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FEDERAL TRADE COMMISSION

I N D E X (PUBLIC RECORD)

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UNITED STATES OF AMERICA

FEDERAL TRADE COMMISSION

In the Matter of:)

Rambus, Inc.) Docket No. 9302

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Thursday, July 10, 2003

9:31 a.m.

TRIAL VOLUME 40

PART 1

PUBLIC RECORD

BEFORE THE HONORABLE STEPHEN J. McGUIRE

Chief Administrative Law Judge

Federal Trade Commission

600 Pennsylvania Avenue, N.W.

Washington, D.C.

Reported by: Josett F. Hall, RMR-CRR

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P R O C E E D I N G S- - - - -

JUDGE McGUIRE: This hearing is now in order. Counsel, how is everyone doing this morning?

MR. ROYALL: Fine. Thank you.

JUDGE McGUIRE: Any issues we need to take up before we begin today?

MR. STONE: I don't believe so, Your Honor.

JUDGE McGUIRE: Then, Dr. Farmwald, you can take the stand. You're still under oath from yesterday.

And Mr. Royall, you may proceed with your cross-examination.

MR. ROYALL: Thank you, Your Honor.

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Whereupon --

PAUL MICHAEL FARMWALD

a witness, called for examination, having been previously duly sworn, was examined and testified as follows:

CROSS-EXAMINATION (continued)

BY MR. ROYALL:

Q. Good morning, Dr. Farmwald.

A. Good morning.

Q. Am I right, Dr. Farmwald, that you do not

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recall any discussion at Rambus board meetings in the early 1990s about whether Rambus needed to disclose patents or patent applications to JEDEC?

A. I'd say it somewhat stronger than that. I'm pretty sure I would recall had there been such discussions, so not only do I not recall, I'm pretty sure I would recall if there had been.

Q. And I think you testified yesterday that it's your recollection that you had never even heard of a JEDEC patent policy before around the year 2000; is that right?

A. That's the best of my recollection, yes.

Q. But isn't it true, Dr. Farmwald, that in the early 1990s you at least had some familiarity with the fact that companies attending JEDEC meetings sometimes made patent-related disclosures to JEDEC?

A. I don't remember. It's possible that I had some knowledge, but I don't remember right now that I had.

Q. Is it possible that you also were aware that companies attending JEDEC meetings sometimes disclosed the existence of patent applications relevant to JEDEC's work?

A. I have no memory of that. It's possible, but I don't remember it.

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Q. Do you have any recollection of knowing in the early 1990s that JEDEC kept a list of patents and patent applications that were disclosed?

A. I have no such memory.

MR. ROYALL: May I approach, Your Honor?

JUDGE McGUIRE: Go ahead.

BY MR. ROYALL:

Q. I've just handed you a document, Dr. Farmwald, that's marked as CX-672, and this is an e-mail that you'll see relates to a JEDEC meeting in February of 1992. And like an e-mail that I showed you yesterday, the second page you'll see ends with the name Billy.

Do you see that.

A. Yes.

Q. And the "to" line at the very top of the first page of CX-672, it says "To: Staff." Do you see that?

A. Yes.

Q. Am I right that in this time period in 1992 you would have received an e-mail sent to staff within Rambus?

A. I believe I would have, yes.

Q. And do you recall receiving this e-mail from Billy Garrett?

A. No, I don't.

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Q. Let me ask you about a statement about six lines down from the top on the first page of CX-672. It's a sentence that begins with the name Fujitsu. Do you see that?

A. "Fujitsu indicated," that?

Q. Yeah.

It says, "Fujitsu indicated that they do have patents applied for but that they will comply with the JEDEC requirements to make it a standard," and then you'll see there are three exclamation points at the end of the sentence.

Do you see that.

A. Yes.

Q. Does that sentence, seeing that sentence in this e-mail from Mr. Garrett to all Rambus staff, does that refresh your recollection that you were aware in this time frame of patents or patent applications being disclosed at JEDEC meetings?

A. No, it doesn't.

Q. Let me ask you about the next -- well, the next sentence says, "Notes from sync DRAM sessions." And then after that do you see where it says, "I have copy of patent list"? Do you see that?

A. Yes.

Q. Does that language refresh your recollection

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that in this time frame you had some familiarity with the fact that JEDEC kept a list of the patents or patent applications that were disclosed at JEDEC meetings?

A. No. I don't remember this e-mail and I don't remember anything about a list.

Q. Okay. Let me ask you to take a look at another document.

May I approach, Your Honor?

JUDGE McGUIRE: Go ahead.

BY MR. ROYALL:

Q. I've just handed you another document, Dr. Farmwald, which is marked as CX-685, and you'll see this is an e-mail sent by David Mooring. Do you see that at the top of the page on CX-685?

A. Yes.

Q. And it was sent in December, specifically December 11, 1992. The subject is JEDEC notes. Do you see that?

A. Yes.

Q. And then there's a "to" line, a number of names, and yours is the first name on the list of the recipients. Do you see that?

A. Yes, I see that.

Q. So this is an e-mail that you received from

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Mr. Mooring in December of 1992; is that right?

A. I'm sure I did.

Q. And Mr. Mooring today is Rambus' president; is that right?

A. I believe that's his title, yes.

Q. And in this time period he was the vice president of marketing and sales for the company; is that right?

A. Yes, I believe so.

Q. In that position he directly reported to the CEO, Geoff Tate?

A. Yes, I believe so.

Q. Now, he states in the second or I guess it may be the third paragraph of this e-mail to you and others at Rambus, Mr. Mooring states: "IBM raised the issue that they were aware that some voting JEDEC attendees have patents pending on SDRAMs that they have not made the committee aware of. They will come to the next meeting with a list of the offenders. There are currently about 20 patents that are on the tracking list so the list will get longer."

Do you see that language.

A. Yes, I do.

Q. Does that refresh your recollection that you were generally aware in the early 1990s of patents or

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patent applications being disclosed at JEDEC meetings?

A. No, it doesn't. And at least at this date -- I don't have a direct recollection of this e-mail at all, but at this date I was already starting to work on a different project and I really wasn't paying too much attention to what was going on at things like JEDEC. I was working on this new company, this new idea that turned into Chromatic, in the middle to late '92.

Q. Well, the earlier e-mail that we talked about, CX-672, from Mr. Garrett, that was sent to you in February of 1992; right?

A. That's right.

Q. So that was before you had started work on this new project, Chromatic; is that right?

A. New project, yes.

Q. Or the new project?

A. It was a new project that turned into another company, yes.

Q. But --

A. I don't remember exactly when I started working on it. My best recollection is it was sometime in middle to late '92 when I worked on that.

Q. And when you started to work on that project, did you not review e-mails that were sent to you by

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senior executives --

A. I get a lot of e-mails each day and so I would either skim them or, you know, glance at them, you know.

Q. Even when they were sent by senior executives of the company?

A. I get fifty to a hundred e-mails a day. I can't read every one of them.

Q. And I take it then that this e-mail from Mr. Mooring, CX-685, it also doesn't refresh your recollection as to your awareness that Rambus or, rather, that JEDEC kept a tracking list of patents and patent applications that were disclosed?

A. I have no memory of that, no.

Q. If we could, I'd like to go back to an exhibit that I think I showed you yesterday. It's on top of your binder. It's Exhibit CX-606. This is a copy of the minutes from the October 1992 Rambus board meeting.

Do you have that.

A. Yes, I do.

Q. Let me ask you to turn to page 2, under the heading Sales and Marketing.

Yesterday I focused you and I think Mr. Stone also may have focused you on language under that

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heading that refers to Mr. Crisp reporting on the SDRAM status at JEDEC. Do you see that.

A. Yes.

Q. I'd like to focus you now on the next sentence below that, where it says that Mr. Mooring spoke about potential competition from the IEEE RamLink strategy. Do you see that?

A. Yes.

Q. And am I right that RamLink was another alternative DRAM design that was -- that Rambus was aware of in this time period?

A. Yes. I have much better recollection of RamLink.

Q. And am I correct that it's your understanding that what was at this time referred to as RamLink at some point became known as SyncLink?

A. That's right. That's my best recollection.

Q. And Rambus considered this RamLink or SyncLink technology to be a source of potential competition for its own Rambus DRAM technology; is that right?

A. Yeah. My best recollection is it was less that we considered it real competition than it was more what's called FUD, F-U-D. They were trying to cloud the issues by claiming they had something that was as good as us and telling them don't use us, use ours,

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that it will be ready in a couple years, but their stuff didn't work, so it was more a marketing concern than a real concern. That's my best recollection.

Q. Just so we're clear for the record, when you mention FUD, are you referring to an acronym that stands for fear, uncertainty and doubt?

A. Yes.

Q. And so it was your understanding that within Rambus RamLink was perceived as a marketing strategy that was designed to create fear, uncertainty and doubt about Rambus' technology?

A. That's my recollection of what I thought about RamLink. I can't speak to my direct recollection as to what other people thought. That's what I thought at the time.

Q. Do you recall, in the early 1990s, do you recall the Rambus board discussing the RamLink technology?

A. I do not recall that, any specific discussion about RamLink.

Q. Am I correct that --

A. At the board meeting.

Q. -- that in the early 1990s Rambus was seeking to develop patent claims directed against RamLink?

A. I remember being quite upset about RamLink and

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thinking that from what I had seen of RamLink that they did in fact infringe on a number of our ideas and that in fact we should -- either should -- either we had or we should get patents based on our original invention because they were blatantly ripping off technology from us. About RamLink, I do remember that.

Q. Let me ask you to look at another exhibit which I left on top of your binder. It's an exhibit that we saw yesterday, Exhibit CX-702. This is Fred Ware's June 18, 1993 e-mail to you and others at Rambus.

A. I'm sorry. I don't see it.

Q. I have another copy.

May I approach, Your Honor?

JUDGE McGUIRE: Go ahead.

THE WITNESS: Oh, I'm sorry. It was inside another one. I've found it.

BY MR. ROYALL:

Q. So we saw this yesterday and I asked you some questions about language in this document that suggests that Rambus was developing patent claims directed against SDRAMs or future SDRAMs.

And what I want to ask you about now is, there's also some language in here, focusing you on numbered paragraph 2, do you see the last sentence in

8372

that numbered paragraph that says, "This is directed against RamLink".

A. Yes.

Q. So were you aware that Rambus in this time period in June 1993 was developing patent claims specifically directed against RamLink?

A. I was aware that we should be and I was very much in favor of us developing -- i felt we had invented a number of things in the original 1999 (sic) patent application and specification that in fact should read on RamLink and so I was very much in favor. I don't know exactly when we filed such claims.

Q. Okay.

A. I also, as I pointed out, was very indignant to the RamLink people that I thought they were stealing our technology, too.

Q. Let me ask you to look at another document. This is a document that you saw yesterday that Mr. Stone showed you. Let me -- if I could approach, Your Honor --

JUDGE McGUIRE: You may.

BY MR. ROYALL:

Q. -- show you another copy so you don't have to dig it out of the binder.

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What I've just handed you is a document that's been marked as CX-681, and I think you'll recall that you saw this yesterday when Mr. Stone was questioning you. It's an e-mail that was sent to you by Mr. David Mooring in October of 1992. Do you see that.

A. Yes.

Q. And Mr. Stone asked you about some of the language at the top of this e-mail. I wanted to ask you about some of the language further on down in the e-mail.

Am I right, though, that this -- generally the topic that's the focus of this e-mail is a meeting, there was an upcoming meeting scheduled that you and Mr. Mooring were scheduled to attend with certain participants in RamLink.

A. Yes. My memory is that we did not attend that meeting. I have actually a pretty specific recollection of what happened.

Q. Well, putting aside whether you attended any such meeting, that was the subject of the e-mail; right?

A. That's the subject of the e-mail, yes.

Q. And Mr. Mooring states in the e-mail a few lines down from the top, do you see where he says

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"Before 11/12"?

A. Yes.

Q. And 11/12 I think you'll see is a reference, if you look in the first -- the first paragraph of the e-mail, there's a reference to this upcoming meeting being scheduled for November 12. Do you see that?

A. Yes, I do see that.

Q. And he says, "Before 11/12 our decision options are," and then he lists three options, three numbered options. Do you see that?

A. Yes.

Q. And those are options for responding to RamLink; is that right?

A. That's -- yes.

Q. And the first option that he identifies states, "Decide they are the enemy and do one or more of (a) kill them ourselves, (b) convince them to kill themselves, and (c) convince their management to kill them."

Do you see that language.

A. Yes.

Q. And then below that, below the numbered paragraphs, Mr. Mooring says that this option, option 1, was the current plan. Do you see that?

A. Yes.

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Q. Do you recall that in this time period that it was Rambus' plan to do as Mr. Mooring outlined in the numbered paragraph 1 of this e-mail?

A. My recollection is this overstates it a little bit, and I also have a direct recollection that what we ended up doing was number two, we just ignored it. We had a meeting with them. We had discussions with them. We decided that they were hopeless and didn't know what they were doing. We ended up doing number 2 and just ignored them, and they did go away.

Q. Let me ask you about option number 3, which says, "Cooperate in some manner with them."

Do you see that.

A. Yes.

Q. And further down in the e-mail Mr. Mooring states -- and I think it's the second to last paragraph -- he says, "I assume that Rambus II will not be point-to-point and differential, which will make option 3 unlikely."

Do you see that?

A. Yes.

Q. Now, by the terms "point-to-point and differential," do you understand that Mr. Mooring was referring to features in the RamLink design that were not used in the Rambus design?

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A. I wouldn't necessarily say that they weren't used in the Rambus design, but I would say that those were some of the differences at that point in time between the first-generation Rambus and the RamLink. I want to separate out our original patent specification and the first-generation Rambus.

Q. But RamLink did not use the same kind of bus that was used in the original Rambus DRAM design; is that right?

A. That's basically right.

Q. And RamLink used something called --

A. Well, again to be more specific, they didn't use a backplane-like bus; they used a point-to-point bus, just to be a little more specific.

Q. Okay. Now, in the prior paragraph, the paragraph before the one I just focused you on, Mr. Mooring states, "The minimum we should do is let every DRAM manufacturer know that RamLink (a) is no faster (b) has technical flaws (c) is very late and (d) infringes our patents."

Do you see that.

A. Yes.

Q. And am I right that you recall that in the early 1990s there was a fair amount of discussion within Rambus about concerns that RamLink and later

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SyncLink might violate Rambus' patents?

A. I do remember such discussions, yes.

Q. And you personally were of the view that RamLink was using Rambus ideas or inventions; is that right?

A. Yes.

Q. And you believed that RamLink was using inventions that were contained in or reflected in Rambus' original 1990 patent application?

A. In the patent specification, yes.

Q. And referring back to Mr. Mooring's e-mail, he suggests in response to RamLink, Rambus at a minimum should tell DRAM manufacturers, among other things, that RamLink infringes Rambus' patents. Do you see that?

A. Yes.

Q. And am I correct that it's your recollection that Rambus in fact did inform some customers or potential customers that it believed that RamLink violated Rambus' patents?

A. I have a direct recollection of telling certain of the RamLink members that I felt they violated certain of our patents or infringed on certain of our patents and have a vague recollection that we told other DRAM companies that we felt in general that they

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did. I don't have specific recollections of who we told on the DRAM side.

Q. Do you know if Rambus informed any DRAM manufacturer of any specific Rambus patent or patent application that it thought was infringed by RamLink?

A. My best recollection is that we would have referred to the original '898 application and the specification therein, but that's my best recollection. It's not specific.

Q. And the time frame in which you recall these disclosures being made was in, what, late 1992, that time frame generally?

A. That's the best I can remember.

Q. And in that point in time, in late 1992, am I right that Rambus did not have access to actual working RamLink parts?

A. There were -- there never were any working RamLink parts.

Q. Right. All you had at that time to base any views about infringement on were not-yet-complete specifications?

A. Right. And just to make it clear -- I hope I said it right before, but I'll say it again just to make it clear -- what I remember distinctly is telling the RamLink people that what they were proposing to do

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would infringe on Rambus intellectual property. I don't think I said that they were already infringing, because they hadn't built anything.

Q. But you told them that it would infringe based on what you had seen in a not-yet-complete specification?

A. That's correct.

Q. Now, do you recall -- you can set that document aside for now.

Do you recall learning in the 1999 -- i'm sorry -- 1995 time frame about the fact that participants in SyncLink were making a presentation or were going to make a presentation about their ideas at the JEDEC meeting?

A. I don't actually remember -- i remember very little about SyncLink other than sort of the same general feeling that it was the same people who were doing RamLink and that what I knew about it I felt infringed upon Rambus intellectual property. I don't remember any knowledge about the relationship between SyncLink and JEDEC.

Q. Do you recall any discussion within Rambus' board or at Rambus board meetings relating to any SyncLink presentation to JEDEC?

A. It's quite possible it happened. I just don't

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have any direct recollection right now.

MR. ROYALL: May I approach, Your Honor?

JUDGE McGUIRE: Yes.

BY MR. ROYALL:

Q. I've just handed you a document that's been marked as CX-794, and you can see from the document that it's an e-mail from Richard Crisp and it's dated May 1995 and the subject line reads "JEDEC JC-42 meeting notes (DRAM)" and then it states in all caps "includes SyncLink info."

Do you see that.

A. I'm sorry.

Q. This is in the subject line of the e-mail up at the top of CX-794. Do you see that language?

A. Could you repeat it. I'm sorry.

Q. I was just reading the subject line. It says "JEDEC JC-42 meeting notes (DRAM)" and then it states in all caps "includes SyncLink info."

Do you see that.

A. Yes, I do.

Q. Now, if you could turn to page 4, on page 4 of CX-794, almost exactly in the middle of the page there's a reference to Hyundai and then it says "SyncLink presentation." Do you see that?

A. Yes.

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MR. STONE: I object on the grounds I don't think he's yet laid a foundation as to whether Dr. Farmwald received this e-mail.

JUDGE McGUIRE: Sustained.

MR. ROYALL: Your Honor, I'm not -- i'm only asking him -- i'm only pointing this language out to refresh his recollection. I'm not suggesting that he did receive the e-mail.

JUDGE McGUIRE: Okay. On that basis --

MR. ROYALL: And I'll just ask him one more question.

JUDGE McGUIRE: You may proceed only on that limited basis.

MR. ROYALL: Thank you.

BY MR. ROYALL:

Q. Now, under that heading or that language where it says "Hyundai: SyncLink presentation" -- well, under that, do you see there is a paragraph beginning -- that says "Gordon Kelley"?

A. I'm sorry.

Q. Actually before I get to that, let me just ask you, does seeing this, this language "Hyundai: SyncLink presentation" in this e-mail, and then does seeing the subject line of the e-mail, does that refresh your recollection about whether you knew that

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in the 1995 time period a SyncLink-related presentation occurred at JEDEC?

A. It doesn't refresh my memory. I think it's unlikely I saw this e-mail. I was not at the company -- i had not been at the company for two years.

Q. And I'm not suggesting you saw the e-mail, but does that refresh your recollection?

A. It does not, no.

Q. Do you recall hearing at some point about Rambus being asked by JEDEC or some JEDEC participants whether it had patents that related to SyncLink?

A. Okay. So let me make sure I understand. Do I remember whether JEDEC asked us, again, because I've told you the only recollection I have, which is that SyncLink -- i'm sorry -- ramLink people asked us, of whom the RamLink members were also JEDEC members, so I need to make sure I understand --

Q. Yeah, this is a different question.

I'm asking whether, in the context of JEDEC meetings or JEDEC proceedings, do you recall whether JEDEC asked Rambus if it had patents that related in some way to SyncLink.

A. So again, the only recollection I have is of the RamLink people asking us and I remember myself

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replying that I felt that, among other things, we had patents on PLLs/DLLs and on a block-oriented -- you know, a block-oriented protocol.

So -- but that was to RamLink, and I don't know whether RamLink was part of JEDEC, which is why I'm answering that way, because I want to be careful. I think it was, but I don't remember whether it was.

Q. Let me just point out one other sentence in this e-mail to see if it refreshes your recollection. It's on the same page, page 4 of CX-794. It's at the bottom of the page.

It says: "Gordon Kelley asked whether or not any companies have patent issues with the material. HP claims that everything is a public domain."

And then it says, "Sam Calvin (Intel) asked whether or not there were Rambus patents covering it."

Do you see that.

A. Yes.

Q. Now, does that refresh your recollection as to knowledge of JEDEC asking Rambus whether Rambus had patents covering SyncLink?

A. No, it doesn't. But if I -- i'm just reading this, so this is now, but it also says that Wiggers claims that RamLink predated Rambus, and my recollection is that Hans Wiggers was one of the people

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at this meeting who I did tell that I thought Rambus patents read on RamLink.

So it's confusing to me because a lot of the same participants at RamLink were also at JEDEC, so it's hard for me to separate the two. But no, I have no direct recollection of this e-mail.

Q. Okay. I thought you had said yesterday in reference to CX-681, which we talked about a minute ago, I thought that you had said that you did not recall that Wiggers attended the RamLink meeting that you --

A. I don't actually for sure. I remember Gustafson and I vaguely remember two other people there. I think I answered that it could have been Wiggers and I had a vague recollection of Wiggers and another gentleman named James, but it's pretty -- i can't swear to it.

Q. Now, I had asked you a moment ago about discussions within Rambus' board about disclosures of SyncLink-related disclosures to JEDEC, and did you say you don't have any recollection of any such discussions?

A. I certainly don't have any recollection of any specific discussions. It probably was mentioned. I just don't have any specific recollections.

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MR. ROYALL: May I approach, Your Honor?

JUDGE McGUIRE: Yes.

BY MR. ROYALL:

Q. What I've handed you, Dr. Farmwald, is an exhibit marked CX-1727A, and I'll represent to you that these are notes taken by Rambus CEO Geoff Tate, and if I could ask you to turn to page 4 of this exhibit.

And I'll note for the record that this is a public-record version or excerpt of a larger compilation of notes, and so the full document with the full compilation of notes, some of which includes in camera material, is CX-1727.

JUDGE McGUIRE: But then we're not going to go into that at this point.

MR. ROYALL: That's the reason I'm using this version.

JUDGE McGUIRE: Very good.

Mr. Stone, any comment?

MR. STONE: That's fine.

JUDGE McGUIRE: Very good.

BY MR. ROYALL:

Q. The page that I'm pointing you to, although it's numbered page 4, I think actually it's the second page in this exhibit, CX-1727A. Do you see that?

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A. Yes, I do.

Q. And do you see at the top of the page, it's difficult to read, but it says "board meeting" at the far left?

A. I'll take your word that that's what it says, but it looks like that.

Q. I'll represent to you that that's what that says. It's easier to read in the in camera version, but I'm trying to avoid using the in camera version.

And then there's a date, it says 95/6/8, and I'll represent to you that that, the date, Mr. Tate has said that that date is June 8, 1995.

And then further down the page or roughly in the middle of the page, do you see the reference, the underlined reference to -- it's hard to read, I admit, but it says "SyncLink strategy".

A. Yes, I do see that.

Q. And then below that, the name "Mike" is written and then there's a colon and then it says "state SyncLink violates patents but will be reasonable on license fees."

And I'm not asking you to read the handwriting. I'll represent to you that that's what that language says.

Do you see that --

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A. Yes.

Q. -- that general language?

Now, does this refresh your recollection as to discussions within Rambus board meetings about whether to disclose, whether Rambus should disclose patent-related information to JEDEC relating to SyncLink?

A. I don't remember now. I have a vague recollection of the time period that I did feel that SyncLink violated our patents, but I don't have a specific recollection of this meeting or what I said or whether this is even me.

Q. So you don't recall expressing the view reflected in Mr. Tate's notes, namely that SyncLink violated Rambus patents but that Rambus should state that it would be reasonable in license fees?

A. I think it's consistent with something I would have said; I just don't remember saying it.

Q. Do you recall whether others within Rambus disagreed with your views in that regard?

A. I don't remember any disagreement, but I don't remember the discussion, so...

Q. Let me just point out some language below the language that I focused you on referencing Mike. Below that -- again, it's very difficult to read, but I'll

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represent to you that it says, "Mark: Stirring pot now makes us look like bad guys, gives them some credibility."

Do you see the language that I'm referring to.

A. Yeah, but I can't read it at all. I mean, I'll have to take your word for it that that's what it says.

Q. And just doing that, taking my word that that's what that says, does that jog your recollection at all about the discussion within Rambus' board about the subject of Rambus disclosing patents to JEDEC or patent information to JEDEC relating to SyncLink?

A. No. As I said, I don't have any direct recollection of this. I just have a vague recollection that I felt -- i can only remember my personal feelings -- that SyncLink did in fact violate Rambus patents.

Q. Do you have any recollection of how the issue of Rambus disclosing patent-related information to JEDEC about SyncLink, do you have any recollection of how that issue was resolved?

A. No. I have no specific recollection. Again, I'll repeat, I don't remember at the time what I felt and I certainly don't remember this meeting.

I do remember that I had felt we had put them

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certainly on notice about RamLink and that RamLink in my mind had been just -- the name had been changed into SyncLink and it was the same people, a lot of the same ideas, and I felt that we had been pretty specific about RamLink, about what we felt violated it, in particular PLLs/DLLs. And other ideas, too, but I remember those specifically.

MR. ROYALL: Your Honor, I would offer at this point CX-1727A.

MR. STONE: No objection.

JUDGE McGUIRE: Entered.

(CX Exhibit Number 1727A was admitted into evidence.)

MR. ROYALL: May I approach?

JUDGE McGUIRE: Yes.

BY MR. ROYALL:

Q. I've just handed you, Dr. Farmwald, a document that's been marked for identification as CX-91a, and you'll see from the first page that these are minutes from a JEDEC meeting, a JC-42.3 meeting on September 11, 1995. And I'm not suggesting that you were a recipient of this, of these minutes, but let me ask you to turn to page 13 of this document.

And you'll see that there's a letter, on the right-hand side of page 13 there's a reproduction of a

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letter on Rambus letterhead, and in the very bottom of that letter, the bottom paragraph, the first sentence states, "At this time Rambus elects to not make a specific comment on our intellectual property position relative to the SyncLink proposal."

Do you see that?

A. Yes.

Q. Does that refresh your recollection that the issue of whether to disclose patent-related information to JEDEC relating to SyncLink, that that issue was resolved in favor of Rambus not making the kinds of disclosures that you had recommended to the board?

A. I have -- i've -- i'm pretty sure I've never seen this e-mail, so it doesn't --

Q. I'm not suggesting that you had. It's not an e-mail; it's a reproduction of a letter that was reproduced --

A. It's a fax.

Q. -- as an attachment to JEDEC's minutes.

A. Yeah. Actually this -- by the way, this doesn't -- again, I don't believe I've ever seen this before. In fact I'm fairly certainly I haven't. I certainly don't remember it. But I don't read it the same way you do, so -- just reading it now even at this

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point in time.

Q. I'm just asking you whether the language that I pointed out to you where it says, "At this time Rambus elects not to make a specific comment on our intellectual property position relative to the SyncLink proposal" --

A. But there's a whole paragraph stating that the first Rambus patents were filed more than five years ago with development starting years before that.

Q. Uh-huh.

A. It basically seems to indicate in every possible way, short of saying here's the specific patents, that we do have patents. That's the way I would read this. But again, I don't have any specific recollection of this e-mail, so...

Q. And it doesn't refresh your recollection about how --

A. It does not refresh my recollection, no.

Q. -- about how this issue was resolved?

A. No, it does not.

Q. You can set that aside.

Am I right -- you were not directly involved in Rambus' decision to withdraw from JEDEC; is that right?

A. I do not remember being involved, no.

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Q. But you did learn about that decision when it was made or sometime after it was made?

A. I'm sure I did. I had a recollection that we had withdrawn earlier, so clearly I was a little confused about the time frames, but I knew generally that we had withdrawn.

Q. And you were never particularly supportive of Rambus' involvement in JEDEC; is that right?

A. I thought it was a waste of time. I thought the organization was hostile to us.

Q. Did your views about the merits of Rambus participating in JEDEC have anything to do with legal risks that JEDEC participation might pose to Rambus' intellectual property?

A. No, it did not.

Q. Were you aware that Rambus had been advised by its lawyers that continued participation in JEDEC could lead to Rambus patents being held unenforceable?

MR. STONE: Objection. Misstates the evidence. Improper as to form.

JUDGE McGUIRE: Sustained.

BY MR. ROYALL:

Q. Were you aware, Mr. Farmwald, that Rambus had been advised by its lawyers relating to potential legal risks associated with JEDEC participation?

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A. I was not.

Q. You never heard about that from Geoff Tate or Allen Roberts?

A. I don't remember ever being told such a thing, and I think it would have been important enough for me that I would remember it.

Q. Now, if I could --

JUDGE McGUIRE: Before we go into that, I want to expand on an answer you just gave, Dr. Farmwald, regarding you felt that JEDEC had been hostile to your company. Could you expand on that for my edification.

THE WITNESS: A lot of the members at JEDEC -- i'm thinking more of individual members as compared to JEDEC as an organization, but a lot of the people who ran the organization had been people who had been at early meetings that I had attended who had expressed a lot of unfriendliness to Rambus.

I remember a meeting with HP.

I remember a meeting with Micron in particular, where -- and just the tone -- i don't have any specific recollections from the sort of '92 on time frame because I was involved in other things, but I just remember a general tone that JEDEC didn't seem very friendly to us and that the specific people who I knew there who I had had dealings with personally were

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definitely not friendly to us.

JUDGE McGUIRE: But you in your own mind, I'm just curious as to how come you thought that way. I mean, what happened that you anticipated that that was the case?

THE WITNESS: Well, again, my specific interactions with several of the people.

The first meeting I ever had at Hewlett-Packard in 1989 , a gentleman named Desi Rhoden was there and it was a very hostile meeting. Mr. Rhoden was very unfriendly. I didn't understand it. I was a little surprised at seeing such hostility. And that unfriendliness sort of carried over into future meetings and so that, you know, that I remembered.

JUDGE McGUIRE: Okay. Mr. Royall, you may proceed.

MR. ROYALL: I was going to ask Mr. Stone whether the demonstratives from yesterday are still in the courtroom.

May I approach the easel?

JUDGE McGUIRE: Yes.

(Pause in the proceedings.)

BY MR. ROYALL:

Q. Now, I'd like to go back, Dr. Farmwald, very

8395

briefly to a demonstrative exhibit that you created on the easel yesterday that I think was marked as DX-254.

And I believe that what you were communicating through this was a list, based on your recollection, of key features of the original Rambus invention; is that correct?

A. I would -- well, the -- i believe what I was asked to put down was the key inventions that I felt we had done, but -- so yes.

Q. And am I right that you believed that Rambus invented use of a dual-edged clock in a high-speed DRAM interface?

A. That's my belief, yes.

Q. And you also believed that Rambus invented use of DLLs or PLLs on a DRAM chip to synchronize clocks?

A. Yes.

Q. And you told us yesterday I believe that it's your understanding that those two features, dual-edged clocking and on-chip PLL/DLL, it's your understanding that they were not used in the original SDRAM specification; is that right?

A. That's my understanding, yes.

Q. But it's your understanding that both of those features are used in the later DDR SDRAM specification; is that right?

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A. I can't actually answer as to whether it's in DDR-I or DDR-II, but I believe they're now used in current parts.

Q. And I believe you told us yesterday that in the 1997 or '98 time period that you felt strongly that DDR parts were going to infringe Rambus patents; is that right?

A. I'm sorry. Could you repeat that, the time frame.

Q. I can just restate the question, including the time period.

You told us yesterday that in the 1997 or 1998 time period that you felt strongly that DDR parts were going to infringe Rambus patents.

A. Okay. I can't specifically remember when I said it, but I do have a feeling that in the late '90s that I felt that the next-generation DRAMs, i.e., DDR, were going to have to use PLLs to get to the clock speeds and so that in fact they would infringe upon Rambus intellectual property. I don't remember specifically when I said that. But I would have believed it.

Q. Now, you told us earlier that in reference to RamLink, that in the early 1990s -- and specifically I said -- i think you said late 1992 -- when Rambus had

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concluded that RamLink parts in the future were likely to infringe Rambus patents that it proceeded to tell at least some customers that it had those feelings or those beliefs; right?

A. I have a direct recollection of telling some members of the RamLink committee that. I have a vague recollection that we had told some customers that we felt, without remembering any specifics of what we said, that we felt that RamLink was going to infringe.

Q. Well, by contrast to that, isn't it true that even after Rambus had concluded that DDR parts were likely to infringe its patents that Rambus sought to withhold that information from its customers and business partners?

MR. STONE: Objection. Assumes facts not in evidence and misstates the record as to Rambus concluding, improper as to form.

JUDGE McGUIRE: Sustained.

Restate it.

BY MR. ROYALL:

Q. Are you aware, Mr. Farmwald, Dr. Farmwald, that Rambus' senior management, after concluding that Rambus or that Rambus patents were likely to be infringed by DDR parts, adopted a strategy to withhold that information from customers and business partners?

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A. I am not aware of that, and in fact that is not my understanding of what we did, but I am not aware of that, no.

MR. ROYALL: May I approach, Your Honor?

JUDGE McGUIRE: Yes.

BY MR. ROYALL:

Q. I've just handed you a document that's been marked as CX-919, and I'm not suggesting that you were the recipient of this document, but I want to see if I can use it to refresh your recollection.

It's a February 1997 e-mail sent by Mr. Geoff Tate, and I'd like to focus you on some language about three-quarters of the way down the page.

Do you see the reference to -- it says "re IP"? It's in the right-hand side a couple inches up from the bottom of the text.

A. I'm still looking for it.

Okay. Now I see it.

Q. It says "re IP" and then after that it says, "There are many issued and in-process patents that DDR SDRAMs/SGRAMs might infringe."

Do you see that language.

A. Yes.

Q. And then below that, there's the word "action." Do you see that?

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A. Yes.

Q. Do you see the word "action"?

And then there are two items, but the second item says, "Do not," all caps, "tell customers/partners that we feel DDR may infringe -- our leverage is better to wait."

Do you see that.

A. Yes, I do.

Q. Does that refresh your recollection that Rambus' senior management, even after concluding that DDR parts might infringe Rambus patents, had a strategy of withholding that information from customers and business partners?

A. I haven't seen this -- i'm pretty sure I haven't seen this e-mail before. Also in reading that, that's not the inference I would take from it again. It actually says there are no patents that we can definitely say are infringed.

MR. ROYALL: Your Honor, I'd move to strike that answer as nonresponsive. I'd like to ask the question again.

JUDGE McGUIRE: All right. Sustained.

BY MR. ROYALL:

Q. Now, I'm asking you, Mr. Farmwald -- I'm not asking you for your interpretation of the document.

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I'm not asking whether you've seen it. In fact I started my question by saying I'm not suggesting that you ever did see this document. I'm simply asking if it refreshes your recollection, and let me ask my question again.

Does this document and specifically the language that I pointed out to you, does this document refresh your recollection that Rambus' senior management even after concluding that DDR parts might infringe Rambus patents had a strategy of withholding that information from its customers and business partners?

A. It does not refresh my memory because I don't remember that, so...

Q. Okay. And do you recall discussions within Rambus, Rambus' board, at any time relating to whether the company should disclose information to third parties about whether SDRAM or DDR SDRAM parts infringed or potentially would infringe Rambus patents?

A. I have no specific recollections. I have a vague recollection that there was a feeling that we shouldn't say that they infringed until we were certain that they did, but that's a vague recollection. I don't know when that happened.

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Q. Now, I'd like to turn now to another subject that Mr. Stone asked you about, asked you some questions about, which is Rambus' business relationship with Intel. And I'd like to focus you initially on the mid-1998 time frame.

Do you recall that in that time frame Rambus' relationship with Intel had become fairly tense or there were some tensions in the relationship?

A. I don't have a direct recollection, but we saw some e-mails yesterday that seemed to set a date that's consistent with my memory, so if that was '98, then I think that's right.

Q. And let me, if I could, I'll give you a copy of one of the same e-mails I think Mr. Stone showed you.

May I approach, Your Honor?

JUDGE McGUIRE: Go ahead.

BY MR. ROYALL:

Q. I believe this is one of the same e-mails that Mr. Stone showed you yesterday. This is marked as CX-1016.

And am I right that this is an e-mail that you received from Geoff Tate in April of 1998?

A. Yes, I did. I actually remember this e-mail.

Q. You do remember the e-mail?

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A. I do remember this e-mail, yes.
Q. And in this e-mail Mr. Tate is reporting on a meeting that he had with an Intel executive, Pat Gelsinger, on that same day the e-mail was written, April 14, 1998; is that right?
A. Yes.
Q. And Pat Gelsinger was one of Rambus' principal business contacts at Intel?
A. Yes, he was.
Q. Do you also remember the name Gerry Parker as another Intel contact?
A. More vaguely, but yes, I remember the name.
Q. In the executive summary on the first page of CX-1016, do you see the heading Executive Summary?
A. Yes.
Q. And under that heading, Mr. Tate states, "Intel says they are basically going to compete with us on next generation."
Do you see that.
A. Yes.
Q. And you recall that issue arising in this time period; right?
A. Yes.
Q. And --
A. Although I don't think that was really the

8403

issue, but...

Q. And am I right that you responded to Mr. Tate's e-mail?

A. Yes, I did.

MR. ROYALL: May I approach?

JUDGE McGUIRE: Yes.

BY MR. ROYALL:

Q. Now, I've just handed you another document, CX-1021, which I think again you saw yesterday when Mr. Stone was questioning you.

This is your April 15, 1998 response to Mr. Tate's e-mail, CX-1016; is that right?

A. Yes.

Q. And let me ask you about just a few of the statements in your e-mail.

The third paragraph down on the first page of CX-1021 states: "I'm not even sure we want to agree to work together on the next-generation memory interface. Given their stated objectives, they will be very aggressive about using/claiming ownership of any new ideas and will clearly use those new ideas/IP to force us to their point of view, i.e., zero or no royalties."

Do you see that.

A. Yes.

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Q. And am I correct that you understood that at this point in time Intel was placing pressure on Rambus to lower its royalties on RDRAM?

A. That was one of the things they were doing, yes.

Q. And --

A. I felt it was a negotiating point, but yes.

Q. And Mr. Tate's e-mail to you, the earlier document, CX-1016, made some comments along those lines I believe, and let me point you to what I'm referring to.

Page 4 of CX-1016, towards the very bottom, do you see the paragraph beginning "Pat perceives"?

A. Yes.

Q. So Tate says here in reference to Mr. Gelsinger, Pat Gelsinger, "Pat perceives the Rambus business model has been what makes the RDRAM ramp so hard to manage." And then below that it refers to royalties and then control/Rambus using Intel as a club.

Do you see that.

A. Yes.

Q. So one of the things that Intel was complaining about in this time period was the size of Rambus' RDRAM royalties or the amount of the royalties; is that

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right?

A. It was one of the things they were complaining about. Essentially Intel likes to have all the profits in a PC. They don't like to see anybody else have profits.

Q. And turning to page 6 of the same document, CX-1016, do you see the heading Car Ride Back to Rambus?

A. Yes.

Q. And under that heading, Mr. Tate says -- this is the third paragraph under the heading -- "When will Intel tell the DRAM companies that they are investigating next-generation interface without Rambus? If so, will the DRAM companies then not want to work with us (on next generation)? This could force us to play our IP card with the DRAM companies earlier."

Do you see that.

A. Yes.

Q. In focusing you on that last sentence that I read, do you have an understanding of what Mr. Tate meant here when he refers to the possibility of Rambus having to play its IP card with DRAM companies earlier?

A. We -- rambus always has felt that it has a very

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substantial intellectual property portfolio, including some very strong patents, so my best recollection, this refers to our telling the DRAM companies that if you work on a new generation with Intel, we will sue you, because we feel we have patents on those ideas. That's my best recollection.

Q. And isn't this a reference to enforcing Rambus patents specifically against SDRAM and DDR SDRAM devices?

A. That's not my recollection. It's possible, but I would read it and I think -- i would read it now and I believe I would have read it then as a threat that if you work with Intel on a new generation, we will sue you on the new generation. It's possible that it includes SDRAM DDR, I won't argue with that, but I would read it mostly on a threat about a next generation.

MR. ROYALL: May I approach, Your Honor?

JUDGE McGUIRE: Yes.

BY MR. ROYALL:

Q. I've just handed you another document --

A. Just -- if I could just comment quickly, too, in reading my own e-mail also -- I remember being pretty angry about this, so I actually do remember this e-mail. I think my own e-mail is consistent with

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that because I talk about that we shouldn't work with them and in fact we should enforce our patents against the next -- a new standard that we'd try and put together.

So I think that's consistent with what I'm saying.

Q. Let me show you this next document I've just handed you, which is CX-1022.

Now, this document is an e-mail from Bill Davidow to you dated the 16th of April 1998. Do you see that.

A. Yes.

Q. And this is Mr. Davidow's response to your e-mail, CX-1021, that we saw a moment ago; right?

A. Yes.

Q. And Mr. Davidow is the chairman of the board of Rambus?

A. Yes.

Q. And in responding to your e-mail -- let's turn to page 2 of CX-1022. I'd focus you to the -- at the language on the top of the page.

In responding to your e-mail, Mr. Davidow, Rambus' chairman of the board, states: "The advantage of trying to negotiate something with them is that it will take months. In the process we gain time. We

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will not have to play the intellectual property card with Micron and SDRAMs during this time. If things blow up with Intel, then we can begin to pursue the intellectual property issue with these guys."

Do you see that.

A. Yes.

Q. Now, does that refresh your recollection that in the term IP card, playing the IP card, as that term was used by the CEO of Rambus, Geoff Tate, and the chairman of the board of Rambus, Bill Davidow, was a term used in reference to enforcing patents against SDRAMs?

A. All I can -- i think all I can answer to is what I understood it to be at the time and from what -- reading my e-mail, at least I interpreted it as attacking a next-generation DRAM from my own e-mail.

Now, I can't testify as to what Geoff intended it to mean. I think I can only testify to what I think I felt it to mean at the time.

Q. Isn't it true that in this time period in the late 1990s -- and let's say specifically 1997-1998 -- isn't it true that in that time period Rambus was seeking to avoid discussing with its DRAM manufacturer business partners its belief that SDRAMs and DDR SDRAMs would infringe on Rambus patents?

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A. I don't actually have any direct knowledge or recollection of what we did say or did not say in that time, so I don't know.

MR. ROYALL: May I approach, Your Honor?

JUDGE McGUIRE: Yes.

BY MR. ROYALL:

Q. I've just handed you another document, Dr. Farmwald. I'm not suggesting that you were a recipient of this, but I want to see if it refreshes your recollection. This is CX-939.

And you'll see that on the first page of CX-939 there's an e-mail from Bill Davidow, Rambus' chairman, to Gerry Parker, dated June 11, 1997.

Do you see what I'm referring to.

A. Yes.

Q. And you said earlier --

MR. STONE: I believe that counsel misspoke. I think it's July 11, if that matters.

BY MR. ROYALL:

Q. I'm sorry. I certainly don't want to misstate it. I don't know what I said, but it is July 11, 1997.

And Gerry Parker, you said earlier that you understood that he was one of Rambus' business contacts at Intel; is that right.

A. I don't remember what his title was, but I

8410

remember him from being an Intel person.

Q. And then you'll see that Mr. Davidow at the very top of the page on CX-939 forwards his e-mail to Mr. Parker of Intel, he forwards that on to Geoff Tate and Dave Mooring, and he says, "I sent Dave's memo with minor modifications and my lead paragraph."

Do you see that?

A. Yes.

Q. Now, referring to Mr. Davidow's e-mail to Gerry Parker of Intel, in the first paragraph he states: Gerry, I have been discussing with the DRAM company -- I have been discussing the DRAM company problem with Rambus. One of the things we have avoided discussing with our partners is intellectual property problem discussed in the fourth paragraph."

Do you see that? Do you see that language I was just reading from the --

A. I'm sorry. I must have the wrong part.

Q. I was just reading --

A. No. I found it. Yes.

Q. -- the first couple of sentences from Mr. Davidow's e-mail to --

A. I found it, yes.

Q. And he refers to the fourth paragraph, and if you look down in the heading Below Is the Rambus

8411

Update, the fourth paragraph under that, the first two sentences state: "We have not yet told Siemens that we think SLDRAM and SDRAM DDR infringe our patents. We think that will just irritate them."

Do you see that?

A. Yes.

Q. And then it says, "Hopefully SLDRAM and DDR will die due to their technical/infrastructure faults so we don't have to play that card."

Do you see that.

A. Yeah.

Q. Now, does any of that refresh your recollection that in this general time frame that Rambus was seeking to avoid discussing with DRAM makers its views relating to potential patent infringement by SDRAM and DDR SDRAM?

A. This e-mail doesn't help. Again, I think that would misstate my vague recollection of it, if that's what you're asking.

Q. You have a recollection that is --

A. Well, my vague recollection is not that we were trying to keep it secret from them but, rather, we were not trying to bring it up as an irritation issue. We were trying to sign DRAM contracts with them.

This is not saying we're keeping it a secret.

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This is threatening -- we are not going to -- and that's my vague recollection at the time. We weren't trying to keep it a secret because we had discussions in the end -- I know we did. I just don't have any specific recollections -- we had discussions where they would ask us about the rights to noncompatible uses of Rambus and we had negotiations along that. I just don't remember where and how they came out.

I do know that some of our Rambus partners in fact were given usage to noncompatible uses of Rambus technology, so they must have known. You're asking me for my vague recollection, so I'm trying to give it to you. This e-mail doesn't help me, though.

Q. I'm not asking you, Mr. Farmwald, about what may have later occurred or what may have later been agreed to in terms of licensing these patents. I'm focusing you on the time period that this e-mail was sent and this is now mid-1997. And let me go back to what you just said.

It's your recollection that in that time period that Rambus was avoiding discussing patent infringement related to DDR and SDRAM with its business partners because it was seeking to promote RDRAM and it didn't want to irritate --

A. I think that isn't quite it. I think we were

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avoiding threatening them with litigation because we were trying to get them to stay on the Rambus path.

Q. And you do have a recollection of that?

A. I do have a recollection that we were definitely trying to avoid being threatening because we were trying to be partners with them.

Q. And Mr. Davidow --

A. But I can't date it to this time period. I mean, if -- again, this is a recollection from the late-ish 1990s. I can't tell you when that recollection is from.

Q. Well, let's go back, just before we leave this document, let's go back to the first paragraph of Mr. Davidow's e-mail to Gerry Parker, CX-939.

He says -- he goes on to state after the language that I've pointed out to you, he says: "We feel that it would drive a deeper wedge between us some of them and that maybe the problem will solve itself with time. We are hoping that they will either drop their competitive efforts or discover for themselves that they have violated Rambus patents and will conclude that getting around them will be either extremely difficult or impossible and will take a lot of time."

Do you see that.

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A. Yes, I do.

Q. Now, does that help to trigger any recollection on your part as to Rambus' approach in this point in time of avoiding discussions with DRAM makers about the potential for SDRAM or DDR SDRAM to infringe its patents?

A. I think that's consistent with my vague recollection that we felt they already knew that they violated, potentially violated Rambus patents and that we were trying to avoid threatening them with litigation while we were trying to negotiate RDRAM contracts with them.

Q. And the point, what you're saying is that at this time Rambus was working with these same companies to try to get them to make RDRAM; right?

A. Yes.

Q. And you didn't -- the company didn't think it would be in its interest at that time to take the aggressive step of seeking to enforce patents on an alternative product that those same companies were working on or might be working on?

A. I believe that threatening litigation of any form with someone who you're trying to negotiate friendly contracts with is a bad idea.

Q. But at some point Rambus did begin to enforce

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those SDRAM and DDR SDRAM patents against DRAM makers; right?

A. Yes.

Q. And that was in late 1999 ; right?

A. My recollection is 2000, but '99 possible, yes. And again, I believe that was after we felt that they had started to not carry through with their part of the contracts, so...

Q. That who wasn't carrying through with their part of the contracts?

A. That certain of our partners in fact were not meeting their contracts. That's my recollection.

Q. Their RDRAM-related contracts?

A. Yes.

Q. So the timing of when Rambus began to assert its SDRAM and DDR SDRAM patents, it's your understanding that the decision on when to begin asserting those patents had to do with your business partners' lack of compliance with RDRAM-related contracts?

A. That's my best recollection.

Q. And let me show you another document that I think you saw yesterday --

A. Could I just make one thing clear? I was working full-time at another company right now, so this

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was not my primary focus, so recollections as to date and specifics obviously are going to be a little fuzzy because I worked full-time doing something else.

MR. ROYALL: May I approach, Your Honor?

JUDGE McGUIRE: Yes.

BY MR. ROYALL:

Q. Now, these are -- this is CX-4623, and these are the minutes from the October 1999 Rambus board meeting. Do you see that?

A. Yes, I do.

Q. I think Mr. Stone asked you a few questions about these same minutes yesterday, and I just want to point out some of the same language I think that he asked you about.

On page 4 under the heading Intellectual Property, you'll see it says, "Mr. Karp reviewed various strategic IP issues including target selection and a negotiation timeline."

Do you see that.

A. Yes, I do.

Q. And I have forgotten your exact testimony yesterday, but am I right that you understand this to be a reference to deciding which company to approach first about enforcing the Rambus' SDRAM and DDR SDRAM related patents?

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A. To the best of my recollection, yes.

Q. And it was very soon after this October 1999 meeting that Rambus approached Hitachi in an attempt to get Hitachi to take a license for those patents; isn't that right?

A. I can't say who we approached in what order. Yeah, I do remember approaching Hitachi. I'm not sure they were the first ones we approached. I just don't remember that.

Q. Now, if I could ask you to go back to Exhibit 1021 -- i'm sorry. Well, let's see. 1022 is the one I had in mind.

This is Mr. Davidow's April 16, 1998 response to your April 15, 1998 e-mail; right.

A. Yes.

Q. And focusing you on the same language at the top of page 2 of that e-mail that I pointed out earlier, the last sentence of what I drew your attention to earlier says, "If things blow up with Intel, then we can begin to pursue the intellectual property issue with these guys."

Do you see that? It's the top of page 2 of CX-1022.

A. Yes, I do. Yes.

Q. Now, isn't it true that in October 1999, the

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same month that Rambus' board met to discuss the selection of targets for SDRAM-related patent enforcement, in that same month isn't it true that Rambus' relationship with Intel did, to use Mr. Davidow's words, blow up?

A. I don't remember that.

Q. Let me see if I can refresh your recollection.

May I approach, Your Honor?

JUDGE McGUIRE: Yes.

BY MR. ROYALL:

Q. I've just handed you, Dr. Farmwald, a document that's marked as CX-2541. I'm not suggesting that you received this, but I want to see if I can refresh your recollection. It's an October 26, 1999 letter to Mr. Tate, the CEO of Rambus, and Mr. Davidow, the chairman of Rambus, from Patrick Gelsinger of Intel.

And let me focus you on -- let's start with the first paragraph.

In that first paragraph Mr. Gelsinger states, "Events over the past several months, including changes within the global memory industry and changes in customer demand for memory products, lead us to believe that it is important for Intel and Rambus to conduct a very serious and comprehensive review of our current relationship, particularly in light of these larger

8419

issues."

Do you see that.

A. Yes.

Q. Were you aware that Intel in this time period was proposing to have serious and comprehensive discussions with Rambus about the business relationship between the two companies?

A. I don't remember the specific event. This sort of blowup seemed to happen every one to two years with Intel. We had a number of these episodes. This is one of many. I don't remember this specific one.

Q. Let me point to some of the other language here.

Paragraph 1 states, paragraph numbered 1 on the first page of CX-2541 states, "Industry acceptance of RDRAM technology is poor at best."

Do you see that language, the first sentence of that numbered paragraph.

A. Yes.

Q. Were you aware that Intel was expressing views of that sort about Rambus' technology in that time frame, October of 1999 ?

A. I don't remember specifically this time frame. I remember generally that there was some unhappiness with some of the OEMs were refusing to ship product.

8420

Q. Well --

A. Some of the DRAM makers were refusing to meet their contractual commitments to produce product, so I do remember that. Intel was unhappy with that.

Q. What about the next -- skipping the next sentence, and the next sentence down on that paragraph number 1 says, "Intel has on several occasions attempted to accelerate adoption/acceptance of Rambus technology, but on each occasion Rambus has failed to support our efforts."

Do you see that.

A. Yes.

Q. Were you aware that Intel was expressing views of that sort not relating to DRAM manufacturers' failure to produce the product but relating to Rambus' failure to support Intel's efforts? Were you aware that Intel was expressing those views in this time frame?

A. I don't remember it. I also don't believe that it was accurate at all. I believe we were supporting them quite strongly because -- so this again relates to the -- well, I don't remember specifically what they were complaining about, so...

Q. What about paragraph 3 on the first page of CX-2541 where Mr. Gelsinger says, "Rambus' original

8421

commitment of achieving less than or equal to 5 percent parity with SDRAM on cost has been grossly missed."

Do you see that.

A. Yes, I do.

Q. And were you aware of Intel complaining about that issue in this time period?

MR. STONE: Your Honor, this is -- i object to the use of a document the witness has never seen before. The limited use under the rules under which I think I've been held by complaint counsel is to see if it refreshes the recollection, not to use it to argue with the witness if he hasn't seen it before or to try to in some sense say, well, you have one recollection, the document has another. That's proper for argument.

JUDGE McGUIRE: Sustained.

I'm going to ask you to restate your question with the proper foundation, Mr. Royall.

You're saying are you aware. That's not in proper form.

MR. ROYALL: I'm sorry?

JUDGE McGUIRE: That's not proper in form in compliance with his objection.

BY MR. ROYALL:

Q. Let me just ask you one other question about this document, and it's solely from the standpoint of

8422

seeing if I can refresh your recollection.

If you can turn to page 2 of CX-2541. There are two statements. Let me see if I can refresh your recollection about this.

In paragraph numbered 5, about halfway down it says, "Our customers are rapidly losing confidence in us and in the technology, largely due to the lack of total prioritized support from Rambus."

Do you see that.

A. Yes, I do.

Q. Now, does that refresh your recollection as to the nature of the complaints that Intel was making to Rambus in this particular time period, October of 1999 ?

A. Again, my recollection of the complaints were really all essentially the DRAM makers aren't making enough parts, they're not selling them cheaply enough, you need to try harder to help. All the complaints came from that. In the end, it was the DRAM makers not producing enough parts that was what they were upset about.

Q. One last sentence I'd like to ask you about and that's a few lines down in that same paragraph, it says, "Taken as a whole, these factors cause us serious concern regarding Rambus' long-term commitment to

8423

making this technology robust."

Do you see that.

A. Yes, I do.

Q. Now, does that or does anything else that I've pointed you to in this letter refresh your recollection that in October 1999 , the same month that Rambus identified targets for enforcing its SDRAM-related patents, that the relationship between Rambus and Intel had blown up or had reached a very low point?

A. This happened a lot. And it's also my recollection that this was a minor thing. Within a few, six or so months after this, they were shipping high-volume production of some of the fastest machines in the world, so this blowup went away.

I don't recall any connection between this particular blowup and any litigation that we did with Hitachi or anybody else. I do not recall that at all.

Q. So it's your testimony or your belief that the interactions with -- between Rambus and Intel that are described -- this is certainly some evidence of those interactions in this time period, October 1999 -- that this was a minor thing?

A. It happened a lot. It wasn't minor. It was something -- I'm sure we would have taken it fairly seriously, but I'm also saying that I do remember that

8424

within a fairly short period, one year or so after this, we were in high-volume production with Intel. They were shipping, their fastest machines were using Rambus DRAMs.

So we clearly got through this problem with Intel. But I don't remember anything specific about this issue, and I don't think it led to any litigation with the DRAM companies.

MR. ROYALL: Your Honor, before I move on, I'd offer CX-2541.

MR. STONE: No objection.

JUDGE McGUIRE: Entered.

(CX Exhibit Number 2541 was admitted into evidence.)

BY MR. ROYALL:

Q. So it's your belief that the nature of what was occurring in the Intel-Rambus relationship in October of 1999 did not have anything to do with Rambus' decision in October 1999 to begin to approach DRAM makers about enforcing its SDRAM and DDR SDRAM-related patents?

A. That's actually not what I said. What I said was I don't remember there being any connection. I'm not denying that there's a possible one. I just don't remember it to be the case.

8425

MR. ROYALL: May I approach, Your Honor?
JUDGE McGUIRE: Yes.
BY MR. ROYALL:
Q. Let me, Dr. Farmwald, just show you one more document to see if I can refresh your recollection on this, and this is CX-1379.
And you'll see that the document has the title Intel Executive Meeting, August 8, 2000.
Do you recall any such meeting with Intel executives, Rambus meeting with Intel executives, in that time frame.
A. I don't remember knowing about the meeting, no.
Q. Let me ask you to turn to page 2 of CX-1379.
A. I can definitely say, by the way, I was not involved in this meeting. I know that.
Q. And I'm not suggesting that you were. I just want to see if some of the language in this document refreshes your recollection.
Turning to page 2 -- let me ask you about this -- there's a -- under the heading Rambus priorities, there's a -- then there's a bullet point that says: Our goals are the same since the 10-99, or October '99, ops review.
Do you see that.

8426

A. I'm sorry. What page are you on?

Q. It's page 2.

A. Yes, I see it.

Q. Do you see the first bullet?

A. Yes.

Q. The term "ops review," is that a term that you're familiar with being used internally within Rambus?

A. Yeah. Every so often the company would have an operational review. I don't remember whether it was once or year or not. I didn't attend, so I don't remember.

Q. And do you recall a Rambus operations review in October 1999 ?

A. I do not.

Q. Let me ask you to turn to page 4.

At the top of the page do you see the heading -- it says Another Slide from 10 or October '99. Do you see that.

A. Yes.

Q. And then it says "Rambus IP for high-bandwidth DRAM" and below that there are six bullet points. Do you see that?

A. Yes.

Q. And the second bullet point states, "Since 1996

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we assumed Intel would drive a rapid transition from SDRAM to Rambus."

Do you see that.

A. Yes.

Q. And then the fourth bullet point says, "Before, we chose not to rock the boat if all would be Rambus in 2-3 years."

A. Yes.

Q. Do you see that?

A. Yes.

Q. Does that language, seeing that, does that refresh your recollection at all about the subject I was asking you about earlier, that is, Rambus withholding from DRAM makers information about its views as to likely infringement or infringement by SDRAM or DDR SDRAM parts?

A. Well, that's not what this says. This says not to rock the boat, so I'm not sure --

Q. I'm not asking for you to interpret it. I'm just asking if it refreshes your recollection.

A. It doesn't refresh my recollection at all.

Q. Now, let me go ahead and ask you, though, what -- do you have an understanding of what "not to rock the boat" means in the context of this slide?

MR. STONE: Your Honor, I object. There's no

8428

foundation he's ever seen the document before.

MR. ROYALL: I'll withdraw it. I'll withdraw that.

BY MR. ROYALL:

Q. One last -- well, a couple of questions, but along the lines of seeking to see if I can refresh your recollection.

It then says, the next bullet point down says, the fifth bullet point on page 4 of CX-1379 says, "Intel has shifted to let the market decide, is enabling DDR and may be working on DRAM 2003 ."

Do you see that.

A. Yes.

Q. Now, does that in any way refresh your recollection that in October 1999 -- and again, I point you to the October 1999 reference at the top of this slide -- does that language refresh your recollection that in October 1999 , when Rambus' board was discussing selecting targets for enforcement of SDRAM and DDR SDRAM-related patents, that there was a significant adverse development in Rambus' relationship with Intel?

A. It's possible that's true. I don't remember it.

Q. And what about the next sentence where it says,

8429

"We must be proactive on our IP with DRAM companies"? Does that refresh your recollection, again in the context of a slide with the date 10-99 at the top, that there was a connection between Rambus' relationship with Intel and trouble in that relationship in October 1999 and Rambus' decision in that same month to begin approaching DRAM companies to enforce SDRAM and DDR SDRAM-related patents?

A. As I said before, this does not affect my recollection. My vague recollection is that what the reason that we started to litigate was because of the -- a number of the DRAM companies were not meeting their commitments. That's my recollection. I don't remember it having that much to do with Intel, other than the fact that the fact that they weren't meeting their commitments was upsetting Intel.

Q. And when you say -- just to be clear, when you say that it's your understanding that the reason that Rambus began to litigate on SDRAM and DDR SDRAM-related patents was because the DRAM companies were not meeting their commitments, by that you're referring to their commitments under licenses on RDRAM?

A. And their commitments to Intel. Intel invested $500 million in Micron to produce RDRAMs and they never did. They essentially never really came to market, so

8430

Intel was, for obvious reasons, not happy. We were not happy about that.

Q. So it's your understanding that Rambus' decision to begin -- the timing of when Rambus decided to enforce its SDRAM and DDR SDRAM-related patents, the timing of that decision related to Rambus' unhappiness with the DRAM makers relating to their commitments on RDRAM?

A. And to us and to Intel, yes. That's my best recollection. Again, I'm not an executive of Rambus, so I'm telling you my best memories from that time frame.

MR. ROYALL: No further questions, Your Honor.

JUDGE McGUIRE: Okay. Why don't we take just a short break and we'll come back with redirect.

MR. ROYALL: Your Honor, I'm sorry. I did want to offer that last document. We can do it after the break.

JUDGE McGUIRE: Well, let's do it now while we're on.

MR. ROYALL: CX-1379? Is that right?

MR. STONE: No objection.

JUDGE McGUIRE: Entered.

(CX Exhibit Number 1379 was admitted into evidence.)

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JUDGE McGUIRE: All right. Off the record.

(Recess)

JUDGE McGUIRE: At this time you may proceed, Mr. Stone, with your questioning.

MR. STONE: Thank you, Your Honor.

REDIRECT EXAMINATION

BY MR. STONE:

Q. Dr. Farmwald, one of the exhibits you were shown this morning was CX-919, which was a one-page e-mail, if you could find that again.

A. I've found it.

Q. Okay. And I want to draw your attention back to this just briefly. You'll notice it's dated February 10 of 1997?

A. Yes.

Q. And down in the area where Mr. Royall asked you some questions where it says "re IP" about a third of the way up from the bottom, "There are many issued and in-process patents," do you see that?

A. Yes.

Q. And then do you see the sentence which says, "There are no patents that we can definitely say are infringed"?

A. Yes, I see that.

Q. Was it your understanding in the early 1997

8432

time frame that that's a correct statement of what you thought about whether there were patents that were infringed by these products?

A. My best recollection -- i can't tell you specifically when. My best recollection is that I thought we had pretty good patents until sometime I think after this date when I was sort of surprised to find out that in fact our patents were -- our claims, issued claims, were somewhat weaker than we thought.

Q. Okay. So at that point in time when you learned that, you understood that the claims of the patents that Rambus then had maybe were not as strong as you had earlier thought they would be?

A. Yeah. So the fact that I was surprised that I found out they were weaker I'm sure in retrospect meant that I did think we did have good claims at that time.

Q. Then if you would look at CX-794, page 5 if you would.

A. I'm sorry. Which?

Q. It's a lengthy series of e-mails. It's a lengthy e-mail. I'm sorry. CX-794.

A. Is it in the binder or --

Q. No. It's in the stack. It's one you got this morning.

8433

A. Okay. I've found it.

Q. And I want to ask you if you could turn to page 5.

And the seventh paragraph, which is the large paragraph in the middle, is what I want to direct your attention to if I could.

You were asked about some earlier pages of this document. I just want to ask you if you would to take a moment and read that to yourself.

(Pause in the proceedings.)

A. I've read it.

Q. Okay. Did you have any knowledge of a conversation between the author of this e-mail, which was indicated on the cover to be Richard Crisp, did you have any knowledge of a conversation between Mr. Crisp and Sam Calvin and Conrad Lai about SyncLink until you were shown -- had a chance to see this document today?

A. I do not remember such a conversation.

Q. Okay. And you don't recall anyone telling you about such a conversation back at the time; correct?

A. I don't remember it, no.

Q. Let me ask you -- now, let me go back to the Intel issue that Mr. Royall asked you about, and I'm going to ask you, if you don't mind, to try and look on

8434

the screen at a document for me -- and I'll give the hard copies I have to Mr. Royall as soon as I get them up on the screen -- CX-2542.

You'll note this is an Intel letter dated November 2, 1999 . If you don't mind looking at it in on the screen.

A. I can see the date.

Q. Okay. If we can bring up just the first couple of paragraphs.

Do you see where it says, "Thank you for taking the time to meet with me and my colleagues on October 28 "?

A. Yes.

Q. Do you recall from your recollection whether or not there was a meeting with Intel representatives and Rambus representatives on October 28th of 1999 ?

A. I don't remember one.

Q. Let me ask you then if you'd look at another document -- we'll bring that up on the screen as well -- which is CX-2546.

You'll notice this is another letter like the one Mr. Royall showed you from Intel addressed again to Geoff and Dave in this instance.

Do you see that.

A. Yes.

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Q. And if we could bring up the first paragraph of the text.

Do you have any recollection independent of this document of a meeting that was attended by Rambus representatives and Intel representatives in Oregon in December of 1999 ?

A. I don't remember it.

Q. And you don't recall anybody reporting to you about that?

A. No. Nothing at all specifically.

Q. Okay. Go to the second page of the document if you could.

And up at the top, if we could just bring up the first paragraph.

MR. ROYALL: Your Honor, I would just say, again, there's no foundation that he ever saw this document. I have no objection to him being asked to refresh his recollection, which is what I was limited to doing.

JUDGE McGUIRE: I've heard that before, Mr. Stone.

MR. STONE: And that's exactly what I intend to use it for, Your Honor. I don't have any reason to think he saw this document any more than he'd seen the earlier ones.

8436

BY MR. STONE:

Q. I want to ask you about the second page of this document.

You were shown a slide by Mr. Royall that he asked you about from a set of slides and he asked you if that refreshed your recollection. I want you to take a look at this one paragraph and ask you whether this refreshes your recollection about a presentation that Intel made to a Rambus board meeting in November of 1999 .

A. I have no specific recollection of it. It's consistent with my vague memory that in fact Intel stuck with Rambus for several years after this in a pretty strong way, but I don't specifically remember this meeting.

Q. Okay. That's all I have with that document. Thank you.

I would like to offer these two letters in evidence, CX-2542 and CX-2546.

MR. ROYALL: No objection, Your Honor.

JUDGE McGUIRE: All right. Then we'll have each of them entered at this time.

MR. STONE: Thank you.

(CX Exhibit Number 2542 was admitted into evidence.)

8437

(CX Exhibit Number 2546 was admitted into evidence.)

BY MR. STONE:

Q. Yesterday Mr. Royall asked you about your prior deposition testimony. Do you recall that?

A. Yes.

Q. And he asked you whether that deposition testimony refreshed your recollection about whether Rambus at any point in time had asked that the RDRAM product be or any portion of the RDRAM product be standardized at JEDEC. Do you remember that testimony?

A. Yes.

Q. I want to show you again that same page of your deposition that you were shown by Mr. Royall, which is page 73 of your deposition dated January 7, 2003 , beginning at line 24, continuing to page 74, line 1.

May I approach, Your Honor?

JUDGE McGUIRE: Yes.

BY MR. STONE:

Q. And then read the top line on the next page if you would.

A. Okay. I've read it.

Q. And is that consistent with your current recollection, the testimony I just asked you to read?

8438

A. Yes. I do not still -- I didn't then and still do not remember whether Rambus ever did ask to submit a proposal to JEDEC.

Q. And the testimony you gave in your deposition when Mr. Royall was asking you questions back in January at that point in the transcript was what?

A. He asked me, "What specifically do you recall in terms of feedback from JEDEC or JEDEC participants" -- and I think that's what I focused on -- "about the possibility of considering Rambus DRAMs as a standard?"

The problem with "JEDEC participants" is everybody we were dealing with, every single company we were dealing with was a JEDEC participant.

And I answered, "Nothing specific, but the main feedback was it was considered too big a leap."

Q. And then at the bottom of that page, what was the answer -- the question you were asked and the answer you gave there?

A. "QUESTION: And based on that feedback, did Rambus decide not to make an attempt to present Rambus DRAMs to JEDEC as a potential standard?"

And my answer was: "I don't know specifically whether we did or did not submit Rambus to them as proposed, as a proposed standard, so I don't know

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whether we did or did not."

Q. Is that consistent with your testimony here and your recollection here?

A. Yes, it is.

MR. STONE: May I approach, Your Honor?

JUDGE McGUIRE: Yes.

BY MR. STONE:

Q. I'm going to ask you to look at an exhibit you were shown yesterday, which is CX-671, if you would. And it's going to be on the screen. I don't think the exhibits Mr. Royall used are still there, so if you could look at the screen for a moment. If that doesn't work, I'll bring you my copy.

Do you remember being shown this e-mail that you were a recipient of and it's dated December of 1991, do you remember seeing this yesterday.

A. I think so, yes.

Q. Could we bring up the last four or five paragraphs at the bottom.

Let me give you my copy.

Do you recall this -- may I approach, Your Honor.

JUDGE McGUIRE: Go ahead.

BY MR. STONE:

Q. Do you recall this e-mail being a report on a

8440

meeting that Mr. Tate had with someone at Toshiba?

A. Well, I have no direct recollection of the e-mail, but that's what it appears to be and I think it's consistent.

Q. And you were asked yesterday about the paragraph, oh, three paragraphs up from where it says "Redundancy" where it says, "Thinks we should develop a plan before announcement to take Rambus to JEDEC after announcement."

Do you see that.

A. Yes.

Q. And how long after this e-mail was written did Rambus have their public announcement party in Tokyo and Palo Alto?

A. Three to four months.

Q. And do you know one way or the other whether it was Toshiba that invited Rambus to attend the first JEDEC meeting that anyone from Rambus attended?

A. I don't really remember. I have a vague recollection, but unfortunately it's probably colored by documents I've seen recently, so I can't really answer.

Q. I really only want your recollection based on what you knew at the time.

A. Okay. I don't remember.

8441

MR. ROYALL: Your Honor, I didn't want to interrupt the witness' answer, but I think that question goes beyond the scope of my cross-examination. I didn't ask about who invited Rambus to attend the JEDEC meeting. I don't think that's within the scope.

MR. STONE: No. I'm simply trying by that question to clarify that the document the witness was asked about, that the document is completely consistent with not a discussion about standardizing but a discussion about someone from Rambus simply attending a JEDEC meeting.

JUDGE McGUIRE: I'll entertain the question.

BY MR. STONE:

Q. Did you ever think it important to have a JEDEC standard on any Rambus-designed part?

A. I did not.

Q. Is that something you ever asked anyone to try to achieve?

A. I did not. I was not interested in doing that.

Q. Okay. Yesterday you -- today --

JUDGE McGUIRE: I'm sorry, Mr. Stone. Let me interject.

And again, I want you to expand on that answer. Could you tell me exactly why you came to that conclusion, Dr. Farmwald.

8442

THE WITNESS: Well, this is my best memory of why. I know I felt that way, so I'm giving you my best memory as to why I would have felt that way. Partly because I was pretty confident in the strength of our patents.

And of course certainly in that time period that we're talking about here, 1991 , I really felt that our ideas were inevitable, that we would win, that we didn't need to be part of these large group committee standards things which took forever to do things. I considered them wastes of time and that real breakthroughs were made by small groups of people.

JUDGE McGUIRE: Did that also go back to your earlier -- when I inquired of you earlier and you had indicated in a prior answer that you felt that to some extent the organization was hostile toward your company, was that part of why you didn't feel you'd have to go back to them to try to get these patents part of the standard?

THE WITNESS: It was certainly related. In fact that was going to be the second part of my answer, is I think I felt at the time that even if we had wanted to do it, we probably couldn't have gotten it done anyway.

So I think it was both. I didn't feel it was

8443

necessary and I felt that the organization would not have been friendly to us.

JUDGE McGUIRE: Okay. Mr. Stone, I just wanted to interject that for my understanding of the issues, so go ahead.

MR. STONE: I appreciate it, Your Honor.

BY MR. STONE:

Q. Earlier today at one point in your testimony you said with respect to a discussion you had with RamLink that you thought that RamLink was making use of ideas that were included in a 1999 application, and I want to ask you whether at the time you talked with RamLink you were referring to a 1999 application or an application of some other date.

A. I meant the 1999 original.

Q. Which date?

A. Excuse me. The 1990 . I'm sorry. The 1990 original patent application.

Q. Your RamLink meeting occurred prior to 1999 , didn't it?

A. Yes, it did.

Q. And yesterday you were asked something about -- that led you to say that you were very careful about NDAs until a particular event occurred, and was there an event that you were particularly careful about NDAs

8444

until that event occurred?

A. Well, my recollection pretty strong is that we had -- we were under orders to be very careful about NDAs until we had filed our first patent and that past that point we should still be careful, but we could be a little bit more open with information.

Q. Okay. And you were shown yesterday several letters you received from lawyers relating to patent applications in the '92-93 time frame. Do you recall that?

A. Yes, I do.

Q. And you've told us to some extent today that at a certain point in time you began to get active in another business venture?

A. Yes.

Q. What was the business venture you got active in?

A. I had an idea for building a multimedia processor that would go into a PC that would actually use Rambus technology, so while I was still at Rambus, I started working on these ideas. This was in sometime in 1992. I can't actually date it very accurately, but I think it was sort of middle to, you know, middle to late '92 I started working on it, and in '93 I actually left to start a new company called

8445

Chromatic Research.

Q. And did that -- just describe for us how much of your time then was devoted to Chromatic.

A. Well, once I started work -- i mean, given my nature, once I start working on an idea, I actually spend most of my time on it, so...

Q. And did Chromatic become a large company or a successful company?

A. Yeah. We shipped quite a lot of product. We had 300 employees. In the end, we sold the company to another company.

Q. And in the time period from '93 up until 2000, other than your activities with Chromatic, did you have other activities?

A. Yes, I did.

Q. What other activities? Just briefly.

A. I started several other companies and worked with several other companies in that time frame. The bulk of it was spent with Chromatic, but I did do some other things, too.

Q. You were asked yesterday by Mr. Royall about whether you knew of any documents that would show the discussions that Rambus had with various licensees about noncompatible uses of Rambus technology. Do you recall that?

8446

A. I don't recall the question, but it sounds reasonable.

Q. Okay. Have you ever taken it upon yourself to review the various license agreements that Rambus entered into with various companies to see what those agreements say about noncompatible uses one way or the other?

A. I have not.

Q. You were -- i think it's going to be in your binder since we don't have those exhibits there, so just take a look if you would at -- let me just find the number.

Okay. If you would look, it's in your binder, I think it's 543a. I think yesterday Mr. Royall showed you 543 and I'd shown you 543a , but I think they're the same document.

A. Okay. I've found it.

Q. And turn if you would to page 14 of 543a.

Do you recall being asked yesterday about the first paragraph under the heading Resistance to Business Model.

A. Yes, I do.

Q. Where it makes reference there to system companies, systems companies, what's that a reference to?

8447

A. Companies that actually build computer systems as compared to chips or parts.

Q. Okay. And when it says "IC companies," what's that a reference to there?

A. In this context I'm fairly certain it means non-DRAM companies in this particular context, just because I'm reading the rest of the document, so it's somebody who builds a memory controller or a CPU or a graphics chip.

Q. Did you, in the early meetings that you attended with potential customers, did you find some of those customers more receptive than others to your ideas?

A. Yes.

Q. If you'd allow the witness to approach the chart, Your Honor.

Could you go back to the chart from yesterday where you gave us a list of companies that you approached. And I'm going to ask you to make some additional notations on it if you would in light of some of the questions since then.

JUDGE McGUIRE: What chart was that?

MR. STONE: That will be -- may I approach, Your Honor?

JUDGE McGUIRE: Yes.

8448

I think it's DX-255.

MR. STONE: You're right, it is.

JUDGE McGUIRE: All right.

BY MR. STONE:

Q. Directing you to DX-255, Dr. Farmwald, to the extent you recall the reception, can you put a plus in the right-hand side of each one where you thought you received a positive reception, put a check if you thought it was neutral and a minus if you thought it was negative, if those terms make sense to you?

A. Sure.

Very positive at IBM, Intel, Toshiba, NEC, Matsushita, Mitsubishi, Fujitsu. I remember those all being very positive.

Micron was negative.

Siemens I feel was -- my best recollection is somewhere between a plus and a check, so I'm going to say plus on that one.

Motorola I don't remember, so --

Q. Just leave it blank.

A. -- I'll leave it blank.

Apple is somewhere between a minus and a check.

Sun somewhere between a minus and a check and it got more negative at following meetings.

8449

SGI very positive.

HP I'm going to put a double minus. That was an extremely negative meeting.

And Tandem I don't remember.

Q. Now, if you would resume the stand, I just want to ask you about a couple of those meetings.

Do you recall who it is at Sun that you met with?

A. It was a large group of people. At the first meeting there were probably 25, 20 to 25 people there.

Q. Do you recall Andy Bechtelsheim was there?

A. Andy definitely was there.

Q. And do you recall whether his views as he expressed them at the meeting were positive or negative?

A. They were surprisingly negative, and that's why I say it was somewhere between positive and negative, between a check and a minus. A lot of the people liked it, some of the people didn't, and I remember distinctly Andy was one who didn't like it very much.

JUDGE McGUIRE: Now, who is he again just for the record?

MR. STONE: Andy Bechtelsheim?

JUDGE McGUIRE: Yes.

8450

MR. STONE: Who testified here, is now at Cisco but then was at Sun.

JUDGE McGUIRE: Very good.

BY MR. STONE:

Q. And at the HP meeting, do you recall anyone who was in attendance at the HP meeting on behalf of HP?

A. Yes, I do. I don't remember all the names. It was a moderate size meeting as I remember, maybe five or six people. I do remember that Desi Rhoden was there.

Q. And do you recall his attitude at the first meeting you had with them?

A. It was amazingly hostile and that sort of surprised -- the reason I remembered it, because I sort of didn't understand at all what I had done to merit such hostility.

Q. Let me ask you to look at -- it's the Rambus business plan dated June 26, 1989 . The one Mr. Royall showed you is CX-570, but I believe I showed you the same document with a different number, which was -- if I could have just one minute, Your Honor -- which is RX-15.

It's the very first document in your binder, if you would just go to that for a minute. Again, I

8451

believe this is the same document as the one Mr. Royall showed you, just different exhibit numbers.

Turn if you would to page 9 of that document.

A. Okay.

Q. Do you see the heading Rambus Company Profile?

A. Yes.

Q. And I think you were asked by Mr. Royall about the last sentence in that paragraph, "The DRAM market is already highly sensitized."

Do you see that.

A. Yes, I do.

Q. And you were asked some questions about interchangeability. Do you recall being asked that yesterday?

A. Yes.

Q. Were all Rambus products interchangeable with each other generation to generation?

A. No. They're not at all interchangeable.

Q. Are SDRAM and DDR products, to your knowledge, interchangeable generation to generation?

A. They are definitely not interchangeable.

Q. When you were working on designing the Rambus products, did you have as a goal establishing interchangeability to some extent?

A. Only within a generation. Generation to

8452

generation you essentially can't because you're shooting for fairly significant performance increases and it's almost impossible to maintain backwards compatibility.

Q. What was the first generation of the Rambus product called?

A. Just RDRAMs.

Q. And were they interchangeable within that generation?

A. With each other, with all the different manufacturers were interchangeable, yes.

Q. So if I bought that first-generation RDRAM from one company or another, they would be interchangeable?

A. They were all identical. Yes.

Q. Was it your goal at any point in time to ensure that the next generation of a Rambus-designed product would be interchangeable with the first?

A. No. I believe it's impossible.

Q. Okay. Let me ask you to -- maybe we can pull it.

Do you have the stack at all from yesterday **(directed to complaint counsel)**? Could you find me the witness' copy of CX-1283, perhaps if you could give him that back.

8453

Thank you so much.

May I approach, Your Honor?

JUDGE McGUIRE: Yes.

BY MR. STONE:

Q. I've handed you CX-1283, Dr. Farmwald, which I think you were asked about yesterday. And let me just ask you to look at a couple of different pages for me if you would.

First, if you would look at page 5.

A. Okay.

Q. Does looking at page 5 give you any insight into whether this is a document that you used in meetings with venture capitalists or in meetings with potential customers or with some other people?

A. This would have definitely been with investors, with venture capitalists.

Q. And how do you know that?

A. Well, you wouldn't brag about how much money you're going to make to potential partners.

Q. To customers?

A. To customers, yeah.

Q. Then go back if you would and look at page 4.

Do you recall being asked yesterday about the language under Current Solutions where it says "very wide, interleaved memory systems".

8454

A. Yes.

Q. What does that refer to?

A. That refers to memory systems, not chips, so that refers to memory cards or, you know, the whole integration of the memory system on a card basically.

Q. And were you referring there at all to anything about the width of any particular DRAM that was then being manufactured?

A. Absolutely not. That refers to the fact that the way you make a high-speed memory system out of fairly low-speed memory chips is to put a whole bunch of them in parallel and make a wide bus out of individually narrow chips.

Q. Let me ask you to turn if you would to page 6 of this document.

Do you recall being asked some questions I think both by me and by Mr. Royall about the last bullet point on that page which says, "Use existing DRAM fab technology and designs, only change the interface".

A. Yes.

Q. When you talked about changing the interface here, what were you talking about? What's that a reference to?

A. Again, the -- we had to build the parts -- our

8455

new idea had to be implemented within a DRAM fab and within something that was pretty close to existing DRAM core designs, so our idea was just to change the externalities of the chip primarily, which is the interface, the how you talk to the outside world, how you get the data in and out.

Q. And on page 9 of this document, do you describe some of the various elements of the Rambus interface?

A. Yes.

Q. What did the -- what are the different elements of the Rambus interface that are identified on this page?

A. It talks about a bus. It talks about a -- by using the bus you can build a dense 3D package. And then it talks separately about a custom signal interface that runs at an extremely high rate, 500 megahertz, which is the same as a two-nanosecond clock cycle -- I'll start again -- two-nanosecond bus. Very low voltage swing interface. Special drivers and of course receivers. The drivers drive -- controlled impedance transmission lines which are terminated. This is important to run at high speed.

And then of course we pipeline the transfers. So we overlap. We'll start the first -- we'll start

8456

the second transfer before the first one is even done, which is what pipelining means.

And then finally, we talked about allowing block-mode transfers from individual DRAM. This is related to the concept of a DRAM chip as a memory card, and the idea is that you can send a request to a single DRAM and have the entire block of data anywhere from one byte up to maybe 128 bytes come back from a single DRAM chip.

Q. We've heard testimony in this case about a variable block size. Is that referenced in the last bullet point on this page?

A. Yes.

Q. Are all of the aspects communicated on page 9 of Exhibit CX-1283 included within what you were referring to as Rambus interface?

MR. ROYALL: Your Honor, I object to the leading nature of these questions, that one in particular.

MR. STONE: Okay. Let me rephrase.

BY MR. STONE:

Q. When you used the word "change the interface" on page 6, which if any of the various elements listed on page 9 were included in that reference to interface?

8457

A. All of them.

Q. Okay. Look if you would at page 7 of this document.

Can you tell us generally and briefly what is depicted here?

A. It's a comparison between Rambus and conventional DRAMs, which at the time of course were page mode DRAMs.

Q. And is this a comparison of one DRAM to another DRAM?

A. Yes. It's actually -- it's a comparison of both at the systems level and at the chip level. Some of the comparisons are at the chip level and some of the comparisons are at the system level, so it's both.

Q. And which are which?

A. The bandwidth per chip is obviously a per-chip comparison.

The power per chip, it's at the system level, but it's averaged per chip because it even says so, average across 32 chips. So you build a system, you calculate the average power and then you compare chip to chip, so it's at the system level.

Density is obviously at the systems level, and packaging cost is at the systems level.

Q. Turn if you would to the next page, which is

8458

page 8.

What's described on this page?

A. The -- sort of an overview of how we viewed the current DRAM interface.

Q. And there's a reference there to multiplexed address lines. What's that's a reference to?

A. The current DRAM interface which used RAS/CAS, row address stroke and column address stroke, sent half the address lines on any given cycle. So of the total address that you needed to interface to the DRAM, only half of the bits were sent at any one time, so there were half the number of bit lines in the address bus as there were total address lines.

Q. The next bullet point that says "one to four data I/O lines," do you see that?

A. Yes.

Q. What's that a reference to?

A. To get data in and out of the chip you -- we could either send -- at that point in time you could either send one bit in or out at a time or up to four bits in or out at a time.

Q. And how many data lines were there, if you know, in the DRAMs that you were describing on page 8 of CX-1283?

A. Oh, I'm sorry. There would be four typically.

8459

Q. And how many data lines were there on the original design of the first Rambus DRAM chip?

A. We -- eight or nine, depending how you count. I would say eight basically.

Q. Turn if you would then to page 10 of this document, and look at that page and page 11, both of which have the heading Rambus protocol -- that's the first one, page 10, and page 11 says "Bus Protocol Continued."

And did you describe for us yesterday using a demonstrative in conjunction with your testimony what is referenced here as Rambus bus protocol or Rambus protocol.

A. I think so, yes.

Q. And is there anything different in the description on these two pages than what you told us about yesterday when I asked you questions?

MR. ROYALL: Can I ask for clarification of what demonstrative you're referring to?

MR. STONE: Sure.

Can I approach, Your Honor?

JUDGE McGUIRE: Certainly.

BY MR. STONE:

Q. Directing you to DX-254, Dr. Farmwald, do you remember preparing this for us yesterday?

8460

A. Yes, I do.

Q. And at the top half where it says "bus protocol inside DRAM," do you see that?

A. Yes.

Q. Is that a reference that is similar to the reference or the description on page 10 and 11 of CX-1283 of a protocol?

MR. ROYALL: Objection. Leading.

JUDGE McGUIRE: Sustained.

BY MR. STONE:

Q. Let me rephrase.

What's the relationship, if any, between the description under Bus Protocol on DX-254 and the description we see of Rambus protocol on pages 10 and 11 of CX-1283.

A. They're both an attempt to describe the key ideas in the first-generation Rambus protocol.

Q. And then look if you would at page 13 of CX-1283. And if you can -- you were asked questions about this drawing yesterday. Do you recall?

A. Yes.

Q. There's a description of something -- there's a heading that says "Very Constrained Wiring." Do you see that?

A. Yes.

8461

Q. What was the significance, if any, of that aspect of this drawing or this design?

A. Part of it would have been part of a verbal description of what's going on because it's not totally obvious from this picture.

But it's constrained in the sense that even inside each package there's some wiring that's not shown and the wiring for each different pin is exactly the same as every other pin, so every length of every wire in every chip is the same, and that was pretty important to achieve the maximum performance, and so that's what it meant by "constrained."

Q. And when it talks about Rambus packaging here, what was that meant to refer to?

A. In this case it was the idea of having a bus with all the signals along one side of a chip so that you could achieve these tight tolerances and the short distances to send signals over.

Q. And when you ultimately concluded the design of the first Rambus DRAM, was it packaged in the way shown on page 13 of CX-1283 or in some other way?

A. It was packaged differently.

Q. And how was it packaged, if you could describe that for us verbally?

A. We laid the chips down flat so that the wires

8462

got a little bit longer, but it was more conventional packaging technology. People, in the end, didn't like having the chips sticking up at right angles to the traces, so we laid them down flat.

Q. Let me ask if you would go to the binder and turn to a document, CX-635, which is a set of board minutes back towards the back.

A. I'm sorry. I'm not finding it in the documents.

Q. I'm not either.

I'm just going to show you my copy of CX-635, which was the version that Mr. Royall showed you.

May I approach, Your Honor?

JUDGE McGUIRE: Go ahead.

BY MR. STONE:

Q. I've confused my exhibit numbers. I apologize, Dr. Farmwald.

I'm asking you to look if you would at the January 1992 board minutes, which is page 3 -- go to page 3 of Exhibit 635 under the heading 7.0, Marketing and Partners, if we could bring that up.

Do you see that reference.

A. Yes, I do.

Q. Do you understand what's meant by the Rambus technology announcement plans that are referred to in

8463

these January 1992 board minutes?

A. Yeah. It's consistent with my memory. We had a big announcement in the spring of 1992 and I'm pretty sure this is talking about that big announcement, public announcement.

Q. And I want to ask you with respect to that --

MR. ROYALL: Your Honor, I believe that this is beyond the scope of my examination. I don't think that I asked the witness about that aspect of these minutes.

MR. STONE: I think he asked him, A, about this document, but B, I want to -- this is just to lay a foundation for issues he did ask about, if I can.

JUDGE McGUIRE: Then only for the foundation.

MR. STONE: Okay.

BY MR. STONE:

Q. Mr. Royall asked you some questions yesterday about describing the Rambus technology as revolutionary. Do you recall that?

A. Yes.

Q. Have you ever described the Rambus technology as anything other than revolutionary?

A. No, I have not.

Q. And to your knowledge, has Rambus always been proud or at least willing to express pride in its

8464

technology as revolutionary?

A. We have always been very proud of it.

Q. Okay. I want you to turn back in your binder to CX- -- i mean to RX-67, if you would. It's about right in the middle I think.

A. I've got it.

Q. Okay. And I want you to turn to page 2, the first sentence on that page.

Is it consistent with your views in 1992 that until the advent of the Rambus solution there was no vehicle or impetus to undertake this revolution to a much needed new standard?

A. I believe that. I believed it then. I still believe it.

Q. How many of the technologies that or inventions that you described for us yesterday as being part of your original inventions do you understand to currently be in use today in high-volume products?

MR. ROYALL: Your Honor, I believe that that goes beyond the scope of my examination.

JUDGE McGUIRE: I think that's sustained. I'm going to sustain that one, Mr. Stone.

BY MR. STONE:

Q. Okay. You were asked yesterday about desires

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to have the Rambus technology become a de facto standard. Do you recall?

A. Yes.

Q. And based upon the volume of products being shipped today, have some of the Rambus technologies or the inventions that you described for us yesterday become high-volume products or de facto standards?

A. In my opinion, yes.

MR. STONE: Thank you.

No further questions, Your Honor. Thank you.

JUDGE McGUIRE: Okay. Any recross, Mr. Royall?

MR. ROYALL: Very brief.

JUDGE McGUIRE: Go ahead.

RECROSS-EXAMINATION

BY MR. ROYALL:

Q. Now, Dr. Farmwald, a couple questions following up on what Mr. Stone asked you about.

You said in response to one of his questions that you thought that Rambus' ideas or inventions were inevitable. Do you recall that.

A. Yes.

Q. But you also said in response to my questions earlier that you acknowledged that certainly in the early '90s that Rambus' ideas were somewhat ahead of their time; is that right?

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A. I think that's consistent, but yes, I think I said that.

Q. So when you say that Rambus' ideas were inevitable, do you mean in the longer run?

A. Yes. I believe my feeling back then was that sometime in the late '90s, early 2000 that you would have to use these ideas. So roughly ten years after we started they were inevitable.

Q. Okay. You also had made some comments today about your perception that JEDEC or certain JEDEC participants were not receptive to Rambus or had some type of unfriendly attitude towards Rambus. Is that what you said?

A. Yeah. I believe my testimony was that certain JEDEC participants were. I would hesitate to say that JEDEC as a whole was unfriendly, because I don't know what that means, but...

Q. Well, did you understand that this lack of receptiveness to Rambus on the part of some JEDEC participants had to do with the fact that Rambus was seeking to charge royalties for its DRAM interface technology?

A. I think that was an element, yes. I think it was also a lot of what we normally called NIH, not invented here. A lot of people were upset that they

8467

hadn't thought of these ideas first.

Q. And did you also understand that JEDEC as an organization was seeking to develop standards that wherever possible would be free of royalties?

A. I don't know whether I had such an understanding or not. It wasn't my issue. I felt we had invented these things and that they were inevitable and all we had to do was wait and we were going to develop -- i mean, we were very focused on developing our idea, so I don't know whether I knew that was part of a JEDEC goal or not.

JUDGE McGUIRE: Well, when I asked you earlier why did you feel they were hostile to you and you really didn't -- and I asked you do you have any cause for that feeling and you had just said a couple times you had gone there and they were unfriendly, but you never did quite say as to exactly how come they were unfriendly. Is that in part because of what you're being asked now?

THE WITNESS: My belief was and is that most of the unfriendliness had to do more with NIH, with the not-invented-here feeling, than with any specific royalty numbers, but that's my belief.

I mean, I didn't know why they were unfriendly. I'm just telling you my belief.

8468

BY MR. ROYALL:

Q. And you said that you were not aware of the extent to which JEDEC as an organization seeks to develop standards that wherever possible avoid the use of royalty-bearing patents; is that right?

A. I was not aware of the details of the rules behind JEDEC, no.

Q. You don't recall seeing e-mails from Richard Crisp reporting to you and others within Rambus that JEDEC was seeking to avoid royalty-bearing patents in the standard?

MR. STONE: I object. This is beyond the scope of any redirect.

JUDGE McGUIRE: Sustained, Mr. Royall.

MR. ROYALL: Well, Your Honor, this goes directly to what Mr. Stone elicited about this unfriendly attitude that the witness testified about.

JUDGE McGUIRE: Well, you're going to have to get to that in some other way.

BY MR. ROYALL:

Q. Let me ask you about something else, and then I think I'll be done.

In response to Mr. Stone's questions, you talked about commencing work on the -- what ultimately became the Chromatic project.

8469

A. Chromatic Research, yes.

Q. And you said that was sometime in mid-1992?

A. Mid to late '92. I don't remember exactly when.

Q. And I understood you to be suggesting that once you started on that that you were in a sense pulling back from your work at Rambus. Is that correct?

A. That's correct.

Q. But even after you started work on this Chromatic research project in mid-1992, you did continue to interact with Rambus' lawyers on patent-related issues, didn't you?

A. I don't remember specific meetings. I think it's likely that I did have some meetings. I just don't remember.

MR. ROYALL: May I approach, Your Honor?

JUDGE McGUIRE: Yes.

THE WITNESS: I was still at Rambus and still an employee of Rambus, so...

JUDGE McGUIRE: Let me just, again for my edification, get a clear date as to when you started, you know, your new company and you were no longer active in Rambus to the extent that you were in early days.

8470

THE WITNESS: It was -- my actual leaving Rambus where I ceased to go into the company as an employee, that was sometime in 1993. My best recollection was somewhere around -- somewhere in the middle of the year. I don't know exactly when but in the middle of 1993.

But I was working on the ideas that led up to Chromatic while at Rambus, with Rambus' permission of course.

JUDGE McGUIRE: Of course.

BY MR. ROYALL:

Q. Now, I've just handed you a document that I presented you with yesterday. It's CX-1937. And let me ask you to turn to page 26.

Again, we identified these yesterday, but this is a copy of the billing statements from the Blakely Sokoloff law firm, Lester Vincent's law firm, relating to work that his firm was doing on behalf of Rambus.

And do you see on page 26 -- this is a billing record relating to work done in October 1992 -- that there's a reference there to teleconference with Mike Farmwald concerning draft amendment and prior art, prepare letter to Mike Farmwald enclosing copy of draft amendment, teleconferences with Mike Farmwald

8471

concerning review of amendment? Do you see that language.

A. Yes, I do.

Q. So at this point in time is it correct that you were continuing to, even though you had started work on your Chromatic research project, you were continuing to interact with Rambus' outside counsel relating to patent issues?

A. I believe that to be true. I don't have any direct recollection, but I believe it to be true.

Q. And that work continued, did it not, to the very end of 1992?

A. I think it's likely.

Q. Okay. And I'll just point you in that regard to page 33 of the same document. And you'll see that this is a reference to a billing record, and the date at the top is December 31, 1992, and again there's a reference to teleconference with Mike Farmwald concerning filing of amendment. Do you see that?

A. Yes, I do.

Q. So at least through the end of '92 you were interacting with Rambus' outside patent counsel relating to patent issues?

MR. STONE: I object, Your Honor. He's not using the document to refresh recollection. The

8472

witness has never seen it before. He's using the document to try to get the witness to agree with its contents and there's no foundation.

JUDGE McGUIRE: Sustained, Mr. Royall.

MR. ROYALL: I'll withdraw that question.

JUDGE McGUIRE: All right.

MR. ROYALL: And I have no further questions.

JUDGE McGUIRE: Okay. Very good.

MR. STONE: I have no questions, Your Honor.

JUDGE McGUIRE: Very good.

Dr. Farmwald, I want to say thank you for your testimony. You're excused from this proceeding.

Counsel, it's twelve o'clock. I suggest we take a break for lunch and reconvene around twenty after one.

MR. STONE: That's fine, Your Honor. Thank you.

JUDGE McGUIRE: Hearing in recess.

(Whereupon, at 12:02 p.m., a lunch recess was taken.)

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A F T E R N O O N   S E S S I O N

(1:21 p.m.) .

JUDGE McGUIRE: This hearing is now in order.

At this time the respondent may call its next witness.

MR. DETRE: Your Honor, we're going to call Dr. Mark Horowitz. I believe Dr. Horowitz stepped out for one second and we've just sent somebody to fetch him.

JUDGE McGUIRE: Okay.

Did you all get a copy of my order on the post-hearing briefs? Would this be a good time to talk about that? Does anyone have any comments or inquiries as to how that's going to proceed?

MR. STONE: I don't at this time, Your Honor. I appreciate getting it now. We will have questions to raise.

JUDGE McGUIRE: How about the other side?

MR. WEBER: That's fine.

JUDGE McGUIRE: And while we're just at it -- this probably will only take a couple minutes -- are we on track to complete this hearing by the end of the month? Because I do not want to go into August.

MR. STONE: I am very hopeful that that last week of July which includes either two or three days in

8474

August -- it does include August 1 and 2 I think -- that that week we should be able to conclude our case by that week.

JUDGE McGUIRE: By the week of --

MR. STONE: By that last week in July.

JUDGE McGUIRE: Then we'll have the other side's rebuttal in early August? Is that what we're talking about?

MR. DAVIS: Obviously it depends on what the rest of the case is.

JUDGE McGUIRE: If this would expedite this, we could start earlier in the morning and we could go later. Again, that's going to be up to counsel, but I was hopeful we wouldn't have to go into August.

MR. STONE: I can say we're doing everything we can to trim our list and run it as tight as we can. We aren't proposing any deliberate Fridays off, although we may finish early on one or two days, but I think in general we're trying to do it -- i'll look at it again.

JUDGE McGUIRE: I'll ask that the two sides confer, and let's try to get this thing done as soon as we can as close to the end of July.

MR. STONE: I appreciate that.

JUDGE McGUIRE: At this time you can call your

8475

next witness.

MR. DETRE: Your Honor, respondent calls Dr. Mark Horowitz.

JUDGE McGUIRE: Okay. Dr. Horowitz, would you please stand and be sworn by the court reporter.

- - - - -

Whereupon --

MARK ALAN HOROWITZ

a witness, called for examination, having been first duly sworn, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. DETRE:

Q. Good afternoon, Dr. Horowitz.

A. Good afternoon.

Q. Could you please state your full name for the record.

A. My full name is Mark Alan Horowitz.

Q. And where do you live?

A. I live in Menlo Park, California.

Q. Where about in California is that?

A. It's part of the Silicon Valley. It's right next to Stanford University.

Q. How long have you lived in the Silicon Valley?

A. I've lived in the Silicon Valley area since 1978.

8476

Q. What is your present job?

A. My present job is primarily as a faculty member at Stanford University.

Q. In what department are you a faculty member?

A. I actually have a joint appointment in the electrical engineering department and in the computer science department.

Q. I'd like to step back a little bit and get some background about you, Dr. Horowitz.

Where were you born.

A. I was actually born here -- well, not in this building but in Washington, D.C. .

Q. And where were you raised?

A. I was raised in Maryland in Silver Spring.

JUDGE McGUIRE: And then after that, then you still went to California?

THE WITNESS: Yeah. I really disappointed my mother, too.

JUDGE McGUIRE: All right.

BY MR. DETRE:

Q. Where did you go to college, Dr. Horowitz?

A. I went to college at MIT in Boston.

Q. And what did you study at MIT?

A. Electrical engineering.

Q. Did you get a degree from MIT?

8477

A. Yes. I graduated with both my bachelor's and master's degree from MIT.

Q. In what year was that?

A. I graduated in 1978.

Q. How long did it take you to get those degrees?

A. Four years.

Q. Is that the usual amount of time it takes to get a bachelor's and a master's from MIT?

A. No. MIT has a reputation for taking a long time for a master's. After three years at MIT I realized that they paid graduate students instead of having to pay them to be a student, and since I was supporting myself through school, I had taken enough credits, I applied to be a graduate student.

Q. So how old were you when you got your master's from MIT?

A. I was born in '57, so that made me 21.

Q. Did you do well at MIT?

A. Yes, I did.

Q. Can you explain?

A. Well, MIT has a 5.0 scale, it's not 4.0, because they like to be different, but through my career I got one B and the rest A or A-pluses.

Q. And after graduating from MIT, what did you do?

8478

A. I moved out to the Silicon Valley and got a job at an integrated circuits company called Signetics.

Q. What did you do at Signetics?

A. I was a chip designer, and the first project that I worked on was a bipolar chip, an ECL chip. It was a kind of memory called a content addressable memory.

Q. And Dr. Horowitz, you said you were a chip designer?

A. That's correct.

Q. In this case we've heard the term "circuit designer" used. Would you call yourself a circuit designer also?

A. Yeah. A chip designer and a circuit designer are used interchangeably.

Q. And we've also heard a fair amount of testimony about systems architects or architecture engineers. Are you familiar with those terms?

A. Yes, I am.

Q. How does a circuit designer differ from a systems architect?

A. Well, to design a large digital system it's very complicated, so it's typically broken into different levels.

8479

So the systems architect will work on what's called a logical level. Oh, I should apologize.

(Discussion off the record with the court reporter.)

THE WITNESS: So for you to build these very complicated things you basically break them into different levels of abstraction, and so the system designer will work at sort of the logical level, thinks about things in terms of signals being one or zero and different logical blocks, and a circuit designer is responsible for creating the logical blocks that the system architect would use.

And so things that might seem simple to a system architect are really the problems that the circuit guys need to work on, and that's primarily the level that I've been working at.

BY MR. DETRE:

Q. I'm sorry. There was a bit of digression there.

How long did you work at Signetics.

A. I worked at Signetics for a year and then the group I was working in was disbanded.

Q. And what did you do at that time?

A. I decided to go back to school and I became a Ph.D. student at Stanford University.

8480

Q. What did you study at Stanford?

A. I studied integrated circuit design, both circuit design and some system design issues.

Q. And did you graduate from Stanford?

A. Yes, I did. I got my Ph.D. from Stanford in December of 1983.

Q. What did you do after graduation?

A. I basically was looking at faculty positions, and I was given an offer at both MIT and Stanford, and I took the offer at Stanford and became a faculty member there.

Q. What year was that again?

A. I became a faculty member in 1984 .

Q. What were your initial responsibilities when you became a faculty member at Stanford?

A. The sort of standard faculty member responsibilities. I was teaching classes and advising research students.

It was a little unusual since the faculty member who I thought was going to be my mentor, John Hennessey, decided to take leave to start a company. It was MIPS Computer Systems actually. And as a result I ended up running his whole research project.

Q. What research project was that?

8481

A. It was design of a microprocessor chip, one of the RISC chips that we had heard about earlier.

Q. And what are your current responsibilities at Stanford?

A. I'm currently a full professor at Stanford University. I'm actually the director of the computer systems lab, which is a joint laboratory between the electrical engineering department and the computer science department. It deals with all aspects of computer systems.

I also have some administrative responsibilities, overseeing some campus IT and some other stuff.

Q. During your time at Stanford, what sorts of research have you pursued?

A. My research agenda is fairly broad in the general area of digital systems and integrated circuits. I've worked on computer programs to aid the design of such chips, circuit design, like how to build low-power or very high-speed memories or I/O.

Recently, for the past decade, I've done a lot of work at high-speed I/O.

Q. And when you say "I/O," you mean?

A. These are the pins that connect chips together. I/O stands for input/output.

8482

I've also worked on computer designs of various kinds. I've built large-scale multiprocessor systems as well as single-chip implementations, so fairly broad in that range.

Q. Have you received any honors or awards during your time at Stanford?

A. Yes. A number of them.

Q. Could you give us a couple of examples.

A. Okay. Well, when I first became a faculty member, I was awarded the National Science Foundation Presidential Young Investigator Award.

I've been awarded -- some of my publications have won best paper awards at either conferences or journals.

And it's a little embarrassing because I actually hold two endowed chairs at Stanford, so I'm the official Yahoo! at Stanford -- I'm the Yahoo! professor of industrial engineering and computer science at Stanford, and I also hold the Cadence chair at Stanford.

Q. Have you worked at Stanford as a faculty member continuously since 1984 ?

A. No. I've taken a few leaves. The first leave was in 1990 to start Rambus.

Q. How long was that leave?

8483

A. I was away from Stanford for one year during 1990 , and then during 1991 I ramped back to Stanford, split my time. And by September of 1991 I was back full-time at Stanford.

Q. And after you returned to be full-time faculty at Stanford, did you continue your relationship with Rambus in any way?

A. Yes. Stanford faculty members allow faculty to do a one-day-a-week consulting, so I've taken that one day a week and worked with Rambus since the founding of the company, and I'm still working there one day a week.

Q. And are you also on the board of directors?

A. Yes, I'm on the board of directors.

Q. What sort of work are you doing at Rambus these days with your one-day-a-week consulting?

A. I'm acting as a consultant since I'm only there one day a week, but I'm working mostly with the high-speed serial link group, talking about methods of building ever faster I/O interfaces.

Q. Is that related to memories?

A. This group isn't directly related to memory. It's technology that could be put onto memory devices; it could be put on other devices.

Q. You were present yesterday and today during

8484

Dr. Farmwald's testimony; is that right?

A. That's correct.

Q. When did you first meet Dr. Farmwald?

A. I believe it was in the mid-1980s, right when Mike was starting the company FTL that he described yesterday. He came to Stanford and asked if I'd be interested in joining the company, and I had just become a faculty member at Stanford and was not really interested in leaving at that time, and I declined the offer.

Q. Did you get to know Dr. Farmwald after that time?

A. Yes, I did.

FTL was acquired by MIPS Computer Systems, and then they hired me as a consultant to do design on some of their ECL microprocessor chips, since I had done some bipolar circuit design before.

Q. And during what period were you doing that?

A. That was in the probably -- i don't remember exact dates. I'm not very good on dates, but I would guess it's '86-87 time frame.

Q. Now, did Dr. Farmwald call you at some point about an idea for high-speed DRAMs?

A. Yes. He called me I believe it was late in '88 with this idea that he was pretty excited about.

8485

Q. And so just briefly, what did he tell you at that time?

A. Well, this led to the discussion that was brought up yesterday about the meeting at Saint Michael's Alley and he told me about this new idea for changing the interface to DRAMs.

Q. And Dr. Farmwald went over that yesterday. You listened to that. Did he basically get it right?

MR. WEBER: Objection. Leading.

JUDGE McGUIRE: Sustained.

BY MR. DETRE:

Q. What was your reaction to Dr. Farmwald's testimony about that?

A. Unfortunately, he was correct that I'm often very skeptical when I hear new ideas, and so I was pretty skeptical about the idea, but on further thought, I really did think that it was, A, technically correct, that was -- excuse me -- that is, the problem he was addressing was going to be a real problem, that bandwidth in a DRAM was really a difficult problem to solve and that his approach was a really good approach to solve that problem, and so technically I thought it was both a challenging problem and an important one.

Q. Did you ultimately decide to work on that

8486

project?

A. Yes. After Mike -- after working with Mike a little bit, I decided that even if I didn't think the business aspects necessarily -- you know, I didn't know too much about the business aspects -- the technical problem was interesting enough and challenging enough, it sounded like a fun thing to do.

Q. But you did take a leave of absence for --

A. Yes.

Q. -- a year from Stanford; is that right?

A. Yes.

So basically at that point I had been at Stanford almost six years, and to be honest, I had been running very hard and was a little fried at Stanford and needed a break, so I decided this would be a good break, I would do something very different than what I was doing before, and I set up to take a leave from Stanford and work with Mike full-time.

Q. Now, what was your goal in working on this project with Dr. Farmwald?

A. Well, Mike saw that the problem that we were facing was a shortage of bandwidth to a DRAM, so when I joined the project, my goal was to build the fastest possible interface that you could get on the DRAM, to get as many bits per second as you could, you know, to

8487

push the technology as far as you could.

Q. Did you think it was important to push the technology to the very fastest interface you could build?

A. Well, I think at the time it was -- it wasn't that this very fast interface was going to be required. I mean, people were doing the -- dealing with the current DRAMs and we were talking about something, as Mike said, which was basically a factor of a hundred times faster, but it seemed that these techniques would be inevitable, and like I'm an engineer and I like the technical challenge, so what we tried to do is figure out the best interface that we could figure out.

Q. Now, in trying to build this high-speed interface, what sort of problems did you have to solve?

A. Oh, there were numerous problems that we needed to solve in order to get a really high-speed interface.

Current interfaces couldn't run at high speeds for a number of different issues having to do with electrical issues, having to do with clocking, having to do with the whole way -- what Mike called the protocol, so all those areas would need innovations in

8488

order to get a really high-speed interface.

Q. The first thing that you mentioned was electrical issues?

A. Yes.

Q. What sort of -- could you break that down some more. What sort of issues arose in that area?

A. Well, in order to get a high-speed interface, we were going to need to be able to get very high-frequency signals from the DRAM to whatever it was talking to, the memory controller, and back. And that meant we needed circuits that basically could generate the high-speed signals, but we also needed the environment, the wires -- I think people call it bus; I sometimes call it channel -- between these things to be able to allow these very high-speed signals to propagate through.

And therefore, we needed to work on what the wires look like, the bus. We needed to worry about the driver circuitry, the receiver circuitry, in order to be able to generate signals that are high enough performance.

Q. And you mentioned that there were also problems that arose with respect to clocking?

A. Yes.

Q. What do you mean by that?

8489

A. Well, the current memory chips of that time are what are now called asynchronous chips. They had RAS/CAS interfaces. And it was both Mike and my opinion that in order to get very high performance out of a device it would have to be a synchronous device, which means that it would need to have some sort of timing reference, and that timing reference is usually called clock.

And then even with a clock you have to have very tight control over the timing in order to be able to know which bit was which. If each bit is only two nanoseconds in length, then you have to sample it at the right time to get the right bit; otherwise, you'll either get garbage or the wrong bit. And that's what I mean by "clocking issues."

Q. I'll come back to your solutions here, but let me get to the last topic you mentioned.

A. Sure.

Q. You said that there were also problems in respect to designing of protocol?

A. Correct.

Q. What did you mean by that?

A. Well, again, the current DRAMs of that time had an interface where you would present an address and it would give you back one bit of data or maybe four bits

8490

of data, but generally the system that was using that DRAM didn't want that small amount of data; it wanted a chunk of data, many bits of data.

And that we thought in order to really get high performance what we wanted to do is put a little, what used to be called a memory controller or a controller for the memory chips directly on the memory chip, and that would then allow us to optimize the signals that went on the bus, the wires between the memory chip and the controller.

And to do that controller it meant putting some registers onto the chip, it meant allowing it to do -- sort of return variable chunks of data back, issues like that.

Q. Now, we've broken down the problem somewhat. Let me go back and talk a little bit about each of the things that you mentioned.

A. Sure.

Q. With respect to the electrical issues, you said that you had to work on the bus?

A. Correct.

Q. What sort of solutions did you come up with to the problems that arose with respect to the bus?

A. Well, there are, again, many different steps that we took in order to get ultimately a

8491

high-performance result. The first thing that we did is we said -- let me digress for a second.

Up until that time, people viewed wires as just connectors between two points, and in the design you would think, well, they're connected so they have the same voltage, but in reality there is this thing called the speed of light and signals can't travel faster than the speed of light.

And if you go at very high frequencies, the delay along the wires is comparable to the frequencies that you're worrying about, and you have to worry about the fact that there's a speed-of-light delay.

When you do that, you have to view the wires as something called a transmission line, and what we did is then viewed the wires as transmission lines. In order to get good signaling quality in our transmission line you have to terminate it, so we had --

Q. Let me stop you there for a second, Dr. Horowitz, and let me also point out, I've set up an easel behind you, so with the court's permission, whenever Dr. Horowitz might feel it helpful to draw a picture, that easel is available.

A. Okay. Great.

Q. But you said that the -- in order to get high-quality signals on the transmission lines they

8492

have to be terminated?

A. Yes.

Q. What do you mean by that?

A. Well, let me, if I could --

Q. Certainly. With the court's permission?

JUDGE McGUIRE: Yeah, go ahead.

BY MR. DETRE:

Q. And I think there are markers there on your table, Dr. Horowitz.

A. Thank you.

So basically if this was a DRAM device and it wants to transmit a signal to another device, let's say there's a memory controller, what it would do is it would transmit a signal, put a signal onto this wire, but because there's a speed -- the speed of light is finite, it would take some time for the signal that it put on this end of the wire to get to the other end.

During that period of time this chip is actually putting energy into the wire and it's driving the voltage, which is putting some energy into the wire. When that energy finally reaches this end, if there's no place for that energy to go, it does something called reflects and causes another signal to travel backwards on that wire.

8493

Q. Is that reflection a problem?
A. And that reflection is a very big problem, because if I want to get a signal that looks nice like that, if the reflection comes back, I'm going to get an additional signal added to that which may go up again, so the signal I get, the results may look really strange.
Q. And that's because of the reflected signal being added to --
A. Right. Because this signal just gets added to the signal you were intending to transmit.

And in the old systems, when you went slow enough, these reflections ultimately die out and the signal ends up settling to some value which is the final value you want. But if you want to go fast, that's too slow, and so what you have to do is you have to add resistors, so when the energy comes to the end of the line, it flows into the resistor and doesn't reflect back.

And there's a value resistance which matches the characteristics of this line, which is called its impedance, and so we started building systems that looked like that.
Q. And that's what you mean by terminating line?
A. So this resistor is called the terminator for

8494

the transmission line.

MR. DETRE: Perhaps we can leave the chart there, and to the extent Dr. Horowitz draws more on this page, once he's done with that page, we can mark it as a demonstrative; is that --

JUDGE McGUIRE: Yes, that's fine.

BY MR. DETRE:

Q. You mentioned that problems had to be solved with the driver circuitry?

A. That's correct.

Q. What did you mean by that?

A. Well, in addition to building a nice transmission line environment, so now let's say we've done the transmission line, the wire that connects the DRAMs to the controller correctly, the next problem is we now need to build a circuit that can drive a nice signal onto this transmission line.

Q. What do you mean by driving a signal on a transmission line?

A. Well, we need -- this is a wire, so we need to basically impress a voltage onto the wire. And at the time, people just drove the signal between ground and the high-power supply, which was five volts. But because we have to terminate the transmission lines, if you try to drive a high volt signal, it would take way

8495

too much power. So instead, we had to figure out a way of driving a small voltage signal onto the wire, and so we built a particular kind of a driver, called a current source driver, to drive that signal.

And then the next problem we had to solve was we now had a really nice wire, but our signal, our -- the circuitry on the DRAM couldn't drive the signal quite as fast as the wire could take it, and so we wanted again to drive the highest possible speed, we had to figure out a way of driving a very fast signal.

Q. And did you solve that problem in some manner?

A. Yeah. So the basic problem was for the technology at the time we really couldn't build a 500 megahertz clock; that is, you couldn't build a 500 megahertz clock on a chip at that time.

And so what we ended up doing is saying, well, if I can't get a clock that's fast enough, I'm going to try to get two bits per every clock cycle, and what we ended up doing was called the dual-edged clocking or double data rate. It's been referred to as that.

Q. And we've heard a lot about that in this case. Maybe just briefly, what do you mean by "dual-edged clocking" here?

A. Well, again, the idea is I want to get a data stream out that's faster than I could get out if I

8496

transmitted one bit for every clock cycle, so instead, what I do is -- can I go to the board again?

Q. Sure. I mean, if --

JUDGE McGUIRE: Go ahead.

THE WITNESS: I guess I should be asking you.

So a normal clock waveform is defined by having two edges. It has a rising edge and a falling edge. And the clock cycle is the time between one rising edge and the next rising edge.

Okay. And the problem is that for this -- because of the speed of the transistors, we can't get this to be 500 megahertz; that is, this has to be about four nanoseconds. It couldn't be two nanoseconds.

So in order to get higher data rates, what we're going to end up doing is transmitting one bit when the clock is high, so we put one data value here, and then when the clock went low, we put another data value, and when the clock went high again, we again transition another data value. As a result, we get two data values in every clock cycle.

BY MR. DETRE:

Q. Thank you, Dr. Horowitz.

Now, you've also mentioned that there were problems with constructing the receiving circuitry.

8497

A. That's correct.

Q. What sort of solutions did you come up with there?

A. A very similar kind of solution works there as well. The problem is that, as I said, we couldn't transmit full values onto the bus because the transmission -- the transmission line was terminated, so we ended up having small voltage swings. That meant for the circuitry at the receive side we had to take that small swing and amplify it to be a full swing.

Now, amplification also takes time, and it turns out that the circuitry that we had was not fast enough to amplify in the two-nanosecond bit time.

So we did a very simple trick of having two receivers, again sampling one on the rising edge of the clock and another one on the falling edge of the clock, giving each receiver a full cycle, four-nanosecond cycle, to amplify it.

Q. So did the dual-edged clocking that you referred to enter into this solution also?

A. Right. So essentially we used dual edges on both the transmitter and the receiver.

Q. Now, you mentioned with respect to clocking that you decided you needed to go to a synchronous

8498

design?

A. That's correct.

Q. Do you recall that?

Why did you find that you had to go to a synchronous design.

A. Because I don't think one can build a very high-performance asynchronous I/O interface.

Q. And maybe just stepping back for one second, what do you mean by the term "synchronous"?

A. I basically mean that you have a signal, usually called a clock, that defines the timing of all the operations, so every -- all transitions are referenced to that timing signal, that clock.

Q. And why did you think such a synchronous design was necessary?

A. Well, because -- i can try to explain why I think that an asynchronous design is difficult, if -- should I do that?

Q. Sure.

Maybe what we can do is mark this as DX-257?

JUDGE McGUIRE: 256, is it not?

MR. DETRE: I believe we believe it's 257.

JUDGE McGUIRE: Then I take your word for it.

And if that's the case, could someone explain what we had as 256. That was one of the charts?

8499

MR. STONE: I think it was the large board.

JUDGE McGUIRE: Okay. That's fine.

(DX Exhibit Number 257 was marked for identification.)

BY MR. DETRE:

Q. Now, Dr. Horowitz, I think you were going to explain why you felt at the time that an asynchronous design would be difficult.

A. Correct.

So this is one of those issues where a circuit designer has a very different perspective from maybe a system architect or a logical designer. And that's because that every time you go through some block of circuitry, so this is let's say some logic, the logical guys think it has some delay. Right? But the circuit guy knows that if the input changed here, the output over here is going to change not at one time but there's going to be some range of times.

There's going to be some region of uncertainty that the output can transition between. That is, the delay of this block is not a number; it could be any one of a number of numbers depending upon a bunch of different parameters.

Q. What causes that uncertainty?

A. Things like temperature, power supply voltage,

8500

just the previous transitions that happened, right, the history. Other signals that are nearby that happen to couple in a little bit will affect the timing.

So basically every time you go through -- so then now if I went to another block of logic over here, right, that also is going to have a delay that's going to have some uncertainty to it. Right?

And so if I add what is the output time of the output, what we find is that delay has basically a large --

Q. May I stop you for one second, Dr. Horowitz.

Can you see, Your Honor.

JUDGE McGUIRE: Yes, I can see.

THE WITNESS: That's all right. I should stand not to block you. Problem being left-handed.

So it has a bigger region of delay because obviously it has this uncertainty and a bigger region of uncertainty because it has the first -- the uncertainty from the first element plus the uncertainty of the second element.

And this uncertainty will grow unless you have some other reference to basically time things off of.

BY MR. DETRE:

Q. And when you say that the uncertainty will

8501

grow, is that because you're going through more and more blocks?

A. Right. Exactly.

So in an asynchronous DRAM, there's a timing signal that starts off at the memory controller, okay, and then you go through a whole bunch of circuitry in the DRAM and you come back with the data that comes back. And there's a whole bunch of circuitry in the DRAM that you go through and there's actually some circuitry within the memory controller, too. And that means that the precision, the uncertainty in when the data arrives is fairly large.

Now, you can easily see if you're trying to get a stream of data bits out and the uncertainty in each of the data bits is some large -- you can't -- the bits have to be longer than the uncertainty. So there's a region of where it's certain.

And it was my feeling then as it is now that in order to get high performance you have to have very small amounts of uncertainty, and that means you have to have a way of getting rid of this, and a synchronous system gives you that.

Q. And can you just briefly explain how a synchronous system solves this problem?

A. Sure. So let's -- in a synchronous system what

8502

you would do is you put some element over here called a latch or a flip-flop -- let's call it a flip-flop -- and what the flip-flop does is it basically samples the data and changes its output on the rising edge of some clock.

Q. Since you've marked "async" at the top of this, maybe you could mark "sync" where you're --

A. Right. I will put -- so if you put a synchronous system, yes, the signal has uncertainty, but what you're going to do is you're going to only look at that signal at some clock edge.

So let's say the clock edge occurred here, which means we look at the signal right here when it's stabilized and the output of this flip-flop will then only change a small delay after the rising edge of this clock, so that means its output will change only here and will have a much smaller uncertainty because it's a much smaller delay off the clock **(indicating)**.

Q. And is the amount of uncertainty that you get with a synchronous system predictable?

A. Yes. Generally the amount of uncertainty is a percentage of the delay from the timing edge that you're using as a reference, so if you knew what the delay from the clock to the output was, then you could say that uncertainty is some percentage of that.

8503

Now, it's still uncertain. I can't say exactly what it is, but...

Q. Okay. Please resume your seat, Dr. Horowitz.

And if I may approach, Your Honor, I'll mark this one as DX-258.

JUDGE McGUIRE: Yes.

(DX Exhibit Number 258 was marked for identification.)

BY MR. DETRE:

Q. Now, Dr. Horowitz, I think you mentioned when you were running through the various problems you faced that even with a synchronous system you felt that at the type of speeds you wanted to go that would not entirely solve the uncertainty problem; is that right?

A. That's correct.

Q. Could you explain why not.

A. Sure. The problem is even in a synchronous system there's some delay when the clock rises to when the output transitions.

Now, part of that delay is something that you know about. It's the expected delay of the buffers. So there's some circuit, so it has some expected delay. And then I said there's some variability and variability is about maybe 10 percent or less of the

8504

expected delay.

Now, the problem is that in a different part the expected delay might be a little different because it was fabricated differently or something like that, so if I really --

Q. I'm sorry. Are you envisaging now that you have more than one DRAM?

A. Sure. Or I have a DRAM at a controller. It's always two different chips and their delays are not -- wouldn't be the same.

So if we really wanted to go as fast as possible, which remember was our goal initially, is to do everything as well as we could, we wanted to take all the deterministic errors and try to force them to zero.

And one way you can do this is by using a circuitry that I think was talked about in the court before, which is a delay-lock loop or a phase-lock loop, which is a feedback system which measures some delay and then adjusts another delay to make the total or to make the -- yeah -- the total constant.

So one can essentially adjust delay to be effectively zero.

Q. And is that what has been called in this courtroom a delay-lock loop?

8505

A. Yes. So a delay-lock loop is one circuit that will do that.

Q. What other types of circuit might do that?

A. A phase-lock loop is another circuitry that might do that.

Q. Now, I believe you previously threw out the number 500 megahertz.

A. Right.

Q. And I think from Dr. Farmwald's testimony we understand that means 500 million transmission -- transitions per second; is that right?

A. That's correct.

Q. Where did that number come from?

A. That was part of the embarrassing part of starting Rambus. We were thinking about this interface. We wanted it to go as fast as we could possibly make it go, and we were thinking about how fast that would be. And you know, when you do this, this is not very precise engineering, so you take nice round numbers, and we thought, you know, a hundred was too small and a billion, you know, was -- a hundred million was too small and a billion was too high, 500 million seemed like the, roughly, the right number.

It wasn't through a lot of detailed technical

8506

analysis that we came up with that, but it seemed like that was the fastest I could think that I could do or that we could do, and so that's the number that we wrote down and got started.

Q. Now, in order to get your system running at 500 megahertz, did you believe at the time that a DLL or PLL circuit on the DRAM was necessary?

A. Yes. I still believe that today.

Q. We'll get to that.

Now, the third category of problems that you mentioned were problems related to the protocol. Do you recall that.

A. That's correct.

Q. And you mentioned that part of that involved putting registers on the DRAM?

A. That's correct.

Q. What was the purpose of the registers on the DRAM?

A. Well, basically the purpose of the registers was to make the interface more efficient. That is, we were going to spend a lot of time and engineering effort to make these I/O circuits run at very high performance. Okay. And once you do that, you want to use them wisely. You want to get the most out of them that you can.

8507

And we thought that the interface of DRAMs at the time really didn't allow us to get the most out of them and what we really wanted was something more like a bus interface that happened in those old computers that Mike talked about where you'd send a request out to the memory chip and it would provide you back a bunch of data.

But to do that, the DRAM had to be a little more clever than it was before and it needed to have some parameters stored in it that were basically useful for the bus.

Q. What sorts of parameters were those?

A. Well, so one of the parameters was what address range it should respond to.

When you send out a request, you ask for a certain address, you had to figure out which DRAM was to respond. That's one.

Another thing was different buses might have different response times when you send out a request to when you provide the data back, and so you wanted that to be a register that you could write on system start-up that said basically what the response time should be.

Q. And let me actually step back for just one minute.

8508

What does the term "register" mean?

A. Register is just a storage -- a circuit that will remember something. And it's like a memory cell except -- so if you looked at them you could tell, but you use it a slightly different way, and it could either be a flip-flop or a latch, you know. It depends on how you use it and would depend what circuitry you put in.

Q. What is a flip-flop?

A. A flip-flop is a circuit like I showed on the board before which has a property that every time the clock rises, it transfers its input. It looks at its input pin and puts the value at its input pin on its output pin, and that happens only in the rising edge of the clock.

Q. So you can use that to store one bit of data?

A. Sure. Because if you put some data into the input pin and then you have the clock toggle once, that data will then be the output, and if you don't toggle that clock or that signal anymore, it will remain there indefinitely.

Q. And what is a latch?

A. A latch is similar to a flip-flop, but it's a little simpler. And what it has a property of is that it transfers the input signal to the output as long as

8509

the control signal is high. So it's not edge determined; it's level determined.

Q. And that's another way that you can store one bit of data?

A. Sure.

MR. WEBER: Objection. Leading.

JUDGE McGUIRE: Sustained.

BY MR. DETRE:

Q. How many bits of data can you store with a latch, Dr. Horowitz?

A. You can use it to store one bit of data.

Q. And how does it do that?

A. Again, now you raise the control signal, you put the data that you want to store on the input, then you lower the control signal. That piece of data is now stored in the latch and it will remain there indefinitely.

Q. Now, you mentioned that one of the registers that you envisaged putting on the DRAM would store response time?

A. That's correct.

Q. What do you mean by that exactly?

A. Well, in the design that we had done, we were going to have a request come to the DRAM and then sometime later the DRAM was going to send the data

8510

back. It had to be sometime later because the DRAM takes some time to actually do the access to get the data that we wanted.

And what we wanted to be able to do is make that access time variable. And the reason it had to be variable is twofold. Since we weren't exactly sure how fast the bus was going to be, we were going to measure the bus in bus cycles.

Maybe I should draw this rather than using my hands.

JUDGE McGUIRE: It's up to you.

BY MR. DETRE:

Q. Why don't you flip to the next page?

JUDGE McGUIRE: Did we mark that last chart?

MR. DETRE: I did.

JUDGE McGUIRE: And that was 258, so this will be 259.

THE WITNESS: So the reason -- let's say the DRAM takes -- so let's say it takes that much access time.

Now, in some systems the clock may be at this frequency. So it takes six cycles.

But maybe we get to improve the bus somehow, we make the frequency of the bus faster, so each of the bus takes us faster, so what that means is it's going

8511

to take seven cycles now because the -- you know, each cycle is shorter. And we wanted to be able to have the same part work in that system if it could run at that faster frequency or slower frequency.

In a similar way, DRAMs can have different access times, and again, we wanted to be able to program all the DRAMs to be as slow as the slowest one so the memory access was the same for all the chips in the system. And that's why we went to the variable read delay.

BY MR. DETRE:

Q. Okay. Thank you, Dr. Horowitz.

In this case we've heard quite a bit about the term "programmable latency."

Are you familiar with that term.

A. Yes.

Q. Does programmable latency have any relation to what you described now about variable access time?

A. They're the same.

Q. You mentioned in an earlier response about the protocol that you want to get more than one bit of data back in response to each request. Do you recall that?

A. That's correct.

Q. Why is that?

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A. Again, it's efficiency. It's an efficiency issue. There's some overhead in doing the request, and if we want to get the highest performance possible, we want to get as many bits out for each request as is useful, and printing a lot of bits back in each request is not very useful, so we wanted to be able to have the requester tell us how many bits they wanted.

Q. And is this -- another term that we've heard a lot in this case is "variable block size" or "variable burst length."

Are you familiar with those terms.

A. Yes, I am.

Q. Is that related at all to what you've just now described?

A. In my view, variable block size, variable burst length and what I just talked about are all the same.

MR. WEBER: Your Honor, I'd just like to raise a point for clarification. This is getting very close to expert testimony. I'd like to clarify it for the record that what Dr. Horowitz is talking about is what he was thinking about in 1989 .

JUDGE McGUIRE: Let's do that. I think that's a good point. It's a little hard to understand that

8513

this is from his personal -- which I'm sure it is, but we have to be careful that he doesn't go too far over that line, counsel.

MR. DETRE: I understand, Your Honor. That's certainly what I intended.

BY MR. DETRE:

Q. And Dr. Horowitz, when you've been describing the various aspects of technology that you've just been describing, was that about what you were thinking of back in the 1989 to 1990 time frame when you were developing your high-speed DRAM interface?

A. Yes, it was.

Q. Now, have we at this point gone over all of the various innovations and solutions to problems that you came up with in that period?

A. No.

Q. Were there many others?

A. Yes.

Q. And over what period of time did you work out these solutions to design a high-speed bus interface?

A. Well, I focused almost all my attention on that from mid -'89 up through the time that I rolled back to Stanford, which was sort of mid-'91, but I continued to work with Rambus on all those problems on memory interfaces for another couple years, and then one can

8514

argue I've been working on high-speed interfaces since that time.

Q. Well, when do you think that you had, you know, the basic underlying ideas in place?

A. We had a very, you know, complete set of ideas put together by the early '90s -- early in '90, and that's what went into the original patent description.

Q. And did you describe the various technological features that we've been discussing up until now in that original patent application?

A. Yes, I did.

Q. Was it your understanding at the time that you were working out these solutions to problems that these various solutions could be used independently of one another?

MR. WEBER: Objection. Lack of foundation.

MR. DETRE: I'm talking about his understanding at the time.

JUDGE McGUIRE: Overruled. I'll hear his question.

THE WITNESS: Yeah. We were, as I said, you know, were trying to build the best thing that we could, and in order to do that we had to solve a number of problems. It was always clear to me that if you didn't want quite the level of performance we got you

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wouldn't necessarily need to use all the different techniques that we described, that some of the techniques would -- you know, some subset of those techniques might satisfy your need, so yeah, sure.

BY MR. DETRE:

Q. Did you talk to people about the high-speed interface technology you were developing?

A. Yes, I did.

Q. What sorts of people did you talk to about it?

A. Well, I talked to both DRAM companies that build DRAMs as well as companies that use DRAMs to try to convince them about our approach, get feedback from them.

Q. Did you actually visit some of these companies in the 1990 time frame?

A. Yeah. Well, in the 1989 -1990 time frame Mike and I were the company, so we made a lot of visits to various people trying to convince them.

Q. Can you give me some examples of DRAM manufacturers that you personally visited?

A. Yeah. I personally visited TI. I visited with IBM. And then as Mike described, we went on this tour of Japan and so we went to Toshiba, Fujitsu, Mitsubishi, NEC.

Q. And did you also personally visit some systems

8516

companies?

A. Yes. I visited -- well, obviously IBM was also a systems company and I visited them. And I remember pretty vividly the discussions at Sun Microsystems.

Q. What was your role during these visits?

A. I was the -- i mostly talked about technology. My love is technology and I like figuring out how to design things, and so I mostly tried to convince people that what we were trying to say was not completely absurd.

Q. What was the reaction to your initial presentations in technology?

A. Well, I think fairly uniformly when we told people we were going to do 500 megabits per second on DRAMs there was just disbelief. People said we couldn't do that.

As Mike said, some people were worried that maybe we could, right, and were interested in talking to us more, and those are the people that I think were positive, and there were people who were just hostile, but I don't think anybody thought, oh, yeah, that's easy.

Q. And other than the speed that you were contemplating going at, were people skeptical about any

8517

other features of the technology you described?

A. I think almost all the features of the technology the people were skeptical about.

They were skeptical -- dRAMs were commodity parts. They were not sold at high margins. So the thought that we were adding stuff to a DRAM, even this little memory controller that we were talking about putting on a DRAM, people thought that was a bad way. You would never put registers on a DRAM. It was too expensive.

A phase-lock loop was even worse. This is a very tricky analog circuit. You couldn't put this on a DRAM. You couldn't get the I/O speeds, the circuitry to run. You know, you name it, people were kind of skeptical.

Q. So what did you do in the face of this skepticism?

A. Well, maybe I'm a -- i like technical challenges and I really like explaining to people things, so my goal was to explain to people why I thought it was possible and to see if I could convince them. I mean -- or they could convince me. Right? So maybe I was wrong.

And so we would have these discussions about why I thought this was -- i would tell them why I

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thought it was possible, and they would tell me why they didn't think it was possible, and I was trying to figure out if they knew something I didn't know. But over time, we got more and more details worked out and we were able to convince more and more people that this in fact was possible.

Q. Let me show you a document, Dr. Horowitz.

May I approach, Your Honor?

JUDGE McGUIRE: Yes.

MR. DETRE: And actually let me also hand a copy of this binder to complaint counsel.

Perhaps as long as I'm approaching, I'll mark this DX-259, Your Honor?

JUDGE McGUIRE: Yes, go ahead.

(DX Exhibit Number 259 was marked for identification.)

BY MR. DETRE:

Q. If you could turn to the first document in the binder, RX-29.

Have you got that, Dr. Horowitz.

A. Yes, I do.

Q. Can you tell me what that document is?

A. It's one of the presentations that I would have made trying to describe to people, you know, in the early time frame what Rambus technology was like.

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Q. If you look down at the very bottom in the first slide, do you see a date there?

A. Yes.

Q. What date is that?

A. That's January 31, 1990 .

Q. And is that date consistent with your recollection of when you might have been using these slides to present the technology?

A. Yes, it is.

Q. And were you in fact giving presentations to various companies at around that time?

A. Yes, I was.

Q. Did you give out copies of these or similar slides at such presentations?

A. Yes, we did.

Q. Did you take any efforts to preserve their confidentiality?

A. Oh, certainly. We wouldn't -- this is -- this is something that has the technical issues and technical details, and those discussions were always done under NDA.

Q. Now, is there a portion of this presentation that describes the problem that you were trying to solve?

A. Sure. The beginning part of the presentation,

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so that's from really page number 3 on to -- well, maybe we should stop at 6, is sort of the setup of what the problem is.

Q. And now, if you would turn to page number 9.

A. Okay.

Q. And I believe we saw this or a similar slide with Dr. Farmwald.

If you look at the last bullet point on that page, allows -- the last big bullet point, could we blow that up.

Could you explain what's being described there, Dr. Horowitz.

A. Yes. This is basically I'm describing the point that I mentioned earlier about not requesting a single bit out of the DRAM but requesting a chunk of data out, and that's what the block mode refers to.

And then in the description it talks about the number of bytes that you could request out of the DRAM being variable from 1 to 1024.

Q. So that relates to variable block size or variable burst length?

A. That's correct.

Q. And if you could turn to page 31 -- actually let me -- let me actually point you to a different page --

8521

A. Okay.

Q. -- if I could. Let's go to page 33.

Can you tell me what's being described there, Dr. Horowitz.

A. I'm not there yet.

Q. Sorry. I'll give you a second.

A. Okay.

Q. Can you tell me what's being described on that page?

A. Yes. So this was describing the clocking scheme that we initially proposed in the -- proposed for Rambus.

Q. And does this relate to one of the solutions or innovations you were talking about earlier today?

A. Yes. So this basically talks about having a phase-lock loop or actually in this case multiple phase-lock loops on a DRAM to reduce the timing uncertainty in each of the DRAM devices.

Q. And this talks about delay lines in there; correct?

A. Correct.

Q. Would this also be referred to as a delay-lock loop?

MR. WEBER: Objection. Leading.

JUDGE McGUIRE: Sustained.

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BY MR. DETRE:

Q. Is there any other terminology other than phase-lock loop that you could use to describe what's being described in this page, Dr. Horowitz?

MR. WEBER: Objection. Leading.

JUDGE McGUIRE: Overruled.

THE WITNESS: Yeah. The circuitry that's used here with the controlling the delay through delay lines is referred to either as delay -- as a delay-lock loop.

BY MR. DETRE:

Q. Now, if you would turn to the very next page, it's headed Bus Summary. Do you see that?

A. Yes.

Q. And the third bullet point there, use clever clock deskew, do you see that?

A. Yes.

Q. Does that relate to one of the solutions to the problems that you were discussing earlier?

A. Well, that basically refers to the use in the previous page, the circuit industry on the previous page that used delay-lock loops to basically get rid of clock skew both internal and external to the part.

Q. And if you look at the last bullet point on that page, standard clocked sense amplifier receiver

8523

run at one-half frequency, does that relate to one of the solutions you talked about earlier today?

A. Yeah. That was the solution I talked about in terms of the receivers taking too long to amplify, to have two receivers, each one clocked at half the bit rate, and so that's another dual-edged clock or double data rate technique.

Q. Are other of the solutions that you talked about earlier today described in this presentation?

A. I'd have to scan the whole presentation.

Q. Well, let's not take that amount of time, but are other technical features that you came up with in that period anyway described in --

A. Sure. I mean, there are lots of other descriptions of sort of technical issues at the time. Sort of output drivers and how to do the termination are all talked about as well as some more detail about the protocol.

Q. Now, Dr. Horowitz, did you also work on more detailed technical descriptions in the 1990 to 1991 time frame?

A. Yes. After the company was formed, we started to create a more complete description of the first version of the Rambus interface for both our internal use as well as for our customers.

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Q. And when you say that it was also for the customers, what was the purpose of providing those to customers?

A. Well, our goal was to both convince customers to take a license and then, having convinced them to take a license, educate them on how to build this interface, and so we needed some documentation to first convince them and then help them build it.

Q. If you would turn to the next document in your binder, RX-63. Have you got that?

A. Yes, I do.

Q. Would you tell me what that document is, Dr. Horowitz.

A. This is a very early draft of the technical description of the Rambus interface.

Q. And if you look down at the bottom, do you see a date on that?

A. Yes, I do.

Q. What is the date?

A. May 7, 1990 .

Q. And is that date consistent with your recollection of when this document might have been generated?

A. Yes. This document has a lot of similarity to the patent application which was filed in April, so it

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makes sense that would be in that time frame.

Q. And now, four of your inventions that we've heard a lot about in this case are what have been referred to as programmable latency, variable burst length, on-chip PLL or DLL, and dual-edged clocking.

Have you got those in mind, Dr. Horowitz.

A. Yes, I do.

Q. Could you just scan through this document, RX-63, and let me know whether you see any of those inventions described in there.

A. Sure.

So on page 10 of the document in figure 6 --

Q. Okay. Let's just stop there for one second, but make sure we have it on the screen.

A. Okay. So this is --

Q. Does this figure 6 relate to one of those inventions that I just mentioned?

A. Yes, it does.

Q. Which one?

A. It -- double data rate, dual-edged clocking.

Q. Could you explain how this figure shows double data rate or dual-edged clocking.

A. Sure. I mean, it shows the input pad driving into two receivers.

Q. And where is that on the figure?

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A. I could point, but I don't think that's going to help you. It's the two --

Q. Right or left?

A. Left. Stage left. Right.

Q. And there at the left there are two little squares which say "input REC" in them?

A. Correct.

Q. Is that what you're referring to?

A. Yes. Those are the input receivers.

Q. Okay. Sorry, Dr. Horowitz. Please go --

A. One of them is clocked by the clock.

Q. That's -- how do you see that one of them is clocked by the clock?

A. There's a wire that comes out that under it are the letters CLK.

Q. Okay.

A. That stands for clock.

And the other one has the wire coming out connecting to CLK with a line on top of it. In engineering-speak, the line on top of it is often called bar with a complement. So that means when clock is one, clock bar is zero, it's the opposite. And therefore, one input samples when the clock goes high and the other input, the other sampler works when the clock goes low.

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Q. And if you could go on scanning through this document, Dr. Horowitz, and just let me know whether any of the other three inventions that I've listed are disclosed.

A. Sure. On page 14 of 30, again --

Q. Let's just stop for a second and get there.

And what are you looking at on page 14.

A. Figure 10. Figures are easier for me to catch than scanning the text, so --

Q. What does this figure describe or disclose?

A. This figure discloses a delay-lock loop -- or actually it's got two delay-lock loops generating the internal clocks for the design, so this shows a delay-lock loop on a DRAM.

Q. And maybe you could just describe one of the delay-lock loops that you see there.

A. Sure.

So if you look at the delay line whose output is labeled A --

Q. At the very top of the figure?

A. At the very top of the figure -- you'll notice that it has an arrow going into it from the bottom.

Q. Yeah.

A. That's actually the control line that's adjusting the delay of the delay line. And so there's

8528

a signal B that comes into the comparator that we take and filter the output.

Q. And that's over at the far right on the top?

A. Yeah. Far right is B and trace that wire back down to the little block that has -- it says "clocked input receiver."

Q. Yes.

A. That one.

So that's basically looking at whether the clock that comes out B is earlier or later than the input clock, and we filter that to adjust the delay to make those two signals exactly the same time.

Q. Well, if you could keep on scanning then, Dr. Horowitz, let me know -- i think we're still looking for programmable latency or variable burst length.

A. Okay. So on page 18, under the device register section, so there's something called access time, which is the access-time register, and that's the register that I think you've referred to as variable latency, so...

Q. And is variable burst length also disclosed in this document?

A. Yes, it is. On page 21, there's a table there -- I'm sure it's described someplace else, but

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the table is easy to find -- that says that the encoding for a field that determines --

Q. Now, I see two tables on that page. Which table --

A. The second table on that page.

Q. So excuse me, Dr. Horowitz. I think I was talking over you, so I apologize.

What does the second table on that page show?

A. It shows the encoding that's used for the variable block size, so it has different numbers in the field and a four-bit field that can have numbers between 0 and 15 and it shows how many bytes are requested for those different numbers.

Q. If we could go back to page 5 in this document, and could we blow up the very last paragraph on that page.

Now, the first sentence there says, "The need for a simple DRAM implementation suggests that the time between request and response be fixed prior to the start of any transaction."

Do you see that, Dr. Horowitz.

A. Yes, I do.

Q. What did you mean by that?

A. Well, I meant that in a system design if you wanted it to be simple, it would be nice if the DRAM

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knew every time it got a request how long it had to wait to stage the data. So in a simple implementation that would be a fixed thing.

Q. And is that time between request and response, is there a word for that?

A. That's usually called latency.

Q. And then the next sentence says, "This could be part of the bus specification," and let me just stop there.

What does that mean that this could be part of the bus specification.

A. It means it could be a fixed number that's true for all the different buses.

Q. And then you go on and say "but that does not allow for technology improvements."

Do you see that.

A. Yes.

Q. What did you mean by the fixed value for latency would not allow for technology improvements?

A. Well, I think that was what I was referring to on the chart that's still up on the board, which just says if I improved the bus speed, I couldn't take advantage of that, or if I improved the DRAMs, I couldn't take advantage of that, and in order to be more flexible it would be nice for that to be

8531

adjustable.

Q. And then you go -- let's continue with the next sentence: "It could be negotiated with each transaction, but that introduces needless complexity and degrades the performance of the simple case."

Do you see that.

A. Yes.

Q. What did you mean by that?

A. Well, I meant that you could on every transaction have a field that specifies what the length of that transaction should be, but that's going to add complexity to the DRAM to do that decoding and might harm the performance in the simple case, might make the minimum delay, the minimum, let's say, larger.

Q. And then if we finish off that paragraph, it says, "A good compromise is to set the time between request and response during system reset."

What does that mean.

A. Well, that means that in most systems this delay register would be fixed when you started up the system and when you booted the machine and you probably wouldn't change it after that time.

Q. And is that the compromise that's then discussed later in this technical description?

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A. It's been a long time since I read this technical description. I believe that was the compromise that we eventually used in the first RDRAM chip, but what we talked about in 1990 I'm not sure.

Q. That's good enough.

Now, did you consider solving this problem by just having different parts with different fixed latencies?

A. Yes, we did consider having a fixed latency, but there's something that I learned when I went and talked to the DRAM partners initially that really surprised me.

Q. And what is that?

A. Well, I went to a DRAM manufacturer, and at that time there were two different packages you could put a DRAM in, and to be honest, I --

Q. Let's stop there for a second.

What do you mean by "a package"?

A. Oh. Excuse me.

When DRAMs are manufactured, they're manufactured in a piece of silicon that is then sliced up, called diced, into little individual memory chips, but those memory chips are very delicate and they need to be encapsulated in some way before they're sold to people, and that encapsulation is called the package.

8533

Q. And you mentioned there were two different types of packages at that time?

A. Right. So at that time the chip could be put into one of two different packages. And what I was surprised by is they built one die that could fit into either package.

Q. And did you have an understanding of why they built one die to fit into either one of those packages?

A. Yeah. So that in order to do that it made the die bigger than if they built it specified for either package A or package B. I think it was a 10 percent additional die area. But they did it that way because the manufacturing time for the DRAMs was sufficiently long that the inventory costs for doing that -- or at least that's what they told me -- was not worth the flow.

MR. WEBER: I object to the part of the answer where he's talking about "the inventory costs for doing that -- or at least that's what they told me " as hearsay.

MR. DETRE: Your Honor, we've had lots of testimony about complaint counsel's witnesses talking with various DRAM manufacturers about various alternatives.

8534

MR. WEBER: Your Honor, this is a fact witness, not an expert witness.

MR. DETRE: And we've had various fact witnesses from complaint counsel and from HP and other systems companies and what they spoke about with DRAM manufacturers.

JUDGE McGUIRE: I will hear the testimony on the issue as long as it's to his understanding and not hearsay as to what he was told.

So if he can answer that to his understanding, I'll let it in; if not, I won't let it in.

MR. WEBER: Thank you, Your Honor.

BY MR. DETRE:

Q. Did you have an understanding of why DRAM manufacturers wanted to make just one part even though it meant a bigger die size?

A. Right. It was my understanding at the time that making many different parts and having to keep inventory on many different parts was expensive and it was not something that was a good idea.

Q. If you could turn to the next document in your binder, Dr. Horowitz, RX-94.

And could you tell me what this document is.

A. This is yet another technical description, a slightly later one with a slightly later date.

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Q. What's the date on this one?

A. November of 1990 .

Q. And is that date then consistent with your recollection of when this particular technical description might have been generated?

A. It's consistent with it.

Q. Now, if we could turn to page 15 of this exhibit.

Could you blow up the figure on the top there, please.

Does that figure relate to one of the inventions we've been discussing?

A. Yeah. It's the same figure we saw in a previous description for the double clock receivers.

Q. And now if we could go a few pages further to page 19.

And blow up that figure.

Does that figure relate to one of the four inventions we've been discussing, Dr. Horowitz?

A. Yes. This is now a blowup of the output transmitter, the double data rate output transmitter.

Q. So does that differ from what we saw on page 10?

A. Well --

Q. Excuse me. On page 15. The previous figure we

8536

looked at?

A. The previous figure showed the input receiver having two receivers on clock and clock bar and showed sort of a multiplexer driving the output. This blows up what that block includes and shows that we have two bits of data. If you look at the two triangles with little bubbles on them and --

Q. And that's sort of towards -- yeah. Is that what you mean by the --

A. That's the --

Q. The highlighting on the screen?

A. Yes, I think it's highlighted on the screen.

Those are inverters, and they basically represent the two bits of data that need to be transmitted out, and then the circles with the Xs on them are sort of like little switches, and one switch turns on when the clock is high, and the other switch turns on when the clock is low.

Q. Now, if we could move ahead to page 45.

And blow up the figure in the middle of that page.

Can you tell me what that figure represents, Dr. Horowitz.

A. That's a phase-lock loop.

Q. And was this phase-lock loop meant to go in the

8537

DRAM?

A. Yes. It was one of the alternatives we were considering at that point for building a clock circuitry.

Q. What was the alternative you were considering?

A. The other alternative is shown on the next page.

Q. Could we go to the next page, please. That would be page 46.

A. That is correct.

Q. And are you referring to the figure on that page?

A. That's correct.

Q. And what does that figure show?

A. This is another version of the diagram that we showed in the previous document for a dual delay-lock loop solution.

Q. And now, if you could turn to page 59 in this document.

A. Okay.

Q. And do you see at the top of that page -- can we blow up that top part? Yeah, just exactly that -- it's marked "request" and at the bottom there's a field marked "data delay." Do you see that?

A. That's correct.

8538

Q. Do you recall what that refers to?

A. Yes. In the first document we actually had flexibility for selecting one of a number of different data delays in the part and those data delays were held by registers. I believe in this version we went to just having the data delay in the request packet, and so the data delay is the variable latency that we talked about earlier.

Q. And then finally, if you would turn to the very next page.

If we could blow up that table.

Can you tell me what that table relates to.

A. That's our favorite variable block size encoding table.

Q. Now, let's skip a document. I'll come back to it. But if we could move to RX-130 in your binder, Dr. Horowitz.

A. Yes.

Q. Could you tell me what that document is.

A. Yeah. This is a much more complete version of the technical description that we have been talking about previously, and so this version was released on April 1, 1991 , and you can see from its heft it's got a lot more technical details than the previous versions have had.

8539

Q. And if we could just quickly run through this one, would you turn to page 36.

What does the figure on the bottom of that page show?

A. Oh, that's the same figure we've been looking at lots of times before. It's got the two input receivers.

Q. And does that relate to one of the four inventions?

A. That's the dual-edged clocking of the input.

Q. And if you could turn to page 56 and tell me what the top diagram there shows.

A. That's just a picture of the phase-lock loop.

Q. And page 64.

And if you could blow up just the last paragraph on that page with the heading count.

A. So basically --

Q. Could you tell me what that relates to, Dr. Horowitz.

A. Yeah. The count is just the count field of the number of bytes to be transferred within the data packet. So that's the variable block size.

Q. And finally, if we could turn to page 94 of the document.

Could you tell me what is being -- does

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anything on that page relate to one of the four inventions we've been talking about?

A. Yeah. The whole page basically is talking about different delay registers that have delay values to control various of the transactions, and one of them is the read delay, which is also called latency.

Q. And now, is this a different implementation of variable latency from what we saw in the previous technical description, RX-94?

A. Right.

So on the very first one that we showed --

Q. RX-63?

A. I'll take your word for it.

Q. Why don't you double-check and just to make sure we've got the record clean.

A. Yeah, RX-63.

It had a solution that had both the ability to do it within the header, within the request, and variable registers. The second one had it only in the request and this one has it only in the registers. I think. You know, that's what I believe.

MR. DETRE: This might be a good time to take a break, Your Honor, if that's okay.

JUDGE McGUIRE: All right. Very good. We'll take a ten-minute recess.

8541

(Recess)

JUDGE McGUIRE: You may proceed, Mr. Detre.

MR. DETRE: Thank you, Your Honor.

BY MR. DETRE:

Q. Dr. Horowitz, before the break, you reviewed three technical descriptions that Rambus produced. Do you recall that?

A. Yes, I do.

Q. Do you recall receiving any feedback from companies regarding any of those technical descriptions?

MR. WEBER: Objection. Lack of foundation.

MR. DETRE: I'm just asking if he recalls, Your Honor. I'm trying to lay a foundation.

JUDGE McGUIRE: Overruled.

MR. WEBER: There's been no foundation laid that these technical descriptions were shown to anybody outside of Rambus.

JUDGE McGUIRE: Overruled.

I'll hear your question.

THE WITNESS: Could you repeat the question. I'm sorry.

BY MR. DETRE:

Q. Sure.

Do you recall receiving any feedback from any

8542

companies about any of these technical descriptions.

A. Yes, I do.

Q. And which company do you recall receiving feedback from?

A. From Siemens.

Q. Could you turn to RX-117 in your binder.

Do you recognize this document, Dr. Horowitz?

A. Yes, I do.

Q. What is it?

A. It's the feedback that I got from Siemens.

Q. And what's the date on the cover page?

A. It's January 1991 .

Q. Is that date consistent with your recollection about when you received feedback from Siemens?

A. Yes.

Q. Now, if we turn to the second page of this exhibit -- and if you could just blow up the introductory paragraph -- it says: "Dear Dr. Horowitz,
concerning the Rambus technical description some basic items remained open. In the following we present a list of detailed questions to you which we would like to get answered."

Do you see that.

A. Yes, I do.

Q. Have you had a chance to look to determine

8543

which Rambus technical description the questions in this fax relate to?

A. Yes, I have.

Q. And which one was it?

A. It was the November of 1990 technical description.

Q. And could you just check. Is that RX-94?

A. Yes, it is.

Q. Now, if we could go to the paragraph marked 1 on that page.

Can you tell me what you understood the subject matter of that question, question number 1, to be?

A. Yes. As I -- as we talked about earlier, Rambus was proposing a variable block size memory so that each DRAM could produce many bits at a time during fetch. And because the output circuitry that was shown showed a four -- taking four bits and being able to transmit it once, the question was what happens when you have more than four bits, like eight bits.

They wanted to know whether there was a hiccup, so you would transmit sort of four bits, have a break and then four more bits, or whether it would be just a transmission of those eight bits in one chunk. It was

8544

the latter, the eight bits smoothly.

Q. And is that shown on one of the diagrams here in the document?

A. Sure. Between the two options, what Rambus really did was option B.

Q. And if we could go down to question number 2 on that page, did you have an understanding when you received this fax what question number 2 related to?

A. Yes.

Q. What does that question relate to?

A. It was asking about how we were going to implement the variable latency feature and whether we were going to change the latency on a transaction-by-transaction basis or have it fixed for the entire operation.

Q. Now, if we go to the fourth page of this exhibit, you'll see that there -- let's just stay on page 4 on the screen, but if you look at pages 4, 5 and 6, there are additional questions. Do you see those?

A. Yes.

Q. Do those questions relate to the same technical description?

A. Yes, they do.

Q. If we could look at the first question on the chart, which says under Page 14 and under Reference it

8545

says "figure 13."

Do you see that.

A. Yes.

Q. Let's just go back for a minute -- sorry, Matthew -- to RX-94 and go to page 14.

Oh, and excuse me. That's of course internal page 14, which is page 19 of our exhibit.

Could you blow up figure 13 on that page.

Now, Dr. Horowitz, when you received that fax, was it your understanding that the question related to page 14, figure 13 related to this diagram we're looking at?

MR. WEBER: Again, Your Honor, this is really getting into the hearsay question. The document speaks for itself. He's just having him read the document and put his gloss on it.

MR. DETRE: I'm asking what his understanding was when he received the fax, Your Honor.

I mean, it's a fax addressed to Dr. Horowitz which he received and reviewed.

JUDGE McGUIRE: That's overruled.

I'll let him answer that, but we're on a very fine line here, Mr. Detre, so let's try to avoid crossing it again if we can.

MR. DETRE: Yes, Your Honor.

8546

BY MR. DETRE:

Q. Was it your understanding that that question that Siemens was asking about page 14, figure 13 related to this diagram on internal page 14 of the November 1990 technical description, RX-94?

A. Yes. The question was basically about the double data rate driver, and they were asking why we had so many latches and multiplexers to implement it.

Q. And finally, if you could turn back to RX-117, page 4, and look at the last question on that page.

A. Uh-huh.

Q. Which refers to page 41, figure 28.

Did you have an understanding of what that question related to.

A. Yes. I'm just double-checking here.

Yeah. So that was just a question about the delay line, delay-lock loop, generation of the clocks in the previous diagram.

MR. DETRE: Your Honor, at this time I'd like to move RX-117 into evidence.

JUDGE McGUIRE: Objection?

MR. WEBER: No objection.

JUDGE McGUIRE: Entered.

(RX Exhibit Number 117 was admitted into evidence.)

8547

BY MR. DETRE:

Q. Now, if you could turn to the -- we're going to skip a couple of documents and get back to them, but if you could turn to RX-2183, the last document in your binder, Dr. Horowitz.

Do you recognize this document.

A. Yes, I do.

Q. What is it?

A. It was I think the first glossy that Rambus produced about the Rambus technology.

Q. What do you mean by "glossy"?

A. A marketing brochure. It's called glossy because it's on glossy paper.

Q. And was this distributed to potential customers?

A. I believe this was given out to various people after it was basically produced, which was in the beginning of 1992 time frame. But specific customers I couldn't say.

Q. And were the four -- have you had a chance to check whether the four inventions that we've been discussing , the programmable latency, variable burst length, on-chip PLL or DLL and dual clock edge, are described in this document?

A. I believe they're all described in the

8548

document.

MR. DETRE: Your Honor, I'd like to move RX-2183 into evidence.

JUDGE McGUIRE: Any objection?

MR. WEBER: No objection, Your Honor.

JUDGE McGUIRE: Entered.

(RX Exhibit Number 2183 was admitted into evidence.)

BY MR. DETRE:

Q. Dr. Horowitz, what was your involvement at Rambus in the 1991 to 1992 time frame?

A. Well, during 1991 , I was still fairly heavily involved in some aspect of Rambus, but I got myself out of all of the sort of management or leadership positions because I was transitioning back to Stanford.

And by 1992, I was a consultant, obviously a fairly powerful consultant because I was involved with much of the major decisions, but I wasn't in sort of management of any of the major projects by that time.

Q. And do you recall what project you were working on at Rambus in that time frame?

A. Yes. So in that time frame the most critical project was the building of the Rambus DRAM, and so I was helping out in building Rambus DRAMs, on the design

8549

of Rambus DRAMs, not manufacture.

Q. Was a Rambus DRAM actually built in that time frame?

A. Yes, it was. Our first part or the first Rambus DRAM that was produced was a Toshiba four-and-a-half-megabit Rambus DRAM.

Q. And did the four inventions that you've talked about today -- i won't list them again -- get implemented in this Toshiba 4.5-megabit DRAM?

A. Yes, they did.

Q. Now, did that Toshiba DRAM have any pins that used more than two voltage levels?

A. Yes. One of the -- in that early part we added an extra voltage level on one of the pins to enter a kind of test mode, so it was thought that we didn't want to use -- create an extra pin just for the test mode, we thought, well, we could add an extra level on one of the pins to enter the test mode, so overvoltage level.

Q. So how many voltage levels were there on that pin used to enter the test mode?

A. There are three levels. So there are two normal levels plus one super high level.

Q. And why didn't you want to just add an extra pin to enter the test mode?

8550

A. Well, at that time pins were still relatively expensive on DRAM packages and we were -- we didn't have extra pins to spare.

Q. Now, was this different from the other pins on the Toshiba device?

A. Yes. This one pin I know was different because it had an extra receiver on it to detect the overvoltage level.

Q. How many voltage levels were there on the other pins?

A. Just two. Most digital systems have two levels.

Q. Were there any difficulties in implementing this pin with the extra voltage level?

A. Well, this is one of those issues, you know, that logically and circuit-wise are a little different. Logically it should seem like it was straightforward.

When we built the circuit, we thought we had built the circuit with enough margin, but when we actually started using the part in some systems, it turned out that in strange circumstances the part would accidentally enter the special test mode or could enter the test mode, which would cause its operation to fail.

8551

Q. Now, when you say, Dr. Horowitz, that you thought you had built it with enough margin, what do you mean by "enough margin"?

A. Well, all the systems that we were talking about are digital systems, and that means people who use them like to think about the values going in as being either one or zero, but in fact the world is not discrete, it has continuous levels, and so what you try to do is you try to build circuits where the distinction, you know, the difference between the one and zero is sufficiently large so that you never confuse a zero with a one or a one with a zero.

And the amount of extra guard that you have between the value that it should be and where you start making errors is called the margin, and so we had a value that had a low level, a normal high level, and then a super high level, and we thought the super high level was sufficiently far from the high level that they'd never get confused. We were wrong.

Q. After -- in later Rambus DRAMs after that initial 4.5-megabit Toshiba part, did you ever use a pin which had more than two voltage levels?

A. No.

Q. Did Rambus publicize the Toshiba DRAM?

A. Yes, it did.

8552

Q. Could you turn to RX-301 in your binder.

Do you recognize this document, RX-301.

A. Yes, I do.

Q. What is it?

A. It's the proceedings from the International Symposium on VLSI Circuits in 1992.

Q. Are you familiar with the VLSI circuits symposium?

A. Yes, I am.

Q. What is the VLSI circuits symposium?

A. It's a conference for circuit designers, people like me, and it's probably one of the top two circuits conferences in the world, where people talk about different, innovative circuits that have been designed.

Q. Is that an annual event?

A. It's an annual event.

Q. And what sorts of people attend the VLSI circuits symposium?

A. Mostly people who design integrated circuits, obviously.

Q. Now, if you turn to page 5 of this document, you see a listing of something called the technical program committees. Do you see that?

A. Yes, I do.

8553

Q. Have you yourself ever served on the technical program committees of the VLSI circuits symposium?

A. Yes, I have.

Q. When have you done that?

A. I don't remember when I started. I believe it was '93-94. It might have been as late as '95. I became a member of the technical program committee and I was on until a couple years ago when I had a son and I decided I didn't have quite the time that I had before.

Q. What's the role of the members of the technical program committee?

A. They receive all the papers that are submitted to the conference and read the papers and then choose which are the better papers that actually get published at the conference.

Q. Now, was there a paper about the Toshiba 4.5-megabit DRAM that we've been discussing that was presented at this conference?

A. Yes, there was.

Q. So that was selected by the technical program committees?

A. That's correct.

Q. If you would turn to page 76 of the exhibit, do you recognize the document at pages 76 and 77?

8554

A. Yes, I do.

Q. What is it?

A. It's the paper that we wrote for the DRAM, for the Toshiba DRAM.

Q. Did you actually attend this 1992 VLSI circuits symposium?

A. Yes, I did.

Q. Did you present this paper at this symposium?

A. No, I did not.

Q. Who did present the paper, if you recall?

A. I don't recall precisely, but I believe it was Kushiyama. We had a policy at Rambus to allow our partners to present papers.

Q. Mr. Kushiyama was with Toshiba?

A. That's correct.

Q. Now, are any of the four inventions we've been discussing here today described in this document, the paper at pages 76 and 77 --

A. Yes, they are.

Q. -- rX-301?

Yes.

A. Yes, they are. Sorry.

Q. Which ones?

A. Well, if you flip to page 77, figure 3 is our famous --

8555

Q. That's over on --

A. I think figure 3 goes up. That one.

So that's our double data rate input receiver.

If you look at figure 2 --

Q. Just wait for Matthew to get there.

Yes.

A. That shows basically the block size transfer and also the read latency.

Q. Now, if you turn back to the first page of this -- let me just direct your attention to -- sorry. Excuse me . Page 76 of the exhibit, first page of the paper.

If I could direct your attention to the very last line in the left-hand column.

A. Right.

Q. The last line: "To eliminate skew caused by the internal circuitry, the DRAM contains two PLLs."

What does that relate to.

A. That relates to putting PLLs on a DRAM.

Q. After this paper was presented at the conference, were you asked to do anything else in connection with this paper?

A. At the end of the conference, the top papers of the conference are invited to provide a longer description into the Journal of Solid-State Circuits,

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which is the top journal for circuits designers.

Q. And was this paper selected?

A. This paper was selected.

Q. And was in fact a longer version of this paper published in the Journal of Solid-State Circuits?

A. That is correct.

Q. If we could turn to the next exhibit, RX-385, is that the longer version of the VLSI circuits symposium paper that was published in the Journal of Solid-State Circuits?

A. Yes, it was.

Q. Now, you said it was one of the top journals.

Is the IEEE Journal of Solid-State Circuits widely read.

A. I think it is the most widely read journal for circuit designers.

Q. And when was the this paper published, by the way, in that journal?

A. I think April '93.

Q. Now, Dr. Horowitz, you mentioned earlier that when you first were presenting the Rambus technology in the 1990 time frame there was some skepticism?

A. That's correct.

Q. Do you have any understanding about whether the technical descriptions that were distributed or

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the publicity about the Toshiba part convinced any of the doubters about the viability of Rambus technology?

A. Well, yes. I think that as we worked more and more on the technology and had more and more details fleshed out, it convinced a larger group of people that what we were saying is possible. And when we finally built the part, people no longer told us we couldn't do it, because we'd done it.

There's still some skepticism about how practical it would be and whether this was the right direction to go with DRAM technology, at least in the early time frame.

Q. Now, have you generally kept up with the development of high-speed DRAMs in the mid to late 1990s?

A. Yes. I think I have.

Q. Do you have any understanding of whether aspects of the technology that you invented have been used in other high-speed DRAM designs in the mid to late 1990s?

MR. WEBER: Objection, Your Honor. Calls for speculation. Calls for expert opinion. Lack of foundation.

JUDGE McGUIRE: Sustained.

8558

BY MR. DETRE:

Q. Dr. Horowitz, we have heard some testimony at trial about alternatives that could be used for certain features of Rambus technology, and I'd like to ask you whether you considered using some of these alternatives.

A. Okay.

Q. Now --

MR. WEBER: Your Honor, just before we get into this line of questions, we're again getting very close to expert opinion testimony here, so I'd like to clarify exactly where Mr. Detre is headed with this line of questions.

JUDGE McGUIRE: Could you clarify that for us, Mr. Detre.

MR. DETRE: Certainly, Your Honor. I'm going to be asking Dr. Horowitz about particular alternatives that he personally considered using at various points in time in the Rambus technology.

MR. WEBER: Alternatives in the Rambus technology? In other words, alternatives to what became the Rambus RDRAM?

MR. DETRE: Well, perhaps Mr. Weber could wait until questions have been asked to --

JUDGE McGUIRE: Well, to the extent we can

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outline your questioning now to avoid him having to jump up two or three times, let's see where we're going, and if we can --

MR. DETRE: Yes. Just alternatives that Dr. Horowitz considered with respect to Rambus technology.

JUDGE McGUIRE: Then I'll entertain that question.

MR. WEBER: That's helpful, Your Honor. Okay.

BY MR. DETRE:

Q. Now, Dr. Horowitz, you testified earlier that you decided to use a synchronous design for the Rambus DRAM?

A. That is correct.

Q. Now, at the time that you decided to use a synchronous design, had you had any experience with asynchronous designs?

A. Yes, I had.

Q. What sort of experience did you have?

A. A couple of my Ph.D. students had done their dissertations in asynchronous design, and I had done some studies of, you know, comparisons between synchronous and asynchronous design styles.

Q. And did you consider using an asynchronous design at that time?

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A. We thought about what -- let me -- we started to think about what technique would allow us to get the bandwidth that we would want, but as I think I explained earlier, the increased variability in the asynchronous design styles led us to a synchronous design.

Q. Now, since the early 1990s have you kept up with research into asynchronous designs?

A. Yes, I have.

Q. What sort of -- have you attended any conferences about asynchronous designs?

A. Yeah. Asynchronous designs are presented in the circuit conferences that I've gone to, and I've been asked in fact to give a keynote at the asynchronous design conference, so...

Q. Has there been a substantial amount of work into asynchronous designs in the last decade?

MR. WEBER: Objection. Lack of foundation. Calls for expert opinion.

MR. DETRE: I think I laid a foundation, Your Honor, about his experience in asynchronous designs.

JUDGE McGUIRE: Overruled.

THE WITNESS: I'm sorry. Can you repeat the question?

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BY MR. DETRE:

Q. Certainly.

Has there been a substantial amount of work into asynchronous designs in the last decade.

A. Yes, there has.

Q. Now, you mentioned earlier that your original design for Rambus DRAM had a DLL on the DRAM. Do you recall that?

A. Yes, I do.

Q. Did Rambus ever consider alternatives to having a PLL or DLL on the DRAM?

A. Yes, it has.

Q. Were you involved in considering those alternatives?

A. Yes. Some of those designs were done by former students of mine working at Rambus, so we talked about how to do them.

Q. What alternatives do you recall being considered at Rambus to having a PLL or DLL on the DRAM?

A. Well, because a PLL on a DRAM is a complicated circuit block that you can easily get wrong, we tried to figure out if we could move the DLLs off the DRAMs and onto the memory controller chip instead.

Q. And what was your conclusion in that regard?

8562

A. Well, each of the times that we have attempted to move the DLLs off of the DRAM, when we do the margin analysis and figure out how much time we have, we've always found that we can't meet the timing requirements without having at least a DLL on the DRAM chip.

Q. And can you explain why that is, why can't the PLL or DLL on the controller compensate for the timing just as well as the PLL or DLL on the DRAM?

A. Because of various variations in the delay on the DRAM chip that need to be compensated for, if you need a relatively -- you need a feedback loop to be able to measure those to track those out at reasonably high bandwidth or high frequencies, and if you move that off to the controller, it's hard to get that at the same frequency without having other substantial costs.

Q. Are you familiar with the term "vernier"?

A. Yes, I am.

Q. What is a vernier?

A. A vernier is usually just a circuit that gives you very fine time increments.

Q. Is a vernier used in Rambus DRAMs?

A. Yes. Some of the Rambus technology used verniers.

8563

Q. Is that vernier used in addition to a PLL or DLL?

A. Yes. It almost always is used in addition to a PLL or a DLL -- well, it always is used in addition. It's very hard to do the circuitry without having a PLL or a DLL on there.

Q. Now, another proposal that has been made at trial here to improve the speed of DRAMs is called simultaneous bidirectional input/output.

Are you familiar with that term.

A. Yes, I am.

Q. What does it mean?

A. It means that on one piece of wire, one of the bus lines, you simultaneously transmit data from like the DRAM to the memory controller at the same time you're transmitting your information from the memory controller to the DRAM. So you don't wait and take turns; you basically talk simultaneously.

Q. Have you personally ever considered using simultaneous bidirectional input/output at Rambus for high-speed signaling?

A. I believe we've considered using simultaneous bidirectional signaling.

Q. Has it ever been used?

A. No, it has not.

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Q. Why not?

A. It -- again, it comes down to the margin issue that I talked about, having more than one -- more than two levels on a wire. When you have simultaneous bidirectional signals, in order to figure out what someone is transmitting to you, right, in order to receive the signal, you have to subtract out the signal that you're trying to transmit to the other side. Because they're both added together on the wire.

And when you do that compensation, when you subtract out that value, you find out that you can't do that perfectly, and so it ends up adding noise to the signal.

Q. And that noise is a problem with high-speed signaling?

A. It reduces the voltage margins and therefore makes it more likely to have an error.

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

JUDGE McGUIRE: Okay. Thank you very much.

At this time we'll hear the cross-examination by complaint counsel.

MR. WEBER: We need a few minutes to set up, if that's all right, Your Honor.

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JUDGE McGUIRE: Let's take just a short break, five minutes.

(Recess)

JUDGE McGUIRE: Let's go back on the record.

CROSS-EXAMINATION

BY MR. WEBER:

Q. Good afternoon, Professor Horowitz.

A. Good afternoon, Mr. Weber.

Q. Professor Horowitz, you have about two million reasons why you think Rambus should win this lawsuit with the FTC, don't you?

MR. DETRE: Objection, Your Honor. Vague. Argumentative.

JUDGE McGUIRE: Sustained.

BY MR. WEBER:

Q. Well, in addition to sitting on the board of directors of Rambus, you are a large shareholder in Rambus; is that true?

A. That's correct.

Q. And you own about two million shares of Rambus stock; is that correct?

A. That is correct.

Q. And at today's price, the stock is valued at about 30 to 40 million dollars; is that correct?

A. I have no idea what the stock price is.

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Q. But for every dollar the stock goes up, your net worth goes up by $2 million?

A. If I own two million shares, yes.

Q. So if it goes up $10, that's $20 million; right?

JUDGE McGUIRE: The court understands that, so let's proceed.

MR. WEBER: All right. Okay.

BY MR. WEBER:

Q. Before we go on, I want to make sure I understood some of the terms used in your direct examination with Mr. Detre, so I'd like to go back to the four inventions that you described when he was asking you do you see these four inventions in these various technical descriptions. Do you recall that testimony?

A. Yes.

Q. Okay. And maybe we can take as an example -- we have RX-63 in your book. I think you discussed page 18 with Mr. Detre. Can you pull that out?

A. What page, please?

Q. I believe it was page 18.

And my notes have that you said that this had something to do with the -- help me out -- the programmable latency invention; is that right?

8567

A. That's correct.

Q. And I think you also referred to it as a variable latency invention; is that right?

A. That's correct.

Q. I never heard you call it a programmable CAS latency invention; is that right?

A. That's correct.

Q. Have you ever referred to your invention as a programmable CAS latency invention or not?

A. I don't recall.

Q. Okay. Is there any reason why the words "programmable" -- do the words "programmable CAS latency" appear in any of these documents that you went over with Mr. Detre? Because I think you testified you'd studied them.

MR. DETRE: Objection, Your Honor. Misstates prior testimony.

JUDGE McGUIRE: Do you want to comment on that, Mr. Weber?

MR. WEBER: Well, I think in one of them he said that you'll find the four inventions there, and he said yesterday, I've studied them, I've looked at it, so --

JUDGE McGUIRE: I'll entertain the question.

THE WITNESS: Well, then I should correct you.

8568

I haven't carefully studied any of these documents, so if you want me to say what the document says, I'll have to carefully read all the documents.

BY MR. WEBER:

Q. Well, let me ask the question this way. Let me rephrase it.

In any of the technical descriptions that Rambus shared with customers, say, under NDAs and under any other agreement, were the words "programmable CAS latency" used to describe that variable latency invention we've been talking about?

A. You're talking about documents that were written that I dealt with over a decade ago. Again, if you want me to say what the documents say, we're going to have to go through the documents one by one, so...

MR. WEBER: Move to strike as --

JUDGE McGUIRE: To the extent you can answer that question, Doctor, off the top of your head, can you answer that, or do you have to go back through these documents in order to answer that question?

THE WITNESS: I would say that we talked about variable latency and a read delay request. I don't know that we ever used "CAS." I would doubt that we used "CAS," but again, the documents were created a

8569

long time ago, so -- so I don't remember using that term, if that would be good for you.

BY MR. WEBER:

Q. So you can't recall any documents as you sit here today that use the term "programmable CAS latency"?

A. No.

Q. The same thing for the words "programmable burst length." Can you recall any document that used the words "programmable burst length" in describing this variable block sizing that you had discussed with Mr. Detre?

A. To me, burst length and block size are sort of interchangeable, so you're making a distinction between the two words. The words seem similar to me in this context, so I cannot say whether word A or word B was used.

Q. So is the answer to my question you can't recall a single instance?

A. No. The answer to your question is to me the two words are interchangeable and I would not remember at this time which word was used.

Q. In your mind is the term "variable block size" the exact same thing as programmable burst length?

A. Could you repeat the question.

8570

JUDGE McGUIRE: He's asking you -- he wants you to restate the question, Mr. Weber.

BY MR. WEBER:

Q. Yeah.

I believe the question was: In your mind, is the term "variable block size" the exact same thing as programmable burst length.

A. No.

Q. Is the term "access-time register" the same thing as programmable CAS latency?

A. No. Well, excuse me. Before you said exactly the same thing, and I answered the second question assuming you said exactly the same.

Q. Okay. So let me restate the question.

Is the term "access-time register" exactly the same thing as programmable CAS latency?

Your answer is.

A. No.

Q. Now, you were in court for Dr. Farmwald's testimony the last couple days; right?

A. That's correct.

Q. And do you recall Dr. Farmwald was asked a question about whether he thought the Rambus invention as set forth in the original patent application was a revolutionary idea. Do you recall those questions,

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that testimony?

A. Yes.

Q. Let me ask you the same question. Because I think he said he was speaking as a systems analyst and circuit designers might disagree. I think he said that at one point.

So would you agree with your colleague Dr. Farmwald that your invention as set forth in the original patent application was a revolutionary idea?

A. I don't generally think about things in terms of revolutionary/evolutionary. I just think about what's a good technical solution.

So I don't really want to take a hard stand on this one way or another. But sure, I thought they were pretty revolutionary.

Q. Now, as time went on with Rambus and obviously you were sitting on the board of directors, going to the company one day a week, you were getting some feedback on how well-received the Rambus RDRAM was during those years from, say, 1991 to 1996 time period; correct?

A. Yes.

Q. And would it be fair to say that the Rambus RDRAM was never in that time period as successful as you and Dr. Farmwald had hoped in terms of being

8572

adopted by a wide variety of companies in the memory industry?

A. I don't think that's fair.

Q. Okay. Do you recall seeing estimates as to RDRAM perhaps getting as much as 50 percent of the market? Do you recall seeing estimates like that?

A. Sure.

Q. Did RDRAMs ever get to 50 percent of all the DRAMs sold?

A. No.

Q. Now, one of the -- one of the reasons that the Rambus RDRAM didn't get to that high a percentage, wasn't it because people in the industry considered evolutionary as better than revolutionary?

A. No.

MR. DETRE: Objection, Your Honor. This whole line of questioning is outside the scope of my direct. We never discussed how RDRAM was received in the marketplace in the late '90s.

MR. WEBER: May I respond, Your Honor?

JUDGE McGUIRE: Yes.

MR. WEBER: He went into his meetings he had with customers and what the feedback was from customers, so I think --

JUDGE McGUIRE: I'll entertain the question.

8573

BY MR. WEBER:

Q. Okay. In terms of your feedback from customers, did you get any feedback from customers to the -- where the gist was that this was so revolutionary, we want to go with something more evolutionary?

A. No. I don't think -- i didn't receive any feedback along those lines. That was not what...

Q. Do you recall making a presentation to a group at the International Electron Devices Meeting in 1996?

A. Sure, I do.

Q. And do you recall as part of that presentation sort of touching on your experience at Rambus going back to the early years?

A. Yes, I do.

Q. And do you recall we actually discussed this document at your deposition, didn't we?

A. Yes, I do.

MR. WEBER: May I approach, Your Honor?

JUDGE McGUIRE: Yes.

BY MR. WEBER:

Q. Let the record reflect I have handed the witness what's been marked as CX-1322.

Dr. Horowitz, is this the presentation you've just been discussing to the International Electron

8574

Devices Meeting?

A. Yes, it is.

Q. In terms of putting a date on it, I know it's very hard to read in the lower left-hand corner, but do you agree with me this is probably late in the year 1996?

A. I think we did -- went over this in my deposition and I have the original someplace, but I can't read this and I don't remember the date.

Q. Okay. Well, one way of figuring out the date, you have some references on the last two pages, pages 17 and 18?

A. Yes. We did this in our deposition as well.

Q. Right.

And when you put references in a paper, you try to cite the most recent stuff, don't you, usually?

A. I'm under oath and I should say only the truth and things that I am sure of the truth, and I am not sure of the date of this presentation.

Q. But the most recent presentations, the most recent references that appear on pages 17 and 18 of this document -- take a moment if you need to refresh your recollection -- are in the year 1996; is that correct?

A. Yes. But it's February 1996.

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Q. Right. I think -- this conference was always towards the end of the year, wasn't it?

A. It's in December. That's correct.

Q. So would it make sense that the -- it certainly was no earlier than November 1996; right?

A. Well, it's certainly -- well, the last reference is November. I haven't had a chance to check all the references.

Q. Well if you want, it's on also the last page of the document, the 17 and 18. Do you want to take a moment to scan that?

A. Okay.

Q. Sir, you would agree that this presentation was no earlier than November of 1996?

A. Well, the conference is in December, so --

Q. No earlier than December of 1996?

A. Yes. So it would have been in December -- it couldn't have been earlier than December of 1996.

Q. Would you turn to page 12, please.

Can we get up on the screen the bottom part that says --

A. My thing does not have page numbers on it, so which --

Q. I'm sorry. It's page 12 in the lower right-hand corner by the CX number. Do you see that?

8576

A. Yes, I do. Sorry.

Q. And this is one of the slides you presented, this slide that says "One Thing Worries Me" that we have on the screen here?

A. Yes. That's correct.

Q. And it says, "Will the customer buy it in high enough volumes to justify the effort?"

Is what you're meaning here, that there would have to be enough volume so the costs could be amortized over a large volume of DRAMs?

A. This was talking about basically merged DRAM logic, so I'm not sure what you mean by "DRAMs."

Q. Would that also apply to the Rambus RDRAM?

A. This talk was about merged DRAM logic, so this was talking about merged DRAM logic. It wasn't talking about Rambus DRAMs.

Q. But was this observation generally applicable to other DRAMs, including the Rambus RDRAM, your experience started on Rambus?

MR. DETRE: Objection, Your Honor. There's no foundation for this testimony. The witness already testified this is about a completely different topic.

JUDGE McGUIRE: Sustained.

BY MR. WEBER:

Q. Okay. Could we move on to page 14,

8577

Dr. Horowitz.

A. Sure.

Q. Would you look at the bottom slide that says "Rambus Status."

Now, this slide is relating based on your experience at Rambus; right, not this merged DRAM logic.

A. Correct.

Q. Okay. And you wrote under the third bullet "cost modest." The first thing it says is: "But too expensive for main memory at 16M"; right?

A. Yes.

Q. 16M means 16 meg, a particular density of DRAM; is that right?

A. That's correct.

Q. And when you wrote that, you meant for the 16-meg generation of DRAMs and main memory, the cost differential of Rambus compared to traditional memory was just too great to get customers to go with Rambus; right?

A. What I meant was that for the systems at that time the cost differential was larger than the value returned at least from the systems designer's perspective and therefore they're not using that.

Q. So that was a problem in getting the Rambus

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RDRAM adopted at least in the main memory part of the market; right?

A. Well, yeah.

Q. And by "main memory" we're talking about products like PCs and workstations; correct?

A. That's correct.

But remember that shortly thereafter Intel adopted Rambus memory for PCs in the future, so you know, in 1996 it hadn't been adopted, but by the late '90s it had been adopted.

MR. WEBER: Move to strike everything after "that's correct" as nonresponsive, Your Honor.

JUDGE McGUIRE: Sustained.

BY MR. WEBER:

Q. And the customers that you were referring to were the users of DRAMs, companies like Hewlett-Packard, Compaq or Dell?

The customers -- excuse me. Let me rephrase.

The customers in this main memory market were users of DRAMs like Hewlett-Packard, Compaq or Dell; correct?

A. Those are some of the customers.

Q. Any others come to mind?

A. Well, the most important customer is Intel.

Q. And why did you say that, that Intel is

8579

important?

A. Because Intel controls the main memory business. For PCs.

Q. Is that because of their microprocessor market share?

A. Well, not only their microprocessor market share, but they built most of the memory controllers that go into PCs which connect to the DRAM chips, and when Intel says the memory chips are going to look like this, that's what they look like.

Q. All right. Can you turn to the next page of this document, page 15, Dr. Horowitz.

The top slide is titled Marketing Rambus; right? This is another slide that was part of your presentation.

A. Uh-huh.

Q. And again, you're looking back on your experience at Rambus, drawing on it; correct?

A. Correct.

Q. And the first bullet says, "Much harder than (I) expected"; right?

A. Right.

Q. And that's a reference to marketing the Rambus RDRAM product?

A. That's correct. But I'm an engineer, so what I

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thought about marketing didn't hold much weight.

MR. WEBER: Move to strike everything after "that's correct" as nonresponsive, Your Honor.

JUDGE McGUIRE: I'm going to let him say that. I'm not worried about it.

MR. WEBER: Okay.

BY MR. WEBER:

Q. If we move on, it talks about -- the third -- or actually the last bullet under Marketing Rambus, it says, "More serious was the unwillingness to take risks."

Do you see that.

A. Yes, I do.

Q. And that refers to the fact that people in the DRAM industry do not always choose the technologically best solution?

A. No, that's not what it refers to.

Q. Okay. Could you go down to the next slide where you talk about it.

"People don't choose the best solution," you wrote that; right.

A. That's correct.

Q. And that was partly based on your experience at Rambus, wasn't it?

A. That's correct. But that's not what you said

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before.

Q. Okay. And then the next bullet says, "They choose the least risk solution that meets their needs"; right?

A. That is correct.

Q. If we go back to the '90-91 time period when you were starting to go out and make these presentations to customers, the least risk solution at that time was whatever was currently being used in the marketplace; right?

A. That's correct.

Q. And it was -- for a while it was fast page mode, but in the early '90s it became something called EDO; right?

A. That's correct.

Q. And those were both asynchronous technologies; is that correct?

A. That's correct.

Q. And so just so I'm clear, your testimony is the lowest-risk solution is the technology currently being used; right?

A. My testimony is the lowest-risk solution is the lowest-risk solution, and if it's already being used, that's pretty low risk. I can't say there might be something that's lower risk, but generally that's one

8582

of the lower-risk solutions.

Q. Could you turn to your FTC deposition. It's the very top one in the pile.

A. Sure.

Q. It's at page 43, line 15 --

JUDGE McGUIRE: Now, what's the date of that? Is that the 27th?

MR. WEBER: This would be February 27, is the top one, Your Honor, says FTC on it.

JUDGE McGUIRE: All right.

THE WITNESS: What page number, please?

BY MR. WEBER:

Q. We're going to look at page 43.

And at lines 13 through 15 did you not testify, "The lowest-risk solution is always the solution that is currently being used because there's very little risk in that"?

A. Okay.

Q. Did I read that correctly?

A. Yes, you did.

Q. Was that testimony accurate when you gave it, sir?

A. Excuse me?

Q. Was that testimony accurate when you gave it, sir?

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A. Yeah. But I don't think the testimony I just gave really differs from that testimony. I'm sorry.

JUDGE McGUIRE: But that's not the question. Just answer the question and he can go on to his next question.

THE WITNESS: Sure. Sorry.

BY MR. WEBER:

Q. Would that still be your testimony today, that sentence I just said, the lowest-risk solution is always the solution that is currently being used because there's very little risk in that?

A. I would amend that there could be other solutions that other people are using which are also low risk, so -- but I think we're trying to split hairs here, and I don't see a large difference between either of those two responses.

Q. Now, one more point of clarification, to go back to CX-1322, the page we were just looking at, page 15.

Under that last set of bullets that starts off "Advantage must be very," in caps, "significant" and then it says "People don't choose the 'best' solution," the people you're referring to there, you meant the aggregate nature of the market; is that correct?

A. I -- i just meant really if you looked at each

8584

designer individually, they're likely not to choose the best solution. Each person is likely to choose the thing that makes their rear hang out the least, right, because people are worried about being blamed for things.

Q. My only question was: When you used the term "people" here, you were referring to the aggregate nature of the market, the customers in the market?

A. I didn't think of it that way.

Q. Would you turn to page 40 of your FTC deposition, lines 21 through 25.

A. The lines, please?

Q. Lines 21 through 25.

A. Okay.

Q. You were asked this question: "And when you say 'people,' are you talking about just the company -- companies in the business? What companies do you have in mind?"

And your answer was: "When I say 'people,' I mean the aggregate nature of the market."

Do you see that.

A. Yes, I do.

Q. Was that testimony accurate when you gave it, sir?

A. Yes, it was.

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Q. Is that still your testimony today?
A. I would modify the testimony slightly to say I was talking about each individual person at the company, which you could aggregate together. Again, I don't think this is a significant difference, and I don't remember what I say verbatim. I'm sorry.
Q. Well, let's go down to the bottom line.
This assessment that people tend to choose the lowest-risk solution as opposed to the best technical solution, that is still your view today based on your experience in the industry.
JUDGE McGUIRE: Mr. Detre?
MR. DETRE: Your Honor, I really think this is far afield of anything I asked about. We've been on it for a long time.
JUDGE McGUIRE: I myself am just curious where you're headed, Mr. Weber.
MR. WEBER: I only have a few questions --
JUDGE McGUIRE: I'm asking you now, where are you heading with this?
MR. WEBER: I think it has to do with his understanding based on his experiences at Rambus trying to market the Rambus RDRAM, which there was testimony about on direct.
JUDGE McGUIRE: Well, I think we've gone into

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all the detail we need to do as to what he intended by the term "people." Now, if you want to go on, I'll let you and depending on, again, if we have any opposition on the issue of scope, but let's move on.

MR. WEBER: Okay. I just got one more question -- it's a different subject -- on this document and we're going to move on.

JUDGE McGUIRE: All right.

BY MR. WEBER:

Q. Could you look at the last page of the document, page 18.

Do you see under references -- under the last four references you have Rambus DRAM papers?

A. Okay.

Q. And you have the first one as I think we've identified Kushiyama, but we have a B. Garrett and an R. Crisp. Do you see that?

A. Yes.

Q. B. Garrett would be Billy Garrett?

A. Yes, I assume.

Q. And R. Crisp would be Richard Crisp?

A. I assume.

Q. Those are people who were engineers at Rambus?

A. Yes, they were.

Q. While you worked -- and you're familiar with

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them based on your work at Rambus; correct?

A. Yes.

Q. And those are two engineers who knew and understood the Rambus technology?

MR. DETRE: Objection, Your Honor. Lacks foundation. Outside the scope.

JUDGE McGUIRE: Sustained.

BY MR. WEBER:

Q. Going back to your early years at Rambus in the 1990 -1991 time frame, when you went out and talked to these DRAM manufacturers, did you have an understanding of whether or not it would have been desirable to have Rambus become an industry standard or whether industry standards were important?

A. I think as Mike Farmwald also testified, I strongly believe that the memory business relied on standards, de facto standards, and it was important for Rambus to have enough mass behind it so it would, you know, exist.

Q. So following up on your last answer, would it be fair to say that one of the goals from the early days of the company was to have a Rambus RDRAM be widely adopted in the DRAM industry?

A. Yes.

Q. And isn't it true that that was one of the

8588

reasons for Rambus initially joining JEDEC?

A. I have no idea about JEDEC.

Q. Okay. Could you turn to your Micron deposition, sir. It's the second day at page 279.

Let me see if I can refresh your recollection here.

The question starts at line 8 and continues to line 19.

A. Excuse me. What page are we on?

Excuse me?

Q. I'm looking at page 279. This would be the August -- i believe it's August 6, 2001.

And I don't know if we'll be able to get it up on the screen, but let me just read into the record the question at line 8:

"Are you aware of any" -- are you there yet?

The question is at line 8: "Are you aware of any of the reasons" --

JUDGE McGUIRE: Hold on a second.

Let's make sure you're there. Are you there?

THE WITNESS: I just got there.

MR. WEBER: Okay.

JUDGE McGUIRE: You're there now.

BY MR. WEBER:

Q. The question at line 8 is: "Are you aware of

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any of the reasons as to why Rambus ended up becoming a member of JEDEC?

"ANSWER: You're asking me if I have any direct memories during the period of time about why we joined JEDEC?

"QUESTION: Yes.

"ANSWER: Let me think. Yes, I believe we joined JEDEC initially because we were thinking that we ultimately might want Rambus to be a JEDEC standard, and I believe that was the original -- one of the original reasons for joining JEDEC. And we thought it would be interesting and useful to be -- to understand what went on there before we tried to put a standard in place."

Does that refresh your recollection of your prior testimony.

A. Yes.

Q. Was that testimony accurate when you gave it, sir?

A. Sure.

Q. Would you change it today?

A. No. Again, I don't believe that really -- i don't have any strong recollections about JEDEC.

Q. And you're aware that --

JUDGE McGUIRE: Let me interject here and

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inquire of the witness.

You were here during the testimony of your colleague, were you not --

THE WITNESS: Yes, I was.

JUDGE McGUIRE: -- of Dr. Farmwald?

And I asked him a couple times about his involvement with JEDEC, and he also indicated I think on a couple of occasions where it was his intention that I guess the RDRAM was to become a de facto standard. I don't know if you recall that testimony.

THE WITNESS: Yes, I do.

JUDGE McGUIRE: That seems to be to some extent in conflict here where you want it to become a JEDEC standard, and I'm curious. Would you like to perhaps for my edification clarify that from your own understanding at the time.

THE WITNESS: Sure. I think actually what he said and what I said were pretty much in line.

I said ultimately it would become a JEDEC standard. I strongly believe that all the useful inventions that happened in the industry generally came out by a company or two, many people started using it, and then once it was building momentum or widely used or already a de facto standard, it often went into a JEDEC organization and became an officially approved

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IEEE standard.

So there are many examples I could give, and that's the example I thought we were going to use; that is, we were going to make it a de facto standard, and then once it was a standard, we would have somebody put a stamp of approval on it. And that's why I said ultimately we might want to be a JEDEC standard.

JUDGE McGUIRE: Okay. All right, Mr. Weber. You may proceed.

MR. WEBER: Do you have any more, Your Honor? Because I'm -- i'd like to follow up on that.

JUDGE McGUIRE: Yes, please, go ahead.

BY MR. WEBER:

Q. You said you were aware, in your answer to His Honor's question, you were aware of some examples of people going to JEDEC and then it became a standard?

A. Not -- i didn't mean --

Q. What examples did you have in mind, is my question?

A. So for example, the high-speed bus and the PC. I think Ethernet was initially done by a couple of companies that was then made an IEEE standard.

So in my experience, there are a number of

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different parts that were done by sort of de facto.

And even in the JEDEC business, what really mattered for DRAMs and the SDRAM thing was not the JEDEC standard because it wasn't compatible, different parts could be JEDEC compatible and not compatible, but what mattered is what Intel did.

So it was my impression that what really mattered is what the industry used and the standards bodies were second best.

Q. You are aware, though, that there were commercially viable technologies in the DRAM business that had gone through the JEDEC standard-setting process; correct?

A. And there are commercially inviable options that went through the JEDEC standard-setting.

Q. Okay. But are you testifying that that didn't influence Rambus' decision to go to JEDEC, the fact that there were other standards that were adopted?

A. No -- yes, I am testifying that.

Q. Okay. Could you look at the page two pages later in your Micron deposition, at page 281, sir.

A. Okay.

Q. The question at line 13 and answer at line 15.

A. Excuse me. 231?

Q. 281, two pages after where we just were.

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And the question you were asked at line 13 was: "Why did you think that that might be a fruitful way to pursue standardization of Rambus?"

And your answer was: "Because there are other commercially viable techniques that went through that process."

A. Right. But the process I'm talking about is some company that develops something, then people would use it, then it would become a common interface, that is, a de facto standard, and then it would be standardized.

Q. When you answered the question --

JUDGE McGUIRE: Wait just a second. We have an objection.

MR. DETRE: Your Honor, for completeness, I'd like to read the previous question and answer.

JUDGE McGUIRE: All right. Go ahead. We'll do that now.

MR. DETRE: "QUESTION: What do you recall of those discussions, sir?

"ANSWER: We wanted to develop a new standard that was widely used in the industry. I mean, we wanted to develop an interface that was widely used in industry. And we thought that, ultimately, once it was established, it might be useful for it to be -- you

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know, to be a industry's -- you know, a standard interface, an IEEE standard interface. So we thought it was wise to understand that standardization process."

Thank you, Your Honor.

JUDGE McGUIRE: Okay. You may proceed, Mr. Weber.

MR. WEBER: Thank you, Your Honor.

JUDGE McGUIRE: I want to expand on this same area while we're on it and before we get off it, because ultimately it's important that I have some inherent appreciation of the testimony.

So again, Dr. Horowitz, your colleague, which you were here to hear his testimony, had indicated on this same line that he felt because of the hostility toward your company from JEDEC that he didn't feel it was worth the company's time to even be involved in JEDEC.

If that was the case, to the extent that you understand the times we're referring to, how did you hope to ultimately incorporate this RDRAM into that organization's standards if you weren't even involved in JEDEC at some point?

THE WITNESS: Well, I should --

JUDGE McGUIRE: And I'm not asking you to

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answer what his impression was, but how do you answer that?

THE WITNESS: I think two things. One is I should say that I didn't think having a JEDEC standard was terribly important, and given the hostility that we later saw, it loomed less important.

But I truly believe that once you have a de facto standard, once everybody is using it, an organization, even if they don't like you, will standardize it, you know, because they -- that gives them something because it's already being used by everybody, and you know, it gives them some clout to say that they had some effect.

JUDGE McGUIRE: So then you thought it was going to occur ultimately even if you weren't involved with the operations.

THE WITNESS: Exactly.

JUDGE McGUIRE: Is that your testimony?

THE WITNESS: That's my testimony.

So generally, once you have a very popular interface, oftentimes standards organizations come to you and ask you if they can standardize, make that a standard.

JUDGE McGUIRE: Okay. And you know, I just wanted to interject while we're on that topic, and I'll

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try to stay out of this for a while, Mr. Weber.

MR. WEBER: Actually, Your Honor, I was about to suggest you take over because your questions seem a lot better than mine now, so -- but I can move on to something else, unless you have more questions.

JUDGE McGUIRE: No, I have nothing further.

BY MR. WEBER:

Q. Now, was the subject of JEDEC discussed at Rambus board meetings in 1992?

A. I don't recall.

MR. WEBER: Your Honor, may I approach?

JUDGE McGUIRE: Yes.

MR. WEBER: Your Honor, I think we may have a little xeroxing problem, but what I have is CX-606, and I'll just read in the Bates numbers so it's clear.

It's the same -- it's R -- the CX number on the hard copy was inadvertently cut off in the xeroxing, but we'll also have it on the screen.

This appears to be the minutes of a regular meeting of the Rambus board of directors October 22, 1992.

If you want, you can also look at the screen, Dr. Horowitz.

THE WITNESS: Okay.

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BY MR. WEBER:

Q. Let me just read in the Bates numbers for the record just so it's clear it's the same document. It's R 28106 through 28109. It's a four-page document.

Now, on the first page of this document, which has also been marked an CX-606, do you see it indicates you were present at this particular board meeting; right?

A. Yes.

Q. And could you turn to the second page of the document under Sales and Marketing.

Do you see the second -- if we could blow up -- in the second sentence it talks about at this point Richard Crisp of the company joined the meeting.

Do you see that.

A. Yes.

Q. And then further down it talks about what Mr. Mooring presented, and then there's a line that starts with Mr. Crisp and it says, "Mr. Crisp reported on the SDRAM status at JEDEC," and it goes on to list two other things, the Rambus patent strategy and also system-level difficulties with SDRAMs.

Do you see that?

A. Yes, I do.

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Q. Does this refresh your recollection that the subject of JEDEC was discussed in 1992 at a Rambus board of directors meeting where you were present?

A. No.

Q. Do you have any reason to doubt the accuracy of these minutes?

A. No.

Q. Do you recall -- whether it's this specific meeting or not, do you ever recall a connection between the SDRAM status at JEDEC on the one hand and the Rambus patent strategy on the other?

MR. DETRE: Objection, Your Honor. Outside the scope. Lacks foundation.

JUDGE McGUIRE: Response, Mr. Weber?

MR. WEBER: Well, the Rambus patent application was certainly referred to during the direct examination and also the scope of the inventions. There was discussion about what he thought he had invented in 1990 .

MR. DETRE: Your Honor, there was absolutely no discussion about SDRAM, no discussion of JEDEC. The witness has testified that he was not really aware of what was going on at JEDEC.

JUDGE McGUIRE: Sustained.

MR. WEBER: I'll move on, Your Honor.

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BY MR. WEBER:

Q. Is it fair to say that when you and Dr. Farmwald put the original patent application together you tried to define everything you thought you had invented?

A. No, that's not fair to say.

Q. Could you turn to the first day of your Infineon deposition at page 238, sir. This was in January of 2001 I believe.

A. The Infineon depo?

Q. Right.

A. Okay. Which page are you interested in?

Q. We're on page 238, the first question and answer starting at the top of the page.

Let me make sure my question that led to this was clear.

My question was: When you and Dr. Farmwald put the original patent application together, you tried to claim everything that you thought you had invented.

A. Oh, I'm sorry. I misunderstood the question.

Q. Oh, okay. Let's clarify the record then.

When you and Dr. Farmwald put the original patent application together, did you try to claim everything you thought you had invented?

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A. When we wrote the original -- let me answer it this way. When we wrote the initial patent application, we were trying to claim everything that we invented. I wasn't very involved in the claiming process, but I was hopeful that we had claimed everything that we invented, but --

Q. And --

A. But it turns out we didn't.

Q. And that's consistent with the first line of your answer in the testimony we just looked at, lines 6 through 7 of page 238 of your January 2001 Infineon deposition?

A. Yes, that's correct.

Q. And then also you thought, moving on, you thought you had some pretty broad claims, didn't you?

A. Yes.

Q. Now, were you aware of efforts to broaden patent claims at Rambus before the time Joel Karp joined the company?

A. Yes.

Q. And in fact one of the goals of Rambus was to obtain broad patent protection, meaning coverage that would go beyond the invention and just the RDRAM architecture?

A. No. Our goal was to broadly cover our

8601

invention. Or our inventions.

Q. Did you think the scope of the invention went beyond just the RDRAM architecture, sir?

A. Did I think the scope of the invention -- yes. Well, you -- well, let me correct you. When you say "the invention," that's a little confusing because there wasn't one invention, it was made very clear when the patent office came back and told us we had to divide it into a number of whatever they're called.

Q. It was divided into 11 different applications or continuations or whatever the patent word is; right, patent office word?

A. Exactly.

Q. Well, in terms of -- if we were just to look at the term "broad protection for your inventions " -- I'll use the plural here -- that would include protection that would go beyond the invention just in the RDRAM architecture in your view; correct?

A. I'm not sure what you mean by "the RDRAM architecture." If you're talking about the implementation of the first RDRAM chip, yes, we wanted basically coverage for our inventions, and they're not limited to the architecture that we use in the first chip.

Q. So your answer to my question was yes?

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A. If you read back the question, I'll -- if you'd read back your question, because at this point I'm not sure exactly what it was.

Q. If we were just to look at the term "broad protection for your Rambus" -- i'm afraid I can't. I'm afraid it's not here.

A. Why don't we just start over.

JUDGE McGUIRE: Maybe you'd better restate.

BY MR. WEBER:

Q. You wanted broad protection for the inventions in the original patent application; correct?

A. That is correct.

Q. And when you use the phrase "broad protection," that means protection so it would go beyond just using those inventions in the RDRAM architecture?

A. I wanted -- i would like to protect the inventions that we made, and one could use subsets of those inventions without using the entirety of all the inventions together.

Q. Well, it was your belief that including the four items that were discussed on direct with Mr. Detre -- and those were the latency, block size, the DLL/PLL on-chip, and the dual-edged clock? Do you recall discussing those four technologies with Mr. Detre?

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A. Yes, I do.

Q. With those four technologies, was it your belief that Rambus should obtain broad patent protection beyond just the RDRAM architecture?

A. You know, you keep on saying "beyond the RDRAM architecture," and I would say that I wanted, our hope was to get protection for each of those inventions.

Q. And people who were working on improving the claims language from fairly early on after the patent office came back and divided the original application -- strike that.

Isn't it true that people at Rambus were working on improving the claims language from fairly early on after the patent office came back and divided the original application into separate filings?

MR. DETRE: Objection, Your Honor. Lacks foundation. Outside the scope. There was no testimony about patent prosecution efforts after the patent application was divided.

JUDGE McGUIRE: Sustained.

BY MR. WEBER:

Q. Let's talk about PLLs for a minute. You discussed that on direct, PLLs and DLLs; right?

A. Okay.

Q. Do you recall discussing those on direct with

8604

Mr. Detre?

A. Yes.

Q. And you agree with me that when Rambus was -- and you would agree with me that obtaining patent coverage over the generic concept of a PLL on a DRAM in Rambus' patent portfolio was important?

A. Yes. I thought that the notion of putting a DLL or a PLL on a DRAM chip was an important advance.

Q. And if Rambus was successful in obtaining the patent, it would be, one, a relatively broad patent; correct?

A. I would hope it would be broad. That would be good.

Q. It would be broad and it would be a good patent to have; right?

A. Right.

Q. If you were able to get a patent covering the concept of a PLL on a DRAM?

MR. DETRE: Objection. Asked and answered.

JUDGE McGUIRE: Sustained.

BY MR. WEBER:

Q. And the way you look at things, the terms "PLL" and "DLL" are interchangeable in your mind?

A. That is not correct.

Q. Do you recall testifying in April of 2001

8605

before a judge and a jury in the federal district court in Richmond, Virginia?

A. Yes.

Q. We have the transcript there. I believe it says the Infineon trial transcript. If you could pull that up, please.

MR. DETRE: What page are you on, Mr. Weber?

MR. WEBER: I'm going to wait until the witness finds that. And we're on page 108, counsel.

BY MR. WEBER:

Q. Could you turn to -- it's April 24, 2001.

Do you have the right date there?

A. This says "Infineon TR," so April 24; right?

Q. Could you turn to page 108, please.

A. Right.

Q. And this was during your direct examination.

A. Okay.

Q. You were asked this question at line 3:

"QUESTION: And where is DLL or delay-lock loop shown on here?

"ANSWER: Well, it says on the top, the title of the slide is PLL Characteristic. And a phase-lock loop is another name -- a DLL is kind of a phase-lock loop. So they are interchangeable. So PLL means some sort of a phased-lock loop."

8606

Was that testimony accurate when you gave it, sir.

MR. DETRE: I believe Mr. Weber read it incorrectly. It does not say "a DLL is kind of a phase-lock loop." It says "a DLL is a kind of phase-lock loop."

MR. WEBER: Okay. Thank you. Thank you for that correction, counsel.

THE WITNESS: So --

BY MR. WEBER:

Q. With that correction by your counsel, did I read that accurately with his correction?

JUDGE McGUIRE: Hold on. Don't answer it until you have a question on the floor.

BY MR. WEBER:

Q. The question is: With your counsel's correction, is that testimony accurate, sir?

A. Yes, it is.

Q. And is it still your testimony today?

A. Yes, it is, but it's not what you asked before.

Q. Well, you said -- when you said, "So they are interchangeable," were you talking about a PLL and a DLL or something else?

A. Can I explain?

8607

Q. Sure.

A. The way I used the terms, a PLL is the generic term for any circuitry that adjusts phase, so a DLL is a kind of PLL, but they are not interchangeable because a PLL is not a kind of DLL, which I think is what I testified at the trial and what I -- and is what I think I've said consistently through this period.

Q. Let's see if I've got the terms right.

A phase-lock loop is a generic term that means any circuit using feedback to adjust phase of two signals in some fixed relation. Do you agree with that so far.

A. Correct.

Q. And also there are two types, those with VCOs, and then the other type being a delay-lock loop which doesn't have a VCO; is that right?

A. That is correct.

Q. And VCO stands for voltage control oscillator. Did I get that part right?

A. That's correct.

Q. And as you've defined it -- I think you've testified to this a minute ago; just nail it down -- a DLL is a type of PLL; is that correct?

A. That is correct.

Q. Now, PLLs have been used in processors and

8608

Ethernet controllers long before Rambus; correct?

A. That's correct.

Q. And -- but the PLL was a tool in the circuit designer's tool box by the late 1980s. Do you agree with that?

A. I believe I testified to that.

Q. And you're not saying that Rambus invented DLLs in general, are you?

A. No. Of course not.

Q. DLLs were around way before Rambus existed; right?

A. That is correct.

Q. Now, let's talk about this concept of the circuit designer's tool box.

You're saying as a circuit designer you like to solve problems, that's sort of your thing; right.

A. And I do like to solve problems.

Q. And if we were to compare the items in the circuit designer's tool box --

JUDGE McGUIRE: Boy, could I use you here.

MR. WEBER: We all could, Your Honor.

JUDGE McGUIRE: It's just time for some lightheartedness.

BY MR. WEBER:

Q. It's your view that there were more items in

8609

the circuit designer's tool box to choose from in the mid-1990s than in 1989 when you started working on Rambus, the design; correct?

A. I think we've gone through this in my depo as well.

Q. Right. But I don't think His Honor has the depo.

A. May I explain? Because these are a lot of jargon terms. I'm not sure this is doing anybody any good, so --

Q. Well, right now the pending question is: It's your view that there were more items in the circuit designer's tool box to choose from in the mid-1990s than in the 1989 time frame when you started working on the Rambus design; is that correct?

A. That's correct.

Q. Okay. Now, one of the things you talked about on direct was the cost of pins. Do you recall discussing that with Mr. Detre?

A. Yes, I do.

Q. And you know that the cost of pins on memory chips has been declining since the early 1990s or the late 1980s when you started working on the Rambus RDRAM; right?

A. The costs of pins have been declining globally

8610

on DRAM chips and other chips. It's one of the things that scaling seems to do.

Q. And over time the ability to build packages with more pins has improved, hasn't it?

A. That is correct.

Q. And in fact you're aware that in the direct RDRAM -- the current generation of RDRAM is called direct; right?

A. That's correct.

Q. And in that product you increased the number of bus lines from 8 to 16, didn't you?

A. That's correct.

Q. And more bus lines means more pins?

A. That's correct.

Q. And it was less of a concern at that time because the cost of adding the pins was less?

A. That's correct.

Q. Are you familiar with something called the no-connect pin?

Have you seen pin diagrams with an NC on them.

A. Sure.

Q. Are you familiar -- that means no-connect pin; right?

A. That means pins not used.

Q. And it's easier to use the no-connect pin if

8611

you have a new function than to add a new pin, put a new pin on; right?

A. Well, if you're going to say it's cheaper not to have any pin, not to use it, if you had a no-connect, it's cheaper to use the no-connect pin than if you didn't have a no-connect pin, so you know, there's costs -- pins have costs both integral to the die and the package, so just because you have a no-connect pin doesn't mean that connecting it is free.

Q. Well, you would agree with me that if there are some pins on the DRAM that are not fully utilized, then the marginal cost of adding or using that pin would be less than adding a new pin?

A. That's correct.

Q. Thank you.

A. But that doesn't say the marginal cost is small or zero.

MR. WEBER: Your Honor, I'm about to enter a new area. We can either break for the day or we can take a break, whatever you prefer.

JUDGE McGUIRE: How much more time do you have on the new area?

MR. WEBER: I think we're looking at at least an hour, Your Honor.

8612

JUDGE McGUIRE: At least an hour.

MR. WEBER: I don't want to give you an underestimate like I did the other day.

MR. DETRE: Your Honor, it would be our preference to finish today with Dr. Horowitz even if it means going a little bit late.

JUDGE McGUIRE: So you have another hour and only -- is that the total or just in a new area?

MR. WEBER: Well, the next area I'm about to get into is quite lengthy, so I don't --

JUDGE McGUIRE: In total how much more time do you anticipate?

MR. WEBER: I think in total it's probably an hour to hour and a half, to be honest.

JUDGE McGUIRE: And then we'd have to go back again and that's going to take us to, what, seven o'clock or so?

MR. DETRE: Six o'clock, Your Honor. An hour and a half.

JUDGE McGUIRE: It's going to take him an hour and a half to six, and then probably we're going to go back again for another round.

MR. DETRE: I will have five minutes at most, Your Honor.

JUDGE McGUIRE: Then let's take a break, just a

8613

short break, and we'll try to I guess conclude with this witness.

If we do that -- and let me ask you -- what's on tap tomorrow? Because I understand the intention was he was going to carry over till Friday. If he does that, then what's the plan for tomorrow?

MR. STONE: Then we would not have a witness for tomorrow, Your Honor.

JUDGE McGUIRE: Just go dark tomorrow?

MR. STONE: I think we would just be dark tomorrow because our next witness doesn't get in until then and he was planning to go up on Monday.

JUDGE McGUIRE: Okay. That's fine.

MR. STONE: Before we go off the record, I just would mention to you, just on a housekeeping matter, that complaint counsel filed a brief on the Reese Brown deposition issue, and we have filed our response, so that issue is now, from our perspective, fully briefed. We filed it this afternoon. Just a page I think.

JUDGE McGUIRE: I thought that issue had already been resolved.

MR. STONE: Complaint counsel filed another brief on it. Maybe it hasn't all made it to your desk yet.

8614

JUDGE McGUIRE: I don't think it has.

MR. DAVIS: I think it's a motion for clarification.

MR. STONE: And our opposition is there.

JUDGE McGUIRE: Okay. All right. Let's take a short break.

(Recess)

JUDGE McGUIRE: Let's go on the record.

MR. WEBER: May I approach, Your Honor?

JUDGE McGUIRE: Yes.

BY MR. WEBER:

Q. Let the record reflect I've handed the witness what's been marked and also in evidence as CX-1451.

Do you recognize this document as the original '898 patent application that you and Dr. Farmwald filed with the U.S. patent office in April of 1990 ?

A. It's a version of that. It's got some handwritten notes on top of it that --

Q. Well, could you turn to page 128 of CX- -- it's the little number in the right-hand -- lower right-hand corner.

A. Okay. Excuse me. 128?

Q. Page 128, yes, sir.

A. I think they're out of order. Hold on one second.

8615

I'm sorry. The pages were rotated, so I've got to get them back in order.

Q. It should have a signature I think you'll recognize at the bottom of the page?

A. 128?

Q. Right.

A. Yeah. Yep.

Q. And was that your -- is that your signature on this page?

A. Yes, it is.

Q. So -- and you recognize Dr. Farmwald's signature up above yours under the line that says "inventor's signature"?

A. Yes.

Q. And above that there's a paragraph talking about statements, that you're declaring that the statements are true and accurate under penalty of perjury; right?

A. Yes.

Q. And that was something that you read and signed when you filed this patent application at the U.S. patent office back in April of 1990 ; correct?

A. Yes.

Q. Would you turn to page 3, sir.

A. Sure.

8616

Q. By the way, just so it's clear, you had a major role in drafting the technical description in this application; correct?

A. Yes, I did.

Q. Okay. Do you see the first paragraph? It says "field of the invention"; right?

A. Yes, I do.

Q. And under that, the second sentence, "A new method of physically implementing the bus architecture is also described."

Do you see that?

A. Yes.

Q. And isn't that the key feature that distinguished the RDRAM from other DRAMs that existed previously?

A. It's a feature.

Q. And the notion in the bus architecture was to have this high-speed bus and then to multiplex some information on the bus so that the address, control and data could use some of the same bus lines; correct?

A. Yeah, I didn't understand the question. I'm sorry.

MR. WEBER: Can I have the reporter read the question back, please.

8617

(The record was read as follows:)

"QUESTION: And the notion in the bus architecture was to have this high-speed bus and then to multiplex some information on the bus so that the address, control and data could use some of the same bus lines; correct?"

THE WITNESS: I still don't know exactly what that means. I'm sorry.

I can tell you that the patent describes many inventions. One of those inventions was a protocol that multiplexed information on top of high-speed bus lines. Other parts of the invention were the technologies and techniques needed to generate those high-speed bus lines.

BY MR. WEBER:

Q. But when you talked about this multiplexing feature in your testimony in Richmond, Virginia in district court, you said that was one of the basic -- that was the basic notion of your invention. Do you recall that?

A. No. If you want to look at the testimony, we can. Maybe it will refresh my memory. I'm sorry.

Q. Sure. We could do that.

Do you have the trial transcript, page 53.

MR. DETRE: Did you say 53?

8618

BY MR. WEBER:

Q. Page 53, line 23 up to the top of page 54.

Do you see you were asked the question by your counsel at line 23: "Okay. And so what was the basic notion?

"ANSWER: So the basic notion was to have this high-speed bus and to then multiplex some information on the bus so that the addresses and the data could use some of the same control -- some of the same wires, these high-speed wires we were trying to share. Now, multiplexed just means some sort of sharing."

A. That's correct. If you read -- if you read the paragraph above, it says one of the issues --

JUDGE McGUIRE: Just a second.

MR. DETRE: I was going to read the rest of it in, but Dr. Horowitz --

JUDGE McGUIRE: But it's not his task. I'll let you, for the rule on completeness, go ahead and so we can get this complete and then we can move on.

If it will save some time, then I'll let him go ahead and read the part.

Go ahead, Dr. Horowitz.

THE WITNESS: So it said "let's get back to" -- so the question was: "So let's get back to this initial notion that Mike Farmwald had for your

8619

consideration.

"With respect to Exhibit 911, what was the basic notion?"

And the answer was: "The basic idea, as I said, was to change the interface to the DRAMs to make the wires go from the CPU to the memory chips at high-speed bus.

"Now, in order to do that, the first thing that we both agreed is that the bus had to be a synchronous bus, which meant that the DRAMs had to be synchronous DRAMs.

"But then in order to do that, what we were going to have to do is get those wires to be high-speed wires. Okay. And there were certain techniques you could use to make wires high speed, but those were going to be a little expensive.

"So what we decided to do was try to see how few wires we could use. Because we thought, especially back in 1990 , if we're going to have these high-speed wires, then less of them would make it more possible -- more feasible to implement."

JUDGE McGUIRE: Okay. Mr. Weber, you may proceed.

BY MR. WEBER:

Q. And then what follows is the question and

8620

answer that I read in; right, professor?

A. That's correct.

Q. And was the testimony that I read in and you just read in accurate when you gave it?

A. Yes, it was.

Q. Is that still your testimony today?

A. Yes, it is.

Q. Now, this patent application that you filed in 1990 uses the term "narrow bus" to describe the bus architecture, doesn't it?

A. I think the -- i don't know. If you say it is, I assume you've read it in there?

I mean, I don't -- we referred to it in many ways, and as Mike Farmwald testified yesterday, he said there's implementation that was not such a narrow bus.

Q. We'll talk about that in a few minutes.

Could you turn to page 43 of the CX-1451, lines 1921 -- through 21.

Do you see at lines 19 through 21 it describes a narrow, multiplexed time-shared bus? Do you see that?

A. Yes.

Q. And the term "multiplexing" as used here means you have a bus that is carrying different pieces of

8621

information at different points in time; right?

A. Yes.

Q. So that means you could have a bus carrying address and control information as well as data on the same bus line; right?

A. You could, but you could also multiplex just address information on the same points.

Q. Well, another aspect of your invention was the use of a packetized protocol; true?

A. Yes. Another invention that we made was bus protocol to use on the bus.

Q. And "packetized" means the data traveling over the bus is grouped together in packets?

A. Okay. I wouldn't say it exactly that way, but okay.

Q. And this packetized feature was something unique to RDRAM compared to other DRAMs; correct?

A. Well, at the time the other DRAMs were asynchronous and they returned a single data bit back, so yeah, it was very different.

Q. Do you have any understanding whether JEDEC-compliant SDRAMs have packets or not?

MR. DETRE: Objection. Outside the scope. Lacks foundation. Also calls for expert testimony.

JUDGE McGUIRE: Sustained.

8622

BY MR. WEBER:

Q. Well, anyway, it's your view that putting these -- this packetized system on a DRAM was an innovative step?

A. Yeah. The interface that we put on the DRAM was I believe innovative.

Q. Let's look at some of the drawings in your patent application.

Can you turn to page -- let's start with page 129, figure 3 at the bottom of the page, if you could pull that up.

A. Excuse me. 129?

Q. Right.

A. Okay.

Also, I just noticed there are pages on the end of this document that were not part of the original patent application, so...

Q. But the page 129 is the first page of drawings after your signed statement; right? Do you see that?

A. Yes, I do.

Q. Okay. And these drawings were attached to the original application; is that correct?

A. That's correct.

Q. Could we pull up and put alongside one of the documents you discussed on direct with Mr. Detre,

8623

RX-301. Could we pull up page 77 of RX-301, the figure 3, not the one in the -- okay.

I'm going to go to page 77 -- actually it's figure 6 on the lower left-hand corner of the page, if we could pull that up. And enlarge it.

And just so the record is clear, RX-301, if I've got that right, that was part of one of the articles that you discussed on direct with Mr. Detre.

A. If you want me to confirm that, I'd need to --

Q. Yeah, it's page 77, RX-301.

A. Okay. Yes. So that was the figure presented at the conference.

Q. Now, are these two diagrams generally showing the same thing, sort of an overview of the Rambus physical configuration or Rambus architecture?

A. These things are showing the same thing and they're showing the invention that we did in packaging, which was a vertical mount of the DRAM packages, so it's one of the inventions that we disclosed in the technical specification.

Q. And this is one of the things you thought was innovative; right?

A. Yes, we did.

Q. Other DRAMs didn't look like this, did they?

A. Not at the time.

8624

Q. And if you look at figure 3 on the bottom, am I right, on the right-hand side that would be the controller or CPU?

A. The controller or CPU.

Q. What's in the middle that's sort of blacked out, that would be where the bus lines would be?

A. Right. I believe in the original description they were -- this is a result of xeroxing -- they were individual lines in there.

Q. Right.

And you actually can see some of the individual lines if you look at figure 6; right.

A. That is correct.

Q. And then over on the left-hand side it's a bunch of DRAM, RDRAM -- in this case it would be RDRAM memory chips; right?

A. That's correct.

Q. And that's how it would be lined out with the memory chips lined out in a line, then the bus and then the controller; right?

A. Well, in the original description, we had an innovative packaging solution and a packaging invention was described here.

Q. And this was one of the drawings that was attached to your patent application?

8625

A. Yes. Because it was describing one of the inventions.

Q. Let's go on to the next -- if we can go on to the next drawing in CX-1451, which is figure 2, at page 130, take a look at that, please.

What's depicted in figure 2?

A. Figure 2 is an electrical drawing of the bus interface.

Q. Would figure 2 depict a typical RDRAM-style architecture?

A. I'm not sure what you mean by "typical RDRAM-style architecture." I'm sorry.

Q. Was this something that was also depicted in the published articles?

Again, if you need to refresh your recollection, you can take a look at the RX-301.

A. This was a picture of the Rambus bus which had multiple lines that went across that each of the DRAMs connected to.

Q. Okay. And if we look at this, there's a total of eight data lines; right?

A. That's correct.

Q. They're not all shown, but it would be lines zero through seven would all carry data; is that right?

8626

A. Yeah, I believe in some implementation -- and then there's the address valid line which also is another, essentially, data line.

Q. But you would agree with me that all eight of these lines that are shown in figure 2, in addition to carrying data, they would also be carrying control and address information; correct?

A. Well, this picture doesn't denote what they carry, but in the first implementation of the Rambus DRAM that's exactly what happened. In later implementations that's not what happened.

Q. The later implementation, you're talking about the direct where it went to 16 lines?

A. It went to 16 lines and certain lines were address lines and other lines were data lines.

Q. But there were still -- in the 16 lines there were still some lines that carried control, address and data information; correct?

A. To be honest, I don't know the details of the direct RDRAM spec, and I'm not sure that what you're saying is true.

Q. Do you recall discussing the issue of what would happen when you went to 16 bus lines instead of 8 in your trial testimony in the Infineon matter in federal district court in Richmond, Virginia in

8627

April 2001, sir?

A. I just remember being cut off when I tried to talk about it, so I don't remember exactly what got in the transcript.

Q. Well, I don't think you were cut off in this answer.

Could you turn to page 206 of that transcript.

This was redirect from your own counsel. The question at line 17 --

A. 206?

Q. Let me know when you're there, sir.

A. At 206?

Q. Yes.

MR. DETRE: Your Honor, I believe that the testimony Mr. Weber was eliciting just now was about direct RDRAM and this testimony is not about direct RDRAM but what's in the original patent application, so I don't think it's relevant to the line of questioning.

MR. WEBER: Your Honor, the last question I asked before I referred him to this was what would happen when he went to 16 instead of 8, and that's exactly what the question is.

MR. DETRE: That was about direct RDRAM, Your Honor.

8628

JUDGE McGUIRE: Overruled. I'll hear the question.

MR. WEBER: Not the last question.

BY MR. WEBER:

Q. Okay. Were you asked this question at line 17 and did you give this answer at line 19:

"QUESTION: So in the circumstance of 16 wires instead of 8, what do the lines carry?

"ANSWER: In the case of 16 wires versus 8, the wires would carry -- some wires would carry control, address and data. Other wires would carry address and data. And it's possible that some wires would carry just data."

Was that the answer you gave, sir?

A. Yes.

Q. Was that testimony accurate when you gave it?

A. I think so, but I think you're trying to -- okay. Let me -- if we're talking about what I -- if we're talking about the patent description, which is what I think we're talking to...

JUDGE McGUIRE: Mr. Weber?

MR. WEBER: I'm just asking if his testimony was accurate.

JUDGE McGUIRE: Well, let's draw a context here as to what he's talking about. If it's not clear what

8629

he's talking about, then this whole inquiry is not going very far.

MR. WEBER: The question I'm asking him is when he goes from 8 bus lines to 16 does he still have lines that are fully multiplexed that have control, address and data information, and in your answer you said you would --

JUDGE McGUIRE: Mr. Detre, did you have an objection?

MR. DETRE: Yes.

Mr. Weber still has not clarified what the context is here, whether we're talking about a hypothetical implementation of the invention, whether we're talking about implementation of direct RDRAM.

JUDGE McGUIRE: Can you clarify, Mr. Weber?

BY MR. WEBER:

Q. Well, first of all, it's a fact that direct RDRAM was in existence at the time you gave this testimony in April 2001; correct?

A. That's correct.

Q. And there was a spec written for direct RDRAM by then?

A. That's correct.

Q. Okay.

MR. DETRE: I don't think Mr. Weber is

8630

clarifying the question. He's asking new questions that are outside the scope.

JUDGE McGUIRE: Mr. Weber, again, can you clarify the context of your question?

BY MR. WEBER:

Q. In every implementation of RDRAM there have been multiplexed bus lines; correct?

A. I do not know -- i cannot answer that. I do not know the direct RDRAM spec.

Q. Can you tell me any implications -- any implementation of your invention in an RDRAM architecture that does not have at least one bus line carrying control, address and data on the same line?

A. I do not know the specifications of the RDRAMs that have been produced by Rambus, so therefore I cannot say anything pro or con to what you're saying.

But if I could, I thought we're talking about the patent application. And if you're asking me --

JUDGE McGUIRE: Well, that's what we're trying to get to. Now, if you want to -- i'm not going to get into this anymore. If you haven't got the context at this point clear, let's move on.

MR. WEBER: Yeah, my only question that I think he still hasn't answered --

JUDGE McGUIRE: Are you talking about the

8631

patent application? He's trying to -- he's not clear. Now I'm not clear.

Are you talking about the patent application -- what are you talking about?

MR. WEBER: We're talking about how the patent application has been implemented by Rambus.

JUDGE McGUIRE: Now we're getting somewhere then.

Now, can you answer it in that context, Doctor?

THE WITNESS: If you're asking me what I thought about when I wrote the patent application, that, I can answer.

JUDGE McGUIRE: Is that what you're asking him?

MR. WEBER: No. I'm actually asking him, first of all, if he can confirm the accuracy of his testimony in Richmond that I just read into the record that some wires would carry control, address and data when you went from 8 to 16.

MR. DETRE: I think that question was about possible implementations of the patent application when he wrote it, and given that context, I'm sure Dr. Horowitz could answer whether it's accurate or not. With respect to questions about implementations of

8632

RDRAM, Dr. Horowitz has answered he doesn't know, and there's no foundation for further such questions.

JUDGE McGUIRE: Okay. Doctor, can you understand the context of your prior testimony that he just referred to?

THE WITNESS: Yeah, I think I can.

JUDGE McGUIRE: All right. Now, in that context, does his current inquiry comport with the context of that earlier answer?

THE WITNESS: I think if you're going to construe my previous answer to say that all -- in the patent application I was thinking that the wires had to be multiplexed for control, address and data, that's incorrect. I did not think about that at the time. I do not think about that now.

And I don't read the previous testimony quite that way, but it seems like you do. I think I was saying they could be multiplexed or they could not be multiplexed. And basically when you have more wires, you do less multiplexing.

BY MR. WEBER:

Q. Let me just make sure I've read your testimony correctly.

Did I read it correctly where it says "some wires would carry control, address and data"?

8633

Was that testimony accurate when you gave it, sir?

A. I -- if -- if you're reading it as saying "would" meaning they had to, then my testimony is not accurate because I -- what I meant was they could control -- they could handle this. They could be multiplexed control, address and data. They could be address and data. They could be control and data. They could be address-only multiplexing. They could be data only.

JUDGE McGUIRE: Mr. Weber, does that help you with your question?

BY MR. WEBER:

Q. Yeah. I just want to make sure it's clear.

You're telling me then that this answer that you gave on redirect in response to your own counsel in the trial before a judge and jury where you were sworn under oath in Richmond, Virginia is now inaccurate.

MR. DETRE: Objection. It misstates the prior testimony.

JUDGE McGUIRE: Sustained.

BY MR. WEBER:

Q. Now, you referred to your patent application in one of your prior answers after Mr. Detre got up and

8634

objected a few minutes ago. Do you recall that?

A. Yes.

Q. Would you turn to page 9 of CX-1451, please.

Could we highlight the -- do you see -- there's a section that says "Summary of Invention"; right?

A. Yes.

Q. So if someone wanted to get a good summary of your invention, they'd go right here, wouldn't they?

MR. DETRE: Objection. Lacks foundation. Calls for speculation.

JUDGE McGUIRE: Sustained.

BY MR. WEBER:

Q. Okay. The first paragraph starts off -- the words are: "The present invention." Do you see that?

A. Yes, I do.

Q. Is there anything in that paragraph that talks about a preferred implementation?

MR. DETRE: Objection. Vague. Is the question do the words "preferred implementation" appear in that paragraph or is it whether it's talking about --

JUDGE McGUIRE: Can you clarify that, Mr. Weber?

BY MR. WEBER:

Q. Yeah.

8635

The words "preferred implementation" don't appear in that first paragraph that starts "The present invention"; correct.

A. Let me check.

(Pause in the proceedings.)

No, they don't.

Q. And was this a paragraph you wrote, sir?

A. I'm sorry. I don't -- i don't recall what I wrote and what I didn't. It's possible that the lawyers wrote the summary and I just wrote the actual description, but I don't remember.

JUDGE McGUIRE: Okay. Good enough. Let's move on.

BY MR. WEBER:

Q. One of the things it says were the present invention here, if we could highlight it, is that the bus includes a plurality of bus lines for carrying substantially all address, data and control information needed by said memory devices.

Do you see that.

A. Yes, I do.

Q. And was that an accurate statement of your invention, sir?

A. Sure.

Q. So that's saying the bus lines are going to

8636

have address, control and data on the same line; right?

A. No.

Q. Do you think someone else could read it differently?

A. I could read it differently --

MR. DETRE: Objection. Lacks foundation. Calls for speculation.

JUDGE McGUIRE: Sustained.

BY MR. WEBER:

Q. By the way, if we could go back to figure 2 for a second, it's the page 130 I think. And if you could take RX-385 -- it's the second to last document in your book that Mr. Detre used on direct.

That's the IEEE article you were a coauthor with with the Toshiba folks and other folks at Rambus. Do you see that.

A. Yes.

Q. Do you see in the upper right-hand corner, figure 1, the first figure on that article is very similar to figure 3 in the -- at page 130 of the patent application; correct?

A. That's correct.

Q. And we've already discussed that sets forth how the bus system is laid out in Rambus RDRAM

8637

architecture; right?
A. That's correct.
Q. So that's the first diagram somebody would see when they read this article; right?
A. Yes.
Q. Now, let's go back to the 16-line implementation we were talking about.
Let me make sure I understand. When you go to 16 lines, you're still using the packets, aren't you, in your Rambus system?
A. The application that I submitted contained -- or that Mike and I submitted contained a number of different inventions, right. It contained inventions on how do you get high-speed signals. It contained inventions on clocking. It had inventions on protocol. It had a whole set of inventions.
So when you said in the 16-bus-line implementation, you would still use packets, well, depending on what you could do, you could just do 16 bus lines with high-speed circuits in the clock stuff. I mean, you could do that.
You're making it sound like it's one monolithic thing, but it's a set of -- a collection of inventions.
Q. The patent application you filed only described

8638

the system that was using packets; correct?

A. I -- again, I wrote the patent application -- much of the technical description of the patent application. I thought it described a whole bunch of things. One of the things it did is it described a vertical packaging. Did you have to use packets with a vertical packaging? You know, I think it's just about packaging.

Q. Let's take a look at figure 4, which I think is on page 131 of CX-1451. Maybe we can speed this up a little bit.

Do you see at the top of the page, figure 4.

A. Uh-huh.

Q. Am I right that figure 4 illustrates a request packet?

A. Yes, it does.

Q. And this would be something that's part of a packetized protocol; right?

A. Right. Because one of the inventions that we described was a packetized protocol for this high-speed bus.

Q. Is the packetized protocol described in this patent application as an option or a preferred implementation or not?

A. It is one of the inventions described in the

8639

application.

MR. WEBER: Move to strike as nonresponsive, direct the witness to answer the question.

MR. DETRE: I think it was responsive, Your Honor.

JUDGE McGUIRE: Overruled.

MR. WEBER: Does that mean --

JUDGE McGUIRE: That means I'm not going to strike.

MR. WEBER: Okay. So I ask the next question. All right.

BY MR. WEBER:

Q. Now, regardless of how many bus lines there are, you agree with me that the packetized system that we have illustrated on figure 4 describes a system in which access time and block size is chosen with each packet?

A. To be honest, I don't recall right now. I believe that's probably the case because there's a field for block size certainly that's chosen with each packet and there's an access time.

But I believe, as I testified earlier, that the first description had the capability for selecting which of one of a number of access-time registers were chosen.

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So there's a notion, I mean, of different types of transactions and that each of those types of transactions would have a programmable access time.

So the way I would say it is that this described a layered approach which had both the ability to program what the access time was for a kind of transaction and then allowed you to have different kinds of transactions on the same bus for bus efficiency purposes.

Q. And the information about both the latency and the block size is sent out with each request packet?

A. No, that's not correct.

Q. Let's look at figure 4, and you see at the bottom box there's something that says "block size"; right?

A. That's correct. But we both agree that the block size is set out on a per-transaction basis.

Q. And is what is being illustrated in figure 4 the fact that in the Rambus RDRAM system the block size can be set or programmed in every request packet?

A. Well, what we're describing in the patent application is that one can build a bus-to-DRAM interface that allows you to have variable block size.

Q. And that variable block size can be set or programmed in every request packet; correct?

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A. Yeah. In this implementation it allowed you to change it on the request packet on each request.

Q. Is there any other implementation that's described in your application for block size?

A. I don't know. I'd have to go back through the application if you'd like.

Q. I was just wondering. As you sit here today, nothing comes to mind?

A. I haven't read the application in many years.

Q. Do you know whether or not block size or burst length in SDRAM works the same way as it does described in your patent application?

MR. DETRE: Objection. Lacks foundation. Outside the scope.

JUDGE McGUIRE: Overruled.

THE WITNESS: I have not taken apart an SDRAM. If you give me the spec, I'm sure I could figure it out, but I don't know.

BY MR. WEBER:

Q. In fact, you've never even looked at a JEDEC SDRAM spec; correct?

A. That is correct. I've never looked at a JEDEC spec because I don't think they're of much value.

JUDGE McGUIRE: Actually I'm going to change my ruling on that. That objection, to be I think

8642

consistent with my prior holding, is sustained, and so we're going to strike that answer and the follow-up question.

BY MR. WEBER:

Q. Are you familiar with something called a mode register in an SDRAM or not?

MR. DETRE: Same objection, Your Honor.

Also, Mr. Weber generally objected as calling for expert testimony to my questions about how aspects of Dr. Horowitz' inventions might be in SDRAMs or DDR SDRAMs and he was not allowed to answer, so I don't quite understand why Mr. Weber --

JUDGE McGUIRE: I gave you quite a bit of leeway on the crux of his testimony, and certainly he has the expertise, though he's not here as an expert, but I want to go back to your first objection.

You're saying that it's outside of the scope; right?

MR. DETRE: Yes, sir.

JUDGE McGUIRE: Do you want to respond to that, Mr. Weber?

MR. WEBER: Your Honor, I'll save some time and withdraw the question.

JUDGE McGUIRE: Thank you.

MR. WEBER: I think it's pretty clear from the

8643

expert testimony we've had what the right answer is.

BY MR. WEBER:

Q. Is there anywhere in this patent application in CX-1451 where it says that some lines will only carry data?

A. If I recall what you said, is there somewhere in this application, I do not recall the application word by word and so I cannot answer that question. I'm sorry.

Q. Do the words "programmable CAS latency" ever appear in this application, CX-1451?

A. I think we went over this once before. I do not know, but I don't think so.

Q. We've been looking for two years and we haven't been able to find them.

MR. DETRE: Can we strike the comment?

JUDGE McGUIRE: Mr. Weber, it's ten after five. If you're going to take time, I expect you to conduct yourself in a far better fashion than that, and I don't have the time at this point or the patience to put up with that kind of conduct.

MR. WEBER: Okay, Your Honor. I apologize.

May I approach, Your Honor?

JUDGE McGUIRE: Yes.

MR. WEBER: Your Honor, I've handed the witness

8644

what's been marked previously as a demonstrative. I believe it was with Professor Jacob. It's DX-96. It should be on the screen and also it's entitled Rambus Clock Synchronization.

BY MR. WEBER:

Q. Professor, Horowitz, does this document depict the Rambus clocking system as set forth in your patent application, your '898 application, CX-1451?

A. I don't believe so actually.

Q. Okay. Well, let me --

A. I believe it's wrong.

Q. Okay. Where is it wrong?

A. In Rambus systems the bus master is on the side of the clock where the clock is basically joined together, so you have the master on the wrong side.

Q. So the bus master is on the wrong side. Anything else?

A. That seems to be the -- that seems to be the main point.

Q. Okay. Do you see there's an outbound and inbound clock?

A. That's correct.

Q. And there's something called an early clock signal and late clock signal; right?

A. That's correct.

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Q. Is that an accurate depiction of your invention, as far as the clock, clocking system is described in the patent?

A. Well, I'm confused. What clocking system are we talking about here?

Q. Okay.

A. There was a very sophisticated clocking system that was described in the patent application and then, remember, we were trying to do the whole complicated system and then in the first part we actually simplified it somewhat, so which clock system are we talking about?

Q. I'm talking about something that's called a U-shaped clocking system that's been referred to as a U-shaped clock where it takes a U-turn.

Do you see the outbound clock and then it takes a U-turn back to --

A. Both of the systems take a U-turn, so I'm still not clarified on what you're asking me about. I'm sorry.

Q. Okay. So is it your testimony that this exhibit is not -- does not accurately depict the Rambus clocking system other than the bus master being in the wrong place?

MR. DETRE: Objection, Your Honor. Vague.

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The witness already testified he doesn't know whether he's talking about the patent application or the first part.

JUDGE McGUIRE: Sustained.

BY MR. WEBER:

Q. Do you recall testifying about the U-shaped clock in your Infineon deposition, sir?

MR. DETRE: I don't think this is proper use of deposition testimony, Your Honor. We don't have --

JUDGE McGUIRE: Sustained.

BY MR. WEBER:

Q. Do you recall testifying that this U-shaped clocking system was exactly the clock scheme distribution that's described in the original patent?

JUDGE McGUIRE: Testifying where, Mr. Weber?

MR. WEBER: Here.

JUDGE McGUIRE: Here.

MR. WEBER: Let me rephrase the question, Your Honor.

JUDGE McGUIRE: Please.

MR. WEBER: I know it's getting late.

BY MR. WEBER:

Q. Do you agree with me that DX-96 depicts the clock scheme distribution that's described in your original patent application?

8647

A. This picture looks wrong to me, and you're telling me I should move some things around to fix it up. I just think it's wrong.

So I'm not going to testify that anything in this thing is right because it's not right. So --

Q. Well, does the clock -- let's talk about -- let's forget the picture for a minute.

Does the clock scheme that was described in your patent application have a clock originating at one end of the bus, going down the bus, taking a U-turn at the other end and returning back.

A. Yes, it does.

Q. Thank you.

Do you have any knowledge of the DDR SDRAM clocking system?

A. Do I have any knowledge?

JUDGE McGUIRE: Sustained.

BY MR. WEBER:

Q. Okay. Would you turn to figure 12. It's at page 137, sir, of CX-1451?

A. Excuse me. Page 12?

Q. Yes, sir.

No. It's figure 12. I'm sorry. We're at page 137.

And do you recall actually discussing either

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the same or very similar diagram with Mr. Detre during your direct examination, sir.

A. Yes, I do.

Q. And am I correct that this figure 12 shows circuitry to align the midpoint between early clock and late clock 54?

A. That's correct.

Q. And that you testified before that there are delay lines involved here?

A. Well, there are clearly delay lines because they labeled them in the picture "delay lines." I think I testified there are two delay-lock loops here.

Q. Okay. And is the term "delay-lock loop" used anywhere in your patent application?

A. I don't know. If you want me to read it, I can. Certainly the concept of delay-lock loops was talked about in the patent application because it's in the figure.

JUDGE McGUIRE: All right. That answers the question.

BY MR. WEBER:

Q. Could you turn to -- you discussed with Mr. Detre on direct the concept of an access-time register?

A. That's correct.

8649

Q. And could you turn to page 16 of CX-1451.

A. Page 16?

Q. Yeah. It would be -- i'm getting -- the little number on the right-hand corner, lower right-hand corner.

A. I just wanted to make sure it wasn't figure.

Q. Right.

A. Okay.

Q. And look at lines 21 to 22.

Do you see there's a reference to access-time registers?

A. Right. Yes, I do.

Q. Okay. And in your view, access-time register includes the concept of programmable CAS latency; correct?

A. Access-time register is a register that sets the response time of the memory. It's a super -- you know, it's a big idea, and you can do that in many ways, and programmable CAS latency is one implementation. So superset/subset kind of thing.

Q. You chose to use the term "access-time register" because it's a more general term; is that right?

A. That's correct.

Q. Is there anything in this application about

8650

the concept of blowing fuses on the DRAM to set latency?

A. I don't recall.

Q. Is there anything in this patent application about using the concept of blowing fuses on the DRAM to program burst length or block size?

MR. DETRE: I'll object to the extent this calls for a legal conclusion. If he's asking do those words appear, that would be okay; but if he's asking whether the claims could be broad enough to cover that, that's something else.

MR. WEBER: Your Honor, I would like to clarify my question. I'm not asking about claims. I'm asking about the technical description that he was involved --

JUDGE McGUIRE: About the term "blowing fuses"?

MR. WEBER: Yes.

JUDGE McGUIRE: Is that -- if they appear in that?

MR. WEBER: Either the term or the concept in the technical description only, not the claims.

JUDGE McGUIRE: I'll entertain it.

THE WITNESS: Well, look, it's been a very long time since I read this document carefully and I read it way too many times when I was writing it.

8651

I believe there was one concept that basically one time programming some features I think like an ID register or something. Whether we talked about blowing fuses I don't know. I can't say. You know, I'd have to look at it more carefully to say whether this was included or not included. I don't remember.

BY MR. WEBER:

Q. Okay. Why don't we move on to something else and something you mentioned in your last answer that I think also appears earlier on this page we've been looking at.

I think at lines 4 to 5 there is a reference to a device ID or device identification register. Do you see that.

A. Uh-huh.

Q. That's something you just referred to in your last answer?

A. Yes.

Q. And then there's also a device type descriptive register?

A. Uh-huh.

Q. Do you have an understanding of what those terms mean as was used in this patent?

A. Well, yes. I think so. I would need to read up a little bit more about exactly what the device ID

8652

register was. But I'm pretty sure I can give you a rough feeling for it.

JUDGE McGUIRE: Mr. Detre?

MR. DETRE: Your Honor, I believe this is outside the scope. We didn't talk at all about patent interpretation issues on direct. We talked about Dr. Horowitz' understanding of his inventions.

JUDGE McGUIRE: I'm not going to let anyone go into patent interpretation issues.

Now, to the extent he can testify as to his personal knowledge of the patent, I think I gave you some leeway in that regard as well, but let's be clear. We're not asking about any patent interpretation.

MR. WEBER: Yes. Your Honor, I can rephrase it as a leading question, might make it go faster.

JUDGE McGUIRE: That would be wonderful.

BY MR. WEBER:

Q. Do you agree with me that the device ID register is a way of distinguishing which device is being activated?

A. Right. My recollection is the device ID register was to give each device a unique number in the bus so it could be activated.

Q. And the device type register is just to let you

8653

know what kinds of things are actually plugged into the bus?

A. Right. It's to be able to read back and say what the speed of the DRAM was or what the size of the DRAM was. That's my recollection.

Q. Is there anything involving the Rambus RDRAM and using something called a chip-select line?

A. There's nothing in the patent application about a Rambus RDRAM, so I'm not sure how to answer the question.

Q. Is there anything in your patent application about using a chip-select line to activate devices?

A. I don't recall one way or the other. I don't think so, but I don't recall.

Q. Now, you discussed on direct that in Rambus' early years you made a number of presentations to potential customers where you described the Rambus technology; correct?

A. That's correct.

Q. And in those presentations you would describe the Rambus technology as it was being proposed in connection with the RDRAM architecture you were offering to license?

A. Basically I was trying to convince people that we weren't crazy, so in order to do that, I had to

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explain why we felt we could accomplish what we accomplished, and as a result, I had to describe many of inventions that allowed us to accomplish the performance.

So I talked about how to use phase-lock loop chips -- I talked about how to use phase-lock loops on a chip or DLLs. I talked about how to read double data rate. I talked about how you look at the bus lines as terminated transmission lines.

So we went through all the different sections to do that, explaining the different inventions that would allow us to reach the speed we reached.

Q. Did you ever tell any customer that you thought your intellectual property was broad enough to cover products outside the RDRAM architecture, sir?

A. I believe I talked about technical stuff and I didn't talk about patents.

Q. So is the answer to my question no?

A. Let me rephrase my answer. My answer is I remember talking about technical discussions. I don't remember talking about anything else, so I don't want to say yes or no. I just don't remember.

Q. Do you recall telling me in your deposition that you never specifically said we have IP protection on this or that feature?

8655

A. I don't recall saying that. I could have. As I said, I focused mostly on the technical description. That's what I like. That's what excites me.

Q. Could you turn to page 103 of your deposition, sir, the FTC deposition. And see if this refreshes your recollection.

Lines 24 through 25 --

A. I've got too many up here. Hold on a second, please.

Q. I'm sorry. It's the one with the little sticker that says "FTC." I think you got that one?

A. I got it now. What page?

Q. We're looking at page 103, bottom of the page.

At line 24, let me just quote a portion of your answer: "We never -- but to say did we say, We have IP protection on this, no."

Is that testimony accurate?

A. Yeah. If you just take the context, I think what I said was correct.

JUDGE McGUIRE: All right. Mr. Detre?

MR. DETRE: Could I read the context, Your Honor?

JUDGE McGUIRE: I'm sorry. Do you want to read some other portion?

MR. DETRE: Well, I want to read the entire

8656

answer.

JUDGE McGUIRE: Go ahead.

MR. DETRE: "We basically told people what the Rambus technology was, and one of the things that was part of the Rambus technology was programmable CAS latency, and we told people that we had IP protection. We never -- but to say did we say, We have IP protection on this, no. We just said, We have these technologies. Here's how you do this stuff. So we're educating people how to do things, and we tell people we have protection on the Rambus interface."

JUDGE McGUIRE: Okay. Mr. Weber?

BY MR. WEBER:

Q. So on the part Mr. Detre read where it says "we told people that we had IP protection," you were just talking generally without referring to any particular feature that was protected; correct?

A. No. That's not how I interpret it.

Q. Your focus during this time frame was to secure licenses for the RDRAM technology; correct?

A. My focus during this time frame was to convince people we could do it.

Q. And the end result, for example, Toshiba, one of the first licensees, they signed an RDRAM license with you; right?

8657

A. That's correct.

Q. And as a matter of fact, when they signed that RDRAM license in, what, 1990 about?

A. I don't recall.

Q. Right. But at that time you had no issued patents; correct?

A. In 1990 , no, we had no issued patents.

Q. And at the time -- i know you can't remember the date, but at the time of the first RDRAM license you had no issued patents?

A. I believe that's the case, yes.

Q. Could you turn to page 138 of CX-1451, sir.

A. 138?

Q. Yes, sir.

Does figure 13 on page 138 of this document depict a system with dual-edged clocking?

A. I believe it does.

Q. Do you recall what your initial response was when I asked you this same question about figure 13 at your deposition last February in San Francisco, sir?

MR. DETRE: Objection, Your Honor. It's misleading. Mr. Weber said "initial response" because Dr. Horowitz was initially mistaken and corrected his response.

JUDGE McGUIRE: Restate it.

8658

BY MR. WEBER:

Q. When I first asked you the question about figure 13 at your deposition in San Francisco, didn't you tell me that I don't think anything in this picture has anything to do with dual-edged clocking?

A. Yes, I did.

JUDGE McGUIRE: All right.

MR. DETRE: It's an improper use of deposition testimony, Your Honor.

JUDGE McGUIRE: Sustained.

BY MR. WEBER:

Q. When I asked you about figure 13 the first time in your deposition, when later you corrected your testimony, you admitted you made a mistake?

JUDGE McGUIRE: That's the same question I think, Mr. Weber.

BY MR. WEBER:

Q. Later on you corrected your testimony and said that it was dual-edged clocking; right?

A. That's correct.

Q. And the reason is -- you made the mistake was you just scanned the diagram and you hadn't looked at the clock waveforms at the bottom of the page; right?

A. No --

Q. At the bottom of the figure. Excuse me.

8659

A. It wasn't the clock waveforms. It was at the very bottom of the figure you see the little upper arrows, and I just didn't notice the little upper arrows, and the left of the figure is talking about the complicated clock alignment scheme, so I just missed that. I'm sorry.

Q. Let me see if I understand this. You're the named inventor on these patents based on this patent application, over 50 patents; right?

A. If you say.

Q. And yet testifying under oath initially you made a mistake and missed this dual-edged clocking and double data rate in this figure 13; is that right?

A. That is correct.

MR. DETRE: Objection, Your Honor. Asked and answered.

JUDGE McGUIRE: Sustained.

BY MR. WEBER:

Q. Would you agree with me that it's possible for an engineer looking at this figure 13 back in 1991 or 1992 to make the same mistake and not see dual-edged clocking or double data rate in the diagram?

MR. DETRE: Objection. Lacks foundation. Calls for speculation.

JUDGE McGUIRE: I'm going to hear that

8660

question.

THE WITNESS: I believe if you looked at this diagram, sure. But there are other diagrams that we've talked about earlier that showed it much more clearly and so I think it -- i think it is impossible to read the technical disclosure and look at the figures and not think that double data rate systems had been disclosed.

BY MR. WEBER:

Q. Bottom line, Dr. Horowitz, you would agree with me that it's possible that two engineers could read this technical description and look at the drawings of your inventions and come to different conclusions about what might be covered by intellectual property?

MR. DETRE: Objection, Your Honor. It's overly broad and calls for speculation and lacks foundation.

JUDGE McGUIRE: I'm afraid that one does. I mean, I tried to let you go with the other one, but I just can't allow that kind of inquiry from this witness. Sustained.

BY MR. WEBER:

Q. Isn't it true that no one would know for sure what's covered by the Rambus intellectual property

8661

until Rambus told them?

MR. DETRE: Objection, Your Honor. Well, same objections.

JUDGE McGUIRE: Sustained.

MR. WEBER: Nothing further, Your Honor.

JUDGE McGUIRE: All right. Thank you, Mr. Weber.

Now, Mr. Detre, any redirect?

REDIRECT EXAMINATION

BY MR. DETRE:

Q. Dr. Horowitz, Mr. Weber asked you whether variable block size and programmable burst length are exactly the same. Do you recall that?

A. Yes, I do.

Q. And you testified they weren't exactly the same?

A. That is correct.

Q. What are the differences between those two terms?

A. Well, the reason I said they're not exactly the same is he said they're exactly the same, and variable block size and variable burst length aren't the -- exactly the same words, and at the time I didn't want to say they were exactly the same.

I use them interchangeably, and if we wanted to

8662

go through, we could look at the definitions and maybe find some difference. I use them interchangeably. I just didn't want to say they're exactly the same.

MR. DETRE: Thank you, Your Honor. I have no further questions.

JUDGE McGUIRE: Mr. Weber?

MR. WEBER: Nothing else, Your Honor.

JUDGE McGUIRE: Thank you, Mr. Weber.

Okay. Then, Dr. Horowitz, you're excused from this proceeding. And thank you for your testimony.

THE WITNESS: Thank you very much.

JUDGE McGUIRE: So counsel, if I understand then, the courtroom tomorrow will be dark; is that correct?

MR. STONE: It is, Your Honor. I apologize for not having filled it. I think we underestimated the length of these two witnesses. We're going to try not to let that happen.

We do have a modest amount of deposition testimony to present in our case, but we are still exchanging -- we have about one hour of it that has been agreed upon as joint designations. I don't think we should take an hour tomorrow to do it. I think we will have enough windows before we finish that we'll fill that hour.

8663

JUDGE McGUIRE: All right. Very good. Then we will I guess convene again at 9:30 on Monday; correct?

MR. STONE: Yes.

JUDGE McGUIRE: Thank you.

Hearing in recess.

(Time noted: 5:32 p.m.)

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C E R T I F I C A T I O N   O F   R E P O R T E R

DOCKET NUMBER: 9302

CASE TITLE: RAMBUS, INC.

DATE: July 10, 2003

I HEREBY CERTIFY that the transcript contained herein is a full and accurate transcript of the notes taken by me at the hearing on the above cause before the FEDERAL TRADE COMMISSION to the best of my knowledge and belief.

DATED: July 11, 2003

JOSETT F. HALL, RMR-CRR

C E R T I F I C A T I O N   O F   P R O O F R E A D E R

I HEREBY CERTIFY that I proofread the transcript for accuracy in spelling, hyphenation, punctuation and format.

DIANE QUADE