at that point | 02:07:07 |
| 20 | in time.  So I'm not referring to specifically the | 02:07:13 |
| 21 | papers, if -- if that was your question. | 02:07:15 |
| 22 | Q.        That was my question. | 02:07:16 |
| 23 | A.        Right.  So with respect to particular | 02:07:16 |
| 24 | paper, no, but I do mention in my report why I | 02:07:19 |
| 25 | think, and I believe strongly, that a person of | 02:07:23 |

| | | |
|---|---|---|
| 1 | ordinary skill would have not combined these ideas | 02:07:25 |
| 2 | and applied them to the standard RA codes.  But I | 02:07:29 |
| 3 | don't refer to it as -- the RA codes as in the '98 | 02:07:34 |
| 4 | paper. | 02:07:37 |
| 5 | Q.        Okay.  And we'll come -- we'll come back | 02:07:37 |
| 6 | to those opinions. | 02:07:39 |
| 7 | But my question -- my next question is, | 02:07:40 |
| 8 | there's no opinion stated in your report about what | 02:07:43 |
| 9 | a person of ordinary skill would understand from | 02:07:47 |
| 10 | reading Divsalar 1998 together with Richardson 1999, | 02:07:51 |
| 11 | correct? | 02:07:57 |
| 12 | A.        Yes, I only refer to it in terms of RA | 02:07:57 |
| 13 | codes, but not in terms of a specific paper. | 02:08:00 |
| 14 | Q.        Okay.  And then there's no -- I think we | 02:08:03 |
| 15 | covered this already, but just to make sure. | 02:08:10 |
| 16 | There's no opinion in your report about comparing | 02:08:15 |
| 17 | any of those three combinations to the actual | 02:08:17 |
| 18 | limitations of the claims of the patents-in-suit? | 02:08:20 |
| 19 | A.        There's certainly nothing that would look | 02:08:24 |
| 20 | at the actual limitations of the -- or the claims | 02:08:26 |
| 21 | themselves and -- | 02:08:29 |
| 22 | Q.        Okay. | 02:08:29 |
| 23 | A.        -- make a comparison. | 02:08:31 |
| 24 | Q.        Okay.  Now... | 02:08:32 |
| 25 | A.        So maybe if I can, you know -- perhaps I | 02:09:05 |

| | | |
|---|---|---|
| 1 | don't know if I have to correct my statement or not. | 02:09:08 |
| 2 | In Paragraph 141, I opinion on the Paragraphs 578 | 02:09:10 |
| 3 | and 579 in the report by Frey. | 02:09:13 |
| 4 | And that report refers to Luby '97 and | 02:09:18 |
| 5 | repeat-accumulate codes described by Divsalar or | 02:09:26 |
| 6 | repeat-accumulate code described by Wang. | 02:09:29 |
| 7 | So I guess the question is whether or not | 02:09:31 |
| 8 | you insist that the reference is they're implicitly | 02:09:33 |
| 9 | or explicitly. | 02:09:37 |
| 10 | Q.       Let me put it to you this way, there's no | 02:09:43 |
| 11 | opinion in your report that says that if you take | 02:09:47 |
| 12 | the Divsalar disclosure and the Luby 1997 | 02:09:50 |
| 13 | disclosure, the following limitation of the | 02:09:55 |
| 14 | following claim is not present? | 02:09:57 |
| 15 | A.       I do not compare to the claims.  That's | 02:09:59 |
| 16 | correct. | 02:10:04 |
| 17 | Q.       Okay. | 02:10:04 |
| 18 | A.       But I do opinion on the general papers, if | 02:10:04 |
| 19 | you so want, without explicitly referring to the | 02:10:08 |
| 20 | Divsalar paper, I only implicitly refer to it by | 02:10:12 |
| 21 | referring to paragraphs in Frye's report which | 02:10:16 |
| 22 | presumably explicitly refers to the paper. | 02:10:20 |
| 23 | Q.       Now, if we go back to the Khandekar | 02:10:25 |
| 24 | thesis, and if you turn to Page 3301, let me ask | 02:10:35 |
| 25 | when you have that, you see in the middle of the top | 02:10:50 |

| | | |
|---|---|---|
| 1 | paragraph there's a reference, again, to the | 02:10:54 |
| 2 | Luby '97 and Luby '98 papers? | 02:10:56 |
| 3 | A.          Excuse me, is this 3331 or 3301? | 02:10:59 |
| 4 | Q.          I apologize if I misspoke.  I meant 3301. | 02:11:03 |
| 5 | A.          Okay, sorry, my mistake. | 02:11:08 |
| 6 | Q.          And do you see in the middle of the top | 02:11:25 |
| 7 | paragraph there, there's again a reference to the | 02:11:28 |
| 8 | Luby '97 and Luby '98 papers? | 02:11:30 |
| 9 | A.          Yes, that's correct. | 02:11:32 |
| 10 | Q.          And he says just below that: | 02:11:33 |
| 11 | "Luby, et al., also introduced the | 02:11:35 |
| 12 | concept of irregularity." | 02:11:38 |
| 13 | Do you see that there? | 02:11:40 |
| 14 | A.          I see that there, yes. | 02:11:41 |
| 15 | Q.          And is Dr. Khandekar correct that Luby in | 02:11:42 |
| 16 | Luby '97 and '98 were the first to introduce the | 02:11:45 |
| 17 | concept of irregularity? | 02:11:48 |
| 18 | A.          To introduce the particular concept of the | 02:11:50 |
| 19 | irregularity in the '97 paper, referring to a | 02:11:52 |
| 20 | particular version of hierarchical LDPC codes. | 02:11:55 |
| 21 | Q.          Now... | 02:11:59 |
| 22 | A.          Just to, you know, amend what I mean, | 02:12:08 |
| 23 | there are also other versions of irregularity, for | 02:12:11 |
| 24 | example, in the turbo coding literature and other | 02:12:13 |
| 25 | versions of -- also in the LBC literature of what | 02:12:17 |

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|---|---|---|---|
| 1 | | irregularity could mean. | 02:12:22 |
| 2 | | MR. DOWD: Now, let's mark as Exhibit 15 a | 02:12:24 |
| 3 | | copy of Dr. MacKay's "Gallager Codes Recent Results" | 02:12:29 |
| 4 | | paper from the 1999 Allerton conference. | 02:12:39 |
| 5 | | (Urbanke Exhibit 15 was marked for | 02:12:44 |
| 6 | | identification and attached to the | 02:12:44 |
| 7 | | transcript.) | 02:12:46 |
| 8 | | BY MR. DOWD: | 02:12:46 |
| 9 | Q. | Do you have Exhibit 15? | 02:12:46 |
| 10 | A. | Yes. | 02:12:51 |
| 11 | Q. | Do you recognize it? | 02:12:55 |
| 12 | A. | It says: "Gallager Codes Recent Results." | 02:12:55 |
| 13 | Q. | And this is a paper by Dr. MacKay, right? | 02:12:59 |
| 14 | A. | Yes, according to the authorship, it's | 02:13:02 |
| 15 | | Dave MacKay. | 02:13:06 |
| 16 | Q. | Now, Exhibit 15 is talking about Gallager | 02:13:09 |
| 17 | | codes, right? | 02:13:13 |
| 18 | | MR. GLASS: Objection. Outside the scope. | 02:13:14 |
| 19 | | THE WITNESS: I have not looked at that | 02:13:15 |
| 20 | | paper in a very, very long time. I don't know. But | 02:13:18 |
| 21 | | it has "Gallager Codes" in the -- in the title. But | 02:13:22 |
| 22 | | I have absolutely no idea. | 02:13:27 |
| 23 | | BY MR. DOWD: | 02:13:29 |
| 24 | Q. | My question is just -- a Gallager code's | 02:13:30 |
| 25 | | just another way of talking about LDPC codes, right? | 02:13:35 |

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|---|---|---|
| 1 | MR. GLASS: Objection. Vague. | 02:13:38 |
| 2 | THE WITNESS: I don't know exactly what he | 02:13:39 |
| 3 | had in mind in here. Some people use this term. | 02:13:40 |
| 4 | BY MR. DOWD: | 02:13:43 |
| 5 | Q. Okay. Do you see in the abstract there's | 02:13:43 |
| 6 | a -- there's a third paragraph which begins: | 02:13:46 |
| 7 | "This paper reviews low-density parity | 02:13:48 |
| 8 | check codes (Gallager codes), | 02:13:51 |
| 9 | repeat-accumulate codes, and turbo codes"? | 02:13:57 |
| 10 | A. Yes, I see this. | 02:14:00 |
| 11 | Q. And so do you understand this paper is | 02:14:02 |
| 12 | about all three? | 02:14:05 |
| 13 | MR. GLASS: Objection. Outside the scope. | 02:14:06 |
| 14 | THE WITNESS: I have no idea. I would | 02:14:07 |
| 15 | have to read that carefully and that could take a | 02:14:08 |
| 16 | while. | 02:14:12 |
| 17 | BY MR. DOWD: | 02:14:12 |
| 18 | Q. Okay. When's the last time you read | 02:14:12 |
| 19 | Exhibit 15? | 02:14:16 |
| 20 | A. I don't recall. | 02:14:16 |
| 21 | Q. Would it have been back in the 1999 time | 02:14:17 |
| 22 | frame? | 02:14:22 |
| 23 | A. Possible. I don't know. | 02:14:22 |
| 24 | Q. If you turn to Page 2, which has the Bates | 02:14:24 |
| 25 | Page 1847, you see there's a discussion of | 02:14:32 |

| | | |
|---|---|---|
| 1 | low-density parity check codes, right? | 02:14:35 |
| 2 | A. Yes, I see that. | 02:14:40 |
| 3 | Q. And there's also a discussion of | 02:14:42 |
| 4 | repeat-accumulate codes, right? | 02:14:53 |
| 5 | A. Yes. | 02:14:55 |
| 6 | Q. And he especially cites Divsalar '98, | 02:14:56 |
| 7 | right? | 02:15:02 |
| 8 | A. Next to "repeat-accumulate codes," I see | 02:15:02 |
| 9 | in parentheses "Divsalar '98"; yes, that's correct. | 02:15:04 |
| 10 | Q. And it also discusses turbo codes, right? | 02:15:14 |
| 11 | A. I also see turbo codes in the paragraph | 02:15:20 |
| 12 | below. | 02:15:23 |
| 13 | Q. And if we turn to Page 1850, he says: | 02:15:26 |
| 14 | "The best -- " | 02:15:40 |
| 15 | This is in the bottom paragraph. | 02:15:41 |
| 16 | "The best binary Gallager codes found | 02:15:43 |
| 17 | so far are irregular codes whose parity | 02:15:46 |
| 18 | check matrices have nonuniform weight per | 02:15:51 |
| 19 | column." | 02:15:55 |
| 20 | Right? | 02:15:56 |
| 21 | A. I see that sentence there, yes. | 02:15:56 |
| 22 | Q. And in 1999 that was true, right? | 02:15:57 |
| 23 | A. I believe it to be true, yes. | 02:16:01 |
| 24 | Q. And the two references that he cites are | 02:16:04 |
| 25 | the Luby '99 -- withdrawn. | 02:16:08 |

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| | | |
|---|---|---|
| 1 | The two references he cites are the | 02:16:09 |
| 2 | Luby '98 paper and your Richardson '99 paper, right? | 02:16:13 |
| 3 | A.      Yes, I see that in parentheses. | 02:16:15 |
| 4 | Q.      So it was true in 1999 that people were | 02:16:22 |
| 5 | actually looking at Divsalar, those two Luby papers, | 02:16:25 |
| 6 | and the Richardson 1999 reference together, right? | 02:16:31 |
| 7 | A.      He mentions all these three names together | 02:16:38 |
| 8 | in a paper, yes. | 02:16:41 |
| 9 | Q.      And he's comparing those different types | 02:16:42 |
| 10 | of codes, right? | 02:16:44 |
| 11 | A.      That I don't know.  I have not read that | 02:16:46 |
| 12 | paper in detail to say what he's actually doing. | 02:16:48 |
| 13 | Q.      Okay.  But you can at least tell from the | 02:16:52 |
| 14 | abstract that the paper reviews all three types, | 02:16:54 |
| 15 | right? | 02:16:54 |
| 16 | A.      He mentions -- | 02:16:57 |
| 17 | MR. GLASS:  Objection.  Outside the scope. | 02:16:57 |
| 18 | THE WITNESS:  He mentions some of these | 02:16:59 |
| 19 | names.  What exactly he means with these terms, how | 02:17:01 |
| 20 | he defines them, what he does with them, I have no | 02:17:04 |
| 21 | idea. | 02:17:05 |
| 22 | BY MR. DOWD: | 02:17:06 |
| 23 | Q.      Now, Ambleson (verbatim) '99, that was | 02:17:06 |
| 24 | before the patents in this case, right? | 02:17:10 |
| 25 | A.      I believe so, yes. | 02:17:12 |

| | | |
|---|---|---|
| 1 | Q. I meant to "Ambleside," I apologize. | 02:17:13 |
| 2 | A. Ambleside, yes. | 02:17:17 |
| 3 | Q. It was before Caltech filed the lawsuit, | 02:17:19 |
| 4 | right? | 02:17:22 |
| 5 | A. If the conference happened before 2000 -- | 02:17:22 |
| 6 | May 2018 (verbatim), then that's true. | 02:17:25 |
| 7 | Q. And it was long before you were retained | 02:17:27 |
| 8 | for this case, right? | 02:17:30 |
| 9 | A. That is true. | 02:17:31 |
| 10 | Q. Now, at Paragraph 153 of your report you | 02:17:32 |
| 11 | say that: | 02:17:39 |
| 12 | "RA codes were not considered to be | 02:17:40 |
| 13 | good codes as of about 1999." | 02:17:42 |
| 14 | Right? | 02:17:45 |
| 15 | A. Yes. | 02:17:45 |
| 16 | Q. Let's turn back to Page 2 of Exhibit 15, | 02:17:49 |
| 17 | the MacKay Ambleside '99 paper. In the bottom | 02:17:57 |
| 18 | paragraph he says: | 02:18:08 |
| 19 | "All these codes can be decoded." | 02:18:09 |
| 20 | Do you see that? | 02:18:12 |
| 21 | A. Yes, I see that. | 02:18:17 |
| 22 | Q. So he's looked at irregular LDPC codes, RA | 02:18:18 |
| 23 | codes, and turbo codes? | 02:18:22 |
| 24 | MR. GLASS: Objection. | 02:18:24 |
| 25 | /// | |

| | | |
|---|---|---|
| 1 | BY MR. DOWD: | 02:18:26 |
| 2 | Q.        Just above that, right? | 02:18:27 |
| 3 | MR. GLASS:  Objection.  Outside the scope. | 02:18:28 |
| 4 | THE WITNESS:  I see that sentence. | 02:18:29 |
| 5 | BY MR. DOWD: | 02:18:30 |
| 6 | Q.        And he says: | 02:18:30 |
| 7 | "All these codes can be decoded by a | 02:18:31 |
| 8 | local message-passing algorithm." | 02:18:34 |
| 9 | There's some citation.  And then: | 02:18:37 |
| 10 | "While this algorithm is not the | 02:18:41 |
| 11 | optimal decoder, the empirical results are | 02:18:43 |
| 12 | record breaking." | 02:18:46 |
| 13 | Right? | 02:18:48 |
| 14 | A.        I see that sentence, yes. | 02:18:49 |
| 15 | Q.        And so at least MacKay is saying that | 02:18:51 |
| 16 | repeat-accumulate codes produce record breaking | 02:18:56 |
| 17 | results, right? | 02:19:00 |
| 18 | A.        I don't think that's -- | |
| 19 | MR. DOWD:  Outside -- | |
| 20 | THE WITNESS:  -- what he says. | |
| 21 | THE REPORTER:  Wait.  Wait.  Wait.  I | |
| 22 | didn't get the objection. | |
| 23 | MR. GLASS:  Just outside the scope. | 02:19:04 |
| 24 | Go ahead. | 02:19:05 |
| 25 | THE WITNESS:  I don't read that in that | 02:19:06 |

| | | |
|---|---|---|
| 1 | way. | 02:19:09 |
| 2 | BY MR. DOWD: | 02:19:09 |
| 3 | Q.        Okay.  So when he says:  All these codes, | 02:19:09 |
| 4 | and then says:  The empirical results are record | 02:19:13 |
| 5 | breaking, you think he actually just means some of | 02:19:16 |
| 6 | these codes? | 02:19:21 |
| 7 | A.        I have no idea what he means, but I very | 02:19:21 |
| 8 | much -- you know -- and that is right now I'm not | 02:19:25 |
| 9 | really forming a final opinion.  I have not studied | 02:19:26 |
| 10 | that in any detail.  But it would be strange for me | 02:19:29 |
| 11 | to believe that that's what he meant, given that | 02:19:33 |
| 12 | these codes were not very good codes. | 02:19:35 |
| 13 | Q.        Well, he goes on to -- so your -- | 02:19:40 |
| 14 | withdrawn. | 02:19:40 |
| 15 | So your position is because MacKay's paper | 02:19:44 |
| 16 | is inconsistent with your assertion that RA codes | 02:19:48 |
| 17 | were not good, you think that can't be what he | 02:19:52 |
| 18 | meant? | 02:19:55 |
| 19 | MR. GLASS:  Objection.  Misstates the | 02:19:55 |
| 20 | testimony. | 02:19:57 |
| 21 | THE WITNESS:  I -- I don't know what he | 02:19:57 |
| 22 | meant.  But it's a fact that much better codes were | 02:19:58 |
| 23 | known at that time. | 02:20:03 |
| 24 | BY MR. DOWD: | 02:20:04 |
| 25 | Q.        Okay.  Well, he goes on to provide | 02:20:04 |

| | | | |
|---|---|---|---|
| 1 | | performance in Figure 2, 2A and 2B, right?  So he is | 02:20:08 |
| 2 | | looking at the performance of an RA code, right? | 02:20:17 |
| 3 | A. | I don't know. | 02:20:20 |
| 4 | Q. | You don't know.  All right. | 02:20:20 |
| 5 | | Well, let's go back to Divsalar in | 02:20:29 |
| 6 | | Figure 3.  Do you have that still?  It should be -- | 02:20:31 |
| 7 | A. | Which exhibit are you talking about? | 02:20:36 |
| 8 | Q. | Exhibit 6. | 02:20:38 |
| 9 | A. | Exhibit 6.  Yes. | 02:20:40 |
| 10 | Q. | And in your report, at Paragraph 154, you | 02:20:49 |
| 11 | | say: | 02:20:55 |
| 12 | | "Even if someone thought to modify RA | 02:20:55 |
| 13 | | codes to improve them, there are any | 02:20:58 |
| 14 | | number of modifications that could be | 02:21:00 |
| 15 | | made." | 02:21:01 |
| 16 | | And then in 155: | 02:21:03 |
| 17 | | "Even if someone thought to make RA | 02:21:05 |
| 18 | | codes irregular, there are any number of | 02:21:08 |
| 19 | | ways irregularity could be applied?" | 02:21:10 |
| 20 | | Right? | 02:21:14 |
| 21 | A. | Yes. | 02:21:24 |
| 22 | Q. | The RA code in Figure 3 has three blocks, | 02:21:26 |
| 23 | | right? | 02:21:38 |
| 24 | A. | The way it is in Figure 3? | 02:21:38 |
| 25 | Q. | Of Divsalar. | 02:21:41 |

| | | |
|---|---|---|
| 1 | A.      Yes, that is correct. | 02:21:43 |
| 2 | Q.      So you could make the repeat block | 02:21:45 |
| 3 | irregular, right? | 02:21:48 |
| 4 | A.      That might be one of the ways to go. | 02:21:51 |
| 5 | Q.      Could you make the accumulator block | 02:21:55 |
| 6 | irregular? | 02:21:59 |
| 7 | A.      You could go do what the standard way of | 02:22:02 |
| 8 | irregular was considered at that point and go back | 02:22:06 |
| 9 | to direction of turbo codes. And then have any | 02:22:09 |
| 10 | number of variations on the theme of turbo codes. | 02:22:11 |
| 11 | That would be the most natural codes to make -- | 02:22:15 |
| 12 | natural way to make these codes more powerful. | 02:22:18 |
| 13 | Q.      Well, I'll get to that. | 02:22:21 |
| 14 | But my question was, could you make the | 02:22:23 |
| 15 | accumulator block irregular? | 02:22:26 |
| 16 | A.      Sure. If you had several of them, you | 02:22:29 |
| 17 | could choose each of them to be different. | 02:22:32 |
| 18 | Q.      Well, in this code you only have one, | 02:22:33 |
| 19 | right? | 02:22:36 |
| 20 | A.      That's your choice, but that's not a | 02:22:36 |
| 21 | given. | 02:22:39 |
| 22 | Q.      Okay. Let's just stick with what's | 02:22:39 |
| 23 | actually in Divsalar, okay? | 02:22:42 |
| 24 | A.      But you asked me whether or not you could | 02:22:43 |
| 25 | have made it irregular. And I'm claiming, yes, you | 02:22:45 |

| | | |
|---|---|---|
| 1 | could. And one particular way to do it would have | 02:22:47 |
| 2 | to be several branches and then make these branches | 02:22:47 |
| 3 | to be any -- | 02:22:47 |
| 4 | THE REPORTER: Wait. | 02:22:47 |
| 5 | "One particular" -- "one particular | 02:22:54 |
| 6 | way..." | 02:22:54 |
| 7 | Start there. | 02:22:54 |
| 8 | THE WITNESS: Would have been to choose | 02:22:55 |
| 9 | several branches. And then as for turbo codes, | 02:22:56 |
| 10 | choose various ways of using the components. | 02:22:59 |
| 11 | BY MR. DOWD: | 02:23:02 |
| 12 | Q. Okay. So now -- now I think I understand. | 02:23:03 |
| 13 | So if I was going to make an IRA code | 02:23:06 |
| 14 | using Figure 3, you could do that by making the -- | 02:23:09 |
| 15 | having multiple different accumulators? | 02:23:13 |
| 16 | A. That might be one way, but, you know, | 02:23:16 |
| 17 | there's any number of ways that you can do it. You | 02:23:19 |
| 18 | could, for example, branch off there, this one | 02:23:22 |
| 19 | particular branch having as many as accumulators as | 02:23:24 |
| 20 | you wanted. You could have the permutations in any | 02:23:27 |
| 21 | way you wanted. | 02:23:31 |
| 22 | You could have, you know, many -- many | 02:23:32 |
| 23 | other things. You could have several branches in | 02:23:33 |
| 24 | the beginning and branch off there. You could do | 02:23:36 |
| 25 | over non-binary alphabets and make them kind of | 02:23:38 |

| | | |
|---|---|---|
| 1 | different.  You could choose different and stronger | 02:23:42 |
| 2 | component codes.  There's any number of ways of | 02:23:45 |
| 3 | doing this. | 02:23:49 |
| 4 | Q.        Well, I'm not asking about making a | 02:23:49 |
| 5 | different and stronger code.  I'm just making it | 02:23:51 |
| 6 | irregular; okay? | 02:23:54 |
| 7 | A.        The only motivation for making them | 02:23:54 |
| 8 | irregular would be to make them stronger. | 02:23:57 |
| 9 | Q.        Well, let's just -- without respect to | 02:23:59 |
| 10 | whether they make them stronger or not stronger.  If | 02:24:00 |
| 11 | I wanted to make it irregular, I could make the | 02:24:03 |
| 12 | repeat irregular, that's one way, right? | 02:24:05 |
| 13 | A.        That's one way. | 02:24:08 |
| 14 | Q.        Can I make the permutation irregular? | 02:24:10 |
| 15 | A.        You could have many branches, as I | 02:24:13 |
| 16 | claimed.  There's no reason you have a single box -- | 02:24:15 |
| 17 | THE REPORTER:  Slow down, please. | 02:24:15 |
| 18 | "There's no reason..." | 02:24:15 |
| 19 | Start there. | 02:24:19 |
| 20 | THE WITNESS:  There's no reason that each | 02:24:19 |
| 21 | of those boxes should be a single box. | 02:24:20 |
| 22 | BY MR. DOWD: | 02:24:24 |
| 23 | Q.        Okay.  And then if I make accumulate | 02:24:25 |
| 24 | irregular, that would also require multiple boxes, | 02:24:27 |
| 25 | right? | 02:24:30 |

| | | |
|---|---|---|
| 1 | A.      Perhaps there might be other ways of doing | 02:24:30 |
| 2 | it too. This would be a research question. But | 02:24:32 |
| 3 | there must be many, many, many ways of making it | 02:24:35 |
| 4 | irregular. | 02:24:38 |
| 5 | Q.      Okay. Well, let's break it down. | 02:24:38 |
| 6 | If I'm going to keep the exact same | 02:24:41 |
| 7 | structure as Figure 3, so I've got one repeat box, | 02:24:43 |
| 8 | one permute box, one accumulate box, am I correct | 02:24:47 |
| 9 | that the only way to make this an irregular | 02:24:52 |
| 10 | repeat-accumulate code is to make the repeater an | 02:24:56 |
| 11 | irregular repeat? | 02:25:00 |
| 12 | A.      No. Because you could, for example, take | 02:25:01 |
| 13 | symbols which are not bits, you could take bits and | 02:25:03 |
| 14 | put -- group them together, and then treat the | 02:25:06 |
| 15 | blocks in these symbols as symbols in the higher | 02:25:08 |
| 16 | alphabet and do any number of operations of them. | 02:25:11 |
| 17 | So there is a large degree of how you | 02:25:14 |
| 18 | could make them irregular. | 02:25:17 |
| 19 | Q.      So you're saying upstream, instead of | 02:25:18 |
| 20 | inputting bits, you're inputting something else? | 02:25:22 |
| 21 | A.      You would still put bits, but there's no | 02:25:22 |
| 22 | reason you have to treat them as bits. | 02:25:22 |
| 23 | THE REPORTER: Repeat your answer. | 02:25:26 |
| 24 | THE WITNESS: There's no reason -- you | 02:25:26 |
| 25 | would still input bits, but there's no reason that | 02:25:30 |

| | | |
|---|---|---|
| 1 | internally you have to treat them as bits. | 02:25:32 |
| 2 | BY MR. DOWD: | 02:25:34 |
| 3 | Q.        Okay.  Let's just stick with what Divsalar | 02:25:34 |
| 4 | says. | 02:25:38 |
| 5 | Assume that the input N is bits, okay?  Do | 02:25:38 |
| 6 | you have that in mind?  You have to answer verbally. | 02:25:43 |
| 7 | A.        Yes. | 02:25:47 |
| 8 | Q.        And assume that you're not going to change | 02:25:48 |
| 9 | the number of permuters, there's going to be one | 02:25:50 |
| 10 | box, you're not going to change the number of | 02:25:54 |
| 11 | accumulators, there's going to be one box, okay? | 02:25:56 |
| 12 | Do you have that in mind? | 02:25:59 |
| 13 | A.        Yes. | 02:26:01 |
| 14 | Q.        I'm correct that you could make this an | 02:26:01 |
| 15 | IRA code by making the repetition irregular, right? | 02:26:04 |
| 16 | A.        Correct. | 02:26:07 |
| 17 | Q.        And you say that I could also make it | 02:26:08 |
| 18 | irregular by changing the repeater so that it treats | 02:26:11 |
| 19 | the bits as symbols instead of bits? | 02:26:16 |
| 20 | A.        For example. | 02:26:19 |
| 21 | Q.        But that repeater would still be an | 02:26:20 |
| 22 | irregular repeater, right? | 02:26:23 |
| 23 | A.        It may or may not.  You -- you might -- it | 02:26:24 |
| 24 | might, for example, keep that regular but simply | 02:26:28 |
| 25 | treat bits as symbols, and then later on treat them | 02:26:30 |

1    in a particular way that it reduces -- introduces                02:26:34

2    irregularity.  There's many number of ways that you              02:26:38

3    can do that.  And these number of ways have been                 02:26:40

4    explored, for example, in an -- in LDPC setting.                 02:26:43

5    Q.        So let's talk about where the repetition              02:26:46

6    requires creating a duplication of the bits, okay?              02:26:49

7    Do you have that in mind?                                        02:26:51

8    A.        We're talking about the first box?  You're            02:26:53

9    referring to the first box?                                      02:26:56

10   Q.        I am.  If the first box must create a                  02:26:57

11   duplicate, it's duplicating the input bits?                      02:27:02

12   A.        It's repeating them, yes.                              02:27:06

13   Q.        Do you have that in mind?                              02:27:08

14   A.        It's repeating them, yes.                              02:27:09

15   Q.        Okay.  And so we're not making them                    02:27:11

16   symbols, we're not doing anything else.                          02:27:13

17             In that circumstance, then the way that                02:27:15

18   you would change Figure 3 to become irregular is you             02:27:20

19   create some number of duplicates for some bits and a             02:27:25

20   different number of duplicates for other bits,                   02:27:30

21   right?

22   A.        That would be --

23             MR. GLASS:  Vague.

24             THE WITNESS:  -- one way of doing it.

25             MR. DOWD:  All right.

| | | |
|---|---|---|
| 1 | THE REPORTER:  I didn't catch either the | |
| 2 | objection nor the answer.  Maybe you guys could | |
| 3 | separate them. | |
| 4 | MR. GLASS:  Vague. | |
| 5 | Go ahead. | 02:27:39 |
| 6 | THE WITNESS:  That would be one way of | 02:27:39 |
| 7 | doing it.  But as I claimed, you can do this in any | 02:27:41 |
| 8 | number of other ways.  Even if you repeated a | 02:27:45 |
| 9 | constant number of times and they were bits, you | 02:27:48 |
| 10 | could later on, for example, combine this bits to | 02:27:51 |
| 11 | symbols.  You can do this at any stage. | 02:27:53 |
| 12 | And there's no reason that you would fix | 02:27:55 |
| 13 | every single thing so that the conclusion -- only | 02:27:58 |
| 14 | conclusion can be that the only thing you can do is | 02:28:00 |
| 15 | repetition.  You -- if you're telling me to tie your | 02:28:02 |
| 16 | hands behind -- | |
| 17 | THE REPORTER:  Wait. | |
| 18 | THE WITNESS:  -- behind your back so -- | |
| 19 | THE REPORTER:  Hold on.  Hold on.  Slow | |
| 20 | down.  Okay? | |
| 21 | THE WITNESS:  You're telling me, | 02:28:08 |
| 22 | basically, if you tie your hands behind your back | 02:28:09 |
| 23 | and, you know, disallow any of the reasonable things | 02:28:11 |
| 24 | you could have done, then the only thing you could | 02:28:14 |
| 25 | have done is the one thing that you can do, given | 02:28:17 |

| | | |
|---|---|---|
| 1 | that they're restricted in so much. | 02:28:19 |
| 2 | My claim is that that's not the way code | 02:28:22 |
| 3 | design works. | 02:28:25 |
| 4 | BY MR. DOWD: | 02:28:26 |
| 5 | Q. My -- my actual question is different than | 02:28:27 |
| 6 | that. | 02:28:29 |
| 7 | Any one of those would have produced an | 02:28:30 |
| 8 | irregular repeat code, right, irregular | 02:28:33 |
| 9 | repeat-accumulate code? | 02:28:36 |
| 10 | A. Which one? | 02:28:36 |
| 11 | Q. Any one of the options that you are -- | |
| 12 | (Overlapping speakers.) | |
| 13 | THE REPORTER: Wait. I didn't -- I didn't | |
| 14 | hear the -- his -- I didn't hear his question. | |
| 15 | MR. DOWD: I'll ask the question again. | |
| 16 | THE REPORTER: Please. Thank you. | 02:28:42 |
| 17 | BY MR. DOWD: | 02:28:42 |
| 18 | Q. Any one of the options that you are | 02:28:44 |
| 19 | describing would produce an irregular | 02:28:46 |
| 20 | repeat-accumulate code? | 02:28:48 |
| 21 | A. No. | 02:28:49 |
| 22 | Q. No? | 02:28:50 |
| 23 | A. No. | 02:28:50 |
| 24 | Q. Okay. | 02:28:52 |
| 25 | THE REPORTER: Can we take a break, | 02:28:52 |

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| | | |
|---|---|---|
| 1 | please? | 02:28:55 |
| 2 | MR. DOWD:  Sure. | 02:28:56 |
| 3 | THE VIDEOGRAPHER:  This marks the end of | 02:28:56 |
| 4 | Disc No. 2 in the deposition of Dr. Urbanke.  We are | 02:28:58 |
| 5 | off the record at 2:29 p.m. | 02:29:03 |
| 6 | (Recess taken at 2:29 p.m.) | 02:29:21 |
| 7 | THE VIDEOGRAPHER:  This begins Tape No. 3 | 02:41:47 |
| 8 | in the deposition of Dr. Rüdiger Urbanke.  We are | 02:41:51 |
| 9 | back on the record at 2:41 p.m. | 02:41:56 |
| 10 | BY MR. DOWD: | 02:42:01 |
| 11 | Q.        Before the break we were talking about | 02:42:01 |
| 12 | Figure 3 of Divsalar, and I'd like to continue with | 02:42:04 |
| 13 | that.  Do you still have that in front of you? | 02:42:06 |
| 14 | A.        You're talking about Exhibit 6? | 02:42:09 |
| 15 | Q.        I am. | 02:42:11 |
| 16 | A.        Yes. | 02:42:12 |
| 17 | Q.        Now, right below the figure, do you see it | 02:42:12 |
| 18 | says: | 02:42:17 |
| 19 | "The outer repetition code is | 02:42:17 |
| 20 | trivial"? | 02:42:20 |
| 21 | A.        You're talking about the heading of | 02:42:21 |
| 22 | Figure 3? | 02:42:26 |
| 23 | Q.        I'm saying, if you look at the last | 02:42:27 |
| 24 | sentence on the page below the figure, it says: | 02:42:30 |
| 25 | "The outer repetition code is | 02:42:32 |

| | | |
|---|---|---|
| 1 | trivial." | 02:42:35 |
| 2 | A. Okay. | 02:42:35 |
| 3 | Q. And then it continues. Do you see that? | 02:42:35 |
| 4 | A. Yes. | 02:42:37 |
| 5 | Q. If a person of ordinary skill, back in | 02:42:38 |
| 6 | '98, '99, wanted to make the repetition code | 02:42:43 |
| 7 | irregular, they would have been able to do so, | 02:42:49 |
| 8 | right? | 02:42:53 |
| 9 | A. What is your definition of irregular? | 02:42:53 |
| 10 | Q. That some subset of the bits are repeated | 02:42:55 |
| 11 | one number of times and at least one other subset of | 02:43:03 |
| 12 | bits is repeated a different number of times. | 02:43:07 |
| 13 | A. It seems to me that if you're asking that | 02:43:10 |
| 14 | if you tell someone make it so, then you're telling | 02:43:14 |
| 15 | exactly what to do. So I don't quite understand | 02:43:17 |
| 16 | what do you mean, they would have been able to do | 02:43:20 |
| 17 | so. Because in order to tell him what to do, you | 02:43:23 |
| 18 | would have to give them the exact description what | 02:43:26 |
| 19 | to do. Otherwise, you have not given me a | 02:43:28 |
| 20 | definition of what irregular means. | 02:43:30 |
| 21 | Q. Okay. So with the understanding that | 02:43:32 |
| 22 | irregular means that some of the bits are repeated | 02:43:34 |
| 23 | one number of times and other of the bits are | 02:43:37 |
| 24 | repeated a different number of times. Do you have | 02:43:40 |
| 25 | that in mind? | 02:43:44 |

| | | |
|---|---|---|
| 1 | A.          If that is your definition. | 02:43:44 |
| 2 | Q.          Yes, for purposes of this question. | 02:43:46 |
| 3 | A person of ordinary skill in 1999 would | 02:43:53 |
| 4 | have been able to take the RA encoder of Figure 3 in | 02:43:59 |
| 5 | Divsalar and make the repetition an irregular | 02:44:07 |
| 6 | repetition, correct? | 02:44:11 |
| 7 | A.          It seems to me that, again, you're putting | 02:44:13 |
| 8 | into the question exactly what the -- what you want | 02:44:15 |
| 9 | the person to do.  The question was, if I rephrase | 02:44:17 |
| 10 | it, and please correct me if I'm wrong, if you tell | 02:44:20 |
| 11 | a person to repeat different bits a different number | 02:44:23 |
| 12 | of times, would that person have been able to repeat | 02:44:27 |
| 13 | different bits a different number of times? | 02:44:31 |
| 14 | If that's your question, then it's a | 02:44:33 |
| 15 | tautology and the answer's yes. | 02:44:35 |
| 16 | Q.          Okay.  So let's start there.  So if you | 02:44:37 |
| 17 | said to somebody in this field:  Take Divsalar | 02:44:41 |
| 18 | Figure 3 and I want you to repeat different numbers | 02:44:44 |
| 19 | of bits a different number of times, that wouldn't | 02:44:46 |
| 20 | have been difficult to do at all, right? | 02:44:49 |
| 21 | A.          If you're telling them exactly what to do, | 02:44:51 |
| 22 | then no. | 02:44:53 |
| 23 | Q.          Okay.  And, no, it wouldn't have been | 02:44:55 |
| 24 | difficult? | 02:45:00 |
| 25 | A.          Because it's in the description of what | 02:45:00 |

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| | | |
|---|---|---|
| 1 | you tell them to do. | 02:45:02 |
| 2 | Q. Okay. So there's nothing difficult about | 02:45:04 |
| 3 | following that instruction, right? | 02:45:07 |
| 4 | A. If the instruction is as explicit as | 02:45:08 |
| 5 | telling them exactly what to do, then it's simply a | 02:45:11 |
| 6 | program that you have to follow. | 02:45:15 |
| 7 | Q. Okay. And if you said to a person in the | 02:45:17 |
| 8 | field, without more: I'd like you to take the | 02:45:21 |
| 9 | repetition code of Divsalar Figure 3 and make it an | 02:45:25 |
| 10 | irregular repetition code, they'd be able to do that | 02:45:29 |
| 11 | too, right? | 02:45:33 |
| 12 | A. If you could tell me what your definition | 02:45:33 |
| 13 | of irregular repetition code is. | 02:45:35 |
| 14 | Q. Using any definition. | 02:45:38 |
| 15 | A. I think it seems -- your question -- or | 02:45:39 |
| 16 | the answer to the question hinges exactly on what | 02:45:42 |
| 17 | you tell a person to do. | 02:45:45 |
| 18 | I'm sorry if I repeat myself. But if you | 02:45:46 |
| 19 | tell the person explicitly what to do, then | 02:45:49 |
| 20 | inherently it's easy to do. But if you tell a | 02:45:53 |
| 21 | person, you know, fairly vague things, improve, | 02:45:57 |
| 22 | let's say, the code, or any other number of | 02:45:59 |
| 23 | questions that perhaps at that point might have come | 02:46:01 |
| 24 | up, the question is an entirely different one, and | 02:46:03 |
| 25 | my answer would be entirely different. | 02:46:06 |

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| | | |
|---|---|---|
| 1 | Q.        Okay.  And my question is, if the | 02:46:08 |
| 2 | instruction was:  Take Divsalar Figure 3, I want you | 02:46:11 |
| 3 | to change the repeater so that it performs an | 02:46:15 |
| 4 | irregular repetition, would a person of ordinary | 02:46:19 |
| 5 | skill know how to do that? | 02:46:23 |
| 6 | A.        I would say yes because you would have, in | 02:46:25 |
| 7 | the -- in the question, told the person exactly what | 02:46:30 |
| 8 | to do. | 02:46:32 |
| 9 | Q.        Okay.  And, in fact, are you aware of | 02:46:32 |
| 10 | people in 1998 taking a repeat-accumulate code and | 02:46:38 |
| 11 | making the repeat an irregular repeat? | 02:46:42 |
| 12 | A.        In 1998, for the -- you're talking about | 02:46:46 |
| 13 | RA codes themselves? | 02:46:55 |
| 14 | Q.        Yes. | 02:46:55 |
| 15 | A.        I am not aware of other results than the | 02:46:56 |
| 16 | one -- you know, if we're talking about strict sense | 02:47:03 |
| 17 | RA codes as they're described in here, I'm not aware | 02:47:07 |
| 18 | of other people doing it. | 02:47:10 |
| 19 | MR. DOWD:  Let me show you what I'll mark | 02:47:27 |
| 20 | as Exhibit 16, a copy of a document that bears Bates | 02:47:29 |
| 21 | number HUGHES1858 through 1873, entitled:  "RA.c." | 02:47:33 |
| 22 | (Urbanke Exhibit 16 was marked for | 02:47:44 |
| 23 | identification and attached to the | 02:47:44 |
| 24 | transcript.) | 02:47:54 |
| 25 | /// | |

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|---|---|---|
| 1 | BY MR. DOWD: | 02:47:54 |
| 2 | Q. Do you have Exhibit 16? | 02:47:55 |
| 3 | A. Yes. | 02:47:56 |
| 4 | Q. Do you recognize it? | 02:47:56 |
| 5 | A. It seems to be some computer code. | 02:47:58 |
| 6 | Q. Have you seen Exhibit 16 before? | 02:48:03 |
| 7 | A. I believe that a program was mentioned in | 02:48:05 |
| 8 | Brendan Frey's report. I have not -- I don't | 02:48:12 |
| 9 | believe I've seen the actual computer code to that. | 02:48:15 |
| 10 | Q. Okay. So let me start with, with respect | 02:48:17 |
| 11 | to Exhibit 16, you have formed no opinion about what | 02:48:21 |
| 12 | this is, sitting here today? | 02:48:25 |
| 13 | A. No. | 02:48:27 |
| 14 | Q. All right. Do you see there's a date at | 02:48:27 |
| 15 | the top that says September 28, 1998? | 02:48:30 |
| 16 | A. I see '98, 09/28, yes. | 02:48:34 |
| 17 | Q. And the initials next to that are David | 02:48:37 |
| 18 | J.C. MacKay; do you see that? | 02:48:41 |
| 19 | A. I see the "DJCM," and that might stand for | 02:48:42 |
| 20 | David MacKay. | 02:48:47 |
| 21 | Q. And the title of this in the comment right | 02:48:49 |
| 22 | below that is a repeat-accumulate code simulator, | 02:48:52 |
| 23 | right? | 02:48:57 |
| 24 | A. That is correct. | 02:48:57 |
| 25 | Q. Now, if you look a few lines down there's | 02:49:00 |

| | | |
|---|---|---|
| 1 | a -- a line that says: | 02:49:03 |
| 2 | "N sub 1, N sub 2, dot, dot, dot, N | 02:49:04 |
| 3 | sub K." | 02:49:08 |
| 4 | A.      Yes. | 02:49:10 |
| 5 | Q.      And there's a description there that says: | 02:49:11 |
| 6 | "Number of repetition of each source | 02:49:14 |
| 7 | bit." | 02:49:17 |
| 8 | Right? | 02:49:17 |
| 9 | A.      I see that, yes. | 02:49:18 |
| 10 | Q.      And so what's happening there is you've | 02:49:19 |
| 11 | got at least three subsets of source bits, N sub 1, | 02:49:22 |
| 12 | N sub 2, through N sub K, right? | 02:49:27 |
| 13 | A.      That I don't know.  I have not looked at | 02:49:30 |
| 14 | the program.  I've never run it.  I have not looked | 02:49:31 |
| 15 | at what the definition of the variables are.  That | 02:49:34 |
| 16 | is a program that seems to have 16 pages.  It's not | 02:49:37 |
| 17 | a triviality to say what this code actually does. | 02:49:40 |
| 18 | THE REPORTER:  Hold on.  State the last | 02:49:42 |
| 19 | part over. | 02:49:44 |
| 20 | THE WITNESS:  It's a program that seems to | 02:49:44 |
| 21 | be containing about 16 pages of source code.  It is | 02:49:46 |
| 22 | not a triviality to determine what such a code | 02:49:48 |
| 23 | actually does. | 02:49:52 |
| 24 | BY MR. DOWD: | 02:49:53 |
| 25 | Q.      Okay.  And so you've formed no opinion | 02:49:54 |

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|---|---|---|
| 1 | about what this "N sub 1, N sub 2, N sub K" means, | 02:49:58 |
| 2 | right? | 02:50:07 |
| 3 | A.      No. | 02:50:07 |
| 4 | Q.      Is that correct? | 02:50:08 |
| 5 | A.      Yes. | 02:50:12 |
| 6 | Q.      And to the extent that that is setting the | 02:50:12 |
| 7 | number of repetitions of each source bit, you have | 02:50:15 |
| 8 | no opinion about that, right? | 02:50:20 |
| 9 | A.      I don't know what these variables are.  It | 02:50:22 |
| 10 | would take, you know, a fairly extensive study to | 02:50:25 |
| 11 | determine what this program actually does and what | 02:50:28 |
| 12 | these parameters might be for. | 02:50:31 |
| 13 | Q.      Okay.  Now, let's assume that you've got a | 02:50:33 |
| 14 | repeat-accumulate code like the Divsalar code, | 02:50:36 |
| 15 | Figure 3? | 02:50:39 |
| 16 | A.      Uh-huh. | 02:50:40 |
| 17 | Q.      And assume that you divide the input block | 02:50:41 |
| 18 | of N bits into three subgroups:  N1, N2, NK, okay? | 02:50:49 |
| 19 | A.      Correct. | 02:50:57 |
| 20 | Q.      And assume also that the number of | 02:50:57 |
| 21 | repetitions for each subgroup will be different, | 02:51:01 |
| 22 | okay? | 02:51:04 |
| 23 | A.      Okay. | 02:51:08 |
| 24 | Q.      In that case, the code would be an IRA | 02:51:08 |
| 25 | code, right? | 02:51:14 |