BEFORE THE
FLORIDA PUBLIC SERVICE COMMISSION

In the Matter of Determination of the cost of basic local telecommunications service, pursuant to Section 364.025, Florida Statutes.	:	DOCKET NO. 980696-TP

VOLUME 8

Pages 876 through 1006

PROCEEDINGS: HEARING

BEFORE: CHAIRMAN JULIA L. JOHNSON
COMMISSIONER J. TERRY DEASON
COMMISSIONER SUSAN F. CLARK
COMMISSIONER JOE GARCIA
COMMISSIONER E. LEON JACOBS, JR.

DATE: Tuesday, October 13, 1998

TIME: Commenced at 9:10 a.m.

PLACE: Betty Easley Conference Center
Room 148
4075 Esplanade Way
Tallahassee, Florida

REPORTED BY: H. RUTHE POTAMI, CSR, RPR
Official Commission Reporter

APPEARANCES:

(As heretofore noted.)

ADDITIONAL APPEARANCES:

JOHN B. WILLIAMS, Collier, Shannon, Rill & Scott, PLLC, 3050 K Street N.W., Washington, D.C., appearing on behalf of **GTE Florida Incorporated.**

THOMAS W. MITCHELL, Collier, Shannon, Rill & Scott, PLLC, 3050 K Street N.W., Washington, D.C., appearing on behalf of **GTE Florida Incorporated.**

WITNESSES

EXHIBITS

NUMBER		ID.	ADMTD.
45	DJW/BFP-22	906	921
44			921
43			921
42			921
46	KDD-1 and KDD-2	923	
47	KDD-1 through 15 (rebuttal)	924	
48	KDD-3	999	

P R O C E E D I N G S

(Hearing reconvened at 9:10 a.m.)

(Transcript follows in sequence from Volume 7.)

CHAIRMAN JOHNSON: If everyone could settle in, we're going to go back on the record in a few moments.

- - - - -

DON J. WOOD

continues his testimony under oath from Volume 7 as follows:

Q (By Mr. Williams) Good morning, Mr. Wood.

A Good morning.

Q Welcome back. Mr. Wood. When we broke last night I had asked you if you recalled the decision by this Commission in the MCI/AT&T arbitration with GTE and the basis upon which this Commission rejected the Hatfield model. Do you recall that discussion yesterday?

A I do.

Q And do you recall that one of the bases upon which this Commission rejected the Hatfield model, Version 2.2.2, was that its review led it to conclude that the Hatfield model appeared to understate costs? Do you recall that discussion yesterday?

A I recall your reading that to me, yes, or suggesting that that was in the order.

Q And we did have a question which was unresolved yesterday as to what the Hatfield p cost was for GTE that was the subject of that decision. Do you recall that discussion as well?

A Yes.

Q And would you agree, subject to check, that the Hatfield loop costs in the earlier arbitration proceeding Hatfield 2.2.2 was $11.44?

A For a -- what exactly? I'm sorry.

Q For all GTEFL loops as submitted by MCI and AT&T in that proceeding, the Hatfield loop cost.

A As I told you yesterday, I don't recall what it was.

Q Would you accept that, subject to check?

A I would certainly want to check it, yes.

Q And would you accept, subject to check, Mr. Wood, that if you were to take Hatfield 5.0a and run it for GTE's loops here in Florida it would give us a loop cost for all GTE loops statewide of $9.81?

A That's again something I would certainly want to check.

Q I will give you these after our cross-examination, and you may check them.

Now, as we were discussing yesterday, you were familiar with a price survey entitled the "Telephone Plant Index"?

A Yes, I am.

Q And you were aware -- by the way, I just want to make sure -- you do not consider that authoritative, although you do consider it helpful. Is that the gist of your views on the Telephone Plant Index?

A No. I hope I had been a little more clear on that. I don't consider it to be the authoritative source. You had asked me about some supporting documentation for my view that the incumbent companies feel that costs are tracking downward, and since this is their document itself, I certainly consider it indicative of that view, but not necessarily authoritative in its own objective sense of where all prices are tracking.

Q Who publishes the Telephone Plant Index? It's the local ILECs? Is that what you're saying?

A I don't think anybody publishes it. I think, though, the companies use their own version of it.

Q I'm sorry. You said it was their document.

A Yes. "Their," being the incumbent LECs, but it's not something that's published and then in general use. I think each company prepares internally its own projections and creates its own telephone plant index.

Q And you are unaware of the document entitled -- excuse me -- a price index titled the "Turner Plant Index"?

A I have not seen something titled that, no.

Q So you don't know if the Turner Plant Index was used in coming up with some of the default values that are used in the Hatfield model?

A Well, I certainly would know that. I haven't suggested that either of these, either the Telephone or the Turner Plant Index, was used in developing these default values.

These are internal documents to the companies. I had only brought them up in response to your question of what makes me think that the incumbent companies believe that the cost of acquiring these assets is trending down. They're your projections not related to this model that I'm sponsoring.

Q So you're saying the Turner Plant Index is a document internal to the local exchange companies?

A No. I keep -- I'm describing to you the

Telephone Plant Index. I --

Q I see. All right. Thank you. You don't need --

A I hope I've responded each time the Turner Plant Index is not something I've seen a title to.

Q I understand. Let me turn your attention to the expense module in the Hatfield model.

A Yes.

Q You are familiar with that? Yes? As a general matter, am I correct in understanding that the expenses are generally calculated as a percentage of ARMIS reported expenses to investment?

A No. Some expenses --

Q Some expenses. I'd say as a general matter.

A Well, I don't want to overgeneralize this, because it's a little misleading. Those expenses that tend to vary with units of investment like maintenance, the more you spend on switchings, for -- switching, for example, the more dollars of maintenance you would have, those do track with investment.

Some expenses track with the number of lines in service rather than the number of dollars of investment, and we have those as a percentage -- as a -- on a per-line basis. And the model also gives you the capability if you see a certain expense and you feel like, well, that's something that really ought to vary by line instead of by dollar, you can make that adjustment and have the model allocate those expenses based on lines instead of dollars.

So it's something that is done in both ways depending on how the expense varies, and it's also something that, if the Commission were interested, they could actually go in and change how those expenses are treated.

Q All right. Some are per line, and then some are based upon an ARMIS ratio. Is that a fair characterization?

A No.

Q You have some that are per line? How are the other --

A And some are per dollar of investment.

Q Per dollar investment.

A Yes.

Q And which --

A And that it does come from ARMIS information.

Q Per dollar investment from ARMIS. And how about switching and circuit equipment expenses? Are they per line or per dollar investment from ARMIS?

A It depends on expense, I believe. There are certainly some switching expenses that vary by line. There's circuit expenses that vary by dollar.

Q Is there a switching expense factor in the Hatfield model that is taken from a New Hampshire study?

A There is a specific maintenance factor -- let me look it up. (Pause) There is, yes.

Q Yes. And there is also a circuit equipment factor taken from a New Hampshire study.

A I believe that's correct, and I believe both of those are on a dollar of investment basis.

Q I'm sorry, Mr. Wood. I didn't hear what you said.

A I believe both of those were on a dollar of investment basis, but I'll confirm that for you, if you'd like.

Q I believe you're right. I believe they are per dollar, but you can check, if you wish.

And so those two factors are not taken from ARMIS data; is that right?

A That's correct.

Q There is an override in the model that plugs in these values from the New Hampshire study instead of the per dollar investment from ARMIS?

A Well, there's actually no override. The source of these inputs is a separate source. There was --

Q They are replacing the ARMIS calculations.

A They are used instead of ARMIS data because --

Q That's fine.

A -- those folks found them to be more reliable.

Q And why is it that data from New Hampshire was used nationwide instead of the per dollar investment from ARMIS?

A Yeah. That's just what I was going to explain. There's -- you have to take an objective look at each of these inputs to determine the best available public information. We don't want to be relying on proprietary information.

There are a number of proprietary studies available throughout the country showing a switching expense that is comparable or certainly in this range but are not values that can be divulged directly.

This particular cost study is one of those that was consistent with others nationally, but which was made public by the New Hampshire Commission. It was simply a judgment call, and I think a sound judgment call, th t that represented the best available public data for the percentage of expenses compared to the cost of switching, because this particular value is related to the price paid for new switches and the maintenance of those new switches versus what would be in ARMIS, which is an embedded mix of previous purchases and expense and which would capture this historic ratio rather than the most current forward-looking ratio; and that was simply the judgment that was made.

Q And of course this best available data from New Hampshire provides factors that are lower than what would have been if the general approach using per dollar investment from ARMIS was used; isn't that correct?

A That's not generally true. It can be higher or lower depending on the company.

Q Now, you aware that the use of these New Hampshire values has been specifically rejected by the California Public Service Commission as being not representative of real world situations in California, are you not?

A I'm not aware of that language from the California Commission. They may very well have adjusted these inputs.

Q Thank you. Let me move on, Mr. Wood. You are an economist; is that right?
A I have a master's in economics, but I reserve the title of economist for those with a Ph.D.
Q All right. Well, having a master's in economics, do you agree that cost models should be based upon consistent information sources?
A I think they should be based on the best available information source.
Q And should --
A And that always -- that won't always be the same source certainly.
Q Of course not. But should an effort be made to ensure that those sources are consistent?
A Well, an effort should certainly be made to make sure that the input values are consistent with each other and that they don't represent something totally different, that you've got an apples and apples basis, but I wouldn't say that you should err on the side of getting all your information from a single source, because that may not be the best source of information.
Q Well, you would agree, though, that the underlying assumptions used within a model should be consistent?

A With each other, absolutely.
Q Are you aware of an AT&T model that is entitled the "Transport Incremental Cost Model," TICM?
A I am.
Q And what is TICM?
A I actually -- what you just described is about the extent of my knowledge. It's an internal model that AT&T used to cost interoffice networks for an internal purpose, and I don't know what that internal purpose is.
Q And are you aware of an AT&T model entitled the "Nonrecurring Cost Model"?
A If you're referring to the one that's been sponsored in proceedings here, yes, I am.
Q And are you aware of an AT&T model that deals with collocation issues?
A Again, if you're referring to the one that's been presented in UNE proceedings, yes, although I think I would characterize both of those as AT&T/MCI models.
Q All right. I apologize.
A Just to be fair.
Q AT&T/MCI Collocation and Nonrecurring Cost Models?
A Right.

Q But the TICM model is just unique to AT&T?
A That's right; and it's not a model that's being used for the type of purpose that we would normally see in these proceedings.
Q Now, Mr. Wood, have you checked to see if the underlying assumptions in the Hatfield model are consistent with the assumptions in the TICM model, the Nonrecurring Cost Model, and the Collocation model?
A Yes, certainly, with regard to Nonrecurring and Collocation. No for TICM, because it doesn't cost any of the things we're trying to cost here. It's not a local service model. It doesn't cost anything related to local service.
Q Well, it does the cost circuit equipment expense, doesn't it?
A For large interoffice circuit equipment, yes; but we don't have any of that in what we're studying here.
Q It does --
A But there's really no overlap in the network facilities that we're dealing with.
Q What about power investment necessary to run switches? Isn't there overlap there?
A There is -- certainly you would have two things called power to run a switch. You would not

have similarly configured switches. We're dealing with local Class 4, 5 switches here, local and tandem. What's in, as I understand it, the AT&T study, are the much larger interoffice switches.

Q Well, some of the AT&T switches are similarly sized to some of the local ILEC switches, are they not? Or are you unaware of that?

A If you mean in terms of processor capacity, it's possible, but they wouldn't be similarly configured, because those large AT&T switches don't have the line configuration that a local switch has.

An interoffice has trunks coming in on both sides. A local switch has lines coming in on one side and trunks on the other. That's a very different configuration. It's a different set of investments and a different set of power requirements.

Q All right.

A It's just not something you can put side by side and meaningfully compare.

Q Now, you have said that you compared the assumptions used in the nonrecurring cost model and the collocation model with those assumptions in the Hatfield model; is that right?

A Where they're comparable, yes.

Q And you have determined, I take it, that in all cases they are consistent?

A I've certainly not seen any inconsistencies, no.

Q Thank you. Are you aware of the fact that the AT&T TICM model has expense factors for switch maintenance and circuit equipment that are higher than the values used in the Hatfield model?

A They could very well be. Again, we're talking about -- other than the fact that they're both called a switch, we're talking about very fundamentally different beasts here. It's a completely different machine to do large interoffice switching than to do local switching.

Q And I take it you're also aware of the fact that AT&T's TICM model assumes power investment significantly higher than the assumptions used in Hatfield?

A I don't know that that's true. And, again, there's no reason they would be comparable.

Q Now, are you aware of the fact that Hatfield model assumes copper based T-1 technology over DLC, although the technology -- that technology is not considered forward-looking technology in the nonrecurring cost model --

A I'm sorry --

Q -- sponsored by AT&T and MCI?

A I'm sorry. You need to back up there. There was a lot of --

Q Well, let's take it in two parts. You are aware of the fact, are you not, Mr. Wood, that the Hatfield model uses, incorporates T-1 technology, T-1 over copper?

A Yes. We use that for those road cables to those outlier clusters, or what we call the 1-4 people, the small serving areas that -- where we actually have to run cable either to the person or to a series of people.

Q And are you similarly aware of the fact that the sponsors of the nonrecurring cost model have testified that they do not consider that technology to be forward-looking?

A I think they've said that they don't consider digital loop carrier on copper to be forward-looking for a feeder facility, and I agree. That's not what we do with those facilities in this model.

Q Are you aware that the land and building investment in the Hatfield model is lower than similar assumptions used in the AT&T collocation model?

A No. In fact, I don't think that's true, and

I think the key word there might be "similar". You might be confusing what is, in fact, comparable.

Q Let me ask this question, Mr. Wood: Are you aware of a publication entitled "Bellcore Notes on the Network"?

A I've seen "Notes on the Bach --

Q Well, it's probably the same --

A I mean, there's a longer title than that, but, yeah, I've seen that. It's an old document. It's an early '80s document, I believe.

Q Well, it is an early '80s document, and it is also used as the basis for some of the assumptions in the Hatfield inputs portfolio summary, is it not?

A For those particular engineering constraints that haven't changed since that time, yes.

Q Okay. Are you similarly aware of a publication entitled "AT&T Outside Plant Engineering Handbook"?

A I'm aware that there is one. I think Mr. Wells would be more familiar with it. That's his area.

Q Well, these two documents contain guidelines and engineering standards that are relevant to the construction of a local exchange network, do they not?

A In part. Again, there will be parts of those that relate to technology that is still applicable, and there will be parts of those that represent technology that's no longer forward-looking. So you would have to look very carefully at the document to decide what is still the current engineering standard and what's a 20-year-old engineering standard.

Q I see. So you do not consider those two documents to contain generally accepted design and placement standard in the telephone industry?

A Oh, I certainly would, but I would also --

Q You --

A I certainly would, but I certainly would also want to look at them very carefully, because a lot has changed since they were published. You want to make sure what is there still reflects forward-looking technology and forward-looking principles.

Q And are you capable to make that determination, or would you rely upon engineers?

A I would certainly rely on engineers. I think any cost analyst would.

Q Well, if --

A Or should.

Q So I take it that your opinion is that some of the standards and guidelines reflected in the two documents we've discussed are relevant in helping this Commission determine the proper forward-looking technology and some are not?

A My testimony is that I would certainly, given the time that those were published and what has changed, I would want to look at any given principle very carefully to make sure that it still applied in 1998 as it did in 1984. Some will; some won't.

Q Is there any other publication or reference material you could point us to that would contain up-to-date specifications with respect to design and placement standards in the telephone industry?

A Oh, there are an ongoing series. Bellcore publishes what are called technical references, TR documents, and also general references, GR documents. They don't come out on any specific schedule. They come out as issues come up. But those are still -- there will be a number of those every year that are published.

Q Anything else?

A I would ask Mr. Wells.

Q So then to the extent there is inconsistency between what is published by AT&T in the Outside Plant Handbook and the Bellcore references in the -- what is it? TR and GR?

A That's right.

Q You would suggest use of the latter; is that right?

A No. I would suggest you look at the time frame that each one was published, because one may, in fact, supersede the other. They often do. You have to stay current on these, and you have to look at the most current document.

Q I see. So then I take it there is no authoritative compendium of design and placement standards that can be used in designing the network of the future. You have to look at various different publications.

A Absolutely. Anything -- if you try to publish a comprehensive work, it would be out of date in this industry before you ever got it to press. That's why these technical and general references come out of Bellcore as issues arise and as things are revolved by the standards.

Q Now, returning for a moment to the Bellcore Notes on the Network -- which, by the way, are also republished, are they not; they're rereleased -- Bellcore continues to come out with updates to its Notes on the Network, doesn't it?

A They do from time to time, yes.

Q Thank you. Any reason to believe that those do not represent the most up-to-date engineering and design specifications?

A At the time they're published, no. But, again, I would urge you to be very careful in all of these, as the engineers are certainly very careful to make certain they're looking at the current information.

Q With respect to the Bellcore materials and the AT&T Outside Engineering Handbook, you are aware, are you not, that there are instances in which the expert engineering judgment that is reflected in the Hatfield design is inconsistent with those guidelines in those documents?

A I'm not aware of that, and I would urge you to talk to Mr. Wells about it, because he's the engineer.

Q Well, you were able yesterday to discuss with us this issue about copper loops extending beyond 12,000 feet.

A I believe I described that in my presentation yesterday morning as an engineering debate that the Commission would hear quite a bit about from engineers on both sides.

I have received some comfort in the 18 kilofoot figure because of the BellSouth press release that says they can offer ADSL out to 18,000.

Q Right.

A But I certainly wasn't suggesting that I don't rely on the engineers in that regard, because I certainly do.

Q Well, I think your testimony yesterday when you talked about the BellSouth press release was that you had seen this press release and it was good enough for you. Do you recall that testimony?

A Well, I assume that what they're saying in their press release is, in fact, true, and that they're not trying to mislead anybody; and that gives me some comfort in this figure. But it is certainly, as I characterized it, an engineering debate that's properly between the engineers.

Q And just so we understand the engineering debate, the Bellcore engineering guidelines specify 12,000 feet as the maximum carrier serving area necessary to support advanced digital services; is that right?

A I don't know. That's a question for Mr. Wells.

Q All right. You don't know. But the

Hatfield model will go up to 18,000 feet; is that right?

A Theoretically, yes; although there are no 18,000-foot loops in the run done for Florida for any of the companies. In fact, less than 1% of the total copper loops in this model are more than 12,000 feet, and that's actually true for both models. Both this model and the BCPM produce less than 1% of loops that are more than 12,000 feet. So as a practical matter, I'm not sure this debate is worth all the time it's going to receive.

Q It may not be, but what I want to understand is the underlying methodology and basis on which the Hatfield sponsors arrive at their engineering judgement. And now you indicated yesterday that you had seen this BellSouth press release. You saw that they were offering advanced ADSL up to 18,000 feet and said that that was good enough for you.

Let me ask you what you know about that press release. Let me ask you what you know about the BellSouth offering up to 18,000 feet for ADSL.

A Okay. Let me be clear. You've prefaced that with a lot of different things. If you want to understand the source for the engineering inputs, you have a witness for that, and that is Mr. Wells.

In terms of what -- how I characterize this, again, I think I said that this gave me some comfort. What I know is that I've read the press release, and what I know about it is, in fact, what's written here dated September 9th, 1998, entitled "BellSouth rolls out ADSL."

Q And what is the maximum number of megabits that can be provided under that press release?

A 1.5.

Q 1.5. And, Mr. Wood, would you tell us what the FCC's definition is of the number of megabytes necessary to offer ADSL for universal service purposes?

A In the May 7th order they actually just refer to enhanced digital services. That's the phrase they use.

Q And how many --

A If BellSouth is offering something as ADSL that isn't in fact ADSL, then I certainly --

Q That's the point, isn't it?

A -- stand corrected.

Q Doesn't the FCC say that you have to offer 6.144 megabytes in order --

A Again --

Q -- to qualify for ADSL?

A Not -- I think the -- I'll look up the May 7th language. Specifically I don't think it refers to any bit rates at all. In fact, the FCC requirement refers to digital services. It refers to advanced services.

Q Read the footnote, please, in that paragraph.

A I'm just looking at 1(b). "The loop design incorporated into a forward-looking economic cost study should not impede the provision of advanced services."

Q Does it have a footnote there, Mr. Wood?

A I don't, in my printout.

Q Well, we'll get that when we see you again. Just so I understand it, does the BellSouth offering at 18,000 feet comply -- does that give the necessary amount of technology for everybody to have universal service that's been defined by the FCC, knowing what you know about it now?

A Well, knowing what I read here in the press release, if BellSouth is telling the truth in its press release, there's not a problem. Again, as a practical matter, there are no 18,000-foot loops in Florida produced by the --

Q Assume there are.

A Assume there are?

Q Right.

A Then according to BellSouth, ADSL will be available where existing loop facilities can support the service. The loop must be unloaded 2-wire copper and not more than 18,000 feet.

MR. WILLIAMS: Thank you, Mr. Wood. I have nothing further.

Madam Chairman, I would like to give Mr. Wood the documents with respect to the Hatfield loop costs. I can do it now or during a break, whatever.

CHAIRMAN JOHNSON: Okay. Either is fine. You can give it to him now. But you've finished all of your questioning?

MR. WILLIAMS: I'm sorry?

CHAIRMAN JOHNSON: You said you have finished all of your questioning?

MR. WILLIAMS: Yes. I'm sorry. I only have one copy of these.

CROSS EXAMINATION

BY MR. COX:

Q Good morning, Mr. Wood. Will Cox on behalf of the Commission Staff.

MR. COX: Before I begin, Chairman Johnson, Staff would ask if we could at this time mark as a late-filed exhibit -- you should have the cover sheet in front of you, the deposition transcript. It was a panel deposition.

Can you hear me at all?

(Technical difficulties. Microphones adjusted.)

MR. COX: Okay. We're good, I think. If we could mark at this time as a late-filed deposition exhibit the deposition transcript. It was a panel deposition taken of Mr. Wood and Mr. Pitkin, and it also will include the late-filed deposition exhibits. It's identified as DJW/BFP-22.

CHAIRMAN JOHNSON: DJW/BFP-22 will be marked as 45.

MR. COX: Thank you.

CHAIRMAN JOHNSON: And is this accurate? You said both the deposition transcript and the late-filed deposition exhibits are not available yet?

MR. COX: I think they are actually finally available today. I got an e-mail when I came in this morning, but we didn't have them at the time we prepared this.

CHAIRMAN JOHNSON: So should we do this as a late-filed?

MR. COX: I don't know if we have all the late-fileds yet, so I'd rather just call this a late-filed exhibit at this point.

CHAIRMAN JOHNSON: Okay.

MR. LAMOUREUX: Just to clarify, I think we handed out the late-filed exhibits for the Wood-Pitkin deposition this morning.

MR. COX: So they're all available now?

MR. LAMOUREUX: So everyone should have those, yes.

MR. COX: Okay. Well, then we can provide those for the record.

MR. MELSON: And, Chairman Johnson, would that include any errata sheet that Mr. Wood prepares as well?

CHAIRMAN JOHNSON: Yes. Thank you.

MR. COX: So that will be Exhibit 45.

(Exhibit 45 marked for identification.)

CHAIRMAN JOHNSON: Anything else?

MR. COX: That's all.

Q **(By Mr. Cox)** Mr. Wood, I have some questions regarding various versions or, depending upon how you want to characterize them, revisions to the version of Hatfield that you have filed in this proceeding.

Did you file with your direct testimony on August 3rd two exhibits, DJW-6 which was the CD containing the HAI cost proxy model, Version 5.0a, and DJW-5, results from that model for BellSouth, GTE and Sprint for Florida?

A Yes.

Q On August 19th did you revise these exhibits?

A Yes, we did.

Q What was the nature of those revisions?

A I had been asked by AT&T and MCI to include costs associated with access and intraLATA toll minutes and the calculation that we produced.

The model uses all of those minutes to size the facilities, but then it goes back and applies costs to local or access or toll based on how much usage is represented by each service.

We had not added that into the originally -- the original filed exhibits, and that was added in in that revision.

Q Okay. So an incorrect number of intraLATA toll minutes had been used; is that correct?

A That's right. We had to revise that calculation to get this proper add-on for access and intraLATA toll minutes.

Q Staff in this process has requested through Interrogatory 17 an explanation as to why, when the Staff attempted to run the edition of the model you provided, it generated results that did not match the results of revised Exhibit DJW-5. Are you familiar with that request?

A I am.

Q Did you provide the initial response to that request?

A I did. I've also had conversations with various Staff members on this topic to see if we could figure out what the discrepancy might be that was coming up, and apparently there were a couple things that could have happened.

One was that just running the model without putting in the inputs that we had changed for Florida specificity would have yielded a different result, but you actually had to put those in to make the run.

And, also, this modification to include the correct access and intraLATA minutes was a process we talked through with Staff to make sure that they understood that process, because it's something that we had added to the mix, if you will, based on the revised exhibits.

Q But initially your thought was that there shouldn't be or there weren't any discrepancies?

A That's right. When I went back and ran -- I took DJW-6 and the CD ROM, took the model that was on that, ran it with our inputs, and I got the same results as we had filed in DJW-5. So I couldn't find a discrepancy.

And then based on conversations with Staff, we found a couple of sources where -- that were potential reasons for an apparent discrepancy based on Staff runs versus my runs.

Q And how did you end up resolving these discrepancies that you discovered after further discussion with Staff?

A Again in two parts. One was to make sure that the inputs had, in fact, been changed to the ones used in the run; you know, the cost of capital, the depreciation, the labor factor and the like.

And then the second was to talk through this process of adding in access and intraLATA toll minutes, which has several steps to it; and that needed to be talked through pretty carefully. But at that point I thought we had resolved that issue completely.

Q Okay. So just to clarify, your initial response in Interrogatory 17 was not entirely correct, but you since have discovered some discrepancies and you've corrected those; is that correct?

A No. The interrogatory, as I understood it, was why are there discrepancies between what's on the CD ROM and what's in DJW-5. And my response was, I checked, and I don't find any discrepancies.

So then the next step was to talk with Staff and find out why they felt like when they ran the model they were getting a different number, and we found a couple of possible reasons for that; and I thought we had, based on those, come to a conclusion that there wasn't a discrepancy.

Q There was not a discrepancy?

A That's right.

Q Just one moment. (Pause)

Are you familiar with the revised response you filed to Interrogatory 17?

A I didn't prepare it, so I'm not sure if --

Q You didn't prepare it?

A -- I've seen it or not.

Q Well, it involves the issues that we're talking about trying to reconcile the two exhibits.

A Yes. I mean, there's been an ongoing effort to talk with the Staff and make sure that we've gotten everybody on the same page. And we'd certainly -- if there's still an unresolved issue, I didn't know it, but we'd obviously be more than happy to continue to work on that.

Q Okay. Are you aware that in the response you said that in order to run DJW-6 to reflect the outputs on DJW-5, please refer to the following, and you offer some instructions. And the first two preliminary instructions were to -- you will need a wire center run and a density zone run.

A Yes. That's part of the specific adjustment to add in the access and intraLATA toll minutes.

Q Okay. I thought earlier in the questioning when Mr. Carver was addressing you that you indicated that a density zone level run would not be required.

A I don't recall that discussion with Mr. Carver. You need the density level run simply because the density zone USF worksheet has a specific piece of traffic information that you need in order to make this adjustment.

You don't really need the results of a run on a density zone basis per se. What you need is the specific access minute calculation that's included on that worksheet.

Q Why does your revised response to Interrogatory 17 say "Use a density zone run"? Is that --

A Well, because that produces this worksheet that includes the access information that you need to make the adjustment.

Q Okay.

A We're not suggesting that USF costs be calculated on a density zone basis; merely that by running the model on that basis, it actually outputs a piece of information that is an output on a wire center run, and that is this access information that you need in order to add those minutes in.

Q Mr. Wood, have you refiled the CD containing the Hatfield model since the August 19th revised filing?

A Yes, we did.

Q What was the date of that filing?

A October 4th or 5th, I think.

Q Subject to check, would you agree that it was October 7th?

A That's -- yes, that's entirely possible.

Q What revisions were made to this filing of the model?

A Simply one, and that was to add in the cost of white pages listing. I had not realized, quite honestly, in what we had filed that that had not been included until the Staff interrogatory that asked if it had been in there pursuant to the Florida Statute definition of local service.

When we saw that, we realized that it hadn't been included and that it should have been, and we reran the model to include those costs.

Q And what was the impact of that revision? How did it affect the output of the model?

A It increased it slightly. It's not a big expense item compared to the other things we talked about, but it does increase the cost somewhat; less than 20 cents, I think, per line.

Q Are the steps necessary that we've talked about that were outlined in your revised response to Interrogatory 17, are they necessary to correct the number of intraLATA toll minutes used within the August 19th edition of the model? Are they still necessary with the latest edition, the October 7th edition?

A Actually -- the steps are actually not to correct an improper use of minutes. The steps are to actually include those minutes. So if you follow these steps correctly, which we didn't do the first time but did do with the subsequent filing, you should get the same results.

They really aren't part of the correction. They're simply the process to go and find information that is in the model with regard to access and intraLATA toll costs, and then include that in the cost results in a way that is consistent with the methodology and make sure that we just increase local costs by that amount.

MR. COX: Okay. Thank you, Mr. Wood.

CHAIRMAN JOHNSON: Commissioners?

COMMISSIONER JACOBS: Mr. Wood, I wanted to touch on briefly the issue of the geocode, success of geocodes in rural areas.

WITNESS WOOD: Yes.

COMMISSIONER JACOBS: How do you deal with that where you -- and I think I understand what -- the response to it when you don't have a geocode of address. That's where you put them along the boundary of the grid; is that correct?

WITNESS WOOD: Well, of the census block; that's right.

COMMISSIONER JACOBS: Census block --

WITNESS WOOD: Yeah. We don't do grids.

COMMISSIONER JACOBS: I'm sorry --

WITNESS WOOD: Yes. We do spread those out, those people out, as far as we can.

COMMISSIONER JACOBS: The effect of that would be in terms of the costs in that particular block -- what would be the effect of that on the cost that you would report for that block?

WITNESS WOOD: It increases the cost, and, unfortunately, the more people that you have to do that, the more it increases.

Now, what we have done is also run the model for Florida by putting people not just on that outside boundary, but also distributing along the inside roads; in a sense, the BCPM methodology where we -- we geocode everybody we can. That's the best case. But then where we can't, we do essentially what BCPM does as its first try on these things.

When you do that, it reduces the number of route miles of cable, the amount of physical cable you need by about 5%. So certainly moving those people to interior roads as well as exterior would -- would reduce the cost somewhat. So we do overstate the costs by putting them on the outside.

COMMISSIONER JACOBS: Well, that brings me to my real question. The impression I had is that that would result in an overstatement of the cost.

WITNESS WOOD: It will.

COMMISSIONER JACOBS: But the criticism I've seen says that it results in not enough plant being placed there, and I'm trying to understand how that would work. Not enough distribution plant being provided for, how does that work?

WITNESS WOOD: We discussed that in a lot of detail, Mr. Pitkin and I, in our rebuttal testimony -- and, unfortunately, you'll have to see me again later in the week -- on this whole analysis and on this criticism of insufficient cable.

But when you look at what's actually being calculated, it is not a test for whether the model produces enough cable to reach customers. That's not what the test was ever intended to be. That's not what the people of -- the creators of this test ever intended it to be, but I think it's been suggested that that's what the results indicate; and that's simply wrong.

It would certainly be -- when we try to be conservative in terms of overstating rather than understating, moving these people out, certainly moving them to interior roads, the costs would go down some, and that's a possibility --

COMMISSIONER JACOBS: I'm sorry. I didn't hear that last part.

WITNESS WOOD: It would -- the costs would go down some, and, you know, that's a possibility here if that's something -- you know, if you decided, well, I see your second best solution for people you can't geocode, and I think that does overstate costs and I really think you ought to move these people internally, we could do that.

COMMISSIONER JACOBS: Okay. Thank you.

COMMISSIONER DEASON: You estimate that that inherent bias for that assumption is in the magnitude of 5% more cabling required?

WITNESS WOOD: Yes. We've actually calculated it. We had -- it is part of the -- an ex parte filing at the FCC. We obtained from the company that BCPM gets its data, road data, from the information necessary to spread on those interior roads, and it's an exhibit to our rebuttal, and I'll look and see which one. I think it's a 5.1% decrease, and it's not at -- that's a calculated decrease in the total route miles of cable required.

COMMISSIONER DEASON: So it's 5.1% if you change the assumption to distribution consistent with interior road --

WITNESS WOOD: That's right. You'll use 5% less cable in that scenario.

COMMISSIONER DEASON: Did you attempt to look at just a random distribution within the census block? Would that make any difference?

WITNESS WOOD: We have not -- that's actually the old -- if you remember the earlier versions of that model, we did try to spread throughout. We got a lot of criticism for that.

COMMISSIONER DEASON: I'm just trying to get an order of magnitude comparison.

WITNESS WOOD: We have -- I have not done that analysis, and I don't think Mr. Pitkin has. What we're trying to do here is where we can get it right in terms of geocoding, we want to get it right.

The question then becomes, well, what's the next best solution for the next set of people. And it's either put them on the outside or move them on the outside and the inside.

CHAIRMAN JOHNSON: Redirect?

MR. MELSON: I think just two questions.

REDIRECT EXAMINATION

BY MR. LAMOUREUX:

Q Could you just briefly explain, Mr. Wood, what the difference is between making a density zone run and using density zone results that come out of the model? I just want to clarify that.

A Oh, sure. When you run the model on the input screen, the one that has the run button that you click on, it also has some choices for the level of aggregation.

The model calculates costs down at this customer group level, this cluster level, and then you can aggregate that up by wire center, you can aggregate it up by density zone or by census block group, and you just choose that.

Certainly, as Mr. Guepe testified, we think the results on a wire center basis are what are most useful to you in the task that you have before you.

The difference in the two runs in this case happens to be the way the output sheet is formatted. There's a piece of information that comes out in a density zone run that doesn't come out in a wire center run. It happens to be this access data that we use to add those minutes back in.

It's not like there's two fundamentally different calculations; it's just rolling up the costs. And this piece of information shows up on one output sheet and doesn't show up on the other, so you need to make the other run just to get the -- pull that piece from the output.

Q Are there any wire centers in Florida with a 0% geocode success rate in the Hatfield model?

A No.

MR. LAMOUREUX: No further questions.

COMMISSIONER DEASON: I have one other question. Mr. Wood, you indicated that you are not aware of any loops which exceeded 18,000 feet in Florida.

WITNESS WOOD: That's right. We actually -- let me pull this exhibit for you.

COMMISSIONER DEASON: Well, just let me ask my next question.

What about between 12,000, 18,000; what percentage of the loops fall in that category?

WITNESS WOOD: For both models, less than 1%.

COMMISSIONER DEASON: Less than 1%?

WITNESS WOOD: Yes. We have an exhibit to the rebuttal testimony that's actually a color chart that's a distribution for the Hatfield model for, you know, 1,000-foot increments, what number of loops fall into each band. And they are predominantly much, much shorter. There are only less than 1% that go beyond 12 for either model, and none go as far as 18.

CHAIRMAN JOHNSON: Exhibits?

MR. COX: Chairman Johnson, Staff would request that Exhibit 45 be moved into the record at this time.

CHAIRMAN JOHNSON: I'll show it admitted without objection.

(Exhibit 45 received in evidence.)

MR. CARVER: BellSouth moves Exhibit 44.

CHAIRMAN JOHNSON: Show that.

(Exhibit 44 received in evidence.)

MR. LAMOUREUX: AT&T moves Exhibit 43.

CHAIRMAN JOHNSON: Show 43 and 44 moved without objection.

(Exhibit 43 received in evidence.)

MR. HATCH: And 42, as well.

CHAIRMAN JOHNSON: Show 42 moved without objection.

(Exhibit 42 received in evidence.)

CHAIRMAN JOHNSON: Thank you, Mr. Wood. We'll see you later.

(Witness Wood excused.)

\- - - - -

MR. CARVER: Should I call the next witness?

CHAIRMAN JOHNSON: Yes.

MR. CARVER: BellSouth calls Dr. Kevin Duffy-Deno.

(Discussion off the record.)

(Brief recess.)

- - - - -

CHAIRMAN JOHNSON: We're going to go back on the record.

- - - - -

DR. KEVIN DUFFY-DENO

was called as a witness on behalf of BellSouth Telecommunications, Inc. and, having been duly sworn, testified as follows:

DIRECT EXAMINATION

BY MR. CARVER:

Q Dr. Duffy-Deno, could you please state your full name and your business address?

A My name is Kevin Duffy-Deno, D-U-F-F-Y, hyphen, D-E-N-O.

Q By whom are you employed and in what capacity?

A I'm employed by INDETEC International as an economist and quantitative analyst.

Q And have you caused to be prefiled in this docket 20 pages of direct testimony, including two exhibits?

A That's correct.

Q And have you also caused to be prefiled 44 pages of rebuttal testimony including 15 exhibits?

A That's correct.

Q Do you have any changes to your direct or rebuttal testimony?

A I do not.

Q And if I were to ask you the questions today that appear in your direct and rebuttal testimony, would your answers be the same?

A They would.

MR. CARVER: Madam Chairman, I would like to request that Dr. Duffy-Deno's direct and rebuttal testimony be inserted in the record as though read.

CHAIRMAN JOHNSON: It will be so inserted.

MR. CARVER: And, also, if we could have the exhibits to both his direct and rebuttal marked for identification, please.

CHAIRMAN JOHNSON: We'll identify KDD-1 and 2 as Composite Exhibit 46.

(Exhibit 46 marked for identification.)

MR. CARVER: And 1 and 2 are to his direct testimony. He also had rebuttal exhibits, but I don't think they're listed on the prehearing statement. On the prehearing order, rather. And those are KDD-1 through 15, rebuttal.

CHAIRMAN JOHNSON: KDD --

MR. CARVER: 1 through 15.

CHAIRMAN JOHNSON: 1 through 15 of rebuttal exhibits as 47.

(Exhibit 47 marked for identification.)

MR. CARVER: Thank you.

Table of Contents

REBUTTAL TESTIMONY

OF DR. KEVIN T. DUFFY-DENO

ON BEHALF OF BELLSOUTH TELECOMMUNICATIONS, INC.

BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

DOCKET NO. 980696-TP

SEPTEMBER 2, 1998

I. INTRODUCTION

Q. PLEASE STATE YOUR NAME AND BUSINESS AFFILIATION.

A. My name is Kevin T. Duffy-Deno. I am the Managing Director-Market Research at *INDETEC* International, a telecommunications consulting firm.

Q. ARE YOU THE SAME KEVIN T. DUFFY-DENO WHO FILED DIRECT TESTIMONY IN THESE PROCEEDINGS?

A. Yes.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. The primary purpose of my testimony is to respond to Mr. Wood's assertion in his testimony of August 3, 1998 on page 20 that:

"By developing costs based on the actual locations of most customers, this release of the HAI Model provides a degree of precision in its results that simply cannot be duplicated by a model such as the BCPM which uses a more simplistic approach of arbitrarily distributing end users along roadways or within an artificial grid structure."

My testimony provides theoretical and empirical evidence that refutes Mr. Wood's assertion. This evidence consists of a relative evaluation of three key features of the HAI Model Release 5.0a (HAI 5.0a) and the Benchmark Cost Proxy Model Release 3.1 (BCPM 3.1): (1) the customer location methodology; (2) the customer aggregation methodology; and (3) a comparison of the minimum distance, as the crow flies, required to connect customers and the distribution plant provisioned in HAI 5.0a.

Q. PLEASE SUMMARIZE YOUR PRIMARY FINDINGS AND CONCLUSIONS.

A. The following summarizes key evidence that counters Mr. Wood's assertion that HAI 5.0a is more "precise" than BCPM 3.1.

- The rate of successful geocoding is extremely low in the rural, low-density areas of Florida. Consequently, the HAI Model customer location methodology is reduced to estimating the lion's share of customer locations in these areas. HAI simply places such customers on the perimeter of relatively large Census Blocks, ignoring the importance of placing customers along interior roads.
- The HAI's sponsors claim that the model accurately locates customers remains unsubstantiated because AT&T has refused to allow anyone access to the underlying geocoded and surrogate data to BellSouth for Florida.
- The rectangular HAI clusters to which the HAI model engineers plant, do not fully encompass the underlying geocoded and surrogate locations upon which these HAI clusters are based. The geocoded and surrogate locations themselves are not

used in the HAI model.

- An analysis of the Yankeetown wire center in Levy County indicates that BCPM's customer location methodology effectively identifies the actual distribution of customers within this wire center.

- An analysis of whether HAI 5.0a estimates the minimum distance needed to connect all of the customers in their main cluster locations identified by the model indicates that HAI 5.0a substantially underestimates this distance by 1,866 miles for BellSouth's Florida territory. In the lowest density zone, the model's estimated distribution distance (including drop and connecting cable) is less than this minimum connecting distance in 87% of its main clusters. Hence, HAI 5.0a's distribution plant substantially underestimates the requisite plant by a substantial margin to provide basic service, particularly in rural areas.

- In contrast to the pronounced internal inconsistency in HAI 5.0a determination of requisite distribution plant, a comparable analysis of BCPM 3.1 reveals that BCPM's modeling of distribution plant is internally consistent with BCPM's modeling intent. The minimum connecting distance analysis of BCPM 3.1 indicates that BCPM is only 465 miles short in the lowest density zone and short in only 32% of its ultimate grids.

Q. HOW IS YOUR REBUTTAL TESTIMONY ORGANIZED?

A. Section II provides an overview of HAI 5.0a's and BCPM 3.1's customer location methodology and an evaluation of the two methodologies. Section III provides similar information for the model's customer aggregation methodologies. The models' provision of distribution plant is addressed in Section IV. A summary of key points is provided in Section V.

Q. ARE THERE EXHIBITS TO YOUR TESTIMONY?

A. Yes. The following is a list of the Exhibits that accompany my testimony:

KDD-1	The Road Network in Dixie County, FL
KDD-2	Geocoded Locations in Dixie County, FL
KDD-3	Geocoded Locations in Levy County, FL
KDD-4	Geocoded Locations in Washington County, FL
KDD-5	Satellite Observations in the Yankeetown Wire Center, FL
KDD-6	Effect of Surrogate Point Placement On Minimum Spanning Tree Length
KDD-7	March 2, 1998 AT&T *ex parte* to the FCC
KDD-8	Concentric Ring Analysis of the Yankeetown Wire Center, FL
KDD-9	Figure 1. Yankeetown Wire Center: Distribution of Actual and BCPM predicted Counts.
KDD-10	BCPM Ultimate Grids in the Yankeetown Wire Center, FL
KDD-11	HAI Distribution Cable Requirements
KDD-12	HAI 5.0a Clusters in the Yankeetown Wire Center, FL
KDD-13	Figure 2. Stylized PNR Polygon Cluster and the HAI Equivalent-area rectangle (Access Database); Figure 3. Formation of the HAI 5.0a Rectangular Clusters
KDD-14	Using Minimum Spanning Trees to Estimate Subscriber Dispersion and Minimum Network Length
KDD-15	The "Shorter-Than-Minimum-Spanning-Tree" Fallacy

II. CUSTOMER LOCATION

A. HAI 5.0a Customer Location Methodology

Q. HOW DOES HAI 5.0a LOCATE CUSTOMERS?

A. As explained in the HAI Model Documentation, "address geocoding" is used to spatially locate customers. First, an address database is acquired from a source such as Metromail, which supplies addresses to the mass-mail marketing industry. These addresses are then input to geocoding software, which then determines the latitude and longitude of the address on a map of the road-network.

When customers cannot be accurately address-geocoded, their locations are placed uniformly on the perimeter of the Census Block in which they are located. These estimated customer locations are called "surrogate" locations.

Q. OF THE COMPLETE ADDRESSES METROMAIL PROVIDES, CAN THE LOCATIONS OF ALL CUSTOMERS BE ADDRESS-GEOCODED?

A. No. P.O. Box and Rural Route addresses cannot be accurately geocoded. Since P.O. Boxes and Rural Route addresses occur much more frequently in rural areas, this affects the ability to geocode in rural areas substantially more than it affects geocoding in the urban areas.

Failure to address-geocode may also result from incomplete information in the road network database. For example, consider a fictional Mrs. Emma Jones who lives at 120 Town Road. To accurately geocode Mrs. Jones' location, one needs three pieces of information in the road network database. First, the physical road segment Town Road, the portion of road between two intersections, needs to be in the database. Second, the physical road segment must be identified with the name "Town Road." Finally, the address range associated with "Town Road" must include "120."

The leading reason why customer locations in rural areas cannot be accurately address-geocoded is this road network information requirement. As an example, Exhibit KDD-1 shows the road network in Dixie County, Florida. Physical road segments are shown in black, named road segments are shown in blue, and named road segments with address ranges are shown in red. Customer locations can only be accurately geocoded to the red road segments. The portion of total road segments that are named and numbered is quite low. Less than 1% of the physical roads in Dixie County are named and have address ranges.

Q. WHAT SHARE OF CUSTOMER LOCATIONS COULD BE ADDRESS-GEOCODED IN FLORIDA?

A. The sponsors of HAI 5.0a filed with the FCC an *ex parte* on February 3, 1998 which presents the geocode rates obtained by the HAI Model developers, by density zone, for the 50 states. For the < 5 line per square mile density zone, the HAI Model developers could accurately address-geocode the locations of only 34% of customers in Florida. The national average was reported as being 15% for this density zone. Table 2 below shows all of the geocode rates for Florida.

Table 2. HAI 5.0a Address-Geocode Rates for Florida:

CBG Density Zone

Density Zone	MCI Reported Successful Geocode Rate
0 - 5	34%
5 - 100	62%
100 - 200	80%
200 - 650	85%
650 - 850	84%
850 - 2,550	78%
2,550 – 5,000	64%
5,000 – 10,000	46%
10,000 +	50%

Q. IS THERE ANOTHER WAY TO EXAMINE THE GEOCODE RATE IN FLORIDA OTHER THAN THAT PRESENTED IN TABLE 2?

A. Yes. Another set of geocode success rates has been provided by AT&T to the Fcc to support HAI 5.0a. These data are success rates by Florida wire center. These data, shown in Table 3, reveal that no residential customer locations could be successfully address-geocoded in 25 wire centers in Florida, or 5.3% of the total wire centers in Florida.

Table 3. Distribution of HAI Address-Geocode Success Rates for Florida Wire Centers.

Geocode Rate	WC Count	WC Share
0%	25	5.33%
0 - 10%	65	13.86%
10 - 20%	25	5.33%
20 - 30%	19	4.05%

30 - 40%	20	4.26%
40 - 50%	25	5.33%
50 - 60%	20	4.26%
60 - 70%	43	9.17%
70 - 80%	78	16.63%
80 - 90%	105	22.39%
90 - 100%	43	9.17%
100%	1	.21%
Total	469	100.00%

Another way to examine these wire center level data is to categorize wire centers into density zones using wire center level densities (density in Table 2 refers to Census Block Group density, the measure of density used by HAI 5.0a). This approach suggests that the address-geocode rate in the lowest density wire centers is lower than the 34% reported in Table 2. In fact, on average, the success rate in the less than 5 line per square mile density zone is 22%. These data for all HAI wire centers in Florida are shown in Table 4. Wire center area is taken from BCPM 3.1 as the HAI Access database does not provide these data.

Table 4. HAI 5.0a Address-Geocode Rates for Florida: Wire Center Density Zone

DZ	WC Count	Average Geocode Rate
< 5	19	22.43%
5 - 20	71	23.30%
20 - 100	91	46.83%
100 - 200	52	68.17%

200 - 650	79	72.78%
650 - 850	20	79.84%
850 - 2,550	62	70.16%
2,550 - 5,000	55	60.17%
5,000 - 10,000	18	40.87%
> 10,000	2	21.19%
Total	469	54.74%

Q. HAVE YOU EXAMINED THE ADDRESS-GEOCODE RATE FOR RURAL FLORIDA?

A. Yes, I have. Table 5 shows the 1995 Census housing unit count for three randomly selected rural Florida counties. Dixie and Levy Counties are located on the western coast of northern Florida while Washington County is located just east of Eglin Air Force Base. All three counties are characterized by low housing unit densities (i.e., less than 15 housing units per square mile). These counties were selected using a MapBasic random selection program from a list of the state's counties with densities less than 25 housing units per square mile and known to contain a BellSouth owned wire center. Wire centers containing Native American reservations, major state parks, or predominantly water were rejected if they were selected.

Also shown in Table 5, for each county is the number of Metromail complete addresses provided to INDETEC on July 11, 1998, the number of these addresses that can be geocoded, and hence, the share of 1995 Census housing units that can be geocoded.

Table 5. Address-Geocoding in Low-Density Counties of Florida

	1995 Census Housing Units	Metromail Complete Addresses	Geocodable Addresses	Census Count Geocodable
Dixie	7,361	216	0	0%
Levy	14,011	7,074	3,748	27%
Washington	8,461	3,794	2,253	27%

Table 5 clearly shows that the share of total customer locations (Census housing units) that can be geocoded varies across counties and can be extremely low, zero in fact, consistent with the HAI Model sponsor findings.

Q. YOU MENTIONED THAT THE ADDRESS-GEOCODE RATE DIFFERS BETWEEN RURAL AND URBAN AREAS. CAN YOU PROVIDE EVIDENCE OF THIS IN THESE RURAL FLORIDA COUNTIES?

A. Yes. The geocode rates shown in Tables 2 - 5 do not show the fact that customer locations in towns are much more likely to be geocoded than those out of town. As evidence of this, consider the three maps of wire centers in these counties provided as Exhibits KDD- 2, 3, and 4. These maps show, by red diamonds, the geocoded locations in these wire centers. No customer locations could be geocoded in Dixie County (KDD-2). Usually one sees that in rural counties, geocoded locations tend to occur in clusters, centered on towns. This is the case in both Levy (KDD-3) and Washington (KDD-4) Counties. In Levy County, the geocoded locations are clustered around the towns of Inglis, Williston, Bronson, and Chiefland. In Washington County, tne geocoded locations are clustered around Chipley, at the intersection of Interstate 10 and route 77.

In fact, the 34% geocode rate for the lowest density zone in Florida reported by the sponsors of HAI 5.0a likely overstates the geocode rate in the truly rural areas for this reason. The density zones used to report these geocode rates likely contain both towns and out-of-town areas. Hence, an aggregate geocode rate is typically higher than what is true for the out-of-town areas.

Q. IS IT LIKELY THAT ADDRESS-GEOCODED LOCATIONS ACCURATELY REPRESENT THE TRUE DISTRIBUTION OF CUSTOMER LOCATIONS IN THESE WIRE CENTERS?

A. No. By examining **actual** locations relative to geocoded locations, one can see that indeed, geocoded locations tend to be only in and around towns, despite there being housing units scattered throughout the wire center.

Q. DID YOU EXAMINE A WIRE CENTER IN RURAL FLORIDA FOR THIS PHENOMENON?

A. Yes. Address-geocoded locations were obtained for the Yankeetown wire center in Levy County. In addition, **actual** customer locations were obtained through the analysis of a satellite image for this wire center.

Q. WHAT KIND OF SATELLITE IMAGE WAS USED FOR THE FLORIDA ANALYSIS?

A. The satellite image used is referred to as a "10-meter product". That is, one pixel equals 10 meters on a side. The image was taken on December 4, 1995 from an altitude of 520 miles. It was purchased from SPOT Image Corporation and analyzed by ERIM (Environmental Research Institute of Michigan).

Q. HOW WAS THE SATELLITE IMAGE ANALYZED BY ERIM?

A. Since the image is digitized, it can be loaded into a personal computer and enlarged on the computer monitor. ERIM's experienced imagery analysts then visually identified houses on a Census Block by Census Block basis.

Q. WHAT DID YOUR ANALYSIS REVEAL?

A. A map of the Yankeetown wire center Exhibit KDD-5 shows the locations of the houses that could be identified from the satellite image locations. Six hundred and thirty-three of the 2,119 housing units in this wire center could be geocoded to the HAI Model standards. It is clear that geocoding does not capture a significant portion of the customer locations in Florida low-density areas. Moreover, Exhibit KDD-5 shows that actual customers are dispersed throughout the wire center.

Q. CUSTOMERS WHOSE LOCATIONS CANNOT BE ADDRESS-GEOCODED ARE PLACED ON THE PERIMETER OF CENSUS BLOCKS. IS THERE EVIDENCE THAT CUSTOMERS ARE ACTUALLY LOCATED OTHER THAN ON THE PERIMETER OF CENSUS BLOCKS?

A. Yes there is. It is true that people tend to live along roads. It is also true that roads are not limited to the perimeter of Census Blocks. For example, in Florida, 44% of the populated roads in the low-density Census Blocks (densities greater than 0 but less than equal to 20 housing units per square mile) are "interior roads."

The share of populated road mileage that is interior to Census Blocks for the four lowest density zones in Florida is shown in Table 6.

Table 6. Florida Interior Roads

Density (HU / SQMI)	% of Populated Roads that are Interior to Census Block
< 5	48.2
5 - 20	39.5
20 - 100	38.3
100 - 200	32.7

In addition, when *INDETEC* geocoded customer locations in the counties of Levy and Washington we found that 32% and 27%, respectively, are located on interior roads. These findings are inconsistent with the placement of all non-geocodable customers on the perimeter of Census Blocks. Thus, HAI inappropriately disregards the fact that customers in rural areas live along both interior and perimeter roads.

Q. IS THE PLACEMENT OF SURROGATE LOCATIONS ON THE PERIMETER OF CENSUS BLOCKS A "CONSERVATIVE" ASSUMPTION AS THE HAI PROPONENTS CONTEND?

A. No. By "conservative" I assume the reference is with respect to the *dispersion* of customer locations. Exhibit KDD-6 provides an example of where uniform placement of customer locations along roads both exterior and interior to a Census Block yields a *greater* dispersion (as measured by the Minimum Spanning Tree distance) than uniform placement along the Census Block boundary.

In addition, uniform placement along Census Block boundaries is not conservative if artificial clusters are formed along contiguous Census Block boundaries.

Q. HAVE THE DEVELOPERS OF HAI 5.0a PRESENTED AN ALTERNATIVE METHODOLOGY TO THE SURROGATE PLACEMENT YOU DISCUSSED ABOVE?

A. Yes. On March 2, 1998, AT&T filed with the FCC an *ex parte* that presents an "alternative methodology for determining the location of customers who were not geocoded to their precise street address location by the HAI Model, v5.0a." This *ex parte* is attached to my rebuttal testimony as Exhibit KDD-7.

Q. WHAT IS THIS ALTERNATIVE METHODOLOGY THAT HAI PRESENTED TO THE FCC?

A. The methodology discussed in this *ex parte* locates customers whose addresses cannot be accurately geocoded within a Census Block on the basis of both interior and boundary roads. This methodology uses the internal Census Block road network much in the same way that BCPM has used all along. The *ex parte* states, "We are currently using the **same** roads that are claimed to be used in BCPM3." (Emphasis added).

Q. IS IT TRUE THAT A MODEL WHICH ADDRESS-GEOCODES SOME CUSTOMER LOCATIONS IS NECESSARILY BETTER THAN ONE THAT DOES NOT USE ADDRESS GEOCODING?

A. No. First, the mere use of address-geocoding does not necessarily make a model's customer location methodol gy better than one which uses some other technique to locate customers. This argument is especially suspect in the low-density areas where the address-geocode rate is extremely low. Consequently, the assertion of accuracy of HAI's placement of customers in rural areas depends critically upon the erroneous assumption that customers live on only perimeter roads.

Second, the degree to which a model uses address-geocoding needs to be determined. For example, as discussed later, the address-geocoded and surrogate locations are used only to define the perimeter of the PNR polygon clusters in the HAI preprocessing stage. Once HAI transforms the PNR clusters, generating new HAI clusters that encompass a different geographic area than the PNR clusters, the customer latitude and longitude information is discarded. This information in no way enters the Access database used by HAI 5.0a.

Q. WHAT IS YOUR OVERALL ASSESSMENT OF THE HAI CUSTOMER LOCATION METHODOLOGY?

A. First, the HAI customer location methodology *is* severely limited in its ability to use geocoded data, especially in rural areas. Since the rate of successful address-geocoding is low in rural low density areas, this methodology relies heavily on an inadequate estimate of customer locations. This estimation places customers on the perimeter of Census Blocks, disregarding the fact that customers live along interior roads as well.

Secondly, despite claims by the HAI proponents that the HAI customer location methodology more accurately locates customers than BCPM, particularly in the low-density areas, this conclusion is counterintuitive given the limitations just described. Furthermore, AT&T has not provided any quantitative evidence to substantiate this claim, nor has it provided the underlying data for the geocoded and surrogate locations as requested by BellSouth in discovery, to permit such an analysis.

B. BCPM 3.1 Customer Location Methodology

Q. WOULD YOU PLEASE BRIEFLY REVIEW BCPM'S CUSTOMER LOCATION METHODOLOGY?

A. BCPM 3.1 assumes that customers are located on or near roads and uses detailed road-mileage information to allocate U.S. Census housing units counts within Census Blocks. Specifically, a "fishnet" of microgrids, each roughly 1,500' by 1,700', is placed over a wire center. Census Block housing unit counts are then allocated to each microgrid based on each microgrid's share of total Census Block road mileage. The end result is a statistical distribution of customer locations across the microgrids of a wire center. That is, the process yields the *likely* (estimated) location of customers within a wire center.

Q. HOW ARE HOUSING UNITS DISPERSED WITHIN A MICROGRID?

A. The customer location methodology results in a housing unit count for each microgrid. However, BCPM effectively assumes, for purposes of estimating distribution cable distances, that housing units are evenly distributed along the roads within a microgrid.

Q. DID YOU COMPARE BCPM's CUSTOMER LOCATION PREDICTIONS WITH ACTUAL CUSTOMER LOCATIONS?

A. Yes. A key test of any customer location methodology is whether the model's estimated customer locations are consistent with actual customer locations. This is of paramount importance in the rural, low-density area since Census Blocks are quite large in these areas.

The first step was to choose a BellSouth - Florida wire center in a low-density area. As described earlier, this selection was made randomly and resulted in the Yankeetown wire center in Levy County. ERIM then analyzed two satellite photographs that covered this wire center and identified house locations. These locations (latitudes and longitudes) were then digitized with the result being the map presented as Exhibit KDD-5. As Exhibit KDD-5 shows, house locations are scattered through out the wire center.

The next step is to overlay this map with concentric circles each with a radius 1-mile greater than the previous circle's. This yields "rings" around the central office "bull's eye" with a width of 1 mile. The idea is to count the number of actual houses that fall within each "ring." These counts are summed and then plotted against the ring's outer-edge distance from the central office. The result is the distribution of actual houses as measured against distance from the central office.

The map shown in Exhibit KDD-8 (with the concentric rings) is next overlaid with BCPM's microgrids. As noted earlier, housing units are allocated to the microgrids in the wire center based on each one's share of livable road mileage. Using the centroid of the microgrid, each microgrid is assigned to an appropriate ring and the number of BCPM predicted housing units is summed for each ring. This step yields the distribution of BCPM predicted housing units as measured against the distance from the central office.

The actual house and BCPM housing unit distributions for Yankeetown are shown graphically in KDD-9, Figure 1. As one would expect, the majority of houses (62%) is actually located within 3 miles of the central office with the distribution having a "long tail." Figure 1 also shows that the actual and BCPM distributions are a very close match. Since the "actuals" are single, detached-houses and the "predicted" are all housing units, there cannot be an exact one-to-one match. What we are looking for is the tendency of actual locations to lie where BCPM predicts them to be.

For example, 62% of actual locations are within 3 miles of the central office. The comparable figure for BCPM's predicted housing unit locations is 66%. At 10 miles, the percentages are 86 and 88. Moreover, the simple correlation between the actual house counts and BCPM's predicted housing unit counts across the rings is 0.99. Hence, BCPM's customer location methodology, using this benchmark, accurately identifies the actual distribution of customers within this wire center.

Q. DID YOU PERFORM A SIMILAR EVALUATION OF THE HAI CUSTOMER LOCATION METHODOLOGY?

A. No. BellSouth requested in discovery that AT&T provide the customer location data necessary to perform this analysis. AT&T claimed that the information is proprietary and refused to produce it. Thus, AT&T has refused to provide the data needed to conduct a comparable test of the Hatfield model.

Q. WHAT IS YOUR OVERALL ASSESSMENT OF THE BCPM CUSTOMER LOCATION METHODOLOGY?

A. Since the rate of address-geocoding is extremely low in the areas of primary interest for universal service, most, if not all, customer locations must be estimated in the low-density areas. Using road information is a logical approach for estimating customer locations. Not only is the relationship between Census Block road mileage and housing unit counts empirically verifiable but the methodology is based on a comprehensive database. That is, road data are reasonably complete for every Census Block in the country. Address databases are not.

Moreover, the soundness of BCPM's approach has been validated by comparing the customer locations predicted by the BCPM model with real-world customer locations. As presented above, such a test of BCPM's road-based methodology indicates that it effectively predicts the actual distribution of houses, as a related to distance from the central office, in the Yankeetown wire center.

III. CUSTOMER AGGREGATION

Q. HOW DO THE COST PROXY MODELS USE THE CUSTOMER LOCATION INFORMATION?

A. The next step in the modeling process is to aggregate customers into telephone serving areas. These serving areas are the fundamental units that are served by the wire-based network. A brief presentation of the models' aggregation process is necessary as it bridges my discussion of the customer location and distribution plant methodologies.

A. HAI 5.0a Customer Aggregation Methodology

Q. HOW DOES HAI 5.0a FORM ITS TELEPHONE SERVING AREAS?

A. Once the address-geocoded and surrogate customer locations are determined, a process developed by PNR and Associates (PNR) determines clusters of customers. This process is described in the HAI Model Documentation in section 5.5. The documentation indicates that there are several criteria used to determine the ultimate size of a cluster. These stated criteria are: (1) no point in a cluster may be more than 18,000 feet distant (based on right angle routing) from the cluster's centroid; (2) no cluster may exceed 1,800 lines in size; and, (3) no point in a cluster may be farther than two miles from it's nearest neighbor. The end result of this process is a set of irregularly shaped polygon clusters.

Q. WHAT ARE OUTLIER CLUSTERS?

A. The process described above applies to the "main" clusters, which consist of 5 or more locations. PNR also identifies very small clusters, called outlier clusters, which consist of 4 or less locations. These outlier clusters are "homed" on a parent main cluster and are strung together in HAI 5.0a by T1 road cable. In BellSouths's Florida service territory, there are 5,948 main clusters and 210 outlier clusters. The main clusters account for 99.99% of the locations and 99.99% of the

 946

lines identified by HAI 5.0a.

In the discussion that follows, "serving areas" in HAI 5.0a are synonymous with "main clusters."

Q. VISUALLY, WHAT DO THE PNR POLYGON CLUSTERS LOOK LIKE?

A. Given that AT&T refused to provide BellSouth the necessary data when it was requested through the discovery process, it is not possible to graphically depict the actual PNR polygon clusters for a wire center in Florida.

B. BCPM 3.1 Customer Aggregation Methodology

Q. PLEASE BRIEFLY REVIEW BCPM'S CUSTOMER AGGREGATION METHODOLOGY?

A. Once housing units and business lines are allocated among the micrograds in a wire center, micrograds (along with the estimated locations within each microgrid) are aggregated into telephone Carrier Service Areas (CSAs), referred to as "ultimate grids." Ultimate grids range in size from a single microgrid (in the high-density areas) to approximately 12,000 feet by 14,000 feet, roughly 6 square miles, in the low-density areas.

In rural, low-density areas, a BCPM ultimate grid situated away from the edge of the wire center is typically a rectangle that is 8 contiguous microgrids wide by 8 contiguous microgrids tall.

Q. VISUALLY, WHAT DOES THE BCPM 3.1 ULTIMATE GRID NETWORK LOOK LIKE?

A. Exhibit KDD-10 shows the Yankeetown wire center with actual locations, overlaid with the BCPM ultimate grids. Also shown is the number of housing units predicted to reside in each ultimate grid. There are 51 ultimate grids in this wire center. The maximum sized grid is 8.3 square miles. BCPM 3.1 places 2,392 housing units (1,865 households) in this wire center and 350 business locations.

Q. ONCE "ULTIMATE GRIDS" ARE FORMED, HOW ARE CUSTOMER LOCATIONS TREATED WITHIN THE ULTIMATE GRID?

A. Customers are still located within the ultimate grid in the microgrids to which they were originally assigned.

Q. HOW DOES THE BCPM CUSTOMER AGGREGATION METHODOLOGY DIFFER FROM THAT USED BY HAI 5.0a?

A. The PNR methodology is a "nearest neighbor" methodology whereby a cluster is formed from the "bottom up." Distance to the nearest neighbor is a primary guide in this process. The BCPM methodology starts with a macrogrid, a 1/25th of a degree latitude and longitude grid consisting of, at the most, 64 microgrids, and seeks to determine if this area can be broken into smaller serving areas. Hence, the BCPM methodology is a "top down" approach. Density, or concentrations of lines, is the primary guide in the BCPM process. Both methodologies yield serving areas of varying sizes, with larger areas serving the lower-density zones.

V. DISTRIBUTION PLANT ESTIMATION

Q. WHAT IS THE NEXT STEP IN THE MODELING PROCESS ONCE CUSTOMERS ARE AGGREGATED INTO SERVING AREAS?

A. The next step is to design a distribution network to serve these areas from the current location of the central office. My focus in this section is on whether the models estimate enough "distribution" plant to serve customers in the locations assumed by the models

A. HAI 5.0a Distribution Distance Estimation

Q. HOW DOES HAI 5.0a ESTIMATE THE AMOUNT OF DISTRIBUTION CABLE DISTANCE NEEDED TO SERVE CUSTOMERS IN THE LOCATIONS WITHIN THE PNR POLYGON CLUSTERS?

A. This is a multiple step process. The first step is a transformation of the irregularly shaped PNR polygon clusters into rectangles. The second step is placement of customers within these rectangles. The last step is the design of a branch and backbone network to serve these customers.

Q. HOW DOES HAI 5.0a TRANSFORM THE PNR CLUSTERS?

A. HAI 5.0a converts PNR's irregular polygons into the model's rectangular serving areas in two steps. First, for each of PNR's polygon clusters, HAI 5.0a forms a "minimum bounding rectangle," a rectangle that exactly bounds the cluster's "convex hull," by enclosing the polygon's four most northerly, southerly, easterly and westerly coordinates. (See Exhibit KDD-11 for an illustration.) This minimum bounding rectangle has a North-South, East-West orientation.

Next, HAI 5.0a converts each minimum bounding rectangle into an "equivalent-area" rectangle. The model performs this second step by forming a rectangle with the same area as the underlying PNR polygon cluster but with the "aspect ratio" of the minimum bounding rectangle. An aspect ratio is the ratio of a rectangle's height to its width. HAI 5.0a uses the resulting equivalent-area rectangles as the telephone serving areas *internal to HAI 5.0a*. That is, these are the areas to which the HAI model "builds plant."

Q. WHAT DO THE MAIN, "EQUIVALENT-AREA" RECTANGULAR CLUSTERS LOOK LIKE IN FLORIDA?

A. Exhibit KDD-12 shows the Yankeetown wire center and the rectangular clusters as derived from the cluster Access database accompanying HAI 5.0a. In this wire center, HAI 5.0a assumes there are 15 main clusters and 3 outlier clusters. Ninety-nine point eight percent of the locations assumed to exist in this wire center are placed into the main clusters. The largest main cluster is 13.8 square miles. In the State as a whole, the largest HAI 5.0a cluster is 20.2 square miles in size.

Q. ONCE THE RECTANGULAR MAIN CLUSTERS ARE FORMED, FOR MODELING PURPOSES, HOW ARE CUSTOMERS LOCATED WITHIN EACH RECTANGULAR CLUSTER?

A. HAI 5.0a assumes that customer lots are, essentially, evenly distributed within each cluster.

Q. HOW DOES HAI 5.0a DESIGN THE DISTRIBUTION NETWORK WITHIN THE MAIN, RECTANGULAR CLUSTERS?

A. Distribution plant is modeled in a simple branch and backbone configuration. HAI 5.0a assumes customer lots are essentially evenly distributed within each main cluster. Each lot is assumed to be twice as tall as it is wide. The size of each lot is simply the area of the polygon cluster divided by the number of locations. If the model determines that more than one DLC is needed, then connecting cable is also placed to connect the centroid of the main cluster (where the subfeeder terminates) with the DLCs.

Q. DO THE EQUIVALENT-AREA, RECTANGULAR MAIN CLUSTERS CONTAIN ANY INFORMATION ON THE LOCATION OF THE ADDRESS-GEOCODED AND SURROGATE LOCATIONS USED TO DEFINE THE PNR POLYGON CLUSTERS?

A. No. The equivalent-area rectangles are a modeling tool used by HAI 5.0a to estimate the amount of distribution cable needed to serve customers in the locations within the associated PNR polygon clusters. The address-geocoded and surrogate locations are used only in the determination of the PNR polygon clusters. Once the shape and area of the PNR polygon clusters are determined, the information on the geocoded and surrogate locations is no longer used by HAI 5.0a.

A visual representation may help. KDD-13, Figure 2 shows a stylized PNR polygon cluster (on the left) with 19 locations spatially located. Information on the exact spatial placement (by PNR) of these 19 locations is not provided in the HAI 5.0a Access database nor is information on the shape of the polygon cluster provided. We only know that there are 19 locations associated with this cluster as well as the area, location, and dimensions of the equivalent-area rectangle. What is provided in the HAI 5.0a Access database is the corresponding equivalent-area rectangle shown in Figure 2 (on the right).

Q. DO YOU HAVE A CONCERN WITH HOW THESE EQUIVALENT-AREA RECTANGULAR CLUSTERS ARE FORMED?

A. Yes, since these rectangles are used in the determination of distribution plant distances. The concern with these rectangular clusters is that, although the actual sizes and shapes of the underlying (polygon) clusters are not revealed, the equivalent-area rectangles can bear little relationship to the underlying shape of the PNR polygon cluster. Exhibit KDD-11 discusses this in detail.

Q. WHY IS IT AN ISSUE IF THE RECTANGULAR CLUSTER BEARS LITTLE RESEMBLANCE TO THE SHAPE OF THE UNDERLYING PNR CLUSTER?

A. The concern is that the transformation process can effectively result in a reduction of customer dispersion. That is, the dispersion of customers *assumed* for estimating distribution distances can be less than the level of dispersion that occurs in the underlying PNR polygon cluster. The result is that HAI 5.0a can estimate too little distribution distance to connect customers in the locations within the PNR clusters.

Q. CAN YOU PROVIDE A VISUAL DEMONSTRATION OF THIS ISSUE?

A. Certainly. KDD-13, Figure 3 shows a cluster of customer locations, some geocoded, some surrogate. This polygon cluster is transformed by HAI 5.0a into a rectangle that is used in the estimation of distribution plant. Although HAI 5.0a constrains the area of the rectangular cluster to the area of the PNR polygon cluster, the resulting rectangular cluster may bear little resemblance to the shape of the underlying PNR polygon cluster of customer locations. The original customer locations as well as the original distance between these locations are not preserved in the transformation process.

Q. DO YOU HAVE A CONCERN WITH THE HAI 5.0a DISTRIBUTION NETWORK DESIGN WITHIN THE MAIN RECTANGULAR CLUSTERS?

A. Yes. There is an assumption that reinforces the effect on the estimated distribution distance caused by the compression of customer dispersion discussed above. This assumption concerns the placement of the branch and backbone cable within the main rectangular clusters.

After producing the customer lots, HAI 5.0a places backbone distribution cable vertically and branch cable horizontally. Because branch and backbone cable extends to within one lot width (depth) from each rectangle's boundary, low-density rectangles are characterized by locations (i.e., structures) that must be compressed around the interior lots in order to be reached. Now this is not a problem in clusters that are densely populated. However, in sparsely populated clusters, the assumed lots are very large and the compression around the interior lots is much greater. The total effect of the transformation process coupled with this assumption concerning branch and backbone length is a tendancy to underestimate the distribution distance. Again, Exhibit KDD-11 illustrates how this underestimation can occur.

Q. WHAT MEASURE CAN BE USED TO QUANTIFY THE EXTENT TO WHICH THE HAI 5.0a UNDERSTATES DISTRIBUTION DISTANCE?

A. The Minimum Spanning Tree ("MST") can be used to provide an appropriate lower bound for quantifying customer dispersion. The MST is the most conservative measure of the minimum distance required to connect all customer locations. As such, it provides a measure of customer dispersion.

Simply, the MST of a set of points is that set of connecting line segments whose total length is the *shortest possible* for this set of points. The attached paper, "Using Minimum Spanning Trees to Estimate Subscriber Dispersion and Minimum Network Length" (Exhibit KDD-14) provides further rationale for the usefulness of the MST. The attached paper also provides a step-by-step example of how a MST is calculated.

Q. IN REALITY, ARE NETWORK DISTRIBUTION DISTANCES LIKELY TO EXCEED THE MST DISTANCE?

A. Yes, for the simple reason that actual distribution distances likely exceed the MST distance. For example, actual distribution paths must adhere to rights of way (e.g., streets). The MST ignores any such constraints and simply measures the shortest way to connect houses with a straight line. As such, a MST segment will traverse straight across a lake rather than follow a road around the lake to reach the other side.

Q. CAN YOU PROVIDE AN ANALOGY TO HELP EXPLAIN THE MST CONCEPT?

A. Yes. Suppose that an interstate highway is to be constructed directly between Gainesville and Jacksonville. We know that as the crow flies, the aerial distance between these two cities is approximately 65 miles. Clearly, the constructed interstate that connects these two cities cannot be shorter than 65 miles. If it were then cars would have to "fly" over the gaps in the highway. Realistically, the amount of interstate highway distance constructed would be greater than the "crow" distance as natural barriers, rights-of-way, and other obstacles would have to be factored into the routing of the highway.

Hence, the MST distance should be considered as a "reality check," not as the amount of distribution distance that a model should estimate. A model should estimate a distribution distance that *exceeds* the MST distance.

Q. SHOULD THE MINIMUM SPANNING TREE DISTANCE BE CONSIDERED A 'LOWER BOUND' FOR A REQUIRED AMOUNT OF DISTRIBUTION DISTANCE?

A. The MST should not be considered as a "lower bound" for a required amount of distribution distance. Such a lower bound likely *exceeds* the MST for the reason given above. Our analysis is based on the premise that if a model's calculated distribution distance is less than the MST distance, then it is less than the

955

minimum distance required for a functional distribution network.

Q. IS IT TRUE THAT THE MST DISTANCE MAY NOT BE THE SHORTEST DISTANCE CONNECTING A SET OF POINTS?

A. Theoretically speaking, yes. By adding points (nodes) one *may* be able to reduce, under certain conditions, the distance needed to connect the original set of points. However, in most cases of interest, i.e., ***greater than 5 locations***, it is very difficult to find a connecting distance that is less than the MST distance. Exhibit KDD-15 discusses this in more detail.

Q. DOES THE MST TEST THAT YOU ARE PROPOSING CONSIDER ACTUAL, I.E., "REAL-WORLD," CUSTOMER LOCATIONS?

A. No. It is important to realize that the test I am proposing is one for examining whether HAI 5.0a estimates enough distribution cable distance to connect the customers in the locations ***assumed by HAI 5.0a, i.e., in the PNR clusters***, not in their "real-world" locations. A ***comprehensive*** database on the real-world locations of ***all*** customers is ***not*** available. Hence, this is a test of a model's "internal consistency."

Q. DID YOU USE THE MST TO DETERMINE IF HAI 5.0a UNDERESTIMATES DISTRIBUTION DISTANCE FOR BELLSOUTH'S FLORIDA SERVICE TERRITORY?

A. Yes. We first calculated the MST distance for each PNR irregular polygon falling within BellSouth's wire centers in Florida. The MST distance represents the minimum distance required to connect the geocoded and surrogate coordinates encompassed by each polygon. For each ***corresponding*** equivalent-area, rectangular main cluster formed by HAI 5.0a, we then compared the MST distance with the distribution route distance calculated by HAI 5.0a. In making this comparison, we added drop lengths and connecting cable lengths to the distribution route distance calculated by HAI 5.0a.

Q. DID YOU ACQUIRE THE COORDINATES FOR THE GEOCODED AND SURROGATE LOCATIONS FROM THE ACCESS DATABASE THAT ACCOMPANIES HAI5.0a?

A. No. As discussed earlier, the Access database that accompanies the HAI model does not contain any information on the original locations in the PNR polygon clusters. A data request was made of AT&T to obtain the MST distance, based on a program supplied to AT&T by StopWatch Maps. We received for each HAI 5.0a cluster the MST distance, but was not provided any geocoded or surrogate locations.

Q. HOW ARE YOU DEFINING "UNDERSTATEMENT OF DISTRIBUTION DISTANCE"?

A. An understatement or "shortage" occurs if the MST distance is greater than the distribution route distance calculated by HAI 5.0a. Again, this does not imply that the MST is a lower bound for a required amount of distribution distance. It simply means the model is not providing for enough distribution distance to connect all the customer locations identified by PNR in the underlying polygon cluster ***using the shortest distance configuration that is theoretically possible.***

Q. WHAT DID YOUR CALCULATIONS OF THE PERTINENT MINIMUM SPANNING TREES REVEAL?

A. Using the HAI 5.0a default drop lengths, we calculated the difference between the MST distance and the distribution route distance calculated by HAI 5.0a for each main cluster. Table 9 presents a summary of our findings, again by density zone. Table 9 shows the cumulative amount by which the HAI 5.0a calculated distribution route distance falls short of the MST distance ("shortage"), the cumulative MST for the clusters that are short, the average shortage, the number of main clusters that are short, the number of main clusters in each density zone, and the percentage of main clusters that are short.

HAI 5.0a does not use the 5 - 20 and 20 - 100 density zones but considers only the aggregate 5 - 100 density zone. To provide greater detail for low-density areas, we provide data for these two subcategories.

Table 9. HAI 5.0a Distribution Route Distance Understatement: Default Drop Lengths, BellSouth Florida

Data for Only Main Clusters That Are Short

DZ	HAI MC Dist Route Feet Shortage	MST for Short MC	% Short	Number of MC Short	Number of MC in DZ	Number of MC Short in DZ (%)
< 5	2,764,677	6,569,067	42.39%	136	157	86.62%
5 - 20	4,491,981	15,796,651	28.44%	265	396	66.92%
20 - 100	1,793,590	7,124,473	25.18%	142	415	34.22%
100 - 200	300,093	1,384,879	21.67%	31	227	13.66%

200 - 650	192,303	687,053	27.99%	32	604	5.30%
650 - 850	10,600	46,356	22.87%	5	216	2.31%
850 - 2,550	163,312	1,099,637	14.85%	43	1,491	2.88%
2,550 - 5,000	64,046	624,884	10.25%	31	1,376	2.25%
5,000 - 10,000	35,165	291,621	12.06%	24	832	2.88%
> 10,000	18,648	130,309	14.31%	15	234	6.41%
	9,854,415	33,753,930	29.19%	724	5,948	12.17%

As Table 9 indicates, HAI 5.0a significantly underestimates the required distance to simply connect the customers, as the crow flies, to the network. The understatement by HAI 5.0a of distribution distance is greatest in the lower density areas, specifically, zones with fewer than 20 lines per square mile. Generally, the understatement declines as density rises. Estimated distribution distances that are short of the MST distance characterize 87% of the main clusters in the lowest density zone. This shortage in the lowest density zone is, on average, 42%. For BellSouth's entire Florida service territory, HAI 5.0a understates distribution distance by at least 9.9 million feet (1,866 miles) using the HAI 5.0a default drop lengths.

Q. IS IT LIKELY THAT THE PLACEMENT OF SURROGATE LOCATIONS ON THE PERIMETERS OF CENSUS BLOCKS LEADS TO AN OVERSTATEMENT OF THE MST DISTANCES FOR THE PNR POLYGON CLUSTERS?

A. No. Exhibit KDD-6 shows that a placement of locations on interior and boundary roads can lead to greater dispersion than placement just on the Census Block perimeter. Hence, this counters the argument that the MST distances calculated for the PNR clusters are "too long," and the shortage in distribution distance is overstated, because of the location of the surrogate points along the perimeter of the Census Block boundaries.

Q. IS IT MORE APPROPRIATE TO FOCUS ON THE GROSS SHORTAGE OR NET SHORTAGE IN DISTRIBUTION DISTANCE?

A. It is more appropriate to focus on the gross shortage in distribution distance. First, a definition of terms is in order. A gross shortage is the total shortage that occurs across main clusters when only the distribution distance shortages are added together. A net shortage is the total shortage that occurs when both shortages and "surpluses" are added together across main clusters.

Now, the shortage in one cluster (for which the MST distance exceeds the distribution distance calculated by HAI 5.0a) cannot be offset by another cluster for which the opposite is true. There are two reasons. First, the MST is not a "lower bound" distribution distance for a functional network. Second, and more fundamentally, distribution cable is not fungible across distribution areas. Because a *physical* network is being modeled, 100 feet of distribution distance beyond the MST amount in cluster X cannot be used to offset a 100 feet deficiency in distribution distance in cluster Y. Each and every cluster should have an appropriate amount of distribution distance so that *everyone* on the modeled network can "talk," not just the "average" customer.

Q. BUT IF THE OBJECTIVE IS A COST ESTIMATE, THEN WHY DOES IT MATTER THAT THE MODEL IS SHORT IN SOME CASES IF THERE ARE

POSSIBLE OFFSETS ELSEWHERE IN THE MODEL?

A. First, there has been no quantification of any offsets in HAI 5.0a. A ***quantified*** shortage cannot be offset by a ***speculated*** overestimation. Second, from a modeler's perspective, an identified error in the model should be fixed. This is true whether it results in an under- or overestimation. This is particularly true considering the use that will be made of the model selected, the identification of high cost areas. The Hatfield proponents have suggested, in affect, that overestimation of costs in each area will somehow average out. This is patently inconsistent with the development of a fund to support Universal Service in high cost areas. This process requires that cost be accurately determined for each high cost area.

Q. WHAT IS YOUR OVERALL ASSESSMENT OF THE HAI 5.0a DISTRIBUTION DISTANCE ESTIMATION METHODOLOGY?

A. The methodology can clearly result in too little distribution distance being estimated by the model. That is, in many cases, the HAI model does not estimate enough distribution distance to connect customers in the locations assumed by the model. This underestimation is the most severe in the low-density areas, the areas of concern for universal service purposes. Hence, the model is not internally consistent. A MST check should be included as part of the distribution distance estimation methodology.

B. BCPM Distribution Distance Estimation

Q. HOW DOES BCPM 3.1 ESTIMATE THE AMOUNT OF DISTRIBUTION

CABLE DISTANCE NEEDED TO SERVE CUSTOMERS IN THEIR MICROGRID LOCATIONS WITHIN THE BCPM SERVING AREAS?

A. BCPM employs two modeling tools in this estimation. First, each ultimate grid is divided into 4 potential "distribution quadrants," with the "cross hairs" being at the road-centroid of the ultimate grid. Subfeeder then extends into each ultimate grid to the road-centroid of the ultimate grid. In low-density areas, this is where the DLC is located. Horizontal and vertical connecting cable extend from the DLC to each ***populated*** distribution quadrant of the ultimate grid. The connecting cable terminates at the road-centroid of each populated distribution quadrant.

Q. HOW IS THE AMOUNT OF BRANCH AND BACKBONE CABLE DISTANCE NEEDED TO SERVE THE CUSTOMERS IN EACH POPULATED DISTRIBUTION QUADRANT DETERMINED?

A. This is determined with the aid of another modeling tool. An area equal in size to 1,000' times the amount of road mileage within a populated distribution quadrant is conceptualized. This area is assumed to be a square consisting of equal sized customer lots. Branch and backbone cable is then "laid" to serve each lot.

Q. HAVE YOU APPLIED THE MST REALITY TEST TO BCPM IN FLORIDA?

A. Yes, I have. I performed a test on BCPM 3.1 for BellSouth's service territory in Florida. The relevant unit of analysis in BCPM 3.1 is the Carrier Serving Area or "ultimate grid." The MST is computed for each ultimate grid based on the assumption that customer locations are evenly distributed along roads.

Q. HOW SHOULD THE TERM "DISTRIBUTION" BE USED TO ANALYZE

 962

BCPM'S DISTRIBUTION NETWORK USING THE MST TEST?

A. The issue is whether BCPM is estimating enough cable distance to connect customers to each other ***and*** to the network. Hence, "distribution" cable should include all cable on the customer's side of the subfeeder termination point in the serving area, i.e., ultimate grid. This distance includes branch, backbone, drop, and connecting cable distance. For the purpose of the MST test, connecting cable is always defined as "distribution" cable regardless of the location of the FDI.

Q. WHAT ARE YOUR FINDINGS FOR BCPM?

A. The findings are presented in Table 10.

Table 10. BCPM 3.1 Distribution Route Distance Understatement: Default Drop Lengths BellSouth Florida

Data for Only Grids That Are Short

DZ	BCPM Dist Route Feet Shortage	MST for Short Grids	% Short	Number of Grids Short	Number of Grids in DZ	Number of Grids Short in DZ (%)
< 5	1,136,087	5,387,477	21.09%	256	806	31.76%
5 - 20	621,726	3,991,302	15.58%	106	703	15.08%
20 - 100	349,609	770,058	45.40%	22	751	2.93%
100 - 200	82,343	205,984	39.98%	8	536	1.49%
200 - 650	86,867	177,997	48.80%	12	1,931	0.62%
650 - 850	18,399	19,563	94.05%	4	836	0.48%
850 - 2,550	109,886	224,708	48.90%	16	4,975	0.32%
2,550 - 5,000	9,634	35,370	27.24%	4	1,223	0.33%
5,000 - 10,000	26,507	26,507	100.00%	1	40	2.50%
> 10,000	12,958	12,958	100.00%	1	5	20.00%

2,454,016	10,851,924	22.61%	430	11,806	3.64%

In Table 10, the data are for the ultimate grids for which the MST distance exceeds the amount of distribution cable estimated by the model (i.e., "short" grids). In addition, BCPM 3.1 does not use the 5 - 20 and 20 - 100 density zones but considers only the aggregate 5 - 100 density zone. To provide greater detail for low-density areas, we provide data for these two subcategories.

Q. WHAT DOES TABLE 10 SHOW?

A. In the areas of interest for universal service, i.e., the *two* lowest density zones, the data in Table 10 show that BCPM 3.1 does not estimate enough distribution distance to connect customers in their estimated locations in 24% of its ultimate grids. Considering the entire BellSouth Florida service territory, BCPM's estimated distribution distance falls short of the MST distance in 4% of the ultimate grids. The total "shortage" is at least 2.5 million feet or 465 miles of distribution distance.

Q. WHAT IS YOUR OVERALL ASSESSMENT OF BCPM'S DISTRIBUTION DISTANCE ESTIMATION PROCESS?

A. The results indicate that BCPM is much more internally consistent than HAI 5.0a. That is, BCPM more effectively estimates a minimum required distribution distance (i.e., the MST distance) to connect customers in the locations estimated by the model.

Q. CAN ONE COMPARE THE BCPM MST RESULTS WITH THOSE OF THE

 964

HAI MODEL MST TEST?

A. Yes, but it is important that one keep in mind what the MST test represents. The test is a test of a model's internal consistency, in other words, whether the respective model does what it purports to do, assuming that one accepts its particular modeling assumptions.

With respect to the HAI model, the test addresses whether the HAI model estimates the minimum amount of cable distance, via the rectangular ***main clusters***, to connect customers in the locations identified by the model, i.e., in the corresponding PNR ***main clusters***.

With respect to BCPM, the test addresses whether BCPM estimates the minimum amount of cable distance, via the road-reduced areas and connecting cable configuration, to connect customers in the locations identified by the model, i.e., in the microgrids that comprise an ultimate grid.

Hence, the conclusion one can make is that BCPM is more internally consistent than HAI 5.0a. That is, BCPM is much more likely to estimate the minimum amount of distribution distance needed to connect customers in ***its*** serving areas, i.e., ultimate grids, than is HAI 5.0a to connect customers in ***its*** serving areas i.e., main PNR polygon clusters.

Q. DO THE RELATIVE RESULTS OF THE TWO MODELS' MST TESTS CHANGE IF THE DEFINITION OF A "SERVING AREA" IN THE HAI MODEL IS EXPANDED TO INCLUDE THE ASSOCIATED OUTLIER

CLUSTERS?

A. Not substantially. Table 11 presents the results of the HAI MST test, in the same format as Tables 9 and 10, for HAI serving areas defined in this manner. As Table 11 indicates, the addition of the outlier clusters reduces by 0.89 million feet (169 miles or 9%) the total shortage for BellSouth's Florida territory. In the lowest density zone, < 5 lines per square mile, the share of "servings areas" that are short declines from 87% to 76%. The comparable figure for BCPM 3.1 (from Table 10) is 32%. Including outliers improves the HAI model's showing in this test because the T1 road cable distance between the outliers is estimated assuming rectangular routing while the MST is the straight-line distance.

Table 11. HAI 5.0a Distribution Route Distance Understatement: Default Drop Lengths, Expanded Serving Area Definition, BellSouth Florida

Data for Only Serving Areas That Are Short

DZ	HAI SA Dist Route Feet Shortage	MST for Short SA	% Short	Number of SA Short	Number of SA in DZ	Number of SA Short in DZ (%)
< 5	2,314,677	6,789,656	34.09%	120	157	76.43%
5 - 20	4,016,334	15,756,075	25.49%	256	396	64.65%
20 - 100	1,697,531	6,980,288	24.32%	138	415	33.25%
100 - 200	295,974	1,360,514	21.75%	30	227	13.22%
200 - 650	187,645	740,964	25.32%	32	604	5.30%
650 - 850	19,973	137,864	14.49%	6	216	2.78%
850 - 2,550	250,752	1,380,601	18.16%	48	1,491	3.22%
2,550 - 5,000	80,714	661,603	12.20%	31	1,376	2.25%
5,000 - 10,000	35,165	291,621	12.06%	24	832	2.88%
> 10,000	64,757	176,762	36.64%	16	234	6.84%
	8,963,523	34,275,948	26.15%	701	5,948	11.79%

VIII. SUMMARY

Q. PLEASE SUMMARIZE THE MAIN POINTS OF YOUR REBUTTAL TESTIMONY.

A. There are three points I wish to emphasize that pertain respectively to the Hatfield models' customer location, customer aggregation, and provision of distribution plant.

First, the rate of successful address-geocoding in the rural areas of Florida is very low. In fact, not a single location could be geocoded in 25 wire centers in Florida. HAI 5.0a relies on an estimation process for those locations that cannot be address-geocoded. Due to the limited ability to address-geocode customers in rural areas, HAI 5.0a's customer location methodology is reduced essentially to placing customers along the perimeter of Census Blocks.

The proponents of the HAI model have not provided any quantitative analysis of the predictive accuracy of the geocode-surrogate methodology relative to actual, real-world customer locations. In comparison, it has been demonstrated in this testimony that BCPM yields a reasonably accurate depiction of the distribution of customers across the randomly chosen Yankeetown wire center.

Second, the degree to which a model uses address-geocoding needs to be determined. For example the address-geocoded and surrogate locations are used only to define the perimeter of the PNR polygon clusters in the HAI preprocessing stage. Once these clusters are formed, the customer latitude and longitude information is discarded. This information never enters the Access database used by HAI 5.0a.

 967

Third, a key validation test is whether the models estimate enough distribution cable distance to at least connect customers, as the crow flies, in the locations identified by the models.

Once customers have been located and aggregated into serving areas, HAI 5.0a and BCPM use different modeling tools in the estimation of the distribution distance needed to connect customers to each other and to the network. The focus should not be on the assumptions behind these tools but on the estimated distances that result from the application of these tools. Specifically, the focus should be on whether the models estimate enough distribution cable distance to connect customers in the locations identified by the models. In the case of HAI 5.0a, these are the geocoded and surrogate locations within the PNR polygon clusters. In the case of BCPM 3.1, these are the microgrids within the ultimate grids.

The minimum spanning tree (MST) test, offered in my testimony, is a test of a model's internal consistency in this regard, i.e., whether it does what its purports to do based upon its own modeling assumptions. When applied to HAI 5.0a and BCPM 3.1, the test indicates that the HAI 5.0 contains a substantial shortfall. In the lowest density zone, the model's estimated distribution distance (including drop and connecting cable) is less than its MST distance in 87% of its main clusters. For the same density zone, BCPM 3.1's estimated distribution distance (including drop and connecting cable) is less than its MST distance in substantially fewer ultimate grids. Overall, the HAI 5.0a shortfall totals at least

1,866 miles while that of BCPM totals at least 465 miles.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes.

DIRECT TESTIMONY

OF DR. KEVIN DUFFY-DENO

ON BEHALF OF BELLSOUTH TELECOMMUNICATIONS, INC.

BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

DOCKET NO. 980696-TP

AUGUST 3, 1998

I. INTRODUCTION

Q. PLEASE STATE YOUR NAME AND BUSINESS AFFILIATION.

A. My name is Kevin T. Duffy-Deno. I am the Managing Director-Market Research at *INDETEC* International, a telecommunications consulting firm.

Q. PLEASE DESCRIBE YOUR WORK EXPERIENCE AND EDUCATIONAL BACKGROUND.

A. As the Managing Director-Market Research at *INDETEC* International, I manage the development of economic models and the evaluation of existing models and their supporting data. I am responsible for database acquisition and data analysis. In particular, I have participated in the ongoing analysis of the HAI Model and the development of the Benchmark Cost Proxy Model. My participation includes providing testimony on both of these cost proxy models in Alabama, Kentucky, Louisiana, Minnesota, Mississippi, North Carolina, South Carolina, Tennessee, and Wyoming.

I have over 12 years of experience in conducting quantitative and economic analysis and modeling. I served as an economist with the Utah Division of Public Utilities where I directed the Division's analysis of telecommunications loop costing models. As an economist with the Utah Office of Energy, I analyzed a wide range of resource, energy, and electric utility issues.

I have a Ph.D. in economics from the University of Oregon; I have served as an assistant professor at three universities; and, I am currently an adjunct professor in the MBA program at Westminster College of Salt Lake City. I have authored or co-authored 17 academic papers as well as numerous reports. I have attached my curriculum vitae as Exhibit KDD-1.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. The purpose of my testimony is to respond to the second issue specified by the Florida Public Service Commission regarding "the appropriate cost proxy model to determine the total forward-looking cost of providing basic local telecommunications service pursuant to Section 364.025(4)(b)." My testimony describes several key features of the model that BellSouth is proposing the Commission use to determine the cost of universal service in BellSouth's Florida territory: the Benchmark Cost Proxy Model version 3.1 (BCPM 3.1). The task the Commission faces is to determine if BCPM 3.1 can arrive at a reasonable estimate of the forward-looking cost of universal service. In this regard, the Commission's attention should be focused on three aspects of a cost proxy model: (1) how does the model locate customers and how does it aggregate customers into telephone service areas; (2) the engineering criteria that influence the design of the wireline network "built" by the model; and, (3) the values for the literally hundreds of user-adjustable inputs used by the model. Dr. Bowman's testimony addresses item (2); Ms. Caldwell of BellSouth addresses item (3) in her testimony. My testimony focuses on item (1). Specifically, I describe the key features of BCPM 3.1 pertaining to its customer location and customer aggregation methodologies.

Q. WHAT ARE YOUR PRIMARY FINDINGS AND CONCLUSIONS?

A. All cost proxy models that seek to arrive at a reasonable estimate of a geographically disaggregated cost of basic local service face a fundamental challenge. This challenge is to locate customers at the sub-Census Block level. The U.S. Census reports housing unit counts at the Census Block level. However, since Census Blocks can be quite large in the rural, low-density areas, areas of particular interest in the universal service arena, further locating customers within these potentially large areas is important. The exact spatial location, i.e., latitude and longitude, of every potential telephone customer is not known. Hence, BCPM uses an alternative methodology to geocoding. BCPM's customer location methodology is based on the plausible assumption that customers tend to live on or near a road. This assumption facilitates the use of a geographically comprehensive road-network database provided by the U.S. Bureau of the Census.

In low-density areas, BCPM allocates Census Block level data across a Census Block based on the amount of livable road mileage that occurs in each section of the Census Block. The fundamental unit of analysis used by BCPM is called a "microgrid," an area roughly the size of 4 by 3 typical city blocks. Each Census Block is overlaid with a "fishing net" of these rectangular microgrids. If a particular microgrid has 10 % of the livable road mileage within its borders, then

10 % of the Census Block housing units are allocated to this microgrid. The end result is a statistical distribution of customer locations. In other words, the methodology yields the likely (*estimated*) location of customers.

Once customer locations are estimated in this manner, telephone serving areas are formed by aggregating contiguous microgrids into larger areas. This aggregation is governed by engineering network design criteria. The resulting serving areas, or "ultimate grids," are also geographically comprehensive and rectangular in shape. In the rural, low-density areas, the ultimate grids are typically approximately 6 square miles in size. Some ultimate grids may be unpopulated, to which BCPM does not "build" plant.

Once the serving areas are determined, BCPM then divides each ultimate grid into quadrants. A modeling tool referred to as the "road-reduced area" is used to estimate the amount of branch, backbone, and drop cable needed to serve each populated quadrant. The amount of cable required to connect the road-centroid of the ultimate grid, where the sub-feeder terminates, with the road-centroid of each populated quadrant is also estimated.

In sum, the BCPM road-based methodology addresses the issue of how to estimate customer locations when a complete set of data on exact customer locations, i.e., latitudes and longitudes, does not exist. In addition, the methodology used to aggregate these estimated locations into serving areas is consistent with standard engineering design principles, as discussed by Dr. Bowman, and is logically consistent. The estimated customer locations are preserved spatially throughout the aggregation process. There is no transformation of grids from one shape to another other than simply aggregating, where appropriate, contiguous rectangles into a larger geographic area, that corresponds to serving area. Moreover, customer locations are never moved. Hence, the methodology used by BCPM facilitates its estimation of a reasonable forward-looking cost of basic local service in Florida.

Q. HOW IS YOUR TESTIMONY ORGANIZED?

A. *Section II.* of my testimony provides a general description of a cost proxy model, including key assumptions made by cost proxy models. *Section III.* provides an overview of BCPM 3.1's customer location and aggregation algorithms.

Q. ARE THERE EXHIBITS TO YOUR TESTIMONY?

A. Yes. The following is a list of the exhibits that accompany my testimony:

KDD-1	Qualifications
KDD-2	Census Blocks in the Bunnell Wire Center, FL

Q. PLEASE BRIEFLY DESCRIBE THE HISTORY OF THE BCPM.

A. Two models, the Benchmark Cost Model 2 (BCM2) and the Cost Proxy Model (CPM), are the direct predecessors of the BCPM. BCM2 was developed in a joint effort by Sprint Corporation and U S WEST and was filed with the FCC on July 3, 1996, for consideration in CC Docket 96-45 (Federal-State Joint Board on Universal Service). Pacific Telesis and *INDETEC* International developed the CPM, which was filed with the FCC at the same time. The California Public

Utilities Commission in its universal service cost proceeding accepted the CPM.

The BCPM was initially designed to incorporate the best attributes of two models, BCM2 and the CPM, and to add capabilities that did not exist in either of the earlier models. *INDETEC* International was retained to aid in the development of the BCPM as well.

II. GENERAL DESCRIPTION OF A COST PROXY MODEL

Q. PLEASE DESCRIBE THE CHARACTERISTICS TYPICAL OF A COST PROXY MODEL.

A. The term "cost proxy model" has emerged only recently in the telecommunications industry. There is, therefore, no precise definition of "cost proxy model" in economics. In industry usage, the term has come to mean a mechanism used to estimate the forward-looking economic cost of universal service or unbundled elements. A cost proxy model for use in the universal service arena is generally considered to have the following characteristics: (1) it relies largely upon public information that is available nationwide; (2) many of its key inputs can be modified; (3) its complexity does not preclude its application nationwide; and, (4) it is generic enough so that it can estimate the forward-looking cost of any company that chooses to be a universal service provider.

Q. WHAT IS FORWARD-LOOKING ECONOMIC COST?

A. Forward-looking cost represents the economic cost an efficient provider of universal service would likely incur to serve the area in question, in this case, BellSouth's Florida service territory. This cost is forward-looking in the sense that it reflects the econon.'c cost that would be incurred today if the wireline network were rebuilt entirely. Hence, it relies on current market prices and current, but proven, technology.

Q. HOW DOES A COST PROXY MODEL ARRIVE AT AN ESTIMATE OF THE COST OF BASIC LOCAL SERVICE?

A. Conceptually, there are four steps in the estimation process. The first step is the design of a new wireline telephone network to serve customers in their current locations from central offices also in their current locations. This requires that customers be spatially located, that customers be aggregated into telephone serving areas, and that a feeder/sub-feeder network be designed to serve these groupings of customers in an efficient manner, yet still adhere to the requirements of the 1996 Telecommunications Act and of the Florida Commission.

The second step is the estimation of the investment needed to actually build such a network from scratch. Such diverse items as the cost of poles, the investment multiplier required when "difficult terrain" is encountered, and the cost of digital switches are taken into account.

The third step is the application of factors, such as the rate-of-return, to the estimated investment to yield the annual capital cost.

Finally, the fourth step is the estimation of the recurring costs, i.e. expenses, associated with the operation of such a network.

Q. WHAT ARE SOME OF THE KEY ASSUMPTIONS MADE BY COST PROXY MODELS?

R. One key assumption concerns the determination of customer locations. The challenge faced by the cost proxy models is the spatial location of customers at the sub-Census Block level. This is especially important in rural, low-density areas where Census Blocks tend to be very large. Since information on the exact latitude and longitude of customer locations is sparse for rural, low-density areas, customer locations must be estimated. Hence the methodology used by the models to estimate customer locations is important.

Another key assumption is the models' definition of "customer." In terms of residential customers there are three possibilities: housing units, households, and households who currently have telephones. Which definition is used depends on the model developers' interpretation of what the FCC meant when it stated in Criteria 6 of paragraph 250 of the FCC Universal Service Order, "The cost study or model must estimate the cost of providing service for all businesses and *households* within a geographic region." (italics added). Did the FCC mean housing units that are currently occupied, which is the U.S. Census definition of households? Did they mean all inhabitable structures (housing units)? Or did they mean only households with current phone service? Which definition is used affects the amount of plant "built" by the model, affects the economies of scale, and, hence, affects the estimated cost of basic local service.

Another key assumption is the engineering criteria that govern the aggregation of customers into serving areas and the design of the feeder/sub-feeder network needed to serve these areas. These criteria are important for they affect whether the network is capable of providing access to advanced services in both urban and rural areas, as required by the 1996 Telecommunications Act, Section 254. Items of design interest are the maximum length of copper loop beyond the digital loop carrier (DLC) and the maximum number of lines per DLC.

A third key assumption, actually set of assumptions, are the values for the hundreds of user-adjustable inputs. The user is allowed to specify values for a wide range of items that can affect the model's estimated cost. For example, the user can specify values for a wide range of items such as the cost of drop wire, the cost of 200 pair cable, the activity-share of "cut and replace sod" in the underground placement of cable in the 5 to 100 line per square mile density zone, the cost of money, and the recurring cost of buried cable maintenance, to name just a few.

Q. WITH RESPECT TO CUSTOMER LOCATION, WHY IS THE ACCURACY OF A COST PROXY MODEL'S ABILITY TO LOCATE CUSTOMERS IMPORTANT?

A. It is important that a cost proxy model locates customers with a reasonably high level of accuracy because the size of the universal service fund and the appropriate targeting of eligible recipients depend upon the degree of accuracy with which customers are located. The more accurately customers are located, the greater the accuracy in cost estimation across geographic areas. Thus, it is essential that an evaluation of a cost proxy model include not only an assessment of the relative accuracy of the cost proxy models in locating customers but also of how these customers are then aggregated into telephone serving areas.

Q. AT WHAT LEVEL OF GEOGRAPHIC DETAIL SHOULD THE CALCULATION BE PERFORMED?

A. Because costs vary substantially across geographic areas, the calculation should be done with as much geographic specificity as possible, such as at the level of a grid cell or a census block group or, at a minimum, a wire center. Traditional Incumbent Local Exchange Carrier (ILEC) forward-looking economic cost studies will be difficult or impossible to apply because they were generally designed to reflect the costs for much broader geographic areas.

III. BCPM 3.1'S CUSTOMER LOCATION AND AGGREGATION ALGORITHMS

A. Some Basics

Q. WHAT FUNDAMENTAL CHALLENGE DO COST PROXY MODELS FACE?

A. Cost proxy models that seek to estimate cost at geographically disaggregated levels must locate customers with a reasonable degree of accuracy. The smallest geographic unit for which U.S. Census data are available is the Census Block. However, in the rural, low-density areas Census Blocks can be very large.

Q. WOULD YOU BRIEFLY EXPLAIN THE DISTINCTION BETWEEN "CENSUS BLOCK GROUPS" AND "CENSUS BLOCKS"?

A. The U.S. Bureau of the Census has devised a tiered geographic reference system. Starting at the state level, states are disaggregated into counties, which are further disaggregated into census tracts. Census tracts usually have between 2,500 and 8,000 persons. They were originally designed to be homogenous with respect to population characteristics and do not cross county boundaries. On average, there are 28 Census Tracts in a county.

Census tracts are further disaggregated into Census Block Groups. A Census Block Group is a collection of Census Blocks generally containing between 250 and 550 housing units, with an ideal size of 400 housing units. On average, there are three Census Block Groups in a Census Tract.

The finest level of geography, for which Census data are provided, such as housing units, is the Census Block. The U.S. Bureau of the Census defines Census Blocks as "small areas bounded on all sides by visible features such as streets, roads, streams, and railroad tracks, and by invisible boundaries such as city, town, township, and county limits, property lines, and short, imaginary extensions of streets and roads." On average, there are 31 Census Blocks in a Census Block Group.

Q. HOW LARGE CAN CENSUS BLOCKS BE?

A. In urban areas, Census Blocks are fairly small. For example, in a downtown area they tend to be 0.005 square miles in size. In a typical suburban area they tend to be in the 0.5 to 1.0 square mile range. In rural areas, Census Blocks tend to be much larger. Census Blocks as large as 60 square miles are not uncommon, with

20 square miles being more typical.

Q. HOW LARGE ARE CENSUS BLOCKS IN FLORIDA?

A. Table 1 shows U.S. Census Block data for Florida by density zone. The maximum size populated Census Block in Florida is 544 square miles. In the two lowest density zones, zero to 20 housing units per square mile, populated Census Blocks constitute approximately 5.3 % of the total populated Census Blocks and span 69 % of the total populated land area in Florida. In Florida, there are 98,285 unpopulated Census Blocks. A cost proxy model's customer location methodology for placing customers within a Census Block is much more critical in these rural, low-density areas.

Table 1. Florida Populated Census Blocks

Density (HU/sqmi)	CB Size (sqmi)		CB Counts		1995 Housing Units		CB Area	
	Maximum	Minimum	Number	%	Number	%	SQMI	%
< 5	543.62	0.20	3,965	1.81%	24,768	0.37%	16,322.10	43.79%
5 – 19	85.03	.05	7,721	3.52%	99,163	1.48%	9,401.10	25.22%
20 – 99	39.72	0.01	15,861	7.23%	267,125	3.98%	5,997.15	16.09%
100 – 199	23.62	0.01	11,003	5.02%	201,539	3.00%	1,428.38	3.83%
200 – 649	5.694	0. 002	29,477	13.44%	669,837	9.99%	1,801.51	4.83%
650 – 849	3.37	0.001	10,362	4.72%	227,611	3.39%	371.27	1.00%
850 – 2549	3.25	0.0004	77,296	35.24%	2,050,259	30.57%	1,330.87	3.57%
2550 – 4999	0.97	0.0002	44,509	20.90%	1,529,693	22.81%	453.83	1.22%
5000 – 9999	0.41	0.0001	13,275	6.05%	822,800	12.27%	122.88	0.33%
> 10000	0.31	0.0000006	5,851	2.67%	814,858	12.15%	45.08	0.12%
Total	692.85	0	219,320		6,707,653		37,274.17	

Visually, the challenge faced by a cost proxy model is shown in Exhibit KDD-2. KDD-2 shows the Census Blocks in BellSouth's Bunnell wire center in Flagler County, Florida. The wire center is 18.7 miles wide (East-West) and 14.1 miles long (North-South). In the more rural portions of the wire center (western portion) the Census Blocks are much larger. The yellow-shaded Census Block in Exhibit KDD-2 is 74.7 square miles in size and is 8.1 miles wide (East-West) and 10.6 miles long (North-South). U.S. Census data indicate that there are 164 housing units located in this Census Block. The challenge faced by a cost proxy model is locating these 164 customers with reasonable accuracy within the 75 square mile area of this Census Block.

Q. WHAT LEVEL OF GEOGRAPHIC DISAGGREGATION DOES BCPM 3.1 USE?

A. BCPM 3.1 uses the Census Block as the starting point for its customer location methodology. BCPM 3.1 utilizes 1990 Census Bureau housing unit data that have been updated based upon 1995 Census statistics regarding population growth by county. BCPM 3.1 also uses business line data obtained from PNR and Associates (PNR) to assign businesses to Census Blocks. The U.S. Bureau of the Census provides housing unit counts at the Census Block level.

The Census Block data is then allocated among a large number of small geographic units within a Census Block called microgrids.

Q. WHY DOES BCPM 3.1 REJECT THE USE OF CENSUS BLOCK GROUP DATA AS THE RELEVANT GEOGRAPHIC UNIT FOR LOCATING CUSTOMERS AND DESIGNING A NETWORK?

A. Census Block Groups, while of similar population size, tend to be very large and irregular in shape in rural, low-density areas. This leads to three problems. First, such large areas make it difficult to reflect actual underlying population location and population dispersion. Second, large Census Block Groups make it difficult to aggregate accurately Census Block Groups to higher levels of geography, such as wire centers. Consequently, using Census Block Groups to assign customers to the appropriate wire center and the appropriate serving incumbent local exchange carrier is problematic. Third, large irregular shaped Census Block Groups may not readily correspond to meaningful telephone plant design areas.

Q. HOW DOES BCPM 3.1 DEFINE A RESIDENTIAL "CUSTOMER" IN TERMS OF THE CENSUS DATA?

A. BCPM 3.1 defines a residential customer based on the U.S. Census designation of housing units. Recall that housing units consist of both occupied and unoccupied inhabitable structures, as opposed to households that consist of only occupied inhabitable structures. The difference is important because BCPM 3.1 builds a network to serve housing units. The developers of BCPM 3.1 believe that a sound and proper cost model should reflect the costs to provide service to all housing units, currently occupied or unoccupied. Because of its obligation to provide timely service to customers, an ILEC must place facilities to serve all housing units, not just those units that are occupied at one point in time. Any particular housing unit is likely to be occupied at some points in time, and unoccupied at other points in time. To assume otherwise requires costly new installation to serve a previously unoccupied housing unit.

Q. WHAT IF THE COMMISSION DEEMED THAT IT IS MORE APPROPRIATE FOR BCPM TO "BUILD" ONLY TO HOUSEHOLDS?

A. Although the assumption that a residential customer is a housing unit is integral to the base BCPM 3.1 model, a module does exist that would allow the model to "build" only to households if this is what the Commission deems is reasonable. In addition (or alternatively), there is a "wireless cap" on loop investment. This cap says that if the investment for any given loop exceeds a user-defined amount, that loop cost would be capped at that amount assuming that in reality either some other, less costly technology would be used or the customer would share in the cost of installing the loop. This prevents the model from estimating too much investment for housing units that are far removed from the central office.

Q. WHAT DATA DOES BCPM 3.1 USE TO ESTABLISH WIRE CENTER BOUNDARIES?

A. BCPM 3.1 uses wire center boundaries provided by Business Location Research (BLR).

Q. HOW DOES BCPM 3.1 ENSURE THAT CUSTOMERS ARE ASSIGNED TO THE APPROPRIATE WIRE CENTER?

A. BCPM 3.1 ensures that customers are assigned to the appropriate wire center by utilizing Census Block data. Those customers located in Census Blocks that fall within the BLR wire center boundary are assigned to that wire center.

B. **Customer Location**

Q. WHAT KEY ASSUMPTION DOES BCPM 3.1 MAKE REGARDING THE LOCATION OF CUSTOMERS WITHIN CENSUS BLOCKS?

A. BCPM 3.1 assumes that customers are located on or near roads and uses detailed road-mileage information to allocate U.S. Census housing units counts within Census Blocks. BCPM 3.1 attains greater precision than that obtained using Census Block information alone, by using road data for both interior and perimeter roads to place customers within the Census Block. The end result is a statistical distribution of customer locations. In other words, the process yields the *likely* (estimated) location of customers within a wire center.

Q. HOW DOES BCPM 3.1 ESTIMATE CUSTOMER LOCATIONS WITHIN A CENSUS BLOCK?

A. The BCPM 3.1 customer location algorithm begins by partitioning the area of a wire center into "microgrids," roughly 1,500 feet by 1,700 feet in size (i.e., roughly 1/10th of a square mile or 4 x 3 city blocks). Thus, each Census Block within the serving wire center is overlaid with microgrids (unless the entire Census Block falls within a single microgrid). In the rural areas of the wire center, the allocation of customer locations is based on the road network, the location of which is known in every Census Block. Census Block housing units are apportioned to microgrids based on the share of the Census Block's road mileage that occurs in a given microgrid.

In fact, there are actually two methodologies for allocating housing units to microgrids used in BCPM 3.1. For Census Blocks greater than 0.25 square miles in area, relative road lengths are used. For small Census Blocks, housing units are apportioned based on the land area of the microgrid relative to the Census Block's total area. Since large Census Blocks characterize rural areas, the road methodology applies to rural areas.

Q. WHAT IS THE SOURCE OF THE ROAD DATA USED TO ALLOCATE CUSTOMERS TO THE MICROGRIDS?

A. The 1994 U.S. Census Topologically Integrated Geographic Encoding (TIGER) files form the foundation for the road database. The 1994 TIGER files use the NAD27 datum unit, which corresponds to the datum unit used in the BLR wire center boundaries data. This is important for ensuring that the BCPM customer location process, which is based on locations of roads, is consistent with the boundaries of wire centers. The BCPM developers made a determination as to which of the TIGER road types people are likely to live and work along. This subset of the TIGER data was then used in the customer allocation process.

Q. WHAT TYPES OF ROADS WERE INCLUDED AND WHICH TYPES OF ROADS WERE EXCLUDED?

A. Examples of an included road type are a neighborhood street and state highway. Examples of road types that were excluded are four-wheel drive dirt roads, access ramps, limited access highways, and any road type that is in a tunnel or is an underpass.

Q. IS THERE ANY EMPIRICAL EVIDENCE TO SUPPORT THE ASSUMPTION THAT CUSTOMERS TEND TO BE LOCATED ALONG ROADS?

A. Yes. Causal observation suggests that this is true. In addition, if one examines the relationship between the number of housing units in a Census Block and the total road miles in a Census Block, one will find a reasonably high correlation.

Table 2 presents the correlation between housing units and road mileage for Florida, Kentucky, and Mississippi for four density zones less than 200 housing units per square mile.

Table 2. Census Block Road Mile - Housing Unit Correlation

Density Zone	Florida	Kentucky	Mississippi
0 – 5	0.69	0.78	0.68
5 – 20	0.86	0.86	0.81
20 – 100	0.87	0.93	0.87
100 – 200	0.91	0.93	0.92

The correlation is always positive, and indicates a strong association between housing unit locations and road miles. A measure of correlation ranges between -1 and +1. Values that approach either extreme indicate a strong association, either directly (positively) or inversely (negatively).

It should be noted that the road miles used in this analysis are the road miles used in the BCPM customer allocation process. In addition, the analysis is suggestive as the correlation is between aggregate measures of location and roads. It is not a correlation between actual location coordinates, i.e., latitude and longitude, and road segement coordinates. A full set of the former would negate this discussion entirely as no estimation of customer location would be needed.

C. Customer Aggregation

Q. HOW ARE THE ESTIMATED CUSTOMER LOCATIONS AGGREGATED INTO TELEPHONE SERVING AREAS?

A. Contiguous microgrids (along with the estimated locations within each microgrid) are aggregated into telephone engineering Carrier Service Areas (CSAs) according to engineering design criteria. A CSA is referred to as an "ultimate grid." The maximum size of an ultimate grid is usually approximately 12,000 feet by 14,000 feet, (roughly 6 square miles) to comport with engineering guidelines. Although the BCPM ultimate grids are geographically comprehensive, many can be unpopulated. If an ultimate grid is unpopulated, then no plant is "built" to serve the grid.

Q. ONCE "ULTIMATE GRIDS" ARE FORMED, HOW ARE CUSTOMER LOCATIONS TREATED WITHIN THE ULTIMATE GRID?

A. BCPM 3.1 does not assume that customers are uniformly distributed within each ultimate grid. Rather, customers are located within the ultimate grid based on the microgrids to which they were originally allocated based on road mileage. Each ultimate grid is divided into four distribution quadrants. The latitude and longitude coordinates of the distribution quadrants are determined by first establishing the road centroid, i.e. weighted average of the road coordinates, of the ultimate grid. The quadrants are centered on this road centroid. If a distribution quadrant does not contain any roads, that distribution quadrant is simply treated as an empty distribution quadrant. Hence, road information is used to further locate customers within the ultimate grids.

Q. HOW LARGE ARE THESE DISTRIBUTION QUADRANTS?

A. The maximum size ultimate grid is typically 12,000 by 14,000 feet or roughly, 6 square miles. If we assume that the road centroid of such an ultimate grid falls at the geographic centroid, i.e. geographic center, then each distribution quadrant will be roughly 1.5 square miles in size. Each distribution quadrant in this case will be comprised of 4 contigu..us microgrids.

Q. HOW DOES BCPM 3.1 ESTIMATE THE AMOUNT OF PLANT NEEDED TO SERVE THE ESTIMATED CUSTOMER LOCATIONS IN EACH OF THE POPULATED DISTRIBUTION QUADRANTS?

A. BCPM uses a tool called the "road-reduced area" to estimate the amount of branch, drop, and backbone cable needed to serve the estimated customer locations within each populated distribution quadrant. The exact methodology is described in the BCPM Release 3.1 Model Methodology. Each populated distribution quadrant must then be connected to the road-centroid of the ultimate grid at which point the sub-feeder terminates (in low-density grids, this will also be the location of the DLC). The determination of the length of these "connecting cables" is also described in detail in the BCPM 3.1 Model Methodology.

It is important to make clear that BCPM does not locate customers within the road-reduced areas. Estimated customer locations reside in the microgrids and are not "moved" to the road-reduced areas. Rather, the road reduced area is used as a tool to estimate the amount of cable needed to serve the estimated customer locations that reside within the microgrids in the populated distribution quads.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes.

Q (By Mr. Carver) Dr. Duffy-Deno, could you summarize your testimony, please?

A I would be happy to. The purpose of my testimony is to convey to the Commission why BCPM should be used to estimate the cost of basic local service in Florida, and the focus of my testimony is on two elements of the model; one, customer location and, two, plant estimation.

The conclusions of my analysis are as follows: First, BCPM accurately depicts the distribution of customers across a wire center that we looked at here in Florida. That was the Yankeetown wire center.

And, secondly, the model is generally internally consistent with respect to the amount of plant estimated to serve the customers in the locations identified by the model.

Hence, BCPM likely yields an accurate estimate of the forward-looking cost of basic local service here in Florida.

And what I would like to do for the rest of my summary statement is to focus on those two conclusions and describe how I arrived at them.

First, some brief background. High cost to serve areas are largely in the rural, low density areas of the state; and I have a graphic I'd like to put up just to exemplify I that. This graphic is a graphical representation of data that is found in Table 1 of my direct testimony.

The focus of this graphic is simply on the amount of green space that you see. There are two shades of green, a lighter green and a darker green; and all of the green together show you the amount of land area, populated land area, in the state that is in the less than 20 housing units per square mile density zone.

So in my mind, this is the extent of the universal service issue here in Florida. High cost areas will tend to be concentrated in this portion of the state and, as you can see, it's a fairly large portion; and if you look at the data in Table 1 of my direct testimony, you'll see that the figure is roughly 70% of the populated land area falls within this density zone.

Second background point: The majority of the basic local service cost is due to the loop. I don't think we have an argument there. Roughly 70 to 75% of the cost of basic local service is attributable to the connection between the customer and the central office.

So how a model locates customers and then how it estimates plant to serve these customers directly affects the cost of the loop and, hence, affects the cost estimated by the model, the cost of basic local service.

In terms of estimating the cost of the loop, the model goes through essentially four steps. Let me briefly state what these are. First; the model estimates customer locations. Second; the model aggregates these estimated locations into serving areas. Third; the model estimates the amount of cable needed to serve or connect customers within these serving areas. And, four; the model estimates the amount of feeder cable needed to serve the serving areas from the central office. Four central components of how the model estimates the cost of the loop.

My analysis focuses on customer location and the amount of cable needed to serve customers within the serving areas identified by the model.

Let's look first at customer location. Why is it important? If we don't get customer location accurate, then we can't estimate the proper amount of cable to serve customers.

Before the Commission are two competing

customer location estimation methodologies. BCPM uses roads. Customers are assumed to reside along roads. Census block housing units are distributed throughout a census block based on the road distribution within that census block.

The Hatfield model uses two estimation processes. It uses address geocoding, and it uses a census block boundary placement when an address cannot be successfully geocoded.

We must emphasize that there's no database in existence, to my knowledge, that identifies the actual spacial location of housing and business structures in the state or anywhere in the country. So both methodologies are essentially estimating customer locations.

Now, we can debate all day the assumptions behind these estimation methodologies, and I'm sure we will today. But I wanted to bring the Commission's focus to what is the real test of a customer location methodology, and that the test is how well does the methodology predict. Simple as that.

If it predicts well, then we can look at the assumptions and see, okay, that assumption was a good one; but if it predicts poorly, then we especially need to go to those assumptions and find out which one is the one that's causing the inaccuracy.

But I think we ought to focus first on predictions and then on assumptions later. So how well does BCPM predict? What we did is we went to -- we randomly selected a wire center here in Florida, the Yankeetown wire center, and we obtained through satellite imagery the locations, actual locations, of houses in that wire center.

And let me put up another graphic that you'll find in my rebuttal testimony. What this graphic shows is the Yankeetown wire center. It shows the -- by the yellow dots the actual locations of houses identified through the satellite imagery, and it also shows concentric rings emanating from the central office.

And what we did is we said how many actual locations occur within each ring and how many locations are predicted by BCPM. The idea is to see whether or not BCPM yields an accurate depiction of the distribution of customers as you move away from the central office. And when we did that we find that, indeed, BCPM does a very good job of that.

And if I can put up another graphic that is also found in my rebuttal testimony. (Pause) This graphic shows that distribution. The blue line is the distribution of the actual houses in that wire center as we move away from the central office, and the red line is the nurber of housing units predicted by BCPM, again as we move away from the central office. As you can see, a very, very close correspondence. Based on this benchmark, BCPM does an excellent job of predicting the distribution of customers in that wire center.

How does the Hatfield model customer location methodology predict? We don't know. A definitive answer requires unfettered access to the geocoded and surrogate points.

So far AT&T has refused us access to those points. And this is simply more than taking a visit, a very brief visit, to PNR. This requires getting the database in house so that we can look at it on our own commuters at our own time to determine whether or not the customer location methodology yields a similar type prediction.

What do we know about the Hatfield customer location methodology? We don't know how well it predicts. What do we know? Well, it is an estimation process, and in the rural areas it's probably a fairly poor estimation process, because those locations, or those addresses, that cannot be spacially located or estimated are assumed to be distributed on census block boundaries.

And, finally, the surrogate placement on census block boundaries does not necessarily yield the maximum dispersion of customers. We have to remember that the model does not use census blocks. It uses census blocks as a starting point, but the fundamental unit in the Hatfield model in terms of customer clustering is the irregular polygon clusters formed by PNR, and these span multiple census blocks, possibly, and once that -- you consider that, and you consider two census blocks that are side by side uniformly distributing customers on the perimeter of the census blocks could yield an unnatural cluster on the boundary on that sense -- on that common boundary between those two census blocks. And in that sense that would not be a conservative placement.

Also, another reason is even if it was true that boundary placement yields a conservative or a maximum dispersion of customers, it's not necessarily true that the PNR placement does so.

By changing the surrogate placement, you can change the size and shape of the PNR polygon cluster. To me, that says that simply saying uniform placement maximizes dispersion is not necessarily true, because it also requires that the PNR placement adhere to that same -- that criterion; and there's no guarantee that it does.

Okay. Customer location: We've got customers estimated, and we've determined their estimated locations. The next step is to determine amount of cable to serve those customers. Again, why is this important? Even if we've accurately located customers, it doesn't guarantee that we estimate enough cable to serve them. I mean, that's another step in the process that we've got to go through.

The test that I performed to determine whether the models are doing this has been referred to as the Minimum Spanning Tree Test, and it sounds a lot more complicated than it is. What it is is simply let's estimate the minimum amount of cable needed to simply connect customers in their serving areas and compare that minimum connecting distance, minimum crow-fly distance, with the amount of cable estimated by the model.

So it's a reality check on the model, and I refer to it as an internal consistency test. Does the model estimate enough cable to simply connect customers in the locations identified by the model, not in their actual locations, but in the locations identified by the model; and that is in a -- a completely valid test. And when we apply that test to both models, we get stark differences in the results.

First of all, BCPM. How well does BCPM perform? It could do better, I'll be the first to admit. We do come up short. We come up short in 24% of the serving areas. That is, the estimated cable is short of the minimum spanning tree distance in 24 of the serving areas. I'm not happy with that. I don't think the sponsors are happy with that, and the sponsors are certainly willing to work with the Commission to fix that. So there is room for improvement.

In all fairness, we should apply that same test to both models, and we have. So how well does the Hatfield model perform? Well, it turns out they perform -- it performs much worse. Remember, 24% of the BCPM serving areas are short. Hatfield, the comparable number is 68%, and this is for BellSouth serving area.

So what that means is that in 68% of the Hatfield serving areas, the model is not estimating enough cable to simply connect customers in the underlying serving areas. Conclusion is that BCPM is much more internally consistent.

So in conclusion, to yield an accurate estimate of the cost to serve rural, low density customers, a mod·l must do two things. It must locate customers accurately, and it must estimate enough cable to serve customers in these estimated locations. And as I've just explained, BCPM excels on both counts.

The Hatfield model, in contrast, has not demonstrated any superiority in customer location and does much worse than BCPM in its test of internal consistency. Hence, the Commission should adopt BCPM.

By choosing BCPM, the Commission will obtain an accurate estimate of the forward-looking cost of basic service particularly in the low density areas, because that's really the areas that we want to focus on. It would also ensure an appropriately sized and targeted universal service fund. We need to find those particular areas that are indeed high cost. And, finally, by doing so will ensure that Florida residents have access to basic local service at affordable rates.

Thank you for your attention.

MR. CARVER: Does this conclude your summary?

WITNESS DUFFY-DENO: It does.

MR. CARVER: The witness is available for cross.

MR. COX: Chairman Johnson, before we get to cross-examination, Staff thinks it would be appropriate to mark as an exhibit the deposition transcript and late-filed deposition exhibits of Dr. Duffy-Deno. It's identified as KDD-3, and I believe those are all available as of this morning.

CHAIRMAN JOHNSON: It will be identified as 48.

MR. COX: Yes.

(Exhibit 48 marked for identification.)

CHAIRMAN JOHNSON: Is that it?

MR. COX: Yes. Thank you.

MR. FONS: Sprint-Florida has no questions.

CROSS EXAMINATION

BY MR. LAMOUREUX:

Q Good morning, Dr.Duffy-Deno. My name is Jim Lamoureux. I represent AT&T.

A It's nice to see you again, Mr. Lamoureux.

Q I'm happy that we're talking about microgrids and macrogrids at 10:30 rather than 6:30 last night.

A Do you think it will make more sense?

Q I hope so. Do you agree that a proxy model for calculating universal service costs should calculate forward-looking costs?

A As a general principle, yes.

Q You say at Page 6 of your direct testimony that forward-looking costs represent the economic cost an efficient provider of universal service would likely occur to serve an area in question; in this case, BellSouth's Florida service territory?

A I say that, yes.

Q So I presume from that statement you agree, then, that the Commission should identify the costs an efficient provider in a given service territory in Florida would incur and not the cost that a particular company has incurred or will occur; is that correct?

A That's correct.

Q In terms of customer location, the issue of customer location is critical to the calculation of universal service fund costs, correct?

A I would agree with that.

Q And by customer location, you mean the identification of the spacial location that is the longitude and latitude of customers; correct?

A Yeah. Customer location is the spacial estimation of a housing and/or business structure, yes.

Q And by spacial location, we mean identificatio. of longitude and latitude?

A Generally that's our coordinate system. I liken it to putting a pin in a map.

Q And when you use the term "locating customers," you refer to spacial locations of those customers; correct?

A Yes, I do.

Q At Page 9 of your direct testimony you say it is important that a cost proxy model locates customers with a reasonably high level of accuracy because the size of the universal service fund -- I'm sorry -- of the universal fund and the appropriate targeting of eligible recipients depends upon the degree of accuracy with which customers are located.

MR. CARVER: Could we have a line reference for that, please?

MR. LAMOUREUX: Were you able to find that reference in your testimony, Dr. Duffy-Deno?

WITNESS DUFFY-DENO: I have. It's Line 20.

MR. CARVER: Thank you.

Q (By Mr. Lamoureux) What do you mean by the appropriate targeting of eligible recipients depends upon the degree of accuracy with which customers are located?

A By that statement, I mean that we have been able to identify high cost to serve areas.

Q So by targeting eligible recipients, you mean targeting areas?

A Targeting -- yes, yes; not particular people, subsets of people, but areas of high cost.

Q And when you talk about the accuracy with which customers are located, you're referring there only to the areas in which customers are located?

A No. I'm referring to the spacial location -- or the accuracy of the spacial location of housing and business structures, which is synonymous with customers.

Q Okay. Do you agree that it is important to calculate costs with as much geographic specificity as possible?

A Yes. If we're to appropriately identify high cost areas, then we need to incorporate into our models as much specify -- it's too early to even pronounce that word -- with as much focus as possible. And BCPM does so by starting with a very, very small area called a microgrid, which is about a 10th of a square mile; and by targeting -- or by starting with such small areas, the model then is able to come up with a very good idea as to where the high cost areas are in the state.

Q Okay. Now, with respect to the Hatfield model, all customers in the Hatfield model, both the geocoded locations and the surrogate locations, are assigned a precise spacial location in the form of a longitude and latitude; correct?

A That's correct, whether it's accurate or not. It's an estimate, but they are assigned a latitude and longitude.

Q And that's for each customer?

A That is for each customer, yes.

Q BCPM, however, does not identify or calculate the spacial locations of any individual customers, does it?

A I disagree. BCPM starts, remember, with a census block. And the idea is, given that we've got, say, 100 housing units in a census block, where within that census block are these housing units located.

We start with a microgrid net that is overlaid on this census block where these microgrids are a 10th of a square mile in size. And we look at the roads within that census block, and we assign customers, those 100 customers, to each of these microgrids within that census block based on the relative road mileage.

So if a particular microgrid has 10% of the roads, then it is assigned 10% of the housing units. Those microgrids have a spacial orientation. So, yes, BCPM spacially locates customers to those microgrids.

Q Now, you define the --

COMMISSIONER DEASON: Excuse me just a second. What about the phenomenon that if you have a main road and then there's a smaller road connecting to the main road, that there's a likelihood that you're going to have more households closer to the main road than at the end of the secondary road? Do you understand?

WITNESS DUFFY-DEMO: I understand.

COMMISSIONER DEASON: That's not a problem?

WITNESS DUFFY-DEMO: The way the model works now is that first a determination is made as to what type of roads people are likely to live and work along, and then that subset is used in the assignment of customers within the census block. Now, all roads within that subset are treated equally.

So in your example the model would not distinguish between a main road and secondary road. Those roads would all be considered the same, and essentially there would be an even distribution, if you will. The model doesn't actually do this, but for talking purposes, the model would simply evenly distribute it along those roads.

Now, that is a refinement that going forward I certainly would want to look into in terms of improving BCPM, because there is information on road types. For example, we can look at state highways versus a neighborhood street, and, clearly, more people live on neighborhood streets than state roads, state highways.

But that is a refinement, and it's a refinement that we can do, but currently BCPM does not do that for you.

Q (By Mr. Lamoureux) You defined the phrase for me earlier, "spacial location," as assigning a longitude and latitude.

A That's correct.

Q BCPM does not spacially locate any individual customers, does it?

A No, I disagree. You can argue that BCPM, because a microgrid has a spacial orientation, that if you allocate, say, 10 housing units to that microgrid, those 10 housing units have a spacial orientation. They're within that 1/10th of a square mile area.

Now, for talking purposes, if you want to pin me down to a coordinate, let's use the road centroid of that microgrid as the latitude and longitude for all 10 of those housing units.

Q BCPM itself does not assign a longitude and latitude for any of those individual 10 customers in that microgrid, does it?

A Well, I think we're starting to split hairs as to what we mean by "assign".

Q As Mr. Carver asked Mr. Wood to do yesterday, if you could begin with a yes or no, that would help me out.

- - - - -

(Transcript continues in sequence in Volume 9.)

BEFORE THE
FLORIDA PUBLIC SERVICE COMMISSION

In the Matter of Determination of the cost of basic local telecommunications service, pursuant to Section 364.025, Florida Statutes.

DOCKET NO. 980696-TP

VOLUME 8

Pages 876 through 1006

PROCEEDINGS: HEARING

BEFORE: CHAIRMAN JULIA L. JOHNSON
COMMISSIONER J. TERRY DEASON
COMMISSIONER SUSAN F. CLARK
COMMISSIONER JOE GARCIA
COMMISSIONER E. LEON JACOBS, JR.

DATE: Monday, October 13, 1998

TIME: Commenced at 9:10 a.m.

PLACE: Betty Easley Conference Center
Room 148
4075 Esplanade Way
Tallahassee, Florida

REPORTED BY: H. RUTHE POTAMI, CSR, RPR
Official Commission Reporter

APPEARANCES:

(As heretofore noted.)

D

E

F

G

H

I

J

K

L

Q

R

S

T