FEDERAL TRADE COMMISSION

I N D E X (PUBLIC RECORD)

UNITED STATES OF AMERICA

FEDERAL TRADE COMMISSION

In the Matter of:)

Rambus, Inc.) Docket No. 9302

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Wednesday, June 25, 2003

9:33 a.m.

TRIAL VOLUME 35

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

For The Record, Inc.
Waldorf, Maryland
(301) 870-8025

APPEARANCES:

ON BEHALF OF THE FEDERAL TRADE COMMISSION:

M. SEAN ROYALL, Attorney
GEOFFREY OLIVER, Attorney
JOHN C. WEBER, Attorney
MICHAEL FRANCHAK, Attorney
Federal Trade Commission
601 New Jersey Avenue, N.W.
Washington, D.C. 20580-0000
(202) 326-3663

ON BEHALF OF THE RESPONDENT:

GREGORY P. STONE, Attorney
STEVEN M. PERRY, Attorney
PETER A. DETRE, Attorney
SEAN GATES, Attorney
Munger, Tolles & Olson LLP
355 South Grand Avenue, 35th Floor
Los Angeles, California 90071-1560
(213) 683-9255

APPEARANCES:

ON BEHALF OF THE RESPONDENT:

A. DOUGLAS MELAMED, Attorney
Wilmer, Cutler & Pickering
2445 M Street, N.W.
Washington, D.C. 20037-1420
(202) 663-6090

P R O C E E D I N G S

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JUDGE McGUIRE: This hearing is now in order.

Before we start this morning, any housekeeping tasks we need to take up?

MR. PERRY: Yes, Your Honor. We have a few exhibits to move in, if we could, from yesterday's examination of Mr. Lee.

JUDGE McGUIRE: All right.

MR. PERRY: There are ten exhibits. I shared the list with Mr. Oliver, and he has informed me that complaint counsel have no objections, so if I could just read the numbers?

JUDGE McGUIRE: Go ahead.

MR. PERRY: RX-1527, JX-40, CX-1314, RX-757, RX-763, RX-765, RX-2061, RX-2062, RX-2064 and RX-2070. We would move in those exhibits at this time.

MR. OLIVER: We have no objection, Your Honor.

JUDGE McGUIRE: All right. All those at this time are entered to the record.

MR. PERRY: Thank you, Your Honor.

(RX Exhibit Numbers 757, 763, 765, 1527, 2061, 2062, 2064 and 2070 were admitted into evidence.)

(JX Exhibit Number 40 was admitted into evidence.)

(CX Exhibit Number 1314 was admitted into evidence.)

JUDGE McGUIRE: Anything else?

Mr. Stone.

MR. STONE: Yes, Your Honor. Two other housekeeping matters.

The first is, as you know, we discussed with you the date on which respondent's case would start.

JUDGE McGUIRE: Yes.

MR. STONE: Because the case has gone a bit longer than any of us have anticipated, we have been trying to juggle vacations, sabbaticals and a honeymoon of some of --

JUDGE McGUIRE: You know, I need all three of those things right now.

MR. STONE: Well, I don't think you're alone in that, Your Honor.

We had talked with complaint counsel. Because of some travel problems, if we could delay the start by one day to July 9 of our case --

JUDGE McGUIRE: That's fine with the court.

Is it the expectation that -- and I asked you this I think on Tuesday, Mr. Oliver, and you said that or you indicated the other day that you anticipated the completion of the complaint counsel's case in chief by

the end of June, which would be next Monday.

Do you anticipate you're going to go beyond that date at all, like up to the 2nd or the 3rd perhaps?

MR. OLIVER: Your Honor, if I could explain in a little more detail where we stand. This may actually raise a second issue that Mr. Stone -- at this point we expect that Professor McAfee will be our second to last witness. He was originally of course scheduled to be our last witness, but we of course had to take Mr. Vincent out of order.

In addition to that, we still have remaining reading from the deposition testimony of Mr. Joel Karp. If time permits on Friday, we hope to finish with the deposition testimony of Mr. Karp on Friday.

We expect to take Mr. Vincent next Monday. If we don't finish Mr. Karp's deposition Friday, we expect to finish it Monday. That would complete the live witnesses for us.

In addition, we still have a number of other depositions that we and respondent have agreed can be submitted in paper.

JUDGE McGUIRE: Okay.

MR. OLIVER: But we are -- after consultation, what we would propose to do is during the break,

perhaps up to about July 9, 10 or 11, whatever it takes to accommodate their break as well, we would focus on consolidating the designated portions of the depositions, including those portions without objections and those portions with objections. We'd then offer those to you sometime on July 10 or 11.

JUDGE McGUIRE: That's fine.

MR. OLIVER: That would then be the completion of our case.

JUDGE McGUIRE: So again, you anticipate being done with your case by next Tuesday perhaps?

MR. OLIVER: I believe that, again, assuming that there's time on either Friday or Monday to complete the reading of Mr. Karp's deposition, I think we can finish by the end of the day Monday.

JUDGE McGUIRE: Great. Okay. Anything else?

MR. STONE: Just one other item, Your Honor.

And we have talked with complaint counsel about the depositions and I think we will give you probably a joint brief that sets out what deposition testimony will come in, what objections you would need to rule on as you read it, and I think it's possible that there will be a few objections people might want to argue orally and we'll propose -- we'll tell you which those are and propose a time that might work for that, if we

could.

JUDGE McGUIRE: All right. Very good.

MR. STONE: My one other point, in preparing for Mr. McAfee's examination, we realized that two of the exhibits on complaint counsel's exhibit list, of which they gave us notice, CX-1680 and 1681, which are license agreements entered into by Rambus with third parties and which set out royalty rates for DDR and SDRAM devices, were not by us included in our motion for in camera treatment as the other license agreements were.

We would ask that the court afford those two exhibits provisional in camera treatment today. We'll file a motion before the end of the week seeking formal --

JUDGE McGUIRE: That's fine.

Any opposition?

MR. ROYALL: Your Honor, I don't think we have any opposition to that. Mr. Stone says they're going to file a motion. We'll look at that and see if we have any response.

JUDGE McGUIRE: That's fine. At the time it comes up, then I will grant it provisional in camera treatment.

MR. STONE: And we have talked with complaint

counsel. They have some royalty rates in Professor McAfee's demonstratives, but I understand they're going to treat those as in camera for the purposes of his testimony, and that will deal with that issue.

And I think complaint counsel and Your Honor both got a copy of the brief. I hope. If not, I have hard copies.

JUDGE McGUIRE: Are you talking about the brief for the proposed slides that they're going to show?

MR. STONE: Yes. That at some point will come up today. I'm not sure when.

JUDGE McGUIRE: I'd just gotten that brief about fifteen minutes a ago. I have just had a couple of moments to go through it.

Do you have any comments you want to make to any of this, Mr. Royall?

MR. ROYALL: Well, Your Honor, like you, I'm not even sure if I saw it fifteen minutes ago, but I have quickly looked at it and I do think that there is a response that I think should resolve the issue and create -- make it a nonissue.

The motion, as I understand it, is predicated upon Your Honor's motion in limine ruling.

JUDGE McGUIRE: On April 21, right.

MR. ROYALL: This was a ruling relating to Professor McAfee's testimony.

JUDGE McGUIRE: Right.

MR. ROYALL: And as you may recall, in that ruling, you granted, in part, Rambus' motion, finding that the issues were moot because we had explained in our opposition that we had no intention of Professor McAfee -- he made clear --

JUDGE McGUIRE: It was complaint counsel who had advised the court that those issues were I think moot.

MR. ROYALL: Yes.

JUDGE McGUIRE: Because you had no intention to inquire regarding state of mind, the patent disclosure policy of JEDEC, and some of the other issues involved, so that's where the court came up with that language.

MR. ROYALL: Exactly. That's exactly correct.

And in explaining why we believed it was moot, which then you reflected in your order, we explained that citing to Professor McAfee's own deposition testimony that he doesn't intend to -- he's not a patent expert. He's not a legal expert. He's not an expert on JEDEC's rules.

On the other hand, we explained very clearly that he has made assumptions about facts and he has understandings about facts that supply a predicate for his economic analysis. And we cited quite a bit of case law that says that where an expert testifies, his assumptions not only are appropriate to be explained, but it's really quite necessary because the strength of the testimony can stand or fall on the nature of the assumptions that are made and whether those assumptions prove to be true in terms of the facts that are proved.

And so that was the point that we were making. And I recall after your motion in limine ruling -- I forget exactly the context, but you had asked if we had any comments, and I recall that was the one point I had commented on, is that I just wanted to make clear that -- I do now recall exactly the context. It was a question I had raised -- and this may help you to recall -- of whether we needed to redact anything from Professor McAfee's reports.

JUDGE McGUIRE: Of course I also said at the time that was in case his expert report would be offered and come into evidence, but I've since issued an order that there would be no expert reports into evidence.

MR. ROYALL: Yes, Your Honor. But I'm just recalling now that it was in that context that I made the point that we understood your order not to limit us in terms of bringing out the nature of the assumptions as long as they're so stated and as long as it's very clear that he's not testifying about what JEDEC's rules or what patents cover, et cetera, et cetera.

And I think that really resolves this whole issue.

Obviously Rambus is responding to slides that may give very cryptic explanations, and I understand that they have some concern, but I can tell you that we do not intend for Professor McAfee to testify as to what patents cover what, what JEDEC rules do or do not provide.

He is going to, however, explain the bases of his assumptions and those can be then resolved through the evidence.

JUDGE McGUIRE: Okay. Mr. Stone, did you want to respond to that?

MR. STONE: Your Honor, I think -- I think what's best is to wait as we go forward. We've sort of laid out the underlying premise of law, and I think if his testimony runs afoul of where we think --

JUDGE McGUIRE: But the point is -- and I understood your arguments and now I understand his.

The point is, if he or his colleagues indicate at the time of the inquiry that this is not -- that this testimony is not offered for the state of mind or some of these other areas, is that going to be adequate for your -- for the purposes of your opposition in this brief, as long as it's stated clearly in the record as to what his testimony is not to entail?

MR. STONE: I think to the extent what Professor McAfee does is if he says "For purposes of reaching my expert opinions as an economist I have assumed the following," and if he states them simply as assumptions -- "That's what I've assumed" -- and if they're important or necessary for his opinions, I think that does address our issues.

JUDGE McGUIRE: Then you can always go into that on cross-examination.

MR. STONE: And I think if we go beyond that then we may have an issue.

JUDGE McGUIRE: Then I'll entertain at that time any objections, but let's try to -- I think we have an understanding here pretty much.

So let's be clear from the point of view from,

I guess, complaint counsel that upon your inquiry then make clear on those areas that these are based on his, I guess, assumptions and not a statement as to his conclusions in some of these areas that we've discussed, and hopefully that will address the crux of these problems.

If it doesn't, then I'm sure you'll stand up and we'll hear from you again.

MR. STONE: Thank you, Your Honor.

MR. ROYALL: And we fully intend to do that. The only point I make is in case, as we also stated in our opposition to the motion in limine, it's appropriate in defining assumptions for the expert to explain what, if any, basis he had in making the assumption --

JUDGE McGUIRE: Right.

MR. ROYALL: -- I may ask questions along those lines.

MR. STONE: We may get into an issue as to whether he can rehearse evidence in this case in order to support an assumption, because an assumption is simply an assumption, and if he rehearses testimony in this case to support an assumption, he's then making the assumption part of his opinion. He's then testifying that this is an assumption based on

evidence.

And the appropriate way for this is simply to say "I have assumed that," and then we will argue to Your Honor at the end of the case whether the evidence supports his assumption or not.

JUDGE McGUIRE: Right. Right.

MR. ROYALL: Your Honor, I strongly disagree if what he is saying is that the expert should not -- is not permitted to point to evidence that the expert has seen as relating to or giving corroborating assumption.

Again, we cited and included Supreme Court cases on that point in our original motion. We can deal with it when it comes up.

JUDGE McGUIRE: Right. But I want to be careful. I think one of the concerns that has been raised in this brief is that we not sit here and have him summarize unduly fact testimony of which he has no firsthand knowledge.

Now, to the extent that some facts are part of his overall assumption, then you'll be able to lay that foundation. But I don't want to spend a lot of time on him going back over and restating the facts of other individuals who have testified in this hearing. That's not his role.

But I will give you some leeway in that regard, but if you overdo it, then I want to intervene and cut you off in that regard.

MR. ROYALL: I understand, Your Honor.

And I will tell you that we do think it's appropriate to draw out at certain points what, if any, facts he has seen to support his assumptions, but we don't plan to do that in any great deal and we expect that most of the fact issues may come up on cross as opposed to direct.

JUDGE McGUIRE: Okay. Very good.

MR. STONE: I think we'll --

JUDGE McGUIRE: Mr. Stone, one last thing.

MR. STONE: On that point, Your Honor, I do think rehearsing facts which are already in the record would be both cumulative and is not necessary to support an assumption. If they're necessary to support an opinion, that's different. I don't think they should be offered to support an assumption.

But I do think it's best to deal with this in the context when it arises.

JUDGE McGUIRE: I agree.

And I will advise you, though, for guidance that I will give him some leeway in that regard, the extent of which will be determined at the time that you

stand for objection.

MR. STONE: Thank you, Your Honor.

MR. ROYALL: Thank you, Your Honor.

JUDGE McGUIRE: Are we set?

MR. ROYALL: Yes, Your Honor.

JUDGE McGUIRE: Then at this time complaint counsel may call its next witness.

MR. ROYALL: At this time complaint counsel calls as its next witness Professor Preston McAfee.

JUDGE McGUIRE: Would you please approach the bench and be sworn by the court reporter.

- - - - -

Whereupon --

RANDOLPH PRESTON McAFEE

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

DIRECT EXAMINATION

BY MR. ROYALL:

Q. Good morning.

A. Good morning.

Q. Professor McAfee, can I ask you for the record to state your full name.

A. Randolph Preston McAfee.

Q. And where are you employed?

A. The University of Texas at Austin.

Q. And is that where you reside as well?
A. Yes.
Q. And what position do you hold at the University of Texas at Austin?
A. I'm the Murray Johnson professor of economics.
Q. Is that in the economics department?
A. Yes, that's in the economics department.
Q. And how long have you been employed as an economics professor at the University of Texas?
A. Since 1990.
Q. Have you taught at any other universities?
A. Yes. My first job out of graduate school was at the University of Western Ontario.
Q. And how long did you teach there?
A. Seven years.
Q. In the economics department?
A. That's correct -- actually I was on the faculty for nine years. I then went on leave to Cal Tech.
Q. California?
A. Institute of Technology.
Q. And did you teach economics there as well?
A. I did, yes.
Q. And after teaching at Cal Tech, what did you do then?

A. That's when I went to the University of Texas.
Q. And I think you said that was 1990?
A. That's correct.
Q. Since you have been a professor at the University of Texas, have you taken leave to teach at any other schools?
A. Yes. I've taught at MIT and also at the University of Chicago.
Q. And at MIT, were you teaching in the economics department?
A. I was. I taught industrial organization in the economics department.
Q. And at the University of Chicago what department of the school did you teach in?
A. The Graduate School of Business.
Q. Was it an economics class that you taught in the Graduate School of Business?
A. Yes. The economics of strategy.
Q. Do you specialize in any particular area of economics?
A. Yes. I specialize in industrial organization.
Q. Could you explain to the court what is industrial organization.
A. Industrial organization is the study of firm behavior and the performance of markets.

Q. And do you have any understanding as to whether industrial organization has any relationship to antitrust or antitrust policy?

A. Yes. Antitrust issues are generally an important branch of industrial organization, for the reason that it's the study of market performance and antitrust issues very much concern market performance.

Q. Are you currently, by which I mean not today but in this year, academic year, are you currently teaching classes?

A. Yes.

Q. And what classes do you teach?

A. I teach an undergraduate managerial economics, which is about corporate behavior and firm decision-making, and then I teach a graduate-level course called the economics of strategy, which is about a similar topic.

Q. And was it -- it was fairly recently that you were visiting at the University of Chicago; is that right?

A. Yes. Three years ago.

Q. And what class, if you didn't already mention it, what class did you teach there?

A. It's essentially the same course, the economics of strategy. I think they may just call it

strategy.

Q. Besides managerial economics and business strategy, have you taught other types of economics classes?

A. Yes. For most of my career I've taught industrial organization both at the graduate and undergraduate level.

Q. Let me ask you to describe briefly your own personal educational background.

A. I graduated from the University of Florida in 1976. I went from there to Purdue where I completed master's degrees in both economics and in mathematics, and then I finished a Ph.D. at Purdue in 1980.

Q. Have you --

A. In economics, so...

Q. And have you worked in academia since finishing your Ph.D. in 1980?

A. Yes.

Q. Have you ever worked in government as an economist?

A. I had a -- I spent a long summer, five-month period, at the Department of Justice Antitrust Division in 1987.

Q. And what was the nature of your position or your role at the Antitrust Division?

A. At that time -- and I think actually they may have restarted it -- but at that time they had an annual program where they brought an academic in to assist with various -- well, with their mission, their antitrust mission. The informal name of this program was the scholar in residence.

Q. And what is the nature of that program?

A. Well, I worked on a variety of matters that were going on at the time. They were particularly interested in collusive bidding in auctions, that is, bidders who collude together, and that was one of the reasons they picked me. But they had -- I worked on a variety of matters during that period.

Q. Have you published any articles relating to economics?

A. Yes. Over 60 articles.

Q. And is there any particular area in economics that has been the focus of your academic articles?

A. Well, broadly speaking, most of the articles are in the field of industrial organization. The specific topic I've published the most on is in auctions. I've published on antitrust, on market pricing, and a variety of other topics.

Q. How does economics relate to the issue of auctions that you mentioned?

A. Well, auctions are a form of market organization, and so auctions -- the study of auctions is very much a matter of the study of market performance and market behavior.

Q. You mentioned that you've written on the subject of antitrust or antitrust-related topics.

Can you give an example of an antitrust-related topic that you've written on?

A. Yes. I've written several papers on mergers -- these are coauthored papers I should mention. But I've written several papers on mergers and antitrust policy. I've written papers on cartel behavior and collusion.

Q. And in terms of business strategy, are there any particular topics relating to business strategy that you've focused on in your academic writings?

A. Well, in fact I've written a book on business strategy that's just come out.

Q. I think we may actually have a slide that -- yes. The first slide here.

Your Honor, I don't know where we are in terms of DX numbers.

JUDGE McGUIRE: It should be DX-120.

MR. ROYALL: DX-120.

BY MR. ROYALL:

Q. Is this a picture of the cover of your recent

book, Professor McAfee?

A. It is. Or the dust jacket I guess.

Q. And what does this book relate to?

A. It's a book on business strategy that's useful for teaching both graduate and undergraduate courses on the economics of strategy.

Q. And I take it this is a book that you've recently completed?

A. Yes. It came out in December of 2002.

Q. Now, in addition to your own writings, have you ever edited the work of other economists?

A. Yes. For over nine years I was a coeditor of the American Economic Review, and this is the -- among peer-reviewed economics journals, this is the one that has the most subscribers, and I think by more than a factor of four. AER has four times as many subscribers as the next leading peer-reviewed economics journal, and so it's one of the most important economics journals.

Q. And can you explain what you mean by the term "peer-reviewed"?

A. Yes. So I guess perhaps the best way to explain it is in terms of the well-known phrase "publish or perish."

Generally, as a professor, you're expected to

publish in journals where the work is edited by or considered by -- considered for publication by other academics, and "peer-reviewed" means that it's gone through a scholarly process where it's been checked by other experts, so as opposed to a magazine where the articles are written by people who work for the magazine.

Q. In addition to the work that you did as a coeditor of the American Economic Review, have you served as an editor of any other economics publications?

A. Yes. I'm currently -- actually I'm also an associate of the American Economic Review. I was a coeditor, which meant that I handled a quarter of all of the manuscripts they process. Now as an associate editor I handle way fewer than that.

I'm also an associate editor of the Journal of Economic Theory, which, even though the name is associate editor, it's actually more like a coeditor except there are forty of us, approximately forty of us, so I handle, again, a much smaller volume of manuscripts for that journal, and it's one of the leading journals in economic theory.

Q. Are you a member of any honorary societies relating to the field of economics?

A. Yes. I'm a fellow of the Econometrics Society.

Q. What is that?

A. Econometrics Society is probably the leading group of economists who deal with economic theory and econometrics. Econometrics is the study of economic statistics, and this is sort of one of the leading societies, and a fellow is an elected, honorary position.

Q. In addition to your academic work, have you during your career done any type of consulting work?

A. Yes. I've consulted on a variety of antitrust matters.

Q. And other than consulting on antitrust matters, what other type of consulting work have you done?

A. I've done a good bit of auction work and I've advised companies with respect to auctions. I've also advised the federal government and governments in other nations about how to auction the radiofrequencies or the spectrum, the radio spectrum.

Q. Let me start with antitrust-related consulting.

JUDGE McGUIRE: Let me inquire here. I'm not sure what you're talking about, sir. You said you've done some auction work. What exactly are you -- can

you tell me what you're talking about in that regard?

THE WITNESS: Sure. I'm quite proud of it and I'm happy to talk about it further.

In 1994, the federal government, the Congress, passed a law that required the Federal Communications Commission to auction the rights for the next generation of cellular phones, which are called the PCS phones.

And the Federal Communications Commission didn't know how to do this, they had never run any auctions, and so they sought the advice of companies and companies, not knowing anything about auctions, sought the advice of academics, and because one of my articles was actually cited in a congressional report, they came to me.

In the end, three of us, two professors at Stanford and myself, designed the auctions which have now been used to raise over $20 billion for the federal government. These are sometimes called the FCC auctions.

JUDGE McGUIRE: Okay. We don't have to go quite to that extent. I just want to make sure that when you talk about auctions, it's in its everyday parlance and it wasn't something that I wasn't aware of.

THE WITNESS: Yes, it is.

JUDGE McGUIRE: All right. That's fine.

You may proceed.

BY MR. ROYALL:

Q. Just to be clear, we don't need to go into detail on this, but the consulting work you said you did for foreign governments, was that relating to similar-type auctions?

A. Yes. I sold spectrum for cellular phones and also for microwave spectrum, which is communication, terrestrial communications, in Mexico, and we raised $1.1 billion for the Mexican government.

Q. Now, putting aside consulting relating to auctions, you said that you had done consulting work relating to antitrust.

Was any of that -- has any of that consulting work involved work in which you were retained by a government agency?

A. Yes. In particular, I've worked extensively with the Federal Trade Commission on several different merger matters.

Q. Can you give an example of a merger matter or some merger matters that you've worked with the Federal Trade Commission on?

A. Yes. The FTC retained me to help them analyze

the Exxon-Mobil matter, which at the time was the biggest merger ever proposed. And I provided expert advice on that merger, which ultimately was not challenged.

They also hired me to provide advice on the BP-ARCO merger, which at the time -- well, in fact maybe even still today but which at the time turned out to be the largest merger ever challenged by a U.S. government agency.

Q. Other than this case and other than the merger matters that you've worked on with the FTC, have you worked with the FTC on any other consulting-related matters?

A. Yes. Phillips-Conoco. Monster-HotJobs, which was a proposed merger that was ultimately not consummated by two on-line employment companies. And there might be other matters that I --

Q. Are there any nonmerger matters other than this case that you've worked with the FTC on?

A. I'm forgetting as I sit here.

Q. Okay. Let me ask you this.

Have you ever testified before Congress?

A. Yes. I actually have testified twice before senate subcommittees.

Q. And on what issues?

A. And that actually now prompts me on whether I helped the FTC on other matters.

Yes, I helped the FTC on midwest -- in the year 2000 or 2001, gasoline prices went to $2.50 in Chicago, and there was an investigation. The FTC launched an investigation, and I assisted in that matter and ultimately testified before Congress before two congressional subcommittees on gasoline prices, one specifically targeted to the midwest gas price hike and one more generally on the determinants of gasoline prices.

Q. Now, I've asked you about your government-related or some of your government-related consulting experience.

Have you also consulted with private parties?

A. Yes.

Q. And relating to antitrust matters?

A. Yes. I've worked on a variety of matters, antitrust matters, for the private sector.

Q. And your antitrust-related consulting, has it extended to more than one industry or has it been focused in only to a particular industry or small group of industries?

A. No. Actually it's been quite broad. I've worked on software. I've worked on defense-related

matters, that is to say, military weapons systems. On pulp and paper. I've worked on a variety of matters. Lead.

Q. Are you currently affiliated with any private consulting firms?

A. Yes. I work with two firms, Market Design, Inc. and KeyPoint Consulting.

Q. And do you have an ownership interest in either of these firms?

A. I have an ownership interest in both of them.

Q. Have you ever testified before in litigation?

A. Yes. I've been deposed about a dozen times and testified twice in court.

Q. In what types of cases have you testified?

A. One was for the pulp and paper industry and the other one was in real estate.

Q. And what was the nature of the legal dispute, as you recall?

A. The pulp and paper case was a merger and it was -- my role was an analysis of everything from market definition to remedies.

And in the real estate matter, I was actually testifying on admissibility of economic testimony.

Q. At some point in time I take it you were contacted by FTC attorneys about litigation or

potential litigation against Rambus; is that correct?

A. Yes, that's correct.

Q. Do you recall when that was?

A. Yes. It was in the spring of last year. And I believe we have a -- we have a --

Q. We have another slide here. This is DX-121 I believe.

JUDGE McGUIRE: Correct.

BY MR. ROYALL:

Q. And the slide that has just popped up -- by the way, the slides -- have you brought slides with you today for purposes of your testimony?

A. I have.

Q. And this particular slide, as the title suggests, relates to your assignment. You mentioned you were retained in the spring of 2002.

At the time that you were first contacted by the FTC in the spring of 2002, to your knowledge, had the FTC already instituted litigation against Rambus?

A. I don't believe so.

Q. At the time that you were contacted, did you have an understanding of the purpose for which the FTC attorneys were contacting you?

A. Yes, I did.

Q. And what was your understanding?

A. Well, that's -- I set this out on a slide to remind me of the -- as an aide-memoire. It was, broadly speaking, to conduct an economic analysis of Rambus' conduct.

Q. Before getting to the substance of the slide, I'm going to ask you just a few more questions.

You obviously agreed to be retained; is that correct?

A. I did, yes.

Q. And have you been working with the FTC on the Rambus matter since roughly the spring of 2002?

A. That's correct.

Q. Have you been paid for your work?

A. I have.

Q. Are you paid on an hourly basis?

A. Yes, I am.

Q. And what is your hourly rate?

A. $400 an hour.

Q. Is that the normal rate that you charge for consulting services?

A. I have a government rate and that is my normal government rate.

Q. In your work on this matter, have you received any support or assistance from any consulting firm?

A. Yes. From KeyPoint Consulting.

Q. What type of assistance have you received from KeyPoint Consulting?

A. KeyPoint Consulting has several -- well, actually they have a variety of talent. They have everything from Ph.Ds in economics to people with bachelor's degrees on the other end, and I've received a variety of economic help.

Q. To your knowledge, has the staff at KeyPoint, the staff members that have assisted you, have they been compensated as well by the FTC for their work?

A. Yes. They are compensated in the same manner, in the sense of hourly.

Q. Now, getting to the slide, when you were retained by the FTC, were you asked to take on any particular assignment?

A. Yes. Broadly speaking, I was asked to conduct an economic analysis of Rambus' actions.

Q. And does this slide reflect the nature of the initial assignment that you were given by the FTC attorneys when they retained you?

A. It does. In addition to a broad economic analysis, I was to analyze the competitive nature and the competitive effects of the conduct and determine the appropriate remedies.

Q. And in describing your assignment here, you've

referred a couple of times to Rambus' alleged conduct or to alleged actions.

In conducting the work that you have been asked to take on in this case, was it important for you to have or to develop an understanding of what conduct Rambus was alleged to have engaged in?

A. Absolutely. That would be -- that would form the starting point of an analysis, would be the conduct.

Q. And can you just elaborate on what you mean by the conduct forms the starting point for the analysis?

A. Well, as I understand the question, the questions I was asked by the Federal Trade Commission, to perform an economic analysis, I'd have to have something to analyze.

In this case it's the conduct of Rambus in the setting of the marketplace in which it operates, and so the alleged conduct is very much the starting point of economic analysis of, for example, the competitive effects of the conduct. I have to understand conduct to understand competitive effects, for example.

Q. And what, if anything, have you done to gain an understanding of what conduct Rambus is alleged to have engaged in?

A. Well, I've done -- in addition to reading the

complaint, I've done a great deal of work to appreciate just how Rambus has behaved in this market and the nature of its actions.

Q. But are you here to testify as a fact witness as to what Rambus may have done or not done?

A. No, I'm not.

Q. And when you say that you've conducted an investigation into the facts relating to Rambus' conduct, is that for the purpose of conducting an economic analysis?

A. Yes. Generally an economic analysis -- the conclusions of an economic analysis are only going to be as good as the assumptions on which they're based, and so it's important to base your assumptions on what will prove to be correct or what will be demonstrated to be true, that is, to have correct assumptions.

Now, my role is to reason from the assumptions to the conclusions, but it's important for the conclusions to be valid, that is, valid in the actual circumstance as opposed to just valid given the assumptions, that the assumptions be correct.

Q. Well, and have you in fact made assumptions as to the nature of the conduct that Rambus is alleged to have engaged in, that is, the nature of the conduct that you understand to be the focal point of the FTC's

claims?

A. I have.

Q. And what is your understanding in that regard?

I believe you may have a slide relating to this as well.

A. Yes, we have a slide.

Q. And that will be DX-123 I believe?

JUDGE McGUIRE: No. 122 I think.

MR. ROYALL: I'm sorry. Is it 122?

BY MR. ROYALL:

Q. Now, can you explain to us, generally speaking, before we get into any details, what this slide is intended to show?

A. So the first part of this slide sets -- so broadly speaking, this slide is about the FTC allegations. These are my understanding of the allegations. Actually let me -- that's the answer to your question.

Q. In each of the bullet points here, are each of these bullet points assumptions that you are making, or do any of these bullet points reflect conclusions or opinions that you're offering?

A. Some of these bullets are assumptions and some are conclusions, and I'm happy to explain.

Q. Please do.

A. The -- for example, the first one, the subversion of the open standard-setting process, that's an assumption that's a factual matter.

Q. Can I stop you there? Why don't we go through them one at a time.

You say that that's an assumption about facts.

To be very clear about this, are you here to testify as to what JEDEC's rules do or do not require?

A. I am not.

Q. Are you making assumptions as to what JEDEC's rules do or do not require?

A. I am.

Q. What assumptions are you making?

A. Well, actually the assumption I'm making in this part is not specifically about what JEDEC's rules do or do not require but, rather, that Rambus did not -- that Rambus violated whatever rules or expectations that -- or actually the process, whatever process, that Rambus took actions which subverted the process.

Q. That is your assumption?

A. That is my assumption.

Q. And do you assume anything as to the manner in which Rambus took actions to subvert the JEDEC process?

A. Well, it's through the non -- it must be -- in order for my conclusions to be valid, it must be related to their intellectual property and in particular to the nondisclosure of their intellectual property. This will I think come out very clearly as we -- when we go through the analysis.

The assumption is that Rambus withheld its intellectual property and that JEDEC -- that JEDEC in essence reacted to that lack of knowledge.

Q. Let's go to the second bullet here.

Does this reflect an assumption that you are making for purposes of your economic analysis?

A. Yes, it does. I have no -- as an economist, I have no independent ability to look at a DRAM and say that it contains intellectual property, nor can I actually appreciate the patents, so I'm assuming that the JEDEC standards do in fact incorporate Rambus intellectual property.

Q. And are you assuming that Rambus has patents over the intellectual property or technologies incorporated in the JEDEC standards?

A. Yes, I am.

Q. Let's go to the third bullet.

Does this relate to an assumption that you are making for purposes of your economic analysis?

A. It does. I am assuming that Rambus is attempting to enforce these patents against the manufacturers of JEDEC-compliant DRAM and also against -- it doesn't say this on the slide, but it's also against the manufacturers of controllers and the like.

Q. You use the term in this bullet "JEDEC-compliant DRAM."

Are you making assumptions as to whether products produced by DRAM manufacturers that purport to comply with JEDEC's SDRAM and DDR standards do in fact comply with those standards?

A. No. I have no ability to ascertain whether they do or do not and I would have to assume that they were complying with the JEDEC standards.

Q. And are you in fact making such an assumption?

A. Yes, I am.

Q. Turning now to the fourth bullet point, does this bullet point relate to facts that you are assuming or is this reflecting an area in which you are offering an economic expert opinion?

A. This is solidly inside the realm of economic analysis; that is, given the assumptions, one of my conclusions will be that Rambus' behavior eliminated alternatives.

Q. I don't know if you need a glass of --

MR. STONE: Your Honor, may I rise? If I can, I don't mean to interrupt taking a drink of water, but this last answer does raise the issue directly of your in limine.

If Professor McAfee is going to testify, as he suggested now, that certain alternatives were commercially viable, if that's an opinion he's going to render, as this testimony we just heard suggests, that runs exactly afoul of Your Honor's order, which says that he is not permitted to testify to any aspect of the cost or performance of alternative technologies.

I can understand that he might assume that there are alternative technologies that were commercially viable, but Your Honor has directly ruled and his prior testimony has established he doesn't have the expertise to opine as to whether they were or were not commercially viable, and we just heard him say that that's something he intends to give an opinion on. He says it's solidly inside the realm of economic analysis.

JUDGE McGUIRE: Any response, Mr. Royall?

MR. ROYALL: I'm sorry, Your Honor. I'm looking to see if I can identify the portion of your

motion in limine ruling Mr. Stone is referring to.

JUDGE McGUIRE: All right. Take a moment.

MR. ROYALL: Could I have a moment?

JUDGE McGUIRE: Sure.

MR. ROYALL: Thank you.

(Pause in the proceedings.)

Your Honor, I think that Mr. Stone may be misreading your order. Your order, as I read it, denies the aspect of their motion in limine relating to cost and performance of alternative technologies. I believe that's right.

MR. STONE: Well, let's just proceed and see where we go, Your Honor.

JUDGE McGUIRE: All right. Very well.

BY MR. ROYALL:

Q. The purpose of this slide, as the title suggests, is to reflect your understanding of the FTC allegations; is that right?

A. That's correct.

Q. And I think that the point that you were making earlier, just to reorient us, is that some of these bullet points, although they reflect your understandings, some of them squarely fall in the areas where you are making assumptions, you're not expressing any conclusions, and then some of them fall by contrast

in the area in which you are expressing conclusions; is that right?

A. That's correct.

Q. And so of the five bullet points here, the first bullet point that falls into that area where not only is this your understanding of the FTC's allegations but it relates to conclusions that you reached, the first of those bullets is this fourth bullet that we just discussed; is that correct?

A. That is correct.

Q. Okay. Now, going on then to the final bullet, does this relate to an assumption that you are making or does this fall into an area where you are reaching economic expert conclusions?

A. This is in the area of economic conclusions.

Q. And can you elaborate within the context of what's stated in this fifth bullet point?

A. Certainly. Assessing the extent of competition and harm to competition and the levels of competition and assessing the monopolization are things that industrial organization economists do as part of their ordinary practice.

Q. And in connection with this fifth and last bullet point, are you purporting to offer conclusions as to legal issues?

A. No, I'm not.

Q. Is there any aspect of your testimony in which you are purporting to offer legal conclusions of any sort?

A. I am not.

Q. Are these the only -- the issues that are identified here in this slide, are these the -- is this the full extent of your understanding of the FTC's allegations?

A. No. These are what I took to be the five major ones, most important ones.

Q. Now, you've explained that you're not here to testify as a fact witness but, rather, as an expert in economics.

What economic issues have you sought to address through your work on this matter?

A. Well, I've actually organized my inquiry around answering a set of questions which --

Q. Could we have the next slide.

Now I believe we are at DX-123.

What, very generally first before we go into the substance, what is this slide meant to show or to display?

A. As part of performing an economic analysis and for the Federal Trade Commission, I tried to set the

project of performing an economic analysis into stages. And this sets out a, if you want, research methodology or a program for understanding, for addressing the question of assessing the competitive effects and remedies associated with Rambus' conduct.

Q. And who developed these particular questions that are listed in DX-123?

A. Well, I did working with my staff.

Q. And are these in fact the economic issues that you have sought to address through your work on this matter?

A. Yes, they are.

Q. Let's start with the first question, which relates to relevant antitrust markets.

Could I ask you first of all to explain what you mean by the term "relevant antitrust markets."

A. So a relevant antitrust market is -- it defines the context of an economic industrial organization analysis. It identifies the products and the firms that produce those products that are the relevant players for the analysis.

And the purpose here is to identify who are the important players and who can be safely ignored and what are the important products, the relevant products, and what products can be safely ignored.

And so this is generally the starting point because it provides the context, if you want, it draws the boundaries around the inquiry and sets the scope of the analysis.

Q. And are relevant antitrust markets or the definition of relevant antitrust markets, is that something that's important in any economic analysis relating to antitrust?

A. Yes. Virtually every antitrust analysis starts with the definition of relevant markets.

Q. And let me ask you to go on to the second key economic question and explain what the nature of this question is and why you regarded it as an important issue.

A. Actually can I add to the relevant markets?

Q. Yes, please.

A. I think it's actually correct -- well, certainly it's the case that in almost every case that I've worked on, my starting point was the development of the relevant antitrust markets; that is to say, this is what one normally does when one performs an economic antitrust analysis.

Q. And by that you're referring to your prior experience in consulting with the government or with private parties on antitrust issues?

A. That's correct.

Q. Now, going to the second key economic question here, let me explain -- let me ask you to explain what the nature of this question is and why it was important to you to focus on this question for purposes of your economic analysis.

A. So what this question is about is assessing whether Rambus has power, market or monopoly power, in the markets defined in question 1. And the reason that that's relevant is a firm without market power, that is, a firm that's normally considered to be a competitive firm, that being the alternative of a firm with market power -- I should say economists use the term "competitive" in a somewhat specialized way because generally that means perfectly competitive when you say "competitive" as opposed to just aggressively competitive.

A firm that lacks market power has no ability to set terms of trade, to influence the evolution of a market. It doesn't have control of any major aspects of that market.

And so consequently, in order to -- in order for there to be any relevant conduct, a firm has to have power in the marketplace, and so it's important to assess whether a firm has market or monopoly power

because, absent that, the firm would have no ability to influence the evolution of that marketplace and to set the terms of trade.

Q. You used two terms here I believe, "market power" and "monopoly power." Is there a difference between those two things?

A. Yes. Monopoly power is a strong form of market power.

There's some ambiguity in the way economists use these terms; that is to say, there's not a complete agreement or consensus on the use of these terms. But I think there's a widespread -- all economists use "monopoly power" to be a stronger term and generally to involve durability; that is to say, the market power will persist.

And also it must be -- in order to be monopoly power, it must be significant. That is, one can imagine having a tiny degree of market power, but a tiny degree of monopoly power is an oxymoron.

Q. Let's move to the third key economic question, and let me ask you the same questions as I asked before: What do you mean by this question, what is the nature of this question, and why did you find it important to your economic analysis?

A. And let me start by saying what is exclusionary

conduct. Exclusionary conduct is generally understood by economists to mean behavior or conduct that would exclude an equal or superior competitor from the marketplace.

And so exclusionary conduct is -- and the reason economists care about that is generally having more and better competitors is good for a marketplace, but having inferior competitors may or may not be good, but you can't certainly conclude that it's good for a marketplace.

And so economists are worried about the exclusion of equal or superior competitors because those will tend to harm competition.

And the reason for question 3, that is to say, was the acquisition of market or monopoly power through a process of exclusionary conduct, the reason that matters is, from an antitrust perspective, economists would not want to deter firms from, say, building a better mousetrap and having a superior product and thereby acquiring market or monopoly power. Not only is there no harm to competition in such circumstances, there's actually a benefit to competition in those circumstances.

Instead, economists are concerned about exclusionary conduct, that is, conduct that -- not

through building a better mousetrap but conduct that actually excludes a superior or equal competitor from the marketplace.

Q. Now, going to the fourth question, can you explain the nature of that question and why it was important to your economic analysis?

A. Yes. In principle, one can have acquired monopoly power through exclusionary conduct and it still wouldn't matter because -- either because the marketplace was so small that it was an insignificant marketplace or there was no potential for damage to the marketplace through the conduct.

And so this is -- question 4 is about an assessment of what were the effects to the marketplaces of this acquisition of monopoly power.

Q. And what do you mean by the term "threatened" or "threatened harm" or "threatened effects"?

A. In some cases the harm may not have been experienced yet; that is, it may appear to lie in the future. Some kinds of damages take a long time to be felt, and so "threatened" refers to the potential for future damages.

Q. And finally, if I could ask you to explain the nature of the fifth key economic question and why you found that question to be important to your economic

analysis.

A. Well, given a finding of harm, one of the natural questions for industrial organization economists is what can you do about it. In fact, much of industrial organization is focused on the question of how to make marketplaces work better.

And so a natural question given a finding of harm is, well, what can be done about it, and that's what that question is about.

Q. Without going into detail at all but just generally speaking, do you personally, Professor McAfee, have experience in addressing the types of economic questions that you've identified in this slide?

A. Yes. All five of these questions have come up in multiple cases on which I've worked.

Q. And does your expertise in industrial organization bear on these issues?

A. It does. As I mentioned, this would be a normal part of an industrial organization analysis.

MR. ROYALL: Your Honor, at this time I would proffer Professor McAfee as an expert in the field of industrial organization economics.

MR. STONE: No objection, as so stated, Your Honor.

JUDGE McGUIRE: I'm sorry?

MR. STONE: I have no objection to him being qualified as so established.

JUDGE McGUIRE: Then he shall be qualified in the area noted. And I'm sorry. Again, Mr. Royall, that was in the area of industrial organization?

MR. ROYALL: Yes. Industrial organization economics.

JUDGE McGUIRE: And economics? Industrial organization economics.

MR. ROYALL: Yes. Yes, Your Honor.

JUDGE McGUIRE: Okay.

MR. ROYALL: The field of economics that he has testified that he specializes in.

MR. STONE: I didn't mean to interrupt. I think I might have misspoke. I meant to say I had no objection to him being qualified as so described.

JUDGE McGUIRE: I understand.

MR. STONE: I think I misspoke.

JUDGE McGUIRE: I understood.

BY MR. ROYALL:

Q. Now, Professor McAfee, let me ask you if you could, now that we've identified or you've identified for us what you believe are the key economic questions relating to your assignment in this matter, let me ask

you if you could describe for us or begin to describe for us the type of work that you have done in addressing these key economic questions.

A. The starting place for an analysis of these questions is an understanding of how the marketplace works, and so my first efforts at working and in fact continuing efforts at understanding this marketplace or answering these questions is to understand how the marketplace operates.

And so in that regard, I've read a very large amount of material, I talked to a lot of people, and I've generally tried to get a sense of what determines outcomes and what determines choices and how choices are made in this marketplace from an economic perspective.

Q. And as part of that work, did you interview anyone?

A. Yes. In fact, let me correct a typo on this. This should say "DRAM plant manager." I believe I interviewed only one plant engineer.

But I spoke with DRAM engineers, with a DRAM plant manager, with JEDEC participants and with DRAM users.

Q. And just to identify the slide that we now have up, I believe it will be marked as DX-124.

Before I ask you about these particular interviews that you conducted, let me ask this.

Is it common for economists in addressing the types of issues that you identified to conduct interviews?

A. Well, it's certainly not uncommon. It's pretty common. That would be -- the purpose here is to understand the economic determinants of the marketplace, and talking with market participants would be a natural way to gain an understanding of how the marketplace operates, and so yes, that would be a normal thing to do.

Q. Well, in referring to the types of people that you identify here as having interviewed, let's take the first item, DRAM engineers. What.

Was your purpose in interviewing DRAM engineers?

A. Well, we haven't of course gotten to my market definition yet, but the markets at issue here are technology markets, and so participants in technology markets are often engineers, and I need to understand the influences on those engineers.

Q. And what was your purpose in interviewing the DRAM plant manager that you mentioned?

A. Well, we'll talk about the economics of DRAM

production at some length, and a plant manager is well-positioned to have an appreciation of the economics of production of DRAM.

Q. Have you ever seen DRAM being produced or the production process? Have you ever seen that in person?

A. Yes. I've toured the Infineon plant in Virginia.

Q. You did that as part of your work on this case?

A. I did, yes.

Q. And why was it important for you to actually -- or why did you deem it important to personally tour a DRAM production facility?

A. Well, I don't want to say it was absolutely essential to tour it. It was certainly useful to see it because it's one of the most extreme production processes in the United States in the sense of the investment on a per-worker basis is about as large as investments in plant and equipment ever get.

Q. And that's something that touring the plant helped you to appreciate better?

A. Absolutely.

Q. The next item, JEDEC participants, what was your purpose in interviewing JEDEC participants?

A. Well, to foreshadow the conclusions, JEDEC wields a large amount of influence in the selection of standards -- and there's been a great deal of trial testimony to that effect -- in the selection of standards which are then adopted by the marketplace, and so understanding the incentives of JEDEC participants is an important part of an economic analysis of this marketplace.

Q. And finally, DRAM users you mentioned on this slide, DX-124.

What was your purpose in interviewing DRAM users and what do you mean by the term "DRAM users"?

A. Well, there are two levels of DRAM users. There are the people who put DRAM in the devices, which tend to be companies, and then there are ultimately consumers and businesses that buy computers and fax machines and other devices that have DRAM, and so there are really two levels of DRAM users.

Economists are very much all about supply and demand. The users are actually the demand side of the equation and it's important to appreciate their motivations or -- not motivations -- their incentives in terms of product and I will use my knowledge of DRAM users in several spots.

Q. In addition to conducting interviews, did you

have occasion as part of your work to review or rely upon any written materials?

A. Yes. I think of all the cases in which I've worked, I've read -- and that includes Exxon-Mobil -- I read more materials for this case than any other, and it's a very large volume of documents and that's summarized on this slide.

Q. Just to identify, the slide that's now on the screen would be DX-125, which has the title Materials Reviewed and Relied Upon.

Before asking you about a couple of these items, let me ask, to follow up on your last answer, why is it that you found it necessary in this case to review such a large volume of written material?

A. Well, partly because it spans a very long period of time, partly because there are multiple levels of markets, so that is to say -- let me give a thumbnail big picture, if you will.

To understand the technology markets you need to understand the demand for technology which is derived actually from the marketplace for the physical product. And so then that proved necessary to understand the or gain an understanding of the DRAM market as opposed to the technology markets that are inputs to the DRAM production process.

To understand the DRAM market you have to understand the products in which DRAM is used, and so computers and the like and the determinants of economic performance of those markets, and so it wound up being a large number of markets, which in many cases operate in a fairly complicated way, and so I think that would be the reason -- that would summarize the reason why it took more investigation to reach conclusions in this case.

Q. And in terms of the nature of the written materials that you reviewed and relied upon, let me ask you about that.

The first item on DX-125 refers to business records from Rambus and third parties.

Is this referring to records produced in the litigation?

A. It is.

Q. And taking Rambus first, did you review a large volume, a small volume? How many Rambus internal business records did you review?

A. Well, it's certainly a large volume. I don't -- it's been over the course of more than a year, so I don't actually -- I'm not sure how large a volume it is. The set of documents occupies -- that I personally reviewed -- and I should say my staff also

reviewed documents, but I'm only relying on the documents that I personally reviewed.

But the set of documents that I personally reviewed fills at least ten Bankers boxes.

Q. What was your purpose in reviewing so many Rambus internal business records?

A. Well, part of it is just being careful and having a good appreciation, but Rambus business records are generally very important to making correct assumptions about conduct, for example. And Rambus itself had an understanding of the marketplace which was an input to my understanding of the marketplace.

So there are a variety of uses for Rambus business documents.

Q. And you reviewed third-party business documents as well?

A. That's correct.

Q. And just generally speaking, what was your purpose in doing that?

A. Again, my goal is to achieve a correct understanding of the economics of these -- of the various relevant markets, and these are participants in those markets and they have useful information.

Q. The next bullet point on this slide, DX-125, refers to minutes and presentation materials from JEDEC

meetings.

Why was it important to your economic analysis to review written materials of that sort?

A. Well, I believe I've already said that JEDEC wields an important influence in selection of technology in the DRAM marketplace, and so the way that JEDEC makes decisions and the issues that arise in the making of those decisions are quite relevant for an economic analysis.

Q. The next item refers to, first of all, deposition testimony.

Are you referring here to depositions that were taken in this case?

A. In this case and also in earlier related cases.

Q. And do you have any idea how many deposition transcripts you've reviewed for purposes of your work on this matter?

A. A very large number. It's a very large volume. But I can't, as I sit here today, tell you how many that is. It's more than twenty.

Q. And was your purpose in reviewing depositions similar to your purpose in reviewing the business records of Rambus and third parties?

A. Absolutely.

Q. And trial testimony, are you referring to the trial testimony in this case?

A. Yes. I've also read trial testimony from the Infineon trial, but what I was specifically referring to was the trial testimony in this case.

Q. How much of the trial testimony in this case have you reviewed, if you can say?

A. I've read all of it up to but not including this week.

Now, let me add one exception. Mr. Vincent's -- I gather that some of -- that something was read of his into the record?

Q. And you haven't seen that?

A. Well, I've seen the listing of things that were read but not the actual what was read into the -- but otherwise, it's up through but not including Terry Lee.

Q. Skipping down to the last item, which refers to publicly available materials, trade press, analyst reports, et cetera, what was your purpose in reviewing this type of material?

A. Well, this includes a large variety of types of information, so this includes everything from analyst reports, which may -- you know, the analysts may be very well-informed or may not be so well-informed,

and -- but other -- it includes company sources, which often have biases in them. It includes the trade press, which is probably unbiased on average, but there are -- it's all over the map in terms of its reliability.

And so the purpose -- but there's often useful information on average in the trade press and in the analyst reports, and so I reviewed a large volume of this to get a picture, although there's a lot of noise in that information as well, and so in order to eliminate the noise you have to read actually a pretty large amount of it.

And the purposes again are the same. It's to understand the economic determinants of behavior in the marketplaces.

Q. And besides the interviews that you conducted and you talked about the written materials that you've reviewed and relied upon, were there any other things that constituted a portion of your underlying work on this matter?

A. Well, actually are you skipping ahead out of this slide? Because I also read a book on semiconductor manufacturing which gave me a picture, maybe a bit dated, a book called Microchip Fabrication.

Q. Are you referring -- is that something that

comes up under the second to last bullet?

A. Yes, it does.

Q. And what was your purpose in reading the book on microchip fabrication?

A. It was to understand the -- well, partly it was just to be able to read the deposition testimony and to have an appreciation of what the witnesses are talking about when they talk about the process.

Q. Now, actually before we do leave this slide, let me also come back and ask you, when you refer to reports of FTC and Rambus experts, indicating I assume that you reviewed those, is that limited to the economic experts or does that extend to other types of experts?

A. No. I think I've read the reports of all of the experts, including the technical experts.

Q. And what was your purpose in reviewing the reports of the technical experts, the FTC and Rambus technical experts?

A. Well, again, my purpose is to understand economic influences on this market, but the economic influences are very much determined by the technology and the available technologies, and so in order to have an appreciation of the economic choices that these markets make, I need to understand the technical

constraints or at least to have an appreciation of the technical constraints that the market participants face.

Q. And did reviewing the reports of either the FTC's or Rambus' technical experts factor into assumptions that you've made for purposes of your economic analysis?

A. Well, they're certainly part of the information that on which I base my assumptions.

Q. Now, going back to the question I asked earlier, other than materials that you've reviewed and the interviews you've conducted, were there any other things that constituted a portion of your underlying work on this matter, any other types of work?

A. Well, one of the things -- so one of the things that I've done in order to -- that I and my staff have done, because I had assistance with this, in order to -- it's more in the form of summary rather than information collection -- is to produce what's known as a case study, which is --

Q. Can I ask you, what is a case study?

A. A case study is a generally chronological analysis of the evolution of a firm or a market, and so a typically chronological presentation of who did what when but with explanations and analysis associated with

it.

Q. And is a case study, is that a methodology that is used by industrial organization economists?

A. Yes. And also with business strategists. Actually both groups use a case study as a common tool for analysis of an industry or a firm.

Q. And what was the nature of the case study that you conducted as part of your work on this matter?

A. This case study looks at the evolution of DRAM technology and standards in the period 1990 to, roughly, 2000.

Q. And for what purpose did you find the need to conduct a case study focusing on that issue, the evolution of DRAM technology and standards?

A. So there are many uses. Partly it's a way of documenting and understanding the determinants of the -- the economic determinants of the marketplace choices.

So it's a way of ensuring that -- it's a way of organizing all of the information that's been collected and putting it in a framework that makes it possible to actually draw broad conclusions from it and also a way of ensuring that you do understand how it -- how the marketplace outcomes are determined.

And so for example, if there were lots of

sources that contradicted the case study, that would show up in the process of trying to organize all that information into a coherent framework.

Q. Did you, in connection with your work on this matter, Professor McAfee, did you prepare an expert report?

A. I did.

MR. ROYALL: Your Honor, may I approach?

JUDGE McGUIRE: Yes.

MR. ROYALL: Would you like a copy of this?

JUDGE McGUIRE: Yes. Thank you.

BY MR. ROYALL:

Q. Professor McAfee, I've just handed you a document.

Do you recognize this?

A. Yes. It appears to be a copy of my expert report.

Q. And who wrote this report?

A. I wrote this report with the help of my staff at KeyPoint Consulting.

Q. And the case study that we were discussing a moment ago, is that included as part of this expert report?

A. Yes, it is. It's Appendix 3 to the report, which is the last roughly or just under 200 pages I

think of the report.

Q. I think if you started from the back and you thumb up to the page, the first page 1, would that be the beginning of the case study?

A. That's correct.

Q. And so it's roughly -- it looks to be around 187 pages?

A. I think that's correct.

Q. And that 187 pages is the description of the chronological analysis of the evolution of DRAM standards that you were discussing earlier?

A. It is.

Q. And does your report contain a copy of your resume?

A. It does.

Q. Let's see if we can identify that.

A. I think that's Appendix 1.

Q. Yes, Appendix 1.

So it's slightly more than an inch into your report, Appendix 1. That's a copy of your resume. Do you see that?

A. That's correct.

Q. Is this a current resume?

A. No. Pardon me. No, it's not. In fact, I think my second child was born about two weeks -- I

have my children listed on my resume and my second child was born about two weeks after the report was filed. She is not listed.

Q. So it's not updated in this version?

A. It is not.

Q. And then everything that comes before the resume, before Appendix 1, this roughly inch stack of paper that I have here, is that your expert report itself?

A. Yes. That's the main body of the report.

Q. By contrast to the case study or Appendix 3 that we mentioned?

A. That's correct. Although the main body of course references and relies on the case study at many points.

Q. And immediately after the curriculum vitae or your resume, there is something entitled Appendix 2?

A. That's correct.

Q. What is Appendix 2?

A. That's a list of all the documents that I relied on and the witnesses that I interviewed and my sources generally.

Q. And are these documents that you personally reviewed and relied on or does this also include materials that your staff reviewed but that you

personally did not review?

A. I've looked at all of the documents relied on for producing the report, and so it's -- these are my -- the documents that I looked at.

Q. And did you at some point produce another report relating to this matter?

A. I did.

Q. And was that a report in response to the expert reports of Rambus' experts?

A. That's correct. It's labeled a rebuttal report I believe.

Q. Now, you can put the report aside for now.

You identified earlier, Professor McAfee, what you have deemed to be the key economic questions in this case or at least the key economic questions that relate to the assignment that you were given by the FTC attorneys when you were first retained in the spring of 2002.

Have you reached conclusions or have you developed expert opinions in response to those key economic questions?

A. Yes, I have.

Q. Now, the first question I believe that you identified earlier, the first -- I've just been handed a note. Before I leave this slide, the case study,

that's DX-126.

The first of the economic questions that you identified earlier related I believe to relevant markets.

And have you reached conclusions as to what market or markets you believe are relevant to an economic analysis in this case?

A. Yes, I have. And I've prepared a slide that sets out the major points of those conclusions.

Q. So that this slide will be DX-127.

And this slide relates to -- it's a summary of the conclusions that you reached on the first of the five economic questions; is that correct?

A. That's correct.

Q. Did you -- you refer in the first point here to four relevant technology markets.

Did you define only four relevant technology markets?

A. I also defined a market that involves all four technologies lumped together, which is more for the purposes of convenience than it is for a strict market definition, but there are -- most of my analysis on market definition is devoted to the four technology markets.

Q. And you say in the second point under the

conclusion heading here that each market consists of commercially viable alternatives for addressing specific DRAM design issues.

Do you see that?

A. Yes. That's correct.

Q. Can you explain what, in this summary slide, what you mean by that language?

A. Yes. Generally, economists in performing market definition are looking for -- start with a product and then look for other products that are price-constraining or influential on the selection of the product in question.

So that is to say, you start with one product and you say suppose you had a monopoly on that product, would that be a valuable monopoly, and the answer is no if there are a bunch of alternatives, and the answer is yes if that product is a valuable monopoly in its own right.

If the answer is no, that is, you haven't reached a market yet, you then add the close substitutes until you come up with a product with its relevant substitutes.

And so the specific language I've used here is that what I'm looking for are the price-constraining or commercially viable alternatives to the -- for the

specific purpose of the product in question.

Q. And each of those commercially viable alternatives that you identify from your analysis you included in the separate relevant technology markets that you defined?

A. That's correct.

Q. And do -- did you reach conclusions as to the geographic scope of these relevant technology markets?

A. Yes. Technology markets usually are worldwide in scope, and that's simply because users of technology typically don't care about the source of the technology, where it originates. Technologies -- in other words, I'm saying technology is easily transportable, has low transportation costs. The technology markets tend to be worldwide.

In this case these technologies are no exception.

Q. Let's go to the next slide, which I think relates to the second key economic question. This would be DX-128.

Can you walk us through in summary form the conclusions that you reached in response to this second question relating to the issues of market and monopoly power?

A. Yes. I find that Rambus does have monopoly

power in each of these four technology markets, and as the slide says, the source of this monopoly power is that the technologies have been incorporated into the dominant standards, so that is to say into the standards that have come to dominate the DRAM industry. Because those incorporate Rambus technology, that provides or confers monopoly power on the Rambus technologies.

Q. In your answer, I think you said that you find that Rambus possesses monopoly power in each of the four relevant technology markets that you identified.

Does that conclusion apply also to the fifth cluster or collective market that you mentioned earlier?

A. Yes. And for the same reasons.

Q. Can you explain briefly the summary conclusion, the second summary conclusion point on this slide?

A. Yes. The source or the origin of the monopoly power is the fact that the -- or actually it's an assumption, but appears to be correct, that the Rambus technology was incorporated into standards which have then by the marketplace come to dominate the DRAM technology.

So that is, the nature of the monopoly power is

the incorporation of the technology into what has then become the dominant industry standard.

Q. And the standards that you're referring to as the dominant industry standards, are those the JEDEC standards, DRAM standards?

A. Yes. That's correct. The SDRAM standards for two of the technologies or -- excuse me -- yes, for two of the technologies and the DDR SDRAM standards for all four.

Q. Let's go to the next summary slide. This will be DX-129.

And this summary slide relates to the third economic question that you identified earlier relating to the issue of exclusionary conduct and whether Rambus acquired market or monopoly power through exclusionary conduct.

Have you reached conclusions on that issue?

A. Yes, I have. I find that Rambus's alleged conduct is in fact exclusionary.

Q. And can -- again in summary form, can you walk us through the basic conclusions that you've reached in that regard?

A. Yes. Providing false or misleading information -- and I will remind you that I'm making assumptions rather than conclusions about the specific

conduct -- but generally in terms of market performance, so that is the economic analysis of false or misleading information, that often has the effect of being exclusionary.

And the reason is false information causes decision makers to incorrectly evaluate the various alternatives they face, and when decision makers are trying to choose the best product, they may fail, they may choose an inferior rather than a superior product because they have incorrect information about the alternatives.

And so the provision of distorted information is often exclusionary, and this case is no exception.

Q. The second bullet point under the exclusionary conduct point relates to exclusion of equally efficient or superior alternative technologies.

How does that relate to your conclusion that Rambus' challenged conduct or what you've assumed to be Rambus' challenged conduct is exclusionary?

A. Again, the definition of "exclusionary" is the exclusion of equal or superior competitors, and so in this case the competitors are alternative technologies and the nature of the exclusion comes about from the provision of misleading or incorrect information.

Q. And then the third subbullet refers to a

conscious choice to jeopardize the enforceability of patented intellectual property.

Do you see that?

A. I do.

Q. How does that point relate to your conclusions that Rambus' challenged conduct is exclusionary in the economic sense?

A. So there is a substantial amount of evidence -- and again, I'm not here to testify about the evidence. I'm relying on the evidence.

MR. STONE: Your Honor, may I interrupt the witness to interpose an objection.

You had said in your in limine order that he would not be allowed to testify about any aspect of the issue that included respondent's state of mind. And for him to go in and say there is a substantial amount of evidence, whether it supports an assumption or a conclusion, is testifying about his evaluation of the evidence on an issue that is clearly within the court's province to decide, Rambus' state of mind, and not something that economists or engineers or others have any particular expertise.

JUDGE McGUIRE: Mr. Royall?

MR. ROYALL: First, I'd ask that Mr. Stone not interrupt the witness' answers to make his objections

because I think his answer would have made clear that he is not speaking as to the state of mind of any Rambus representative or anyone else. He's talking about economic theory that relates to conscious choices and evidence that bears on that economic theory.

JUDGE McGUIRE: I'll hear the testimony and then I'll rule.

BY MR. ROYALL:

Q. Let me go back and re-ask the question, Professor McAfee.

Could you explain how this last bullet point in the list of the three subbullets on DX-129, that is, the point that refers to conscious choice to jeopardize the enforceability of patented intellectual property, how does that point relate to your economic conclusion that Rambus' challenged conduct or what you assume to be its conduct is exclusionary?

A. Perhaps I can best put it this way.

The choice -- it's a -- it would be a very large cost, a very large economic cost, to risk patented technology when you are a firm that deals only in patented technology, when that's your product, and so risking the enforceability of your product would be a very large cost.

If it's found that Rambus in fact did take such a risk, then a natural economic question is why, what was the economic purpose of undertaking such a risk. And I find that the chance of enforcing -- the prospect of creating a monopoly on the JEDEC standards is a compensating gain for undertaking what would be such a large risk.

Q. And does this element to your exclusionary conduct analysis that relates to the taking of risks in this context relating to the enforceability of intellectual property, do your views in that regard have a basis in economic theory or in economic literature?

A. Oh, yes, they do. And in fact, it's quite parallel to the antitrust reasoning on or the economic reasoning on predatory pricing.

The question with predatory pricing is how do you understand -- so let me back up and say what is predatory pricing.

Predatory pricing is charging below cost as a way of driving out competitors or excluding competitors, and so it comes from the exclusionary conduct area of industrial organization.

And the question is why would a firm, why would it ever be rational for a firm to charge below cost,

and the answer is, if you're successful in excluding your rivals, then you can enjoy the fruits of the monopoly; that is, you can recoup the costs you've incurred through the benefits of monopoly. And this is quite a parallel analysis to that.

Q. Now, before we move on to the next slide --

JUDGE McGUIRE: Before we move on, let me rule on the objection. It's overruled in the context of his testimony, and that's an area you can properly take up on cross-examination.

MR. STONE: Based on the answer, Your Honor -- and counsel is right, I shouldn't have interrupted him, and I recognize we don't have a jury here and we can move to strike when it's done -- after I heard the testimony as it was limited, I agree that the objection should have been withdrawn, and if not --

JUDGE McGUIRE: Thank you, Mr. Stone.

Mr. Royall, you may proceed.

MR. ROYALL: Thank you, Your Honor.

BY MR. ROYALL:

Q. Before we go to the next slide, Professor McAfee, let me ask you about the very last item on this slide, DX-129.

Can you explain the point that you're making in that last bullet point?

A. Yes. The nature of the exclusionary conduct is -- operates through JEDEC's standardization process. That is to say, it is the distortion of the information available to JEDEC that is the driver or the basis on which the monopoly power has been obtained.

And so the nature of the exclusionary conduct is the distortion of JEDEC's standardization process.

Q. Now, let's go to the next slide, which corresponds with the fourth of the five key economic questions that you've identified earlier, specifically the question of whether Rambus' conduct or what you assume to be Rambus' challenged conduct resulted in anticompetitive harm, actual or threatened.

Can you explain in summary form the nature of the conclusions that you have reached on that issue?

A. Yes. There are a variety of anticompetitive harms that are created by the monopolization. And some of those are directly in the technology markets themselves. We've seen the prices increased over what they would have been in the relevant technology markets.

Q. And for the record, I believe this will be DX-130.

In addition to the point that you just made

relating to the increase in prices or that effect of -- economic effect of Rambus' conduct, you mentioned several other points. Let me ask you to take each one at a time.

Let's start with the second subbullet that refers to actual or threatened distortions of competition.

Can you explain what conclusions, if any, you've reached relating to that issue?

A. Yes. There are a variety of distortions to behavior that have arisen as a consequence of the -- of a monopolization.

One is that innovation itself has been misdirected. It's been directed in -- it's been directed at an avenue that it would not have been but for the conduct.

Another is that royalties themselves have a -- create a disincentive to further innovation and it's -- a simple way of seeing that is that when a DRAM manufacturer invests in a die shrink or in another way of reducing its costs and hence produces a larger volume, part of the benefits flow to the royalty -- through royalties, so that is, it's a dampening of the incentives to innovation because part of the benefits flow to Rambus.

And so there's a variety of harms to innovation in that way in these technology markets themselves.

Q. In the prior point that we focused on, I believe in response to my question you said that you've concluded that Rambus' challenged conduct or what you assumed to be its challenged conduct has had the effect of substantially increasing prices in the relevant technology markets?

A. Yes.

Q. Was that the point that you made?

A. Yes.

Q. Have you reached any conclusion as to whether Rambus' challenged conduct has had price-related effects in markets for the physical DRAM products themselves as opposed to technology markets?

A. I would put that as it threatens to have that effect. As an economist, I expect it to have a long-run effect.

The nature of DRAM production is such that even a 5 percent royalty would not typically cause them to reduce their current production, and as a result you wouldn't expect to see the current prices of DRAM rise even in the face of a 5 percent royalty.

On the other hand, that such a royalty does

produce a disincentive to further plant building, to going to a larger wafer size and other means of producing more output in the future, and as a result you would expect in the long run that those royalty costs would be passed on to consumers and hence have the effect of lowering output in the downstream DRAM market.

Q. And would the lowering of output in downstream DRAM markets have any effect on price in those markets?

A. Yes. It would have the effect of increasing the price.

Q. And the final point you make in this slide relates to undermining confidence in open standards and standards processes.

Can you explain what you mean by that?

A. Yes. The open standards and standard-setting processes are very important not just in this market but in other markets as well. And the ability for those standards to be monopolized is a threat to the standard-setting process, to standard-setting processes more generally, not just to DRAM standards.

Q. And do you conclude that Rambus' challenged conduct has had such an effect in the markets that you've focused on?

A. Well, let me say that it certainly threatens to.

Q. And let's then go to the final key economic question and the summary of your conclusions on that question. This will be I believe DX-131.

And the question is: What remedy, if any, is needed to restore competition or to alleviate the anticompetitive effects of Rambus' conduct?

Have you reached conclusions relating to that key economic question?

A. Yes, I have.

Q. And can you explain the nature, in summary form, the nature of your conclusions?

A. Well, economists normally start to remedy questions by trying to undo the damage that has been done. That would be the normal benchmark.

In this case, because so much time has gone by, literally, undoing the damage doesn't seem to be feasible, and as a consequence economists go to a second best approach of trying to undo the effects of the monopolization or the effects of the challenged conduct. And here undoing those effects requires undoing the monopolization itself.

Q. I'm sorry. Do you have views from the standpoint of economics as to a manner in which through

a remedy the effects of Rambus' anticompetitive conduct could be undone or mitigated?

A. Yes. If the intellectual property that should have been disclosed -- and I should say I'm not the person to testify as to what should have been disclosed -- but if the intellectual property that should have been disclosed cannot -- the patents on that cannot be enforced against DRAM, that would go -- that would undo the monopolization of those markets.

In addition, that -- those markets are worldwide, and so the enforcement would have to be both -- the undoing would have to be both for the U.S. and for foreign countries.

Q. You mention in this slide, DX-131, you mention a date, June 18, 1996.

What's the significance of that date?

A. Oh, that's my understanding of the date that Rambus withdrew from JEDEC, but I should say that's -- that's a fact as opposed to an economic conclusion.

Q. And how does that fact, understanding that you're making an assumption that that is a correct date, but how does that fact factor into your conclusions as to the appropriate nature or scope of economic remedies to address the anticompetitive conduct?

A. Well, again, it's the -- so this is actually in the nature of an assumption -- is that the -- that what should have been disclosed, the intellectual property that should have been disclosed, was that that was available prior to June 18, 1996. But that's not for me to find.

Q. And finally, the last point that you make on this slide, DX-131, can you explain the point that you're making here?

A. Yes. These remedies will restore competitive pricing because they eliminate the monopolization and they will mitigate in an ongoing sense the anticompetitive effects.

Now, they don't fully undo all the effects because you do have misdirection of efforts as an issue, but they would go very far towards mitigating the effects.

MR. ROYALL: Your Honor, for me this would be a convenient stopping point.

JUDGE McGUIRE: Then let's take a break for ten minutes.

The court is in recess.

MR. ROYALL: Thank you.

(Recess)

JUDGE McGUIRE: You may proceed, Mr. Royall.

MR. ROYALL: Thank you, Your Honor.

BY MR. ROYALL:

Q. Professor McAfee, we've now covered the nature of your assignment, your general understanding, your assumptions about Rambus' conduct, the key economic questions that you've identified, and in a summary way we've covered some of the conclusions that you've reached.

Now I'd like to ask you about the process that you went through in reaching your expert conclusions on these economic issues.

Can you tell me, with all of the information that you've collected and that you've reviewed that you described earlier, what, in terms of your methodology or your analytical approach, what was the first thing that you did or needed to do in order to reach conclusions on the issues that you've identified?

A. The basic starting point is an economic model of the DRAM industry, and that includes the technology industries, DRAM itself and the related devices, and so this is a model -- it's to produce a model and an understanding of how this industry functions, how it operates.

Q. Before we go into the substance of what you

have to say on that, let me ask you this.

Why was it important for you, in reaching conclusions on economic issues relating to this case in the context of the allegations in this case, why was it important for you to develop an understanding or an economic model for competition in the overall DRAM industry?

A. Well, this is the basic tool of economic analysis, is the economic model of the competition and the behavior in these marketplaces, and so this is very much the heart of an analysis, is an understanding or a model of the economic influences and determinants of outcomes in the marketplace.

Q. And when you refer to economic influences, are you -- and determinants, are you referring solely to economic influences and determinants in the DRAM technology markets that you've identified earlier as the relevant markets?

A. No, I'm not. In fact, in order to understand the DRAM technology markets, I need to understand the markets in which those technologies are applied, and that would be DRAM manufacturing and the manufacturers of related products like chipsets. But it doesn't stop there.

In order to understand DRAM manufacturers, I

need to -- and the influences on DRAM manufacturers, I need to understand their customers, and those are -- this is set out in this slide -- are the PC original equipment manufacturers, servers, fax machines, and other uses for DRAM technology.

And in order to understand those market participants, I need to understand their consumers, the people that they sell to, and the -- so the final consumers for the product.

And so ultimately to understand the influences on the technology market, those are all derived -- it's what economists call derived demand -- derived ultimately from the final consumer.

Q. And just to be clear, when as you've said you need to gain an economic understanding of competition at these various levels, is that for the purpose of defining relevant markets or does it relate to other key economic issues that you have identified?

A. It relates to all of the -- I think all five of the issues are related to this. And it's not just for defining markets, because in order to understand the economic incentives in the technology markets, one needs to understand how those incentives were derived or what were they derived from.

Q. We have on the screen now a slide entitled

DRAM Industry Overview. I believe this will be DX-132.

Is that correct, Your Honor?

JUDGE McGUIRE: Yes.

BY MR. ROYALL:

Q. Is this a slide that you've prepared, Professor McAfee?

A. It was prepared under my direction, yes.

Q. And can you walk us through -- there's a diagram here. Can you walk us through generally what this diagram shows and why it's significant to your testimony?

A. Yes. This diagram shows at the top the markets that will be the relevant technology markets and it shows the technology providers. That technology goes directly into two kinds of manufacturing, into the DRAM manufacturers and also into -- the technology also goes into the manufacturing of products that are related to that, so it includes everything from processors to chipsets.

So the same technologies are flowing into both of those markets.

Both of those products are then used in the PC market, in the servers and other products that involve DRAMs, and so that's shown in the third-level box.

Q. And then what does the fourth-level box show? And by that I'm referring to the final bottom level where there's a reference to consumers.

A. It shows that the influences on those companies besides, of course, the technology influences that flow down in this diagram are also derived from the final consumers to which they sell.

So for example, the influences on a Dell, Dell Corporation, are the willingness to pay by the final consumer.

Q. And by "final consumer" here are you referring to commercial consumers or to household consumers?

A. To both. The final consumer includes businesses -- there are PCs all over the room -- and it includes individuals and households.

Q. And in the third level of boxes or figures here you refer to PCs and servers.

Are those products that you understand to use or incorporate DRAM?

A. Yes. I think all PCs have DRAM and servers are actually large users of DRAM as well.

Q. Are there other products that you understand use or incorporate DRAM devices?

A. Yes, there are. And I've prepared a slide.

Q. I'm sorry. This next slide entitled DRAM

Buyers will be DX-133.

I'm sorry. Can you explain what you mean to depict through this slide?

A. Yes. This sets out major uses for DRAM technology in various -- in various different devices, and so you can see that the lion's share goes to personal computers.

Let me say that memory modules -- a memory module is not a final use. It's a device which is then plugged into another device, so if you go to buy DRAM to upgrade your own PC, you buy a memory module which you then plug into your -- onto the motherboard of your PC.

And so that use is going to be distributed among the other uses, but I don't have a specific breakdown of those, of that 19 percent.

Q. And so in addition to personal computers and memory modules, what other types of products are DRAMs used in?

A. Well, there's printers, routers and fax machines, for example, is one category. The workstation is actually a personal computer; it's just a specially brawny personal computer, specially powerful personal computer.

Servers are devices that route Internet traffic

and for that matter they're a specialized kind of personal computer that is used for distributing documents and Internet traffic.

There are other -- you know, mainframe computers are the big machines like IBM makes, Cray. And then there are other uses of DRAM that are relatively specialized.

Q. And to your knowledge, are the same types of DRAM devices used in each of these various applications, or do the types of DRAM devices differ with the application?

A. Well, broadly speaking, the same types of DRAM are used in most of these.

Now, let me say that there are old technology that are used in very low-end devices and there are -- is generally new technology coming into the market or specialized RAM that's used in very high-end devices. There's a tiny amount of RAM that's hardened to withstand a nuclear explosion and in such a small amount that it wouldn't show up here, but its use is classified. There are some specialty DRAMs. But broadly speaking, it's the same DRAM being used in these devices.

Q. And do you have an understanding as to why firms in these various different application markets

that you've identified in DX-133, do you have an understanding as to why firms in such diverse markets, generally or broadly speaking, all use the same type of DRAM?

A. Yes. It flows from the basic economics of determinants of DRAM use. And the basic economics of the DRAM industry.

Q. And do you have a slide related to that issue?

A. I do, yes.

Q. Let's go to the next slide. This will be DX-134. This slide entitled is entitled Basic Economics of the DRAM Industry.

And are the points that you list here, do these relate to your understanding of the economics of the DRAM industry, broadly speaking?

A. Yeah, they do.

Q. Let me ask you if you can walk through each of them starting with the first point, large capital requirements. What are you referring to there?

A. This is the -- what economists refer to as the minimum efficient scale of DRAM production is enormous and growing.

So a minimum efficient scale is what's the smallest plant that you can build that's cost competitive and that's the capital requirement for a

plant in that industry. And the minimum efficient -- I have a slide that sets out the costs of DRAM fabrication plants.

Q. Let's go to that slide quickly and we can come back. This will be DX-135.

Is this the slide you're referring to?

A. Yes, it is.

And this slide shows that the minimum efficient scale or the efficient scale plant associated with DRAM manufacture has grown from roughly $200 million to over one and a half billion dollars over this time span.

Q. And the one and a half billion dollars, is that the most recent figure that you're aware of or is that a figure that's --

A. It's the most recent figure that this particular diagram shows, but this is actually an eight-inch, so that refers to the wafer size that's being used, an eight-inch wafer and a .25 micron, so a quarter micron feature size, and they are already at a tighter feature size than that and I don't know if anyone has actually deployed a twelve-inch wafer yet, but I know that the next size wafer is supposed to be twelve-inch wafers and those will be substantially more expensive plants to build.

Q. And the cost that you're referring to in this slide, DX-135, which for 1999 appear to be north of $1.6 billion, is that the cost of producing or the cost of building a single DRAM plant or is that a cost for multiple plants?

A. That's -- my understanding that's the cost of a single plant.

Q. Let's go back to the prior slide, DX-134.

And you were explaining when we went to that slide the issue of large capital requirements. I think you may have touched on economies of scale, but can I ask you to come back to that point and ask you to explain what you mean by that?

A. So economies of scale refer to if you make more of an item or of any product, it costs less per unit. And many products have this feature, that if you make more of it, it will cost less per unit. The DRAM industry is no exception.

Generally when you get very large capital requirements, you get long economies of scale for a fairly large interval of production possibilities, and so DRAM is an example of an industry with major economies or significant economies of scale, part of which flow out of the large capital requirements.

Q. Let's go to the next point, interoperability.

What are you referring to there?

A. So interoperability refers to the need of DRAM to work with other components in the system. That is to say, DRAM by itself is generally not used for very much. It's only used in the context of -- in fact, it's pretty close to useless by itself. It's only used in the context of other electronic components like controllers and processors, and so forth.

So interoperability refers to the need for DRAM to work with other components in the system. And this is something about which there's been a substantial amount of trial testimony.

Q. Let me ask you if you could explain your economic views on the issue of interoperability by reference to a demonstrative that was identified earlier in the trial.

A. Yes. I have --

MR. ROYALL: This is a picture, Your Honor, a digital picture of what was previously marked in the case as DX-30 during the testimony of Mr. Heye, the AMD witness.

BY MR. ROYALL:

Q. Do you see this on your screen, Professor McAfee?

A. I do.

Q. Now, Mr. Heye explained what this diagram meant to him as somebody who's in the microprocessor business.

What, if anything, do you have to say about this diagram from the standpoint of your economic testimony on the issue of interoperability?

A. Well, this diagram also illustrates the economic concept that is sometimes known as network externality, that the design of the memory -- memory has to work with other products. It has to work with the chipset, which is represented here in the form of the Northbridge. It has to work with the processor because the memory -- the processor is what will actually use the output of the memory.

Mr. Heye also testified it works with the BIOS. It has to be designed to be compatible with the BIOS.

And all of this shows the set of components with which the memory has to interoperate, that is, the memory has to function in a coordinated manner with.

Q. And that's when DRAM memory is used within a PC system or network?

A. That's correct.

Q. And would there be different interoperability

issues when DRAMs are used in other contexts other than the PC system?

A. Yes. For example, with a fax machine or a printer, you typically have a chip that's a controller which often will have the both processing and memory controlling capability, and the DRAM has to work with that chip, and so it then has a specialized part number.

The PC is a larger device. There tend to be more interoperability issues on a PC than on a fax machine or a printer, but the same kind of interoperability requirements arise.

Q. Let's go back to DX-134. You were explaining these points on the basic economics of the DRAM industry. We just covered interoperability.

Let's go to the next point, price sensitivity. What do you mean by that?

A. So -- and there's been testimony on this point as well, but it's an economic concept of price sensitivity, what economists call actually elasticity of demand. Consumers are very sensitive to price.

And price sensitivity refers to the unwillingness to pay for -- to pay increased prices or the general loss in quantity demand when prices rise. And here those are driven by the PC user ultimately.

So when memory prices fall, you see a large amount of upgrading of PCs, you see a large increase in the sales, and generally we've seen lots of testimony about the resistance by consumers to paying price -- paying increased prices for increased performance.

And if I could, I would like to explain the reason for consumers to feel that way.

Q. Now, let me ask you to do that, and just to be clear, this -- you're offering a view from the standpoint of economics as to the economic explanation for the price sensitivity that you've heard discussed by witnesses --

A. Yes.

Q. -- and seen referenced in documents?

A. Yes.

Q. Okay. What is the economic explanation or what do you have to say from the standpoint of economics on that issue?

A. A major portion of the economic -- of the use of DRAM is in the PC industry. And if a consumer looks at having a small amount of very fast DRAM, so if you have 128 megabytes on a modern machine, a very fast DRAM, on occasion your system will not have enough memory to store what the processor needs, and

what it will do in that instance is actually write to the hard drive. It will store information on the hard drive. And compared to even the slowest DRAM, hard drives are very slow.

And so the effect -- it's what's known as virtual RAM. The effect of this is that a system that has a small amount of very fast RAM will not perform as well as a system that has a large amount of slower RAM. And this means that consumers generally are just trying to get more RAM rather than get fast RAM.

Now, that's not to say that they don't value fast RAM. They do value fast RAM. But the trade-off is often located for consumers on the what I really need is more RAM as opposed to fast RAM. And that puts both price sensitivity towards new technologies or faster technologies and this emphasis on very large volumes of commodity kind or basic DRAM.

MR. STONE: Your Honor, I'd like to move to strike the testimony about consumer behavior and what consumers do unless it's simply an assumption this witness has made.

He was not qualified as an expert on consumer behavior nor has any foundation been laid for any sort of consumer survey.

So as to what consumers do in buying PCs, it's

outside the area of an industrial organization economist, outside the area of any of the foundation he's testified to, unless he's simply saying "I'm making that assumption" and then that assumption will rise or fall in the evidence in the record.

JUDGE McGUIRE: Mr. Royall?

MR. ROYALL: Your Honor, I think that this is squarely within the scope of industrial organization economics as he explained earlier, so I think there is a foundation.

He's talked about that an industrial organization economist studies markets and how markets operate from a supply and demand standpoint, and in referring to consumers, he's simply referring to the demand or the demand side of the marketplace and what economic conclusions he's drawn.

He certainly can be cross-examined on that issue, but I see no reason to limit his testimony. Indeed, it would be a serious problem if an economist were not permitted to give economic testimony about the demand side of the markets that he's focused on.

MR. STONE: Your Honor, this is not an issue on which he gave us a report. If he's being proposed as someone who can give expert testimony on what consumers do in the marketplace, it's not within scope of his

report.

More importantly, no foundation has been laid that he has any basis for testifying to it. It may be the subject on which economists do from time to time testify, but it's not a subject on which they've laid any foundation that he has expertise to testify or that he's done any work.

If he's simply saying the evidence in this case will establish whether consumers act that way or not, then we can go back and look at the record and see if there's evidence to support that.

JUDGE McGUIRE: All right. Is he basing his testimony on his assumptions of the evidence in this case or is he -- the other question I wanted to ask, are these conclusions included in his expert report?

MR. ROYALL: Your Honor, I would submit to you that his expert report, the principal portion of which is nearly 200 pages long --

JUDGE McGUIRE: My question isn't how long. My question is: Is this proposed testimony included in there in some way, shape or form?

MR. ROYALL: Yes, it is, Your Honor. There is an entire section in Professor McAfee's expert report that relates to factors that influence demand of DRAMs and the factors that influence consumer decisions in

DRAM markets.

There are other sections of his report that discuss factors that influence the demand in DRAM technology markets.

For Mr. Stone to say that they have not been given a report on that issue is quite incorrect, and we could take the time to demonstrate that. But again, I don't see the point in this.

This is squarely within the scope of his testimony, it's within the scope of his expert report, and it would be a serious artificial limitation on the testimony of this witness if he weren't able to get into these issues and explain his views.

JUDGE McGUIRE: Mr. Stone, one last comment.

MR. STONE: Yes, Your Honor.

Setting aside whether we can go through the report to find a reference to that, the support for that is under the decision of Daubert in Merrell Dow, which holds that this witness has to have been qualified as someone who has particular expertise in consumer behavior.

That expertise has not been shown, and for him to testify I have an opinion as to why consumers do or do not make certain purchasing decisions is outside his area of expertise.

JUDGE McGUIRE: I'm going to hold this in abeyance until I've had a chance to hear all the testimony, and that is certainly an area I expect you to go into on cross-examination, and I will then determine post-hearing the proper weight, if any, to give this line of inquiry.

MR. STONE: Thank you, Your Honor.

MR. ROYALL: Thank you, Your Honor.

BY MR. ROYALL:

Q. Now, let me go back to where we were, but first of all, just to cover the foundational issue, let me ask, Professor McAfee, in connection with the type of economic analysis that you've done in answering the five key economic questions that you identified earlier, was it important for you in any way to consider factors that influence the demand of either DRAM or DRAM technology?

A. Yes. Of course economists always needs to know both supply and demand and to have an understanding of supply and demand and that would be a normal part of the inquiry.

And because demand for DRAM technology is derived from the demand for DRAMs themselves and the demand for DRAMs themselves is derived from the demand for the final products in which DRAM is used,

ultimately the demand for the technology traces back to the demand for the final good.

And so it's important to have an understanding of the demand for the final good to understand what is the derived demand for the DRAM technologies.

Q. And you mentioned earlier that your area of expertise in economics relates to something called industrial organization economics.

A. That's correct.

Q. Does industrial organization economics in any way relate to the study or analysis of consumer behavior?

A. Well, consumers are the final demand for most of the products that industrial organization economists study, and so an understanding of consumer demand is integral generally to the study of those marketplaces.

Q. And in performing your economic analysis in this case, have you undertaken any sort of study relating to consumer demand or consumer behavior or choice?

A. Yes. I have reported on consumer demand in my report and I have labored to understand the determinants of consumer demand as a way of understanding the derived demand ultimately for the

technologies at issue in this case.

Q. And does your analysis of issues relating to consumer behavior and consumer demand, does that have an important bearing on your ultimate conclusions on the key economic issues that you identified earlier?

A. Yes, it does. In fact, I have -- this issue of price sensitivity about which we spoke is one that shows up at several points in the analysis.

Q. Now, let's go back to slide DX-134.

I was asking you earlier I believe about price sensitivity, and in your answer I think you may have referenced the word "commodity," which is the next point.

Let me ask you now to turn to that last point on DX-134, commodity nature of DRAM. What are you referring to by that language?

A. So that actually refers to -- economists call wheat a commodity, a product in which you don't care who makes it, so it's the classic commodity. You don't care the name of the farmer. It's not branded.

A commodity refers to a product where the identity of the manufacturer is for all intents and purposes irrelevant. The products that are commodities are perfect substitutes for each other, that is, within a given commodity segment.

So wheat from one farmer is a substitute for wheat from another farmer and is traded as such.

And DRAM, it's not a perfect commodity, although few things are perfect commodities, DRAM is very close to a perfect commodity in the sense that the standardized DRAM from any manufacturer will work in any particular type; that is to say, a PC133 SDRAM will work in any computer that takes a PC133 SDRAM, and it doesn't matter whether it's Samsung or Micron or Infineon who made it.

Q. And what are the economic implications of this commodity nature of DRAM?

A. Well, there are a variety of them. One is the consumers -- the consumers value this partly to have multiple sources of supply -- here by "the consumers" I'm referring to the original equipment manufacturers -- they value the commodity-type DRAM because that gives them multiple sources of supply which reduces their risk and other -- and ensures price competition.

In addition, consumers, final consumers, have some value for it. What makes it more likely that the product will be available when they go to upgrade.

All of these factors influence in turn the way in which the technologies are selected. And the reason

is given the value that's placed on the commodity nature of DRAM, the process by which technologies are selected put an emphasis on standards that applies to all companies that are in the marketplace.

Q. In connection with your work and your economic analysis in this matter, Professor McAfee, have you gained or sought to gain an understanding as to who produces, that is, what companies produce commodity DRAM devices today?

A. Yes. And I have a slide to show the --

Q. Let's go to the next slide, which is DX-136.

What does this slide show?

A. Well, this slide shows the home countries of the various DRAM manufacturers in the marketplace today. The major manufacturers.

So it shows Micron from Boise, Idaho; Infineon from Germany; and Samsung from Korea, and so on.

Q. If I didn't ask already, let me ask now. What was the time frame for your economic analysis, what period of time did it span?

A. 1990 to roughly 2000-2001.

Q. Are these companies depicted on DX-136, are these the companies that have been producing DRAM to your understanding throughout the time frame that's relevant to your analysis?

A. No. And I've prepared a slide to illustrate, illustrate that.

Q. Let's go to the next slide, DX-137, I believe.

JUDGE McGUIRE: Yes.

BY MR. ROYALL:

Q. What does this slide show?

A. This shows on -- I've forgotten what year, but this shows DRAM manufacturers in the past and shows that there used to be in fact a lot more distinct companies manufacturing DRAM.

Now, some of the plants of these companies are still in operation; that is, they've been incorporated into the existing companies today. But this shows that there were a lot more players.

For example, some of the Japanese companies have merged -- their operations have merged and have a new name. In fact, it's fairly hard to keep track of all the companies, the current names of the companies producing DRAM.

Q. Are there any U.S. companies that in the past during the time period you focused on were producers of DRAM but today are no longer producers of DRAM?

A. Yes. This slide shows three, IBM, Intel and Texas Instruments.

Q. Now, I believe that you mentioned in your

earlier answer that there has been consolidation in the DRAM manufacturing business. Is that your understanding?

A. That is my understanding.

Q. And have you had occasion as part of your economic analysis, have you had reason to probe why there has been a consolidation over time in the DRAM manufacturing business?

A. Yes, I have.

Q. And what views or conclusions have you reached in that regard?

A. Well, they also flow from the economics of DRAM production. And I've prepared a slide to --

Q. Let's go to the next slide, which is DX-138.

Is this the slide you're referring to?

A. Yes, it is.

Q. And this slide -- we had a slide earlier that I believe you titled Basic Economics of the DRAM Industry.

How does this slide differ from that earlier slide?

A. This slide is about DRAM production, so this is -- the earlier slide was about an overview of the industry itself. This is only about the supply side of the industry, which is determined by the production

technologies and costs.

Q. So this slide -- we talked earlier about the distinction in your analysis between supply side considerations and demand side considerations.

This slide is only referring to the supply production side of your analysis?

A. Yes. That's correct.

Q. And let me ask you to explain what you mean by the points that you list here relating to DRAM production and starting with the first point, high fixed costs.

A. So we already saw a slide about the increasing cost of plants, and that's what this refers to, that the scale of operation in the plant, the minimum efficient plant size, has grown over time. And this fact probably by itself explains the consolidation in the DRAM production, DRAM industry, that the increasing capital requirements and fixed costs and technological costs, costs of testing and the like, have forced a shake-out and consolidation in the industry.

Q. What about the next bullet point, volatility, cyclicality? What are you referring to there?

A. From an economist's perspective, one of the most interesting features of the DRAM industry is its

extremely volatile and cyclical nature. And one way of understanding the volatility and cyclicality of this is -- arises out of the production process and the sort of basic economics of the production process.

When there's a die shrink or other changes to the production, often it takes a while to perfect that process; that is, there is a substantial amount of learning by doing. And the effect of this is that you may go from, according to the industry reports, you might go from only having half of your chips on a given wafer actually function to having over 90 percent of them, and that's nearly a doubling of supply and that may happen in a twelve-month period.

That along with the coordination of the industry in its production process means that you get pretty large increases of supply in a very short period of time, and that can cause prices to plummet. And so you get a -- you get a cycle, a price cycle essentially, driven by the technology.

Q. And referring to the third bullet point in the slide, intense price competition, what are you referring to there?

A. When manufacturers sell different products, they all have what you could think of -- what economists call market power, but you can think of

little local monopolies. They have something that's unique about their product.

When manufacturers sell identical products, they have nothing unique about their product, and the effect of this is the customers make the determination of what to buy essentially only on price. And you know, there may be some minor, minor considerations like whether the -- other than price, that is, the company may be a little bit better at packaging or something, but primarily price is the major determinant. And that makes for -- the fact that the products are identical -- and we talked about the commodity nature of DRAM -- makes for intense price competition.

Q. Moving to the next point, maximize capacity utilization/yield, what are you referring to there and how does that relate to the economics of DRAM production?

A. Well, I actually have a slide to -- that talks about the methods of this, but let me say first, before we go to the slide, that the high fixed costs, these very large fixed costs of the plants, dictate that -- and the intense -- the combination of the high fixed costs and the intense price competition dictate an extreme pressure on cost.

That is to say, the focus of the DRAM manufacturers needs to be on cutting costs, because if their costs are a little bit higher than the going price, they'll slowly go out of business. They'll bleed to death. And so -- and whoever has the low cost enjoys the proceeds of that low cost, and so the effect of this is to create enormous pressure on cost reduction. And I have a slide that --

Q. Before we go to that slide, is cost reduction or cost-cutting related in any way to the point you make in the fourth bullet here about maximizing capacity utilization and yield?

A. Yes. In fact that maximizing capacity utilization is a consequence of intense cost pressure and the combination -- and the fixed costs. The fact that you have very large fixed costs means that you want to run your plants full out.

Q. Well, let's go to the next slide, which will be DX-139.

Now, is this -- in this slide are you giving more detail to the points you mentioned earlier about cost reductions and increasing capacity or yields?

A. Yes.

Q. Is that the purpose of this slide?

A. Yes. This illustrates some of the means by

which manufacturers attempt to minimize their per-unit or average cost.

Q. And what -- the first bullet refers to 24/7 operation. What are you referring to by that term?

A. That's operation every hour of the day every day of the year or every day of the week.

The Infineon plant attempts to never shut down, that is, to operate continuously. They did actually shut down for a snowstorm once. They attempt never to shut down because it's an extremely expensive plant and you want to amortize the cost of that plant over as many wafers and chips as possible.

Q. And so running the plant twenty-four hours a day seven days a week is -- you understand that that is motivated by the cost -- the pressures to reduce cost that you'd mentioned earlier?

A. Yes. This is a way of lowering the average cost because it amortizes the fixed cost over a larger volume.

Q. What about the next point, clean rooms? What does that refer to and how does that relate to reducing costs or increasing yields?

A. So at a .2 micron feature size, at a very small feature size, a speck of dust that falls on the chip

will actually tend to short-circuit that chip, that is, disable the chip.

And so they go to extraordinary lengths to -- I think there's been testimony to this effect -- to have the cleanest facilities possible and to have one part per cubic foot of dust, and just to give a comparison, a cubic foot of dust is something like two million particles every hour.

Q. And have you seen these clean rooms directly when you toured the DRAM facility, did you see this in operation?

A. Yes. And when you take the tour, they require -- you like have to put your shoes in a -- in containers to keep them -- keep dust off your shoes, you know, a head net. You can't take notes except on special paper that is dust-free and they have a special pen so the ink doesn't float around.

And this is not going actually into the clean room; this is they want the room next to the clean room to be also clean, because every time someone goes into the clean room, there's a chance for dust in the next room to filter into the clean room.

And so they go to extraordinary lengths and produce much cleaner facilities than any other operation.

Q. And you understand that those efforts are related to costs and yields?

A. Yes. Again, every speck of dust potentially destroys one of their chips and so they try to -- they expend very large amounts of money to try to reduce the loss in yield.

Q. And the next bullet point refers to extended equipment life. How does that relate to costs and to yields?

A. The equipment that is used to manufacture DRAMs is quite expensive and getting more expensive every time they shrink the feature size because a major component, for example, of the equipment are the masks which you use to photoetch the silicon wafers, and as they -- as the feature size gets smaller, the technology used in those masks -- again, all of this stuff is not visible. The feature sizes are not visible to the naked eye. It's minuscule -- are shrunk. Given the cost of those, you would like to amortize their use over as many wafers as possible.

And so the expense of the equipment creates an economic incentive to use the equipment for longer periods of time if possible.

Q. Let's go to the next point, optimize production process. How does that relate to costs and

to yields?

MR. STONE: Your Honor, before we start this answer, if I might object.

We've heard this testimony from Mr. Becker and we heard this testimony from Mr. Williams. This is a matter of fact in the record of how many dust particles humans give off and how clean the rooms are, and I don't think -- all this witness is doing now is simply repeating evidence that's in the record. I think it's unduly cumulative of what we've already heard.

JUDGE McGUIRE: All right. Let me be clear on this, Mr. Royall. He can refer to prior testimony, but I'm not going to allow him or any other expert to sum it up.

So maybe you're walking a fine line here, but there are points where you're going to cross it and I'm not going to allow it, so you know, you decide how you want to proceed on that, but I'm not going to add time to this proceeding with testimony that we've already heard.

Now, if he wants to make a reference to it, that's one thing, but again, I'm not going to allow him to sum it up.

MR. ROYALL: I understand, Your Honor. And I

did not intend to ask Professor McAfee to provide a summary of what others have said, but I do think it's important and fully appropriate for him to give an economic explanation of the factors that he's identified that influence the economic functioning of the markets that he studied.

JUDGE McGUIRE: Well, that's fine and he can do that.

And this is also for you, Mr. McAfee, and keep what I've said in mind when you respond to some of these questions. Okay?

THE WITNESS: Yes, Your Honor.

MR. ROYALL: Thank you.

BY MR. ROYALL:

Q. Now, going to the next point -- and again, I'm asking for your explanation of the economic conclusions that you've reached relating to these various points -- what, if any, conclusions have you reached in your economic analysis relating to the optimization of production processes and how that affects costs or yields in the DRAM production business?

A. An important conclusion from the testimony concerning the efforts taken to optimize the production process is the lead time, that is, production

process -- the optimized production process doesn't happen overnight. There's actually a substantial amount of time that's taken.

And so in -- what's important for the economic analysis is that the efficient or the expedient way to introduce a new generation of product, for example, is you run small batches -- and this has been testified to -- you run small batches for a period of time until -- and maybe revising those designs, learning by doing, while you're producing in large volumes some other product.

And that the lead times in that case are actually substantial. That there may be six months, twelve months, even eighteen months of lead time, depending on the nature of the production process.

Q. Going to the next point, and again not -- I'm not asking for you to summarize what -- you testified earlier that you've read essentially the trial record. I'm not asking you to summarize what you've seen in the trial record relating to this but just to explain what economic conclusions, if any, you have drawn relating to now the next point, die shrinks, and the economic significance of that issue in connection with costs and yields in DRAM production.

A. So one economic -- one component of the

economic significance of die shrinks is that sometime after they occur you tend to get actually jumps in the supply, that is to say, when you make a 20 percent increase in the supply associated with a single die shrink. And so that makes for sort of lumpy quantity outcomes.

Q. Are there any other economic conclusions that you've reached in relation to the issue of die shrinks that have any bearing or impact on your testimony?

A. Not as I sit here today.

Q. Okay. Let's go to the final point.

What, if any, economic conclusions have you reached relating to larger wafer size and the bearing of that issue on costs and yields?

A. So this is another form of scale economy -- oh, I'm sorry. I do actually remember what I'm going to rely on later with respect to die shrinks. May I go back to my previous answer?

Q. That's fine. Let's do that. We'll come back to the other question.

Just so the record is clear, the question I had asked you earlier is: Are there any other economic conclusions that you've reached in relation to the issue of die shrinks that have any bearing or impact on your testimony?

A. This is so embarrassing. I've now managed to forget. I'm sorry.

Q. The question -- just to give reference to the question, we've been discussing ways the DRAM manufacturers reduce costs and increase yield, and I think that your earlier answer relating to die shrinks had something to do with lumpy supply.

Is there a cost -- is there a cost implication of die shrinks?

JUDGE McGUIRE: All right. Mr. Stone?

MR. STONE: If Mr. Royall wants to prompt the witness to something that I think he expects him to say and has probably just forgotten at the moment, I have no objection to this so we can just expedite this.

JUDGE McGUIRE: Noted.

MR. STONE: That would be fine.

JUDGE McGUIRE: You can prompt him.

BY MR. ROYALL:

Q. Thank you, Your Honor.

And I'm not sure whether there is anything to draw out here, but it's -- it's just Professor McAfee thought he recalled something and I'm just asking whether -- you mentioned something related to supply implications I think with respect to die shrinks. Is

there a cost implication to that?

A. Yes. What I had forgotten was, in some cases these manufacturers are making multiple products, and when they are making multiple products, a die shrink essentially represents a fixed cost for them.

That is, there's an amount of effort that's taken to produce a die shrink. You need masks. You need to actually redesign your production process. You may need different chemicals and photoetching. Essentially it's all fixed -- it's not related to the quantity of wafers that you run through the production process -- the cost of producing the die shrink.

And so the effect of this is, from an economic perspective, if you've got two products that you might apply a die shrink to, you're going to apply it to the product that you're producing the most of. That is to say, the product with the -- that you're producing the most of will be the product you shrink first and it will be the product you shrink most.

And that has the -- and since a die shrink lowers cost by producing more chips per wafer, there's a cost reduction associated with a die shrink, the effect of that is the product that you're producing the most of is the product whose cost falls the fastest, and that's actually very important from an economic

analysis perspective.

Q. Now, very quickly, the last point you mentioned on this slide, DX-139, relates to larger wafer size.

What, if any, economic conclusions have you reached relating to larger wafer size and the bearing of that issue on costs and yields in DRAM production?

A. Well, they would actually be parallel to the die shrink conclusions. That is to say, again, if you were moving to a larger wafer size, you would do it on a product that you expected to sell a lot of or were selling a lot of, and in particular with wafer size, you'd do it to a product where you expected to sell a lot in the future because, again, it's a big fixed cost to move to the next wafer size.

Q. Now, we've been discussing with this slide and some prior slides --

A. I'm sorry. I didn't actually quite finish that answer.

Q. I'm sorry. Go ahead.

A. And it's the feedback effect that's important from an economist's perspective. That is to say, we apply our cost reduction to our majority product and that has a feedback effect of lowering the cost of that product which then through the marketplace leads that

product to even grow even larger as a proportion of the total demand.

And it's the feedback effect that's important from the economist's perspective.

Q. This slide, DX-139, and at least one of the prior slides, if not more, relates to DRAM production, and you mentioned earlier that as part of your economic analysis, an important part of your economic analysis, you focus also on demand side or consumer issues relating to these markets.

Have you reached any conclusions as to the economics of DRAM demand?

A. Yes, I have. And I've prepared a slide to illustrate some of those conclusions.

Q. This slide will be DX-140 I believe.

A. Yes.

Q. Again, you have a number of bullet points here related to the economics of DRAM demand.

Let me ask you to start with the first bullet point and explain what, if any, economic conclusions you have reached and what significance or bearing they have on your overall opinions and conclusions in this case.

A. This DRAM demand -- we actually have multiple levels at issue in this case in the vertical chain of

production, what economists call the vertical chain of production.

Just to place this, this is the level of the original equipment manufacturer, so this is the demand for the DRAM product, not by the final consumer, although of course that is shaped by the final consumer, but for the OEM.

And one of the major factors for the OEMs that's an important attribute of DRAM demand is the requirement or the desire for multiple sourcing. As a factual matter, I think there's been a great deal of testimony on that. But from the economic perspective, the value -- there's a couple of values in multiple sourcing. One is that it reduces risk. It also ensures price competition.

And this is not just a feature of this industry, actually it's a feature of many industries, the desire to have multiple sources for inputs.

Q. Let's go the next point, long lead times.

What economic conclusions have you reached, if any, relating to that issue in the context of the economics of DRAM demand?

A. Long lead times refers to the -- as you change the -- so when a new generation of DRAM comes out, there is a series of things that have to happen, and

we'll go into that somewhat more. But other products have to be, as I mentioned earlier, other products have to be designed that work with that.

And one of the characteristics, which again is actually more of a factual matter, is that some of these take a very long time, and so that's going to have -- that long lead time on the demand side, which that -- to get the product actually used is going to be relevant to the analysis, but that actually is more of a factual matter, that there are long lead times needed, rather than a conclusion which I'm drawing.

Q. And backwards compatibility, do you draw any economic conclusions relating to the subject of backwards compatibility?

A. Yes, I do. Backward compatibility refers to -- backward compatibility refers to some features or maybe all of the features -- different people seem to use this term differently -- being consistent as you go from one generation of product to the next.

Now, from an economic perspective, the value of that is in the reuse of existing knowledge, and so one of the characteristics of demand as a cost minimization matter that manufacturers are likely to reuse their existing knowledge, not reinvent the wheel, and that leads to a demand for backward

compatibility.

So there, backward compatibility is actually a consequence of features of the demand by OEMs.

Q. Minimizing costs per bit, what are you referring to by that term?

A. Actually you see a fair amount -- a fair amount of testimony that cost per bit is a very critical aspect.

We already talked about the price sensitivity. An implication of the price sensitivity of final consumers is a desire on the part of the OEMs to minimize their cost per megabyte or per bit for demand for their product, for DRAM.

Q. Are there any economic implications of that that you've identified?

A. Oh, absolutely. That puts pressure on the supply side to do -- to produce the absolute lowest cost, so that is a contributor to the pressure on the manufacturers to have the absolute lowest cost per megabyte basis.

Q. And finally, minimizing design, testing and qualification costs, is that a subject that bears on your economic analysis?

A. Absolutely. This -- the costs of design, testing and qualification in this industry appear to

be quite substantial, and that's a factual matter, but they do appear to be quite substantial. And as a consequence of those, those create an economy of scale.

That is to say, when design, testing and qualification costs are large, you want to try to use a single or not too many different flavors or varieties of DRAM so that I don't have to go through the whole design, testing and qualification process over and over and over again.

And so this creates more pressure for having a single, dominant flavor of DRAM.

Q. And when you say it creates this pressure, are you talking about economic factors that influence the supply of DRAM?

A. That's correct. Well, in the marketplace choice, not just supply, but also the marketplace choice of DRAM.

Q. So the demand side as well?

A. That's correct.

MR. ROYALL: Your Honor, this is a convenient stopping point for me.

JUDGE McGUIRE: Okay. Very good.

It's about twenty-five after. Let's take a break for lunch and we'll reconvene here at 1:45.

MR. ROYALL: Thank you.

JUDGE McGUIRE: Hearing in recess.

(Whereupon, at 12:22 p.m., a lunch recess was taken.)

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

(1:46 p.m.)

JUDGE McGUIRE: At this time you may proceed, Mr. Royall, with your examination.

MR. ROYALL: Thank you, Your Honor.

BY MR. ROYALL:

Q. Just to reorient us after the lunch break, we talked about the economics of the DRAM industry and you explained certain views and conclusions relating to both the economics of DRAM production and the economics of DRAM demand.

Let me ask you now, Professor McAfee, do any of the economic factors that we've discussed in your testimony to this point have bearing on whether standards are important in the DRAM industry?

A. Yes, they do.

Q. And how is that?

A. For example, this issue with die shrinks that the same -- the product that's in the majority of demand tends to get the die shrinks fast and hence its costs fall faster. That encourages a single product to be the dominant product and that's going to make the standard by which that product is manufactured important.

As does the requirement of having multiple

suppliers or the value that buyers put on having multiple suppliers. Again, that would tend to encourage a single product or not very many products as being a dominant standard.

Q. And have you as part of your economic analysis sought to investigate or study the extent to which in the DRAM industry there has at any given time been a dominant industry standard?

A. Yes. And I've prepared a slide.

Q. Let's go to that and I think we're now up to DX-141.

This slide is entitled Evolution of DRAM Standards. It's very colorful, but let me ask you if you can explain what you're seeking to depict through this slide.

A. This slide shows at any given time and across time which product is -- well, the market shares of the various products available for sale in the market.

And just to give an example, defining market share of fast page mode, which is the product -- it's an asynchronous design colored in a greenish color.

In 1995 -- in 1995, one looks at the green color, which starts around 8 percent and ends around 93 percent, and the percentage of the market that would be devoted to fast page mode is the difference between

those two, that is, 93 minus 8.

The proportion of the market that's EDO, extended data out, which is another memory type that was available in 1995, that's associated with the orange color and that would be the difference between 100 and roughly 93, or 7 percent of the market.

I'm just approximating the numbers.

And so this shows the proportion of the market at each year devoted to the various products for sale, at least in the large quantities.

Let me say that the years from 2002 on are projected and we already have -- the 2003 numbers are now available and they are -- DDR actually has a larger market share than is illustrated on this picture.

Q. And you testified earlier that you have focused as part of your analysis on the JEDEC SDRAM and DDR SDRAM standards.

What portion of this chart or graph, DX-141, corresponds with those standards?

A. Well, the "other" is actually not identified, so I don't know about the "other." And the RDRAM, the Rambus product, which is colored in red, is not a JEDEC standard. And the other four technologies are standardized.

Q. But which portion corresponds with -- which portion or portions correspond with SDRAM DDR?

A. I'm sorry. I misunderstood your question.

The blue is the SDRAM and the yellow is the DDR SDRAM, so the blue color represents SDRAM.

Q. And does this graphic have any bearing on what, if any, conclusions you reach as to whether in the DRAM marketplace you have seen the existence of dominant industry standards?

A. Yes. This diagram shows that generally the standards get off to what I think was a slow start. It's sometimes called the S curve because the shape is kind of -- is mirroring an S, at least a stretched-out S a little bit.

They get off to a somewhat slow start, and then market penetration speeds up, and then at some point it tails off again and with its being replaced by a subsequent standard.

Q. And the lines and the changes of colors, those represent transitions from one industry standard to another; is that correct?

A. Well, the -- so the transition across time is represented by the subsequent product's share growing, and you see that by the fall-off in the previous standard.

So as the -- for example, as EDO gives way to SDRAM, the right-hand side of the orange area starts to decline steeply.

Q. Have you, Professor McAfee, in connection with your work on this matter, developed an understanding of what economic factors, if any, cause the DRAM marketplace to transition from one industry standard to another?

A. Yes, I have.

Q. What factors have you concluded impact that transition from one standard to another?

A. I'm sorry. Can I get you to repeat the question?

Q. What -- you said that you have developed an understanding of economic factors that cause the DRAM marketplace to transition from one industry standard to another, and I'm simply asking you what economic factors bear on that transition.

A. Well, the cost of the subsequent product would be a leading candidate for -- a leading economic factor. That is to say, as the cost of a next technology falls, you see initially niche applications for a new standard.

That is, the things like video RAM or the most high-value use for fast memory will be the initial

users and they're paying a relatively high market premium. As the number of buyers grows for this memory, at some point you get a market tipping, or what's called a market tipping, and that's driven by a factor we've already talked about, which is you apply your cost-saving activity most to the product that you're making the most of, and so that tends to drive down -- as the product gets a larger market share, it tends to drive down the price, thus reinforcing the inclination of the market to buy that product.

And ultimately that leads to, the market will tip to the new product.

Q. Have you reached any conclusion as to whether from an economic standpoint standards are an important element of the competitive landscape in the DRAM industry?

A. Yes, they are.

Q. And do you have an understanding or have you developed views as to why standards are important in this industry?

A. Yes. And I will -- provided a slide which in fact echoes many of the market factors that we've already talked -- already discussed.

Q. And this is DX-142 I believe.

I don't want you to recover territory that

we've already covered, for instance, on interoperability, but could I ask if you could just generally explain your views from the standpoint of economics as to why standards are important in this industry.

A. Well, we have talked about interoperability and we've also talked about the cost reductions and the requirement that the DRAM actually work in multiple applications in order to drive down the price. Well, that is to say the effect of cost falling more rapidly for the majority product.

And the effect of this is that the standards, because they allow multiple suppliers, because they allow interoperability, because they allow leveraging the costs of the design, standards are very important for making the product -- for in essence minimizing the cost of delivery or the cost -- the total cost of system products.

Q. And the last bullet point on this slide, DX-142, refers to facilitating price competition. Can you explain what you mean by that?

A. Yes. By setting a common design and adhering to a common standard, the -- an advantage to the marketplace as a whole is that it benefits from price competition associated with the -- from the

manufacturers, and I think I already spoke about price competition.

And identical products or products I should say that for all intents -- for most intents and purposes identical from the different manufacturers will be subject to more intense price competition.

Q. Have you, Professor McAfee, in connection with your work on this matter and your economic analysis, have you found it important to gain any understanding of the nature of DRAM standards, that is, what DRAM standards -- what information or function -- information they provide or function they serve?

A. Yes, I have.

Q. And why is that something that's relevant to your economic analysis or important to your economic analysis?

A. Well, it's a central allegation of the case that there was a manipulation or misdirection of a standards-setting organization, so understanding what kind of standards and the economics of the standards being used would be important for my understanding of the allegations of the function of the marketplace.

Q. And do you have a slide that summarizes your understanding as to the nature of DRAM standards?

A. I do.

Q. Let's go to that, which this slide will be DX-143.

You have several points here relating to the nature of DRAM standards. Let me briefly ask you about each of them.

Starting with the first, which refers to basic design specifications/protocols, what are you referring to there?

A. So my understanding of the standardization process -- and I should say this is in the realm of assumptions rather than -- or facts rather than my economic conclusions -- my understanding of the -- is that the standardizing process does not try to specify every single feature of the manufacturing process.

In fact, it's about a base of design and about the protocols with which the DRAM communicates with the outside world rather than the specifics of this is going to be how the product is designed. It's more about the protocols and the language with which the DRAM will communicate with the outside world.

And that's actually come about as an evolution from what was initially just specifications of pins and voltages and a very crude specification relative to modern times.

Q. And the evolution that you're referring to in

the nature of DRAM standards, is that an evolution that has occurred during the time period that you focused on for your economic analysis?

A. Yes. Although I'm actually referring to somewhat before that time period as well, that is, starting in 1980, even in the late '70s, but in 1980.

Q. Let's go to the next bullet where you state "focus on interface."

What are you referring to there?

A. Well, this is -- I already foreshadowed that point with -- the focus is on how the DRAM communicates with the outside world as opposed to how it's manufactured in its manufacturing process.

So that is to say, from the perspective of what purposes -- and that's important economically from the perspective of what purpose the standards are serving.

The standards are serving to define the characteristics of the DRAM in such a way that the chipset makers, the processor users know enough about it to know how to design their products. They don't need to know how the DRAM is manufactured. They need to know how the DRAM communicates with the outside world and how the DRAM behaves.

And so the focus of the standards as I

understand it is primarily on the interface, the input/output behavior, the reaction of the DRAM to the rest of the world, to the rest of the system, rather than on, for example, manufacturing standards.

Q. The next point refers to parametrics. What do you understand that term to mean and how is that relevant to the points you're making in this slide?

A. So parametrics refer to specifications within a standard; that is, my understanding is that you can have a standard which can then be more tightly defined by what are known as parametrics.

And for an economist, this phrase refers to additional specification or a tighter specification. And it's something that comes up in the standard-setting on occasion, that is, the need for further refinement of the standards, if you will.

Q. And do you understand that to be part of the, referring to the first and second point, part of the basic design specification or interface specification, or is this something separate or in addition to that?

A. I would say in addition rather than separate. That is, it's a more tightly defined or an additional requirement on the specification.

Q. And then the final bullet on this slide refers to module standards. What are you referring to there?

A. Well, some users use -- some users of DRAM actually use DRAM directly. The PCs tend to use modules; that is to say, the DRAM is put on what is itself a circuit board and that circuit board is plugged into the PC.

And so an additional set of standards that are potentially relevant are module standards, that is, the standards on how a module communicates with a PC, which might be silent to how the DRAM works inside the module.

Q. This slide that we've been discussing refers to your understanding or assumptions about the nature of DRAM standards.

Have you, as part of your economic analysis, investigated the manner in which standards are set in the DRAM industry?

A. Yes, I have.

Q. Do you have a slide relating to that?

A. I've prepared a slide.

Q. And this is the slide you're referring to?

A. This is it.

Q. This would be DX-144.

Now, what are you referring to in this slide?

A. Well, these are three competing mechanisms for setting standards associated with DRAM. I should say

that these are also three of the four competing mechanisms for setting standards more generally, the fourth being the government.

The three methods are:

You can have a standard-setting organization, and there are several -- at least going back historically, there were several candidates for standard-setting organizations.

You can have private consortia, and we see private consortia such as ADT that attempt to set standards. SyncLink was also a private consortium.

And then you can have proprietary. That's a consortium of one, a single firm, of standards, proprietary standards.

Q. You said, if I understood you correctly, that these types of or manners of creating standards could exist in any industry.

Do you have an understanding as to whether all three of these approaches to standards-setting have been utilized at some point in time in the DRAM industry?

A. Yes. As I mentioned, JEDEC is a standard-setting organization, ADT was private and SyncLink was both private consortia, and Rambus is a proprietary standard.

Q. Do you have an understanding as to whether any one of these approaches has been more successful than others in the DRAM industry in terms of setting standards that are accepted in the marketplace?

MR. STONE: Objection, Your Honor. This calls -- this improperly calls for opinion testimony outside this witness' area of expertise and lacks the foundation.

If it's simply an assumption on his part and underlies any of his opinions, I don't object. But if he's testifying to this as an opinion of his own or a conclusion, it lacks foundation.

JUDGE McGUIRE: Mr. Royall?

MR. ROYALL: Your Honor, as the question clearly stated, I was asking for his understanding, which is a term I've used to refer to the factual predicate or assumptions he's making.

JUDGE McGUIRE: To his assumptions. Okay.

MR. STONE: To his assumptions. Okay.

JUDGE McGUIRE: All right. Noted.

BY MR. ROYALL:

Q. Do you have the question in mind?

A. Yes. And I am assuming --

JUDGE McGUIRE: Can we assume that's going to be the case until we hear otherwise?

MR. ROYALL: I'm sorry?

JUDGE McGUIRE: Could we assume that the predicate of all your questions to this witness are based on those assumptions? I know you'd indicated that earlier. It's just so we can avoid having to go through this again.

MR. ROYALL: I'll try to -- there are certainly going to be instances --

JUDGE McGUIRE: Just try to keep us up-to-date on the foundation under which you're asking him these questions.

MR. ROYALL: And I will say that when I use the word "understanding," unless I follow up to seek a conclusion or an opinion, by "understanding" I'm referring to understanding the facts and assumptions in that regard.

JUDGE McGUIRE: All right. Very good.

BY MR. ROYALL:

Q. Do you still have the question in mind?

A. Yes.

Q. Okay.

A. I am assuming that JEDEC has been very successful at establishing the standards for DRAM.

Q. And you said "very successful."

Are you assuming anything with respect to

whether JEDEC has been more successful in establishing DRAM standards that have received market acceptance compared to the other two types of standards-setting that you refer to in this slide?

A. Yes. The JEDEC standards have dominated the industry, and I'm assuming as a factual matter that that's because of their success in standard-setting.

Q. Now, putting aside your assumptions, let me ask whether you've developed any economic conclusions relating to the factors that bear on whether a given approach to standard-setting or a given standard is successful in the DRAM marketplace.

A. Yes, I have.

Q. And again, do you have a slide relating to that?

A. I have a slide listing factors that are relevant to the success of standards in DRAM.

Q. This will be DX-145.

Now, again, can you explain to us what -- before we go through the various factors, can you explain to us what you were seeking to convey through this slide or what it relates to?

A. These are factors which I find to be important in the success of a standard. Whether it came from a standard-setting organization or a private consortium,

these are factors that matter to the marketplace, that have consequences for the marketplace and hence matter to the success of the standard -- of a proposed standard.

Q. And when you say that these are factors that matter to the marketplace, by that are you saying that they are factors that you have concluded have economic significance in this marketplace?

A. That's correct.

Q. Let me ask you about, starting with the first bullet point, open, consensus-based process.

Can you explain first of all what you mean by that term?

A. Yes. What I mean by that is a process by which many viewpoints are aggregated or averaged into the standard, so that is a process by which -- that represents the market participants as a whole and not a select sample of market participants.

Q. And could you explain why you have concluded that this is a factor that has economic significance in terms of the success of DRAM standards.

A. Yes. If you'll imagine -- so I should say, in making investments -- to back up a little bit, we talked earlier about the long lead time.

In making investments in a technology one very

much wants to forecast which technology will be successful; that is to say, you don't want to make investments in, say, supporting a product that won't ultimately be used by the market.

And this creates a coordination issue. That is, all of the market participants are in the position of trying to forecast which product is going to be successful in the marketplace, and that's what economists call generally a coordination problem.

And as a result, the -- and so factors that influence those forecasts, ultimate forecasts of success, will ultimately influence the success of the standard itself; so that is to say, if a factor makes it more likely that the participants forecast the ultimate success of the standard, the standard is more likely to be successful.

An open, consensus-based process has the advantage of, by involving more market participants, helping to make the forecast by more of the participants that the standard will ultimately be successful.

Q. Let's move to the second point that you mentioned here, open availability of standard.

First, can you explain what you mean by that, that phrase?

A. So this is a term that refers to whether anyone who wishes to can manufacture to that standard, so that is to say is the standard available to all or is the standard a, for example, trade secret, which it's not published or not published openly.

And so open availability helps by making the standard more widely available, it makes it more likely to be successful.

Q. And the third bullet relates to royalties. What do you mean by that and why is that a factor that you've concluded has economic significance with respect to the success of DRAM standards?

A. Well, economists would refer to what's known as the first law of demand, that demand slopes down. When you increase the price of something, you sell less of it.

Royalties have an influence on the success of standards because they are charges for the use of the standard, and so insofar as the standard requires royalties, it's less likely to be successful. And the higher the royalties, the less likely. And that's other things equal. If a standard with royalties was actually better performing, it might still be successful.

Q. Implementation costs is the next point. Can

you explain what you mean by that and why that is a factor that you've concluded has economic significance with respect to the success of DRAM standards?

A. Yes. I'd actually like to take manufacturing and implementation costs together if you don't mind.

Q. Fine.

A. The manufacturing cost has a direct effect on the manufacturer. The higher the cost of making the product, the less likely the product is going to be successful, but really it's the system cost that matters.

And you can think about this as being derived from the final demand for the product. The customer cares in some sense about the delivered cost of the computer, so he doesn't care whether the cost is in the DRAM or in the chipset. Those two costs get added together in terms of the final demand for the consumer, and hence the final demand for the -- or the demand for the intermediary, the OEM, and then that works back to the standard. What matters is the total cost, not the specific DRAM cost or the specific chipset cost.

Q. And finally, you refer in the last bullet to evolutionary/revolutionary. Can you explain what you mean by that and why you find this to be a factor with

economic significance to the success of DRAM standards?

A. Yes. Other things equal, an evolutionary approach will tend to be more successful than a revolutionary approach. And by "other things equal" I mean wholly performance-cost benefit.

And the reason for that is an evolutionary approach has an advantage of reusing knowledge, so that is to say there's less to work out. The implementation costs will tend to be lower. The risks will tend to be lower with an evolutionary approach.

And so an evolutionary approach has the -- has an advantage over -- typically has an advantage over a revolutionary approach, again, other things equal.

Q. One moment, please.

I want to be clear for the record what you mean by these terms "evolutionary" and "revolutionary."

Let me first ask you to define what you mean by the term "evolutionary" in this context.

A. So by "evolutionary" I mean built on the existing product or existing knowledge base as opposed to a dramatic change from the existing product or knowledge base.

Q. And what do you mean, to make the record clear,

by the term "revolutionary" in this context?

A. So to a lesser extent built on the existing base or it is a radical departure, a major departure from the existing technologies and products. It's more new, if you wish.

Q. And am I understanding you to say that between evolutionary and revolutionary, that the more revolutionary a DRAM standard is, all things equal, the more likely it is to succeed?

A. No. If I heard your question correctly, it's the more evolutionary the DRAM standard is, the more likely it is to succeed.

Q. I did misspeak. Forgive me.

Let me ask you this. Are there -- in your view, is there an economic underpinning to that concept, that is, the relationship between the evolutionary nature of DRAM standard and its likelihood of succeeding in the marketplace?

A. Yes, there is.

Q. And do you have a slide --

A. I have prepared a slide.

Q. This will be DX-146 I believe.

Let me ask you to take us through the points that you make on this slide, starting with the first point where you refer to the reuse of existing

knowledge/infrastructure. How does that relate to the economic underpinnings of the point you were making about evolutionary technology?

A. So just in general, an evolutionary approach means that some of the components or subassemblies or some of the pieces you already know how to do. And what makes it evolutionary is that you're building on a knowledge base and a design or a product or a technology that you've already gotten experience in.

So the reuse of knowledge is you don't have to reinvent a whole bunch of wheels in the process of implementing the technology. And that's not to say that there aren't problems to solve even with an evolutionary approach; it's just to say that the nature of evolutionary approaches means that there are more available solutions from history than with a revolutionary approach.

Q. You refer in the next bullet to increasing marginal cost of changes. What do you mean by that?

A. So that's a feature of DRAM -- I should say that I'm assuming increasing marginal cost of changes rather than deducing it.

But what that refers to is, if I make four changes, the cost of debugging, the cost of making four changes work if I make four simultaneous changes is

going to be larger than if I sequentially make those same four changes; and so that is to say, if I try to do a whole lot at the same time -- and this is a common economic notion of increasing cost -- if I try to do a whole lot at the same time it's going to cost me more than if I do it sequentially.

And where that has a role in evolutionary changes versus revolutionary changes, one way to think of it is if I change my entire design of a DRAM and something goes wrong, I don't have any way of saying, well, this is what went wrong, or it's going to be much more challenging to identify what went wrong.

On the other hand, if I have a functioning product and I change a single feature and it doesn't work, the new product doesn't work, I know it was the single feature that I changed that caused the problem, and so that sort of a consideration leads to a preference for evolutionary changes. And the preference is not -- it's just lower cost of making evolutionary changes relative to revolutionary changes.

Q. And just to be clear, when you use the term "preference," are you referring to economic incentives or are you referring to the literal state of mind of participants in this marketplace?

A. The economic incentives of the firms in the marketplace as driven by their customers.

Q. And I think in that last answer you may have covered the next bullet, debugging and testing, or is there more that you have to say on that aspect of the slide?

A. No. I think that was covered.

Q. Skipping then to the fourth bullet, system-level design, what do you mean by that and how does that bear on this issue of evolutionary versus revolutionary technology?

A. It has bearing because, as I've mentioned earlier, it's the total delivered cost of the product that matters rather than the individual costs of each component, at least to the final consumer, and when you make a radical departure in the DRAM design, that's going to require bigger and more changes of chipsets and other -- and logic -- system logic and other components and so that's going to also add to those costs. And it's going to be another source of cost.

Q. And finally, the last bullet on DX-146 refers to risk. What do you mean by use of that term in this context?

A. The more new something is, the more it's

going -- you're not going to be able to predict how much time is going to be necessary to make it work and how much effort and how much cost is going to be necessary to make it work. And so as a result, there's a large systemic risk associated with a radical departure from technology than with a small departure from technology, just as a general matter.

Q. Now, earlier you said that you have assumed, you have an understanding and you made an assumption about the relative success of the JEDEC standard-setting process as compared to other ways of setting standards in the DRAM industry. Do you recall that?

A. I do.

Q. As part of your economic analysis in this case, have you studied the JEDEC process?

A. I have.

Q. And is that -- is studying the JEDEC process relevant in some way to your economic analysis?

A. It is. Very much so. In fact, as I believe I've already testified, the JEDEC standards, because of their importance in the marketplace, the JEDEC standards matter to how this market behaves and how it performs. As a result, it's important for me to understand how JEDEC behaves and performs.

Q. And in terms of understanding how the JEDEC process functions, is that something that you have made assumptions about for purposes of laying a predicate or a foundation for your economic analysis?

A. I have. And I have prepared a slide.

Q. Let's go to the next slide, which would be DX-147.

Is this the slide you're referring to?

A. It is.

Q. And does this slide identify factors about the JEDEC process that have formed important assumptions related to your economic analysis?

A. It does. It does provide such -- yeah.

Q. Let's take a moment then to walk through what you mean by these various terms.

Let's start with the first bullet, diverse views/preferences. What were you referring to there and why is that relevant or important to your economic analysis?

A. As I testified earlier, many different kinds of users ultimately use the same form of dynamic random access memory, and so that's going to give rise to a situation where there are diverse opinions about what the design of, say, the next generation should be.

And just as a simple practical matter, the video -- for much of this period, the video graphics card producers needed faster RAM than the PC makers. That is, the value to the video graphics card producers for faster RAM was higher.

And so one of the factors of JEDEC is that it does represent a variety of industry viewpoints and it's not, for example, only representing manufacturers, only representing PC producers or only representing graphics card producers.

Q. And how is the diversity of views or diversity of representation within JEDEC relevant to your economic analysis?

A. It's that -- and this shows up on the slide.

It's that the outcome of the JEDEC process is going to be in some sense a consensus product, that is, a product that strikes a balance between the needs of various industry participants.

Q. The second bullet refers to choice among alternatives. What are you referring to there and how is that important to your economic analysis?

A. Well, as I said, there are -- in the first point, there are diverse views, and those diverse views are going to give rise to diverse preferences and diverse preferences when presented with alternatives,

and one of JEDEC's role in the industry is to choose among the set of alternatives available for various DRAM design technologies.

Q. And the choices you're referring to, are these choices made during the process of seeking to finalize a particular DRAM standard?

A. Well, I would have said the choices that are made during the entire process.

Q. Yes.

Then the fourth bullet, I think you may have covered the need for consensus, but the fourth bullet refers to time to market. What are you referring to there?

A. The PC industry generally runs pretty rapidly. There's been a great deal of technical change, technological change, and as a consequence, time to market is more important here than in, say, the automobile industry.

So that is, the importance of having a standard rapidly is more important -- it's more important in this industry than in, say, in many industries.

Q. And how is that relevant to your economic analysis?

A. It tends to put pressure on a fast decision

over, say, the perfect decision.

Q. The next bullet refers to cost/performance considerations. What do you mean by that term?

A. In terms of settling on technologies and representing diverse views, an important aspect of the decision-making process is what does it cost versus -- this is what economists call cost-benefit analysis. But it's what does it cost versus how well will it perform.

Q. And again, how is that relevant or important to your economic analysis?

A. Well, it guides my understanding of the decision-making process; that is to say, the nature of the technological choice will be one that has good cost-performance characteristics and again for a -- in a consensus sense, not necessarily for any one participant.

Q. Moving to the second to the last bullet, which refers to IP considerations, first of all, let me ask you, what do you mean by that term?

A. So this is proprietary or intellectual property, and we already talked about how royalties matter to the success of standards, so IP will matter in the -- will matter in this industry as well.

And I should say the speed at which this

industry moves perhaps makes IP more important, again, than in some other industries. Just there's more technological change, more technological advance, in this industry than in many industries.

Q. Going to the last point, satisficing, what does that term refer to?

A. So "satisficing" is an economic term for once you get something that's pretty good, you stop with it. That's a term I believe introduced by Herbert Simon who later won the Nobel Prize.

And "satisficing" refers to we're not going to actually get the absolute best product that's possible; we're going to get something that's pretty good, pretty much represents what the consensus view or the consensus preference is of the organization, and we're going to stop there and move on.

And it's a way of summarizing -- it's an economic term. It summarizes a kind of decision-making that seems applicable in this case.

Q. And when you say that, are you applying that term in this case based on your assumptions of how the JEDEC process works?

A. Yes.

Q. And how is that concept or how is this term relevant to your economic analysis?

A. Well, it's actually relevant in a number of respects, but probably the largest one is the choice of a technology doesn't necessarily mean it was even the best available technology. The choice was this was the first one looked at that was workable. And that is, it satisfied most of what was desired.

And part of this is driven by time to market, but that is to say, once we have a product that will do the job, we move on.

And so its importance in terms of the economic analysis is that this says generally you can't conclude from the very choice of the technology that it was necessarily even the best of the available alternatives. It just means it was in the top set or the top group. It had good qualities.

Q. Now, just to be clear, you said that the term "satisficing" is important in a number of ways to your economic analysis.

Is there something else, some other way that it's important, or did you summarize what you had to say in response to the earlier question?

A. It's important in that it's a -- it represents my understanding of the JEDEC decision process and the JEDEC decision process is itself important for understanding the behavior in this marketplace.

Q. Going back to the previous bullet, I asked you I believe what you meant by the term "IP considerations." I'm not sure that I followed up and asked you how that factor is important to your economic analysis. Could you explain.

A. Yes. IP matters because the big picture is standardization will create value, that is to say, the -- as I mentioned, the product that's in largest supply, which tends to be the standardized product, will get the die shrinks, will be -- have large investments made in it.

And intellectual property provides a route at which or provides a method by which some of the value of those investments could be expropriated, and so IP has a role because it could influence the ultimate success of a standard.

Q. Now, when you say that -- you used the term "expropriated." You said that the value of those investments could be expropriated in relation to your discussion of IP considerations.

What specifically are you referring to? Is this an economic concept?

A. Yes, this is an economic concept called hold-up.

Q. And do you have a slide relating to that?

A. I do actually have a slide from my own book.

Q. Okay. I think we have that now. This will be DX-148.

There's a quote, a quote here. Did you say this is a quote from your book?

A. It is.

Q. The book the cover of which we saw in an earlier slide?

A. That's correct.

Q. And let me ask you if you could read the quote here and then I can follow up.

A. "The hold-up problem arises because investments that are specific to another party are vulnerable in renegotiation -- the other party can extract some or all of the value of the investments. The value of specific assets -- those specific to a relationship with another party -- are vulnerable to expropriation by that other party because the assets have low or no value without the other party's participation."

Q. And is this essentially a definition of the economic concept that you referred to as hold-up?

A. It is.

Q. You refer in this language that you just read, you refer to specific investments with specific assets,

or I guess in the first line it's investments that are specific.

What do you mean by the concept of specific investments?

A. So generally what specific -- a specific asset or a specific investment is -- it's actually defined at the end of this. But it's an asset that has low or no value unless another party participates or does something; that is, it requires another party to do -- to behave in a certain way.

And I've actually prepared an example, which is a classic economic example of specific investments.

Q. Before we go to that, that example, let me ask, before we leave this slide, how is it that where there are specific investments of the sort that you've described that parties may become vulnerable to expropriation?

A. Having made a specific investment, if the terms of trade change, that is to say, if my agreements are renegotiated or I just have no agreements, then I've got a large sunk -- not necessarily large, but I do have a large -- I have a sunk asset which is now lost, and as a result I may -- the terms of trade could change in such an adverse way that the value of my investment could be lost.

And so I'm vulnerable to the loss of that -- the loss of the value of that asset.

Q. Let's go now to -- you said you had an example relating to this.

Is this the slide you were referring to?

A. It is. This is an example of what's -- well, it's the beginning of an example of a hold-up problem. This is actually referring to lock-in, which is to say, once you've made your investment, you're now tied to something related to the nature of your investment.

Q. First let me identify this as DX-149.

There is a picture on this slide of a power plant and then in the -- just to the right of that a number of different potential fuel sources are listed.

Can you explain how that information relates to the concept of specific investments?

A. Yes. Prior to building a power plant, I have a lot of choices for the nature of the energy source for my power plant, and so prior to actually making the investment in the power plant, that is, prior to starting construction, I have a lot of available choices. And in this case it lists five potential fuel sources for my power plant that I might have available.

And then what the next slide shows is that once

I've built a power plant, I'm locked into one form of energy or one source, so I'm now -- I now have an investment which is at least specific to the energy source. A coal-fired plant is going to not be able to use solar power.

Q. So let's pause here for a moment and identify this next slide as DX-150.

And following up on what you just said, am I correct that in DX-150 what you're depicting is that the power plant, hypothetical power plant in this example, has made a choice of what type of fuel that it will design the plant to use?

A. That's correct.

Q. And that choice of one of among various alternative fuel sources, is that a form of specific investment?

A. Yes. The investment would be specific to the coal-powered fuel source, and so they are now, having built the power plant, they're now locked in. If the price of coal goes up, they will be unable to shift to solar power, because even at a substantial hike in the price of coal, it won't pay to try to use solar power. It won't even be feasible much less profitable.

Q. And by that you mean that once the plant has been designed to use coal, it's difficult, potentially

costly to try to redesign the plant to use some alternative fuel source?

A. Yes. That's correct.

I might add as a practical matter, they have built plants to burn, say, oil and natural gas. Typically a coal-fired plant would not shift to any other fuel, but there are plants that can substitute between oil and natural gas, and that's actually an advantage to those plants, is that flexibility.

Q. Do you have an understanding, to refer to that, do you have an understanding as to what economic factors influence decisions of that sort to use two alternative sources in the fuel plant or power plant?

A. Yes. That provides them flexibility in the face of changing prices. When the price of natural gas goes up, as it did a couple of years ago, goes up dramatically, the plants that were able to shift to oil actually had much lower energy costs than the plants that were locked in and could only burn natural gas.

Q. Is there more to this example, of the power plant example, in your slides?

A. There is.

Now having locked the power plant into coal, we're going to ask where in the country it should be

built.

Q. And let's go to the next slide. This will be DX-151.

And can you explain, Professor McAfee, what you're depicting through this slide?

A. I should say this is the classic economic example of specific investments. Normally a coal plant wouldn't consider where to locate in the entire United States. It might try to decide where to locate in Illinois or in a smaller geographic region.

But what this slide is intended to illustrate is that there may be multiple mines and you can decide where to locate your plant and you might want to locate your plant near an inexpensive source of coal. And since transportation costs are important in the price of coal, locating near an inexpensive source of coal is a way of saving on transportation costs and lowering the total price of the coal.

Q. Is there, in this example, is there an economic basis upon which the power plant builder would likely choose among alternative locations?

A. Yes. That's illustrated in the next slide. It would look at how much does coal cost and it would typically want to locate near an inexpensive source of coal, in this case mine number 1 whose price is $10 a

ton.

Q. So other things equal, other considerations aside, economics, basic economics, would tell you that the preference, in referring to this slide which is now -- will be DX-152, that the power plant will choose to locate near the least-cost source of coal?

A. Yes. Again, other things being equal, that's true. And that's illustrated in a subsequent slide.

Q. Let's go to the next slide. I think I'm keeping track here. This one is DX-153.

This slide has a different title. It's now referring to an example of lock-in as opposed to an example of specific investment.

Let me ask you first to explain what you mean by the use of the term "lock-in" on this slide, DX-153.

A. It's essentially the same thing as a specific investment. That is to say, having located next to the coal mine number 1, mine number 1, the power plant is now locked into the use of that coal in the sense that alternative coals -- alternative sources of coal are actually substantially more expensive. That's an identical, from an economic perspective, an identical statement to it's made a specific investment in coal mine number 1 and it's locked in in the sense that it

could lose its specific investment to that mine.

Q. Well, in the context of your example, isn't it true that by locating near mine number 1, which is in your example the lowest-cost source of the chosen fuel, coal, by doing that, hasn't the power plant achieved the optimal outcome in terms of minimizing its cost of fuel?

A. Provided that it has a firm contract with that mine. This is illustrated in the next slide.

Q. This will be DX-154.

And again, you're referring to the example of hold-up, but what is it that you're seeking to depict through this slide?

A. So in this case, once a power plant is built next door, the coal mine has a great incentive to increase the price that it charges for coal. And that's because the mine -- the power plant is now locked in or has made a specific investment, and even if the price of coal goes up substantially, the power plant won't shut down. It will continue to operate and pay the higher price because that's a better alternative for the power plant than to actually shut down.

Q. If we can go back to the prior slide for a moment, in the prior slide, 153, were you making any

assumptions about whether contracts existed or when contracts were signed between the power plant and the coal mine?

A. Well, in this slide it doesn't say one way or the other whether there's a contract. It just says the power plant located next to the mine.

Q. Well, then let's go to DX-154, the next slide, and here you say in the heading of the slide that the power plant signs the contract after building. What is the significance of that?

A. Once the power plant has sunk hundreds of millions or even half a billion dollars into building the power plant, its willingness to absorb a price increase is enhanced. Essentially you can think of it's going to sell electricity for whatever it can sell electricity for.

Once it's spent hundreds of millions of dollars on the plant, an increase in the price of coal by $10 a ton isn't enough economically to put it out of business. It may render the original decision to build the power plant unprofitable, but it won't actually cause the plant to shut down; that is, the plant will still cover its variable costs, it just won't be able to pay the debt associated with its investment.

And in this case it's -- this is what's known as hold-up. Once the power plant has made its investment, the rational move of the coal mine is to actually increase the price.

Q. And is this what you meant in the quote from your book that we looked at earlier about the potential for specific investments to make parties vulnerable to expropriation?

A. Yes. This would be the expropriation of the power plant's specific investment.

Q. And it's the fact that the power plant made the investment before entering into a contract with the coal producer that made it vulnerable to the investment?

A. That's correct.

Q. And does economic theory suggest anything in terms of how parties in this type of situation can avoid or might be able to avoid this type of expropriation?

A. Yes. One method of avoiding expropriation, which is shown on the next slide, is to contract in advance or do what's called ex ante contracting, contract before building the plant.

At that time the power plant still has viable alternatives in the form of other locations, and it can

threaten the coal mine with -- the mine number 1 with the alternative of building elsewhere. Once it's built, it's now locked in to its geographical location and that threat is now empty.

And so by contracting prior to the building of the mine, the power plant contracts when it still has a great deal of bargaining power.

Q. Are these concepts that we've been discussing, specific investment, lock-in, hold-up, the manners of avoiding hold-up, are these concepts that are addressed in the economic literature?

A. Yes. These are very important and central concepts to industrial organization. And I've prepared a slide with a few references, a few of the more important references in that literature.

Q. Let's go to that. This would be DX-155.

I don't want to ask you to summarize the detailed contents of these various articles or books that you are referring to here, but generally speaking, do you have something to say about these or other portions of the economic literature relating to hold-up?

A. Yes. The first paper represents one of the most popular economic theories of vertical integration, and I think it's fair to say that in both the Grossman

and Hart and the Williamson book and actually other works of Oliver Williamson, they have subsumed the entire economic theory of organizations and of corporations to the question of hold-up. That is to say, hold-up is central to the understanding of how firms are organized.

MR. ROYALL: Now, before we go any further, I just want to make sure that we have identified the right demonstrative exhibit numbers.

I believe that this exhibit that we now have on the screen, the economic literature on hold-up, would be DX-156.

MR. STONE: You skipped the earlier one entitled Avoiding Hold-Up before which was DX-155.

MR. ROYALL: The avoiding --

MR. STONE: The Avoiding Hold-Up should be DX-155.

MR. ROYALL: Thank you. So the prior slide Avoiding Hold-Up will be DX-155.

BY MR. ROYALL:

Q. Professor McAfee, have you, as part of your work on this matter, part of your economic analysis, considered whether the hold-up problem that you have described has application in the context of standard-setting?

A. I have.

Q. And what, if anything, have you concluded in that regard?

A. I've prepared a slide which sets out the broad conclusions.

Q. Let's go to that.

Is this the slide you're referring to?

A. It is.

Q. This would be DX-157.

And can you explain what you're seeking to convey through this slide?

A. This slide lists the most important factors for the risk -- associated with the risk of hold-up for a standard-setting organization. And in particular -- so these are actually common from the hold-up literature itself.

The size of the specific investments matters; so that is to say, how big are the investments in the standard will matter.

How costly it is to change the standard, that corresponds to how hard is it -- in going back to the previous example, it would correspond to how hard is it to move the power plant once it's been built.

The importance of intellectual property would be the risk of hold-up associated with intellectual

property, and the more important is intellectual property, the more at risk the standard would be at being held up by intellectual property.

And finally, the ease of reaching agreement would have a bearing again on the cost of changing the standard. That would be another factor on how hard it would be to get out from under intellectual property that whose purpose was to hold up the standard.

Q. And are these factors that the economic literature suggest have bearing on whether a hold-up is likely to be a problem in any given industry?

A. Yes. These would be -- well, other than the importance of IP, since normally hold-up is coming through other means besides intellectual property, these would be the standard analysis of risk of hold-up in any industry.

Q. And have you as part of your economic analysis reached conclusions as to whether these factors are present in the DRAM industry?

A. Yes, I have.

Q. And have you reached a conclusion as to whether the existence or presence of these factors in the DRAM industry creates a risk of hold-up?

A. I find that it does.

Q. And you in your example earlier, the coal mine

example, you ended by explaining that economic theory suggests that there are ways to avoid the hold-up problem when it exists.

Have you considered whether in the standard-setting context economic theory suggests any way or ways to avoid the type of hold-up problem which you describe?

A. Yes. In the power plant example, the method of avoiding hold-up that was illustrated was to sign contracts prior to building the power plant, that is, ex ante contracts.

In this case -- and I prepared a slide -- it would be to try to prevent the hold-up of the standard ex ante in much the same way.

Q. Let's go to the next slide, and this I believe will be DX-158.

This is the slide that you have entitled Application of Hold-Up to Standard-Setting, and then below that you refer to mechanisms for mitigating risk of hold-up ex ante.

Are what you list below that -- let me just ask you to explain what are you seeking to convey through the list of items that you have on this slide.

A. So the parallel to contracting in advance would be to try to contract on IP in advance. And these are

three different levels of advanced contracting that one might imagine not necessarily JEDEC but any standard-setting organization adopting.

You could imagine them just requiring disclosure, requiring licensing, and requiring searches to establish the disclosure was actually full.

Q. Let me ask you briefly about each.

How would, in the context of a standard-setting organization, how would requiring IP disclosure or disclosure commitments mitigate the risk of hold-up?

A. It would help ensure that if intellectual property was included in the standard, it was done so in a conscious and deliberate manner.

Q. What about the next point, IP licensing commitments?

Well, before I ask you about that, let me ask you to define a term. In the second of the three subbullets you use the term "RAND," R-A-N-D. What are you referring to by that?

A. That's reasonable and nondiscriminatory contracting. And it's a restriction on the kind of licenses that can be offered.

Q. Now, how can IP licensing commitments or the source of RAND or reasonable and nondiscriminatory

licensing commitments that you've described, how can that mitigate the risk of hold-up in the context of a standard-setting organization?

A. Well, let me give a more extreme example.

If the licensing commitment was for free licensing, that would completely eliminate the risk because it would say any participant agreed to give their IP away and not charge for it, so there's no mechanism by which hold-up would occur.

RAND is a less severe, substantially less severe requirement for licensing, and so it's not going to eliminate the risk of hold-up, but it might mitigate or reduce the risk of hold-up.

Q. And finally, the last subbullet refers to IP searches. How is that concept something that relates to the potential for mitigating the risk of hold-up in the standard-setting context?

A. So in addition to disclosure requirements, you could have a standard-setting body actually search for intellectual property or have a requirement for the members to search for intellectual property, and that would be a way of providing more -- identifying more potential intellectual property and hence reducing the likelihood that the standard is held up.

I should say that numbers 1 and 3 on this --

they're not numbered, but the items 1 and 3 on this list, both of those refer to ensuring that the standard-setting organization has better information and makes deliberate choices and is then not held up after the fact by making inadvertent choices that embody intellectual property.

Q. And is the existence of information or wholesome information in any way important to mitigate the risk of hold-up?

A. Yes. The better the information, the better the choices that will be made, as a general economic matter.

Q. Now, you explained earlier that it has been important to you in conducting your economic analysis to gain an understanding about and to make assumptions about how JEDEC's process works.

Have you gained an understanding or made any assumptions about how JEDEC's process works with respect to any of these issues that are listed in DX-158, including IP disclosure, licensing commitments or intellectual property searches?

A. I have. My understanding -- and again, this is an assumption more than a conclusion -- is that there are both disclosure requirements and disclosure commitments and RAND licensing commitments expected of

JEDEC members.

Q. Let's go to the next slide, which will be DX-159.

Does this slide, DX-159, set forth your understanding and assumptions or certain assumptions relating to the manner in which IP disclosure is dealt with in the context of JEDEC?

A. Yes, it does. These are assumptions that I've made on IP disclosure for JEDEC.

Q. And before we go through the assumptions, can you explain how these assumptions or -- how these assumptions are important to your economic analysis, or just to state that differently, why it was important for your economic analysis to make assumptions relating to this general issue?

A. Well, one of the important issues, one of my list of important issues, involved whether or not it made a difference, Rambus' conduct made a difference, and if there were no requirements for disclosure, I don't see how the conduct could have made a difference.

And so that -- so in particular, it plays a role in that, in that finding. But as I said, these are assumptions, not my conclusions.

Q. Well, let's go through and just make sure we're

clear on what assumptions you are making.

Referring to the first bullet point, which states "preference to avoid patents," what assumption are you making relating to that and how is that important to your economic analysis?

A. So I'm assuming that JEDEC has a preference for avoiding patents, which I understand to be an expression of the hold-up problem; that is to say, a patent creates a risk of hold-up and a preference to avoid patents would be a natural consequence of the threat of hold-up.

Q. Referring to the second bullet, early disclosure/good faith, what do you mean by that and how is that important to your economic analysis?

A. Well, early disclosure is important also in avoiding hold-up because it gives the committee, the JEDEC committee, a better chance to avoid hold-up. The earlier they know, the better their decisions will tend to be.

So that's actually an economic statement. The disclosure requirement that goes along with that economic statement is one for early disclosure and one for full disclosure.

Q. What about good faith? What do you mean by that and how is that relevant to your economic

analysis?

A. That's in essence a -- actually let me back up and say I don't actually see any evidence -- I see contrary evidence that JEDEC requires searches; that is to say, there have been witnesses who have said JEDEC does not require searches.

So in the absence --

JUDGE McGUIRE: Mr. Stone?

MR. STONE: Oh, I didn't mean to interrupt. I will wait.

BY MR. ROYALL:

Q. If you could complete your answer.

A. In the absence of a requirement for searches, it would help in avoiding hold-up to have a requirement of providing as much information as you actually have access to.

And so that's the -- that's my understanding as to good-faith requirement, that is, to not try to change the outcome of the process by manipulating it.

Q. And let's go then to the next, to the third bullet point, where you say, "Disclosure applies to patents/patent applications relevant to JEDEC standards/work."

What do you mean by that language and how is that important to your economic analysis?

A. So this is stating what must be -- what I understand to be required, and the form of disclosure is intellectual property that might ultimately permit hold-up.

That is to say, what's -- so the only thing that can be held up are the actual standards, and so it would be intellectual property relevant to the standards and it would include both patents and patent applications as either one ultimately permits hold-up.

Hold-up is obviously something that happens in the future, not immediately, and so patent applications, because they tend to lead to issued patents, give scope for hold-up.

Q. Going to the next point, you've already defined what you mean by the term "RAND." You make two points in the fourth bullet point. Let me take them separately.

The first one is you say "mandatory for JEDEC." What do you mean by that?

A. That is to say, if JEDEC is aware of intellectual property, it's not supposed to incorporate that intellectual property into a standard absent a guarantee from the intellectual property owner of a reasonable and nondiscriminatory licensing.

Q. And that's an assumption that you're making as

to how JEDEC's process works?

A. That's correct.

Q. And what do you mean by the latter part of that same bullet point where you refer to the "voluntary for members"?

A. A member is not obliged to offer a RAND agreement. That is to say, it is my understanding and my assumption that a member may/can choose to either offer a RAND license or not as they see fit.

However, when combined with the first assumption, what that means is if the member fails to offer a RAND license, JEDEC is forbidden by its own rules to incorporate that intellectual property into a standard.

Q. And how are those understandings or assumptions relevant to your economic analysis?

A. I will find it necessary to ask a question of whether Rambus would have offered a RAND license had it disclosed, and as a consequence, it's important for me to know both was it required to and, second, what consequences does the failure to offer a RAND letter have for JEDEC's decision-making process.

Q. And finally, the last bullet point refers to valid technical justification. What do you mean by that and how is that relevant to your economic

analysis?

A. My understanding of the JEDEC rules is that they prohibit -- and again, this is an assumption -- they prohibit the incorporation of intellectual property, proprietary intellectual property, absent what is called a valid technical justification, which my understanding of that is that there has to be sort of a showing that it's needed or a conclusion within JEDEC that the technology is needed or that it's well-justified.

Q. Earlier in discussion of an earlier slide and just -- I don't think we need to go there, but for the record, I'm referring to DX-157 -- you listed four points that are relevant in determining whether in a given industry there may be a risk of hold-up. I didn't ask you to go through each and to state whether or how you found them applicable to the DRAM industry, but I think you may have a slide that does that or that relates to that.

Let's go to the next slide. This is DX-160.

And you list here the same points that were on DX-157, but I think you may be conveying some additional information here, so let's walk through that quickly.

Referring to the first bullet, size of

specific investments, and below that you have a check mark and the word "substantial." What do you mean by that?

A. Just that specific investments, that is, investments that are specific to particular standards, are quite large. You have a large number of companies who are making substantial investments in the specific technology and hence the size of specific investments is in the hundreds of millions of dollars, is a very large number.

Q. And all of these points you're making here are with reference to the DRAM industry specifically; is that correct?

A. That's correct. This is a threat to the DRAM investment from hold-up of the standard-setting process.

Q. The next bullet is "cost of changing standards" and below that you refer to switching costs. What do you mean by that?

A. This is just the cost of changing the standards is quite substantial in the sense that a large number of components all have to be changed, redesigned. There are testing costs, qualification costs, a large variety of costs, some of which we talked about this morning, to changing the standards. So those costs

tend to be substantial.

MR. STONE: Your Honor, could we just be clear we're still on the assumptions or understanding of this witness, not -- he's not testifying now to factual conclusions that he's drawn?

MR. ROYALL: I would like to clarify that.

I am asking Professor McAfee in the context of this slide about conclusions that he has drawn on economic issues predicated on assumptions about facts. I'm not asking about assumptions here.

MR. STONE: Your Honor, then I think this is an issue on which, if these are his conclusions, then he hasn't established that he has a foundation to draw these conclusions and these conclusions are outside his area of expertise.

MR. ROYALL: Well --

MR. STONE: I think these can be assumptions. I think these could be assumptions for his conclusions as an economist, but I think saying that this is the cost of changing a standard, so in other words purporting to actually have knowledge of the cost of changing from one standard to another, is something I don't think he has a foundation to testify to.

I had understood this -- and I apologize for not trying to clarify it sooner -- that this was simply

a summary of the assumptions that he had testified to earlier. If in fact he's drawing a conclusion, then I don't think there's been a foundation laid that he has a basis on which to draw this, other than the assumptions. And if this is simply a summary of the assumptions, the factual assumptions he made earlier, then I don't have an objection.

JUDGE McGUIRE: All right. Mr. Royall?

MR. ROYALL: I think we're not really in disagreement here, that -- I think if by re-asking the question I can --

JUDGE McGUIRE: All right. Good.

MR. STONE: Thank you.

BY MR. ROYALL:

Q. Relating to this slide, which I think we've previously identified as DX-160, what are you seeking to convey through this slide?

A. So I'm certainly not seeking to convey that I'm the factual witness on the cost of changing the technology. Rather, in trying to understand whether the DRAM industry is subject to hold-up, I identified the economic factors that were important, and in this slide I have actually summarized facts that have bearing on those -- on that economic analysis.

So when I say "substantial," it's a fact

question about whether it's substantial and it's an economic question about whether that matters to the threat of hold-up, in particular, the size of specific investments.

So my role as an economist I would say is to list the factors with the blue squares and the conclusion is drawn when added -- when the facts are added.

Q. Well, and the conclusion that you're seeking to convey here, if I'm not mistaken, is the conclusion that, based on these factors and what you're assuming about the facts as they relate to these factors, you have drawn the economic conclusion that the hold-up problem that you described is a problem that exists or that is relevant in the DRAM industry?

A. Yes. That the risk of hold-up is high within this industry and for these standard-setting issues.

JUDGE McGUIRE: Okay. Mr. Stone, does that satisfy your objection?

MR. STONE: Let me just -- Your Honor, let me just see if I can clarify my understanding maybe what I mean by this, to try to speed it up.

If the witness is saying there are four economic factors indicated by the blue squares, size of the specific investments and so on, and the that if the

court were to find that those -- the size was substantial, the switching costs were high, the IP importance was high and the ease of reaching agreement was difficult and time-consuming, as he will explain what he means by those terms, then as long as the fact-finding is something that's left to the court and he's only saying "Given these factors, if the facts are found that way, and I'm assuming they are, then you should draw this conclusion," then I really have no quibble with what he said, and I thought that's what I just heard him say and I --

JUDGE McGUIRE: Even if that's not quite what he said, ultimately that's going to be my determination in any event. Is it not?

MR. STONE: Right. I just don't want to have to cross-examine on him on costs that he's assumed.

JUDGE McGUIRE: Are we all clear on that? Is that the import of his testimony, Mr. Royall?

MR. ROYALL: I think we are, Your Honor. He will certainly -- as we get further into the testimony I expect he will have things to say from the standpoint of economics about whether the costs that he assumes exists or sees -- made assumptions about, whether they constitute switching costs and how that relates to hold-up.

JUDGE McGUIRE: I just want to make sure the two of you are on the same page, and if that will save some time on cross, let's clear it up.

MR. STONE: And I think Mr. Royall later may go into this, and I'm not saying anything now that prevents him from doing it later.

When I did say a moment ago -- I know we're all being so careful with our words -- when I said I have no quibble with that, what I meant was I have no quibble with this witness' expertise to express opinions as to the four economic factors, not that I agree with his opinions, just so I don't get misquoted later.

MR. ROYALL: And I think, Your Honor, I think certainly for purposes of this slide, I think we have an understanding that I'm eliciting what factual assumptions he has made relating to these points that bear on his economic conclusion that hold-up is a problem in this industry, and there will be later issues that we'll get into where I think we may need to parse these assumption and conclusion issues --

JUDGE McGUIRE: And the court understands that distinction at this point.

BY MR. ROYALL:

Q. So then, Professor McAfee, I don't want to

belabor this or spend too much more time on this particular slide, but I think you've explained what you're seeking to convey through this slide.

Can I -- would it be fair to say that the bottom line in terms of what you're seeking to convey through this slide is that based on the understanding that you have about these factors in the DRAM industry that you have concluded that the hold-up problem is, from an economic standpoint, is a problem that arises in the context of the DRAM industry?

A. Yes, I have.

Q. Let's move on to something else then.

Let me ask you, from the standpoint of economics or economic theory, does it matter within the standard-setting context whether IP disclosure occurs early or late in the process?

A. Generally it matters a lot.

Q. And if I could ask you to explain why from the standpoint of economic theory it does matter a lot whether IP disclosure occurs early or late in the process.

A. I have actually prepared a series of slides that will address that point.

Q. Let's go to the first one of those, which we will mark as DX-161.

Can you explain what you're seeking to convey through this slide?

A. Yes. This slide shows three possible technologies all as candidates for standardization or for incorporation into standardization and illustrates the standard-setting process with a funnel, which will be the motif that will be followed through the remainder of the slides.

And this is actually an action slide, is it not?

So this is actually just introducing the funnel.

Q. Well, let's pause for a moment and just identify -- you said that there's some motifs that are represented here that are reflected in later slides. Let's make sure we identify what you're seeking to convey.

Let's start with the funnel. What is it precisely that you're seeking to convey through depicting the standard-setting process as a funnel?

A. The standard-setting process tends to narrow the choices as choices are made, and so this is using a funnel to depict that process in the sense that only one of the candidate technologies will be selected.

Q. And what are you seeking to depict through the

three blue arrows pointing into the funnel?

A. Those are candidate technologies which might be used for standardization.

And if I could give a specific example, think about battery size. This could be the size of the battery, it could be the voltage of the battery, it could be any of the specifics of a battery.

Q. So we're clear on that, by that are you suggesting that if the standard-setting process that we were focusing on was, let's assume, a process through which the battery industry were setting standards about the voltage of batteries, then what you would be depicting through the three arrows would be alternative proposals as to what voltage should be identified as the industry standard?

A. That's correct.

Q. Now, I understand you do have a series of slides here. Let's go to the next, which we will mark as DX-162.

Can you explain what you are seeking to depict through this slide?

A. So this slide shows the standard-setting process actually involves selection of multiple features. Here we have feature 1, feature 2 and feature 3, each of which in this example have three

candidate technologies.

For example, feature 1 has candidates A, B and C.

And the standard-setting process requires selecting each of a technology or a choice for each of the features.

And so in the battery example, the choices are being narrowed to two each. In the battery example, the choices might be both voltage, length, diameter of the battery, would represent three different selection choices.

Q. And as you were speaking, the -- this is an animated slide -- three of the arrows dropped down and changed colors in the process to white.

What are you seeking to depict through that animation?

A. There, the choices have been narrowed, so for example, with feature 1, there's been a consensus that A or B is a better choice than feature 3 and so that -- excuse me -- than feature C, and so for feature 1, choice C has dropped out of the running and we're now down to the choices of A or B; that is, there are two choices left. And similarly for features 2 and 3.

Q. So keeping with the example here that you're illustrating, certain alternative proposals for these

certain -- for these features have been dropped out or rejected in the process, and the standardization body is still considering for each of the features identified -- at least in this case they're considering two alternatives still for each of those features; is that --

A. That's correct.

Q. -- right?

Now, is there further animation on this slide? Let's do that.

Can you explain in the animation that just occurred in the movement of three of the arrows what you're seeking to depict?

A. The selection process now has selected feature B for -- excuse me -- technology B for feature 1, technology F for feature 2, and technology G for feature 3. That is, the standard-setting funnel has actually picked one of the three technologies for each feature.

Q. And are these, these technologies, B, F and G, which went through the first series of funnels, have those, in this example, have those features become a standard yet or is there still something more that has to happen?

A. Not yet. They've been selected as the leading

feature, but at this point the standard-setting process has not produced the final standard.

Q. And in this -- in this view of DX-162, what are you seeking to depict as to alternatives A, E and I?

A. Well, they have not dropped out yet, so the process of dropping out is for them to fall to the bottom and they are not selected, they're not the leading candidate, but they're still there.

Q. Let's then go to the next level.

We just witnessed a further animation of DX-162. What were you seeking to depict through that?

A. Well, at this point features B, F and G have been incorporated into the final standard and that standard is now set, and so at that point the remaining candidates have now fallen aside.

Q. And by showing the remaining arrows falling to the bottom and changing color, are you again seeking to depict those alternatives were rejected in this particular standard-setting process?

A. That's correct.

Q. Do you have another slide that relates to that --

A. Yes, I do.

Q. -- example?

Let's go to that.

This -- is this the beginning slide?

A. So that wasn't quite what I expected to happen.

Q. I'm not sure that --

A. So but --

Q. Let's first identify this. This is DX-163.

And is this -- do we have the initial view of this slide up?

A. There they are.

Q. Now I believe we have the initial view in this slide and this again is animated.

What are you seeking to convey through the initial view of DX-163?

A. Well, this is a reprise of the earlier slide with three candidate technologies, although it's also added the process has moved on some in that there are some rejected technologies lying at the bottom, which are actually labeled D, E and F, but I can't actually read that on the screen.

Q. Is there another view of this slide?

Okay. And in that animation that just occurred which leaves only the C arrow at the top, what were you seeking to depict?

A. So technologies A and B in this case have not

been selected, C has been selected and it will move through the standard-setting process.

Q. Let's see that view.

A. And become part of the standard.

At that point the value of C tends to rise, which is illustrated by this green -- the appearance of this green dollar sign down below, because C now is incorporated in the standard. And the value is going to rise only insofar as that standard becomes successful, but it's going to -- that's going to tend to rise because of its incorporation in the standard.

Q. And that concept, the concept that an alternative selected through a standard-setting process and embodied in the standard, that that alternative increases in value as a result of standardization, is that something for which there is some economic underpinning or rationale?

A. Absolutely. In fact, I suspect that every economics article on standardization has the statement that standardization confers value or may confer value. Certainly that's in most of them if not all. That's a common economic conclusion.

And the source of it is actually quite simple to explain. It's just that the standardization, because it becomes a popular product through

standardization or insofar as it becomes a popular product through standardization, that increases the value of the components of the standard.

Q. And is that the basic point you're seeking to convey through this slide, DX-163, the economic concept that standardization confers value?

A. It is.

Q. Let's go to the next slide. This will be DX-164.

Can you explain what you're seeking to convey through this slide?

A. Well, this slide has added another component. The standard-setting process is still represented by a funnel as in the previous slides, but what this standard -- what this slide adds to that is over time, as the standard is rolled out, that is, as the standard is adopted and the industry uses it, so over -- time is on the bottom axis -- over time as the standard is rolled out, the value of the standard tends to rise.

So you'll see the dollar signs indicating the value associated with the standard or with control of the standard, and as plants are designed, as compatible feature or compatible products are introduced, because as -- as manufacturing arises, all of that is going to

tend to increase the popularity and the importance of the standard and create an enhanced value for each of the features in the standard.

Q. There are four smaller green arrows in the left-hand side of this exhibit, DX-164. What are you seeking to convey through those arrows?

A. Those are the -- they convey the things that develop over time or the items that develop over time that tend to be industry commitments to that standard.

So this is compatible parts, plants being designed, investments in interoperability and finally manufacturing of the products. All of these things are specific investments to the standard.

Q. Does this slide have anything to do with the term "lock-in" that you've used earlier?

A. It does. The specific -- as I said earlier, specific investments create lock-in, and these are the specific investments, which then lead to the industry being locked into the standard and it's locked into the extent to which it's made investments specific to the standard.

Q. And you used the terms in this slide, DX-164, you used the terms "ex ante" and "ex post." Can you explain what you mean by use of those terms?

A. Yes. As you can see in this slide, time is

actually a continuum, and in fact that's the best economic model of the phenomenon. But generally, early in the process, what's known as the ex ante period, there has been little or no investment or a small amount of investment in the standard. The industry is not very locked into the standard and it's made few specific investments.

Over time and at some point that I'm referring to as ex post, the size of those investments has grown, and the more time that goes by, it tends to be the larger the specific investments to that standard itself.

Q. You'll recall that we started discussing these slides when I asked you about the economic implications of early versus late disclosure of intellectual property in the context of a standard-setting organization.

Does this slide bear on that issue?

A. It does.

Q. And how does it bear on that issue?

A. Early -- in the left -- and this is actually illustrated beginning with the following slide.

Q. Let's go to the next slide. This will be DX-165.

A. Early in the process, prior to the specific --

Q. Okay. We have this up. Is this the slide you're referring to?

A. It is.

Q. And this relates to what you have to say about early disclosure of IP in the standard-setting process?

A. Yes. Early in the process, so indicated with the red flag early on, early in the process or in the ex ante period, there have been few investments, so that's to the left, few specific investments, and the industry is not -- has very little exposure in the form of specific investments or locked in to this particular standard. And so early in the process, disclosure permits the industry to revise the standard if needed.

Q. And can early disclosure of IP, depending on the factual circumstances, alter the outcome of a standard-setting process?

A. Yes. That's correct. And I've illustrated that with another slide that involves scales.

Q. Let's go to that. This is DX-166.

Can you explain to us what you're seeking to convey through this slide?

A. Yes. In this slide there are two technologies A and C that are being considered for incorporation

into a standard. The assumption is that the red technology C has intellectual property attached to it and it is the winner absent patent disclosure; that is to say, it is the selected technology.

Once the disclosure occurs, that is, once it's found out that C has intellectual property attached to it and A does not, as a method of avoiding hold-up and risks, the industry chooses or the standard-setting organization chooses technology A, and so that is A is the selected technology with disclosure.

Q. Now, through this slide are you meaning to suggest that anytime that intellectual property is disclosed within a standard-setting organization that it will in fact alter the balance of considerations causing one alternative to be chosen over another?

A. No, I'm not. And in fact, if the technology C was sufficiently superior to the technology A and at least in the JEDEC case if it came with a RAND assurance, then in fact it might be selected in spite of having intellectual property, and of course there are standards that embody intellectual property.

Q. So the point that you make --

MR. STONE: Your Honor, I rise only to make clear that his statement about JEDEC is simply a statement of his assumptions again, not that he's

testifying to the state of mind of JEDEC members or other areas covered by the in limine.

MR. ROYALL: I'm happy to make that clear, that we do not intend to elicit nor do I believe that Professor McAfee intends to testify as to any issues relating to the state of mind of JEDEC members.

JUDGE McGUIRE: Noted.

MR. STONE: Thank you, Your Honor.

BY MR. ROYALL:

Q. Before we leave this slide, just to make it clear, all you're seeking to depict through this slide is that early disclosure of intellectual property in the context of a standard-setting process can alter the outcome of the process; is that a fair statement?

A. That is a fair statement.

Q. From the standpoint of economic theory, is there any preferred time for IP disclosures or intellectual property disclosures to be made in a standard-setting process?

A. Yes. As I believe I testified earlier, the earlier actually any economic agent, not just a standard-setting organization, has access to information the better. Decisions with early information is good, but the earlier the information, the better.

Q. And do you have a slide relating to that?

A. I do.

Q. Let's go to the next slide. This will be DX-167.

Can you explain, Professor McAfee, what you are seeking to depict through this slide?

A. Well, in the context of several of -- of a series of slides, this slide is going to illustrate very early revelation of relevant information, so that is to say before the decision is made, and it's illustrated in this way by having a red flag before the funnel, that is, early in the process. And on the -- towards the left of the process. And that's going to cause the standard that has intellectual property attached to it, in this case C, not to be selected.

And here what's happened now is that A has been selected.

Q. When disclosure of intellectual property occurs early in the standard-setting process, does that give rise to opportunities within the process that would not exist or might not exist if the disclosure occurs later?

A. That's correct. That allows for a deliberation that involves better information.

Q. And do you have a slide that seeks to depict that concept?

A. Yes.

Q. Let's go to the next slide. This is DX-168.

And could I ask you, Professor McAfee, to explain what you're seeking to depict through this slide.

A. This slide depicts a disclosure that occurs middle way through the process, that is, after the -- after some amount of deliberation has already occurred. And what happens in this slide is that first the technology C is the leader, then the disclosure occurs, but because it's not -- it's still in the midst of the process, technology A will then go on to win the -- to be selected.

Q. And you refer in the title to this slide to the term "work-around." What are you referring to by that term?

A. Yeah. So let me say that I've actually assumed with JEDEC that the process takes time and effort on the part of the participants, that is to say -- this is a factual assumption on my part -- that when proposals are made, they actually go back to their labs and examine how that proposal affects them.

And having made that assumption, the later in

the process, the more effort that's been devoted to candidate technologies without full information, but if it's not too late in the process, there's still time to actually investigate alternatives, and that's what this refers to as a work-around option.

Q. And when we saw the animation earlier of this slide, DX-168, as alternative A went through the funnel, I believe the balance at the bottom of the slide shifted with A dropping down and C moving up.

What are you seeking to convey through that?

A. Well, this is a reflection of the earlier slide in which the revelation of intellectual property shifted the balance from technology C to technology A, and as I said, that's -- can happen. It need not be the outcome of the -- in that case.

Q. So we've talked now about, in terms of economic theory and this hypothetical context, the benefits of early disclosure.

What, if anything, does economic theory suggest about the consequences of late disclosure of intellectual property in a standard-setting process?

A. Well, I've prepared a slide on this.

Late disclosure which I'll refer to as ex post disclosure after the investments are made exposes an industry to hold-up.

And so in this case, late disclosure after complementary products have been developed and investments made in plant and equipment exposes the industry to classic hold-up as we've discussed.

And you see that depicted in this diagram by the increasing size of the dollar signs. Those are the values of the technology.

And I should say the value of the technology that's depicted there is meant to represent the value that's been conferred by the standardization itself. The technology of course may have additional value in some other application.

Q. I think you have a second slide relating to the concept of late disclosure. Let's go to that. This one, by the way, I believe is DX-169. If we go to the next slide, this would be DX-170.

A. So in this case no ex ante disclosure or no early disclosure is made. As a consequence, following the earlier examples, technology C will be selected, and then at the time the disclosure is made, the industry has made specific investments and is now locked into that technology.

Q. And by "lock-in" in the context of this slide, DX-170, are you referring to the fact that when the industry learns that the alternative that it chose or

that the standard-setting process chose as its standard, when it learns that that technology or that alternative is subject to a patent that it, the industry, has already invested substantial specific investments relating to that standard?

A. Yes. That is the -- that is what I mean by "lock-in. Specific investments in the plant and equipment, complementary goods and other investments that are specific to that technology.

Q. And in that situation, understanding that you're discussing these issues in a hypothetical context, but in that situation, when it occurs, what, if anything, does economic theory tell you about whether the industry can go back and resurrect alternatives A and B which were rejected in the initial standard-setting process?

A. Well, generally the industry has suffered or experienced lock-in to that standard and the size of the lock-in is measured by the size of those specific investments. So the industry might be able to go back to technologies A and B, but not without losing the specific investments.

Q. And you've talked earlier about hold-up and about the potential to be vulnerable to expropriation.

Does that condition in the context of this

hypothetical, does that condition exist in what you're depicting here?

A. Yes, it does. It's a consequence of hold-up. The problem of hold-up is the vulnerability to expropriation and the size of the vulnerability is the size of the specific investments that have been made.

Q. And in the example that you depict in DX-170, specifically whom is vulnerable to expropriation?

A. Well, the users of the technology, which would be all those who have made specific investments in the technology, would be the ones vulnerable to the expropriation of the size of the specific investments.

Q. And what is the nature of the expropriation that they're vulnerable to?

A. It's charging royalties that are beyond the ex ante value of the technology but are conditioned on the specific investments that have been made.

Q. And when you say that they're vulnerable to expropriation by being forced to pay royalties that exceed the ex ante value of the technology, precisely what do you mean by "the ex ante value of the technology"?

A. The ex ante value is the amount that the industry participants would have been willing to pay to use C over its best alternative, which ex ante were

technologies A and B in this example. And ex post, the value is that same value over the technologies A and C plus the entire specific investment that's been made in the technology -- into the standard.

Q. And just to follow up on that last answer, when you said that the ex ante value is the value that the participants would have been willing to pay for C over its best alternatives, by that do you mean the value that the participants would have been willing to pay for C if the participants had known at the time of the standard-setting process that that technology was subject to patents?

A. That's correct.

MR. ROYALL: Your Honor, this would be a convenient point for me to take a afternoon break. I don't know if others are ready for a break.

JUDGE McGUIRE: I think we're all ready for a break. Let's take a ten-minute break.

MR. ROYALL: Thank you.

(Recess)

JUDGE McGUIRE: You may proceed, Mr. Royall.

MR. ROYALL: Thank you, Your Honor.

BY MR. ROYALL:

Q. Professor McAfee, you'll recall that earlier today you identified for us five what you've termed

key economic questions relating to your assignment in this case of an economic analysis that you've conducted.

And the first one of those was the question: What are the relevant antitrust markets in this case?

And I'd like to turn to that issue now.

Let me ask you as a starting point, can you explain to us precisely what a relevant market is or relevant antitrust market is and what role definition of such a market plays in an economic analysis of the sort that you've conducted?

A. Yes. And I've prepared a slide to that effect.

Q. Okay.

A. Market definition -- I think we talked briefly about this morning -- is -- concerns setting the scope of competitive activity, defining the technologies, products and firms who are relevant to the analysis.

So it defines the scope. It also defines a context for performing analysis. It's the setting. It's the environment in which -- which is analyzed.

Q. You say in this slide, which we should identify it as DX-171, you say in the third bullet point, your words are "common starting point for economic analysis and antitrust-related inquiries."

What do you mean by that?

A. This is the normal starting point for really any antitrust or investigation, economic investigation of an antitrust matter. It's in the Department of Justice and the Federal Trade Commission Merger Guidelines. It's the beginning point of most if not all antitrust economic inquiries.

Q. You talked earlier about matters that you've worked on as a consultant, other than this matter, as a consultant to the Federal Trade Commission, such as the Exxon-Mobil merger, the BP-ARCO merger.

In those matters, did your economic analysis involve definition of relevant markets?

A. Yes. And in both matters relevant market was required.

Q. And without going into identifying the specific matter, but in the other consulting, private consulting matters or litigation-related matters that you've been involved in in the antitrust area, have you typically started your economic analysis with the definition of relevant markets?

A. Yes. That would be the normal starting point and I've even been -- dealt with matters in which I was defining technology matters that began with market definition.

Q. We'll come to that in more detail, but you did mention earlier today that the markets that you've defined are technology markets --

A. That's correct.

Q. -- is that right?

And what other matter or matters other than this case have you been involved in in which you've defined relevant technology markets?

A. There was a relevant technology market in the BP-ARCO merger concerning oil exploration technology.

In addition, I worked on the Lockheed-Northrop merger, which in the end was not consummated, and in that case all of the markets that were involved were technology markets.

Q. Are there contexts in which an economist is able to render opinions or conclusions about such things as market power and anticompetitive effects without defining a relevant market?

A. There are such contexts.

Q. Can you think of an example?

A. In some cases you can actually observe the exercise of market power directly and you're not in a position where you need to infer the exercise or conclude the existence of market power but in fact can see the effects of market power directly.

But this is not one of those cases.

Q. You say that this is not a case in which -- if I'm understanding you correctly, you as an economist are able to render opinions and conclusions about market power and anticompetitive effects without defining a market; is that your --

A. That is correct.

Q. -- point you're making?

A. Yes.

Q. And why in this case is it necessary in your view, if that's the point you're making, to define a relevant market before you can render conclusions, economic conclusions about market power and anticompetitive effects?

A. Well, the nature of exclusionary conduct is the elimination from the marketplace or the threat of elimination from the marketplace of equal or superior competitors. If you haven't identified the market, you aren't in a position to say whether alternatives have been excluded or not.

Q. Is there any well-accepted methodology among economists for defining relevant markets in antitrust cases?

A. Yes. And I have prepared a slide illustrating that methodology.

Q. This slide I believe will be DX-172.

Let me ask if you could to explain -- start with the first point -- explain what you mean here when you say that the analysis starts with market hypothesis.

A. This is an approach which is iterative in nature. That is, it starts out with a market hypothesis and then seeks to say is that -- and tests whether that hypothesis actually constitutes or comprises a market, and if not, it adds products or technologies to the market and then goes back and tests again is this a market, and so in that sense it's a self-referential or a looping definition that works like a computer program in some sense as a method.

And so it starts with a market hypothesis, which you would -- your natural starting point is whatever the relevant product or products -- the product or products that are relevant to the issue at hand, so in a merger, it tends to be products that are produced by both firms.

In this case it's the challenged technologies that I start with.

Q. And when you say that typically the market definition process starts with the product or products

at hand, does that relate to your second bullet point?

A. That's correct. You tailor the initial hypothesis to the antitrust issues under consideration, so as I said, in a merger, it would be the relevant -- the products that are an overlap of the two companies.

In this case it's the technologies that are relevant in the alleged -- about which the alleged conduct concerns.

Q. What do you mean by the third bullet point on DX-172, assume hypothetical monopolist?

A. The goal here is to identify products that don't have serious constraining alternatives, so to identify products or in our case technologies which lack price-constraining alternatives.

And the approach is to say, well, suppose I controlled all of the technologies in the market, would I be constrained by products outside the market, would I feel that is a major constraint or would I actually enjoy a substantial monopoly power.

And so the approach, which is taken both by the Federal Trade Commission and the Department of Justice guidelines, is to assume a hypothetical monopolist who controls those products and say does that monopolist have serious price-constraining alternatives or can they exercise monopoly power on the products that are

in the market.

And the basic logic is, if it's no use to be a monopolist over a set of products, then that set of products is not a market. There are other products that are relevant to that market and must be included.

And so that's the sort of underlying logic of the market definition.

And this is a method of identifying -- if we go to the fourth bullet, identifying the competitive constraints on that marketplace.

Q. And did you say that the methodology for defining markets that you've just described is reflected in Department of Justice and Federal Trade Commission guidelines?

A. Yes. That's correct. These guidelines have evolved over the years, but they continue to have the hypothetical monopolist market definition logic.

Q. And when you were working as an economist at the Department of Justice in the Antitrust Division, did you apply those same guidelines that you're referring to in defining markets?

A. Yes, I did. Or to be exactly accurate, I helped others in that, in the sense that I never did it alone at that time.

Q. And in the antitrust-related matters, unrelated

to this case, but in the other antitrust-related matters in which you've served as a consultant to the Federal Trade Commission, did you, in defining markets in those matters, follow these same FTC/Department of Justice guidelines that you referred to?

A. Yes, I did.

Q. Do you have a slide that graphically depicts or illustrates the process of defining a relevant market?

A. I do.

Q. Let's go to that. This will be DX-173.

A. And so as I indicated before, one starts with a relevant product or products, and in this case the product we'll start with is C.

Q. And what are you depicting here with the other letters other than C?

A. These are other candidates for inclusion in the marketplace. These are other -- if we're talking about technologies, these would be other technologies which are potential substitutes for the technology C.

Q. I think this again is an animated slide. Let's go to the next view.

A. And so here we are starting with the technology C and asking the question: Does C comprise a market in its own?

Q. Well, let's stop there.

Does this relate to what you mentioned earlier, in the context of the earlier slide, that the market definition process is tailored to the antitrust issues or the products that are presented?

A. Yes. That's correct. So if the issue involves technology C, one would start with technology C as a candidate market, candidate market.

Q. And then let's go to the next view of DX-173.

A. So if C does not comprise a market, that is, a monopoly over C faces significant price constraints and would face significant substitution from alternative technologies, the next step is to include the closest substitutes into the market, that is, the technologies which are the most price-constraining for technology C.

In that case those technologies are A, B and D, and so those are incorporated into the marketplace. And then we go back to the beginning of the market definition and say do the technologies A, B, C and D together comprise a market; that is, if we had a monopoly over those technologies, would we face significant price constraints from outside or would we actually be able to profitably charge a higher price.

Q. And in asking that question, are you in essence

asking whether the products that you've now defined in your provisional market, A, B, C and D, whether those products face material price competition with the products that are outside of the circle?

A. That's correct.

Q. And let's go to the next view.

We've just seen another view of this same slide. What are you depicting here?

A. So what's depicted here are that A, B, C and D face significant price constraints from technologies E, F and G outside of the market, and so those technologies have been added in as -- into the marketplace now to give A through G as the set of technologies in the marketplace.

And in this case, in this example, technology H is not going to be a significant price constraint, and so the process stops there. That is to say, A through G, if a hypothetical monopolist controlled all technologies A through G, they would not face significant price constraints from technology H and would be able to substantially increase the price and enjoy the benefits of monopoly pricing.

Q. And in that case would you stop at this point and define the relevant economic market or relevant antitrust market to consist of all of the products

depicted here except H?

A. Yes. That's correct. So technologies A through G would be the technologies.

And I should also say there's a principle called the smallest market principle. The goal is to stop with the fewest number of market members. And the purpose of that is not to include spurious candidates but just include the minimum number of technologies or products that are required to reach market status.

Q. And what you've depicted in this, in these slides, is this an attempt to illustrate the same market definition process that you just described being contained within the FTC/Department of Justice guidelines?

A. It is.

Q. Now, in conducting this type of economic market definition analysis, what information would you need as an economist to make judgments about whether the various alternative products that you're considering do in fact impose material price constraints on one another?

A. Well, I need information about substitution by the buyers or selectors of the technology; that is, the information I need -- and this would be parallel to in

any market definition -- is I need information about what buyers will substitute to.

So when I'm defining gasoline markets and markets for retail gasoline, what I need to know is when the price goes up at one station or a set of stations, how far will consumers drive and how much substitution is there to more distant but less expensive stations. And so I need information on the choices that consumers make in that marketplace.

Q. In performing this type of market definition analysis, would it be helpful to you as an economist to have historical data relating to relevant changes in price, actual changes in price that have occurred in the marketplace that you're studying?

A. Absolutely.

Q. And why would that type of data be helpful to you?

A. Well, as I indicated, what's important is actually substitution by buyers, so that is to say an alternative is price-constraining if, when you try to raise the price of the products in the marketplace, the buyers substitute in a meaningful way, in a significant way, to a product outside of the marketplace.

If you can directly witness that substitution

through historical data is of course a major advantage in identifying which products are in the marketplace and which products are not.

Q. Is that type of historical pricing data generally available to you as an economist in instances in which you're seeking to define relevant antitrust markets?

A. Well, sometimes it is and sometimes it isn't. It's certainly not always available and in some cases it is available.

Q. Are there some industries of which that type of historical pricing data tends to be more readily available than in other industries?

A. Well, physical products that are traded frequently will often have more of a history of data than in this case, which involves technology markets where you don't see frequent trades or even any trades in some cases.

Q. How do you go about defining relevant markets in industries in which you do not have historical pricing data relating to actual sales or transactions?

A. Well, the general economic approach is to nonetheless try to understand buyer substitution and so to try to understand the buyers.

And when I worked on the technology markets for

the Department of Defense, my procedure was actually to talk to buyers of technology -- in this case they tended to be colonels -- and ask them about their decision process and try to model in my model how they make their decisions of which technologies to buy to try to understand the decision-making process.

And in addition, I relied on industry reports and that sort of evidence so that I could reach an understanding of the decision-making process of the buyer and thereby assess the substitution that buyers would make when faced with price increases.

Q. So in instances in which pricing data, relevant pricing data of the sort that you've described, in instances in which that data is not available, are you saying that one of the sources of information you might turn to would be data gleaned through interviews of the relevant purchasers in the marketplace that you're studying?

A. Yes. That's correct.

Q. And in defining markets in merger-related matters in which you've worked with the FTC as a consultant, have you or have other economists working with you conducted interviews in part for the purpose of gaining information to factor into a market definition analysis?

A. Yes. That's true for both the Exxon-Mobil and for the BP-ARCO mergers, for example.

Q. And you told us earlier today about various interviews that you've conducted in relation to your work in this case and the general types of people that you interviewed.

Was your purpose for conducting those interviews, was that at all in relation to the market definition aspect of your work?

A. It was a critical input to the market definition, in particular to understand the substitution by the buyers in terms of technology choice.

Q. And when you use the term "buyers" in the context of the markets that you've defined in this case, who specifically are you referring to?

A. Well, the buyers are the firms that select technologies. The importance of JEDEC, as we already discussed, in the standard-setting process -- now, JEDEC is not a monopoly in the standard-setting process, but the importance of JEDEC means that the JEDEC process itself is part of the technology selection and the buyers of the technology -- and here buyers may just be selectors; they're the ones who choose the technology -- include DRAM manufacturers who

are then driven by their customers, and so all of the market participants are in some sense the buyers of the technology.

Q. Now, you've mentioned several times that the markets that you've defined in this case, the relevant markets, relevant antitrust markets, are technology markets.

What do you mean -- to be clear, what do you mean by the term "technology market"?

A. So technology markets are markets for ideas or inventions, markets for discovery, markets for technology-related products, where technology is itself a product.

I have actually a slide concerning technology markets.

Q. This slide I believe will be DX-174.

Does the market definition methodology that you described earlier, does that methodology apply in the case of technology markets as opposed to physical product markets?

A. Sure. It's -- actually the concept or the logic of it is no different than in physical products, and that's recognized by the Department of Justice intellectual property guidelines. I think it's well-accepted in economic analysis.

Q. And you say in the third bullet point in this slide, DX-174, you state, "Data on price/sales may be more limited."

What do you mean by that?

A. There are many technology markets, but one sees few trades.

For example, in the Department of Defense technology markets you would see at most one trade, the ones that I worked on, and so often the sales data is just not available. You don't have -- it's not like gasoline where you see millions of transactions. In fact, it's kind of the opposite. You see very few transactions and so you often -- with technology markets you're often in a situation where you have little data, direct data, on pricing.

Q. And related to your earlier testimony, does that suggest that in technology markets you're more often in the situation as an economist defining markets in which you need to seek to gain information directly from relevant purchasers through interviews or other sources?

A. Yes. That's correct.

Q. You've mentioned in the second to last bullet on DX-174, you say, "Geographic scope is generally worldwide."

What do you mean by that?

A. Users of technology generally don't care about the source of their technology. They don't -- they care about the quality of the technology, they care about the price of the technology, but they don't care if it comes from the United States or Japan.

And so the effect of that is that technologies tend to compete worldwide, which is really just another way of saying that the transportation cost on technology tends to be low. That is, an idea doesn't -- you don't have to ship an idea in a ship; you can actually just send it over a fax machine.

Q. In defining relevant technology markets in this case, did you in fact apply the methodology that you've described for us earlier in terms of comparing alternatives and making judgments about the extent to which alternative products constrain the prices of other products?

A. I did.

Q. Can you tell us now precisely how then you went about defining relevant markets or relevant technology markets in this case?

A. Yes. The starting point was to try to identify a universe of potential technologies that would be the candidates for the markets, so that is to identify,

referring back to the previous slide with the circles on it, the A through H, that is, the technologies that would be candidates for inclusion in one of the technology markets.

And I did that by looking at what experts said about technical feasibility; so that is to say, I relied on others to identify whether technologies in a sense could do the job, that is to say, were they feasible for the issue at hand.

Q. And do you have a slide relating to that?

A. I do.

Q. Let's go to the next slide. This is DX-175.

Let me ask you first of all to define for us what you mean by the term "technical feasibility."

A. So the technology markets -- let me remind you that we start with the technology that's one of the relevant technologies, so we're starting with the technology, so technical -- the technologies that are technically feasible are technologies that have some related performance to the technology at hand and can actually be carried out.

Now, it's somewhat of a challenge in this case, it's fortunately not my challenge, but it's somewhat of a challenge in this case because my understanding -- and again, this is an assumption rather than a

conclusion -- my understanding is that all of these technologies had problems to be solved in order to implement them; that is to say, none of them worked in a sense right out of the box, they all took work to implement or to use.

And in that sense, what's technically feasible when you haven't actually solved all of the problems associated with the technology is going to be a challenge. But it's not my challenge; it's something on which I rely on the testimony of others.

Q. Are you a technical expert?

A. No.

Q. Are you an engineer?

A. I'm not.

Q. Are you intending through your testimony to offer your own opinions or conclusions about technical issues relating to DRAM designs or the benefits from a technical standpoint of any given DRAM design?

A. I am not.

Q. You say that you've relied on others with regard to such technical issues; is that correct?

A. That's correct.

Q. Who have you relied on in that regard?

A. Well, there is a list presented here. The engineers who have testified, both at trial and in

deposition. Professor Bruce Jacob -- is it Jacob or Jacobs?

JUDGE McGUIRE: Jacob.

MR. ROYALL: Jacob.

THE WITNESS: And discussions that I've had with engineers.

BY MR. ROYALL:

Q. And to be clear, what have you relied on these various technical sources for?

A. For a -- well, for a description -- in this case what this slide refers to is for -- it's the conclusion in the universe of technologies that are potential candidates for market inclusion.

So again, to refer back to the circle diagram, it's A through H, all of the things that are going to be considered as potential candidates.

Q. And we don't need to pull it up, but by that are you saying that by determining what technologies are technically feasible for a given DRAM design purpose you are essentially defining the universe of the various options from which you will then assess through economic means whether various options should be included in the same relevant market?

A. That's correct.

Q. So since you are not yourself a technical

expert and you are not offering conclusions about technical feasibility, once you have determined through others and through relying on others which technologies are technically feasible, what then do you do from the standpoint of economics to make judgments about relevant markets?

A. Well, the next step in the process -- and there's a slide to this effect -- is to examine which of those technologies are price-constraining on the technology at issue.

So that is to say which of the technologies are commercially viable, which are the ones that in the event of a price increase associated with the technology in question would have been adopted or were adoptable, were preferred over a significant price increase of a technology in question.

Q. Let's identify this new slide, the slide on the screen now with the title Commercial Viability, let's identify that as DX-176.

Relating to the text of this slide, let me ask you first of all to define for us what you mean by the term "commercial viability."

A. Well, this is -- what I mean by this is just the technology exercises a constraint on the pricing of a technology in question.

So that is, when we did the hypothetical market experiment, we asked, well, if you controlled these technologies, would you face serious price constraints from an attempt on -- an attempt to increase the price. If you do, then we had to include those technologies. The ones that exercise such a price constraint or constrain the prices of our hypothetical monopolist are the commercially viable technologies.

And so what I mean by that are the technologies which would have an impact on the buyers or would be substitutes for the buyers.

Q. What do you mean here in DX-176 by the second bullet point, which states "parallel to the SSNIP" -- S-S-N-I-P -- "test for markets with no price data"?

A. So the SSNIP test comes directly from the Federal Trade Commission and Department of Justice Merger Guidelines. It hypothesizes a small but significant and nontransitory increase in price.

So that is, take the products in the marketplace, increase the price that is charged for them by a small, not too large amount, but still nonetheless significant -- and significant is in the eyes of the market participants; that's the meaning of it -- and nontransitory. That is, you don't do it for a week, but you do it for weeks. The price increase

has to survive.

And you increase the price, and if you get substitution away significant enough that the hypothetical monopolist would not like to increase the price, then in that case you have not found a market and must add products.

And so that's parallel in the sense that the commercially viable technologies are exactly those that don't survive the SSNIP -- that would be included or would be price-constraining under a SSNIP test.

Q. And so are you saying that the analysis that you've conducted to define markets involving the identification of which technologies are, economically speaking, commercially viable, that that methodology is in your view parallel to the SSNIP test reflected in the FTC/DOJ guidelines?

A. That's correct.

Q. And when you say here "for markets with no price data," what do you mean by that?

A. Well, you would like to carry out the SSNIP test generally by actually asking how substitution would occur. Here, we don't have historical data on substitution, so the approach that I'm taking is then to examine whether the market participants view these technologies as being price-constraining alternatives

or being good substitutes.

And so it's like a SSNIP test, but it's being applied in a technology market without historical price data.

Q. Below the reference to the SSNIP test you have three subbullets. Let me ask you about those.

What do you mean by the first point, well-informed market participants treat as good substitutes?

A. A technology is going to constrain an existing technology, that is, a second technology will constrain the first technology in price and hence be commercially viable if the buyers of the technology would substitute, and so in this case what I'm looking for is evidence that well-informed market participants view these technologies as good substitutes. And if they do, that would be evidence that they are price-constraining alternatives. If they don't, that would be evidence that they aren't price-constraining alternatives.

Q. And again, was this -- did this have something to do with your purpose in conducting the interviews that you've conducted?

A. It did. This is part of the investigation of the facts which I'm using as evidence for market

definition conclusions.

Q. And to the extent that you have gathered information about whether well-informed market participants treat certain alternatives, technology alternatives, as good substitutes, are you relying solely on interviews that you've conducted or is there some other source of information that you've relied on for this purpose?

A. Well, as this slide suggests, that consideration of JEDEC -- and it's not just any consideration, but serious consideration -- is also suggestive that the buyers of the technology, in this case the market participants, viewed those technologies as significant substitutes and hence price-constraining substitutes.

Q. And what do you mean by the last point here, qualitative judgments of knowledgeable engineers?

A. So engineers today have knowledge -- of course unfortunately over time the base of knowledge that they have is changed, it's improved, but it also means that it's hard to go back and say as of 1992 were these price-constraining disputes, but the judgments of the engineers are certainly informative about whether technologies are substitutes. And if in the view of knowledgeable engineers they're substitutes, then that

makes them substitutes.

Q. Does this issue of commercial viability have any connection to the JEDEC standardization process or your understanding of that process?

A. Yes, it does. And I've prepared a slide that lists some of the considerations that are relevant.

Q. Let's go to that. This will be DX-178.

Oh, I'm sorry. 177.

Before I ask you about the various points that you list in DX-177, let me ask you, first of all, what are you seeking to convey through this slide?

A. This slide is listing considerations which are relevant to the evaluation of the technology as commercially viable, that is to say, as a price constraint on one of the relevant technologies.

So these are listing the kinds of considerations that would inform such a judgment.

Q. Let me ask you what you mean by the first point, which refers to time to market.

A. Well, I spoke earlier about satisficing behavior. Now, that as an assumption on JEDEC's -- as an assumption -- well, the term "satisficing" is an economic term, but its application to JEDEC would be an assumption.

And that arose out of the time-to-market

issues, and what that meant was or what that entails is that for commercial viability is that several products can easily be commercially viable in that they aren't trying to make it perfect. They're trying to get a workable product that everybody or most of the companies can manufacture and that the buyers can use in their installations in a rapid and expedient manner.

And given that assumption, what that does is make products with similar performance essentially equal.

Q. And how is that relevant to your consideration of whether various technology alternatives are commercially viable?

A. Well, so it -- in a process that took an extremely long period of time, it could be that two technologies which were barely distinguishable but one was slightly better in performance were not in the same market because the market participants would choose the superior technology.

In this case the decision-making under satisficing behavior would actually make -- would render such technologies equal.

Q. Let's go to the second bullet on DX-177, which refers to IP/royalties. What are you referring to

there and how does that relate to the process that you conducted in analyzing issues of commercial viability?

A. Well, again, I'm assuming that JEDEC has a preference to not adopt intellectual property; that is to say, that's a factual question. But given that assumption, it has implications for commercial viability because it says an intellectual property is actually -- you can think of it as hobbling a technology; that is, it makes it less likely to be selected. And that's not to say that it will never be selected but, rather, to say that it's less likely to be selected.

So that has the effect of making other technologies, that is, technologies other than the one with intellectual property, more likely to be commercially viable.

Q. The third bullet refers to the cost of the solution to DRAM manufacturers and others. Can you explain how that relates to your views on commercial viability?

A. Yes. If I can, I'll take that bullet and the subsequent bullet in the same answer.

The industry generally, that is, both the buyers and the sellers care both about the cost of manufacture and the performance. And I should say just

as a matter of basic economics, buyers care about costs because costs tend to get passed on to buyers; that is, buyers ultimately bear the cost.

So both the buyers and sellers care about both the cost and performance, and in fact the general economic model is that the goal of the organization -- and it doesn't actually matter whether it's a firm or a standard-setting organization -- is approximately to try to get the biggest performance bang per dollar or the most performance given the cost.

And so cost is going to matter to commercial viability. If a technology is extremely costly to manufacture, it's going to make it less likely to be commercially viable. And similarly, performance matters. The more the technology -- the better it performs, the more likely it would be to be commercially viable.

Q. Now, going to the second to the last bullet point on DX-177, which refers to strategic considerations that reflect the competitive position of each member, what do you mean by that and how does that relate to the subject of commercial viability?

A. So we've talked about the diversity of interest among the firms, and what I want to highlight here is that there are differences among the firms even in

their technical ability. That would actually be a fact assumption that there are differences. Although it's a normal fact assumption for economic analysts.

And the effect of that is going to make differences among members in terms of what kind of technologies are preferred by them in their preferences and there will be some disagreements and you can think of those as strategic considerations.

And I believe we already spoke about the graphics card manufacturers preferring relatively high-performance DRAM relative to a PC manufacturer.

Q. And finally, the last bullet uses a phrase that I think you may have used in an earlier answer, but I didn't ask you at the time what you meant by that, but you state here, "Every technology had problems to be solved."

What do you mean by that?

A. So again, this is a factual assumption, but it's a factual assumption that none of the -- it is my understanding that none of the technologies that are considered at JEDEC generally work right out of the box, that is, in the sense that until they've actually built some chips and learned about it, they don't -- they don't know exactly how the technology is going to work, how much it's going to cost, what the

implications of the technology are. All of them had problems to be solved.

And that's important for the understanding of commercial viability because, again, what it says is at the time that the technologies are selected, not all the facts are known. There is still substantial uncertainty attached with each of the technologies that were considered. And only in the technology that was actually exploited are those uncertainties all resolved.

That is to say, at the time that you make the determination, the time that the standard-setting organization makes the determination, they don't know all of the problems that have to be solved, and in fact it may be the case -- again, this is a fact question -- different manufacturers solve those problems in distinct ways.

The effect of this, though, from a JEDEC perspective or from a buyer substitution perspective is that all of the technologies have uncertainty and hence that tends to blur the distinctions of the technologies.

And I guess the -- so a short way of summarizing what I'm assuming in that bullet is that the cost and benefits of these technologies are not

known with precision, and as a result it will not generally be the case that necessarily the best technology is selected but, rather, the technology that's workable.

Q. And how does that bear on the economic judgments that you have made as to whether a given alternative technology is or is not commercially viable?

A. Well, the presence of uncertainty tends to blur the distinctions between the technologies and again would make more technologies commercially viable or make it more likely that a technology was commercially viable.

Q. Do you have an understanding as to how -- you mentioned in this slide both cost and performance. But do you have an understanding as to how cost and performance issues were dealt with within JEDEC's standardization process?

A. Yes. And I've prepared a slide that summarizes some of the issues that we've -- the fact issues that we've already discussed.

Q. Let's go to that slide. So this would be DX-178.

Can you explain what you are seeking to convey through this slide?

A. Well, this is listing some of the -- it's listing actually two -- well, three separate points.

First, we've already talked about the different preferences both on cost and performance, and so I won't belabor that.

A different -- a distinct point, a distinct economic analysis point is the value of a technology may depend on the deployment of subsequent infrastructure. And there's a nice example of that. This would of course be a fact, but there's a nice example of that that's been given in the trial testimony, which is that AMD has engineered its processors to exploit a burst length of 8.

Now, it's done that only because a burst length of 8 was available. So that is to say, once the technology of programmable burst length which permitted burst lengths of 4 and 8 was deployed, that's the point at which it became possible for AMD to specialize its processors for the burst length of 8.

And it's made investments that exploit that possibility. Those investments would be lost if the programmable features of the processor were removed.

But the point I want to make in this is that the value of the technology wasn't fully realized until subsequent investments were made, and so as a result,

when you look ex ante, before those investments are made, that technology has lower value than it does subsequently.

Q. And I think you covered the first three points either in reference to this slide or earlier slides, but let me ask you about the last point, costs are uncertain until DRAM is manufactured commercially. What do you mean by that?

A. So there are always unknowns, and I think I've already -- well, I've already assumed that, that there were unknowns, and this is actually just highlighting that point, that the actual costs of production generally are not going to be realized.

And in fact, it is my understanding that the companies guard their costs of production as trade secrets; that is, they try to keep that secret from the world at large and from their competitors.

The costs are uncertain because there are problems to be solved and there are technologies to be exploited. And developed. Excuse me. Technologies to be developed.

Q. And how, if at all, does that uncertainty about cost impact your analysis of questions related to commercial viability?

A. Again, in examining technologies, there's

substantial uncertainty attached to them and the determination of which -- so that makes the solution look closer to each other.

That's a thumbnail way of summarizing it, but that the uncertainty about the technologies blurs the distinctions between the technologies because it could easily be the case and it could easily prove to be the case that the technology that looked least promising wound up being best.

Q. Now, I believe that you've explained this point that in defining the relevant markets that you defined, ultimately you defined them so as to include the commercial -- what you've determined, economically speaking, to be the commercially viable technologies; is that right?

A. That's correct.

Q. Now, I think you have a slide relating to that, but before we go to that, let me ask you on this slide before we leave it, DX-178, the final bullet or subbullet that you identified here relates to DDR. You say "DDR in 1998 versus 2003."

Before we leave this slide, can you explain what you mean by that?

A. Well, DDR in 1998, it wasn't clear that DDR was ever going to work, and in fact -- so to refer -- so

this is a fact-intensive discussion.

To refer to -- I think it was Mr. MacWilliams who said that DDR, while it was less negative, it was still negative, had negative margins even in 1998. That is, it didn't appear that DDR was going to work to Intel.

So what that's referring to is an example from the factual record of products that are -- uncertainty associated with products. It appeared to quite knowledgeable market participants that DDR wouldn't work as of 1998, and of course it's available today.

Q. So over time that uncertainty was removed and with full information the market could better assess the value of the technology; is that the point you're making?

A. That's correct.

Q. Now, let's go to the next slide, which I think will be DX-179.

Can you explain what you're depicting through this slide?

A. Yes. This slide depicts two separate points.

The first is the determination of the relevant technology market, and here there are in this example things have been phrased in terms of cost, so you can think about this as cost per unit of performance, so a

low number is good.

There are three technologies A, B and C that have roughly comparable costs. Those are constraints on each other in the sense that if I started with technology A as a candidate market and tried to increase the price of technology A, the buyers would substitute to B or substitute to C.

And so I don't have a relevant market until I've included all of A, B and C. Once I include those three, however, the next best technology, technology D, is actually noticeably further away or it's significantly further away, and so it ceases to be -- it's not a serious price constraint on A, B and C and the price of those could increase significantly.

And so it illustrates the definition of the relevant technology market.

In addition, it illustrates the uncertainty by the fuzziness of the lines, that is, the cost of A is not -- it's not a clear, sharp amount. It's actually uncertain.

So it's illustrating both of those points simultaneously.

Q. And by the last point that you're making about the fuzziness of the lines, are you -- by that are you saying that there is some inherent uncertainty as to

costs at the time that technologies are assessed for standardization process?

A. Yes. As I've assumed, yes.

Q. And to relate this to the earlier slide relating to market definition and the letters and the concentric circles, would D, E and F here, the alternatives that you don't define as being in the relevant technology market, if we were to go back to that earlier illustration, would those letters or products, would they fall outside of the circle that you defined as the relevant market?

A. That's correct.

Q. Now, you've explained that in defining relevant markets generally you start with a product or the products that you understand to be relevant from the standpoint of the nature of the allegation or the issue.

If it's a merger, I think you said it would be products that are overlapping in the merger. Or in a case such as this, if there's an allegation, you would start with the products that you understand to be the nature of the allegation.

Is that a fair statement --

A. Yes, that's correct.

Q. -- of your views?

And did you in fact in defining relevant markets in this case start with any given product or products as the starting point for your analysis?

A. I did. And I prepared a slide listing the four products.

Q. Let's go to that slide. This will be DX-180.

Are these the products or technologies that you used as reference points to commence your relevant market analysis?

A. That's correct. These are the products that I took from the complaint which are the four products whose conduct is challenged.

Q. Well, let's start with the first product or technology listed in DX-180, programmable CAS latency.

And let me ask you if you could to walk us through the process that you conducted in defining a relevant technology market referencing that product.

A. Okay. So my starting -- let me -- I have a slide that begins that process.

Q. This will be DX-181.

A. The process starts with the -- well, it starts by identifying a universe of alternatives to programmable CAS latency, and those would be technologies used to set latency on a DRAM.

Q. Can I stop you there?

A. Yes.

Q. The first bullet point, technology used to set latency on DRAM, by that are you referring to your understanding of what function this technology, programmable CAS latency, serves within a DRAM design?

A. Yes. That's correct.

I'm not testifying as to what programmable CAS latency is but, rather, taking from other witnesses the assumption that what that does is set latency and that there are substitutes for it.

I'm also not going to testify as to what the substitutes are for it; rather, I take those as from other witnesses who are more skilled than I am.

Q. And when you refer to substitutes, by that are you referring to what you understand from technical witnesses or technical sources to be technically feasible alternatives to programmable CAS latency for the purpose of setting latency on a DRAM?

A. That's correct.

Q. And the third bullet point here states, "Some alternatives are commercially viable"?

A. Right.

Q. Can you explain what you mean by that?

A. Well, I should say some alternatives may be commercially viable, but this is -- the process of

market definition is to identify which of these technically feasible alternatives are commercially viable.

Q. And I think that's the point that you make in the final bullet point here; is that right?

A. That's correct.

Q. Let's go to the next slide. This will be DX-182.

Can you explain what you are depicting through this slide?

A. In this case I began with a list of technically viable alternatives as listed by Professor Jacob. These correspond to the alternatives that Professor Jacob identified as alternatives to programmable CAS latency.

Q. And having identified what you understood from other sources to be the technically feasible alternatives to programmable CAS latency, having identified the universe of such technologies, what did you do then in defining the relevant market?

A. Then at that point I tried to assess or set out to assess the whether these alternatives were in fact commercially viable given the procedure that we discussed earlier that was described in the earlier slide.

That is, I examined four facts that would suggest one way or the other whether these alternatives were commercially viable.

And I should say we haven't talked about time, but the relevant time here is -- well, the relevant time is a fact question, but the relevant time that I used was as of approximately 1992.

So that is to say, the question that I set out to address is whether in the -- whether market participants considered these and would have substituted to one of these alternatives in the event of a significant price increase, a small but significant price increase, in programmable CAS latency, that is, were these price-constraining alternatives for the market participants to programmable CAS latency.

Q. And when you say "1992," by that do you mean that that is a reference point for your analysis in terms of a relevant time frame?

A. Yes. SDRAM was standardized in 1993, and so the relevant time for a disclosure would have been prior to the standard being issued; that is, an ex ante disclosure would be prior to the standard being issued.

So to identify a relevant market for that

purpose I want something -- I want a market at the moment in time that's relevant, and so roughly 1992.

Q. And when you say at the time that's relevant, by that do you mean the earliest point in the time period in which you understand from your assumptions about the allegations or your understanding of the allegations that when would be the earliest point in time, roughly speaking, when Rambus allegedly should have made intellectual property disclosures?

A. Well, I don't know --

MR. STONE: Objection. Leading, Your Honor.

I think at this point he could simply ask him what you mean when you say the time is relevant as opposed to telling him and suggesting the answer.

JUDGE McGUIRE: Sustained.

BY MR. ROYALL:

Q. Well, you said in your earlier answer "roughly 1992."

When you say "roughly 1992," what do you mean by that?

A. So I wanted a time that's prior to the issuing of the standard and at which there might have been -- again, this is a factual question -- but that there might have been a disclosure requirement, and I chose 1992 -- I should say the analysis is not sensitive in

the sense of whether it's 1991, 1992 or middle 1993. The analysis was not sensitive to the time to that level of precision.

And so when I say "1992," that's a short form for during the 1991 to 1993 period.

Q. And would information about the technical feasibility or commercial viability of alternatives for programmable CAS latency from the time frame of 1996 or 1995, would information of that sort be relevant for you to consider for purposes of defining relevant markets?

A. Well, it's certainly relevant. The -- generally economists in carrying out market definitions don't have the perfect information. In fact, it would be really unusual analysis in which the perfect information was available.

The information in 1995 in terms of a 1993 buyer would be imperfect but nonetheless informative.

Q. You've identified I believe a total of six technologies that you understand from other sources to be technically viable or technically feasible alternatives to programmable CAS latency.

When you conducted your economic analysis relating to market definition, did you conclude that any of these technically feasible alternatives was also

commercially viable?

A. Yes, I did. And if we can go to the next slide, I'll illustrate that with fixed CAS latency.

Q. Let's identify this first of all as DX-183.

Now, this slide relates to one of the technically feasible alternatives that you identified on the earlier slide, DX-182; is that right?

A. That's correct.

Q. And have you reached any conclusion as to whether this alternative, that is, fixed CAS latency, was a commercially viable alternative to programmable CAS latency?

A. Yes. I've concluded that fixed CAS latency is commercially viable as an alternative to programmable CAS latency.

Q. And what was the basis for that determination?

A. This is a -- the basis is an examination of essentially all of the facts I had available to me concerning fixed CAS latency, including interviews, including testimony, deposition testimony, including documents. It's a -- I've attempted to actually apply all of the available information in assessing whether fixed CAS latency was for market participants a viable alternative or commercially viable alternative to programmable CAS latency.

And this slide sets out a tiny fraction of the relevant information in making that determination.

Q. You mention in the first subbullet "presented at JEDEC" and then below that you have reference to a particular JEDEC meeting.

By this are you conveying that it is your understanding that this technology, fixed CAS latency, was at the point in time referenced here in 1995 presented as an alternative to JEDEC?

A. Right. It is my understanding that as a factual matter NEC made a presentation involving fixed CAS latency at that time.

Q. And what significance does that understanding have to your conclusions about the commercial viability of this technology?

A. Well, the implication is that NEC first itself believed that this was commercially viable, that it wasn't going to waste its time making a presentation that it thought was not going anywhere and, moreover, that it believed that it could muster substantial support.

Again, it would be a waste of time for a company to make a presentation which they thought had no hope of actually going anywhere.

And so while I think not a proof, it's

certainly strong corroboration that a substantial fraction of the market participants viewed the technology as -- it's strong corroboration that one market participant believed that it -- that that technology was commercially viable and, moreover, believed that it could persuade others that the technology was commercially viable.

So it's significant evidence if not proof -- but not proof of commercial viability.

Q. And below that you have a reference to cost impact and then a reference to certain trial testimony.

Without -- I'm not asking you to read or summarize that testimony, but let me ask you from the standpoint of your economic conclusion about the commercial viability of this technology, what, if any, significance do you attribute to the testimony that's referenced in this slide?

A. Well, this testimony is not actually testimony I had at the time, available to me at the time that I made the determination. Its presence on the slide is to be illustrative of the kinds of information on which I'm relying, and so the purpose here is to illustrate the factual background that I investigated in trying to assess the commercial viability of the --

of fixed CAS latency as a technology and I think it's representative of the kinds of information that I've collected.

Q. So I take it from that answer that there's other evidence that you have considered and relied upon in reaching the conclusion that fixed CAS latency is a commercially viable alternative to programmable CAS latency?

A. Absolutely.

Q. And I won't, in respect to the judge's rulings earlier, I won't ask you to summarize that evidence now. But let's -- well, let's turn to other alternatives.

Have you reached any conclusions as to whether other technically feasible alternatives to programmable CAS latency are also, in your view and from the standpoint of economics, commercially viable?

A. Yes. And I have provided similar slides to that one for three further technologies.

Q. Now, this next slide we'll identify as DX-184.

A. That's correct.

Q. And this slide relates to a technology identified as programmable by pin strapping; is that right?

A. That's correct.

Q. You again refer in this slide, DX-184, to a JEDEC presentation?

A. That's correct.

Q. And what, if any, significance do you attribute to that?

A. Well, the presentation is of course much more recent, and so I would attach less significance to one that's more recent than I would to an earlier one, partly because the economics of DRAM manufacture has evolved over time. But nonetheless, it's suggestive of serious consideration by Micron in this case as a technology that is an alternative to programmable CAS latency.

Q. And the bottom half of the slide again refers to certain trial testimony. Without asking you to summarize that, let me ask you this.

Is your purpose in identifying that trial testimony the same as the purpose that you explained for identifying other trial testimony in the prior slide?

A. Yes. Although I might actually add in this specific testimony that there is more diversity of opinion on the cost of pins than there was on the fixing of CAS latency, and this testimony also has bearing on that, but that is to say that it depends on

the -- it appears to depend on the implementation as to whether it's commercially viable and this testimony is suggestive of that.

Q. But you have concluded based on all of the evidence that you've reviewed that this particular technology is commercially -- is a commercially viable alternative?

A. Yes. And for the same reasons as with fixed CAS latency. Or in the same method, rather, is what I meant to say, as fixed CAS latency.

Q. In addition to fixed CAS latency and programmable by pin strapping, are there any other technologies that through your economic analysis you have concluded are commercially viable alternatives to programmable CAS latency?

A. Yes. There are two. The next one is programmable in the read command.

Q. Let's go to the next one. This would be DX-185.

And can you summarize the basis for your conclusion that this technology is a commercially viable alternative to programmable CAS latency?

A. Yes. Again, in parallel to the previous two technologies, there's a -- he surveyed a large amount of facts and concluded that this technology appears to

be commercially viable, that is, appears to be a substitute for programmable CAS latency.

Q. And when you refer to cost impact on this slide, DX-185, what are you referring to there?

A. Well, this is actually from Professor Jacob who is discussing the advantages and disadvantages of programming CAS latency in the read command. It has some physical advantages. Actually I think it's the case that you don't eliminate the mode register. Again, this is a fact. You just reduce this piece of the mode register. I think that's what happens next in the trial.

But that you -- so it has some advantages in manufacture and it has some disadvantages in that it could suffer somewhat on performance, and on balance, these are approximately canceling.

Q. And in concluding that this is a commercially viable alternative, have you concluded that this technology would have a price-constraining effect on programmable CAS latency?

A. Yes. That's correct.

Q. And is that true of all of the technologies that you have concluded to be commercially viable alternatives; that is, in making that conclusion, have you concluded, based on your investigation and the

facts that you've reviewed and your economic analysis, that those commercially viable alternatives are -- have a price-constraining effect on the technologies that were the focal point of your relevant market analysis?

A. That's the definition of commercial viability that I'm using, so they all must be price-constraining.

Q. You mentioned that there was one other technology that you found, based on your analysis, to be a commercially viable alternative to programmable CAS latency. I believe the next slide relates to that. This will be DX-186.

And the technology referred to here is setting by fuses?

A. That's correct.

Q. Can you explain the basis for your economic conclusion that this technology is a commercially viable or was a commercially viable alternative to programmable CAS latency?

A. Again, it's the same kind of basis as in the earlier technologies. I've examined a large amount of evidence bearing on the substitution possibilities of this technology. Evidence is all in the form of engineers, analyst reports, JEDEC meetings and the

like. And some of that evidence is illustrated by this slide.

Q. Of the technologies that you understood to be technically feasible alternatives to programmable CAS latency, did you eliminate any as commercially viable; that is, did you conclude that any of those technically feasible alternatives were not commercially viable alternatives from the standpoint of the time frame that you were focusing on?

A. There's -- I didn't reach -- so the answer to that question specifically is no, but I didn't reach a determination on one of the technologies.

Q. Let's go to the next slide. This will be DX-187. I think that this lists the five technologies here.

Is this the same list of the technologies that you started with as the set of what you understood from the technical sources that you considered to be technically feasible alternatives?

A. It is the same set, yes.

Q. And you said that you did not ultimately conclude, or to put it differently, you concluded ultimately that one of these technologies was not a commercially viable substitute or you could not conclude that it was a commercially viable substitute

for programmable CAS latency?

Should I restate that? Are there too many double negatives?

A. I'm happy to answer the question.

Q. Let me restate it.

Was there any one of these five technologies that you, based on your analysis, did not conclude to be commercially viable, a commercially viable alternative?

A. I did not determine that scaling CAS latency with clock frequency was a commercially viable alternative primarily because I did not find out enough information to reach a determination in that case.

Q. And so the others -- this is an animated slide and there are now red check marks by four of the five alternatives.

Are these the alternatives that based on the information that you analyzed you concluded to be commercially viable alternatives to programmable CAS latency in the time frame that you focused on?

A. That's correct.

Q. And having determined that these technologies were commercially viable alternatives, did you then proceed to define a relevant market?

A. Yes. This set -- the relevant market is -- contains those four.

Q. And the relevant market that you defined you termed the latency technology market; is that right?

A. That's correct.

Q. And to be clear, what you have termed the latency technology market, does that market consist of programmable CAS latency and the four technologies that are checked in DX-187?

MR. STONE: Objection.

THE WITNESS: That is correct.

MR. STONE: Objection. Leading, Your Honor.

The proper way is to say "Tell us what the latency technology market consists of," not to lead him to the answer.

JUDGE McGUIRE: Sustained.

Restate, Mr. Royall.

MR. ROYALL: That's fine, Your Honor.

BY MR. ROYALL:

Q. Tell us what technologies you included in the latency technology market.

A. Well, following my procedure, I started with programmable CAS latency and then I included the commercially viable alternatives, which are the technologies checked with the check mark attached to

them in this slide. And so all five technologies are members of the latency technology market.

Q. Now, let's turn to the next of the four relevant technologies that you identified earlier. Let's turn to the next technology, programmable burst length.

A. So --

Q. Before we go any further, the slide that we're now looking at I believe is slide 188, or DX-188.

And this slide relates to the analysis that you conducted in defining relevant markets relating to programmable burst length; is that right?

A. That's correct.

Q. And the first bullet point, what does that relate to?

A. So again I'm relying on technical experts and technical knowledge, so this is a factual -- there's a factual matter embedded in this.

My understanding of programmable burst length is that this is something that sets the burst length. Programmable burst length normally refers to setting the burst length at either 4 or 8. And it determines how many steps the DRAM takes, what's called a burst, sometimes called a wrap.

And the -- so the technology -- the substitutes

for programmable burst length are other technologies that set the amount of data read from a DRAM in response to a request for data.

Q. And in defining the relevant technology market with reference to programmable burst length, did you follow the same methodology that you described earlier with respect to programmable CAS latency?

A. Absolutely. And this slide illustrates that by being essentially identical to the earlier slide on programmable CAS latency.

Q. So having first identified the relevant product, you went on then to identify, based on the technical sources you considered, the universe of what you understood to be technically feasible alternatives?

A. That's correct. And again, to emphasize, that's an assumption on my part, not a conclusion.

Q. Let's go to the next slide. This will be DX-189.

And what does this slide present?

A. This lists Professor Jacob's technically viable alternatives for programmable burst length.

Q. And following the same methodology that you've described, did you conclude that any of these technically viable or technically feasible alternatives

were also, from the standpoint of economics, commercially viable?

A. Yes, I did. And I followed again the same procedure that we used on programmable CAS latency.

Q. Let's go to the next slide. This will be DX-190. DX-190 relates to the alternative identified on the prior slide, the fixed burst length.

Did you reach a conclusion as to whether this technology was, based on your analysis, a commercially viable alternative to programmable burst length?

A. Yes. And the logic is in fact almost exactly parallel. The logic and the evidence is almost exactly parallel to fixed CAS latency, and there is highlights of evidence as before presented on the slide.

Q. And by that, you're referring to the substance of the slide being what's conveyed or the information conveyed being similar to the substance of what was conveyed in the earlier slide related to fixed CAS latency?

A. Similar or analogous.

Q. Did you conclude that any other technically feasible alternatives to programmable burst length were also commercially viable from the standpoint of economics?

A. Yes. Again, using a pin, if we can go to the next slide --

Q. This would be DX-191.

Can you explain the basis for your conclusion that use of a pin or what's referred to here as programmable by pin strapping was a commercially viable alternative to programmable burst length?

A. Yes. And in fact the evidence is quite similar to the evidence in favor of programming CAS latency with pins. Programming CAS latency with pins may take more pins than programming burst length with pins, but otherwise, the logic is quite similar, and the testimony of witnesses is quite similar and the evidence quite similar.

Q. I want to move through these slides quickly because I know you have a number of similar slides, but just so the record is clear, do the slides that relate to the technologies that you've concluded are commercially viable, such as this slide, DX-191, do these set forth in full the factual basis for your conclusion that these technologies are commercially viable?

A. No, they do not. And in fact, I reached these conclusions prior to the time that the trial commenced, so the references to trial testimony were not actually

part of my factual basis at the time that I reached the determination. They've since become available to me. But I illustrate them with the slides for relevance and as further information.

Q. Are the bases for your original conclusion that these technologies were commercially viable alternatives, are those bases set forth in your expert report which we identified earlier?

A. That's correct.

Q. Were there any other technically feasible alternatives to programmable burst length that you concluded, based on your economic analysis, to be commercially viable?

A. Yes. If we can go to the next slide, the programmable in read command, so this is a technology which embodies in the read command, so it's the request of the DRAM for data, how long a burst to send, I found to be commercially viable.

This technology has both advantages and disadvantages over programmable CAS latency.

Q. And what was your -- how would you summarize the basis for your conclusion that this technology was a commercially viable alternative to programmable burst length?

A. Again, I investigated the relevance of this

technology as a substitute or its price-constraining ability on programmable CAS latency to -- its ability to serve as a substitute to programmable CAS latency for the purposes of price constraint.

Q. And this slide, before we move to another slide, I believe should be identified as DX-192.

Were there any other technologies that you considered technically feasible technologies that you considered that, based on your economic analysis, you concluded to be commercially viable alternatives to programmable burst length?

A. Yes. The final technology is burst interrupt.

Q. Burst interrupt, and that's the subject of the next slide, DX-193.

And can you state or summarize the basis for your conclusion that the burst interrupt technology was a commercially viable substitute or alternative to programmable burst length?

A. So again, burst interrupt has advantages and disadvantages. It's actually technology that was already available in the standard. It has advantages and disadvantages over programmable burst length and as a technology for setting burst length, and those are relatively small advantages and disadvantages, which renders it a close substitute, and that was what I

found from my examination of the facts.

Q. And what do you mean by the second bullet point here? You say "in SDRAM and DDR SDRAM standards and proposed for DDR-II."

A. So this is technology that's already available; that is, you use burst interrupt in an SDRAM in that it's possible to interrupt your -- so my understanding of burst length -- again, this is a factual question -- is that when I ask for data, I'm not going to be just given back one piece of data, I'm going to be given back a number of pieces data, and what the burst length is is a means of setting how many pieces of data I'll get back.

So again, as I understand the facts -- and this is a fact and not a matter of economic analysis -- the reason that's useful and the reason one cares about that is that it would slow down a DRAM if you had to say, each time you wanted a piece of data, give me one more piece of data, and the reason is you'd have to say that and then get it back, say it again, get it back, and that would add for a lot of requests. It speeds up the process to get a lot of data in a row.

A burst interrupt says, well, once I've gotten three pieces of data I can issue a burst interrupt command that stops the flow of data.

Again, I'm explaining my understanding of the facts.

That has the effect of giving you programmable burst length in the sense that if I want a burst length of 4, I could ask for eight and then interrupt myself after four have come, and that gives you an alternative for programmable burst length.

And then the -- so that's a long -- somewhat long-winded answer to your question of this is already available; that is, it's possible to issue a burst interrupt command for SDRAM or for DDR SDRAM. That is my understanding of the facts, is it's already available in the standard.

Q. We've talked now I think about four alternatives, technically feasible alternatives to programmable burst length that you've concluded to be commercially viable through your economic analysis.

Were there any of the alternatives that you did not conclude to be commercially viable?

A. Yes. I didn't conclude it not to be commercially viable, but I did not reach a determination for using fuses to set burst length.

Q. Let's go to the next slide. This next slide is DX-194.

And you've just referred to fuses. Is that

what's in DX-194, is that what's -- is that the technology referenced in the final bullet point?

A. That's correct.

Q. The other four bullet points identified here, were those all technologies that you did conclude to be commercially viable?

A. That's correct.

Q. And based on your analysis, did you define a relevant technology market related to programmable burst length?

A. Yes. I defined a burst length technology market consisting of programmable burst length and the four technologies that are checked on the slide.

Q. Now, let's go to the next --

MR. STONE: I just wondered if we might be getting close to a convenient breaking point or if this was one for the evening.

JUDGE McGUIRE: I can't hear you.

MR. STONE: I wonder if we were about at a convenience breaking point.

JUDGE McGUIRE: I was going to inquire of that.

I assume you're going to be about another twenty minutes or so, Mr. Royall?

MR. ROYALL: Well, I'm going to be another -- probably another twenty minutes just defining these

relevant markets.

JUDGE McGUIRE: Right. That's what I meant.

MR. ROYALL: Yes.

JUDGE McGUIRE: And then after that, what was your intention?

MR. ROYALL: After that, Your Honor, I don't have a time precisely, but I would expect that I'm likely to have roughly another hour and a half, could be slightly longer, but I would think we're in the range of an hour and a half. I would be happy to finish up in the morning.

JUDGE McGUIRE: When you say "another hour and a half," you mean with this witness or just for this evening?

MR. ROYALL: I meant with the witness after we finish relevant markets. Again, I need to review my notes, but I think that may be in the ballpark, and I'd be happy -- it would make sense to me to at least finish the relevant markets today and I'd be happy to finish the rest in the morning.

JUDGE McGUIRE: Okay. Are you asking now, Mr. Stone, for a break?

MR. STONE: No, no, no.

JUDGE McGUIRE: I'm just trying to get an idea of when we're going to break for the evening. Let's

go ahead and spend the next twenty minutes or so and get over this topic and then we'll break for the evening.

MR. ROYALL: That will be fine. Thank you, Your Honor.

JUDGE McGUIRE: All right.

BY MR. ROYALL:

Q. I believe we've now covered your relevant market analysis relating to two of the four relevant technologies you identified earlier.

Let's move to the third relevant technology, and I think in the list that you provided in an earlier slide that technology was the dual-edged clock technology?

A. That's correct.

Q. And we have another slide now on the screen relating to dual-edged clock. I believe that this will be identified as DX-195.

A. That's correct. Oh, I don't...

Q. And I think we all recognize that this is similar to the earlier slides in explaining the basic methodology, but the top bullet point I believe is unique to this technology. Can you explain what you're referring to there?

A. Yes. Again, I'm relying on the testimony of

other witnesses to characterize the dual-edged clocking, one of the technologies at issue, is used as a way of increasing the bandwidth or the amount of data that's transmitted from the DRAM to the controller or back.

Q. And with respect to this technology, dual-edged clock, did you follow the same methodology of initially, based on technical sources, identifying a universe of what you understood to be technically feasible alternatives?

A. I did.

Q. Let's go to the next slide, which will be DX-196.

And does this slide reference all of the technologies that you understood from the technical sources you relied on to be technically feasible alternatives to the use of dual-edged clock technology in a DRAM?

A. It does.

Q. Let me ask before we go any further, did the time period that -- did the time period that you were focusing on, understanding that it's a rough time period, but did the time period that you were focusing on for your market definition analysis differ with respect to this technology as compared to the two

earlier technologies, programmable CAS latency and programmable burst length?

A. It did because these are technologies -- the dispute on these technologies involves DDR SDRAM rather than SDRAM and that technology was standardized later, so in this case the approximate time period that I aimed at was 1995.

Q. Based on your economic analysis, did you conclude that any of these technically feasible technologies presented in DX-196 was also, economically speaking, commercially viable?

A. I did. If we can go to the next slide.

Q. This will be DX-197.

And this slide refers to keeping each DRAM single data rate and interleaving banks on the module?

A. That's correct.

Q. Is this a technology -- a technological alternative that you concluded based on your analysis to be a commercially viable alternative to dual-edged clocking?

A. It appears to be, yes. That is, I did conclude that it's a commercially viable alternative.

Q. And what -- can you summarize generally what the basis is for your conclusion?

A. Again, I surveyed a great deal of evidence, I

interviewed witnesses, and I read market reports to reach that determination.

Q. Were there any other technically feasible alternatives to dual-edged clocking that you concluded were commercially viable?

A. Yes.

Q. Let's go to the next slide. This is DX-198.

And this slide relates to increasing the number of pins per module?

A. Yes. I put this slide in because I did not in fact conclude that this technology is commercially viable; so that is to say, it does not appear to be commercially viable.

There is some contrary evidence to that, although the evidence is recent and in fact involves a graphics design, a graphics card designer.

So there is some contrary evidence, but overall this is a technology that I think I can rule out as being commercially viable.

Q. And by that, do you mean that you've not included it in any relevant technology market?

A. In fact, I've gone -- the others I was silent on. I've gone further and excluded this one.

Q. Were there any other technologies other than the prior technology, keeping each DRAM single data

rate, that was referred to in DX-197, were there others besides that technology that you've concluded to be commercially viable alternatives to dual-edged clocking?

A. Yes. And the next slide will set that out.

Q. The next slide will be DX-199, and this refers to doubling the clock frequency?

A. Right.

Q. Is this a technology that you've concluded based on your economic analysis to be a commercially viable alternative to dual-edged clocking?

A. That's correct.

Q. And what was the basis for that conclusion or what -- if you could summarize the basis for that conclusion.

A. Again, I examined a great amount of information and facts to reach the determination that this was a commercially viable alternative to dual-edged clocking.

Q. Were there any other technically feasible alternatives besides doubling the clock frequency and the earlier alternative that you mentioned in DX-197 of interleaving banks and keeping the single data rate, were there others besides those that you concluded to be commercially viable alternatives --

A. Yes.

Q. -- to -- there were?

A. Well, I actually reached the conclusion that toggle mode was commercially viable. But I have to say that the exhibit that I hold in my hand does not reflect that. And I'm not sure why that's true.

Q. Well, let's go to the next slide. Again, this is DX-200 I believe.

And I believe that this slide, which, as has been the case with similar slides, similar animated slides, starts by identifying the various technologies that you understood or assumed to be technically feasible, and with the animation you now see that there are checks by two of these technologies and there's an X by one.

What do you mean to depict by that --

A. Well --

Q. -- or to illustrate by that?

A. This was supposed to illustrate the data acceleration technology market that I had reached, but I have to say, I have actually determined that toggle mode was also a commercially viable alternative, and so we have an error on this document.

Q. How would you revise this demonstrative, DX-200, to make it accurately reflect your conclusions

as to commercial viability and the definition of what you termed the data acceleration technology market?

A. I would add a red check to use toggle mode, and then I would conclude that dual-edged clock, keeping the DRAM single data rate and interleaving the banks on the module and doubling the clock frequency and using toggle mode, those four technologies comprise a data acceleration technology market.

Q. Now, I believe we've covered three of what you termed earlier the relevant technologies. Let's move then to the fourth, which is the on-chip PLL or DLL technology. And the slide that's now on the screen will be DX-201.

The first bullet point on this slide, does that refer to your understanding of the function served by use of on-chip PLL or on-chip DLL in a DRAM technology?

A. Yes. My understanding from factual testimony -- and it is my assumption from the factual testimony -- is that on-chip PLL/DLL has the effect of synchronizing the DRAM clock with the system clock. And that that's -- the technologies that serve that purpose are alternatives to on-chip PLL or DLL.

Q. And did you identify, based on the technical sources that you were relying upon, any technically

feasible alternatives to on-chip PLL?

A. Again, my assumptions are set out on a subsequent page. These are I believe Professor Jacob's alternatives for on-chip PLL/DLL.

Q. And the side that's now on the screen will be identified as DX-202.

There are five technologies here. These are the technologies that you understand from the technical sources that you relied upon to be technically feasible alternatives to on-chip PLL/DLL?

A. Yes. That's correct.

Q. And did you through your economic analysis conclude that any of these technically feasible alternatives were also commercially viable?

A. I did, and they're set out on the subsequent slides.

Q. The next slide will be DX-203.

And this relates to putting a DLL on the memory controller. Is that a technology that you concluded through your analysis to be a commercially viable alternative to on-chip PLL/DLL?

A. It is. In my review of the available evidence, it appears to be a commercially viable alternative to on-chip PLL/DLL.

Q. And in summary form, can you identify the

general nature of the basis for that conclusion?

A. Yes. As before, I interviewed witnesses, I read trade reports, I read many documents that had bearing on this.

Q. Were there any other technically feasible alternatives to on-chip PLL/DLL that you concluded to be commercially viable?

A. Yes. Much like putting the DLL on the memory controller, one can put it on the module.

Q. And that's the subject of the next slide, which is DX-204.

A. Yes, that's correct.

Q. Did you conclude that PLL/DLL on the module technology referred to here was a commercially viable alternative to on-chip PLL/DLL?

A. Yes, I did.

Q. And were there any other technologies that through your economic analysis you concluded to be commercially viable alternatives to on-chip PLL/DLL?

A. Yes. Actually I'm not sure how to pronounce it. "Vernier" or "vernier" technique I determined is a commercially viable alternative to on-chip DLL.

Q. And that's the subject of the next slide, DX-205.

A. Yes.

Q. What -- again, in summary form, what basis did you have for concluding that this technology was a commercially viable alternative to on-chip PLL and DLL?

A. I reviewed a substantial amount of information and that had bearing on the vernier technique as an alternative and concluded that it was a commercially viable alternative.

Q. And were there any others, any other technically feasible alternatives to this on-chip PLL/DLL technology that you've concluded to be commercially viable?

A. Yes. One may be able to get away with no DLL at all.

Q. And that option is the subject of the next slide, DX-206.

And can I ask you to explain now your basis for concluding that the use of no DLL at all was a commercially viable alternative to the use of on-chip PLL/DLL?

A. Again, there are advantages -- so in my review of the facts, there are advantages and disadvantages of PLLs and DLLs on-chip, and at relevant speeds, at relevant DRAM speeds, actually not using a DLL at all appears to be a commercially viable alternative.

Q. Of the technically feasible alternatives that you identified through reliance on technical sources, did you conclude that all of those alternatives were also commercially viable alternatives to on-chip PLL/DLL?

A. It depends on whether by "all" you meant the four we've just discussed or also the five that were on the original list.

No. I've concluded that the four that we discussed were commercially viable alternatives to on-chip PLL and DLL. But not achieving -- but not by adding more pins. And that one I did not make a determination one way or the other as to whether it -- whether it was an -- whether it was a commercially viable alternative.

And these four alternatives with the original on-chip PLL/DLL I concluded to be a clock synchronization technology relevant market.

Q. Let me make clear for the record that we're now -- we now have on the screen another slide, which should be marked as DX-207.

And I think your prior answer identified that the technologies in addition to on-chip PLL/DLL that you included in the market that you defined as the clock synchronous technology market; is that correct?

A. Clock synchronization technology market, yes.

Q. Are there any other alternatives, other than the alternatives that we have been discussing and specifically the technologies that you've testified that you concluded based on your economic analysis were commercially viable alternatives to the four Rambus technologies, other than the ones that we talked about, were there any other technologies that you, based on your economic analysis, concluded to be viable alternatives to Rambus' technologies?

A. Yes. I've concluded that asynchronous designs were relevant for at least some length of time, were relevant alternatives, in particular, well through 1995 and probably continuing thereafter.

Q. We now have a new slide on the screen, which we'll mark as DX-208, which relates to asynchronous -- the title is Asynchronous Alternative.

And in the first bullet you refer to asynchronous DRAM designs. Let me ask you first of all to define what you mean by that term.

A. So synchronous designs -- it's easier to define that -- well, let me say again that this is a fact question.

Synchronous design -- it's easier to explain what a synchronous design is.

Synchronous design takes a clock on the DRAM and synchronizes it or synchronizes the action of the DRAM with the system clock rather than with just its own independent clock. It has its own synchronized clock.

So asynchronous designs did not. And the -- what preceded SDRAM were asynchronous designs, so fast page mode and EDO, extended data out, DRAMs were asynchronous designs.

There were -- there was quite a bit of debate at the time that JEDEC standardized SDRAM about whether to move to synchronous or stay with asynchronous designs. Asynchronous designs had evolutionary advantages over synchronous designs, but at that time JEDEC made the determination to move to asynchronous -- to synchronous -- move away from asynchronous to synchronous designs.

Q. Have you reached any conclusion as to whether asynchronous designs were commercially viable alternatives to synchronous designs in the time period that you focused on for purposes --

A. Yes.

Q. -- for purposes of your economic analysis?

A. Yes. Asynchronous designs had a number of advantages and some disadvantages over the synchronous

designs that were ultimately chosen. And the -- they were constraining alternatives on these synchronous designs. And there's a wealth of information from the time that speaks of that.

Q. In the final bullet point on this exhibit, DX-208, you state, "Choice of synchronous DRAM diverted resources away from asynchronous designs."

Can you explain what you mean by that?

A. Yes. The asynchronous designs of 1992 and 1993 are slow relative to, say, modern DDR designs, and that's because a great deal of investment has been applied to SDRAM and its successor DDR. Had the industry stayed with asynchronous designs, it's economically reasonable that those designs would have progressed.

Generally in this industry I find that the application of engineering effort actually improves the product, and so the fact that they went to a synchronous design diverted resources away from asynchronous designs and made those designs less successful than they would have otherwise been.

Q. In this slide, DX-208, you refer in the first bullet point to something called burst EDO.

What is burst EDO?

A. Burst EDO was an asynchronous design that was

proposed to succeed EDO -- we have a slide on this -- that was proposed to succeed EDO and it was an alternative -- it actually represented an alternative DRAM technology, an alternative to SDRAM, and hence an alternative to both programmable CAS latency and burst length.

That is to say, an alternative to using those technologies and many other technologies embedded in SDRAM was to use burst EDO.

Q. We'll mark this slide relating to burst EDO as DX-209.

Have you concluded, Professor McAfee, whether burst EDO was a commercially viable alternative to synchronous DRAM?

A. Yes. It was a constraining factor on -- it would be a commercially viable alternative. That is, it would be a price constraint on the SDRAM technology.

Q. Did you include the burst EDO technology or any other asynchronous DRAM technologies in the relevant markets that you defined?

A. I did not, although one could. They are -- they are -- when one looks at the individual technology, it would be a large departure to switch, in order to avoid an individual technology, to switch to

an asynchronous design. It requires changing a great number of things relative to just changing that one technology.

That would be a more reasonable thought experiment when one was considering changing all four technologies rather than just one of the technologies.

Q. Let's go to the next slide. This would be DX-210.

And you see in DX-210 you've listed I believe the four relevant technology markets that you've identified in your earlier testimony.

Are these the only relevant markets that you have defined?

A. No. I also examined what's known as a cluster market, and that lumps these technologies together. That procedure is more a convenience than it is a -- it's a common convenience among economists, but it is more of a convenience than a strict market definition, and it's because the technologies tend to be used in the same products that one might want to treat them together in what's known as a cluster market.

And that is actually a common expedient in economic analysis.

And so using that common expedient, I found a synchronous DRAM technology market that refers to all

four of those technologies.

Q. You've used the term "cluster market" and you've given an explanation, but I think you may have a slide that illustrates that concept.

A. I do.

Q. This would be DX-211.

Is this slide meant to illustrate the concept that you just described of a cluster market?

A. It is. This slide illustrates -- refers back to an earlier slide that we had, that through the standard-setting process we're going to select features for -- or we're going to select technologies for a variety of distinct features, in this case listed as features 1, 2 and 3, and we'll select specific technologies for those.

Insofar as those technologies relate to each other, that is, they must work together, for example, then it would be natural to cluster them together, so if there was a natural affinity of one technology for another, that is, they work well together, one would want to cluster them together.

Q. I believe, if I'm not mistaken, this may be another animated slide.

A. Yes. Here, the technologies B, F and G have gone through the standard-setting process. They are

unrelated from each other in the sense that D is a standard for feature 1, F is a standard for feature 2, and G is a standard for feature 3, but because they are in some sense embodied in the same device, they can be treated together.

As I said, that's more of a convenience than it is a normal or -- excuse me. It is quite normal. It's more of a convenience than a strictly logical exercise. Since they are, after all, they -- they do different things. They aren't substitutes for one another.

Q. Am I correct that what you're illustrating here is that in defining what you term the SDRAM technology market or the cluster market that you described earlier, you were collecting the other technologies that you defined separately as separate markets into a single, consolidated market in the manner that you've depicted in this slide?

A. Yes. That's correct.

Q. Now, my final question -- and I'll be done with this topic and for the day -- relates to geographic market.

Have you reached any conclusion as to the geographic scope of the technology markets that you described or identified in your testimony today?

A. Yes, I have. I find technology markets to be worldwide.

Q. And the next slide and the last slide for today is DX-212.

And let me just ask you if you could walk us through your reasoning for concluding that each of the relevant technology markets that you've defined is geographic -- or is worldwide in geographic scope.

A. I think I've already testified today that the buyers of technology, the adopters of technology, generally do not care about the geographic source of the technology. They want the technology that is the best for their purposes.

Technologies tend to be licensed worldwide, so that is to say technologies tend to flow across national borders.

In addition, the downstream product is produced and used worldwide. From a technological perspective, the fact that it's produced worldwide, has low transportation costs, means that the downstream product competes in a world market which indirectly forces the technologies to compete in a worldwide market.

And so -- and I think this is not controversial, that technologies tend to be worldwide

markets, and this case is no exception.

Q. And I think you've touched -- may have touched on this in your answer.

But the negligible transportation costs, that's something that bears on your conclusion that this is a world -- that these relevant technology markets are world markets?

A. Yes. That actually -- so there are two instances of negligible transportation costs. The transportation cost of a product itself, a DRAM, that is, the physical product, is very low and that makes DRAM a world market. In fact, they don't seem to mind shipping it across the Pacific Ocean -- this is a fact, but they don't mind shipping it across the Pacific Ocean just to package it.

So transportation costs are very low. But also the transportation -- but more importantly, the transportation costs on the technology is essentially zero, that is, it's trivial. It's a matter of flying the -- those who know how to implement the technology to wherever the technology is to be used.

And so technology -- the transportation costs associated with moving the technology are essentially zero, and that means that the buyers adopt the technology that offers the best technology independent

of the origin of the technology.

MR. ROYALL: Your Honor, that concludes my examination on that subject. I will have some questions in the morning but will hope to conclude that in somewhat over an hour's time.

JUDGE McGUIRE: Very good, Mr. Royall. Thank you.

MR. ROYALL: Thank you.

JUDGE McGUIRE: Then that will take care of it for tonight. We will convene tomorrow morning, Thursday, at 9:30 a.m.

This hearing is in recess.

(Time noted: 5:50 p.m.)

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: June 25, 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: June 25, 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