

dominates CSMG's unweighted average. But of course such an unweighted average is a specious measure, because it does not account for the fact that the few very dense cities contain millions upon millions of lines (and miles of underground cable), while the numerous small low density cities may contain less than a thousand lines each, practically no underground cable and likely very few large business customers.

The CSMG cost model also substantially understates SG&A expenses. Page 32 of CSMG Report and the "Inputs" worksheet on the CD that USTA provided to AT&T show that annual "Incremental" SG&A expenses are calculated as 6.67% of annual revenue for the first year and 6.5% of annual revenue for years two through ten.²⁸ These SG&A expenses expressed as revenue percentages are considerably less than those actually experienced by established RBOCs and competitive LECs.²⁹

RBOC SG&A expense to revenue percentages can be expected to be less than the percentages for competitive LECs, because the RBOCs' large customer bases create economies of scale and because most of the RBOCs' revenues are derived from markets that are

²⁸ The 6.67% for year one is calculated as Customer Care Expense = 4%, Billing Expense = 1%, Bad debt = 1.5% and 1/12 of Sales and Marketing Expense of 2% = .17%, since this percentage is only applied to the first month's revenue. The 6.5% for years two through ten is the sum of the Customer Care, Billing and Bad Debt expenses.

²⁹ The CSMG data reflect only four categories of "incremental" SG&A expenses. Those include Bad Debt, Sales and Marketing, Billing and Customer Care. These general categories have reasonably direct equivalents in ARMIS data, specifically, Uncollectible Revenues (line 5300), Sales and Marketing Expense (line 6610) and Customer Services (line 6623). In combination, these three categories represent 13.2% of operating revenues for the former RBOCs and SNET in calendar year 2000 or more than two times the level reflected in the CSMG analysis. Furthermore, because residential local service revenues, for which there is little marketing or sales expense likely to be incurred, are included in the revenue factor for Sales and Marketing the Sales and Marketing percentage of revenues would tend to be substantially understated when using aggregated information from the ARMIS Reports.

considerably less competitive than the markets in which competitive LECs operate. However, when carefully examined, the figure represented as incremental SG&A excluded sizeable expense categories and therefore cannot properly be characterized as encompassing either “incremental” or “SG&A” expenses.³⁰ Furthermore, and without explanation, the analysis excludes huge categories of expenses that are ordinarily considered SG&A. The following table, based upon ARMIS Report 43-02 (Table 11), illustrates the unexplained liberties taken in the Crandall analyses compared to operating results of the RBOCs and SNET for calendar year 2000:

³⁰ For example, no testing expenses appear to be included (line 6533 of ARMIS) nor are any General & Administrative expenses (line 6720) that represented 1.9% and 7.4%, respectively, of total operating revenues for the former RBOCs and SNET in calendar year 2000.

ARMIS Row #	Row Title	RBOC + SNET 2000 % Total Operating Rev	CSMG Study Input	Notes
5300	Uncollectible Revenue	1.4%	1.5%	
6611	Product Management	1.6%		Apparently excluded from CSMG input
6612	Sales	2.5%		
6613	Product Advertising	0.6%		Apparently excluded from CSMG input
6610	Sales and Marketing	4.7%	.17%/0%	Assumes 1.12 th of a 2% amount for year 1 only
	Billing		1.0%	
	Customer care		4%	
6623	Customer Services	7.1%	5.0%	
6720	General and Administrative	7.4%	none	
	SG&A (5300+6610+6623+6720)	20.6%	6.7%/6%	
6533	Testing	1.9%	none	

Similarly, as shown in the following table, three competitive LECs that Dr. Crandall has himself declared to be well-managed³¹ had SG&A-to-revenue relationships in calendar year 2000 that ranged from 35% to 88.5%.³² Furthermore, the year 2000 percentages are less than the percentages experienced by each of these companies in earlier years of operation, which implies that for early years of operation new competitive LECs with small revenue bases could easily experience SG&A to revenue percentages similar to 1998 and 1999 percentages shown in the table.

³¹ Robert W. Crandall, *An Assessment of the Competitive Local Exchange Carriers Five Years After The Passage of the Telecommunications Act* (June 2001). According to Dr. Crandall, “[t]he most successful of the new entrants are Time Warner Telecom, McLeodUSA, and Allegiance.”

³² Because the huge economies of scale (compared to revenues) are not present for the competitive LECs, the approach of expressing the “Incremental” SG&A as a percentage of revenues is almost certain to understate the costs. Assuming that the CSMG input were correct with respect to incumbent LEC experience (and they are not) and that it is appropriate to express the operating costs as a percentage of revenues (which is questionable), the numbers should be scaled to adjust for the unprecedented assumption that the competitive LEC expenses represent the same percentage of revenues as they do for the incumbent LECs. In fact, multiplying the proportions used by a factor of 2.2 (the ratio of the weighted average SG&A percentage for Allegiance, McLeod USA and Time Warner divided by the weighted average SG&A percentage for the former RBOCs and SNET derived from ARMIS) would be more appropriate.

Actual CLEC SG&A to Revenue Percentages

Year	Allegiance	McLeodUSA	Time Warner Tel.
Total Op. Revenue			
1998	9.8	604.1	121.9
1999	99.1	908.8	268.8
2000	285.2	1396.7	487.3
SG&A			
1998	51.4	266.5	77.4
1999	140.7	392.7	113.4
2000	252.4	563.2	170.7
SG&A/Total Op. Rev.			
1998	524.49%	44.12%	63.49%
1999	141.98%	43.21%	42.19%
2000	88.50%	40.32%	35.03%

Note: The above data were obtained from the Financials Section of the Hoovers.com website.

Finally, Dr. Crandall's SG&A input value also cannot be squared with the projected SG&A to revenue percentages used by investment analysts to estimate the future SG&A expenses for competitive LECs. A typical estimate, made by Lehman Brothers, of future competitive LEC SG&A to revenue percentages is shown in the following table.³³

³³ The table also demonstrates the weakness of using incumbent LEC SG&A expressed as a percentage of revenues to project competitive LEC expenses. By year 2010, the table shows that use of the current incumbent LEC SG&A percentage (*i.e.*, 20.6%) would understate the (continued . . .)

Projected CLEC SG&A to Revenue Percentages

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Allegiance	67.0%	54.0%	44.0%	38.0%	34.0%	32.0%	30.0%	29.0%	28.0%	27.0%
McLeod	34.9%	31.5%	29.5%	28.0%	27.0%	27.0%	26.5%	26.0%	25.5%	25.0%
Time Warner Telecom	41.0%	36.0%	32.0%	30.0%	28.0%	27.0%	26.0%	26.0%	25.0%	25.0%

Note: The above data were obtained from the "CLECs" report by Lehman Brothers, December 1, 2000.

In short, whether measured against small competitive LECs or the enormous RBOCs, the SG&A expenses assumed in the CSMG model are grossly understated. As a consequence, the CSMG model significantly understates the revenues necessary for a competitive LEC to economically extend fiber.

The plentiful local fiber assumption. In its previous filings, AT&T has demonstrated that the incumbent LECs have grossly overstated the amount of competitive local fiber that is currently deployed. In particular, AT&T showed numerous instances in which the incumbent LECs cited the growth of long haul fiber as evidence of local competition. Declaration of C. Michael Pfau ¶¶ 25-27 (attached as Exhibit B to Reply Comments of AT&T (Apr. 30, 2001) ("Pfau Dec.")). All fiber facilities are not the same, and "long haul" fiber facilities are used for the purpose evident from their name. They are *not* substitutes for incumbent LEC *local* facilities that competing carriers must use to provide local and special access services. With regard to the

(. . . continued)

competitive LEC percentage (*i.e.*, 25%). Thus, the approach produces a long-term bias on the order of a 21% (25%/20.6%) understatement of competitive LEC costs in this category.

critical issue – the extent of deployment of local fiber – AT&T demonstrated there is no evidence to conclude anything other than that metro fiber is scarce. *Id.* ¶¶ 22-34.

Additionally, AT&T demonstrated that Dr. Crandall’s specific case studies were flawed because he too treated some long haul fiber as local. For example, as shown in the fiber “maps” for Cleveland, Ohio and Seattle, Washington, Dr. Crandall relies on Level 3’s fiber in performing his calculations. *See* Crandall Reply Dec., App. Part F. However, as AT&T previously explained, according to Level 3’s web cite there is no basis to conclude any significant amounts of the fiber deployed in its network is used to provide local services. Pfau Dec. ¶ 26.

In response, Dr. Crandall alleges that “the local fiber maps produced by iMapData do not include long-haul fiber.” Crandall Rebuttal Dec. ¶¶ 10-11. In particular, citing to Level 3’s 10-K, he says that Level 3’s fiber in Cleveland and Seattle is used for local services. *Id.* It is not clear at all, nor is it explained by Dr. Crandall, how such a determination could be made.

As an initial matter, even if Dr. Crandall could demonstrate that Local 3 had deployed some metro fiber in these cities, that does not respond to AT&T’s demonstration that local fiber is scarce *in general* and that the incumbent LECs have grossly overstated the deployment of local fiber nationally by relying on growth in long haul fiber that cannot practically be used to provide local services. The following significant statements from the Dain, Rausher, Wessels March 22, 2001 research findings entitled *City Light: An Investor’s Guide to Metropolitan Optical Services*, directly refute Dr. Crandall’s assertion:

The percentage of buildings connected by fiber remains relatively small, and the fiber rings currently deployed do not easily support advanced, flexibly provisioned bandwidth services. Moreover, the most pervasive CAPs – MFS, TCG and Brooks Fiber – were subsumed into larger companies (WorldCom and

AT&T, respectively), which by most accounts have significantly diverted their metro fiber focus. (p. 3)

In contrast to long-haul bandwidth connecting most major population centers, *metro bandwidth is scarce*. This circumstance is best illustrated by the fact that less than 10% of commercial buildings in major cities have fiber connections.... as well as [by] the fact that incumbent and competitive carriers alike continue to be hamstrung by shortages of metro backhaul capacity in many major markets. (p. 4; emphasis added)

We believe the majority of metro carriers' services are for transport as opposed to access, and we expect this condition to hold true for some time. (p. 7)

In aggregate, of the entire U.S. pool of approximately 1.6 million commercial buildings, we believe approximately 2% are served by fiber and at least another 2%-4% (or approximately 30,000-60,000) justify near-term fiber deployment. (p. 11)

And all of the preceding is said with the following understanding by the analyst:

We believe that approximately 35%-45% of commercial buildings are located within three-quarters of a mile of fiber. Depending on a variety of issues relating to tenant bandwidth demand, permitting, right-of-way access and deployment costs, a significant percentage of these building could legitimately come into consideration as extensions of the existing metro fiber footprint. (p. 12)

This analysis provides an independent validation that a substantial supply of existing metropolitan fiber does not exist and that the exact issues raised by AT&T (*see* Fea-Taggart Dec. ¶¶ 9-20) need to be considered in order to gauge the practicality of extending fiber to a building. Dr. Crandall's approach fails to adequately address these considerations.

In all events, as shown above, Dr. Crandall is not even successful in his attempts to show that just one of the many carriers (*i.e.*, Level 3) cited by AT&T as a predominantly intercity fiber provider has deployed significant amounts of fiber usable for local services. Level 3's website states the company had 15,486 fiber route miles constructed, 14,700 fiber route miles pulled, and

only 10,021 fiber route miles lit³⁴ and from the network map on the website it is clear that the network is a coast-to-coast intercity network. In fact, the company states: “The Level 3 U.S. Network will consist of approximately 16,000 *intercity* miles, connecting over 150 cities, including 56 markets in which Level 3 will offer service.”³⁵ To the extent Level 3 has deployed fiber in metropolitan areas, that fiber appears to connect Level 3’s *intercity gateway* offices to other carriers’ offices within the city.³⁶

Dr. Crandall’s quote from Level 3’s 10-K (Crandall Rebuttal Dec. ¶ 11) is not to the contrary. The 10-K states that “[t]he Company’s local facilities include fiber optic networks connecting Level 3’s intercity network Gateway sites to incumbent LEC and competitive LEC central offices, long distance carrier points-of-presence (‘POP’), buildings housing communication-intensive end users and Internet peering and transit facilities.” AT&T does not dispute that some buildings are connected by some competitive LECs to their own networks. Rather, as AT&T and many other actual competitive service providers in this proceeding attest, only a small proportion of current buildings are reached by non-incumbent LEC fiber. The public statements of Level 3 and the 10-K reference extracted by Dr. Crandall are further confirmation of this fact. But they do not, as Dr. Crandall apparently hopes, affirm his assertion that metropolitan fiber is widely available, even from the single carrier he elects to discuss.

Dr. Crandall’s “Straw Man Defense.” Ultimately unable to meet AT&T’s arguments on the merits, Dr. Crandall resorts to attacking a straw man. According to Dr. Crandall, AT&T’s

³⁴ See <http://www.level3.com/us/info/network/networkmap>.

³⁵ *Id.*

³⁶ Dan Caruso, Level 3’s group vice president of transport services was recently quoted as stating that “The metro networks connect our data centers to key data aggregation points in each city.” Broomfield, Colorado, July 27, 2001, PRNewswire

allegations are so extreme that AT&T's position is that Dr. Crandall assumes a "100 percent profit margin." Crandall Rebuttal Dec. ¶ 30. To refute that claim, Dr. Crandall points to certain "profit margins" calculated by the CSMG model (associated with a 500 foot extension in Cleveland), which while very high, are all below 100%. *Id.*

Dr. Crandall can only make this argument by selectively misquoting AT&T. In its White Paper, AT&T argued:

Dr. Crandall assumes that the competitive LEC has in place all the necessary back office systems and unused network capacity to handle all the incremental *local and special access* traffic generated by extending the network. Thus, the CSMG model assumes that only minimal costs are incurred to provide these incremental services and that the additional local and special access revenues garnered at the newly-connected buildings have *nearly* a 100 percent profit margin.

AT&T White Paper at 15.

In his Rebuttal Declaration, Dr. Crandall selectively edits this quote and ignores the fact that AT&T specifically referred to the incremental margins associated with *local and special access* services, whereas the "profit margins" cited by Dr. Crandall in paragraph 30 of his Reply Declaration are for *all* services included in his study, which includes long distance service. Given that long distance profit margins are assumed to be only 20%, *see* CSMG Report at 32, this would mean that the profit margins for the special access and local services would have to be significantly higher than the healthy profit margins Dr. Crandall cites in paragraph 30 of his Rebuttal Declaration.

Finally, and in all events, the numerous ways in which the CSMG model ignored significant cost categories are documented in detail throughout AT&T's White Paper. Most critically, as discussed above, Dr. Crandall's "incremental cost" approach *disregards the entire cost of the interoffice network for services other than long distance* and assumes that these potentially enormous costs are either paid by some unidentified customer not included in the

study or, in the alternative, the costs are simply absorbed without further recompense by the competitive carriers' investors. Similarly, as discussed above and in detail in the AT&T White Paper, Dr. Crandall failed to model properly the costs of extending fiber networks, failed to include many of the costs associated with customer retention, and used unrealistic input values that significantly understated costs. *See* AT&T White Paper at 11-28.

D. Dr. Crandall's Purported "Sensitivity" Studies.

As discussed above, Dr. Crandall does not contest the general validity of many of AT&T's criticisms but instead argues that they amount to mere nit-picking on the basis of his "sensitivity" studies. Dr. Crandall however, has failed to provide his sensitivity studies or electronic versions of his models that would allow others to replicate his analysis. That failure alone is grounds to reject any purported defense of Dr. Crandall's simplifying conclusions.

Despite the incumbent LECs' attempts to erect an iron curtain around Dr. Crandall's "sensitivity" studies, the information provided to date indicates significant flaws in the way Dr. Crandall performed his sensitivity studies. For example, with regard to the assumption that a competitive LEC will win the revenues for all services from all customers in a building, Dr. Crandall states that "I performed a sensitivity study analysis of the percentage of buildings and building revenues that remained above the breakeven frontier as the fraction of captured revenues ranged from 50 to 100 percent" and that "when the CLEC only captures half of the building revenues" a "significant number of buildings still remained above the breakeven frontier." June 15 *ex parte* at 9. The sensitivity study referenced by Dr. Crandall is ostensibly the one described in footnote 44 of his initial declaration. However, in that declaration Dr. Crandall stated that the purpose of the sensitivity study was to determine the effect "if the CLEC discounted the expected total building revenues by a certain percentage" and, based on that

analysis, that “I conclude that profit opportunities of serving special access customers would not be eliminated as the CLEC discount rate varies between 0 and 50 percent.” Crandall Reply Dec. n.44. Of course, this conclusion is not surprising given the improper revenue and cost assumptions and bloated terminal value that Dr. Crandall incorporated in the basic study upon which he claims to have performed his sensitivity analysis.

Thus, only reliance on historic revisionism allows Dr. Crandall now to claim that this prior sensitivity study proves that his analysis does not depend upon the assumption that competitive LECs gain all the revenues associated with a building. In his initial declaration, he clearly stated that the sensitivity study was intended to take into account a competitive LEC’s rate discounting.³⁷ Now, however, he says that it was a sensitivity study of the effect on break-even revenues when a competitive LEC does not capture total building revenues (again an attempt to individually correct one of the glaring flaws in the assumptions of the base studies). But Dr. Crandall cannot simply cite the same revenue sensitivity study to justify every instance in which he may have overstated revenues. In order for his analysis to have any validity, he would have had to perform sensitivity studies that *simultaneously* decreased revenues for (i) the rate discounts caused by competition, (ii) the competitive LEC not capturing total building revenues and (iii) any other possible revenue overstatements that may be identified. Furthermore, these sensitivity studies should vary the parameters around reasonably expected ranges, rather than starting with totally unjustifiable initial values. In this regard, it should be

³⁷ This is clearly appropriate due to the competitive environment that he hypothesized but did not reflect in his base study. However, it is a misnomer to call correction of a basic flaw in the study’s methodology a sensitivity analysis.

noted that a sensitivity analysis that reduces by 50% a parameter that initially was bloated by a factor of four still leaves the parameter overstated by a factor of two.

Moreover, even if it were proper to perform sensitivity studies that only correct one flaw at a time, Dr. Crandall's "sensitivity analyses" do not serve that purpose. Because of improper modeling assumptions, the CSMG model will *systematically* underestimate the effect of revenue decreases on breakeven revenue and profitability because, as noted above, Dr. Crandall improperly modeled many of his costs as a function of revenue. As a result, a carrier's costs automatically decrease as its revenues decrease, so that the effect of such reduced revenues on its profitability is mitigated.³⁸ A more realistic model would recognize that some of a new entrant's costs are incurred independent of the level of revenue, and that some of the costs will continue to occur, at least for some period of time, even if its revenues decrease.

Dr. Crandall similarly relies on sensitivity studies to defend his "as-the-crow-flies" methodology for determining the distances competitive LECs must extend fiber from existing rings to potential customers. Crandall Rebuttal Dec. ¶¶ 33-34. Dr. Crandall claims to have run a sensitivity study in which he increased the distances of build-outs and that his results did not change by much. *Id.* However, although he observes that rectilinear routing would increase the distance competitive LECs would have to build fiber, he arbitrarily determined for purposes of

³⁸ As described above, the model calculates capital expenditures and SG&A expenses as a function of revenue and long distance costs are defined to be 80% of long distance revenue. No other service costs are reflected, even though there can be little dispute that the services employed by all the tenants in a building would be diverse, would consume capacity on the carrier's fixed investment and would also generate variable costs of service, including but not limited to provisioning and maintenance costs, which are typically not included in SG&A. Dr. Crandall also excluded the cost of goods sold (*i.e.*, access) for the terminating channel at the far end of a dedicated circuit if non-switched services are provided to the tenant.

his sensitivity study to increase the average distance of deployment by only 20.7%. *Id.*³⁹ Again this is not a sensitivity analysis; rather, the model itself is erroneous. Given that Dr. Crandall himself acknowledges that network extension costs vary strongly with distance, his failure to model accurately the distance between buildings and existing fiber reinforces the conclusion that Dr. Crandall's studies should be accorded no weight.

Finally, Dr. Crandall purports to have used a sensitivity study to justify his assumption that revenues are derived at the same instant that capital and operating expenses are incurred. June 15 *ex parte* at 9. According to Dr. Crandall, "assuming the CLEC can only realize six months of revenue in the first year increases the revenue breakeven threshold only slightly by approximately 4.2 percent, across all distances for each market." *Id.* This is not a conservative revenue assumption as he claims. As noted above, a proper sensitivity analysis would correct all model flaws, not just one flaw at a time. In this case the sensitivity analysis – assuming the revenue timing was the only flaw – incorrectly captures dynamics of that flaw. The sensitivity assumption only reflects the fact that the services will be gradually turned up over the first year (*i.e.*, day 0, the carrier has 0% of the revenues, day 365 it has 100% so the average for the year is 50% of revenues.) This is how the revenues should probably be treated in *the base case* and does *not* address the basic design flaw that for the year before service is provided, there are substantial cash outflows before any revenues are earned.⁴⁰ In short, Dr. Crandall's sensitivity

³⁹ As such, Dr. Crandall's approach is flatly inconsistent with the approach the Commission adopted for calculating universal service costs, *Inputs Order* ¶ 82, which consistently uses rectilinear routing.

⁴⁰ To fix that flaw, the first year's revenue should be discounted for a longer time period than the capital, pre-operating and operating expenditures.

analysis here fixes a bad revenue assumption but it does not address or provide a sensitivity evaluation of the investment timing issue in which the carrier starts service in “debt.”

II. DR. CRANDALL’S STATISTICAL METHODS ARE FLAWED.

AT&T’s White Paper also demonstrated Dr. Crandall ignored rigorous analytical methods. Most vividly, Dr. Crandall’s Probit model, which provides the first and most fundamental input (*i.e.*, buildings that might have sufficient revenues to justify a competitive LEC build) is wrong one out of five times based on in-sample observations and will have a higher error rate when used to predict the buildings in the population that may be high capacity subscribers. AT&T White Paper at 31-41. Moreover, Dr. Crandall’s approach applies three models in sequence – first the Probit Model, then the OLS Model and then the CSMG Model. If the OLS and CSMG models were each also 80 percent accurate in predicting building revenues and “breakeven revenues”/costs respectively, (and there is no evidence that they are even this reliable), the overall conclusion would not be any more than about 50 percent accurate ($0.8 \times 0.8 \times 0.8 = 0.512$).⁴¹

Dr. Crandall’s latest submissions confirm that he had to “fudge” his calculations in order to derive his results. In particular, Dr. Crandall now concedes that he deliberately set a low threshold probability, which has the effect of increasing the pool of potential high-capacity customers to include those that, according to Dr. Crandall’s own calculations, only have about a

⁴¹ Dr. Crandall and USTA have not provided information regarding the variability of the OLS model used to estimate building revenues or relating to the variability of the cost inputs derived by CSMG through its informal and limited interviews. Without full disclosure of (i) the models’ details, (ii) the variability of the inputs to the models, (iii) the variance of model predictions and (iv) a full understanding of the interplay of the models, the reliability of the modeling process cannot be independently established.

20% probability of actually purchasing high-capacity services.⁴² Thus, Dr. Crandall has calculated the break-even revenues necessary to serve customers that are, in fact, *unlikely* to purchase high-capacity services. In addition, Dr Crandall conceded that “a low probability cutoff ensures that more businesses are included in the pool of potential special access customers.” Crandall Rebuttal Dec. ¶ 20. The inflated pool of potential customers, especially when combined with overstated revenues from the OLS model and understated costs from the CSMG Model, result in an overstatement of the number of customers that can allegedly be served profitably with existing competitive LEC fiber.

In addition, even though the inputs used in running the models and the resultant outputs are statistical in nature, the key results are presented as point estimates, rather than a range of probabilistic outcomes. This is a serious omission, because the low values of the “t statistics” Dr. Crandall reports for many of the variables in the Probit and OLS models show that his key inputs are *extremely* variable. In addition, Dr. Crandall was forced to admit that that the revenue estimates from the OLS model have an incredibly high degree of uncertainty. USTA *Ex Parte* Letter at 4-5 (July 2, 2001) (“July 2 *ex parte*”). Specifically, he stated that the standard errors for “the revenue predictions in the six-city sample” are “in the range of 0.0102 to 752,000,” which is *seven orders of magnitude* wide. Tellingly, despite requests from the Commission, Dr. Crandall has not provided variance, confidence intervals or any other statistics that show how well the sample data estimate the characteristics either of the populations that are studied with the Probit and OLS models (*i.e.*, the six cities) or of the United States as a whole.

⁴² Dr. Crandall stated that he estimated that 5.8% of businesses have a high capacity connection and that in the Probit Model “a probability of .1886 is necessary to infer the 5.8%” result. Crandall Reply Dec. n.38.

Indeed, Dr. Crandall would get a failing grade in an elementary statistics course for his rationale for using the Probit model. Dr. Crandall's response confirms that he used a Probit model *without testing the validity of the assumptions that underlie the use of this model*. Dr. Crandall's sole response to the modeling flaws identified by AT&T is that "[t]here are only two widely accepted techniques that an economist can use to estimate a model with discrete choices: a probit model or a logit model" and that they both give approximately the same results.⁴³ Crandall Rebuttal Dec. ¶¶ 21, 22. It may be true that both models would give approximately the same result but, in this instance, they would produce approximately the same *unreliable* results. Any well-reasoned analysis would test the validity of the underlying assumptions before using a model. Moreover, Dr. Crandall's stated rationale (*i.e.*, that he selected one of only two models that are commonly available) ignores the fact that *no* model may produce statistically reliable results for his particular application and data.

Ironically, in attempting to support the validity of his approach, Dr. Crandall has provided conclusive evidence that his statistical methods are infirm. For example, in describing the TNS Telecom Survey in the June 15 *ex parte*, Dr. Crandall concedes that his sample of businesses by geographic area by standard industrial code ("SIC") was very small – 3,500 firms. *See* June 15 *ex parte* at 1. Later in the same *ex parte*, he concedes that his data for the OLS

⁴³ Dr. Crandall completely failed to respond to AT&T's argument that he unreasonably assumed the error terms of the Probit analysis were normally distributed without justifying the assumption. *See* AT&T White Paper at 47. It would be a very simple matter for Dr. Crandall to graph or otherwise analyze these error terms to determine whether or not they are normally distributed. The fact that he chose not to perform this simple analysis raises additional doubt about the validity of his study.

model was even smaller, 2,363 firms, because he did not have telecommunications revenues for the entire sample of 3,500. *Id.* at 5.

This sample is too small to provide statistically reliable results. Dr. Crandall's Probit model is based on samples for each of the seven original RBOC regions, June 15 *ex parte* at 1, the Probit Model predicts results for 66 SICs, and the OLS model predicts results for 67 SICs, Crandall Reply Dec., Tables A1 & A2. Given the sample was for seven regions individually, the Probit model would then, on average, appear to rely upon $3,500/(7*66) = 7.58$ data points per region per SIC and the OLS model would then rely upon $2,363/(7*67) = 5.1$ data points per region per SIC. Because his models produce results for each city by SIC, the small number of samples per strata studied implies large prediction confidence intervals for his results.⁴⁴

Further, the incumbents' most recent filings reveal that the mean number of on-site employees for firms likely to subscribe to high capacity service is 501.1 for the unweighted sample, Crandall Reply Dec. ¶ 17 & Table 2, and that the number of firms sampled per region with 250+ employees is 50, June 15 *ex parte* at 1 & Table 1. Therefore, on average, *less* than one sampled firm in the set of businesses most likely to subscribe to high capacity services could be in each SIC data set. Again, this implies that Dr. Crandall's results are subject to large confidence intervals and his point estimates cannot be taken at face value.

⁴⁴ The confidence interval for a sample mean based on a small number of samples is given by $x \pm t*s/(\text{square root of } n)$ where x = estimated population mean, s = estimated standard deviation based on the sample, t = t-statistic based on $n-1$ degrees of freedom and the desired degree of confidence (*e.g.*, a 95% confidence interval) and n = the sample size. Note that s = square root [(sum of each sample point minus the sample mean) squared divided by $(n-1)$]. Therefore, the width of the confidence interval increases rapidly as the sample size decreases because t , s and $1/(\text{square root of } n)$ increase as n decreases. Morris Hamberg, *Statistical Analysis For Decision Making*, Chapter 6 (5th ed.).

Recognizing these weakness, Dr. Crandall attempts a preemptive response. He argues that sample sizes as small as 30 data points can give statistically reliable results. *See June 15 ex parte* at 5. That is true in some cases, but irrelevant here. Although a much smaller sample may be statically reliable when used to estimate a *single* characteristic (parameter) of a population (for example the average age of students in a class), Dr. Crandall's Probit model does not estimate a single parameter of a population. Rather, the Probit model, whose results are input to the OLS model, is used to identify potential high-cap customers for six cities for 66 SICs and ten on-site employee strata. *See June 15 ex parte*, at 5, Tables 2A & 2B; Crandall Reply Dec., Table A1. Moreover, Dr. Crandall's OLS model estimates firms' telecommunications revenues in six cities for each building that contains a potential high-cap customer that was identified by the Probit model. *See Crandall Reply Dec.* ¶ 56. Thus, even if the Commission were to accept 30 as a reasonable sample size to estimate a single parameter of a population, the samples per cell quantified by Dr. Crandall in the Probit model are often significantly less than 30.⁴⁵

Likewise, in providing information regarding the Probit model's estimation of the purchase of high-capacity service, the June 15, 2001 *ex parte* shows that the model's accuracy declines rapidly by number of employees per strata based on in-sample observations. *See June 15 ex parte* Table 2B. In other words, as the number of employees in a business increase, the Probit model is less likely to correctly predict whether that business is a potential high-capacity customer. According to the June 15 *ex parte*, the percent of correct predictions for the 101-240

⁴⁵ The defining parameters are region (seven cities), SIC (66 industry codes) and number of onsite employees (ten strata). Therefore, apparently 4,260 unique cells must be characterized (7*66*10) using fewer than 3,500 data points which translates, at best, to less than one observation per cell (3,500/4,260 = .758.)

and 241+ number of employee strata are only 50.7% and 53.1%, respectively. But according to Dr. Crandall, these strata are the most likely to be high capacity subscribers according. Crandall Reply Dec. ¶¶ 3, 17, 18. Because the Probit model will be less reliable in making predictions about the population from which a sample was taken than in predicting in-sample observations, this implies that Crandall's model is *less than 50% accurate* in predicting high capacity subscribership for the populations *most likely to subscribe* to high capacity services.

Dr. Crandall's attempts to justify the slipshod statistical techniques identified in AT&T's White Paper likewise are wide of the mark. For example, AT&T demonstrated that Dr. Crandall failed to provide support for his use of a simplistic OLS linear regression model in this context. AT&T White Paper at 35-36. Use of such a linear model is highly suspect in this case, because the distribution of telecommunications revenues from business customers is typically skewed, with relatively few customers in the higher revenue strata. Data skewness of this type is likely to cause violations in all of the main assumptions of linear regression – linearity, additivity, constant error variance and the normality of the error distribution – resulting in incorrect modeling inferences (*e.g.*, standard errors and confidence intervals). The statistically correct approach for dealing with highly skewed data is to transform the data so that the transformed distribution is more approximately linear before performing a linear regression.

As AT&T explained, it is also very possible that a data transformation would have resulted in an improved model or that a few outlying points greatly influenced the results. AT&T White Paper at 36 & n.30. However, these and other aspects of the model cannot be evaluated because Dr. Crandall apparently did not analyze (and certainly did not report on) these alternatives at all, and he has not provided access to the data required for an independent assessment.

Likewise, it is Dr. Crandall, not AT&T that is “confused” about the relationship between the “cutoff probability” and the percentage of customers/buildings that have potential high capacity customers. In footnote 38 of his initial declaration, Dr. Crandall stated that for the weighted survey sample, he estimated that 5.8 percent of businesses have a high capacity connection, and that in the Probit model “a probability cutoff of .1886 is necessary to infer the 5.8%” result. Use of such a low probability cutoff (under 20%) draws telecommunications customers into the set of high-capacity customers. This is inappropriate because it treats numerous customers with a low probability of purchasing high-capacity service as potential high-capacity customers. In response, Dr. Crandall defends his approach by stating that he deliberately set a low threshold probability to increase the addressable pool of customers and that this is a conservative assumption because it would make it more difficult to show that “the majority of all potential customers” can be served by existing competitive LEC fiber. Crandall Rebuttal Dec. ¶ 20.

Dr. Crandall misrepresents the impact of this error, which is amplified by his use of the three separate models in sequence. As Dr. Crandall admits, a “low probability cutoff ensures that more businesses are included in the pool of potential special access customers.” Crandall Rebuttal Dec. ¶ 20. But by setting a low threshold probability of 18.86% in the Probit model, he thereby inflated the pool of addressable customers by arbitrarily including those that have a very low probability of purchasing high capacity access. Critically, the inflated pool of addressable customers, when *combined* with the overstated revenues from his OLS model and the understated costs from the CSMG model, results in a large overstatement of the number of customers that Dr. Crandall alleges can be profitably served with competitive LEC fiber. And even if the OLS and CSMG models could be corrected to give reasonable results, the “fact” that

businesses that are unlikely to purchase high capacity services (for example, those with a 20% chance of purchasing and, therefore, an 80% chance of *not* purchasing high-capacity service) may be profitably served by a competitive LEC sheds little light on assessing whether competitive LECs are “impaired” without access to incumbent LEC network facilities.⁴⁶

Dr. Crandall’s Rebuttal Declaration also reflects a misunderstanding of the basic statistical concept of the confidence interval, and how that concept calls his results into question. As AT&T explained, in reporting his “point” estimates for the percentage of buildings with a high-capacity “anchor tenant” that could (allegedly) be profitably served by a competitive LEC, Dr. Crandall ignores random variation around the predicted values of “Distribution of Expected Revenues From Buildings” shown in Figures 3 and A1-A5 of his initial declaration. Critically, a large number of revenue point estimates lie just above the predicted “breakeven” frontier line. Additionally, the t statistics reported for the coefficients of the SIC variables in the OLS Model, which according to the Probit model have the highest probability of subscribing to high capacity services, were very low. These low t statistic values imply that the true revenue, if it could actually be determined, has an equal probability of being any value in the range defined by the point value estimated by Dr. Crandall plus or minus a large “confidence interval.” Therefore, many of the points that are shown as lying just above the “breakeven” line (indicating the network extension to serve a customer is “profitable”) may actually fall *below* the line and thus,

⁴⁶ Given that Dr. Crandall is asking the Commission to make a decision based on a model, the model should be analyze whether or not competitive LECs may profitably serve customers that are highly likely (*e.g.*, 80% to 90% probability) or, at least more likely than not (probability greater than 50%) to purchase high capacity services. Dr. Crandall does not prove anything by alleging that customers that are highly unlikely to purchase high capacity services (*i.e.*, probability of purchasing as low as 20%) may be profitably served by competitive LECs.

in fact, not be addressable by competitive LECs, even in the wildly hypothetical world that the models assume. Tellingly, Dr. Crandall has not quantified the impact on his results of this effect or provided the data necessary to allow someone else to perform that analysis.

Rather than respond to the argument AT&T actually made, Dr. Crandall invents a new one. According to Dr. Crandall, AT&T argued that his “revenue estimates for the buildings in the six sample cities are distributed uniformly across every value inside the confidence interval.” Crandall Rebuttal Dec. ¶ 36. That is false. AT&T did not claim that Dr. Crandall’s revenue estimates were “uniformly” distributed. Rather, in the specific cite referenced by Crandall (*id.* at n.36) AT&T noted that “the low values of the t statistics indicate that the revenue estimates from the OLS model have large confidence intervals around them and all revenues within the confidence interval have equal statistical validity.” AT&T White Paper at 37. This statement correctly describes the meaning of a confidence interval and does not state, or even imply, that the revenue estimates are “uniformly distributed.” AT&T referred to “equal statistical validity,” not to probability.⁴⁷

Accordingly, the revenue estimates derived from the OLS model cannot be simply characterized by the point estimates Dr. Crandall shows in his Reply Declaration. The large confidence intervals implied by Dr. Crandall’s own reported t statistics mean that the confidence intervals associated with many of Dr. Crandall’s revenue point estimates will fall below the

⁴⁷ Indeed, AT&T’s statement about “equal statistical validity” is based on the definition of a confidence interval. The definition is that if repeated simple random samples of the same size were drawn from a population and, for example, a 95% confidence interval was constructed from each of them, then 95% of the statements that the interval contains the true population mean would be correct. Based on the statistical methodology, it is only known that the true value of the estimated parameter lies somewhere within the confidence interval 95% of the time. Morris Hamberg, *Statistical Analysis For Decision Making*, 280-95 (5th Edition).

breakeven frontier. Thus, many buildings characterized as candidates for lateral extensions could just as likely lack sufficient revenues to make those extensions economic.⁴⁸ Because the confidence interval contains the *true* value of the revenue a specified percentage of the time (*e.g.*, 95%), and the true value can lie anywhere within that confidence interval, the true values for many of the points estimated by Dr. Crandall that are shown above the breakeven line will actually be below that line.⁴⁹

III. DR. CRANDALL'S SIX CITIES ARE NOT REPRESENTATIVE

Dr. Crandall provided virtually no support for his assertion that the six cities he studied are representative of the entire country. He certainly has not attempted to show that the underlying characteristics of the six cities he selected are representative of all cities in the United States. AT&T White Paper at 41-42. He also has not shown that the results obtained from running these cities' characteristics through the Probit, OLS and CSMG models are representative of all cities in the United States. *Id.* Indeed, Dr. Crandall admitted that the cities were selected simply because of "the availability of up-to-date fiber data from iMapData." Crandall Dec. at 21 n.35.

⁴⁸ Dr. Crandall has admitted that he could not develop confidence intervals for the OLS model's revenue prediction. In particular, he stated "For probability-weighted observations from a survey, however, the mean square error of the regression is not defined. Therefore, I am unable to summarize the confidence interval around the predictions that would be used, treating these predictions as "forecasts." July 2 *ex parte* at 4-5. In the same response, he admitted that he obtained the absurd result of standard errors "in the range from 0.0102 to 752,000" for "the revenue predictions in the six-city sample." It is absurd that he could have an error as low as one percent and errors that lie in a range that is seven orders of magnitude wide (*i.e.*, 10^7).

⁴⁹ This is an area where a sensitivity study could provide some insight, but, tellingly, where none appears to have been performed.

Nor has he addressed AT&T's argument (White Paper at 42) that the great variability of addressable customers for each representative pair of cities casts serious doubt on whether those cities are representative of the whole United States. Dr. Crandall has not provided any analysis, statistical or otherwise, that shows that the pertinent characteristics (*e.g.*, number of competitive LEC facility-based carriers, amount of in-place competitive LEC fiber, density of businesses that are likely high-capacity customers) of the two small, two medium and two large cities he selected are representative of all small, medium and large cities, respectively. He also has not attempted to show that the addressable market and profitability results that he obtained by running the characteristics of these six cities through the Probit, OLS and CSMG cost models are representative of the results that would be expected for all cities in the United States.

Indeed, data provided in both the Crandall Rebuttal Declaration and the June 15 *ex parte* confirm that the six cities he used are not representative. In Dr. Crandall's Probit model, the difference between the mean number of employees for likely high-capacity customers in the sample versus the universe of businesses (501.1 versus 102.3, respectively) strongly suggests that the sample is not representative of the universe. In other words, a key characteristic of the sample is very different from the population the sample is used to estimate.

More specifically, the sample is not representative because the population of businesses that have a relatively large number of on-site employees is over-weighted in the sample. Because the businesses most likely to subscribe to high capacity service in his model are over-weighted in the sample, this may result in an overestimate of the businesses in the population that are likely to subscribe to high capacity service. Dr. Crandall states he used a weighting methodology, but he has not documented his methodology. A review of Dr. Crandall's methodology is critical because the differences between the characteristics of the sample and the

population imply that the weighting methodology is not straightforward and may have a large impact on the results. The distribution of the percentage of firms by SIC strata and by number of onsite employees strata each have significant differences between the sample and sample weighted distributions. June 15 *ex parte* at 3-4 & Tables 3A and 3B. Therefore, Dr. Crandall had to simultaneously weight the sample data to adjust for both of these differences between the sample and nationwide distributions.

Dr. Crandall's selection of cities is further undermined by evidence he has provided regarding the frequency distribution of SIC codes by city. Table 5A in the June 15 *ex parte* clearly shows that the six cities have a significantly *higher* percentage of businesses in SICs 80 through 89 than in the United States as a whole. And as revealed in Paragraph 29 and Table A1 (Appendix) of Dr. Crandall's initial declaration, two of the six SICs with "high explanatory power" are in this strata (82-Education and 87-Engineering). The significant over representation of these industries in the six cities studied could significantly overstate any projection from the results for the six cities to the number of business likely to subscribe to high capacity services in the United States as a whole. Similarly, Table 5B shows that the six cities have more than *twice* as many businesses with onsite employees in the 50-100, 101-240 and 241+ strata, which are the strata most likely to subscribe to high capacity service, compared to the United States as a whole. This also could overstate any projection from the results for the six cities to the number of business likely to subscribe to high capacity services in the United States as a whole. As discussed above, the differences between the distributions in the six cities versus the United States as a whole may be adjusted in the study, but Dr. Crandall has not provided the information that is required to assess the effect of his adjustments on the study results.

Finally, any question that the six-city sample provides a reliable basis for drawing national conclusions is put to rest by Dr. Crandall's Response No. 13 in the June 15 *ex parte*. There, Dr. Crandall conceded that that the R-squared of the revenue forecasting regression was .44. This low value of R-squared indicates that fully *56% of the variance in the data is not explained by his regression*. In layperson's term this means that changes in the various factors considered in Dr. Crandall's model account for a *minority* of the changes in the factor (*i.e.*, revenue) that was modeled.⁵⁰ As a result, the model has little predictive value.

CONCLUSION

The incumbents LECs' recent filings all continue to pursue a question the Commission has already answered, *i.e.*, whether the Commission will rely on theoretical models to determine whether competitive carriers are impaired without access to unbundled loop or transport facilities as unbundled network elements. The Commission's definitive decision not to do so and to rely instead on marketplace evidence is particularly appropriate given the sworn record testimony regarding the substantial real-world factors that severely limit competitive carriers' ability to build (or otherwise obtain) alternatives to such facilities.

But even if the Commission were willing to entertain claims based on the use of theoretical models, it should be particularly cautious when the conclusions derived from such

⁵⁰ R^2 , the sample coefficient of determination, is a measure of the degree of association or correlation between a dependent variable and an independent variable. R^2 may be interpreted as the proportion of variation in the dependent variable that is accounted for, or explained by the regression line. Therefore, one minus R^2 represents the amount of variation in the dependent variable (revenue) that is not explained by the regression model. A high percentage of unexplained variation simply means that the model does not provide good estimates of the depended variables that it is estimating. Morris Hamberg, *Statistical Analysis For Decision Making*, 485 (5th ed.).

models are counterintuitive and contrary to the marketplace facts described by competitors who are actively attempting to find adequate substitutes for incumbent LEC facilities. In fact, AT&T's review of the material submitted by the incumbents here shows that the results the incumbents argue for are the result of wish fulfillment, not marketplace reality. As AT&T has shown, the incumbents can only reach the conclusions they wish for by creating a fantasy world in which new entrants can:

- find investors who do not need to recover their initial investment in new facilities for more than 10 years;
- win new customers and either build facilities instantaneously or earn revenues without investing and incurring expenses first;
- win all of the customers in a building immediately;
- hold onto new customers forever at current rates and minimal cost, even though the incumbent has existing facilities in place;
- avoid virtually all fixed costs so that virtually all expenses vary as a percentage of revenues;
- always build connecting facilities from building to existing backbone facilities over the shortest distance possible (at costs lower than are predicted by Commission formulae) and without any need for additional equipment;
- have access to already constructed local fiber ring facilities that are virtually costless; and
- have SG&A costs that are lower than the RBOCs's costs and less than those of even the new entrants the incumbents cite as the best managed.

These assumptions, all of which are integral to Dr. Crandall's models and conclusions, are not representative of the world in which new entrants must operate; rather, they are more akin to Alice's trip through Wonderland than a new entrant's effort to compete in the real world.

But the deficiencies with the incumbents' approach do not end there. As shown above and in AT&T's White Paper, Dr. Crandall's study is rife with methodological errors and uses unrealistic inputs, all of which have a clear bias and create an overly rosy picture of competitive carriers' market opportunities. Moreover, even if the models' conclusions for the six studied cities were correct (and they certainly are not), there is no statistical foundation upon which to extrapolate those conclusions to the rest of the country. And in all events, the incumbents' analysis is not subject to meaningful review, because they have repeatedly refused to make necessary information available to anyone, including the Commission.

The incumbents' recent salvage efforts are also unavailing. For the most part, their defense is two-pronged – assertions that the model applied conservative assumptions and reuse of the same sensitivity analysis to address individually a number of fundamentally unsound premises upon which the model is based. But the models here are based on too many faulty premises to be revived by such an approach. In fact, the modeling assumptions described above are so out of synch with reality, both individually *and in combination*, that conclusions derived from them cannot be saved by tinkering with individual items or by “sensitivity analyses” that only attempt to control for one problem at a time. That is why there is a total disconnection between demonstrated market realities and the conclusions generated by Dr. Crandall's models.

Finally, the Commission should not reward the incumbents for their efforts to prolong further the “temporary” use restrictions that have been imposed on competitive carriers' use of loop and transport elements to provide special access services. The evidence is clear that,

although new entrants have tried (and are trying) to find alternatives to the incumbents' network elements, the harsh reality is that even when such alternatives are potentially profitable they are difficult, expensive and time consuming to implement. This demonstrates beyond question that competitive carriers are impaired without access to those elements as unbundled network elements.

Therefore, the Commission must act expeditiously to complete this proceeding and permit new entrants to use loop and transport combinations for such clearly legitimate purposes. In just the 20 months since the use restrictions were initially imposed, the incumbents have extracted more than \$4 billion in monopoly profits from competitive carriers and their customers, an average of \$7 million per day. It is undisputed that such funds are not necessary to subsidize universal service, and the Commission has already reduced the incumbents' reciprocal compensation payments in response to their claims that they were paying competitive carriers more for terminating usage than it cost them to provide that functionality. The Commission should not continue to turn a blind eye when the competitive carriers are overpaying to the incumbents for use of special access services.

Accordingly, the Commission's actions here should be swift and clear. It should (1) find, based on the record, that no practical alternatives exist for loops or dedicated transport, regardless of the transmission capacity; (2) restart the three year clock for review of the national unbundling requirements for loops and transport and establish disincentives to prevent frivolous petitions to consider the lifting of such national unbundling requirements; (3) void any incumbent LEC restrictions that prevent carriers from substituting UNEs for services (whether retail or wholesale) or from commingling of UNEs with other services; and, (4) set a date certain

by which the incumbent LECs must economically and efficiently support service-to-UNE conversions in an efficient manner.