

1 **Cost-of-Service Studies**

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3 **Incremental vs Average Cost**

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5 **Q. Would you please briefly discuss the distinction between marginal or**  
6 **incremental cost as contrasted with average cost?**

7 A. Certainly. Incremental cost is the change in total cost that results from increasing or  
8 decreasing output by a specified, relevant, increment of output. Marginal cost is the  
9 change in total cost that results from increasing or decreasing output by an extremely  
10 small increment of output. In other words, marginal cost is a specific type of incremental  
11 cost--one that focuses on a very small increment of output occurring at the decision-  
12 making margin. At the risk of oversimplification, marginal cost can be described as the  
13 cost of producing one more, or one less, unit of output.  
14 Marginal cost is perhaps the single most important and useful costing concept in the  
15 economic literature; it is particularly useful in developing prices that advance the public  
16 interest (eg., encourage economic efficiency). In the case of telephone service, marginal  
17 cost considers the change in cost resulting from a small additional block of service, such  
18 as a single minute of usage, or the amount of service provided to one additional  
19 customer.

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21 **Q. Has GTE conducted a study that correctly estimates incremental or marginal**  
22 **cost?**

23 A. No. GTE has not conducted a study that correctly estimates the marginal cost of its  
24 services, nor has it estimated the cost of any relevant increment of service. Because of  
25 the manner in which they have been labeled and described, the Companies's  
26 "incremental" cost estimates may seem to be practical approximations to marginal cost,  
27 perhaps involving a substantial block of customers, rather than an individual customer. A  
28 careful review of the underlying workpapers and documentation confirms that any such  
29 impression is false. The Companies' studies provide approximations of the average  
30 replacement cost of the access bops in a given exchange. Such approximations are not  
31 only completely different from marginal costs, they are also purely hypothetical numbers,  
32 with no discernible relevance to the issues in this proceeding.

33 In essence, the Company has estimated the total cost of building a network, with  
34 its existing number of bops, using a mix of current and historical technology and  
35 applying today's cost of materials and labor; it has then divided this hypothetical total

1 cost by the current number of bops, in order to estimate a cost per bop. This approach  
2 estimates a version of average replacement cost, rather than marginal or incremental  
3 cost. In order to estimate marginal or incremental cost, it is necessary to focus on the  
4 margin of change as customers join or leave the network. To the extent the Company's  
5 approach can fairly be described as "incremental" cost in any sense of the word, it is  
6 looking at the increment from zero customers (or bops) to the entire number of  
7 customers (bops) reflected in the study.

8 Such a huge increment is completely unrelated to marginal cost. When these  
9 results are reported on a per-bop or per-minute basis, they tend to approximate more  
10 closely the level of average reproduction or replacement cost, rather than marginal cost.  
11 Even if the estimate were prepared accurately in every regard, this sort of cost study  
12 should not be relied upon for pricing purposes. An estimate of marginal or incremental  
13 cost would provide a more appropriate and useful guideline for pricing purposes.  
14

15 **Q. Why is marginal cost superior to average cost as a determinant of prices?**

16 A. First, marginal cost is the cost that is most significant in explaining the outcome of  
17 competitive markets. In a purely competitive market, for example, prices will equilibrate at  
18 approximately the level of marginal cost. Second, where prices are appropriately related  
19 to marginal cost, economic efficiency will tend to be encouraged. This follows from the  
20 fact that society saves the marginal cost (not the average cost) when a customer decides  
21 to forgo consumption, and society incurs the marginal cost when a customer decides to  
22 engage in consumption.

23 An awareness of marginal cost is useful in understanding and analyzing the  
24 effect on society of a change in pricing policy, where the change would encourage or  
25 discourage someone from subscribing to a particular service. For example, the Company  
26 advocates substantial increases in its residential local rates. These increases will tend to  
27 push some customers off the network and discourage others from joining. Obviously,  
28 society loses some benefits if these people are harder to communicate with, because they  
29 don't have a telephone.

30 From an economic efficiency perspective, it is not desirable to push these people  
31 off the network, unless the cost saved by not having these customers on the network  
32 outweighs the benefits that would be gained if they remained on the network. Thus, the  
33 key question is how much cost actually will be avoided if we push these marginal  
34 customers off the network. If the proposed price is higher than the potential cost  
35 savings, the proposed price won't send an economically efficient signal to customers.

1 Customers will react to a relatively high price by leaving the network, yet society will save  
2 a relatively small amount upon their departure.

3 Consider a hypothetical example in which the marginal cost of keeping a  
4 particular customer on the network is \$6. The customer is willing to pay up to \$8, but  
5 no more. If the price is set at \$7, the customer will obtain a phone, and everyone will  
6 benefit-- including the utility. Assume that the aggregate benefit to other customers is  
7 \$4. Under these circumstances, the total benefits to society are \$12 (\$8 to the customer  
8 plus \$4 to the rest of society), and this clearly outweighs the marginal cost incurred by  
9 society (\$6). Hence, it would be economically efficient for this customer to remain on the  
10 network. If prices are based upon marginal cost, with or without consideration of the  
11 external benefits to society, this customer can be kept on the network, to the benefit of  
12 everyone.

13 Now assume that the average replacement cost is \$11, and the utility wants to  
14 raise its price to this level. If it imposes this rate increase, the customer leaves the  
15 network, and everyone loses. The customer loses the benefits of telephone service (worth  
16 \$8). Other subscribers lose the benefit of being able to communicate easily with this  
17 customer (worth \$4). The Company also loses the profit, or contribution that could have  
18 been generated from keeping this customer on the network (e.g., the difference between  
19 the marginal cost of \$6 and the \$7 price the customer was previously paying).

20 While this example is oversimplified, it does convey the essence of my argument:  
21 that average cost data, no matter how accurately prepared, do not provide useful  
22 insights concerning the key issues of economic efficiency, universal service, and optimal  
23 pricing policy. To the contrary, marginal or incremental cost information is more useful  
24 and relevant.

25 In this proceeding, if local rates are not increased, some customers will join or  
26 remain on the network, who would not be willing to pay the Company's proposed prices.  
27 In evaluating the Company's proposed rate increases, the key costing issue is: "How  
28 much additional cost does society incur if the pricing policy induces these people to  
29 obtain or maintain telephone service?" Clearly, this question can best be answered by  
30 reference to information on marginal or incremental, rather than average, cost. We need  
31 to focus on the change in total cost that results from having these people on the  
32 network, rather than some measure of average cost. The latter cost figure is not directly  
33 related to policy impacts of the pricing decisions being made in this proceeding. In  
34 contrast, marginal cost is closely related to the effects of increasing or decreasing local  
35 rates.

1       **Q.     Would you provide an example to illustrate the distinction between analyzing**  
2       **average cost as opposed to marginal cost?**

3       A.     Yes. The clearest distinction between marginal and average costs relates to the manner in  
4       which fixed costs are treated. Average total costs include the total of all fixed and  
5       variable costs, divided by the number of units of output. In contrast, marginal cost  
6       includes only the rate of change in variable costs as output increases.

7             Consider, for example, the cost of a pole. Under the economist's definition, the  
8       average cost per bop would include the total cost of the pole divided by the number of  
9       new bops attached to the pole. This is the type of cost calculated by the Companies. It  
10      is not a valid estimate of marginal or incremental cost.

11            Continuing with this example, the short-run marginal cost of a bop most likely  
12      will exclude any costs of the pole, which are considered fixed in the short run. If  
13      additional bops should be needed in the short run, they would be supplied without  
14      additional poles, the existing poles being adequate to handle a small increase in the  
15      number of bops.

16            Some might argue that in the long run, all costs are variable, and thus poles  
17      would not be considered a fixed cost in a long-run study. Even if one views the long run  
18      in this manner, however, the marginal cost associated with poles would be far lower than  
19      the corresponding average cost. Instead of dividing the total cost of the poles by the  
20      number of bops, the long run marginal cost would consist of the change in the cost of  
21      poles associated with an increase or decrease in the number of bops mounted on those  
22      poles. The marginal cost of poles most likely would be very low, or even zero, in the  
23      long run, despite the fact that the cost of poles is considered variable. The reason is  
24      simple: the change in the total cost of poles resulting from changes in the number of  
25      bops generally would be very small, or zero.

26            Admittedly, on some occasions the size of the pole might increase slightly as the  
27      number of bops (and total weight of the cable) increased; or perhaps the spacing of the  
28      poles would be reduced for the same reason. However, the increase in pole costs would  
29      normally be far less than proportional to the rate of increase in the number of bops,  
30      and thus the long-run marginal cost would be far less than the average total cost.

31            In other words, even in the long run, where the number and size of the poles  
32      can be optimized, and this optimizing process considers the number of bops, there will  
33      be very little, if any, resulting variation in costs. This means that the rate of change in  
34      the cost of poles will be extremely small, or zero, and thus the marginal cost associated

1 with poles will be nearly zero, even in the long run. The same principle holds true for  
2 other fixed costs, such as the cost of attaching the cable to the pole.

3 The cost of attaching a small cable, such as one containing 25 bops, will not  
4 differ greatly from attaching a much larger cable, such as one containing 900 bops.

5 With the notable exception of splicing costs, most cable installation  
6 costs vary less than proportionally with variations in the size of the cable.

7 This engineering relationship is reflected in the Company's study; but instead of  
8 reporting the rate of change in cable costs as the number of bops is incremented up or  
9 down, the Company simply reports the average cost of a specified number of bops.  
10 Where a large number of bops is present, it reports a relatively low average cost. Where  
11 few bops are present (e.g., in rural areas) it reports a relatively high average cost. If it  
12 had focused on the incremental, or marginal, cost it would have reported significantly  
13 different results. In both urban and rural areas the reported costs greatly exceed the  
14 actual level of incremental or marginal cost. Interestingly, the greatest discrepancy occurs  
15 in the rural areas, where fixed and sunk costs are spread over the smallest number of  
16 bops.

17  
18 **Q. The Company appears to be motivated by strategic concerns relating to the**  
19 **potential for increased competition in its markets. If a cost study is**  
20 **intended to deal with competitive issues, would it not be appropriate to look**  
21 **at average cost rather than incremental or marginal cost?**

22 A. No, because even in this situation, marginal cost is the relevant cost. As I mentioned  
23 earlier, in competitive markets prices are driven toward marginal cost, not average cost.  
24 Even if one is attempting to understand the potential impact of competition, or  
25 attempting to craft an appropriate pricing response to increased competitive pressures, it  
26 would be more appropriate to focus on marginal or incremental cost, rather than  
27 average cost.

28 For example, the Company currently enjoys essentially 100% share of the local  
29 exchange market. If competition is allowed and CATV companies or other firms enter the  
30 market, the Company's market share inevitably will decline. Accordingly, it could be useful  
31 to estimate the incremental cost associated with a specified change in market share that  
32 might be considered variable, depending upon pricing decisions. For instance, if the  
33 Company will either maintain or lose 10% of the market, depending upon its pricing  
34 decisions, it would be useful to know the cost that it will incur if it retains this 10% share  
35 of the market, and the cost that it will avoid if it loses this market share.

1 In analyzing the potential swing in market share, fixed and sunk costs that will  
2 be incurred by the Company regardless of the outcome are irrelevant, and such costs  
3 should not be considered, since they will simply confuse the picture.

4 In an industry with substantial fixed costs, the average cost will vary greatly,  
5 depending upon fluctuations in market share. If one focuses on average cost rather than  
6 incremental or marginal cost, one can easily be drawn to reach illogical and  
7 inappropriate conclusions. For instance, if the Company loses market share due to  
8 competition, its cost study methodology will report an increase in its costs, (because  
9 fixed and sunk costs will be spread over fewer bops), leading one to the assumption  
10 that prices need to be increased, in order to cover the (average) cost. However, higher  
11 prices will translate into an even smaller market share, resulting in still higher cost  
12 estimates and even higher prices. This type of nonsensical reasoning can be avoided if  
13 one focuses instead on the marginal cost, or the incremental cost associated with a  
14 relevant increment of output (e.g., 10%).

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16 **Q. Can you describe some specific evidence that the Company's costing**  
17 **methodology focuses on average cost rather than incremental or marginal**  
18 **cost?**

19 A. Yes. During a meeting with GIE staff (including Mr. Dominguez), I had an opportunity to  
20 obtain a greater understanding of the bop cost model used by the Company in  
21 developing its proposals. At this meeting, I asked the GIE staff to run several scenarios  
22 using differing numbers of bops. My purpose was to determine how the cost estimates  
23 would change if GIE's market share dropped below 100%. These simulations confirmed  
24 that the model calculates average cost and that fixed and sunk costs heavily dominate  
25 the reported results. In fact, some categories consist almost entirely of fixed and sunk  
26 costs, divided by the number of bops. As a result, when the number of access lines is  
27 cut in half, the cost reported by the model in these categories approximately (in some  
28 cases, exactly) doubles.

29 The COSTIMOD system documentation also provides evidence of the type of cost  
30 that is being estimated. Several pages supplied by GIE have been attached to my  
31 testimony as an exhibit. For comparative purposes, I have attached a copy of a paper  
32 that I presented at the Symposium on Marginal Cost, sponsored by the National Regulatory  
33 Research Institute ("NRRI"). In this paper, I further explain the differences between a  
34 marginal cost methodology and an average cost methodology. Close examination of this  
35 paper, in comparison to the COSTIMOD documentation, confirms that COSTIMOD focuses on

1 average cost rather than marginal cost. Note in particular the emphasis in the COSIMOD  
2 documentation on how the cost per bop varies with the number of bops. This type of  
3 variation is associated with calculations of average cost, not marginal cost, as  
4 demonstrated by the table at the top of page 13 of the NRRI article.  
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6 **Q. Are there other problems with the Company's bop cost study?**

7 A. Yes, there are. First, the Company has elected to model a 12kft length of fiber optics  
8 from the central office for any bop exceeding 12kft. This decision distorts the results,  
9 particularly in areas with relatively few bops or bop lengths only slightly above 12kft.  
10 According to the COSIMOD technical documentation, "Planning policy dictates that a pair  
11 gain device is required if the loop length exceeds 12 kilofeet." However, the same  
12 documentation concedes that "for a strictly analog bop, actual functional lengths would  
13 be in excess of twenty-five kilofeet." [COSIMOD System Loop Cost Model, p.18.] In other  
14 words, the Company has modeled a hypothetical network in which all bops of greater  
15 than 12kft have 12kft of fiber, with the balance of the bop consisting of copper wire.  
16 This is not necessarily the most cost-effective network configuration, yet the Company  
17 claims that it is modeling the long run. By definition, in the long run the network design  
18 should be optimized for minimal cost.

19 In an effort to further analyze the impact of this assumption, we isolated the  
20 Company's estimate of the cost of this 12kft of fiber. When this cost is compared to the  
21 cost of an all-copper bop of equivalent length, the fiber option proves more costly. This  
22 is directly contrary to the impression one gains from the "long run" label given to the  
23 COSIMOD results, as well as the testimony of Mr. Dominguez, which emphasizes that "the  
24 Company can select the technology which is most efficient for the output level and mix  
25 selected." [Dominguez Testimony, p. 5.] In this instance, the Company has clearly not  
26 chosen to model the least costly technology, and, as a result, its bop cost estimates are  
27 overstated. Some might argue that fiber technology provides superior quality, provides a  
28 better platform for future services such as video dialtone and the "information  
29 superhighway," and is therefore an appropriate choice even if the cost is higher than  
30 traditional copper bops.

31 However, even if one accepts this reasoning, it is highly inappropriate to use the  
32 resulting (high) costs as justification for increasing basic local exchange rates. First,  
33 many of GTE's customers are not receiving the quality benefits of fiber--why should they  
34 be forced to pay the higher costs of a better grade of service they aren't receiving?  
35 Second, the Company's study assumes that all of the costs of the fiber system will be

1 borne by basic local exchange customers—none of the costs are assumed to be  
2 recovered from video dialtone or other advanced services that are driving the decision to  
3 install the more costly fiber technology.

4 This problem is further compounded by inappropriate assumptions concerning the  
5 specific fiber technology that was modeled. The COSIMOD system permits the choice of an  
6 integrated or non-integrated configuration. The former choice tends to be more efficient  
7 when designing a network from scratch; the latter choice may be the only viable  
8 alternative, or the least costly option, when retrofitting an existing network. The Company  
9 claims that it is developing a "long run" study, and thus it should have modeled the less  
10 costly integrated technology. Instead, however, it chose to emphasize the more costly  
11 non-integrated option.

12 According to GTE officials, this more closely matches the actual system currently  
13 in place in Virginia. Even so, that does not justify selecting the more costly option. If  
14 the Company wanted to model its existing system (e.g., a short run model), it should  
15 have done so on a consistent basis throughout the study. For example, the cost of  
16 copper cable installed twenty years ago should be considered a sunk cost in such a  
17 study and it certainly shouldn't be included at today's prices. In a valid cost study,  
18 internal consistency is crucial. The Company's cost study in this proceeding fails to  
19 achieve this fundamental requirement, because it selectively models costly elements of the  
20 existing system in combination with other elements which are based upon the assumption  
21 that a very costly new system is being built at today's prices.

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23  
24 **Q. Have you attempted to estimate the impact of these errors on the marginal  
25 incremental cost of a loop?**

26 A. I attempted to obtain complete documentation and workpapers for the Company's cost  
27 studies through discovery. While the Company did not object to this discovery, it failed to  
28 provide the requested information. After extensive negotiations, the Company eventually  
29 did allow me to look at some of the requested documentation, and allowed me to talk  
30 with one of its costing specialists familiar with the COSIMOD software used in this  
31 proceeding. During this meeting, the Company performed some alternative computer runs,  
32 altering the office size for each of the three density scenarios, at certain loop lengths.  
33 Using these results, in combination with the limited workpapers and documentation  
34 provided, I have been able to confirm that the problems I have described are very  
35 significant and drastically impact the reported results.

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If these problems were corrected, the resulting bop cost estimates would be greatly reduced for all bop lengths and all three density scenarios. As demonstrated in Schedule 1, attached to my exhibit, using the Company's COSTMOD software and underlying input assumptions, the estimated incremental cost of a bop is substantially lower than the average cost reported by the Company. Furthermore, although the low density areas are generally more costly to serve than the high density areas, the discrepancy in incremental costs is not as extreme as the discrepancy in average costs.