you see where it says at Line 7:
"Such an accumulator may be considered a block coder whose input block X sub one through X sub N and output block Y sub one through Y sub N are related by the formula," and then it provides a formula? 11:45:45 11:45:49 11:45:51 11:45:55 11:45:59 11:46:02

A. I see that. 11:46:04

Q. That's the same description as Divsalar on Page 5 where it says: 11:46:04 11:46:08

"The accumulator can be viewed as a truncated rate-1 recursive convolutional encoder with a transfer function, one over one plus N, but we prefer to think of it as a block code whose input block X sub one through X sub N and output block Y sub one through Y sub N are related by the formula," and it provides a formula, right? 11:46:09 11:46:12 11:46:14 11:46:17 11:46:21 11:46:24 11:46:28 11:46:31 11:46:33

MR. GLASS: Same objection. Outside the scope. Calls for a legal conclusion. 11:46:33 11:46:34

THE WITNESS: There is some similarities in language, some similarities in words, yes. 11:46:35 11:46:37

BY MR. DOWD: 11:46:41

Q. And the code -- the formula that's written there is the same formula, right? 11:46:41 11:46:43

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

certainly not the same. One are plus signs; the other ones are symbols that perhaps are X or symbols. 11:47:33 11:47:36 11:47:40

BY MR. DOWD: 11:47:41

Q. Do you see at Line 24 it says: 11:47:41

"Where the plus with a circle denotes mod 2 or exclusive OR addition"? 11:47:43 11:47:43

THE REPORTER: "Where the plus" -- 11:47:43

MR. DOWD: "With a circle around it." 11:47:43

THE REPORTER: Start there, please. 11:47:43

MR. DOWD: I will. 11:47:49

BY MR. DOWD: 11:47:49

Q. "Where the plus with a circle around it denotes mod 2 or exclusive OR addition"? 11:47:51 11:47:53

A. I see that. 11:47:57

Q. All right. So if the plus in Divsalar is an exclusive OR addition, we can agree that the formula is the same in both documents, right? 11:47:59 11:48:02 11:48:05

MR. GLASS: Outside the scope. 11:48:07

THE WITNESS: As I said, if, you know, that was an opinion that would be asked from me, I would like to actually study that question in detail and then come to a conclusion after a thoughtful process. 11:48:08 11:48:11 11:48:13 11:48:16 11:48:19

///

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

Q. Uh-huh. And it appears in each of the subsets Y2 down the YN, right? 11:49:25 11:49:28

MR. GLASS: Same objections. 11:49:31

THE WITNESS: As I said, I have not studied this. It appears in three places. This may or may not mean what you are implying. 11:49:32 11:49:34 11:49:38

BY MR. DOWD: 11:49:41

Q. Well, can you -- withdrawn. 11:49:41

Am I correct that the number of subsets in which the information bit appears varies from bit X1 to bit X2? 11:49:43 11:49:46 11:49:50

A. An accumulator accumulates the past. Simply at any point in time a bit comes in or whatever the number is, it will add it to the current running sum. That's what an accumulator does. 11:49:55 11:49:58 11:50:02 11:50:05 11:50:07

Q. Okay. So in the first recursive operation you only have one bit, right, X1? 11:50:08 11:50:11

A. This is simply the state of the system. The state of the system stays there. At any point in time the state of the system is updated. That's what it is. 11:50:14 11:50:17 11:50:20 11:50:22

Q. All right. And let's just talk about how an accumulator operates for a second. 11:50:23 11:50:25

So in the first clockcycle, you have one 11:50:27

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

neither the 1 or the 0 but the product of combining them? 11:51:31 11:51:36

A. It's the sum of combining these two. it's -- it's -- it's taking the sum of the current state with whatever's coming in. That's going to be the output; that's going to be the new state. 11:51:37 11:51:40 11:51:42 11:51:46

Q. Okay. And that new state is a bit that is created by performing the summing? 11:51:49 11:51:54

MR. GLASS: Objection. Vague. 11:51:58

THE WITNESS: It's the state. It's simply a state. It's not a bit. It's the state, and the state could have -- be binary as it's in this form. It could be a higher dimension. It could be over a bigger field, for example. It's whatever the state is at that point. 11:51:58 11:52:00 11:52:03 11:52:07 11:52:10 11:52:12

BY MR. DOWD: 11:52:13

Q. Okay. I'm -- I'm just doing a simple accumulation -- 11:52:13 11:52:15

A. Sure. 11:52:16

Q. -- where we only have -- it can be a one 1 or a 0. 11:52:17 11:52:19

A. Okay. So if the state is binary, then there will be a binary state and it will have a value in the state and -- 11:52:20 11:52:20 11:52:20

THE REPORTER: I'm sorry, state your 11:52:20

answer again, please. 11:52:25
THE WITNESS: Sure. So if the state is 11:52:25
indeed binary, then it will take whatever state that 11:52:28
was before it. It will add the current bit to the 11:52:33
state. This will give you a new state, and the size 11:52:36
of the state doesn't change, so it will still be 11:52:40
binary. 11:52:43
BY MR. DOWD: 11:52:45
Q. Okay. And as each new bit comes in, a new 11:52:45
state is created by combining the -- the current 11:52:50
state in the accumulator with the new bit, correct? 11:52:58
A. According to the description that I gave 11:53:02
before, if the state at any point is updated and 11:53:05
changed according to the value of the new incoming 11:53:08
bit, that is correct. 11:53:13
Q. And that's done -- am I correct that 11:53:15
that's done using mod 2 addition? 11:53:17
A. That's done according to addition in the 11:53:20
field GF(2). 11:53:23
Q. Okay. Just so I make sure I understand 11:53:24
what that is, what is GF(2)? 11:53:27
A. GF(2) is the Galois field that contains 11:53:29
two elements. 11:53:33
Q. Is the addition the same as ordinary 11:53:35
arithmetic, with the exception that one plus one 11:53:40

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

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

Video No. I in the deposition of Dr. Rüdiger Urbanke. We are off the record at 11:55 a.m. 11:55:15 11:55:19 11:55:22

(Recess taken at 11:55 a.m.) 11:55:22

THE VIDEOGRAPHER: Here begins Video No. 2 in the deposition of Dr. Rüdiger Urbanke. We are back on the record at 12:08 p.m. 12:07:59 12:08:01 12:08:04

BY MR. DOWD: 12:08:09

Q. Dr. Urbanke, before the break I was asking you whether the truth table of a mod 2 addition is the same as the GF(2) truth table that you told me about; do you recall that? 12:08:11 12:08:14 12:08:20 12:08:25

A. Yes. 12:08:27

Q. And your answer was: There are many things that may be true but you're only going to tell me what's in your report; do you recall that? 12:08:28 12:08:30 12:08:34

MR. GLASS: Objection. Mischaracterizes testimony. 12:08:37 12:08:39

THE WITNESS: I recall in a sense that you asked me about whether or not these two things were true. Since I have not studied the exact definitions of how these terms are defined, either in the patents or on the paper, I prefer not to give an ad hoc opinion on these. 12:08:39 12:08:42 12:08:45 12:08:48 12:08:50 12:08:53

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BY MR. DOWD: 12:08:56

Q. Well, do you recall at the outset today you swore to tell the truth, the whole truth and nothing but the truth? 12:08:56 12:08:58 12:09:01

A. Absolutely. 12:09:02

Q. So is it true that the truth table of mod 2 addition is one plus one equals 0, one plus 0 equals one, 0 plus one equals one, one plus one equals 0? 12:09:03 12:09:10 12:09:14 12:09:19

A. If you define the mod 2 addition in terms of this truth table, then indeed that's what the truth table is, but that's a tautology. So unless you have given me a definition of what mod 2 is and I have not looked in the patents exactly how this is defined, I cannot answer this question. 12:09:21 12:09:23 12:09:26 12:09:28 12:09:32 12:09:35

Q. So you can't explain what mod 2 addition is? 12:09:36 12:09:39

A. I have some definition of a mod 2, but I don't know if in these patents it's exactly the same definition that's used. 12:09:39 12:09:42 12:09:45

Q. Well, irrespective of the patents, what is your definition of mod 2 addition? 12:09:46 12:09:49

A. One definition of mod 2, it would be exactly the truth table that you mentioned. 12:09:50 12:09:54

Q. Okay. Now, if we go back to the two 12:10:05

formula, the Divsalar formula 5.1 and the formula of the '781 patent, Column 10 through Column 3 -- sorry, Line 10 through about Line 23, those two formulae show the same form of accumulation, right? 12:10:08 12:10:13 12:10:17 12:10:23

MR. GLASS: Objection. Outside the scope. 12:10:27

THE WITNESS: Those two formulae show a certain mathematical relationship between some sequence X and some sequence Y. 12:10:28 12:10:31 12:10:34

BY MR. DOWD: 12:10:36

Q. And it's the same relationship, right? 12:10:36

MR. GLASS: Same objections. 12:10:38

THE WITNESS: I don't know how XOR in this case is defined. I cannot answer this question to you. 12:10:39 12:10:41 12:10:46

BY MR. DOWD: 12:10:46

Q. Okay. If it is defined in the same way that we've been discussing, the mod 2 addition, then it would be the same? 12:10:46 12:10:48 12:10:50

MR. GLASS: Same objection. 12:10:51

THE WITNESS: I don't know the subtleties of the exact definition. As I said, I didn't study the patents, the exact claims to that extent. I don't know if there are any subtle issues of how these things are defined. 12:10:52 12:10:54 12:10:57 12:11:00 12:11:02

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BY MR. DOWD: 12:11:07

Q. Now, let's go back to Figure 3 that you reproduced in your report, there's an output from the accumulator qN, right? 12:11:07 12:11:10 12:11:13

A. That's correct. 12:11:15

Q. And that output is the code word produced by the encoder, right? 12:11:15 12:11:19

A. Whatever comes out of this construction is indeed what is considered the code word corresponding to whatever the input is. 12:11:23 12:11:26 12:11:29

Q. And that code word would include what are called "parity bits," right? 12:11:30 12:11:34

A. That code word is simply the output. Unless you can give me an exact definition what you mean with "parity bits," it's not possible for me to decide whether or not that fits that definition. 12:11:36 12:11:43 12:11:46 12:11:49

Q. Have you heard the term "parity bits" before? 12:11:51 12:11:54

A. Certainly. 12:11:54

Q. What do you understand "parity bits" to mean? 12:11:54 12:11:58

A. Parity bits are -- would be bits that depend on information bits and would -- may or may not be part of a code word. 12:11:58 12:12:04 12:12:14

THE REPORTER: "Be part of" -- 12:12:14

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

THE REPORTER: Thank you. 12:12:20

BY MR. DOWD: 12:12:20

Q. Now, using that definition of parity bits, am I correct that the output of an RA encoder, the code word output by an RA encoder like that shown in Figure 3 would include parity bits? 12:12:21 12:12:28 12:12:36 12:12:41

A. In this case, if that's your definition, you would say that actually all the output bits are parity bits, using the particular definition that I mentioned. 12:12:42 12:12:44 12:12:48 12:12:50

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

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

A. Yes. 12:13:08

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

A. A systematic code would be a code in which the actual data that is to be encoded in an unaltered form appears as part of the code word. 12:13:10 12:13:14 12:13:19

Q. So in a systematic code, the code word includes both the original information bits and the parity bits, correct? 12:13:23 12:13:26 12:13:30

A. Indeed, it -- it includes the original bits plus some additional bits which one might characterize as parity bits. 12:13:35 12:13:38 12:13:42

Q. Okay. And systematic codes were known before 1998, right? 12:13:43 12:13:46

A. In principle you can take a code -- you know, this depends now very much on the world in -- in the turbo coding world -- 12:13:49 12:13:52 12:13:52

THE REPORTER: What? 12:13:58

THE WITNESS: Sorry. Okay. In the turbo code world, this distinction between systematic and parity bits is a very natural one, because the viewpoint is one of an actual encoder in which the bits are being taken. The bits are being transformed in some way and then these bits are being output and perhaps there's a direct branch in which the information bits are also seen. 12:13:58 12:14:00 12:14:05 12:14:07 12:14:13 12:14:15 12:14:18 12:14:21

So there's a very natural representation between information bits or the actual systematic bits and the parity bits. 12:14:23 12:14:26 12:14:29

Q. Okay. 12:14:30

A. But if you look at the world of LDPC codes and you look at a standard representation, like a Gallagher representation, there's no a priori notion unless you do something specific which of the bits would be parity bits or systematic bits. 12:14:30 12:14:35 12:14:38 12:14:42 12:14:45

MR. DOWD: Let's mark as Exhibit 7 a copy of the Figure 3. 12:14:48 12:14:51

Q. Actually, before I do that, you mentioned in your explanation that there might be a direct branch of the original information bits; do you recall that? 12:14:57 12:15:00 12:15:03 12:15:05

A. So -- so one way of indicating in a systems point of view that they're systematic bits would be to draw a direct line from the input to the output. 12:15:05 12:15:09 12:15:13 12:15:16

MR. DOWD: Okay. So let me show you what I've created as Exhibit 7, please. 12:15:16 12:15:18

(Urbanke Exhibit 7 was marked for identification and attached to the transcript.) 12:15:21 12:15:21 12:15:50

BY MR. DOWD: 12:15:50

Q. Do you have Exhibit 7? 12:15:51

A. Yes. 12:15:52

Q. Do you see what I've added is a direct branch from the original information bits to the output? 12:15:52 12:15:55 12:15:57

A. Yes. 12:15:57

Q. That's shown in red? 12:15:58

A. Yes. 12:15:59

Q. And if I wanted to make the RA encoder of Figure 3 a systematic code, Exhibit 7 shows how to do that, right? 12:16:00 12:16:06 12:16:10

MR. GLASS: Objection. Vague. Outside the scope. 12:16:12 12:16:14

THE WITNESS: That might be one of the ways of creating a systematic code. 12:16:14 12:16:15

BY MR. DOWD: 12:16:19

Q. Okay. And a person of ordinary skill in the field in 1998 or 1999 would have known how to do what I've shown in Exhibit 7, right? 12:16:19 12:16:22 12:16:26

MR. GLASS: Objection. Vague. Outside the scope. 12:16:28 12:16:30

THE WITNESS: As I mentioned, there are many ways of taking a code word. And if you're actually having a code which is defined as a set of code words, there's no a priori definition of what systematic bits and the parity bits are. 12:16:30 12:16:33 12:16:37 12:16:40 12:16:44

So even though in this representation the output bits in your original presentation in Figure 3, in the paper we talked about, the output bits in some interpretation can naturally be defined as parity bits. 12:16:45 12:16:48 12:16:51 12:16:55 12:17:01

You might very well go back and decide that some of these bits are actually information bits and some are parity bits and even make a definition from a nonsystematic code as to one and revert it to a systematic one in a very different 12:17:01 12:17:04 12:17:07 12:17:10 12:17:15

way from what you have drawn here. So there's one way to do it as it's drawn here, but that's not -- 12:17:18

THE REPORTER: Wait. Slow down. Slow down. Start again with: 12:17:18

"So there's one way" -- 12:17:25

THE WITNESS: So there's one way to do it and that's the way you show it. But that's not necessarily the only way you can create a systematic code. 12:17:25

BY MR. DOWD: 12:17:32

Q. Fair enough. Let's -- let's break that down, though, a little bit. 12:17:33

Understanding there may be other ways that you could implement Divsalar Figure 3 as a systematic code, one way to do that would be the way shown in Exhibit 7, correct? 12:17:34

MR. GLASS: Objection. Outside the scope of the expert report. 12:17:35

THE WITNESS: You could create a systematic code in that way, yes. 12:17:39

BY MR. DOWD: 12:17:43

Q. Okay. 12:17:45

MR. DOWD: And let's mark as Exhibit 8 a further kind of refinement of what that would look 12:17:47

like. 12:18:06

(Urbanke Exhibit 8 was marked for identification and attached to the transcript.) 12:18:07 12:18:07 12:18:07

BY MR. DOWD: 12:18:07

Q. So do you have Exhibit 8? 12:18:31

A. Yes. 12:18:33

Q. And so in Exhibit 8, I'm -- the only thing I'm really adding is showing what the code word is at the bottom. Can we agree that Exhibit 8 shows one way that you could create a systematic code word from the Figure 3 RA code? 12:18:33 12:18:36 12:18:41 12:18:45 12:18:49

MR. GLASS: Outside the scope of the expert report. 12:18:52 12:18:54

THE WITNESS: So what this figure -- there's some interpretation of this figure that might show a systematic code. 12:18:58 12:19:00 12:19:03

BY MR. DOWD: 12:19:03

Q. Okay. And so you've got the direct branch from the original information bits shown in red, contributing N information bits to the code word; do you see that? 12:19:05 12:19:08 12:19:12 12:19:16

A. I see N information bits appearing somewhere -- 12:19:16 12:19:19

Q. And -- 12:19:19

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

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

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

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

nonsystematic. The main scope of this paper is to come up with coding schemes that are linear time encodable and linear time -- 12:23:51

THE REPORTER: Wait. Hold on. You've got to slow down. I just can't keep up with you. Okay? 12:23:51 12:24:00

THE WITNESS: Sorry. The main scope of that paper is to define as coding is come up with a coding scheme that is linear time encodable, linear time decodable and to come up with a particular analysis for how these various components could be chosen. 12:24:00 12:24:01 12:24:05 12:24:10 12:24:16 12:24:18

What they came up with is a scheme that resembles a hierarchical scheme component that look like LDPC components but are much more complicated. That's what the main scope of the paper is about. 12:24:20 12:24:24 12:24:28 12:24:33

MR. DOWD: Move to strike as nonresponsive. 12:24:36 12:24:38

BY MR. DOWD; 12:24:38

Q. My question, sir, is -- 12:24:38

MR. GLASS: Objection to that -- that motion. 12:24:38 12:24:40

BY MR. DOWD: 12:24:41

Q. When you read Luby, did you know what Luby meant by "message symbols"? 12:24:42 12:24:45

A. There is some interpretation in which I 12:24:47

can assume what he means on this thing by "message symbols," yes. 12:24:51 12:24:53

Q. What do you understand Luby to mean by "message symbols"? 12:24:53 12:24:56

A. A -- one possible interpretation is that these are symbols that represent the data. 12:24:57 12:25:00

Q. And by "the data," you're referring to information bits to be encoded? 12:25:02 12:25:06

A. Yes. 12:25:08

Q. And what did you understand Luby to mean by "check symbols"? 12:25:08 12:25:11

A. One possible interpretation is that these are parity check symbols. 12:25:13 12:25:16

Q. Okay. And so the check symbols would be the -- like the parity bits that we've been discussing, right? 12:25:19 12:25:22 12:25:24

MR. GLASS: Outside the scope. 12:25:25

THE WITNESS: They could be these symbols. 12:25:27

BY MR. DOWD: 12:25:29

Q. Okay. Now, Luby is in 1997, right? 12:25:29

A. Yes, that's correct. 12:25:33

Q. And that's the year before Divsalar in 1998, right? 12:25:35 12:25:39

A. That is correct. 12:25:42

Q. So before Divsalar people knew about 12:25:42

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

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

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

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

noticeable performance difference. So it means you might do that in -- perhaps in some particular version of definition you might be able to interpret it as irregular, but it would have no effect on the actual performance of the code. 01:21:15 01:21:18 01:21:20 01:21:22 01:21:25

BY MR. DOWD: 01:21:27

Q. Okay. So I wanted to break that down. I was going to come to the performance difference in a moment, but -- 01:21:27 01:21:27 01:21:27

THE REPORTER: Slow down, again. Start over. 01:21:27 01:21:30

BY MR. DOWD: 01:21:30

Q. Let's break that down. I'll come to the performance difference between the two in a moment. But just as a matter of first principles, the addition of the additional edge at the top right shown in red makes the code of Exhibit 11 an irregular repeat-accumulate code, correct? 01:21:31 01:21:35 01:21:38 01:21:42 01:21:46 01:21:50

MR. GLASS: Same objection. 01:21:53

THE WITNESS: It's a particular version of making it irregular out of a very large number of ways of making it irregular. 01:21:54 01:21:56 01:21:59

BY MR. DOWD: 01:22:01

Q. Okay. Now, the code of Exhibit 11, because it's an irregular repeat-accumulate code, 01:22:01 01:22:15

that would be covered by the claims of the asserted patents, right? 01:22:18 01:22:22

MR. GLASS: Objection. Outside the scope. Calls -- calls for a legal conclusion. 01:22:22 01:22:23

THE WITNESS: I did not study the patents or the claims or how they relate to the papers in here. 01:22:25 01:22:27 01:22:29

BY MR. DOWD: 01:22:30

Q. Okay. So you -- you can't tell me one way or the other? 01:22:30 01:22:34

A. No. 01:22:34

Q. The irregular repeat-accumulate code of Exhibit 11, that would be an IRA code as you have described it in your report, correct? 01:22:35 01:22:39 01:22:46

A. You're saying what is -- what is shown in Exhibit 11, that that would be -- qualify as an IRA code that is irregular? 01:22:50 01:22:53 01:22:57

Q. Yes, that's my question. 01:22:58

A. That is the question? 01:22:59

Yes, but just to repeat, if you take a code -- first of all, this code is a ridiculously small code, it's a toy example so it would not be of any practical use. 01:23:02 01:23:07 01:23:09 01:23:12

And in, you know, in any real application in any -- and -- and to get any benefit, this would 01:23:14 01:23:18

not be something that is usable in an actual world because what you have to do is you have to actually change a fraction of the bits to make them irregular. Otherwise, it's simply a -- you know, a mathematical coincidence, perhaps, that you can call that item as irregular depending on how exactly that the definition is -- 01:23:21 01:23:25 01:23:29 01:23:32 01:23:35 01:23:40 01:23:44

THE REPORTER: Wait. Hold on. 01:23:44

"...you can call that item..." 01:23:44

Start there and slow down. 01:23:52

THE WITNESS: If you could just please read back to me. 01:23:52 01:23:52

THE REPORTER: 01:23:52

"...a mathematical coincidence, perhaps, that you can call that item..." 01:23:35 01:23:38

THE WITNESS: That item, an irregular repeat-accumulate code, depending on how your definition is set. But it would have no difference and could act in essentially exactly the same as a regular accumulate code. 01:23:53 01:23:55 01:23:58 01:24:01 01:24:04

BY MR. DOWD: 01:24:07

Q. Okay. So let's take that step by step. 01:24:07

The code that we have as Exhibit 11, that code -- the performance of that code would not approach the Shannon limit, correct? 01:24:09 01:24:14 01:24:18

A. For several reasons it would not even get close. Number one, it's a code that has extremely small length. So a code that has such short length could not approach the Shannon limit. 01:24:20 01:24:23 01:24:26 01:24:30

Number two, it has essentially no irregularity. 01:24:32 01:24:34

Q. Well, it does have one irregularity, right? 01:24:34 01:24:39

A. If that's your definition, "irregularity," even the regular IRA code is already irregular. 01:24:39 01:24:41

Q. Well, you testified a moment ago that Exhibit 11 is an irregular repeat-accumulate code, right? 01:24:45 01:24:47 01:24:51

A. That is true according to some definition. I just claimed that even -- 01:24:51 01:24:53

Q. Okay. 01:24:53

A. -- Exhibit 10 might also qualify as an irregular one. 01:24:55 01:24:58

Q. Okay. Well, in Exhibit 10 all of the information nodes are repeated the same number of times. 01:24:59 01:25:02 01:25:04

A. That's not the definition of -- 01:25:04

THE REPORTER: Wait. Wait. You cut him off at the end. Please wait for him to finish. 01:25:04 01:25:04

THE WITNESS: Sorry. 01:25:10

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

"You have to..."

Start there.

THE WITNESS: I cannot assert that. It depends on your definition of what a -- a bad code is. Clearly, the code is very short, so it will never be an absolute scale it could code. But if you compare it to the shortest length, I don't know how good this code could be. 01:26:14 01:26:16 01:26:20 01:26:23 01:26:27 01:26:30

BY MR. DOWD: 01:26:32

Q. Okay. 01:26:32

A. You cannot say that without closer analysis. 01:26:32 01:26:35

Q. Well, can we agree that the patents cover bad IRA codes as well as they do good IRA codes? 01:26:35 01:26:38

MR. GLASS: Objection. Outside the scope of the expert report. Calls for a legal conclusion. 01:26:42 01:26:43

THE WITNESS: That I don't know. I've not studied the patents. 01:26:45 01:26:47

BY MR. DOWD: 01:26:47

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

A. No. 01:26:50

Q. Okay. 01:26:54

MR. DOWD: Let's mark as Exhibit 12 another copy of what I had previously marked as Exhibit 10, but I'm going to make one change. 01:27:04 01:27:07 01:27:10

(Urbanke Exhibit 12 was marked for identification and attached to the transcript.) 01:27:13 01:27:13 01:27:45

BY MR. DOWD: 01:27:45

Q. Do you have Exhibit 12? 01:27:45

A. Yes. 01:27:46

Q. And let me explain what I'm intending by the change that I just made. 01:27:46 01:27:49

Now, instead of only having one of the information nodes repeated four and all the rest three, now one-half of the information nodes are degree three, the other half are degree four. 01:27:50 01:27:54 01:27:57 01:28:04

A. I understand. 01:28:07

Q. And you can have any number of information nodes so you can get it long. 01:28:07 01:28:09

A. I understand. 01:28:12

Q. Exhibit 12 is an IRA code, right? 01:28:14

A. Yes, I agree. 01:28:17

Q. It's an IRA code as you would describe it in your report, right? 01:28:19 01:28:22

A. Yes, I agree. 01:28:23

Q. And this IRA code would have a fine performance, right? 01:28:24 01:28:28

MR. GLASS: Objection. Vague. 01:28:30

THE WITNESS: I don't know. This is not 01:28:31

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

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

A. But let me also mention that these are irregular, according to definition, but they're not irregular repeat codes. So your definition simply doesn't imply repetition. Your definition of irregularity has nothing to do with repetition. 01:30:36 01:30:39 01:30:42 01:30:45 01:30:48

Q. Well, what I mean to say is, is Exhibit 10 an irregular repeat-accumulate code? 01:30:50 01:30:54

A. That is true. But according to the expert report of Dr. Frey to which I respond, the definition of irregularity that he uses is not one that was commonly used and is not one that, you know, is the standard definition of irregularity in the realm of Tanner graph or LDPC codes. 01:30:56 01:31:02 01:31:05 01:31:08 01:31:10 01:31:13

Q. Well, let me ask you this, in Exhibit 10 you agree that the repetition is regular, not irregular? 01:31:18 01:31:21 01:31:24

A. If you're talking about repetitions, yes. 01:31:25

Q. Okay. And let's focus on irregular repeat-accumulate codes where it's the repetition step that is irregular, okay? 01:31:29 01:31:32 01:31:34

A. This is not the definition that's used in the expert report. 01:31:39 01:31:41

Q. Whether that's what Dr. Frey meant or not, can you have that in mind? 01:31:42 01:31:46

A. I -- my reaction is to whatever the expert 01:31:47

report is, that's what I was asked to react, and my claim is that the definition of irregularity in there used is not the correct definition. It's not the definition that was used in time. 01:31:50 01:31:55 01:31:57 01:32:00

It's a definition that's perhaps suitable for the particular purpose of showing whatever he wanted to show. But it's not a valid definition. 01:32:01 01:32:04 01:32:07

Q. What's the definition that's correct? 01:32:09

A. The standard definition in a round of LDPC codes is the definition that a regular code would be one in which all the variable nodes would be -- 01:32:11 01:32:14 01:32:23

THE REPORTER: Wait. I'm sorry. 01:32:23

"A regular code"? 01:32:23

THE WITNESS: A regular code would be one in which all the nodes would have one particular degree and all the check nodes would have one particular degree. 01:32:26 01:32:28 01:32:30 01:32:30

BY MR. DOWD: 01:32:30

Q. And do those degrees have to be the same? 01:32:30

A. No. 01:32:33

MR. DOWD: Okay. So why don't we -- why don't we do this, first let's mark as Exhibit 13 a -- another Tanner graph. 01:32:48 01:32:50 01:33:12

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(Urbanke Exhibit 13 was marked for identification and attached to the transcript.) 01:33:16 01:33:16 01:33:22

BY MR. DOWD: 01:33:23

Q. Do you have Exhibit 13? 01:33:24

A. Yes. 01:33:25

Q. Is Exhibit 13 using your understanding of what a -- an irregular repeat-accumulate code is for purposes of this case? Is it -- is Exhibit 13 an IRA code or an RA code? 01:33:25 01:33:33 01:33:35 01:33:41

A. Exhibit 13, if I see this correctly, and all the -- so simply seeing that itself, okay, would require a lot of interpretation. It's not obvious from the pictures, so let me just explain a little bit. I'm not trying to nitpick here but explain why. 01:33:45 01:33:50 01:33:54 01:33:57 01:34:00 01:34:02

Q. Sure. 01:34:04

A. Standard way of representing RA codes at the time was not that picture. So to getting from the original representation, a representation that -- 01:34:05 01:34:08 01:34:08 01:34:11

THE REPORTER: Wait. Wait. We're going to start again, and you're going to go slower this time. 01:34:14 01:34:14 01:34:15

THE WITNESS: The standard representation 01:34:15

of RA codes at that time is not according to this picture. The standard representation of RA codes at that time used the system's point of view, the one that we had talked about beforehand in Exhibit 6 -- no, 7, I believe, and 8. 01:34:17 01:34:21 01:34:25 01:34:28 01:34:35

BY MR. DOWD: 01:34:38

Q. So if it I can just pause there to understand the difference you're drawing. 01:34:38 01:34:40

You're saying that at the time you would use a figure like Figure 3 of Divsalar, not a Tanner graph like what I've marked as Exhibit 13? 01:34:42 01:34:44 01:34:47

A. Exactly. Yes. 01:34:50

Q. Okay. With that, setting that aside, is Exhibit 13 a regular or irregular repeat-accumulate code? 01:34:52 01:34:56 01:34:59

A. So if you'd just allow me a little bit to elaborate on the point. 01:35:00 01:35:04

Whether or not that corresponds to an IRA code, it's one interpretation that it could be an RA code or IRA code. But there are many other possible representations in the realm of LDPC codes. So this is not one particular code. 01:35:06 01:35:09 01:35:12 01:35:15 01:35:18

What it requires would be a certain interpretation of what these nodes actually mean. So, for example, it would require that I interpret 01:35:19 01:35:22 01:35:24

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

And there might be many other codes that I can interpret like this. So there is one particular way that I can interpret this -- 01:36:59 01:37:02 01:37:02

THE REPORTER: Hold on. Slow down. Start again. 01:37:02 01:37:08

THE WITNESS: There is -- there is a way that I can interpret that as an RA code, but it requires many, many jumps from the original representation. It would require me to know that the original system's point of view can be connected or can be represented in this way. It would require me to understand what the roles of the various nodes are, and it would require to understand exactly what the relationship between the two are. 01:37:08 01:37:09 01:37:12 01:37:15 01:37:19 01:37:21 01:37:24 01:37:28 01:37:32

These are fairly giant steps to be done in order to come to this interpretation. And if you allow me that degrees of freedom, there are many, many interpretations I can give you of this picture. 01:37:34 01:37:38 01:37:40 01:37:43

MR. DOWD: Well, why don't we set Exhibit 13 aside, and we can go back to Exhibit -- Exhibits 10 and 12, okay. 01:37:46 01:37:49 01:37:51

Q. And I'd like to, for the purposes of the next series of questions, just assume that in order to be an irregular repeat-accumulate code, the repetition has to be -- you have to have different 01:37:59 01:38:03 01:38:06 01:38:12

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

a very particular definition of irregularity which is not the standard definition so that you have very strict restrictions of how you have to interpret those nodes, then you could interpret that has an RA code. 01:39:37 01:39:41 01:39:43 01:39:45 01:39:48

But if you didn't have that in place, there would be many ways to interpret that. 01:39:48 01:39:52

BY MR. DOWD: 01:39:54

Q. Okay. Before I began this set of questions, I said: Assume with me that for these questions an irregular repeat-accumulate code, the irregular is of the repetition, okay? Do you recall that? 01:39:54 01:39:56 01:40:00 01:40:06 01:40:09

A. Uh-huh. 01:40:09

Q. So with that in mind, Exhibit 12 shows what you need to do to make an RA code an IRA code, right? 01:40:10 01:40:14 01:40:23

A. It shows that if you assume that you have Picture 10, that you interpret that as an RA Code, which is not the standard, you know, definition at the time, and it's not the standard view. It's the view now, in 2015, in hindsight, you can interpret going from Picture 10 to Picture 12 in adding these irregularity, I agree. 01:40:23 01:40:26 01:40:29 01:40:31 01:40:34 01:40:38 01:40:42

Q. Okay. Okay. Now, I think you've just 01:40:44

been getting at this, but if we turn to your report at Paragraph 152. Just let me know when you have that. 01:41:19 01:41:22 01:41:28

A. Yes. 01:41:34

Q. Now, there you say that: 01:41:34

"Turbo codes and LDPC codes were described using very different language and representations prior to the invention." 01:41:37 01:41:40 01:41:41 01:41:43

Do you see that there? 01:41:44

A. Yes. 01:41:45

Q. And then if we go back to Paragraph 28, you're describing different groups of researchers working on codes. You say there's a traditional coding theorist's group and a group of researchers with computer science, physics, and mathematics backgrounds, right? 01:41:45 01:41:59 01:42:05 01:42:08 01:42:11 01:42:15

A. Yes. 01:42:16

Q. And then you say in Paragraph 29 that: 01:42:16

"Although these researchers all had a common goal, different groups branched off in different directions and there was not much interaction between these different research branches." 01:42:21 01:42:24 01:42:26 01:42:28 01:42:31

Right? 01:42:34

A. Yes. 01:42:34
Q. Did you base the opinions expressed in your report on the belief that a researcher in one of these groups would have been unaware of the publications from researchers in the other group? 01:42:35 01:42:40 01:42:43 01:42:46
A. It's much more than unaware of application. You have to imagine that the way these papers were written, they were written in an entirely different language. 01:42:51 01:42:55 01:42:57 01:43:00
So even though, perhaps, you know, you would have one sentence that expresses exactly the same facts, there might not be a single word that actually is common, you know, in these sentences. 01:43:01 01:43:05 01:43:08 01:43:10
So it's essentially as if you came in a room where you would have people of all kinds of languages. They might all have a similar aim in mind and they might all talk about -- at the end about the same aim, about the same kind of objects. 01:43:13 01:43:16 01:43:19 01:43:22 01:43:25
But if someone speaks Spanish, the second person speaks, let's say, Chinese, and the first one speaks German, it is quite difficult to actually do the translation. 01:43:28 01:43:32 01:43:36 01:43:40
So this is not just something whether or not you have something in -- you know, in front of you. But it would be very difficult to interpret 01:43:40 01:43:43 01:43:45

whatever you have seen in your language seeing something in a different language. 01:43:48 01:43:50

MR. DOWD: Okay. Let's -- let's break that down because I'm going to move to strike as nonresponsive. 01:43:53 01:43:53 01:43:57

MR. GLASS: And object if you do move to strike. 01:43:58 01:44:00

BY MR. DOWD: 01:44:01

Q. My question was, is it your -- withdrawn. 01:44:02

Did you base the opinions in your report on a belief that the researcher in one group would not have known about the publication of a researcher in another group? 01:44:06 01:44:08 01:44:11 01:44:15

A. No. 01:44:17

Q. Okay. All of Divsalar, Luby '97, Luby '98, Richardson '99, the Frey '99 paper, they were all actually written in the English language, right? 01:44:18 01:44:22 01:44:30 01:44:32

A. English is language that was actually used to express it. 01:44:32 01:44:35

Q. Okay. 01:44:36

A. But the -- no, this is not the same thing. You -- I can give you easily examples of a sentence where one in the same sentence would express exactly the same thing and they might share essentially no 01:44:36 01:44:39 01:44:43 01:44:46

words. 01:44:49

Q. And is it your position that a Ph.D. in this field with two to three years of experience with error correction codes would be unable to understand what was said in one of these papers if it was published by a person of an opposite group? 01:44:50 01:44:57 01:44:59 01:45:04 01:45:07

A. I can tell you that studying in 1999, 2000, we had a sequence of workshops trying exactly to bring these kind of groups together. It has taken essentially about 10 years until people in the various groups can comfortably talk to each other. So this is not a trivial effort that is undertaking. It's not something -- imagine like learning another language. 01:45:12 01:45:17 01:45:21 01:45:25 01:45:28 01:45:31 01:45:35 01:45:37

You know, perhaps some people are more gifted, some people are less gifted, but it's not a trivial effort of simply plugging in something and simply having a dictionary or something like that. It's a serious effort that is required. 01:45:37 01:45:40 01:45:44 01:45:46 01:45:49

Q. My question is, is it your position that a traditional coding theorist reading a publication such as Luby which came from the computer science group would not be able to understand what Luby was saying? 01:45:51 01:45:56 01:46:00 01:46:03 01:46:05

A. It's my position that to start with a 01:46:05

person in coding theory would have not even been able to judge at that point whatever was written in Luby was actually of interest to him or her. 01:46:07 01:46:13 01:46:16

Because the way things were represented were so different that, you know, the -- the kind of objective, if they were done, the standard pictures that were done to prove that these things were good were so different that it was far from obvious that whatever was written in this paper was relevant to potentially their problem. 01:46:19 01:46:21 01:46:24 01:46:28 01:46:32 01:46:34 01:46:37

Q. Well, my question is not would they have been able to judge whether it was of interest or whether it was good. 01:46:39 01:46:46 01:46:48

My question is, if they read the words in English, would they be able to understand what the words meant? 01:46:49 01:46:53 01:46:55

A. They might have to read several papers to understand them. They might have to go back to, you know, other literature to understand, perhaps, what is written in there. 01:46:58 01:47:01 01:47:05 01:47:07

Q. Okay. But they could read the English language and they could understand what it meant, correct? 01:47:08 01:47:11 01:47:15

A. If a physicist, for example, talks about a long code, he's talking about -- you know, in a 01:47:15 01:47:18

completely different way. Now, you know, this is a single word that he's using, we are using, let's say, a symptotic, right, they -- 01:47:22 01:47:26 01:47:26

THE REPORTER: Wait. 01:47:26

"We are using..." 01:47:41

THE WITNESS: For example, in our -- in EE, people would be talking about the symptotic limit. Physicists would talk -- 01:47:41

THE REPORTER: Wait. Wait. I'm -- I'm not understanding you. You're going to have to slow down and repeat yourself, please.

THE WITNESS: For example, to give you one trivial example, if people in E talking about long codes, they were talking about, let's say, a symptotically long codes, a physicist would be talking about the thermodynamic limit. It's far from obvious that these two things even relate to each other. And you would need a person to get started to tell you which of these terms indeed at first relate to each other in order to get started. 01:47:43 01:47:44 01:47:47 01:47:50 01:47:53 01:47:57 01:48:00 01:48:02 01:48:07

I'm not claiming that it is impossible to learn. People have learned it. But it is a serious effort to do and it's by far not obvious to do. 01:48:09 01:48:11 01:48:14

MR. DOWD: Let's mark as Exhibit 14, a copy of the thesis of Dr. Khandekar. 01:48:33 01:48:36

(Urbanke Exhibit 14 was marked for identification and attached to the transcript.) 01:48:42 01:48:42 01:48:53

BY MR. DOWD: 01:48:53

Q. Do you have Exhibit 14? 01:48:53

A. Yes. 01:48:54

Q. Do you recognize it? 01:48:55

A. It says: 01:48:57

"Graph-based Codes in Iterative Decoding, Theis by Aamod Khandekar." 01:48:58 01:49:00

Q. So Exhibit 14 is the Ph.D. thesis that Dr. Khandekar submitted, right? 01:49:03 01:49:09

A. That's what it says on the page. 01:49:11

Q. Have you reviewed Dr. Khandekar's thesis before? 01:49:13 01:49:16

A. I must have leafed through it but not in any detail. 01:49:17 01:49:20

Q. Now, before Dr. Khandekar had been awarded his Ph.D.; in other words, at the time he was writing this document, he did not have a Ph.D., right? 01:49:21 01:49:29 01:49:31 01:49:36

A. Presumably not. 01:49:36

Q. He had not been working in the field for two to three years, right? 01:49:44 01:49:46

A. I don't know exactly his employment 01:49:48

history. I don't know how long he actually studied. He might have very well started on a master's level. 01:49:50 01:49:52

Q. Turn to Page 3311. Now, on this page, Dr. Khandekar shows a -- an example of the repeat-accumulate codes introduced in 15; do you see that? 01:49:56 01:50:13 01:50:27 01:50:31

A. I see a picture, yes. 01:50:31

Q. And there's a representation of a repeat-accumulate code like the one we saw in Figure 3 of Divsalar, right? 01:50:33 01:50:39 01:50:41

A. The figure heading says: "A small Tanner graph." 01:50:42 01:50:42

THE REPORTER: Wait. I'm sorry, I didn't hear that part. Please repeat. 01:50:42 01:50:46

THE WITNESS: The figure heading says: "A small Tanner graph." 01:50:46 01:50:48

BY MR. DOWD: 01:50:49

Q. You're on Page 3311? 01:50:49

A. Oh, sorry, 3312, sorry. Okay. 01:50:51

Q. So on Page 3311 there's Figure 1.4, a repeat-accumulate code, right? 01:50:56 01:51:01

A. Figure -- you're talking about Figure 13? 01:51:02

Q. 1.4 in the middle of the page. 01:51:05

A. 1.4, the heading says: "A repeat-accumulate code." Yes. 01:51:08 01:51:12

Q. And in the paragraph right above that he says: 01:51:12 01:51:15

"One example of the SCCC case is the ensemble of repeat-accumulate (RA) codes introduced in 15." 01:51:16 01:51:20 01:51:25

Right? 01:51:26

A. I see that, yes. 01:51:27

Q. And if you turn to Page 3400, near the back. 01:51:28 01:51:37

A. Yes. 01:51:44

Q. We see that Reference 15 is the Divsalar 1998 RA codes paper that we've been discussing, right? 01:51:45 01:51:48 01:51:54

A. Okay. 01:51:54

Q. Do you see that there? 01:51:55

A. I see Reference Number 15, yes. 01:51:56

Q. And that's the Divsalar RA codes paper, right? 01:51:58 01:52:02

A. Yes. 01:52:02

Q. So Dr. Khandekar was aware of the Divsalar RA codes paper, right? 01:52:04 01:52:08

MR. GLASS: Objection. Outside the scope. 01:52:10

THE WITNESS: Dr. Khandekar, as far as I know, was a Ph.D. student of Dr. -- or Professor MacKay. 01:52:11 01:52:14 01:52:20

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

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

Q. Now, in the third paragraph, that paragraph starts: 01:54:18 01:54:21

"We also introduce a new class of codes called irregular repeat-accumulate (IRA) codes which are adapted from the previously known class of repeat-accumulate codes." 01:54:22 01:54:25 01:54:31 01:54:35 01:54:37

Do you see that? 01:54:38

A. Yes. 01:54:39

Q. And Dr. Khandekar is correct that IRA codes are adapted from RA codes, right? 01:54:40 01:54:48

A. I don't know the history of how they came about it; but if he says so, then I trust him. 01:54:53 01:54:55

Q. Okay. So you have no reason to disagree with that statement, right? 01:54:59 01:55:01

A. No. 01:55:02

Q. And then he goes on, in the next sentence, to describe irregular LDPC codes, which he says are: 01:55:03 01:55:07

Quote, arguably the best class of codes known today, at least for long locked lengths. 01:55:14 01:55:16 01:55:20

Right? 01:55:22

A. Yes, I see that sentence. 01:55:22

Q. So Dr. Khandekar was also aware of irregular LDPC codes, right? 01:55:24 01:55:29

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

2002. What he thought, I think it's best to pose the question to him. 01:57:05 01:57:09

BY MR. DOWD: 01:57:11

Q. So you have no opinion on that? 01:57:11

A. How would I know what he thought at that time? 01:57:12 01:57:15

Q. Well, in a Chapter 3 entitled: "Irregular Repeat Accumulate Codes," the first two cited references are Luby '97 and Luby '98. 01:57:15 01:57:18 01:57:21

Do you see that? 01:57:24

A. I see that. 01:57:24

Q. And you can't tell me one way or the other whether that indicates that Dr. Khandekar believed Luby '97 and Luby '98 were relevant to irregular repeat-accumulate codes? 01:57:25 01:57:28 01:57:35 01:57:38

A. I have absolutely no idea, you know, what his motivation were where to put it. I have not read the thesis in that detail. I have not been asked to make a -- you know, a detailed opinion about this thing. I think this is best posed the question to him and that could -- he could clarify the question, what was he thinking and at what point was he thinking that. 01:57:39 01:57:41 01:57:44 01:57:47 01:57:50 01:57:52 01:57:55 01:57:58

Q. Okay. So respect to the question of how Luby '97 and Luby '98 related to Dr. Khandekar's IRA 01:58:01 01:58:06

codes discussion, you can't help us answer that question? 01:58:11 01:58:13

A. I cannot help you in why exactly he put that particular line at, you know, Line, let's say, 10 in his thesis, Chapter 3, I don't know. 01:58:15 01:58:18 01:58:22

Q. Okay. So you do see that Dr. Luby called -- I'm sorry -- withdrawn. 01:58:26 01:58:31

You do see that Dr. Khandekar called Luby '97 and '98 a, quote, major breakthrough, close quote, right? 01:58:35 01:58:39 01:58:43

A. Yes. 01:58:43

Q. And it is true that Luby '97 and Luby '98 were a major breakthrough, right? 01:58:43 01:58:46

A. Luby '97 and Luby '98 brought the state-of-the-art, the theoretical state-of-the-art forward in terms of the analysis. They were the first ones for a very particular channel model, the BC, which is very particular and what was not thought about at that point in time to be relevant. Only in hindsight did it turn out that it was to a new state-of-the-art. 01:58:49 01:58:53 01:58:56 01:59:01 01:59:05 01:59:10 01:59:13 01:59:17

Q. Well, Luby '97 and Luby '98 -- let's take it a step at a time. 01:59:19 01:59:23

Luby '97 and Luby '98 did advance the state-of-the-art, correct? 01:59:25 01:59:29

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

opinion on why Dr. Khandekar chose not to disclose Luby '97, Luby '98, or Richardson '99 to the Patent Office, right? 02:01:24 02:01:28 02:01:31

A. No. 02:01:32

Q. So that -- you've not performed any opinion on that question? 02:01:33 02:01:36

A. No. I would have no idea. 02:01:37

Q. Okay. Now, is it your position that a person of ordinary skill would not have considered Divsalar, the two Luby references, and Richardson 1999 together? 02:01:41 02:01:49 02:01:52 02:01:56

MR. GLASS: Objection. Vague. 02:02:03

Go ahead. 02:02:04

THE WITNESS: If you could, perhaps, please specify a little bit more what "together" means. 02:02:04 02:02:06 02:02:08

BY MR. DOWD: 02:02:09

Q. I mean, is it your position that -- well, let's take them by groups. 02:02:11 02:02:15

A person of ordinary skill would not have considered Divsalar -- the work of Divsalar and the -- the Luby 1997 paper in the 1999 time frame? 02:02:16 02:02:19 02:02:22

MR. GLASS: Objection. Vague. 02:02:29

THE WITNESS: So what I looked at in particular in my report, are the Luby '97, Luby '98, 02:02:34 02:02:37

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

And I there refer in particular here to 12 where, you know, later on we get to the Divsalar paper. But I'm sorry, I guess this was -- you were not referring to the Divsalar paper, 2001 paper, you were referring to the '98 paper, correct? 02:05:08 02:05:14 02:05:19 02:05:21 02:05:25

Q. Correct. 02:05:28

A. I'm sorry. Okay. So I... 02:05:28

Sorry. 02:05:29

Q. So let's just break that down. 02:05:29

First, your testimony just now was talking about Paragraph 135 and the Footnote 12, right? 02:05:32 02:05:33

A. Right. 02:05:38

Q. Okay. 02:05:38

A. But I'm -- 02:05:39

Q. And let me give you my question again because I was -- 02:05:39 02:05:41

A. Right. 02:05:41

Q. -- asking a somewhat different question. 02:05:42

A. Okay. 02:05:44

Q. My question is, you have not offered an opinion about what a person of ordinary skill in the art would understand from reading the Divsalar '98 RA codes paper together with the Luby '97 paper, correct? 02:05:44 02:05:46 02:05:49 02:05:58 02:06:04

A. There is, in my report, I believe no 02:06:04

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

ordinary skill would have not combined these ideas and applied them to the standard RA codes. But I don't refer to it as -- the RA codes as in the '98 paper. 02:07:25 02:07:29 02:07:34 02:07:37

Q. Okay. And we'll come -- we'll come back to those opinions. 02:07:37 02:07:39

But my question -- my next question is, there's no opinion stated in your report about what a person of ordinary skill would understand from reading Divsalar 1998 together with Richardson 1999, correct? 02:07:40 02:07:43 02:07:47 02:07:51 02:07:57

A. Yes, I only refer to it in terms of RA codes, but not in terms of a specific paper. 02:07:57 02:08:00

Q. Okay. And then there's no -- I think we covered this already, but just to make sure. There's no opinion in your report about comparing any of those three combinations to the actual limitations of the claims of the patents-in-suit? 02:08:03 02:08:10 02:08:15 02:08:17 02:08:20

A. There's certainly nothing that would look at the actual limitations of the -- or the claims themselves and -- 02:08:24 02:08:26 02:08:29

Q. Okay. 02:08:29

A. -- make a comparison. 02:08:31

Q. Okay. Now... 02:08:32

A. So maybe if I can, you know -- perhaps I 02:09:05

don't know if I have to correct my statement or not. In Paragraph 141, I opinion on the Paragraphs 578 and 579 in the report by Frey. 02:09:08 02:09:10 02:09:13

And that report refers to Luby '97 and repeat-accumulate codes described by Divsalar or repeat-accumulate code described by Wang. 02:09:18 02:09:26 02:09:29

So I guess the question is whether or not you insist that the reference is they're implicitly or explicitly. 02:09:31 02:09:33 02:09:37

Q. Let me put it to you this way, there's no opinion in your report that says that if you take the Divsalar disclosure and the Luby 1997 disclosure, the following limitation of the following claim is not present? 02:09:43 02:09:47 02:09:50 02:09:55 02:09:57

A. I do not compare to the claims. That's correct. 02:09:59 02:10:04

Q. Okay. 02:10:04

A. But I do opinion on the general papers, if you so want, without explicitly referring to the Divsalar paper, I only implicitly refer to it by referring to paragraphs in Frye's report which presumably explicitly refers to the paper. 02:10:04 02:10:08 02:10:12 02:10:16 02:10:20

Q. Now, if we go back to the Khandekar thesis, and if you turn to Page 3301, let me ask when you have that, you see in the middle of the top 02:10:25 02:10:35 02:10:50

paragraph there's a reference, again, to the Luby '97 and Luby '98 papers? 02:10:54 02:10:56

A. Excuse me, is this 3331 or 3301? 02:10:59

Q. I apologize if I misspoke. I meant 3301. 02:11:03

A. Okay, sorry, my mistake. 02:11:08

Q. And do you see in the middle of the top paragraph there, there's again a reference to the Luby '97 and Luby '98 papers? 02:11:25 02:11:28 02:11:30

A. Yes, that's correct. 02:11:32

Q. And he says just below that: 02:11:33

"Luby, et al., also introduced the concept of irregularity." 02:11:35 02:11:38

Do you see that there? 02:11:40

A. I see that there, yes. 02:11:41

Q. And is Dr. Khandekar correct that Luby in Luby '97 and '98 were the first to introduce the concept of irregularity? 02:11:42 02:11:45 02:11:48

A. To introduce the particular concept of the irregularity in the '97 paper, referring to a particular version of hierarchical LDPC codes. 02:11:50 02:11:52 02:11:55

Q. Now... 02:11:59

A. Just to, you know, amend what I mean, there are also other versions of irregularity, for example, in the turbo coding literature and other versions of -- also in the LBC literature of what 02:12:08 02:12:11 02:12:13 02:12:17

irregularity could mean. 02:12:22

MR. DOWD: Now, let's mark as Exhibit 15 a copy of Dr. MacKay's "Gallager Codes Recent Results" paper from the 1999 Allerton conference. 02:12:24 02:12:29 02:12:39

(Urbanke Exhibit 15 was marked for identification and attached to the transcript.) 02:12:44 02:12:44 02:12:46

BY MR. DOWD: 02:12:46

Q. Do you have Exhibit 15? 02:12:46

A. Yes. 02:12:51

Q. Do you recognize it? 02:12:55

A. It says: "Gallager Codes Recent Results." 02:12:55

Q. And this is a paper by Dr. MacKay, right? 02:12:59

A. Yes, according to the authorship, it's Dave MacKay. 02:13:02 02:13:06

Q. Now, Exhibit 15 is talking about Gallager codes, right? 02:13:09 02:13:13

MR. GLASS: Objection. Outside the scope. 02:13:14

THE WITNESS: I have not looked at that paper in a very, very long time. I don't know. But it has "Gallager Codes" in the -- in the title. But I have absolutely no idea. 02:13:15 02:13:18 02:13:22 02:13:27

BY MR. DOWD: 02:13:29

Q. My question is just -- a Gallager code's just another way of talking about LDPC codes, right? 02:13:30 02:13:35

MR. GLASS: Objection. Vague. 02:13:38

THE WITNESS: I don't know exactly what he had in mind in here. Some people use this term. 02:13:39 02:13:40

BY MR. DOWD: 02:13:43

Q. Okay. Do you see in the abstract there's a -- there's a third paragraph which begins: 02:13:43 02:13:46

"This paper reviews low-density parity check codes (Gallager codes), repeat-accumulate codes, and turbo codes"? 02:13:48 02:13:51 02:13:57

A. Yes, I see this. 02:14:00

Q. And so do you understand this paper is about all three? 02:14:02 02:14:05

MR. GLASS: Objection. Outside the scope. 02:14:06

THE WITNESS: I have no idea. I would have to read that carefully and that could take a while. 02:14:07 02:14:08 02:14:12

BY MR. DOWD: 02:14:12

Q. Okay. When's the last time you read Exhibit 15? 02:14:12 02:14:16

A. I don't recall. 02:14:16

Q. Would it have been back in the 1999 time frame? 02:14:17 02:14:22

A. Possible. I don't know. 02:14:22

Q. If you turn to Page 2, which has the Bates Page 1847, you see there's a discussion of 02:14:24 02:14:32

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

The two references he cites are the Luby '98 paper and your Richardson '99 paper, right? 02:16:09 02:16:13

A. Yes, I see that in parentheses. 02:16:15

Q. So it was true in 1999 that people were actually looking at Divsalar, those two Luby papers, and the Richardson 1999 reference together, right? 02:16:22 02:16:25 02:16:31

A. He mentions all these three names together in a paper, yes. 02:16:38 02:16:41

Q. And he's comparing those different types of codes, right? 02:16:42 02:16:44

A. That I don't know. I have not read that paper in detail to say what he's actually doing. 02:16:46 02:16:48

Q. Okay. But you can at least tell from the abstract that the paper reviews all three types, right? 02:16:52 02:16:54 02:16:54

A. He mentions -- 02:16:57

MR. GLASS: Objection. Outside the scope. 02:16:57

THE WITNESS: He mentions some of these names. What exactly he means with these terms, how he defines them, what he does with them, I have no idea. 02:16:59 02:17:01 02:17:04 02:17:05

BY MR. DOWD: 02:17:06

Q. Now, Ambleson (verbatim) '99, that was before the patents in this case, right? 02:17:06 02:17:10

A. I believe so, yes. 02:17:12

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

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

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

performance in Figure 2, 2A and 2B, right? So he is looking at the performance of an RA code, right? 02:20:08 02:20:17

A. I don't know. 02:20:20

Q. You don't know. All right. 02:20:20

Well, let's go back to Divsalar in Figure 3. Do you have that still? It should be -- 02:20:29 02:20:31

A. Which exhibit are you talking about? 02:20:36

Q. Exhibit 6. 02:20:38

A. Exhibit 6. Yes. 02:20:40

Q. And in your report, at Paragraph 154, you say: 02:20:49 02:20:55

"Even if someone thought to modify RA codes to improve them, there are any number of modifications that could be made." 02:20:55 02:20:58 02:21:00 02:21:01

And then in 155: 02:21:03

"Even if someone thought to make RA codes irregular, there are any number of ways irregularity could be applied?" 02:21:05 02:21:08 02:21:10

Right? 02:21:14

A. Yes. 02:21:24

Q. The RA code in Figure 3 has three blocks, right? 02:21:26 02:21:38

A. The way it is in Figure 3? 02:21:38

Q. Of Divsalar. 02:21:41

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

could. And one particular way to do it would have to be several branches and then make these branches to be any -- 02:22:47

THE REPORTER: Wait. 02:22:47

"One particular" -- "one particular way..." 02:22:54

Start there. 02:22:54

THE WITNESS: Would have been to choose several branches. And then as for turbo codes, choose various ways of using the components. 02:22:55

BY MR. DOWD: 02:23:02

Q. Okay. So now -- now I think I understand. 02:23:03

So if I was going to make an IRA code using Figure 3, you could do that by making the -- having multiple different accumulators? 02:23:06

A. That might be one way, but, you know, there's any number of ways that you can do it. You could, for example, branch off there, this one particular branch having as many as accumulators as you wanted. You could have the permutations in any way you wanted. 02:23:16

You could have, you know, many -- many other things. You could have several branches in the beginning and branch off there. You could do over non-binary alphabets and make them kind of 02:23:32

different. You could choose different and stronger component codes. There's any number of ways of doing this. 02:23:42 02:23:45 02:23:49

Q. Well, I'm not asking about making a different and stronger code. I'm just making it irregular; okay? 02:23:49 02:23:51 02:23:54

A. The only motivation for making them irregular would be to make them stronger. 02:23:54 02:23:57

Q. Well, let's just -- without respect to whether they make them stronger or not stronger. If I wanted to make it irregular, I could make the repeat irregular, that's one way, right? 02:23:59 02:24:00 02:24:03 02:24:05

A. That's one way. 02:24:08

Q. Can I make the permutation irregular? 02:24:10

A. You could have many branches, as I claimed. There's no reason you have a single box -- 02:24:13 02:24:15

THE REPORTER: Slow down, please. 02:24:15

"There's no reason..." 02:24:15

Start there. 02:24:19

THE WITNESS: There's no reason that each of those boxes should be a single box. 02:24:19 02:24:20

BY MR. DOWD: 02:24:24

Q. Okay. And then if I make accumulate irregular, that would also require multiple boxes, right? 02:24:25 02:24:27 02:24:30

A. Perhaps there might be other ways of doing it too. This would be a research question. But there must be many, many, many ways of making it irregular. 02:24:30 02:24:32 02:24:35 02:24:38

Q. Okay. Well, let's break it down. 02:24:38

If I'm going to keep the exact same structure as Figure 3, so I've got one repeat box, one permute box, one accumulate box, am I correct that the only way to make this an irregular repeat-accumulate code is to make the repeater an irregular repeat? 02:24:41 02:24:43 02:24:47 02:24:52 02:24:56 02:25:00

A. No. Because you could, for example, take symbols which are not bits, you could take bits and put -- group them together, and then treat the blocks in these symbols as symbols in the higher alphabet and do any number of operations of them. 02:25:01 02:25:03 02:25:06 02:25:08 02:25:11

So there is a large degree of how you could make them irregular. 02:25:14 02:25:17

Q. So you're saying upstream, instead of inputting bits, you're inputting something else? 02:25:18 02:25:22

A. You would still put bits, but there's no reason you have to treat them as bits. 02:25:22 02:25:22

THE REPORTER: Repeat your answer. 02:25:26

THE WITNESS: There's no reason -- you would still input bits, but there's no reason that 02:25:26 02:25:30

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

in a particular way that it reduces -- introduces irregularity. There's many number of ways that you can do that. And these number of ways have been explored, for example, in an -- in LDPC setting. 02:26:34 02:26:38 02:26:40 02:26:43

Q. So let's talk about where the repetition requires creating a duplication of the bits, okay? Do you have that in mind? 02:26:46 02:26:49 02:26:51

A. We're talking about the first box? You're referring to the first box? 02:26:53 02:26:56

Q. I am. If the first box must create a duplicate, it's duplicating the input bits? 02:26:57 02:27:02

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

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

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

Q. Okay. And so we're not making them symbols, we're not doing anything else. 02:27:11 02:27:13

In that circumstance, then the way that you would change Figure 3 to become irregular is you create some number of duplicates for some bits and a different number of duplicates for other bits, right? 02:27:15 02:27:20 02:27:25 02:27:30

A. That would be --

MR. GLASS: Vague.

THE WITNESS: -- one way of doing it.

MR. DOWD: All right.

THE REPORTER: I didn't catch either the objection nor the answer. Maybe you guys could separate them.

MR. GLASS: Vague.

Go ahead. 02:27:39

THE WITNESS: That would be one way of doing it. But as I claimed, you can do this in any number of other ways. Even if you repeated a constant number of times and they were bits, you could later on, for example, combine this bits to 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

And there's no reason that you would fix every single thing so that the conclusion -- only conclusion can be that the only thing you can do is repetition. You -- if you're telling me to tie your hands behind -- 02:27:55 02:27:58 02:28:00 02:28:02

THE REPORTER: Wait.

THE WITNESS: -- behind your back so --

THE REPORTER: Hold on. Hold on. Slow down. Okay?

THE WITNESS: You're telling me, basically, if you tie your hands behind your back and, you know, disallow any of the reasonable things you could have done, then the only thing you could have done is the one thing that you can do, given 02:28:08 02:28:09 02:28:11 02:28:14 02:28:17

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

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

trivial." 02:42:35

A. Okay. 02:42:35

Q. And then it continues. Do you see that? 02:42:35

A. Yes. 02:42:37

Q. If a person of ordinary skill, back in '98, '99, wanted to make the repetition code irregular, they would have been able to do so, right? 02:42:38 02:42:43 02:42:49 02:42:53

A. What is your definition of irregular? 02:42:53

Q. That some subset of the bits are repeated one number of times and at least one other subset of bits is repeated a different number of times. 02:42:55 02:43:03 02:43:07

A. It seems to me that if you're asking that if you tell someone make it so, then you're telling exactly what to do. So I don't quite understand what do you mean, they would have been able to do so. Because in order to tell him what to do, you would have to give them the exact description what to do. Otherwise, you have not given me a definition of what irregular means. 02:43:10 02:43:14 02:43:17 02:43:20 02:43:23 02:43:26 02:43:28 02:43:30

Q. Okay. So with the understanding that irregular means that some of the bits are repeated one number of times and other of the bits are repeated a different number of times. Do you have that in mind? 02:43:32 02:43:34 02:43:37 02:43:40 02:43:44

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

you tell them to do. 02:45:02

Q. Okay. So there's nothing difficult about following that instruction, right? 02:45:04 02:45:07

A. If the instruction is as explicit as telling them exactly what to do, then it's simply a program that you have to follow. 02:45:08 02:45:11 02:45:15

Q. Okay. And if you said to a person in the field, without more: I'd like you to take the repetition code of Divsalar Figure 3 and make it an irregular repetition code, they'd be able to do that too, right? 02:45:17 02:45:21 02:45:25 02:45:29 02:45:33

A. If you could tell me what your definition of irregular repetition code is. 02:45:33 02:45:35

Q. Using any definition. 02:45:38

A. I think it seems -- your question -- or the answer to the question hinges exactly on what you tell a person to do. 02:45:39 02:45:42 02:45:45

I'm sorry if I repeat myself. But if you tell the person explicitly what to do, then inherently it's easy to do. But if you tell a person, you know, fairly vague things, improve, let's say, the code, or any other number of questions that perhaps at that point might have come up, the question is an entirely different one, and my answer would be entirely different. 02:45:46 02:45:49 02:45:53 02:45:57 02:45:59 02:46:01 02:46:03 02:46:06

Q. Okay. And my question is, if the instruction was: Take Divsalar Figure 3, I want you to change the repeater so that it performs an irregular repetition, would a person of ordinary skill know how to do that? 02:46:08 02:46:11 02:46:15 02:46:19 02:46:23

A. I would say yes because you would have, in the -- in the question, told the person exactly what to do. 02:46:25 02:46:30 02:46:32

Q. Okay. And, in fact, are you aware of people in 1998 taking a repeat-accumulate code and making the repeat an irregular repeat? 02:46:32 02:46:38 02:46:42

A. In 1998, for the -- you're talking about RA codes themselves? 02:46:46 02:46:55

Q. Yes. 02:46:55

A. I am not aware of other results than the one -- you know, if we're talking about strict sense RA codes as they're described in here, I'm not aware of other people doing it. 02:46:56 02:47:03 02:47:07 02:47:10

MR. DOWD: Let me show you what I'll mark as Exhibit 16, a copy of a document that bears Bates number HUGHES1858 through 1873, entitled: "RA.c." 02:47:27 02:47:29 02:47:33

(Urbanke Exhibit 16 was marked for identification and attached to the transcript.) 02:47:44 02:47:44 02:47:54

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

a -- a line that says:
"N sub 1, N sub 2, dot, dot, dot, N sub K." 02:49:03 02:49:04 02:49:08

A. Yes. 02:49:10

Q. And there's a description there that says: 02:49:11

"Number of repetition of each source bit." 02:49:14 02:49:17

Right? 02:49:17

A. I see that, yes. 02:49:18

Q. And so what's happening there is you've got at least three subsets of source bits, N sub 1, N sub 2, through N sub K, right? 02:49:19 02:49:22 02:49:27

A. That I don't know. I have not looked at the program. I've never run it. I have not looked at what the definition of the variables are. That is a program that seems to have 16 pages. It's not a triviality to say what this code actually does. 02:49:30 02:49:31 02:49:34 02:49:37 02:49:40

THE REPORTER: Hold on. State the last part over. 02:49:42 02:49:44

THE WITNESS: It's a program that seems to be containing about 16 pages of source code. It is not a triviality to determine what such a code actually does. 02:49:44 02:49:46 02:49:48 02:49:52

BY MR. DOWD: 02:49:53

Q. Okay. And so you've formed no opinion 02:49:54

about what this "N sub 1, N sub 2, N sub K" means, right? 02:49:58 02:50:07

A. No. 02:50:07

Q. Is that correct? 02:50:08

A. Yes. 02:50:12

Q. And to the extent that that is setting the number of repetitions of each source bit, you have no opinion about that, right? 02:50:12 02:50:15 02:50:20

A. I don't know what these variables are. It would take, you know, a fairly extensive study to determine what this program actually does and what these parameters might be for. 02:50:22 02:50:25 02:50:28 02:50:31

Q. Okay. Now, let's assume that you've got a repeat-accumulate code like the Divsalar code, Figure 3? 02:50:33 02:50:36 02:50:39

A. Uh-huh. 02:50:40

Q. And assume that you divide the input block of N bits into three subgroups: N1, N2, NK, okay? 02:50:41 02:50:49

A. Correct. 02:50:57

Q. And assume also that the number of repetitions for each subgroup will be different, okay? 02:50:57 02:51:01 02:51:04

A. Okay. 02:51:08

Q. In that case, the code would be an IRA code, right? 02:51:08 02:51:14