

VIDEOTAPED DEPOSITION OF RUDIGER L. URBANKE  
CONDUCTED ON WEDNESDAY, FEBRUARY 25, 2015

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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

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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

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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 ///

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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

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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

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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

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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

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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

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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 11:54:39  
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 ///

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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

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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 ///

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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

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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

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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

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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

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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

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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		///	

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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	///	

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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.	

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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, Thesis 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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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		///	

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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

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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

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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

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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

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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

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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

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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

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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

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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.	

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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  
7 doing it. But as I claimed, you can do this in any  
8 number of other ways. Even if you repeated a  
9 constant number of times and they were bits, you  
10 could later on, for example, combine this bits to  
11 symbols. You can do this at any stage.

02:27:39

02:27:41

02:27:45

02:27:48

02:27:51

02:27:53

12 And there's no reason that you would fix  
13 every single thing so that the conclusion -- only  
14 conclusion can be that the only thing you can do is  
15 repetition. You -- if you're telling me to tie your  
16 hands behind --

02:27:55

02:27:58

02:28:00

02:28:02

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

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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

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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

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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

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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