Exhibit No.:	
Issues:	Cost of Switched Access
Witness:	Ben Johnson, PhD.
Sponsoring Party:	MoPSC Staff
Type of Exhibit:	Direct Testimony
Case No.:	TR-2001-65
Date Testimony Prepared:	July 1, 2002

MISSOURI PUBLIC SERVICE COMMISSION

UTILITY OPERATIONS DIVISION

DIRECT TESTIMONY

OF

BEN JOHNSON, PHD.

CASE NO. TR-2001-65

Jefferson City, Missouri
July, 2002

** **Denotes Highly Confidential Information** **

NP

TABLE OF CONTENTS

DIRECT TESTIMONY

OF

BEN JOHNSON, PhD.

CASE NO. TR-2001-65

Introduction

Q. Would you please state your name and address?

A. Ben Johnson, 2252 Killearn Center Blvd., Suite 2D, Tallahassee, Florida 32309.

Q. What is your present occupation?

A. I am a consulting economist and president of Ben Johnson Associates, Inc., an economic research firm specializing in public utility regulation.

Q. Have you prepared any exhibits in support of your testimony?

A. Yes. I have an exhibit which contains 9 schedules. These schedules were prepared under my supervision and are true and correct to the best of my knowledge.

Q. Have you prepared a schedule that describes your qualifications in regulatory and utility economics?

A. Yes. Schedule 7 will serve this purpose.

Q. What is your purpose in making your appearance at this hearing?

A. My firm has been retained by the Staff of the Missouri Public Service Commission (The Commission) to assist the Staff with this docket, which seeks to determine the actual costs of switched access service in Missouri.

Following this introduction, my testimony has seven major sections. In the first section, I briefly review the background of this proceeding. In the second section, I describe costing concepts and definitions pertinent to this case, and discuss the types of forward looking economic cost studies I am presenting. In the third section, I review the FCC model and other cost models which could be used to prepare switched access cost studies. Section three also contains a general discussion of cost study inputs. In the fourth, fifth and sixth sections I describe the methodology used in developing the Staff's switching, loop and transport cost studies, respectively. In the final section, I discuss the current level of switched access rates in Missouri and compare them to the results of the various Staff cost studies, and to rates charged in other jurisdictions.

Background

Q. Let's turn to the second section of your testimony. Would you please start by outlining the history of this proceeding?

A. On June 15, 1999, the Commission issued its Order Establishing Case and Directing Notice in Case No. TO-99-596 in order to investigate certain language appearing in Stipulations and Agreements used with competitive local exchange telecommunications carriers (CLECs). The Commission held an evidentiary hearing in that docket on December 15 and 16, 1999. On June 1, 2000, the Commission issued a Report and Order, in which it found "that the public interest would be best served by reductions in exchange access rates rather than by increases". [In the Matter of the Access Rates to be Charged by Competitive Local Exchange Telecommunications Companies in the State of Missouri, Case No. TO 99-596 (Report & Order, issued June 1, 2000), at pages 29.] The

Commission further stated:

> the present record does not include detailed evidence concerning the actual costs incurred in providing exchange access service. Therefore, the present order is an interim solution addressing only the so-called "standard stipulation" as a barrier to market entry and as a competitive disadvantage to CLECs. The Commission will establish a separate case in which to examine all of the issues affecting exchange service and to establish a long-term solution which will result in just and reasonable rates for exchange access service. [Id.]

On August 8, 2000, the Commission established this case "to investigate all of the issues affecting exchange access service, including particularly the actual costs incurred in providing such service.." [Order Establishing Case, August 8, 2000, at page 1]. The Commission explained that this case " will take the form of a Commission investigation in order to ensure that the necessary detailed cost information is included in the record. [Id., at page 6]. The Commission directed Staff to

> gather, compile and analyze such information as is necessary and useful, including particularly data concerning the actual costs incurred, to examine all of the issues affecting exchange access service in order to establish a long-term solution which will result in just and reasonable rates for this service. [Id.]

On February 22, 2001, the Division of Purchasing and Materials Management (Division) issued a Request for Proposals (RFP) for a Telecommunications consultant to assist Staff and the Commission with this proceeding. In the RFP, the Division explained that the contractor

> shall gather and compile detailed cost information regarding the provisioning of intrastate exchange access service in Missouri which shall include, but should not necessarily be limited to, the following existing exchange access services rate elements: carrier common line charges, local switching charges, line termination charges, and local transport charges. [RFP No. B3Z01165, at page 6.]

The Division further explained that when preparing its cost information, the Contractor "should use a forward-looking costing method consistent with federal costing guidelines". [Id.] According to the RFP, the contractor would be required to identify access costs for incumbent local telephone companies (ILECs) and facility-based competitive basic local exchange companies (CLECs) in Missouri. [Id.]

Q. The genesis of this proceeding can be traced to a dispute concerning access rates charged by CLECs, and some parties didn't believe this was an appropriate forum for analyzing the costs incurred by incumbent local exchange companies (ILECs). Can you briefly discuss this controversy?

A. Throughout the RFP process, as well as subsequent discussions between the Staff and our firm, the scope of our cost development efforts included the ILECs. In fact, since the vast majority of the switched access market is served by a small number of large ILECs in Missouri, the primary focus of Staff's cost studies was necessarily these large ILECs.

Unfortunately, not all parties agreed with this interpretation of the proceeding and the appropriate scope of the cost development effort. However, on multiple occasions, the Commission has clarified that this docket includes ILECs, and that ILEC access costs are within the scope of this proceeding. For example, in its December 12, 2000 Order Granting Clarification, the Commission stated:

> Next, Staff asks whether the Commission intends to include ILECs as well as CLECs in this case. This question should not require clarification. In its Order Establishing Case, issued on August 8, 2000, Staff was directed to compile "a list of all carriers, with their addresses, presently certificated to provide basic local telecommunications services in the state of Missouri." As stated previously, the carriers appearing on that list were all made parties hereto by the order of September 21, 2000. That list necessarily included large and small ILECs, as well as CLECs, because all are

carriers certificated to provide basic local telecommunications services.

> SWBT opposes inclusion of the ILECs in this case. The access rates of the large ILECs have been adopted as caps on CLEC access rates in each exchange; therefore, it is appropriate to review the ILECs' cost information. [Order on Clarification, December 12, 2000, at page 2.]

The Commission again addressed this issue in its March 14, 2002 order. In its Order Clarifying the Scope of this Proceeding, the Commission stated:

> The purpose of this proceeding is "to investigate all of the issues affecting exchange access service, including particularly the actual costs incurred in providing such service, in order to establish a long term solution which will result in just and reasonable rates for this service." The Commission believes that this statement is clear. To the extent rates are an issue, this case includes that issue. [Order Clarifying the Scope of this Proceeding, March 14, 2002, at page 5.]

The Commission also noted that this is an investigation, and that it has not yet announced any intention to modify ILEC access rates. Id. Any such rate modifications would presumably not be determined until the cost studies have been reviewed and evaluated, and the investigation has been brought to a conclusion.

<u>Types of Forward Looking Economic Studies</u>

COST DEFINITIONS

Q. There are many different types of "cost" and thus many types of "cost" studies. Would you please identify and explain some of the major types of "cost" which can be studied?

A. Certainly. In this context, the most fundamental and important types of cost are *fixed* *cost, variable cost, total cost, average cost, marginal cost, incremental cost,* and *stand-alone cost*–all of which are integral parts of economic theory–as well as certain more specialized cost concepts, derivative from these, which have recently come into use in discussions of telecommunications cost theory. The latter concepts include *long run incremental cost, total service long run incremental cost, average service long run incremental cost,* and *incremental service incremental cost*. For orientation purposes, I have provided brief definitions of these terms below. I will also make use of certain other familiar cost terms--*sunk cost, direct cost, joint cost, common cost, embedded cost, fully allocated costs*, etc., that are prevalent in the literature.

Fixed costs do not change with the level of production, during the planning period or "run" under consideration. **Variable costs** change directly (but not necessarily proportionately) with the level of production. Together, these constitute **total cost,** which is the sum of all costs incurred by the firm to produce any given level of output. Dividing the total cost of producing a given quantity of output by the total number of units produced, one can calculate **average total cost**.

Incremental cost is the change in total cost resulting from a specified increase or decrease in output. In mathematical terms, incremental cost equals total cost assuming the increment of output is produced, minus total cost assuming the increment is not produced. Incremental cost is typically stated on a per-unit basis, with the change in cost divided by the change in output. Incremental cost can vary widely, depending upon the increment of output which is being considered. If the entire increment from zero units to the total volume of output is considered, incremental cost is identical to total cost. Similarly, where the increment ranges from zero to total output, incremental cost per unit is identical to average cost per unit. Because a wide variety of different increments can be specified, a wide variety of different incremental costs can be calculated. Thus, in considering any estimate of incremental cost it is crucially important to determine whether or not the specified increment is relevant to the issues at hand.

Marginal cost is the same as incremental cost where the increment is extremely small (e.g one unit) and the cost function is smooth and continuous. In mathematical terms, marginal cost is the first derivative of the total cost function with respect to output--that is, it is the rate of change in total cost as output changes. Conceptually, marginal and incremental costs are very similar; however, there are a wide array of incremental cost concepts, corresponding to the wide array of possible increments that can potentially be analyzed. In contrast, marginal cost corresponds to one small portion of this array--where the increment is narrowly defined and extremely small.

Stand-alone costs are those costs which would be incurred to produce only the item or service in question "standing alone". For example, the stand-alone cost of intrastate switched access service could be estimated as the cost associated with providing intrastate switched access in a stand alone context, without consideration of the additional costs which must be incurred in order to provide local or interstate switched access service. Stand-alone cost are those typically used in developing ceiling prices. Economies of scope (defined below) cause per-unit costs to be reduced when more customer groups are served, or when additional services are provided, over the same network. A comparison of long run stand alone costs (LRSAC) and total service long run incremental costs (TSLRIC) will generally display this phenomenon, and can be useful in establishing the potential range of appropriate prices–with LRSAC representing the absolute ceiling and TSLRIC representing the absolute floor.

Long run costs are those calculated under the assumption that most, if not all, costs are variable, and few, if any, are fixed or sunk. In contrast, **short run costs** are those which arise in situations where most costs are fixed. The classic long run concept is sometimes known as a "scorched earth" approach--that is, no preexisting plant is considered in the analysis. Instead, the firm is free to build precisely the size and type of plant which best fits its assumed output level.

All of these cost concepts have well-established definitions in the economics literature, with characteristics and implications that are widely understood and accepted amongst economists. More recently, some related costing concepts have been developed that are of particular interest in the context of multi-product firms like telecommunications carriers. While a variety of different names have been used to describe these concepts, for convenience I will use those adopted on June 1, 1993 by the Colorado Public Utilities Commission, as set forth in their rules governing the costing and pricing of telecommunications services. [Statement of Adoption of Rules, Docket No. 92R-596T]. I've provided a copy of these rules as Schedule 8 to my testimony.

The **total service long run incremental cost** (TSLRIC) of a service (or group of services) is equal to the firm's total cost of producing all its services including the service (or group of services) in question, minus the firm's total cost of producing all its services <u>except</u> the service (or group of services) in question. Thus, it is a particular form of long run incremental cost (LRIC), in which the specified increment is the entire volume of output of a particular service, while all other services remain unchanged.

The average service long run incremental cost (ASLRIC) of a service (or services) is the total service long run incremental cost divided by the total number of units of the service(s) in question. **The incremental service incremental cost** (ISIC) of a service is the change in total cost resulting form increasing (or decreasing) the quantity of output of the service by a small number of units, divided by that small number. If the cost function is smooth and the increment is sufficiently small, ISIC will approximate marginal cost.

TSLRIC studies can be useful in determining the existence and extent of subsidies and in developing public policies for the preservation of universal service under circumstances where new entrants may engage in "cream skimming," or where barriers to entry may exist (e.g., in rural, high-cost areas). Other state commissions have endorsed the use of TSLRIC studies for this purpose. For example, the Pennsylvania Public Service Commission endorsed TSLRIC and rejected the use of embedded cost studies, which it concluded have been "increasingly discredited by most sectors of the industry and most outside observers" because their methodology is limited to embedded costs and fails to "provide for an adequate depiction of future economic costs of telecommunications networks." [Order, Docket No. I-00940035, at 11.]

In effect, TSLRIC measures the difference between producing a service and not producing it. This difference may not include certain of the firm's joint or common costs; hence, a firm that recovers in its prices only the TSLRIC of its services may find that its total revenues fall short of its total costs. In the case of many telecommunications services, the magnitude of this shortfall can be substantial, because these services use many of the same network facilities. Where facilities are required if any one of several services is produced, the portion of the firm's total cost attributable to the facility in question (or, at least certain portions of that cost) may not vary with the presence or absence of any single service. Where this phenomena exists, the cost in question drops away from the TSLRIC calculations, and thus the TSLRIC of each individual service will be quite low.

By definition, all costs can be classified as variable in a long run cost study. However, that doesn't necessarily mean that all costs vary in every dimension of the cost function, or that they necessarily vary on a proportional basis. Thus, there can be significant discrepancies between costs per unit developed on an average basis, and costs per unit developed on an incremental basis. For instance, while the investment in electronic equipment associated with fiber optic transport systems can be considered "variable" in the long run, that doesn't mean that these costs necessarily vary in proportion to changes in the volume of traffic, or that all of the components of these costs will necessarily increase or decrease as one specific service is added or deleted from the array of services which use this equipment. Due to economies of scale and scope, the incremental fiber electronic investment which is attributable to an incremental service may be substantially lower than the average investment required for all services.

An allocated cost is a joint or common cost that has been divided among the firm's different customers, products, or services, in accordance with a particular formula or the judgments of a cost analyst. *Fully allocated costs* are the summation of direct and allocated costs for a customer, customer class, product, or product group, developed in a cost study in which none of the firm's joint and common costs are left unallocated. Fully allocated costs are often referred to as *fully distributed costs*.

Common costs are incurred when production processes yield two or more outputs. They are often common to the entire output of the firm but can be common to just some of the outputs produced by the firm. An increase in production of any one good will tend to increase the level of common costs; however, the increase will not necessarily be proportional, since economies of scope and/or scale may apply. A **joint cost** is a specific type of common cost--one incurred when production processes yield two or more outputs in fixed proportions. A classic example arises in the joint production of leather and beef. Although cattle feed is a necessary input for the production of both gloves and hamburgers, there is no economically meaningful way to separate out the feed costs that are required to produce each. If the quantity of leather and beef is reduced, there will be a savings in the amount of cattle feeding costs, but it is impossible to say how much of this change in cost results from the change in the quantity of leather and how much from the change in the quantity of beef. Because the appropriate interpretation and handling of joint and common costs tends to be very controversial in regulatory proceedings, I have provided a more extensive discussion of this topic as Schedule 9 to my testimony.

Economies of scale. Economies of scale are achieved when a firm is able to lower the per-unit cost by producing additional units of the product or service—i.e., when marginal or incremental cost is lower than average cost. The ultimate example of economies of scale is a **natural monopoly**, where a single firm can supply the entire market for the product or service at a lower per-unit cost than any combination of two or more firms. Economies of scale appear in telecommunications in such plant elements as poles and trenches used to hold cables, where the increase in carrying capacity (e.g., number of circuits) is disproportionately greater than any corresponding increase in the cost of the pole or trench. That is, it costs little more to install poles for 1,000 circuits along a particular route than to install poles for 100 circuits along the identical route.

Economies of scope result when the resources a firm uses in the combined production of two or more products are less costly than the resources it would use to produce the products separately, as measured by their combined total of their respective stand-alone costs. For example, if a telecom firm produces both toll and local phone service, it may gain some economies of scope. When the same pole route carries both intercity trunk lines and local loops, the firm can achieve economies of scope by using one set of poles instead of two.

Q. Can you elaborate on the differences between marginal and incremental cost?

A. Yes. By definition, incremental costs can fall anywhere along the conceptual continuum from marginal to average cost, depending upon the specific methodology used and the specific increment which has been selected. As two academic experts in this field explain:

> Incremental cost is a generic concept... marginal cost can be approximated by incremental cost when the increment in question is small. But if the increment is large, marginal cost and incremental cost can differ substantially, because the ranges of outputs examined in the two calculations are not the same. [William J. Baumol and J. Gregory Sidak, *Toward Competition in Local Telephony.* Cambridge (MA): MIT Press, 1994, p. 34. 57]

As Baumol and Sidak also note, "TSLRIC includes any fixed cost that must be incurred on behalf of that product alone." Furthermore,

> incremental cost and stand-alone cost are intimately related, and either number can be deduced directly from the other. Specifically, when the firm earns no more and no less than the competitive rate of return, if each of the firm's prices is above

> [TSLRIC], then each of those prices *must* be below its stand-alone cost, and vice versa. [¶58-9.]

Q. Would you provide an example to illustrate the distinction between analyzing average cost and analyzing incremental or marginal cost?

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

Consider, for example, the treatment of the getting started cost of a switch. This is the minimum level of cost associated with a switch, even if it were not equipped with any lines, and even if it didn't have enough capacity to handle any traffic. An average cost estimate would typically include the total getting started cost of the switch divided by some measure of output (e.g. the number of loops terminated on the switch). In sharp contrast, a marginal cost estimate would most likely exclude any of the getting started costs, because these costs would be considered largely, or entirely, fixed and they would not vary with output.

The same principle holds true for other costs which are largely or entirely fixed, such as the cost of installing a cable on the pole. The cost of attaching a small cable, such as one containing 25 loops, will not differ greatly from attaching a much larger cable, such as one containing 900 loops. With the notable exception of splicing costs, most cable installation costs vary less than proportionally with variations in the size of the cable, and thus they should have little or no impact on marginal cost estimates.

Admittedly, some costs which are largely fixed may vary under some limited circumstances. For instance, the getting started costs of a small switch might be lower than the analogous costs of a much larger switch. The point is not whether a particular type of cost is absolutely fixed under any and all circumstances. Rather, the point is that if the increase in costs would normally be far less than proportional to the rate of increase in output, the marginal cost will tend to be less than the average total cost. Because of economies of scale and scope, it is often the case in the telecommunications industry that when properly estimated, TSLRIC will be substantially lower, and stand alone costs will be substantially higher, than average total cost.

Q. Is it possible to develop several different types of cost estimates in this proceeding, consistent with standard cost theory?

A. Yes. Incremental cost principles can be used to compute the additional cost incurred when a network is expanded (or contracted) to serve (or not serve) virtually any specified block of customers, geographic area or zone, or specific service. At least in theory, incremental costing concepts can be applied to virtually any combination of specific customers, geographic areas, and services including switched access service. Thus, incremental cost studies can potentially target whatever portion of the overall telephone network is of particular interest, ranging all the way down to a contract service arrangement provided to a single customer at one or two specific geographic locations.

With the current state of the art, it is now feasible to analyze telecommunications costs in ways which are specifically relevant to particular issues of interest to the Commission. For instance, it is feasible to analyze the incremental cost of serving specific "high cost" (e.g., rural) areas, or the cost of providing basic local exchange service to business customers, or whatever group of customers or set of services happen to be of concern in a particular context. Furthermore, the Commission doesn't need to restrict itself to a single type of cost study.

In an effort to provide the Commission with a clearer understanding of the relationship between current access rates and the underlying structure of the costs which are incurred in providing this service, it is helpful to analyze more than one type of cost. This investigation is narrowly focused on intrastate switched access service in Missouri. There is no need to further narrow the focus to a particular view or method of measuring the costs of providing this service. To the contrary, it can be useful to look at a range of results, corresponding to different costing concepts. More specifically, we have developed stand alone cost estimates, two different average (fully allocated) cost estimates, and TSLRIC estimates for each carrier. Because of the different manner in which economies of scale and scope are dealt with in each of these types of cost studies, the results can vary quite substantially.

In the Stand Alone cost studies, we estimated the cost of providing switched access service over a network which only carries this one type of traffic. This type of study deals with the problem of shared costs by analyzing the cost of providing intrastate switched access service on an isolated basis–excluding the additional costs which are normally incurred in order to provide local and other services over a shared network.

The average, or fully allocated, cost studies correspond to the view of costs which has historically dominated the regulatory process (albeit on an embedded, rather than forward looking basis). In this type of study, cost estimates are developed for a network which handles all types of traffic. The philosophical underpinning of this type of cost study is that joint and common costs are normally recovered from users of all the various services which benefit from the shared costs, and thus the shared costs should logically be spread to all of those services. The difficulty with this type of cost study is that the results depend very heavily upon the methods used in allocating shared costs to the various services. Since the allocation process is inherently controversial, we developed two different versions in order to illustrate the potential impact of varying allocation procedures.

Finally, we developed some TSLRIC cost estimates. These are equivalent to what would result if one compared the total cost of providing every service excluding intrastate switched access to the total cost of providing all services including intrastate switched access. The difference between these two totals represents the incremental cost of intrastate switched access. Stated differently, the TSLRIC study is limited to the costs which would be saved if intrastate switched access service were removed from the group of services which are normally present on the network. Because this approach excludes those shared costs which would remain unchanged because they are necessary in order to provide other services, the resulting cost estimates tend to be relatively low. Perhaps for this reason, the TSLRIC approach has been popular with parties who are seeking to lower rates, and with carriers who have sought increased flexibility to lower rates in response to competitive pressure.

Both stand alone and TSLRIC estimates can be useful and relevant to the Commission's public policy and pricing decisions. For example, any examination of "subsidies" as economists use this term should appropriately include consideration of one or more TSLRIC studies, since a service priced above its TSLRIC is not being subsidized, in the strict sense of this term. Conversely, a service priced below its stand-alone cost is not subsidizing any other service. The relevance of both types of cost studies in the context of telecommunications regulatory policies is confirmed by

Baumol and Sidek, although they use the term "average-incremental cost" to describe the TSLRIC concept:

> marginal costs and average-incremental cost are the figures pertinent for price floors, while stand-alone costs are the costs relevant for price ceilings. [¶58]

Q. Can you elaborate on these concepts, as they can be applied to switched access?

A. Yes. Based upon my past experience, I anticipate that some of the parties to this proceeding will argue that a particular type of cost should be emphasized to the near exclusion of any other type of cost. However, I strongly disagree with any attempt to identify and focus exclusively on a single "best" type of cost (particularly where the parties disagree about which type of cost is the "best" one to use). The Stand Alone, Average/Allocated and TSLRIC concepts are all relevant to the Commission's investigation into the actual costs which are incurred by carriers when providing intrastate switched access service.

According to economic theory, a service priced above TSLRIC is making a contribution to joint and common costs (however small) and the firm is better off producing it than not producing it, even if the contribution level is smaller than that produced by other services. While someone could legitimately argue that particular rates are too low because the level of contribution generated by this service is lower than they believe to be optimal, they cannot properly argue that a service is "subsidized" unless the total incremental revenues it generates are less than the corresponding TSLRIC.

Similarly, while some parties to this proceeding may argue that switched access rates are too high, they cannot properly argue that switched access service is "subsidizing" basic local service, or any other service, unless the current rate exceeds stand-alone cost. A comparison with average (allocated) cost or incremental cost is simply not adequate to draw conclusions about whether switched access service is subsidizing other services.

To the extent current rates for intrastate switched access service are between TSLRIC and stand-alone cost, economic theory demonstrates that this service is neither subsidizing any other service nor is it being subsidized by any other service. It is for that reason that it is often suggested that TSLRIC studies provide a pricing "floor" or (less frequently) that stand-alone cost studies provide a pricing "ceiling." The two average total cost studies are also potentially useful in evaluating the reasonableness of rate levels. For one thing, these studies are conceptually similar to the fully allocated cost approach which has historically been relied upon in developing the existing pattern of cost recovery which is still observed in the industry. While average/allocated cost studies have become less popular in recent years (and there has been a movement from embedded to forward looking costs), the effects of the allocated/average costing approach to the pricing of switched access services remains largely intact. Thus, the pro-rata and weighted average cost studies can be useful in judging the extent to which particular existing rates remain consistent with this long standing pricing pattern. For instance, where specific rates greatly exceed average cost, this may provide evidence that costs have sharply declined, or that forward looking costs are currently much lower than embedded costs were at the time when the rate was developed.

<u>Cost Modeling</u>

TYPES OF COST STUDIES

Q. Can you describe the stand-alone studies you prepared for this proceeding?

A. Yes. Stand-alone cost is the total cost of providing a particular item in a separate production process, without the benefit of economies of scope. Accordingly, the stand-alone cost studies we prepared focus on the actual cost of providing intrastate switched access service, assuming none of the shared cost burden is shouldered by other services (none of the benefits of economies of scope are attributed to intrastate switched access). Since many of the fixed costs of the network are attributed entirely to intrastate switched access service, the resulting cost per unit (per circuit, per minute or per minute-mile) are far higher than in the other studies.

Q. Can you describe the fully allocated (average total) cost studies you prepared for this proceeding?

A. Yes. Average total cost is the total cost of producing a given quantity of output, divided by the total number of units produced. The fixed cost of facilities which carry a mixture of traffic are spread across all of the services that use these facilities using various allocation or averaging procedures. For example, the cost of switching is typically spread over intrastate switched access service, interstate switched access service, basic local exchange service and perhaps other services as well (e.g. custom calling service).

Because these allocation or averaging procedures tend to be controversial, and they necessarily involve a degree of arbitrariness, we prepared two illustrative cost studies using different approaches to the allocation of certain costs. In the “pro rata” study, various shared costs were attributed to intrastate switched access service in proportion to the volume of traffic typically carried over the facilities which give rise to the costs in question. (All minutes are treated as equivalent). In the "weighted" study, more of these shared costs are attributed to intrastate switched access service on the assumption that the selected allocation process give substantially greater weight to switched access and toll traffic than to local traffic. (All minutes are not the same–long distance minutes are given greater weight). The"weighted" study is conceptually similar to (but less sophisticated than) the cost allocation process which has historically been used in the telecommunications industry. For instance, for many years the FCC relied upon a "subscriber plant factor" and "weighted" Dial Equipment Minutes in allocating costs, thereby giving interstate long distance traffic greater weight than local traffic. A weighting approach is designed to reflect (in a simplified manner) various demand factors, such as the greater value associated with transmitting communications over longer distances, and the deterrent effect of attaching a price tag to long distance minutes, which have led many regulators to conclude that a smaller than pro-rata share of certain shared network costs should be allocated to local service.

While the use of a weighted approach to the allocation or averaging of shared costs has always been controversial, it has been widely adopted by regulators–whether explicitly or implicitly. The rationale behind this type of weighting process is twofold. A greater portion of the shared costs are allocated to those services where usage has a higher value per minute of use, and a greater portion of the shared costs are allocated to a category in which usage volumes have been suppressed due to high prices. When comparing long distance and local traffic, it is readily apparent that the average switched access minute has a higher value than the average local minute (due to differences in the total distance covered by the typical call). It is also apparent that switched access traffic volumes are reduced due to the fact that most long distance customers pay a per-minute price, whereas local service is typically flat rated. For both of these reasons, it is sometimes argued that switched access and toll traffic should receive greater weight during the allocation or averaging process.

Q. Can you describe the TSLRIC studies you prepared for this proceeding?

A. Yes. The total service long run incremental cost of switched access is the additional cost of producing this service, assuming a common production process in which all other services would be produced in any event. Stated another way, the TSLRIC of intrastate switched access service is equal to the firm's total cost of producing all of its services assuming intrastate switched access service is offered, minus the firm's total cost of producing all of its services excluding this service. Accordingly, the TSLRIC studies focus on those costs which increase because intrastate switched access service is provided. Costs which would remain largely or entirely the same whether or not this service is provided will largely or entirely be excluded from the TSLRIC results. For this reason, one can anticipate the TSLRIC results per unit (per circuit, per minute or per minute-mile) to be much lower than the average and stand alone cost study results.

Many network facilities would be needed in order to provide interstate switched access, special access and local service, even if intrastate switched access weren't provided. The costs of these shared facilities are largely excluded from the TSLRIC study. These shared costs are only included in the TSLRIC results to the limited extent the costs in question would increase or decrease if the service in question (intrastate switched access) were added or deleted from the overall mix of services.

For instance, due to lumpiness and other technical characteristics, the "getting started" investment in a digital switch (including much of the central processor) would be approximately the same regardless of whether or not intrastate switched access service is offered (and regardless of whether or not the switch needs to accommodate intrastate switched access traffic). Hence, this lumpy investment in central processor capacity will largely or entirely "drop away" from a properly conducted TSLRIC study. In other words, if the TSLRIC study is prepared in a manner which purely consistent with the definition of TSLRIC, the central processor costs will have relatively little (or no) impact on the final TSLRIC cost results.

Of course, by this same reasoning, these costs would also largely or entirely be excluded from a properly conducted TSLRIC study for various other services. (These costs would only be included to the extent they would actually increase or decrease with the addition or deletion of the service in question). This phenomena does not disappear merely because a long run study is being conducted. Although all costs can be classified as "variable" in a long run study, that doesn't necessarily mean that all costs vary in proportion to output, or that all shared costs vary with the addition or deletion of individual services. To the contrary, whenever a firm benefits from economies of scale and scope, one can anticipate that a properly conducted TSLRIC study will yield unit costs which are less than those developed in a properly conducted average cost study.

For this very reason, a carrier that enjoys economies of scale and scope cannot recover the totality of its costs if it sets all of its prices equal to TSLRIC. TSLRIC estimates can appropriately be used as a pricing floor, but they don't necessarily provide a valid indication of an optimal price level. To the contrary, in order to fully recover a carrier's total costs, a markup or contribution above TSLRIC is necessary when establishing at least some (perhaps all) of the carrier's rates.

MODEL SELECTION

Q. Let's turn to the portion of your testimony dealing with cost modeling. Are there several cost models which can be used to estimate the costs incurred by the LECs in providing switched access service in Missouri?

A. Yes. For instance, the Benchmark Cost Proxy Model (BCPM) and the HAI (Hatfield) model could plausibly be used to estimate forward looking costs in Missouri. A more logical choice, however, would be the model which was developed by the FCC for use in administering the federal universal service fund. The FCC model is sometimes called the Synthesis model, because the FCC developed it by combining elements of the BCPM and HAI models with elements of the FCC staff's own modeling efforts. For reasons I will explain later, we relied heavily, but not exclusively, on the FCC model in developing the Staff cost studies in this proceeding.

Q. Would you please provide some background concerning the FCC model, and explain why the FCC decided to develop its own cost model, rather than relying upon models developed by the carriers it regulates?

A. Yes. In its May 8, 1997 *Universal Service Order*, the FCC adopted a universal service plan to replace longstanding federal subsidies to incumbent local telephone companies with explicit, competitively neutral federal universal service support mechanisms. At that time, the FCC also decided that an eligible carrier's level of universal service support should be based upon the forward-looking economic cost of constructing and operating the network facilities and functions used to provide the services supported by the federal universal service support mechanisms.

After a very extensive review, the FCC found problems with all of the models that were initially submitted for its consideration, and concluded that it could not use any of these models to accurately calculate forward-looking economic costs. [¶ 245]. The FCC concluded that the HAI (sponsored by AT&T and other interexchange carriers) and BCPM (sponsored by Sprint, GTE (now Verizon) and other incumbent local exchange carriers should continue to be considered and developed further, and it stated that it might also consider models or model components developed by the FCC staff.

> After extensive additional fact gathering and analysis, the FCC concluded that neither BCPM or HAI offered a high enough level of accuracy and geographic precision, concluding that neither of these models... estimate the cost of building a telephone network to the subscriber's actual geographic location, taking into account the actual clustering of customers groupings such as neighborhoods and towns. [FCC 98-279, ¶ 3].

In an effort to overcome these problems, the FCC endorsed a synthesis approach, relying primarily on the Hybrid Cost Proxy Model (HCPM), developed by members of its staff, together with some aspects of BCPM and HAI. Throughout my testimony, I refer to this synthesis model as the FCC model.

Q. Have the carriers developed any other cost models that could potentially be used to estimate costs in this proceeding?

A. Yes. During discovery and through informal discussions with the parties, we asked the major ILECs to identify and provide copies of any cost models they anticipated using in this docket. Southwestern Bell Telephone L.P., d/b/a Southwestern Bell Telephone Company (SWBT), Sprint Missouri, Inc. d/b/a Sprint (Sprint) and GTE Midwest, Inc. d/b/a Verizon Midwest (Verizon) all provided cost modeling tools they had internally developed. Unfortunately, none of these models was readily capable of estimating costs for any other carriers in the state. Moreover, the models provided by SWBT weren't capable of estimating loop costs, which are an important portion of the costs which have historically been recovered through switched access rates.

We decided not to rely entirely on the ILEC models largely because they were not capable of estimating costs on a consistent basis across the entire state. In our view, the ability to develop cost estimates on a uniform, consistent, basis was imperative in this investigation. Without a reasonable degree of modeling uniformity, it would be impossible for the Commission to know whether differences in the estimated costs for various carriers were the result of differences in the underlying cost conditions facing those carriers (e.g. due to differences in customer density or terrain) or due to differences in the cost models used in developing the estimates.

SWBT didn't provide a model which was capable of estimating loop costs, and the loop modules provided by Sprint and Verizon were structured around input data which was only available for their own service territory. Since this data could not easily be obtained for the remainder of the state, neither model provided a viable option for estimating costs in the remainder of the state, particularly in SWBT's service area. Moreover, neither Sprint nor Verizon showed any interest in obtaining the necessary data, or making the necessary modifications to their models, in order to develop uniform, consistent cost estimates for all carriers within the state. Accordingly, we concluded that any reliance upon the ILEC models would have to be limited. At least in their off-the-shelf versions, none of these ILEC models provided a viable alternative for our use in this proceeding.

Q. You briefly mentioned the HAI and BCPM models and indicated these models are capable of developing consistent cost estimates for the entire state. Why didn't you use one of these models instead of the FCC model?

A. The interexchange carriers which sponsored the HAI model, and the incumbent local exchange carriers which sponsored BCPM strived hard to convince the FCC to use their respective models for the federal universal service support system. Consequently, they designed HAI and BCPM for uniform application to multiple carriers, and they developed the necessary input data to apply these models through the nation. Thus, both models are capable of uniform application throughout Missouri. It is also worth noting that both HAI and BCPM were repeatedly refined and improved in response to criticisms from other parties and feedback from both state and federal regulators. However, both continued to display serious weaknesses in the way they locate customers and deploy cable to reach those locations. This is of crucial importance in estimating costs of a cable network serving low density, rural areas. The FCC model simply does a better job in handling this difficult portion of the cost estimation process, particularly in rural areas.

Perhaps the most important, and most difficult problem in accurately calculating the forward looking economic costs of a loop network involves geography–where are the end-users, and how much cable and equipment is needed to reach them? Although substantial improvements were made in this regard, neither HAI nor BCPM is fully up to the task, as demonstrated by a variety of different indicators that can be used to gauge how well the models deal with geographic aspects of the modeling process. In this critically important area, the FCC model provides a significant improvement over the BCPM and HAI models. For example, the geographic aspects of the modeling process are more open to inspection and modification. The model relies upon data input files containing customer locations and it generates intermediate data files containing cluster locations which can be mapped using standard mapping software, and it includes a more sophisticated approach to the "clustering" phenomena, which better reflects the efficiencies which can be achieved when customers are located near each other. At least with regard to the critically important geographic aspects of the modeling process, and particularly with regard to its clustering algorithms, it is fair to say that the FCC model represents a substantial improvement over both the BCPM and HAI models.

Q. You have indicated that the geographic aspects of the modeling process are crucial in estimating loop costs. What improvements does the FCC model offer in this regard?

A. Perhaps the two most important factors which explain why some carriers have higher loop costs than others are differences in average loop lengths and differences in customer density per route mile. Both of these factors are functions of customer location. Therefore, if one wants to accurately measure loop costs, and in particular if one wants to know how much higher loop costs are for one carrier than for another, it is crucially important to accurately locate the customers served by each carrier. The FCC model locates customers, groups these customers into clusters, then connects these customers to the network using methods which are superior to the methods used by the HAI and BCPM.

In developing its synthesis, the FCC selected some of the strongest features of HAI and

BCPM, as well as the FCC staff model. In designing the customer location and outside plant portion of its model, the FCC applauded HAI's use of geocoded customer location data. The FCC also incorporated BCPM's use of roads to estimate the location of customers for whom precise geocode data is not available. The FCC also endorsed its staff's approach to identifying customer serving areas based on natural clusters of customers, sending cable directly to the specific customer locations within each serving area. All of these decisions are sound, and reflect clear progress over HAI and BCPM. The FCC model is also well positioned to benefit from better geocoded data once this is gathered or becomes available. As the FCC noted:

> ...in addition to the current sources of geocode data, more comprehensive geocode data are likely to be available in the future. (¶ 34)

> ...use of global positioning satellite (GPS) technology and E911 data may [also] be viable alternatives. (Footnote 75)

I believe the GPS option will be cost-effective in rural areas where street addresses don't exist, and the number of customers needing to be located is not extremely large. The E911 alternative also looks promising.

We ultimately concluded that the FCC Model was the best option for estimating loop costs in this proceeding, but it still falls short in some regards. For example, it ignores rights of way, rivers, mountains and other physical constraints, much like BCPM and HAI. It clusters and connects customers using minimum air distance as the sole criterion, which can lead to significant distortions, particularly since rights of way and other physical constraints are ignored. But the FCC Model does offer at least some improvements regarding the layout of the distribution network, as explained by the FCC:

> ...both BCPM and HAI, by relocating customers so as to distribute them uniformly in square or rectangular distribution areas, create an apparent systematic downward bias in the required amount of distribution plant that is constructed in less dense areas.
>
> By designing plant to serve actual customer locations instead of simplified representations of customer locations, HCPM is substantially more likely to estimate the correct amount of plant necessary for providing the supported services (¶ 60).

The FCC model offers a high degree of network optimization, but in some cases the FCC may have gone too far, by "minimizing" costs below a realistic level, since it ignores rights of way, rivers, lakes, mountain ranges, property boundaries and other physical constraints. But, in general, it would be fair to say that the latest version of the FCC model is superior to the HAI model and that the HAI model is superior to BCPM, particularly with regard to the geographic aspects of the loop modeling process.

Q. Are there other reasons why you chose to rely extensively on the FCC model, in preference to BCPM, HAI and other models sponsored by parties to this proceeding?

A. Yes. One of the problems with cost modeling in a regulatory context is that the cost models and inputs developed by participants in that process tend to reflect the biases or advocacy positions of these participants–or at least that is the perception of other participants in the process. For instance, the incumbent LECs who sponsored BCPM frequently argued that HAI was biased downward–producing unrealistically low cost estimates. At the same time, the interexchange carriers who sponsored HAI frequently claimed that BCPM was biased upward–producing unrealistically high cost estimates. Claims of upward and downward bias permeated the discussion of the BCPM and HAI models (respectively) and their inputs. This isn't surprising since these cost models were put forward by parties that have a direct economic stake in the outcome of the modeling process.

An important advantage of the FCC model is that it was developed and refined by a regulatory agency, rather than by a party which had an economic interest in putting forward relatively high or low cost estimates. This contrasts with most of the other available choices, which are models that were developed and sponsored by carriers who have a direct stake in the outcome of the modeling process. In this case, the cost data could influence the rates the carriers are allowed to charge (or will be required to pay) in the future.

Q. Some of the ILECs may argue that their models are superior to the FCC model, because they rely upon carrier-specific inputs. What is your response?

A. While the parties may think that inputs they have internally developed offer an advantage, because they are more "carrier specific," from a regulatory perspective, this actually represents a serious disadvantage. For one thing, the party which developed the inputs will have a strong informational and advocacy advantage over any party wanting to dispute those inputs. Since the Commission wants to achieve the fairest, most accurate results possible, it isn't particularly helpful to "stack the deck" in favor of the party which developed a particular set of inputs, particularly where it would be difficult, or impossible, for opposing parties to verify or refute the validity of many of these inputs.

At least from the Staff perspective, there is a strong advantage to starting with the default inputs developed by the FCC for use in their model. While they are not perfect, these inputs were developed by a regulatory agency after a thorough, detailed review. The major inputs to the FCC model were heavily scrutinized throughout round after round of comments at the federal level. Not surprisingly, these inputs generally produce cost estimates which are higher than those which result from the inputs advocated by the interexchange carriers, and lower than those which result from the inputs advocated by the ILECs.

Admittedly, just because the inputs selected by the FCC tend to fall within the range of inputs advocated by the HAI and BCPM sponsors doesn't necessarily mean that they are perfectly accurate. However, the fact that these inputs were developed by a regulatory agency after careful review of extensive evidence in a highly contested proceeding provides some degree of assurance that they provide a sound, unbiased starting point for this Commission's own deliberations.

I am not suggesting that the default inputs to the FCC model should be followed without exception. Rather, I contend they provide a reasonably unbiased and appropriate starting point for modeling decisions in this proceeding, and that the burden should be on anyone seeking to deviate from these inputs to provide sound reasons for modifying or replacing those inputs with others. I have endeavored to meet this burden with respect to the few areas where we deviated from the FCC's default inputs.

Q. The FCC model is a national model that was developed to suit specific needs of the FCC. It might be argued that this model doesn't produce carrier-specific costs, or that it isn't appropriate for use in a state-specific proceeding. What is your response?

A. Any cost modeling effort is fraught with difficulty and tradeoffs. I will readily concede that because the geographic and other attributes of each state are sufficiently unique, it is difficult, if not impossible, to develop accurate cost estimates for every part of every state. The FCC model is designed to produce consistent, meaningful results across the entire nation. Given the tradeoffs inherent in such a modeling effort, the accuracy of the results may be diminished in some instances. However, that is a relatively minor consideration in this context, and this does not negate the important benefit of an internally consistent modeling effort in a statewide cost investigation of this type.

In a proceeding of this type it is very important to generate internally consistent, reliable cost results for every part of the state. If the Commission were to rely upon carrier-specific models, like those proffered by Sprint and Verizon, it would not have available a consistent set of cost data which can meaningfully be compared across carriers. Consider what would happen if the Commission attempted to rely upon carrier-specific cost studies submitted by various carriers using their respective cost models. If the cost estimates submitted by one carrier were lower than those produced by another carrier, the Commission would have no way of meaningfully interpreting these results, particularly if the estimates don't focus on the same parts of the state. In the absence of a consistent methodology, if different costs are estimated by different carriers, the Commission would have no way of knowing whether the reported differences reflect a difference in the underlying cost conditions in the two carriers' respective service areas, differences in the prices paid by these carriers for comparable equipment, or differences in the carriers' engineering, management or purchasing practices. Even more disturbing, such reported differences in cost might reflect differences in cost modeling techniques, differences in simplifying assumptions used during the modeling process, or differences in costing philosophy, rather than any differences in the actual costs incurred by the respective carriers.

Just as the FCC needed a reasonable degree of consistency in cost estimates for different states in order to accomplish its purpose, this Commission needs a reasonable degree of consistency in cost estimates for different carriers operating in Missouri in order to accomplish its purpose.

While the FCC model is a national model, that doesn't mean that it produces the same cost results for every carrier, or that it is incapable of capturing state-specific or carrier-specific cost differences. To the contrary, the essence of the problem facing the FCC was to accurately estimate the cost of providing service within the specific geographic areas served by particular carriers, in order to determine which carriers and which states deserve high cost support. While there are undoubtedly weaknesses in the FCC model (as there are with any of the alternatives), these weaknesses can be minimized by refining the model, or its inputs, as the Staff has done in this proceeding. I will discuss my recommended Missouri specific inputs later in my testimony.

Q. It might be argued that the FCC adopted its model for a limited purpose, and that it shouldn't be used in this proceeding because it wasn't designed to estimate switched access costs. What is your response?

A. I will readily concede that the FCC hasn't endorsed using its model for any purpose other than administration of the federal universal service fund. That doesn't mean the model isn't capable of being used for other purposes. In fact, the sponsors of the HAI model (one of the predecessor models incorporated into the FCC's synthesis approach) designed it to be capable of estimating unbundled element costs, and they also anticipated the possibility of using the HAI model to estimate switched access costs–the focus of this proceeding. Thus, it isn't surprising that, with a bit of effort, the FCC model can be adapted to provide a variety of different types of cost estimates, including estimates of the cost of providing intrastate switched access cost service.

While the FCC model's approach to estimating costs isn't perfect, it has fewer weaknesses than most of the alternatives. The FCC model is a reliable, solid platform which is open to review and modification. Furthermore, the FCC model's default inputs provide a neutral baseline from which selected inputs can be readily adjusted to provide more accurate, Missouri specific cost estimates. The model is extremely flexible and allows full customization tailored to the unique geography of Missouri.

Even if the FCC model weren't a superior choice on purely technical grounds (which it is, at least with regard to loop costs), I would still recommend using this model, because it has the ability to generate internally consistent, state-specific loop cost results for every wire center in Missouri and because it is unbiased. In contrast, carriers like Sprint and Verizon have a direct interest in the outcome of this proceeding, since it may affect the level of access rates they are allowed to charge (or required to pay) in Missouri. Even if this direct interest in the outcome of the proceeding has no impact on their cost modeling decisions, it could lead other parties to question the reliability of cost estimates which are developed using their models. For this reason as well, I believe the FCC model, and particularly its default inputs, offers a superior alternative to the carrier-specific models and inputs provided by the ILECs in this proceeding.

Q. Hasn't the FCC model sometimes been characterized as a Black Box?

A. Yes, but I don't think this is a fair characterization. To the contrary, I would argue the FCC model is at least as open and accessible as other models which might be considered for use in this proceeding, such as Verizon's Integrated Cost Model (ICM). Like HAI, BCPM and Sprint's cost model, large portions of the FCC's model have been created in Excel, and thus are highly accessible to interested parties, even if they have not previously had an opportunity to become familiar with the model. Other portions of the FCC model (e.g. the customer location and clustering routines) were written in Pascal. This was perhaps an unfortunate programming choice, which some have criticized. However, the source code is open for inspection, and the parties have an opportunity to modify the source code if they feel so compelled. Furthermore, the FCC staff recently released an alternative version of the FCC model which uses the Delphi programming language, rather than Pascal. This provides another option for users who are interested in examining, or modifying, this portion of the model. In general, the FCC model is adequately open to inspection and modification, and it has been thoroughly reviewed, tested, and critiqued by numerous interested parties.

Q. Will you please elaborate on your statement that the FCC model is open to review and modification?

A. "Black box" is a term that is often used to describe cost models which incorporate assumptions that are not readily accessible, rely upon algorithms which cannot be seen or critiqued, or rely upon computational processes which are not fully integrated with each other, so that other parties have difficulty learning, operating, or modifying the model. Unless a model is fully "open" to inspection, regulators and other parties cannot thoroughly study the inner workings of the model, and it will be difficult or impossible to fully audit studies that are produced by the model. Unless the various computer programs or "models" are directly linked or integrated, it is considerably more difficult and time consuming to create altemative versions of the cost studies, to test the impact of different assumptions, or to test the validity of the algorithms within the models. Hence, a model which is open to review and modification is preferable to one that is not. While none of the models available for use in this proceeding are perfectly open and easy to understand, the FCC model is sufficiently open to inspection. Further, many of the parties are already quite familiar with its inner workings.

STAFF USE OF OTHER COST MODELS

Q. Did you rely entirely on the FCC model in developing the Staff cost studies in this proceeding?

A. No. We initially planned to use the FCC model (with some enhancements) to estimate switching and transport costs, as well as loop costs. As our work progressed, we learned that the three largest ILECs in the state had strong objections to our planned approach. Sprint expressed its concerns in a letter dated September 17, 2001, Verizon expressed its concerns in a letter dated September 24, 2001 and SWBT expressed its concerns in a letter dated September 25, 2001. These letters vehemently opposed using the FCC model. Most of the complaints were focused on alleged flaws in the FCC model, and its alleged inability to accurately model carrier-specific costs (e.g., reflecting the actual types of switches that are currently included in their network, and the current configuration of the carrier's actual transport networks).

After carefully evaluating these complaints, we reconsidered our initial plan to rely entirely upon the FCC model. We subsequently decided to reduce our reliance on the FCC model. We used the FCC model to develop loop costs, and used portions of the cost models and data provided by the

ILECs in conjunction with a portion of the FCC model to develop our switching and transport cost estimates.

More specifically, we relied upon switching investments developed by Sprint and Verizon using Telcordia's Switching Cost Information System (SCIS). The SCIS output for Sprint was dated September 1, 2001. The SCIS output for Verizon and Century Tel switches was dated May 17, 2001. It was provided by Verizon in response to an informal discovery request from BJA. We developed analogous investment amounts for SWBT based upon contract information and calculations provided by that firm.

We used a similar approach in developing our transport cost studies. SWBT's transport investments were developed using SWBT's SPICE model (SBC Program for Interoffice and Circuit Equipment Costing, version 1.0, provided by SWBT on December 26, 2001, incorporating a "patch" to fix certain problems, which was provided by SWBT on January 22, 2002.) Sprint's transport investments were developed using the Transport Cost Module (TCM) of the Sprint Service Cost Model dated September 1, 2001. Verizon and Century Tel's transport costs were developed using investment outputs from the Interoffice Transport Module of Verizon's Integrated Cost Model (ICM), Release 4.4, dated October 2001.

The switching and transport investments were converted into annual costs using the portion of the FCC model which converts investments into annual costs. Cost modeling algorithms developed by our firm were used to convert the resulting annual costs into per-minute costs.

INPUTS

Q. You've mentioned model inputs several times. How important are inputs to the modeling process?

A. Without question, input choices are a critical step in any modeling process and can profoundly affect the costs that are developed. The inputs used in the modeling process influence the models' outputs, and some recent studies have indicated that differences in input values are sometimes the dominant reason for differences in outputs. For example, in a comparison of the Hatfield model (sponsored by AT&T) and BCPM model (sponsored by several ILECs), Christensen Associates found that relatively few input items accounted for the majority of the difference in model outputs. [*Economic Evaluation of Proxy Cost Models for Determining Universal Service Support*, January 9, 1997]. Christensen concluded that ..."the surest path to a model that will be satisfactory to the Joint Board and the FCC is through a process that will focus on establishing a few key specifications that drive the proxy cost model results." [Id., p. 4]

Similar conclusions were reached in a Utah study that examined results from three models using similar input assumptions: Hatfield 2.2, the Cost Proxy Model (developed by Pacific Bell), and BCM2. Hatfield 2.2 was a predecessor of HAI, and the other two models were predecessors of BCPM:

> In sum, the three models yield estimates of the average monthly cost of an unbundled Utah loop that all fall within a very narrow range ($3). Hence, it appears that the models may be reconstructing the local network in a cost-comparable manner even though they employ different methodologies. Furthermore, it may suggest that what distinguishes one model from the others, in practice, are the values of the user-defined assumptions employed rather than inherent differences in the hardwired network architecture.

[Kevin T. Duffy-Deno, et al., *A Comparative Analysis of Loop Cost Proxy Models*, Preliminary Draft #2, Utah Division of Public Utilities, October 18, 1996, p. 5]. The Utah study also developed elasticities for changes in placement costs and fill factors. It found significant changes in loop costs when assumptions for placement costs were changed for BCM2 and CPM. It also found significant changes in costs when fill factors were changed for CPM and Hatfield. [Id., Table 2, p. 4].

While these studies confirm the importance of inputs, the algorithms within the models are also important. Even if the inputs are synchronized to achieve relatively similar statewide average results, different models still tend to produce different estimates.

Q. Are some inputs and algorithms more important than others?

A. Yes. There is an informal consensus among model builders that certain aspects of the modeling process are the major "cost drivers". Right at the top of any list of factors explaining why certain areas have unusually high loop costs will be customer location or dispersion, and customer demand (line counts). If a small number of customers are widely dispersed over large areas, loop lengths will be long and line counts will be low, relative to the size of the area served, and thus costs will tend to be relatively high.

Customer demand is an important cost driver, since customer density determines the extent to which economies of scale can be exploited; in remote areas with very few customers, the fixed costs of the network are spread over relatively few lines, driving up the cost per line. Therefore it is preferable for cost studies to use line counts which closely approximate, or match, the actual number of lines in each area. A comparison of actual versus modeled lines can provide an indication of modeling accuracy. An exact match can be achieved if the model is adjusted, or "confomed," to match the actual number of lines in each wire center. Even when this adjustment is performed, a comparison of the model's line counts *before* they have been conformed to the actual line count data can provide a useful indication of modeling error.

The interaction of customer location and demand level largely determines cost per loop, the single most important network cost element. Most high-cost areas are ones with a handful of customers sprinkled far from the wire center. It is obviously much more costly to serve 50 customers spread over miles of roads within a 50 square mile area than it is to serve 50 customers concentrated in a single city block. Hence, the "geographic" inputs, which determine the number of lines, the location of customers, and the amount of cable used to serve those customers, tend to be the most important inputs in the present context–where the key problem is to accurately identify the high cost areas in the state, and to determine how much more costly it is to serve these areas than to serve other parts of the state.

Q. Are other types of inputs also important?

A. Yes. In addition to the "geographic" inputs discussed above, certain other inputs tend to have a significant impact on the cost calculations. Some of the more important ones include:

Asset lives and depreciation rates
Choice of technology (e.g. copper/fiber deployment)
Conduit costs
Cost of capital
Drop lengths
Fiber electronics costs
Fill factors (utilization rates)
Inflation factors and productivity adjustments
Installed cable costs per foot.

Maintenance and other expense factors
NID costs
Other aspects of the development of annual cost factors
Structure sharing
Switch purchase prices and associated vendor discounts

Q. Should the Commission substitute its own judgment for that of the FCC with respect to appropriate values for every input to the FCC model?

A. It is certainly free to do so. However, this isn't necessary. As I indicated, an important advantage of the FCC default inputs is that they are relatively unbiased, and they were developed through a very extensive review and comment process. Besides, there are more than 1400 inputs and it would not be time well spent to thoroughly analyze and debate all of the inputs driving the FCC model. In a Kansas proceeding, we helped organize a collaborative process through which the opposing parties stipulated to all but a handful of the most important inputs, leaving relatively few decisions for the Kansas Corporation Commission to make. In those negotiations, the parties changed only a few inputs, agreeing to use the FCC default values for the great majority of the inputs. For example, stipulated inputs which were modified in Kansas included state-specific tax rates, the cost of capital, and the percentage mix of aerial, buried and underground support structures (i.e., plant mix). The plant mix assumptions included in the FCC model's default inputs reflect national averages, and are not necessarily representative of conditions in states like Kansas or Missouri, which rely more heavily on buried cable.

The willingness of the parties in Kansas to accept many of the default inputs wasn't surprising, since the FCC default inputs have been extensively scrutinized at the federal level, and the FCC attempted to strike a reasonable balance between conflicting claims. Thus, while the parties may have believed the FCC didn't go far enough in adopting their positions concerning various inputs, they realized that for every argument they might raise, other parties–who took conflicting positions on these issues before the FCC–could raise analogous arguments going in the opposite direction. The parties know that, even if they made a convincing argument to change a few of the default inputs, parties with opposing positions might make an equally persuasive argument to change other inputs, which would have an offsetting impact on the final cost estimates. Thus, a lengthy debate about hundreds of different inputs isn't necessarily a very constructive use of limited resources in a proceeding where time could be better spent on other issues. I believe the same principles apply to this proceeding. To the extent the parties want to debate specific inputs, it makes sense to focus that debate on a few of the most important, and most contentious, inputs.

Q. Could you please briefly elaborate on the approach you used in selecting inputs to the FCC model?

A. Yes. As I indicated, Staff believes it is most constructive for the Commission to focus attention on a few key inputs, rather than debating the best setting for hundreds of different inputs. To the extent the number of inputs discussed in this proceeding is somewhat limited, it will allow the parties to focus their resources on the most important topics. With a more focused debate, the parties will be able to provide the Commission with better, more detailed evidence concerning the key issues, and the Commission will be able to devote greater attention to the specific issues which are of greatest concern to the parties.

During discussions with the parties to a cost related proceeding in Kansas, the benefits of this more focused approach became apparent. In that proceeding, it was clear that the parties held widely differing views concerning numerous different inputs. It also became apparent that in many cases the FCC default values fell somewhere in the middle of the range of values preferred by the various parties. This wasn't surprising, since Sprint, SWBT and AT&T were all participants in the proceeding in which the FCC developed the default values, and none of these parties was completely satisfied with the outcome of the FCC's deliberations. However, in adopting the default values, the FCC attempted to balance the competing claims of these and other parties.

While the parties in Kansas didn't reach complete agreement on the appropriate inputs to use in the FCC model, they did agree that it was in everyone's interest to limit the number of input issues being litigated, and they tried to co-ordinate the filings of the different parties, in an attempt to avoid unnecessary confusion. As a result, the parties worked with a "baseline" set of inputs which largely relied upon the FCC's default inputs, with certain modifications to which all parties agreed, at least in general terms. Of course, the parties remained free to run other model scenarios in which they modified selected inputs, and the Kansas Corporation Commission ultimately resolved the remaining disputes.

Consistent with this philosophy, in developing the Staff cost studies in this proceeding, we largely accepted the default inputs adopted by the FCC. We modified inputs in just a few key subject areas while developing the Staff cost studies for this proceeding. These subject areas are as follows: customer location data, customer line counts, the wire center data base including host/remote relationships, plant mix, sharing of trenching costs with other entities, sharing of structure costs between feeder and distribution cable, cost of capital, state and local taxes, and the depreciation rates applicable to copper cable and switching facilities.

COMMON COSTS

Q. The primary thrust of your cost modeling efforts focused on costs related to the network facilities which are used in providing switched access service. Are there other costs incurred by carriers in providing intrastate switched access service?

A. Yes. In addition to costs which vary directly with network investments, carriers also incur corporate overheads and other miscellaneous costs. These remaining, miscellaneous costs can fairly be described as "common costs." Common costs arise because carriers produce multiple outputs using many of the same resources and production processes. Some of these costs are common to the entire output of the firm, while others are common to various subsets of these outputs (e.g. retail services). Typical examples of costs that tend to be common to the entire firm include salaries and other costs of the firm's upper level executives, legal expenses, and audit expenses.

Common costs are not directly attributable to a single service, yet they vary to some degree with the number of services offered, and the quantity of each service which is produced. As a general matter, adding additional services (or increasing production of one of its existing services) will tend to increase the level of common costs; however, the increase will not necessarily be directly proportional to the number of services or the volume of output. Because of what economists refer to as economies of scale and scope, the costs of producing multiple services within a single firm may be less than the sum of the analogous costs that would be incurred if each of the services were produced separately.

Q. Did you model common costs in great detail?

A. No, this wasn't feasible. One of the problems is that common costs vary as a function of many different variables. For example, the number of executives employed by the firm, and the salaries and bonuses paid to those executives varies widely, depending upon the overall scale and scope of the firm's operations. However, it would be exceedingly difficult, if not impossible, to determine the extent to which these and other common costs vary as a function of the firm's investment level, as a function of its traffic volumes, as a function of the diversity and scope of its service offerings, as a function of its revenues, as a function of the geographic scope of its service territory, as a function of the number of customers served, and so forth. All of these factors undoubtedly influence the level of common costs incurred by the firm, but it is difficult, if not impossible, to determine the relatively importance of each contributing factor. It simply wasn't feasible to disentangle all of these different cause and effect relationships in order to precisely estimate the level of common costs which should appropriately be included in each type of cost study.

It is conceptually clear what level of common costs should be included in a TSLRIC study for intrastate switched access service–that amount by which the firm's common costs would be increased or decreased as a result of adding this service to, or deleting this service from, the set of other services offered by the firm. These incremental common costs are not zero, but it isn't feasible to precisely quantify them. During the course of my career, I have reviewed numerous incremental cost studies prepared by parties to regulatory proceedings. To the best of my recollection, none of these studies attempted to precisely measure the extent to which the firm's common overheads would incrementally increase due to offering, or not offering, the service being studied. Due to the inherent complexities of this issue, if common costs were included in the study, they were incorporated on a simplified basis–for instance, they might be estimated as a percentage of other costs developed within the study.

Similarly, if intrastate switched access service were a carrier's only offering, it is obvious that the firm would have fewer executives, and some of the remaining executives would be paid lower salaries. What is not obvious is the precise degree to which these and other common costs would be reduced if this were the only service offered. Yet, this is the relevant amount of common costs which should be included in a Stand Alone cost study for this service.

Given these complications, and the inability to achieve great precision in this area, my initial inclination was to simply exclude common costs from the Staff cost studies. This was the approach we used in the "draft" cost studies which were distributed to the parties for review and comment on April 1, 2002. The accompanying documentation pointed out that corporate overheads and other common costs were not included, and noted that the need to recover common costs should be considered when making comparisons with existing rates, and when using the cost results to develop recommended rates. Based upon feedback we received from the ILECs, however, I concluded that this approach was confusing, and that it would be preferable to include an estimate of common costs in the various cost studies, notwithstanding the fact that any such estimate would necessarily be less precise than the remaining portions of the studies.

Q. Would you please explain the approach you used to estimate common costs?

A. Yes. I began with a review of 20 Automated Reporting Management Information

System (ARMIS) accounts reported by SWBT and Verizon for their Missouri operations. These are the only carriers who file ARMIS data for Missouri. I focused on 14 specific ARMIS expense accounts which contain what I would describe as common costs:

5300 - Uncollectible Revenue
6611 - Product Management
6612 - Sales
6613 - Product Advertising
6711 - Executive
6712 - Planning
6721 - Accounting and Finance
6722 - External Relations
6723 - Human Resources
6724 - Information Management
6725 - Legal
6726 - Procurement
6727 - Research and Development
6728 - Other General and Administrative

In addition, I reviewed six ARMIS investment accounts. The depreciation and other costs associated with these accounts can also be classified as common costs:

6112 - Motor Vehicles
6114 - Tools and other work equipment
6121 - Land and Building
6122 - Furniture and Artwork
6123 - Office Equipment
6124 - General Purpose Computers

In reviewing this ARMIS data, I recognized that downward adjustments are necessary to reflect the differences between retail and wholesale offerings, and to reflect the differences between embedded and forward looking long run costs. The embedded cost data includes costs which would not be incurred on a forward-looking basis by an efficient carrier operating in a long run planning horizon. Moreover, some of these accounts include costs which are not required for, nor beneficial to, switched access service and other offerings which are provided on a wholesale basis to other common carriers. The latter distinction is particularly important to the development of an appropriate common cost factor for switched access service, because many common costs are largely, if not entirely, driven by a carrier's retail service offerings. This is consistent with the FCC's conclusion that no more than

> ten percent of costs in accounts 6611, 6612, 6613, and 6623 are not avoided by selling services at wholesale. [FCC First Report and Order, CC Docket No. 96-98, ¶928]

Based on this reasoning, it is reasonable to conclude that 90% of the costs in these accounts are exclusively related to retail service offerings. The remaining 10% are related to both retail and wholesale operations. Stated differently, it is reasonable to conclude that no more than 10% of the marketing and customer service costs incurred by LECs are attributable to both their retail and wholesale offerings. Similar, but less substantial, complications arise with regard to many of these accounts–the intensity of effort required to provide service to retail customers tends to be higher than the analogous efforts required in provide service to other carriers on a wholesale basis.

After reviewing the ARMIS data, I concluded that the common costs relevant to switched access service are nearly 25% of the total revenues currently generated by Verizon and SWBT in Missouri. Stated differently, nearly 25% of the revenues received by these carriers are attributable to recovery of embedded common costs which are relevant to intrastate switched access service.

Taking this information into account, and taking into account the differences between embedded and forward looking cost levels, I added an allowance for common costs equal to 5% of the current switched access revenues plus 20% of the estimated costs (prior to adding common costs). Under this approach, a small portion of the common costs were included on a uniform basis in each of the stand alone, average/allocated and TSLRIC cost studies, while the major portion was estimated on the basis of total costs, thereby allowing the overall level of common costs to vary widely, depending upon the type of cost being studied. While great precision isn't feasible in this regard, I believe the technique and percentages I have used realistically reflect the overall level of common costs, as well as the degree to which these costs differ when viewed on a stand alone, average, and incremental basis.

The approach I have used ensures that the level of common costs included in the stand alone studies substantially exceeds the level included in the average/allocated cost studies, and it also ensures that a very small, but non-zero estimate of common costs is included in the TSLRIC studies. This follows logically from the fact that a firm's common costs will increase slightly when an additional tariff element or service is added to the overall mix of offerings, but the incremental impact will be quite small. By including an allowance for common costs based upon 5% of current revenues, I have taken this phenomena into account, and have provided an allowance for uncollectibles, billing and collection, tariff development and maintenance, and other common costs which tend to vary with revenues.

End Office and Tandem Switching Costs

MODELING APPROACH

Q. You initially considered relying entirely on the FCC model to estimate switching costs. Can you briefly describe this aspect of the FCC model?

A. Yes. End office switching investments are developed from a user-adjustable table of investments. The default inputs used in this table reflect a fixed cost (in 1999 dollars) for a remote switch of $161,800 and a fixed cost (in 1999 dollars) for both host and stand-alone switches of $486,700. In addition to these fixed amounts, additional investments are estimated to occur at the rate of $87 per line (in 1999 dollars) for remote, host, and stand-alone switches [FCC 99-304, ¶296]. The cost of an entire switching system (consisting of a host and its associated remotes), is allocated evenly over all lines served by the host/remote configuration. So, once the model computes investments for each switch in a host/remote cluster, it calculates the average investment per line for all of the lines in the cluster.

Another option offered by the FCC model blends or averages an overall efficient mixture of host, remote, and stand-alone switches, using the following cost per line formula for large LECs: (y = -14.922*ln(lines) + 242.73). The formula for small LECs is (y = -14.922*ln(lines) + 416.11) [HCPM documentation file 3_HM50a_ModDes_AppB.doc ¶ B82-83].

Q. You ultimately decided not to rely upon this portion of the FCC model. Can you briefly explain some of the weaknesses which contributed to this decision?

A. Yes. Although the FCC model includes a fixed and variable component to switching costs, it does not distinguish between the portion of the variable investment which varies with traffic and the portion which varies with the number of lines. Because traffic volumes tend to vary with lines, it isn't a simple matter to fix this problem. The ability to distinguish between different variable costs is one of the advantages of the SCIS model. This distinction is particularly important when developing stand alone and TSLRIC studies, as we have done in this proceeding.

Another weakness in the FCC model is that the data used by the FCC in developing its default inputs was limited to new switch purchases. I think it is more appropriate to look at the discounts received from the manufacturer on both new and growth purchases. The blend of discounts received over the life cycle of the switch ought to be considered, as I discuss later in my testimony.

Another potential problem is that the FCC model doesn't adequately distinguish between large scale switches like Nortel's DMS 100 and Lucent's 5ESS and smaller scale switches like those offered by Mitel and Redcom. The smaller switches, which have substantially lower fixed costs, are more cost effective in some rural applications. As a result, the FCC model tends to overestimate the cost of stand alone switches for remote rural areas, at least when using the default inputs.

Q. You mentioned that you relied on the SCIS model to develop switching investments for Sprint and Verizon. Can you elaborate on this model and how you used it in developing switching costs for this proceeding?

A. Yes. The SCIS model was developed by Telcordia Technologies. Telcordia, a successor to Bellcore, was created during the divestiture of the Bell System in 1984 to serve the Bell operating companies by providing a center for technological expertise and innovation. The SCIS model is a complex model which is capable of providing many different kinds of switching related outputs. It has been widely used throughout the industry for many years. Both Sprint and Verizon rely on SCIS investment outputs in developing their estimates of switching costs for various regulatory purposes. SWBT previously relied upon SCIS for cost studies submitted in regulatory proceedings, but it no longer does so.

Q. Can you describe the SCIS methodology for developing switching investments, starting with the key inputs?

A. End office switching investments are developed by SCIS using a large number of inputs, including:

a. Type of office (host, standalone, remote, tandem)
b. Number of lines (including integrated DLC lines)
c. Line traffic characteristics (for example, CCS per line and the line concentration ratio)
d. Processor utilization
e. Number of trunks (local and tandem)
f. Trunk traffic characteristics (for example, calls and CCS per trunk)
g. Traffic characteristics for switched features
h. Switch vendor discounts
i. Average fill

Q. Can you briefly describe the process within SCIS which develops specific investments for individual end offices?

A. Yes. SCIS takes the manufacturer list price of the various components of a switch, adjusts them for volume and other discounts available to the carrier, and calculates the total investment necessary to configure the switch. The details of these calculations are hidden from the user, which is why this model has long been characterized as a “black box.” The model also has a reputation for not being very user friendly, and its extensive documentation can be confusing and difficult to absorb.

The investments output by SCIS can be organized into the following six categories or elements [Switching Cost Study Methods, Sprint Missouri, Inc., September 1, 2001, page 12]:

a. Processor - the investment associated with the set-up of calls.
b. Fixed Line - the investment required to terminate the local loop in the central office. It is composed primarily of a line card, the main distribution frame (MDF) and protector.
c. Line Usage - the investment associated with usage sensitive line-side switching.
d. Trunk Usage - the investment associated with usage sensitive trunk-side switching.
e. Umbilical Usage - the usage sensitive investment necessary to operate the host-remote links.
f. SS7 Link - the investment associated with the SSP (Service Signaling Point) located in the central office.

Q. Can the SCIS outputs be analyzed in a manner which facilitates development of stand alone, average and TSLRIC studies?

A. Yes. SCIS provides switching investment outputs for the following categories:

a. Getting started (hereafter referred to as "start up costs")
b. Line Termination (Port)
c. Reserve CCS
d. Line CCS
e. Trunk CCS (applicable to host or stand alone switches only)
f. Tandem trunk CCS
g. Umbilical CCS (applicable to remote switches only)

The first category contains fixed costs which are not traffic sensitive, and which do not vary with the number of lines terminated on the switch. The CCS categories all vary with traffic volumes and the Line Termination category varies with the number of lines terminated on the switch. These distinctions are useful in developing different types of forward looking cost studies.

Q. You mentioned earlier that Sprint and Verizon use the SCIS as part of their switch cost modeling process. Can you briefly explain the approach used by Sprint?

A. Yes. In the discovery phase of this proceeding and through informal discussions with the parties, we asked the major LECs in the state to identify and provide copies of switching models they anticipated using in this docket. Sprint provided its Switching Cost Module, which is part of the Sprint Service Cost Model. The Sprint Switching Cost Module (hereafter referred to as SCM) contains SCIS output, along with switch software investment, demand data from traffic studies, and an estimate of the processor milliseconds required to process calls. The Sprint SCM also includes annual cost factors which are applied to the various investments and algorithms which are used to develop switching costs per minute.

Q. Can you briefly explain the approach used by Verizon?

A. Yes. Verizon provided a copy of its Integrated Cost Model (ICM) which contains a switch module. The copy of ICM which we were provided is also capable of generating cost results for switches which are now part of Century Tel. In July 2000, Century Tel purchased 107 wire centers from GTE (now known as Verizon). Century Tel is currently in the process of acquiring the remaining 98 Verizon exchanges in Missouri. Like the approach used by Sprint, Verizon relies upon SCIS outputs in its modeling process. The ICM also uses switch investment output from COSTMOD (a proprietary switching model developed by GTE) to provide analogous investments for GTD-5 switches. Within ICM, call setup and MOU investments are converted to rate period-specific investments. Loading factors such as EF&I (Engineered, Furnished and Installed), power, and test investments are applied to the SCIS/COSTMOD outputs to determine loaded unit investments. Land and building expenses associated with switch investments are captured in the Expense Module. Algorithms within ICM convert these investments into annual costs and costs per minute.

Q. You mentioned that SWBT no longer uses SCIS. Can you briefly describe the approach currently used by SWBT in developing switching cost estimates for regulatory purposes?

A. Yes. SWBT provided us with copies of its Switching Information Cost Analysis Tool (SICAT) and Network Usage Cost Analysis Tool (NUCAT). SICAT is a Microsoft Excel® spreadsheet based model which enables the user to supply various switching contract data called "bills of costs" in which switching investments are calculated, resulting in an output report containing switch investments per line, trunk, etc. NUCAT is a Microsoft Excel® spreadsheet based model which combines SICAT provided investments with user supplied network and expense data to calculate annual and per-minute costs. The categories of investment data include end office switching, interoffice facility and signaling. Network data consists of the total number of access lines and total minutes of use. The output of NUCAT include switching and transport costs stated on a per minute or per message basis.

Q. How did you develop the switch investments for SWBT?

A. We developed switching investments for SWBT using vendor contract information and other data provided by SWBT in its SICAT model. The resulting investments reflect the characteristics of each wire center, and the way SWBT's contracts with the various switch manufacturers are structured. There is at least one difference between the approach we used and the one used in SICAT. SICAT relies upon SWBT's embedded mix of vendors and switch types. We implemented a simplified cost minimization technique, which calculates the cost of various switches and uses the investment associated with the least costly option.

Q. Why didn't you develop costs per minute relying entirely on the models provided by the major ILECs?

A. We considered this approach, but ultimately rejected it. There were several problems with this option. First, we were interested in developing cost results for all of the ILECs in the state, not just for the three largest carriers. In addition to Sprint, SWBT and Verizon, we prepared cost estimates for Alltel and 37 other small rural ILECs. None of the models offered by the three largest ILECs were capable of directly generating cost estimates for these smaller carriers, nor were the outputs capable of being easily extrapolated to fit other carriers.

Secondly the methodologies used by SWBT, Sprint and Verizon were not consistent. The value of any comparisons which might be made between the results of the three models would be greatly reduced or eliminated by the fact that there were so many differences in the way these carriers calculated their costs per minute. Stated differently, even if we succeeded in "synchronizing" the inputs and models to develop reasonably consistent investment amounts, significant discrepancies would remain in the way these investments are translated into costs per minute and thus it would be difficult to draw meaningful comparison (or to extrapolate results to the other carriers).

In a generic proceeding of this type, it is important to maintain a reasonably high degree of consistency across the various cost studies. We concluded that it was imperative to maintain a consistent approach in converting investments into annual, monthly and per-minute costs. Otherwise, one carrier may appear to have lower costs than another for no reason other than differences in the approach used in developing the annual cost factors, or the process used in converting per-year amounts into per-minute amounts.

Thirdly, none of the models submitted by the LECs were capable of providing all of the specific types of cost studies we felt would be useful in this proceeding, as I described in the preceding section (e.g., stand alone and pure TSLRIC). We felt it was very important to provide the Commission with a full spectrum of different cost estimates, and none of the ILEC models were capable of generating multiple types of studies.

Q. How did you develop switching cost studies for the other 38 ILECs in the state?

A. We developed a statistical analysis of the investments we developed for the Sprint, Verizon, and Century Tel switches. The investments for the various switching complexes (stand alone switches and host/remote groups) were analyzed as dependent variables. The number of switched access lines within each complex were used as the independent variables. The resulting multiple regression coefficients were then used in conjunction with data for the number of switched access lines served by other ILECs in Missouri, as well as the number of switching complexes operated by those ILECs, in order to estimate switching costs for smaller ILECs in the state. Separate regressions were developed for the line termination, traffic sensitive, and getting started investment categories.

Q. What about switching cost studies for CLECs?

A. We used the same approach for two facilities-based CLECs as we used for the rural ILECs. We also developed two studies which reflect the costs incurred by CLECs which rely on the rental of unbundled elements from SWBT to provide service in Missouri. These studies are discussed in more detail later in my testimony.

SWITCH DISCOUNTS

Q. You mentioned vendor discounts. Can you please explain switching vendor discounts and why this can be a controversial issue?

A. Yes. Vendor discounts are an important consideration in developing switching cost estimates. It might seem that the discounts applicable to manufacturer list prices would not be controversial. It has been my experience in other proceedings, however, that the discounts used in cost models can be the subject of considerable disagreement. There are two reasons why this can be controversial. First, the discounts can be very substantial, and thus even slight discrepancies in the precise discount applicable to a particular piece of equipment, or a particular vendor, can have a substantial impact on the final cost results. Second, the discounts that are applicable to purchases of line cards and other components used in accommodating growth on an existing switch can be different than the discounts that apply to purchases of a new switch. Typically, a deeper discount is available from switch manufacturers when a new switch is being purchased. In some cases, LECs give this deeper discount little or no weight, thereby creating the impression that switching is much more costly than is actually the case.

Q. Can you elaborate on the discount controversy?

A. In other regulatory proceedings, the discounts input into the SCIS models have sometimes been one of the more controversial issues. For instance, the incumbent LEC may file studies that only reflect some of the smallest discounts it receives from the switch manufacturers, completely excluding, or greatly downplaying, the much deeper discounts it receives under other circumstances.

The following excerpts from regulatory decisions provide a sense of the potential for controversy in this regard:

> As argued by AT&T, there is a problem with the switching equipment discounts used in SWBT's cost studies; however, AT&T's proposed solution -- to treat all switching equipment as new, in order to reflect higher discounts -- is unrealistic and extreme. SWBT should use the new and replacement switch discounts recommended by Staff, which appropriately reflect forward-looking information and the long-run concept. Staff's recommendation reflects a reasonable weighting between new switches (which have greater discounts) and add-on switching equipment (which has a lower discount). [Kansas Inputs Order, Docket No. 97-SCCC-149-GIT, p. 65]

> After significant modifications to the cost inputs to the SCIS, the Stipulation results in a proposed total recurring cost of $325 per line (for switch investment) for all local switching network element features that are currently available in the switch generics. This result is significantly lower than the $684 Bell Atlantic originally filed, and is reasonable, according to Bell Atlantic. The cost components were reduced from Bell Atlantic's original filing by applying the discounts available for new and growth switches respectively, assuming a weighting of 80% to 20% new to growth switches. [Bell Atlantic-New Hampshire SGAT Approval Order, Docket No. DE 97 ¶171, p. 77]

> Verizon-NJ overstates its switching costs by using vendor discounts that are inconsistent with TELRIC methodology. Even though TELRIC requires modeling of a reconstructed network, Verizon-NJ uses the vendor discounts for additions to switches in its embedded network, and ignores the far greater discounts available when purchasing new or replacement switches. Verizon-NJ's approach has been rejected by the FCC and the courts. Universal Service Order ¶ 317 [See, http://www.rpa.state.nj.us/une/EXECSUM.PDF]

> At oral argument, FCC counsel explained that growth additions to existing switches cost more than new switches only because vendors offer substantial new switch discounts in order to make telephone companies dependent on the vendors' technology to update the switches. [AT&T v. FCC, Appeal No. 99-1538 (D.C. Cir., 2000)]

Q. Can you elaborate on the reasons why vendor discounts can vary so widely?

A. The problem is not simply that switch manufacturers set list prices which greatly exceed the actual prices paid by most carriers, nor is it simply that they offer different discounts to different customers. Compounding the problem is the fact that the manufacturers insist upon keeping secret the negotiated discounts (presumably to prevent carriers from comparing prices and perhaps discovering that they are overpaying). Furthermore, varying discounts may be offered by the same manufacturer for different pieces of equipment, different bundles of equipment, or orders of a different type. Most notably, the manufacturers have historically provided smaller discounts for the purchase of line cards and other components used in accommodating growth on an existing switch, while offering deeper discounts when new switches are purchased.

The wide range of discounts available to carriers on new equipment and upgrades can cause considerable confusion, making it difficult to confirm whether the appropriate prices have been inputted into the SCIS models. In the state proceedings quoted above and others like them, the incumbent LECs proposed cost studies which reflected smaller discounts than they typically received. They rationalized this discrepancy by focusing on the smaller discounts they received in limited circumstances (e.g., for switch upgrade) while ignoring the deeper discounts they obtained on other purchases.

When the FCC dealt with this controversy in its Tenth Report and Order in Docket No. 96-45, it took the opposite approach, relying exclusively on the deepest discounts. The FCC concluded that this was consistent with its focus on cost-effective forward-looking costs:

> We adopt the fixed cost (in 1999 dollars) of a remote switch as $161,800 and the fixed cost (in 1999 dollars) of both host and stand-alone switches as $486,700. We adopt the additional cost per line (in 1999 dollars) for remote, host, and stand-alone switches as $87. [¶ 296]

> The model platform we adopted is intended to use the most cost-effective, forward-looking technology available at a particular period in time. The installation costs of switches estimated above reflect the most cost-effective forward-looking technology for meeting industry performance requirements. Switches, augmented by upgrades, may provide carriers the ability to provide supported services, but do so at greater costs. Therefore, such augmented switches do not constitute cost-effective forward-looking technology. [¶ 317]

Q. In your opinion, should the switching investment in a forward looking study be based exclusively on the deep discounts available on new switches?

A. No. Needless to say, to be consistent with the basic tenets of a long run planning horizon, the study should include the cost of a new switch which is optimally matched to the current volume of output. However, in order to reflect the actual cost of switching over the entire life cycle of the switch, consideration should also be given to the higher prices (lower discounts) which apply to subsequent purchases.

Among other reasons, a blend of discounts or prices is appropriate in order to maintain consistency with the relatively high utilization rate or fill factor which should be used in a long run switching cost study. It possible to maintain a relatively high "fill" rate by acquiring additional components (at the growth discount), as growth occurs. It is appropriate to use a relatively high switching "fill" rate in a long run study, but this assumes the carrier depends on the switch manufacturer to provide additional components as needed, in order to accommodate fluctuations in demand as well as growth. The manufacturer has higher transaction costs, and achieves a higher profit margin, on these smaller subsequent sales, as reflected in the higher prices and lower discounts applicable to those subsequent transactions. In evaluating the long run cost of switching (reflecting a market equilibrium), it is necessary to give at least some consideration to the higher prices associated with these smaller subsequent transactions, which are an expected part of the overall profitability of any particular sale by the switch manufacturer.

Q. What is your recommendation concerning the discounts that should be used in running the SCIS models?

A. I recommend using a mixture of discounts, giving some weight to situations where small discounts are received and much greater weight to situations where deeper discounts are received. The new and growth discounts should be weighted consistent with a life cycle approach. More specifically, I recommend that 80-85% weight be given to the new switch discount, and 15-20 % weight be given to the replacement discount. The exact blend could vary somewhat, depending on the growth rate anticipated by the carrier.

Q. How have you implemented your recommendation in your switching studies?

A. I accepted Sprint's SCIS outputs without further adjustment, because the investments they developed were reasonably consistent with the approach I am recommending. Verizon's SCIS outputs did not reflect a blended discount, although they indicated that a blended approach was appropriate:

> To ensure that switch investments are forward-looking, switch list prices are discounted to reflect Verizon vendor contracts and quotes. Vendors' quotes typically include separate prices for new switch placements and for additions to existing switches. The ICM switch investment outputs for usage and line and trunk terminations reflect a meld of the two discounts. [ICM release 4.4, Model Methodology, Switch Module, p. 10]

Upon further investigation, we determined that Verizon input the discounts for new switch purchases into SCIS and COSTMOD, and these models' outputs (usage and line- and trunk terminations) were subsequently adjusted within ICM using an Investment Adjustment Factor to reflect a meld of new and growth pricing. The Investment Adjustment Factor was not applied to feature related switching investments. [ICM release 4.4, Model Methodology, Switch Module, p. 10] For our studies, we started with SCIS investments developed by Verizon based upon the new purchase discount, and we made an upward adjustment to reflect the effect of using a blended approach, giving 20% weight to the growth discount.

OTHER SWITCHING ISSUES

Q. Can you please explain the process you used to convert investments into monthly recurring costs in your switching studies ?

A. I used the FCC model to develop annual cost factors, which were then applied to investments. We calculated monthly recurring costs by dividing the result by 12. The annual cost factors include capital costs such as depreciation, cost of money, income taxes and plant-specific operating expenses such as equipment maintenance.

Q. What inputs did you use in developing the annual cost factors?

A. I largely relied upon the FCC default inputs. However, I reduced the depreciable life applicable to switching investments. I also developed my own inputs for cost of capital and for state and local taxes in an effort to more closely match the actual level of taxation which is present in Missouri.

Q. Would you please discuss the appropriate life to use for central office switching equipment?

A. Yes. The FCC uses a 16.1 year life for switching facilities in its model, while the models provided by the ILECs used substantially shorter lives. For instance, Sprint assumed 11 years and Verizon assumed 10 years. The figures assumed by the ILECs are far shorter than the actual experience of the industry, as well as the projected lives established by the FCC in recent years. For digital switching plant accounts the FCC has prescribed a generic range of 16 to 18 years. This reflects the fact that there has been a downward trend in the life of this type of equipment, which has historically lasted for 20 or more years.

It is reasonable to assume that switching equipment installed currently will not remain in service as long as equipment installed in the past, due to the rapid pace of technological change and the continuing decline in the cost of electronic components. While I believe the FCC's prescribed range of 16 to 18 years is longer than would be appropriate in this proceeding, my own judgment falls slightly above the figures assumed by the ILECs. More specifically, I would recommend using a life of 12 years for this category. At 12 years, I am recognizing the possibility that the current generation of digital switches may be replaced by new technology (e.g., broadband switches) within a decade or so, while also recognizing that with continuing software upgrades, the existing switches will be able to meet the needs of most customers for 15 or more years.

Q. Can you elaborate on your recommended cost of capital inputs?

A. For Alltel, Century Tel, Sprint, SWBT, and Verizon, I used a weighted cost of capital of 10%. More specifically, I used a 7.5% cost of debt weighted by a factor of 45% and a 12% cost of equity weighted 55%. This compares to the FCC's default inputs of 8.8% for debt and 13.2% for equity with 44.2% and 55.8% weighting, respectively.

I arrived at the 10% weighted cost of capital based upon my general knowledge and experience, as well as my routine monitoring of capital market conditions. My recommended 12% cost of equity is consistent with the actual cost of equity capital currently being incurred by large incumbent local exchange carriers, taking into account a cost effective blend of debt and equity. For purposes of this proceeding, the Commission should use a reasonable estimate of the cost of capital, consistent with sound cost-minimization assumptions.

Although there are numerous considerations involved in the choice of a debt/equity ratio, it is clear that within limits, a lower cost of capital can be achieved by increasing the use of the debt component and reducing reliance upon equity capital. Since the cost of equity is generally higher than the cost of debt, and since interest is deductible for federal income tax purposes while the return on equity is fully taxable, it makes economic sense to maintain a relatively high debt level and a relatively low equity level, particularly where a firm is well established and it faces relatively mild business risks. Of course, debt leveraging should not be so extreme that interest coverage deteriorates below an acceptable level and lenders become unwilling to provide debt capital to the firm. A 45% debt ratio is consistent with an appropriate long-run economic costing approach, because it reflects the most efficient and cost-effective way of doing business. To the extent some carriers rely to a greater degree on higher cost equity funds, the additional costs of this more conservative capital structure should not be reflected in a long run cost study.

The 10% cost of capital I have used in preparing the Staff cost studies in this proceeding is similar to the 10.36% capital cost determined by the Commission in Case Nos. TO-97-40 and TO-97-67. In those proceedings, the Commission determined Southwestern Bell's cost of capital was 10.36%, based upon a 42% debt/58% equity ratio. I would note that current debt and equity cost levels are somewhat lower than those which existed at the time of that earlier decision. For example, interest rates on 1 year treasury bills were 5.47% in December 1996. These rates had declined to 2.32% during the week of June 7, 2002, the last period for which data was reported by the Federal Reserve at the time I prepared this testimony. Similarly, the rates for long term treasury bonds were 6.55% in December 1996 and the analogous rates during the week of June 7, 2002 were 5.77%. Rates on Moody's AAA bonds were 7.20% during December 1996 and they had declined somewhat to 6.74% during the week of June 7, 2002.

During the period since December 31, 1996, the stock market has been relatively volatile, experiencing a strong bull market which caused SBC's share price, for example, to increase from $25.95 to a high of more than $57 in 1999 and 2000. As the market turned bearish, SBC's stock price declined to $30.95 on June 20, 2002. Despite this volatility, I don't believe the returns required by equity investors have changed much during this period. Rather, I believe fluctuations in stock prices have been due to changing growth expectations and massive shifts in investor attitudes about the future course of market prices. Hence, I believe it would be reasonable for the Commission to use an overall cost of capital for SWBT and other large ILECs in the vicinity of 10.36% or somewhat less. More specifically, we used an overall cost of 10% in the Staff cost studies.

For the smaller LECs we used a weighted cost of capital of 10.75%. This reflects an 8.0% cost of debt weighted 45% and a cost of equity of 13.0% weighted 55%. I arrived at the 10.75% weighted cost of capital based upon my general knowledge and experience, as well as my routine monitoring of capital market conditions. The somewhat higher cost of debt and equity I have used with the other LECs reflects the fact that these smaller carriers do not have as ready access to capital markets, and they face greater risks because they serve smaller, less diversified service areas. By allowing a .5% higher cost of debt and a 1% higher cost of equity, I have reflected the somewhat higher capital costs which are incurred by smaller incumbent local exchange carriers and the typical competitive carrier.

Q. You also developed a Missouri specific input for income taxes. Can you explain this recommendation?

A. This input estimates the impact of the federal income tax rate, as well as the state income tax rate, which can vary from state to state. It makes sense to use a Missouri-specific value for this input, rather than relying upon the average level of state and local taxes developed by the FCC. Accordingly I used a composite tax rate 39.06%, which reflects the Missouri state corporate income tax rate of 6.25% as well as the federal income tax rate of 35%.

Q. Have you developed any other inputs for use in preparing your switching cost studies?

A. Yes, there are several other miscellaneous inputs in the "Units & Factors" portion of the switching studies. Many of these inputs were used in calculating Tandem switching costs. These include the "Tandem MOU fraction", the "Intrastate Switched Access portion of Tandem MOUs", the "Non-Local portion of Tandem MOUs", and the "Percent Start Up Costs allocated to Host if also Tandem." We used these factors in conjunction with actual usage data, to estimate the volume of traffic which is routed through tandems, and to develop distinct stand alone, pro rata, and weighted average cost studies. Other factors include the "Power and Miscellaneous" and "Fill" factors.

Q. Can you briefly explain the "Power and Miscellaneous" factor?

A. Yes. This factor is used to estimate the cost associated with purchasing and installing power related equipment and other miscellaneous investments which are needed in order to provide switching service, but which are not included in the SCIS investment outputs. This type of factor is often used in switching studies. For instance, the default switching inputs used in the FCC model are based upon data that excludes power and main distribution frame (MDF) investments. In Docket No. 96-45, *In the Matter of Federal and State Joint Board on Universal Service*, the FCC decided to increase total switching investments included in its switching database by 8 % to estimate total investment associated with power and MDFs [FCC 99-304, October 21, 1999, ¶305]. The FCC adjusted its switch investment data by an additional 8% to account for the cost of LEC engineering and installation costs [FCC 99-304, October 21, 1999, ¶307]. Consistent with this general approach, I have used a factor of 16.7 % to provide a reasonable allowance for power, engineering and other miscellaneous investments which are not included in the SCIS data.

Q. You mentioned that the monthly costs are converted into costs per minute. Can you briefly describe this process?

A. Yes. The fixed monthly start up costs are developed into per line amounts, then divided by carrier-specific intrastate toll/access minutes per line, to calculate the start up costs per switched access minute. Similarly, monthly traffic sensitive costs (including the costs associated with line and trunk CCS) are developed on a per minute basis. These are added to the start up costs per minute costs to calculate total end office switching costs per minute. For the tandem switching study, start up costs per tandem MOU are added to traffic sensitive trunk costs to estimate tandem switching costs per minute. The line termination (port) costs are initially developed on a per line basis, then converted to per minute amounts, based upon the typical level of switched access traffic per line.

<u>Loop</u>

CUSTOMER LOCATION INPUTS

Q. Could you please briefly explain the customer location data used by the FCC model?

A. Yes. The default customer location inputs used by the FCC model were prepared by INDETEC International, Inc. (INDETEC), a wholly owned subsidiary of TNS (Taylor Nelson Sofres) Telecoms (formerly PNR and Associates). The INDETEC data was developed during 1998 using 1996 and 1997 sources. The rural portions of the data base are largely estimated through the use of a “road surrogate” algorithm in conjunction with 1990 census data.

To develop the Staff cost studies in this proceeding, we obtained a complete copy of the Missouri road surrogate dataset. This includes the longitude and latitude of each estimated customer location. The road surrogate algorithm used by INDETEC spaces customer locations (households and businesses) within each census block uniformly along roads within that block. As explained by the FCC, "the total number of surrogate points is ... divided by the computed road distance to determine spacing between surrogate points. Based on that distance, the surrogate customer locations are uniformly distributed along the road segments". [Inputs Order, ¶ 43]. Since customers typically are located along roads, this procedure is quite logical.

The major drawback with this approach is that it assumes customers are spaced uniformly, even though they are not. Particularly in rural areas, there may be long stretches of roads without any customers. All of the customers may be clustered in a relatively small number of locations within each census block. If customers are clustered along certain portions of the roads, or if they are concentrated along certain roads and not others, the road surrogate process will not accurately represent reality. By uniformly spreading customers along every road, the road surrogate algorithms force the FCC model to send cable to every part of each census block. In reality, network engineers don't need to send cable to anywhere except where customers are actually located. In urban areas this discrepancy between reality and assumptions may not be very significant, since customers may be located on nearly every street, and the variation in spacing between customers isn't as significant. However, in rural areas the gap between algorithm and reality may be severe in some places. In some rural areas, there are long stretches of empty roads, yet the road surrogate algorithms will assume these road segments contain customers, and thus the INDETEC data set forces the FCC model to send cable down these empty roads.

INDETEC also offers a geocoded data set which partially avoids this problem, because it places some customers at their actual locations – where known – and it only relies upon the road surrogate approach for instances where the actual customer locations are not known. To the extent actual location data is available, it has the potential to develop more accurate cost estimates, because customers are more precisely located. Unfortunately, the improvement primarily occurs in urban areas, where it has the least potential impact on the modeling process. In rural areas -- where the nuances of customer locations and geographic accuracy are most important and have the greatest potential impact on the cost calculations -- the INDETEC geocoded data set doesn't offer much improvement, because the actual locations aren't known and the road surrogate algorithms are relied upon instead.

Not only does the INDETEC geocode data set fail to offer great improvements in the rural areas where improvement is most needed, but INDETEC imposes greater proprietary restrictions on this alternative data set. For instance, in another jurisdiction we asked INDETEC (then known as PNR) to send us a copy of the actual customer location latitude and longitude points, but they refused, preventing us from analyzing this data in detail (e.g. comparing it to other data sets). In our view, these restrictions outweigh the limited benefits offered by the INDETEC geocoded data set, and thus we did not purchase it for use in this proceeding. If greater accuracy were needed, alternatives to this data set are available, including current white page telephone listings and field collection of data using global positioning system (GPS) satellite technology. These data sources are not subject to the types of restrictions imposed by INDETEC, but they are more costly to develop and use.

Q. Have you compared the INDETEC road surrogate data with actual geocoded customer locations?

A. Yes. We have analyzed the road surrogate data in Kansas and Idaho. In Kansas, we compared the road surrogate data to Select Phone's geocoded data set for Kansas telephone customers, derived from white page listings. This was very similar to PNR's geocoded data set, and of approximately the same vintage. The difference is that it includes the actual latitude and longitude points for each telephone number, and thus we could analyze it in detail. We used GIS mapping software to visually compare the two types of customer location data.

In general, we observed that the Select Phone geocode data set was not spaced evenly, because actual customer locations tend to cluster in certain areas while other areas remain empty. In contrast, PNR's road surrogate algorithms tended to spread customers uniformly along the roads. We also observed that the PNR road surrogate algorithms place many customers at the far edges of the wire center–along roads at or near the boundary. This was not unexpected because the road surrogate method distributes uniformly along all roads in the wire center including those far from the population center. To the extent these customers are actually located in developed areas further inside the wire center, the amount of cable required to connect them at their true location will be substantially less than the amount of cable needed to serve them at their surrogate location.

In some cases we found that approximately four or five miles of phantom additional cable was required by the road surrogate algorithm. This cable would not be required if one were to actually install a network to connect the valid customer locations, as indicated by the Select Phone data set. We found that a single spurious location generated by the road surrogate algorithm (or a handful of such spurious locations) could substantially increase the total amount of cable deployed by the cost model. This potential problem was most noticeable at the edges of the wire center, but it was not limited to these locations. The road surrogate methodology forces deployment of excess cable in every situation where it places surrogate locations at the far edges of a customer cluster or serving area, even though the customer in question is actually located much closer to the middle of the customer cluster.

Q. You mentioned similar work in Idaho. Can you please briefly describe your work in that state?

A. We also performed an extensive analysis of the INDETEC road surrogate data in Idaho, on behalf of the Staff of the Idaho Public Utilities Commission. For purposes of this research, we analyzed geographic information from a variety of different sources:

1. Embedded cable sheath data from the major ILECs in Idaho (Qwest and Verizon),
2. Census TIGER road segment files, population data, census block boundaries, and other data from the Census Bureau,
3. Exchange boundaries from the Commission, and wire center boundaries from GDT–the latter data is relied upon by INDETEC in developing its customer location data sets.
4. Road surrogate customer location data from INDETEC,
5. E911 customer location data for Elmore County's Emergency Services department.
6. Geocoded customer location data which was collected in the field using GPS technology.

We analyzed these data sets in an effort to determine how well the FCC model performs in modeling conditions in Idaho, to determine whether improvements in the accuracy of the model can be achieved by gathering more accurate customer location data, and to determine whether some of the default geographic inputs should be adjusted in order to better reflect cost conditions in the state.

Q. What conclusions did you draw from the Idaho analysis?

A. First, I concluded that, as with Kansas, the FCC model did a very good job modeling the specific geographic conditions in Idaho. Even using road surrogate data (which is dispersed too widely, as I discuss below) and even without compensating for this problem by adjusting the routing inputs, the FCC model does a remarkably good job designing loop networks that conform to conditions in Idaho. This conclusion is supported by the high correlations between embedded sheath feet and route feet generated by the model in that state.

Second, I concluded that when INDETEC's road surrogate data is used in conjunction with the default routing inputs, the FCC model tends to over estimate the amount of cable needed to connect Idaho customers to their wire center. For the great majority of Idaho wire centers the model produces more route feet than the actual sheath feet–despite the fact that the latter data reflects multiple sheaths along individual routes, while the modeled data does not.

Q. In Kansas and Idaho, did you analyze the implications of different customer location data sets in terms of differences in the resulting network configurations and cable quantities?

A. Yes. Overall, we found that connecting the surrogate locations to the serving area interfaces (SAIs) could take as much as hundreds of thousands of additional route feet of distribution cable compared to the corresponding amount needed to connect the actual locations to the same

SAIs. Our experience in Kansas and Idaho confirms that actual geocoded customer locations tend to be more tightly clustered than the road surrogate locations. In turn, we concluded that the FCC default inputs had a tendency to overestimate cable quantities and monthly loop costs, particularly in low density rural areas.

During the course of our work in Kansas, we compared the monthly costs and cable quantities generated by the FCC model using each INDETEC data set. We found that the geocoded INDETEC data set which included some actual customer locations resulted in lower cost estimates in 139 of 167 wire centers we analyzed. Overall, the total quantity of cable deployed by the FCC model declined by approximately 6% when using the INDETEC data set that includes some actual customer locations. We found that this reduction occurs almost entirely within the distribution category.

In considering these results, it is important to remember that the difference is due to differences in the two INDETEC data sets, yet they both rely almost exclusively on the road surrogate algorithm in rural areas. Clearly, if actual customer locations were also known for rural areas–rather than just within the town centers–the reductions in cable quantities and monthly cost might be even more dramatic. The difference between the two data sets is limited almost exclusively to urban and suburban areas which have a high proportion of addressable road segments and thus where INDETEC was able to geocode actual locations. In lower density rural areas the potential impact of geocoding accuracy is greater, but this impact isn't realized because both data sets are essentially the same.

Q. Why is the lack of geocoded locations in the rural areas of such concern?

A. The paradox is that low density, high cost areas are the geographic areas where accurate customer locations are most important, but these are precisely the same areas where neither INDETEC data set contains a large proportion of actual customer locations. Stated differently, the INDETEC data set with some actual locations results in a noticeable reduction in cable quantities, but this discrepancy occurs despite the fact that both data sets are largely identical in most rural areas, where one would anticipate that actual customer clustering patterns would have the greatest impact on the cost results. Hence, one can anticipate that a rural data set consisting entirely of actual locations would reduce cable quantities by an even larger margin–perhaps by as much as 20% or more statewide, with even larger reductions in some wire centers. The problem is that no such complete set of actual location data exists at the present time.

Q. You seem critical of the INDETEC road surrogate data set, yet you ultimately relied upon it, and the FCC has relied upon this data set for the federal mechanism. Can more accurate geocode data be obtained?

A. Yes. Every phone that is connected to the wired network has a specific location, and that location can potentially be identified and mapped. The geocoding "failure" rate can potentially be reduced by using additional data sources, such as the LEC's customer billing records, and/or the data base used in providing E911 service. However, even those data sources are likely to be inadequate in some rural areas. The alternative is to gather additional data. For instance, GPS technology can be used to identify actual customer locations in sparsely populated rural areas. As I mentioned earlier, we used this approach in developing more accurate customer location data for several rural Idaho wire centers.

Q. Are there other available sources of customer location data which could be used?

A. Yes. Other options include white page address listings, LEC billing, customer service and engineering records, or field collection of data using GPS technology. Unfortunately, only the GPS option precisely locates all customers in rural areas–where precision is most needed. The other options are less costly than GPS data collection, but they do not provide a complete solution in rural areas–where greater accuracy is most needed.

For instance, the white pages are an excellent data source, which may be helpful in some areas. This is public data that can be obtained at moderate expense in a computerized, geo-coded format. However, not all rural customers have specific street addresses listed in the phone book. Internal LEC data bases offer another alternative or supplemental data source, but these records suffer from similar weaknesses, and they typically will require additional effort (e.g. geocoding) to use them in a cost model.

Q. You mentioned that, in your Kansas and Idaho experience, the road surrogate algorithm tends to overestimate cable. Can this modeling problem be overcome without expensive data collection efforts?

A. Yes. The FCC model provides adjustable input parameters that allow the modeler to increase or decrease the amount of cable deployed in each wire center. This input can be used to compensate for the problem with the road surrogate data which I have been discussing. More specifically, if there is a problem with excessive feeder cable, the feeder routing input can be reduced below its default value of 1. Similarly, if the model deploys too much distribution cable, the corresponding distribution routing input can be reduced below 1. If both types of cable are being overdeployed, both inputs can be reduced. In turn, the model will develop smaller cable quantities. For example, if both routing inputs were reduced to .8, the total quantity of cable would be reduced by approximately 20% below the level generated using the default values of 1.

Q. What did you recommend in Kansas with regard to the customer location problem?

A. I concluded that the FCC model did a fairly good job of estimating feeder cable despite the problems with the road surrogate data set, but it significantly overestimated the need for distribution cable. To correct for this discrepancy, we recommended using a lower distribution routing input (0.85) rather than the default value of 1. The KCC subsequently adopted our recommendations concerning this issue as discussed in Order No. 16:

> We believe Staff has presented substantial evidence to support reducing the distribution routing variable from its default level of 1.0. Staff supported its recommendation with two general arguments. First, use of road surrogate data rather than geocoded customer location data tends to systematically overestimate the amount of cable "deployed" by the model, which in turn systematically overestimates the cost of universal service. Second, a comparison of embedded cable quantities to cable quantities produced by application of the model using the road surrogate data shows that the cable quantities produced by the model are greater than the quantities in place today. [¶ 38]

As I described above, we found a similar problem in Idaho–the road surrogate data set tends to disperse customers more widely than reality, which in turn results in an overstatement of the amount of cable needed to connect customers to the wire center.

Q. What did you recommend in Idaho?

A. I recommended adjusting the routing variables, similar to the approach we used in Kansas. Specifically, I recommended using a value of .90 for feeder and .75 for distribution. Since the road surrogate problem was not as serious in towns and cities, I concluded that it was reasonable to use the default inputs of 1.00 in areas where densities were higher and the problem of excessive dispersion of the road surrogate locations was not as serious.

Q. What routing variables are you recommending for use in Missouri?

A. In preparing the Staff cost studies in this proceeding, I relied upon the INDETEC road surrogate data set, but I reduced the distribution routing input to .85. I am not recommending an adjustment to the feeder routing variable. This is consistent with the solution which was used in Kansas. My work in Idaho and Kansas has convinced me that the road surrogate data is systematically biased towards excessive dispersion, which translates into a systematic overstatement of the amount of cable needed in the network. I recommend using the adjustment factor which was adopted in Kansas, because that state is adjacent to, and has somewhat similar geographic characteristics as Missouri.

Q. You have indicated that you modified the default routing input. Are there any other customer-related inputs which you have changed?

A. Yes. The default version of the FCC model has the true-up feature turned on, which causes the cost results to be adjusted based upon data concerning the actual number of lines served in each wire center. This true up feature only impacts the SWBT results, because it is the only Missouri LEC for which actual line count data has been included as part of the default version of the FCC model. For consistency, it is necessary to either turn off this feature, or to incorporate actual line count data for all of the Missouri LECs. We turned off the true up feature, which achieves consistency across all Missouri LECs, and avoids certain distortions (related to economies of scale) which can potentially arise when using the true up feature.

Q. You mentioned that you modified the default wire center data, including host/remote relationships. Can you elaborate upon these changes?

A. Yes. We modified certain FCC model databases to reflect the impact of recent mergers and acquisitions within the state of Missouri. The first project was to update various data to reflect the GTE/Verizon merger. This enabled us to run Verizon-Missouri as a single entity. The second project was to update certain data to reflect the sale of over 100 Verizon exchanges (wire centers) to Spectra d/b/a CenturyTel. This enabled us to run CenturyTel as a separate entity.

Q. How were these projects accomplished?

A. Specifically, the exchanges associated with GTE North Inc-Missouri (NECA ID 421186), Kansas State Tel d/b/a GTE of Eastern Missouri (NECA ID 421789), Contel Systems of Missouri d/b/a GTE Systems of Missouri (NECA ID 421846), and Contel Missouri d/b/a GTE Missouri (NECA ID 421922), were all merged into one company, Verizon - Missouri (NECA ID 424313). This was accomplished by updating various tables in the files HM50.mdb, Hcpm.mdb, and MO_DISTANCE.xls which are used by the FCC model to process cost studies. The same databases were updated to reflect the sale of certain exchanges to Century Tel. Analogous adjustments should be made, when and if the Centurytel of Missouri-Verizon sales are completed.

Q. Did you make any other changes to the data base which is used with the FCC model?

A. Yes. We updated the Tandem and Host-remote relationships based upon responses received from Alltel, Century Tel, SWBT, Sprint, and Verizon. This was accomplished by updating the *LERG_host_remote* table in the file HM50.mdb.

OTHER INPUTS

Q. You mentioned that you had modified the FCC's default depreciation inputs for copper cable. Can you explain?

A. Yes. The FCC's default depreciation lives for metallic (copper) cable range from 20.61 years (aerial) to 25.00 years (underground). The default value for buried cable, which is the predominant type of cable in Missouri, is 21.57 years. The ILECs used substantially shorter lives in their models. For instance, Verizon assumed a life of 17 years for all types of copper cable, while Sprint assumed 15 years for aerial and underground cable, and 18 years for buried cable.

The FCC has not established any firm rules concerning the appropriate methods to use in developing economic lives, or depreciation rates, for use in economic cost studies. However, the FCC's view of depreciation in this context is largely the same as in other regulatory contexts. The lives used by the FCC in its model are similar to those accepted by the FCC for traditional regulatory purposes. Similarly, in the definition of forward looking costs adopted by the FCC for pricing of unbundled elements (Total Element Long Run Incremental Cost) as set forth in its Rules, the FCC mandates that "[t]he depreciation rates used in calculating forward-looking economic costs of elements shall be economic depreciation rates." [Rule 51.505(b)].

The FCC Staff also has provided some insight into their view of the appropriate depreciation rates to use in an economic cost study:

> We believe that depreciation schedules specified in a proxy model should be based on forward-looking costing principles and should reflect projected economic lives of investments rather than physical plant lives. As discussed above, we believe that the reported plant lives for loop-plant structures, such as conduit, manholes, and poles, are particularly important. Because of the relatively large investment necessary to construct such facilities, inaccurate estimation of the expected economic lives of such facilities may result in a significant under or overestimation of the forward-looking cost of these facilities. We also believe that the depreciation rates reported by incumbent LECs for financial purposes may provide information to determine the appropriate economic lives of facilities. [*The Use of Computer Models for Estimating Forward-Looking Economic Costs, A Staff Analysis*, January 9, 1997.]

Since the FCC establishes "projection" lives during its traditional triennial review process—considering technological change, market obsolescence, and other economic factors—it is readily apparent that these FCC-approved projection lives are a useful starting point in estimating depreciation rates for cost modeling purposes. And, the default inputs provided with the FCC model generally fall within the range of lives which are adopted by the FCC during the triennial review process. Although the FCC's default lives are generally reasonable, I believe somewhat shorter lives are appropriate in two areas– digital switches (as mentioned earlier) and metallic cable.

There is no question that metallic cable will physically survive a very long time. The only question is whether its useful economic life will expire in a relatively short period of time, due to technological and economic trends. In my view, there is a reasonable likelihood that much of the copper cable which is currently in place (or which will be installed in the near future) will become economically obsolete within the next couple of decades, due to the inherent advantages of fiber over copper. The difficulty lies in predicting how soon this will occur, and how widespread it will be. Logically, one would expect more copper feeder cable to become obsolete sooner than distribution cable.

Fiber optic cable and the associated electronics continue to decline in cost, and fiber holds the potential for more efficiently handling video dial tone, broadband data services, and other offerings that require an enormous expansion of bandwidth. These new offerings cannot be handled as easily over metallic cable, particularly over longer distances. That does not mean that all of the existing copper cable is an albatross hanging around the incumbent carriers' necks. To the contrary, manufacturers are working aggressively on new technologies that hold the potential for offering higher bandwidth services over ordinary copper wires. Depending upon how successful they are in these development efforts, much of the copper cable installed today may continue to be used, and economically valuable, for 20 or more years. Stated differently, while it is possible that copper cable may become economically obsolete in the relatively near future, this will depend in large part on how rapidly the demands for bandwidth outstrip the capabilities of copper cable, and how rapidly the cost of copper electronics decline, relative to the cost of fiber electronics.

Considering all of these factors and uncertainties, I believe it is reasonable to assume that on a forward looking basis, the economic life of copper cable is likely to be shorter than fiber cable. Consistent with this reasoning, I have used a life of 17 years for copper cable in the Staff cost studies, while leaving intact the FCC's default lives of approximately 26 years for fiber cable. If one were to distinguish different cables on the basis of their function and distance from the central office, one could reasonably expect most copper feeder cables to have a shorter life than most distribution cables, for the reasons I have just discussed.

Q. Earlier, you indicated that plant mix is another area where you didn't rely upon the FCC default inputs. Can you elaborate on this issue?

A. Yes. We modified the mix of underground, buried and aerial cable to more closely fit Missouri conditions. The default version of the FCC model uses a table of percentages to determine the feeder and distribution plant mix. The resulting plant mix is tailored somewhat to fit state-specific conditions, since the percentages vary by density zone. However, in an effort to better estimate the actual costs incurred by carriers in Missouri, I modified the default set of percentages, thereby tailoring the plant mix to fit Missouri conditions even more closely. The effect of this modification was to increase the deployment of buried cable, which is consistent with the embedded ARMIS cable sheath feet data, which shows that both SWBT and Sprint have a higher proportion of buried cable in their Missouri network (70+%) than the nationwide average (55.3%).

It is reasonable to conclude that a relatively high proportion of buried plant is cost effective in Missouri. This is the conclusion that has historically been reached by Missouri carriers, and there is no reason to think that a different conclusion would be reached in a forward-looking context. Accordingly, I used the plant mix inputs set forth in the following tables (See Tables 1-3). As indicated in these tables, we have applied different percentage factors to different geographic areas, based upon the density (number of access lines per square mile) in each part of the state.

Table 1

Copper Distribution Plant Mix

Density	Underground	Buried	Aerial
0	0.0%	80.0%	20.0%
5	0.0%	80.0%	20.0%
100	0.0%	80.0%	20.0%
200	2.0%	80.0%	18.0%
650	5.0%	80.0%	15.0%
850	30.0%	60.0%	10.0%
2550	45.0%	45.0%	10.0%
5000	60.0%	30.0%	10.0%
10000	90.0%	0.0%	10.0%

Table 2

Copper Feeder Plant Mix

Density	Underground	Buried	Aerial
0	5.0%	50.0%	45.0%
5	5.0%	50.0%	45.0%
100	5.0%	50.0%	45.0%
200	20.0%	40.0%	40.0%
650	40.0%	30.0%	30.0%
850	60.0%	25.0%	15.0%
2550	75.0%	15.0%	10.0%
5000	90.0%	5.0%	5.0%
10000	95.0%	0.0%	5.0%

Table 3

Fiber Feeder Plant Mix

Density	Underground	Buried	Aerial
0	5.0%	50.0%	45.0%
5	5.0%	50.0%	45.0%
100	5.0%	50.0%	45.0%
200	20.0%	40.0%	40.0%
650	40.0%	30.0%	30.0%
850	60.0%	25.0%	15.0%
2550	75.0%	15.0%	10.0%
5000	90.0%	5.0%	5.0%
10000	95.0%	0.0%	5.0%

Q. What other loop model inputs are you recommending changes to?

A. The inputs concerning the sharing of structures with other carriers or utilities should be adjusted. Also, based on my experience in Kansas and Idaho, I have assumed that feeder placement/structure costs should be reduced to reflect sharing of trenches and poles with distribution routes.

Q. Why are you recommending changes to the FCC's default sharing factors?

A. The debate has raged before the FCC concerning how much sharing should be assumed in development of a forward-looking cost study, and the FCC has attempted to reconcile the disparate views of this issue. In general, the FCC has done a good job of trying to deal with a difficult issue, but I believe its sharing percentages for buried cable are too optimistic. This is particularly significant in Missouri, where so much of the cable is buried.

I believe it is relatively difficult, and therefore less common, for LECs to share the cost of buried cable trenching and placement with other entities. Unlike aerial cable, sharing of buried costs with the electric utility is relatively rare. An important exception occurs in new subdivisions, where cable TV and telephone cable can sometimes be placed simultaneously. In the context of a "fresh build" scenario like that envisioned in the FCC model, however, this sharing of costs would be relatively infrequent. The potential for sharing increases in urban areas, where multiple carriers may be operating, and it certainly increases in an underground context, where sharing can occur after the fact (by pulling another carrier's cable through an existing spare conduit).

Q. What changes did you make to the default sharing inputs?

A. While one can certainly debate the individual values, I believe the default underground and aerial sharing inputs adopted by the FCC are acceptable; however, I have included some changes to the buried percentages. The inputs below represent the share of the structure costs absorbed by the LEC. So, higher percentages in the table below represent lower sharing and higher costs reflected in the FCC model results. For reference, I have used bold type to emphasize the changes we made, which are reflected in the Staff cost studies in this proceeding.

Table 4

Structure Sharing Inputs

	FCC Default Inputs (06-2001)			Staff Recommended Inputs		
Density	**UG**	**Buried**	**Aerial**	**UG**	**Buried**	**Aerial**
0	100.00%	1.00%	50.00%	100.00%	1.00%	50.00%
5	1.00%	1.00%	50.00%	1.00%	1.00%	50.00%
100	85.00%	85.00%	50.00%	85.00%	85.00%	50.00%
200	65.00%	65.00%	50.00%	65.00%	**85.00%**	50.00%
650	65.00%	65.00%	50.00%	65.00%	**85.00%**	50.00%
850	65.00%	65.00%	50.00%	65.00%	**85.00%**	50.00%
2550	55.00%	55.00%	35.00%	55.00%	**85.00%**	35.00%
5000	55.00%	55.00%	35.00%	55.00%	**85.00%**	35.00%
10000	55.00%	55.00%	35.00%	55.00%	**85.00%**	35.00%

Q. You mentioned that one of the areas where you deviated from the default inputs relates to the sharing of placement costs between feeder and distribution cable. Does the default version of the FCC model recognize this phenomena?

A. No. The model ignores the possibility that feeder and distribution cable may be placed on the same poles, or in the same trench. Phone networks typically have feeder and distribution running in parallel along certain routes, yet the FCC model algorithms do not recognize the potential savings that can be achieved with simultaneous placement of feeder and distribution along the same route. The model essentially assumes that a trench is dug for feeder, the feeder is placed and buried, then the crew comes back along the same street, digs another trench and places the distribution cable. The model developers recognized the potential for cost savings in the context of feeder and interoffice transport cables, but they ignored the analogous phenomenon with regard to feeder and distribution cables.

Q. Is it possible for feeder and distribution cable to be placed along the same route, but at different times?

A. Yes. In the embedded network there are undoubtedly many examples of this. Due to unexpected growth or other factors, the LEC might add feeder cable to a route that already has distribution cable, or vice versa. In such circumstances, no cost savings from shared use of the same trench would be realized. The company would incur the full cost of placing the feeder, and the full cost of placing the distribution some years apart. However, when developing long run forward looking costs, where the data is typically developed on the basis of a "fresh build" scenario, it is reasonable to assume that most of the cable along a particular route will be placed at the same time.

Q. What have you done concerning this potential for sharing of feeder and distribution cable along the same routes?

A. During the course of our work in Kansas, we analyzed 14 wire centers in great detail. We found that in every case at least 40% of the feeder routes also included distribution cable. In some wire centers the percentage of overlap was much higher. Based upon that analysis, we reduced the relevant feeder placement and structure costs by 40%. We performed a similar quantitative analysis of 10 Idaho wire centers. This analysis confirmed the same general pattern we observed in Kansas. In two of the Idaho wire centers, the percentage overlap between feeder and distribution was approximately 35%, which is slightly less than the lowest overlap we found in Kansas. In the other 8 wire centers we studied, the overlap was quite high, ranging from 43% to 78%. Averaging the results for all 10 Idaho wire centers, the overlap between feeder and distribution route mileage was approximately 50%.

Although placement costs can't be eliminated on routes where feeder and distribution are both being placed, they can obviously be reduced substantially. For example, pole and trenching costs won't increase much, if at all, when feeder cable is placed at the same time as distribution cable along a particular route. The detailed analyses we performed in these other states demonstrated that opportunities for sharing of feeder and distribution are widespread. Consistent with the conclusions we reached in these other states, I used a 40% factor in preparing the Staff cost studies in this proceeding. The effect of this recommendation is to uniformly reduce the relevant feeder placement and structure costs by 40%.

Q. Did you use any other inputs which differed from the FCC's default inputs?

A. Yes. I developed different inputs for cost of capital and other taxes, as described in the switching portion of my testimony.

CLEC STUDIES

Q. How did you develop loop costs for CLECs?

A. Given the large number of CLECs operating in the state, the difficulties involved in obtaining data from these carriers (e.g. they don't follow the FCC uniform system of accounts), the many differences in the way they are configured, and the very small share of the market served by each carrier, it simply wasn't practical to study in detail the costs incurred by each individual CLEC in the state. Instead, we developed four cost studies which provide some useful insight into the costs incurred by CLECs, and which provide a useful example of a practical approach which could be used by individual CLECs if they wanted to submit cost studies to the Commission in support of future rate proposals. Two of the cost studies are for facilities-based competitive carriers, and two are for CLECs that rely entirely on unbundled elements rented from SWBT.

In developing the first two studies, we used the FCC model to the loop costs incurred by competitive facilities-based CLECs who have installed copper cable in specific locations in the state. The areas served by these CLECs (ExOp of Missouri, and Green Hills Telecommunications, Inc.) fall within the middle of the overall range of geographic service areas within the state. These carriers neither serve very high density (and correspondingly low cost) urban areas like downtown St. Louis, nor do they serve very low density (and correspondingly high cost) rural areas. In developing these studies, we used the available road surrogate customer location data for the specific areas where these CLECs are providing service, and made adjustments to better reflect the fact that they do not serve 100% of the customers within these areas (Sprint continues to serve the area as well). The two other CLEC studies are based upon the UNE rates paid to SWBT. One study focuses on the loop rental rates applicable to the St. Louis metropolitan area, while the other study incorporates the average level of UNE rates charged by SWBT throughout the state. The former study reflects the costs incurred by a CLEC which only serves the St. Louis market, while the latter study reflects the costs incurred by a CLEC which serves a more diverse set of markets throughout the state.

Transport Costs

MODELING APPROACH

Q. Let's turn to the portion of your testimony dealing with Interoffice Transport costs. Can you briefly explain why you used carrier-specific cost models in developing transport costs for this proceeding?

A. Yes. As I mentioned earlier, we initially planned to use the FCC model, with some enhancements. When the major ILECs objected to this approach, we recognized that it had at least one significant weakness: the default version of the FCC model didn't necessarily reflect the specific interoffice routes which are actually used in carrying switched access traffic in Missouri. We had planned to modify the model to better reflect the actual interoffice network configurations which are present in Missouri, but we were not sure how successful we would be in this effort. Since the major ILECs had already done extensive modeling of their SONET rings in Missouri, we thought it would be efficient to build upon their modeling efforts.

Q. How did you develop transport costs per minute?

A. We started with transport related investments generated by the SWBT, Sprint and Verizon models. These investment amounts, stated on a per-DS1 circuit basis, were then converted into annual, monthly and per-minute costs using algorithms developed by our firm. For the other 38 ILECs in the state, we developed a statistical analysis of fixed and variable per-circuit investments derived from the SWBT, Sprint and Verizon cost models. Per-circuit investments were treated as dependent variables and the number of non-SWBT switched lines, the distance from the wire center to the serving tandem and a dummy variable (specifying whether a wire center is served by SWBT) were used as independent variables. The resulting multiple regression coefficients were used (in conjunction with data concerning the number of lines and distance to the serving tandem) to estimate the transport costs for other facilities-based LECs in the state. This statistical approach to estimating investments was applied to each of the wire centers served by 38 other ILECs and two facilities-based CLECs in Missouri

Q. Why didn't you use the models provided by the ILECs in their entirety, to develop transport costs per minute?

A. As discussed in the context of the switching studies we rejected this approach for several reasons. First, we were interested in developing cost results for all of the ILECs in the state, not just for Sprint, SWBT and Verizon. None of the ILEC transport models were capable of generating cost estimates for Alltel and the other small rural ILECs.

Second, there were significant differences in the way the ILEC models calculate costs per minute. These discrepancies reduce the value of any comparisons which might otherwise be made between the results of the three models. In a generic proceeding of this type, it is important to maintain a reasonably high degree of consistency across the various cost studies. While it would have been desirable to model the transport investments using a uniform methodology, we concluded that inconsistencies in this regard were outweighed by the benefits of using carrier-specific network configurations–which were supplied with the ILEC models. No such benefits would have been obtained by using three different methods of converting investments to annual, monthly and per-minute costs. To the contrary, we felt it was particularly helpful to use a consistent approach in this regard. Since the ILECs had adopted widely differing methodologies in this area, one carrier might appear to have lower costs just because of differences in the approach used in converting investments into annual, monthly and per-minute costs.

Finally, as mentioned in the switching portion of my testimony, none of the models submitted by the LECs were capable of providing stand alone and pure TSLRIC studies.

Q. What is a SONET ring?

A. Historically, interoffice networks were connected via "hub and spoke" topology, not unlike the networks of the airline industry. Smaller switches would home on larger, centrally located switches which in turn would be connected to other large switches, as well as tandem switches. These connections were achieved using a variety of different technologies, including microwave radio equipment, copper cable, coaxial cable and fiber optic cable. In more recent years, advances in fiber optic technology have increasingly made it attractive to substitute "ring" networks for these point-to-point connections. With this configuration, a group of central offices is typically connected together using a SONET (Synchronous Optical Network) ring, where information flows in both directions around a circle. This provides two paths for every call, enhancing reliability. The investment in these rings, includes fiber cable and the electronic transmission equipment such as add/drop multiplexers (ADMs) which make it feasible to transmit information over the cable.

By far the dominant factor which drives the level of transport costs is the total number of interoffice circuits which are present on a particular fiber system and the overall speed at which the system operates. Faster systems are capable of carrying more information. While the total cost of a SONET system increases as the total bandwidth or speed of the system increases, the cost per circuit declines sharply as the system speed increases. Thus, if two wire centers are connected together via a SONET system which operates at a very high speed, the cost of transporting a call between these wire centers will be very low. This is to be expected, since one of the most persistent and important phenomena in telecommunications is the dominant importance of economies of scale and traffic or circuit density.

Q. Before you describe the ILEC models you used for your transport cost studies, would you please describe the transport methodology adopted by the FCC?

A. Certainly. As the documentation suggests, the FCC Model:

> determines the required capacity and distances of interoffice transmission facilities, using the traffic data and the interoffice distances that are input to the Module. In doing so, it uses wire center locations and interoffice distances to determine an efficient mix of interoffice SONET fiber rings and redundant point-to-point fiber links. Rings are separately provided for linking host switches to their subtending remotes, and for linking host switches to each other, to stand-alone switches and to the tandem switches on which they home. The numbers and types of elements involved can be examined in the intermediate outputs of the Switching and Interoffice Module as recorded in the workfile. [HCPM documentation file 1_HM50a_ModDes.doc, section 4.7]

The methodology that the FCC Model uses to determine the rings is the same for both classes of rings, with hosts serving as the homing point in the network of hosts, remotes and tandems serving as the homing point in the network of tandems, hosts, and standalone wire centers.

Q. How does the FCC model decide where to put the SONET rings?

A. To compute the set of interoffice rings, the model begins with a case where all wire centers are directly connected to their serving tandem via redundant paths (a redundant hub and spoke configuration). Each wire center is then examined to determine whether it is more cost effective to leave the wire center directly connected to the tandem or include it on a ring. To make this determination, the model compares the investment associated with directly connecting the wire center to the tandem with the investment associated with placing the wire center on a ring. For direct connections, the investment is a function of the distance from the wire center to the tandem. When determining the investment that is required to add a wire center to a ring, the distance between interconnected wire centers and the additional cost of multiplexing are considered. If the investment on the ring is less than the investment associated with directly connecting to the tandem, the office will be placed on the ring.

Q. Can you briefly describe the FCC model's ring optimizing algorithms?

A. Yes. The FCC Model incorporates an optimizing algorithm to ensure that it constructs rings in an efficient fashion. The savings that are generated by placing a wire center on a ring are computed as the difference between on-ring and directly connected investment. The model places the offices that produce the greatest savings on the ring first. When no more savings are possible, the process of creating rings is complete. When computing rings, the greatest savings often is realized by allowing a set of wire centers to form their own standalone ring that does not include the serving tandem as a node. The algorithm requires the tandem to be placed on at least one ring. But since all wire centers must have a communications path to their serving tandem, standalone rings are connected to the tandem through a series of ring connectors that provide paths either between rings, or between a standalone ring and the tandem. The location of each ring connector is determined by identifying the smallest distance from each node on the standalone ring to either the tandem itself, or to any other ring that has tandem connectivity. All ring connector distances and connector terminal costs are doubled to reflect the installation of redundant facilities.

Q. Are there some drawbacks to the FCC's optimization routine?

A. Yes. The FCC model develops a hypothetically optimal interoffice network, but the resulting configuration has little or no resemblance to the one actually in existence. For example, as described above, the model assumes ubiquitous deployment of SONET rings; when in reality, exchange access service is sometimes provided using less sophisticated and potentially less reliable network topology, especially in the case of smaller rural carriers. Arguably, the FCC's approach is more hypothetical than necessary, and thus it isn't fully consistent with the Commission's stated objective of looking at "actual" costs.

Each model has strong and weak points, and the FCC model certainly has some impressive features. However, in this instance we decided it would be preferable to rely in large part on SWBT's SPICE model, because it is capable of estimating costs for the specific interoffice network configurations which actually carry the great majority of the switched access traffic in Missouri. Stated differently, the studies we prepared in this proceeding rely to a great extent on the routing decisions and network configurations developed by LEC engineers, rather than relying upon hypothetical network configurations generated by a computer model.

THE SWBT TRANSPORT MODEL

Q. Can you briefly describe SWBT's SPICE model?

A. Yes. SWBT uses its SPICE model to estimate the cost of providing transmission circuits over Synchronous Optical Network (SONET) facilities between SWBT central offices. SPICE is a complex, database driven model which takes various study assumptions and inputs and combines them with data taken from SWBT's data base of actual network information to estimate various Interoffice and Circuit Equipment costs. The database used by SPICE includes an inventory of all SWBT central offices, the distances between those central offices, an inventory of SWBT's actual interoffice networks, and an inventory of the individual circuits which are active on those networks. The inventory of networks includes the type of technology or design, the bandwidth, the numbers of nodes, the number of fibers on each segment, and the actual route mileage of each segment.

The SPICE model develops cost estimates for all central office pairs which are currently connected by at least one active circuit of the speed being considered in the study in question (e.g., DS1). It computes fixed and per mile investments per unit of capacity (e.g., per voice grade circuit), based on its estimate of the least costly path between each such pair of central offices.

While the SPICE model is quite sophisticated, there are aspects of this model which tend to develop inaccurate, or at least misleading, outputs. For instance, although the network fiber investment is based upon the entire route miles associated with the specific networks (e.g., SONET rings) used in completing each particular central office pair, at a later stage this investment is divided by the direct air mileage between those two central offices. The effect of this later procedure is to translate costs which were developed based upon network miles into costs that relate to air miles. In some cases the difference between route miles and air miles is very substantial–the air miles may be a small fraction of the route miles. As a result, the reported results don't adequately reflect the underlying cost structure.

Further steps in the SPICE costing process include weighting the unit investments by the number of circuits between each pair of wire centers, splitting the per mile fiber investment between underground and buried cables, and estimating conduit investment associated with the underground cables.

Q. Can you explain in greater detail the process used to develop route-specific investments within SPICE, and why the reported results do not adequately depict this underlying cost structure?

A. Certainly. Given the nature of this technology, all of the wire centers on a given SONET ring tend to exhibit very similar costs per circuit, just as all of the coach seats on a given airplane flight tend to have about the same costs, even if the passengers paid widely differing prices. This fact is accurately reflected in the early stages of the SPICE model. Also, many of these SONET rings exhibit very similar costs per circuit, even though their locations within the state, and the total route distances (i.e., circumferences) of these rings may vary widely. Again, the SPICE model does a good job of capturing this underlying cost pattern, in which traffic volumes dominate the overall cost picture.

In developing transport costs per circuit (or per minute) what really matters is the overall scale or density and corresponding speed of the system, as reflected in the total number of circuits or total minutes of traffic carried on that system. Route distance is a valid consideration, but it tends to be of secondary importance, and the relationship between distance and cost is not as simple as one might suppose. For instance, one might suppose that the cost of fiber for the route between wire centers A and Z will be much less than the cost of fiber for the route between wire centers A and Y, if the former route covers 2 miles and the latter route covers 20 miles. To see why this isn't necessarily the case, consider the implications if we assume that A, T and Z are all connected to the same SONET ring, which covers a total route distance of 60 miles. In that case, the fiber costs are essentially the same for any two nodes on the route, including those that are 2 miles apart and those that are 20 miles apart.

One of the reasons this is true is that in order to provide the benefit of total redundancy, every circuit effectively benefits from the full length of the entire ring. In our example, a circuit may head north one mile from A to Z, but a duplicate version of the circuit also heads south from A, then west, then north, then east, and then south again until it reaches Z, covering a total of 60 miles. The same thing occurs with circuits from A to Y, which also use the entire ring. Since the traffic is carried at the speed of light, there is no effective difference between the two directions. In fact, during a single telephone call, parts of the conversation may be completed on the northern route and parts may be completed on the southern route.

While the distance between any 2 wire centers is of little significance, the total route length of the ring does have an impact on costs. Of even more importance is the total volume of circuits or the speed at which traffic is handled on each ring. For that reason, network engineers don't simply try to minimize the total length of each ring. If a ring is expanded to include additional wire centers, the total number of circuits and traffic on the ring will probably increase, which can potentially offset the cost of the extra mileage needed to accommodate the expansion.

A small number of large rings may be more cost effective than a large number of small rings, even if the total ring distance (miles of fiber optic cable) in the former configuration is greater than would be required under the latter configuration. In any event, the distance between two wire centers is by no means a dominant consideration in designing an interoffice network, nor should it be a dominant consideration in analyzing the cost of SWBT's interoffice network. Economies of scale and density are very important considerations in designing a network, and they are equally important in analyzing network costs. Moreover, there is no simple, direct relationship between mileage and cost in this context. For that very reason, it is not surprising that there has been a trend in the long distance industry away from the longstanding historic pattern of mileage-based toll rates.

THE SPRINT AND VERIZON TRANSPORT MODELS

Q. Can you briefly describe the Sprint transport model?

A. Yes. Sprint designed their Transport Cost Model (TCM) to estimate what they describe as the Long Run Incremental Cost (LRIC) of interoffice transport, using forward looking technology (e.g. relying entirely on fiber optic transmission). It is an Excel based spreadsheet model, which calculates fiber and electronic investments on Sprint's OC3, OC12 and OC48 SONET rings. The TCM is designed around the existing locations of Sprint wire centers. The primary cost drivers in the model are the utilization or fill factor, the number of terminals, the size of the terminals (i.e., OC3, OC12, OC48), and the total distance associated with each ring. In order to estimate common transport costs in a switched access context, the TCM identifies routes which 1) originate from a tandem and terminate at a host switch and 2) those that originate at a host and terminate at a remote switch. The TCM then identifies the rings (and the associated costs) required to get from the originating location to the terminating location.

Q. Can you briefly describe the Verizon transport model?

A. Yes. The Interoffice Transport Module:

> develops investments for the network components that connect end offices, end offices to remotes ... , and end offices to tandems. These network components consist of specialized transmission equipment within wire centers and the outside plant facilities that carry communication signals between offices. [Model Methodology, Interoffice Transport Module, p. 1]

The ICM groups or clusters offices by tandem areas, using the existing switching hierarchy in Verizon's network. End offices in the same geographic area are usually clustered together with their tandem (if a Verizon tandem). To determine which offices are included in a ring, the ICM makes a 360-degree sweep from the tandem office, choosing no more than eight end offices or nodes on any one ring. The criteria for interconnecting the offices to the tandem on a ring is distance. The office closest to the tandem is identified and the link between the tandem and the closest office is the first link in the ring. The next closest office to the tandem is the next office included on the ring. This process continues until all end offices are included on the ring. The last office must be connected to the tandem to complete the ring. Then the Interoffice Transport Module:

> • develops the SONET ring and point to point configuration
> • calculates distance between hosts and remotes (including REMX nodes)
> • determines the length of interoffice facilities
> • determines the total traffic on each ring and host/remote link and sizes facilities
> • determines the equipment configuration at each node
> • calculates investments by CLLI code and passes them to the Mapping/Report Module where expense calculations are performed to convert them into monthly costs [Model Methodology, Interoffice Transport Module, p. 7]

If the tandem switch serving areas has more than eight end offices or switch nodes, two or more rings are deployed all connected to the tandem switch. By including all end office switches on a ring which includes the tandem, traffic between any end office and its host tandem can be carried on a single ring. This procedure is somewhat analogous to the one used by the FCC model, in that ICM apparently analyzes costs based upon a hypothetical interoffice network configuration. However, its algorithms are based upon distances between the end offices and the tandem, rather than a cost minimization procedure. In any event, maps of Verizon's interoffice network suggest that the actual configuration it relies upon in providing switched access service is not identical to the one modeled within ICM.

PROBLEMS ENCOUNTERED WITH THE ILEC MODELS

Q. Did you encounter any problems during your review of the ILEC transport models?

A. Yes. We encountered software related problems; design or platform related problems; and input related problems.

Q. Can you briefly describe some of the software related problems you encountered?

A. Yes. We encountered numerous technical problems trying to get the SPICE model working on our computers. Although SWBT personnel were very helpful in trying to help us solve these problems, more than 3 months elapsed between the time we started to review the SPICE model and the time we got a working copy running on our computers which was capable of producing reliable cost results. We began our review in early October 2001, in conjunction with our review of some SWBT cost studies submitted in Docket No. TO-2001-438. On November 6, 2001 SWBT personnel suggested that we use the SPICE model which had been loaded on a computer which SWBT had provided to the Commission Staff. SWBT subsequently installed the switched access version of the SPICE model on that computer. It arrived at our offices on December 26, 2001.

Q. Were you able to run the copy of SPICE which was installed on the computer SWBT provided?

A. No, not initially. We encountered significant problems with this copy of SPICE, as well. After extensive troubleshooting and various attempts to fix the problems, SWBT provided us with a "patch" on January 22nd, 2002 which overcame the problems and allowed us to run SPICE error-free.

Q. Did you encounter any software or compatibility problems with the Sprint or Verizon transport models?

A. No. We didn't encounter any software or compatibility problems with those models.

Q. Another category you mentioned was platform or model design problems. Can you please elaborate on these problems?

A. Yes. We found that the 3 models differed significantly with regard to how they modeled transport costs. For instance, SWBT's SPICE model was primarily developed as a tool for estimating the cost of special access or dedicated circuits. SPICE does not contain information on the large inventory of interoffice trunks which are used to carry most ordinary phone calls, including the vast majority of local and switched access traffic. Instead, special access or dedicated circuits are used as a proxy for switched access circuits. Sprint's model computes monthly costs by route but it doesn't report investments by route. Verizon's model allocates total transport investments to end offices by clli code instead of calculating investments by route or by SONET ring. These inconsistencies made it difficult to evaluate the effect of various inconsistencies in the inputs used in these models, and they made it more difficult to generate internally consistent cost estimates.

Q. You mentioned you encountered some difficulties in evaluating the inputs. Can you please describe some of the inputs you focused on?

A. Yes. We spent considerable time and effort studying the default fiber cable and fiber electronic inputs supplied with the ILEC models in an effort to determine whether they were reliable and consistent. This analysis was made more difficult by the fact that the inputs used in the various models were not structured the same. For example, SPICE requires combined material and placement costs per foot by fiber cable size, while Sprint's model requires separate inputs for fiber material per mile and fiber installation per mile. Verizon's ICM is designed around a 24 fiber cable, and does not accommodate any other sheath size. Similar problems were encountered when conducting our comparison of the fiber electronic inputs. Terminology differences and network configuration differences among the models made an apples to apples comparison difficult at best.

Q. What did you do to overcome these problems?

A. Among other things, we asked the ILECs to provide us with additional information which would enable us to more efficiently compare and reconcile the inputs and outputs of their transport models. For instance, on December 11th, 2001 we asked them to provide us with

> ...an Excel file which shows the investments developed within your model for a specific SONET ring of your choice. Please structure this response so that we will be able to trace all of the steps from the investment inputs and other assumptions (i.e., ring capacity, route distances, fill factors, etc.) to the total investment developed by your model for this particular ring. The investments shown in your response should

be consistent with those contained within and/or produced by the transport model (SWBT, Sprint, Verizon) is proposing that we use in this docket.

Q. How did the carriers respond?

A. Verizon provided a comprehensive response which was structured in the manner we requested. Sprint and SWBT did not provide any additional materials in response to this request. Sprint noted that their model was built in an Excel spreadsheet and was already consistent with the intent of this request. SWBT's model was not built in a spreadsheet and it did not did not provide the detailed example we requested. However, SWBT did make a subject matter expert available for telephone assistance, which helped us gain a better understanding of their model.

Q. What inputs did you use in preparing the Staff transport cost studies?

A. We primarily relied upon the default inputs supplied with these models. However, we relied upon the FCC model's default fiber cable and placement cost inputs, which we believed were more reliable, and allowed us to achieve a greater degree of internal consistency.(I discuss the FCC default inputs later in my testimony.) We also used consistent inputs for utilization or fill, as well as capital costs, including depreciation, cost of money and income taxes and plant-specific operating expenses such as equipment maintenance. In addition, we used algorithms to translate per-circuit investments developed by the ILEC models into monthly recurring and per-minute costs.

FIBER CABLE INPUTS

Q. You mentioned you eventually decided to use the FCC model's default fiber feeder inputs in the ILEC transport models. Can you explain what led to this decision?

A. Fiber is purchased by all of the ILECs in a nationwide, competitive market. As with any purchase, the possibility exists that different carriers may pay different prices for cable, due to differences in bargaining power, different engineering decisions, or other reasons. But it is reasonable to expect that any differences in the cost of acquiring and placing fiber cable will not be extreme. Small farmers receive about the same amount per bushel as huge Agrabusinesses when selling their wheat; similarly, large and small buyers of wheat pay relatively similar amounts per bushel, because this market is very competitive. The same pattern can be observed in many of the markets in which telecommunications carriers make purchases–although smaller LECs don't have as much buying power as the larger carriers, this doesn't necessarily translate into a large difference in costs, because even the smaller carriers can choose between multiple vendors who are eager to obtain their business.

Although the ILEC transport models included widely differing default inputs for fiber cable materials and placement, there was no evidence to suggest that these differences resulted from significant differences in the actual prices paid by the major ILECs. To the contrary, the differences in inputs appear to result primarily from differences in the data sources used in developing the respective inputs, as well as differences in the manner in which the ILECs have structured their inputs to conform with various aspects of their models.

I believe the advantages of greater consistency outweigh any potential benefits which might have been obtained by using carrier-specific inputs for fiber material and placement costs. Hence, we relied upon the default fiber cable inputs used in the feeder portion of the FCC model. These inputs were thoroughly investigated by the FCC, and they are the same inputs we used in the loop portions of the Staff cost studies in this proceeding.

To the extent the input structure or format of the ILEC transport models differed from that of the FCC default inputs, we compensated by setting some of the inputs to zero, or we made side calculations or other adjustments as necessary to ensure consistency in the results. For example, there is a conduit factor included in SWBT's SPICE model which estimates conduit investment as a function of underground cable investment. However, the FCC cable inputs already include conduit related costs, so we zeroed out the SPICE conduit input. Similarly, we used a worksheet provided by Sprint to calculate an overall cost (including material and placement) per fiber per mile, based upon the FCC inputs for various sizes and types of cable. This side calculation yielded inputs which were compatible with the structure of Sprint's transport model.

Q. Since you relied upon the FCC default inputs for fiber cable, would it be fair to say that you developed national average costs, rather than state-specific or carrier-specific investments?

A. No. The fiber costs included in our studies are specifically applicable to carriers in Missouri. For instance, the fiber costs included in the Staff studies reflect variations in placement difficulty based upon variations in population density and the specific soil conditions which are present in each area within the state.

FILL FACTORS

Q. You mentioned that you made changes with regard to utilization or fill factors. Can you explain these changes?

A. Yes. Fill factors (essentially the same concept is sometimes described in terms of utilization rates) are estimates of the fraction of total plant which is actually being used. The amount of spare capacity reflected in the fill factors used in a study will directly impact the resulting unit costs (e.g., cost per circuit or cost per minute of use). Excessively low fill factors raise the per unit costs and thus the prices to be charged. We reviewed the fill factors SWBT, Sprint, and Verizon provided with their transport cost models and found that they were using different approaches, and that some of the assumed factors were significantly lower than would be appropriate for development of valid long run costs. Consequently, we substituted more appropriate utilization or fill factors to ensure a greater degree of conceptual uniformity across the various studies, and to reflect a more efficient level of spare capacity, consistent with a long run approach to economic costs.

As I explained earlier, the key distinction between long run and short run costs is the extent to which the firm is able to vary its plant mix and capacity to match demand for its output. In a true long run planning horizon, the firm will optimize its capacity to closely match its output. In a long run cost study, the amount of capacity should closely match the level of output reflected in the study. There should be enough spare capacity to provide operational flexibility (e.g., the ability to quickly respond to fluctuations in the day-to-day level of demand), but not much more. In comparison, a somewhat larger amount of spare capacity would normally be present on an actual network. Similarly, it would not be surprising to see a larger amount of spare capacity in a short run cost study. In a short run study, at some locations the firm may have less spare capacity than would be ideal, thereby increasing its total costs of administration and maintenance, or forcing it to rely upon more costly routes in order to provide circuits between particular locations. At other locations a firm may have more capacity than would be optimal in the long run, perhaps because it anticipated future growth that hasn't yet materialized, or because it hasn't accurately estimated the level of demand. The key point to understand is that sub-optimal fill factors will often arise in an appropriately constructed short run study, but they are not expected in a long run study. To the contrary, to be consistent with the underlying principles that govern this type of study, and to be consistent with other aspects of this type of study, the fill factors in a long run cost study should always be very close to the optimal, cost minimizing level (taking into account the unavoidable impact of lumpiness of investments). Any substantial deviation from this cost minimizing optimal level of spare capacity is inappropriate, and represents a serious departure from the basic principles which should govern a long run study.

SWBT and other incumbent LECs have long advocated the use of long run, rather than short run, forward-looking costs. Thus, there is no basis for departing from this key aspect of standard economic theory. In a long run planning horizon the firm is assumed to maintain an appropriate amount of capacity which is just sufficient to meet demand for its services, plus a reasonable amount of spare capacity to allow for administrative convenience, operational flexibility, safety backup, and the like. Stated differently, in a long run cost study it isn't appropriate to incorporate the cost of unnecessary or inefficient levels of spare capacity. To the contrary, the study should be strictly focused on capacity levels which are optimally matched to the volume of circuits and traffic reflected in the study.

In a long run scenario, efficiencies are close to their peak and spare capacity costs are minimized. In its *Local Competition Order,* the FCC made an exception to the absolute "least-cost" solution when it rejected a purely hypothetical network by selecting a "scorched node" approach. However, the FCC has generally endorsed the traditional interpretation of long-run costs. For instance, the FCC expects UNE rates to be based upon the cost of an efficient network – not one with high levels of spare capacity:

> Prices based on the least-cost, most efficient network design and technology replicate conditions in a highly competitive marketplace by not basing prices on existing network design and investments unless they represent the least-cost systems available for purchase. [¶683.]
>
> ... We, therefore, conclude that the forward-looking pricing methodology for interconnection and unbundled network elements should be based on costs that assume that wire centers will be placed at the incumbent LEC's current wire center locations, *but that the reconstructed local network will employ the most efficient technology for reasonably foreseeable capacity requirements.* [¶685, emphasis added.]

Q. Were there any problems with the fill factors provided with the ILEC models in this proceeding?

A. Yes. Aside from a general lack of consistency, we noticed that some of the fill factors were rather low. For instance, in the SPICE model, SWBT uses a ** ** fiber fill factor. This would indicate, for instance, that within a cable sheath containing 48 fiber strands, approximately ** ** strands are not being used. While some of these extra strands might be needed for maintenance, emergency repairs, network rearrangements, and network survivability projects, in a long run planning horizon SWBT would not require this much unlit fiber. This is important, because the cost of this excess capacity is added to the transport costs which are developed using SPICE. Similarly, the Sprint model included fiber electronic fill factors which ranged as low as ** .** The fill factors selected by Sprint were based upon an analysis of some embedded network statistics, and there is no indication that this data source is consistent with the levels of efficiency which can be achieved in a long run planning horizon. While it might be appropriate to use embedded, sub-optimal utilization rates in a short run cost study, it is not appropriate to use them in a forward looking long run study, where the firm is assumed to have unlimited flexibility to optimize its network to achieve minimum cost.

Q. How did you develop the fill factors you used?

A. We developed reasonable fill factors, using a simplified life cycle analysis, taking into account a wide variety of different fiber cable sizes, growth rates, and other assumptions. We looked at the percentage of spare capacity (or fill factor) that was present at the time cable was installed, and at various years thereafter up to and including 10 years after the initial installation. Depending upon the rate of growth and various other factors, the number of fibers needed along a particular route could potentially grow to the point where it exceeds the capacity of the originally installed cable. I primarily focused on a 10 year period, which is shorter than the depreciable life of most fiber, but is longer than the number of years before a cable route might be "overbuilt" to accommodate growth or take advantage of technological improvements. For instance, feeder cables are often engineered to be "relieved" within 5 to 7 year. Based upon this analysis, and my general knowledge of the industry, we concluded that a fiber cable fill factor of 62% would be reasonable to use in this context.

Using a similar life cycle approach, we selected a 45% fill factor approach for the fixed portion of the fiber electronics. Although this may appear to be rather low, it is a reasonable factor to use for the fixed electronics components in the transport studies, because of the lumpiness of the equipment in question. Unlike fiber cable, which can be purchased in a wide array of different sizes, there are only a handful of available bandwidth sizes for fiber electronics (e.g. OC 3, OC12 and OC48). This technological constraint results in what economists refer to as "lumpiness" in the cost function, which makes it difficult or impossible to get a precise match between the available amount of capacity and the required amount of capacity on a given route. In contrast, the circuit cards and other variable electronic components can be purchased and installed as needed, resulting in cost characteristics which are not very lumpy. Hence, a much higher fill factor–approaching 100%–is appropriate for this portion of the transport cost studies.

The fill factors we used are higher than some of the inputs provided with the ILEC transport models, and lower than others. For instance, the 62% fiber cable fill factor we used compares with SWBT's fill factor of ** **, Sprint's factor of ** **, and Verizon's factors which ranged from ** ** to ** **.

Similarly, the 45% fill factor we used for the fixed portion of fiber electronics compares to SWBT's analogous fill factor of ** **, Sprint's factors which ranged from ** ** to ** ** for a OC-3 SONET terminal shelf and from ** ** to ** ** for a OC-48 shelf. Verizon's fiber electronics fill factors were not explicitly shown in its model, or the accompanying documentation.

To be consistent with the classic definition of long run cost, a forward looking study should use fill factors that are higher than the average fill level typically present in an incumbent LEC's network, but less than the highest fill levels which are sometimes present in such a network. Aside from the problems associated with lumpiness, the fill factors should approach the "target" levels used by network engineers to determine when more facilities must be installed, or network rearrangements are required.

OTHER TRANSPORT INPUTS

Q. Did you use the same capital cost inputs to convert the circuit investments into monthly recurring costs in your transport studies ?

A. Yes. The per-circuit investments developed using the ILEC models were converted into annual and monthly costs, as well as costs per circuit, per minute, and per minute-mile, using procedures developed by BJA. Annual cost factors were developed using the FCC model, using the same process and inputs I discussed earlier in my testimony. This ensured a reasonable degree of consistency across all of our cost studies. The annual cost factors include capital costs such as depreciation, cost of money, income taxes and plant-specific operating expenses such as equipment maintenance. The annual cost factors were applied to the circuit investments and monthly recurring costs were calculated by dividing the result by 12.

Q. Can you briefly highlight some of the other inputs you used in developing the per-minute costs in your studies?

A. Yes. There are several other inputs in the "Miscellaneous Factors" portion of the transport studies. These include the "DS1 DS0 administrative factor", the "Trunk Minutes per month", the "Stand Alone Ratio", and the "Lines per DS1" factors. The "DS1 DS0 administrative factor" accounts for spare circuits and testing circuits. This factor was included to help ensure that we included the cost of necessary (unavoidable) spare capacity and testing capacity which are needed to efficiently administer the interoffice facilities. The input for "Trunk Minutes per month" represents the monthly trunk minutes carried on a typical voice equivalent (DS0) circuit. We used 10,044 minutes for this input, which is taken from the FCC default input set. The "Lines per DS1" factor represents the typical relationship between the number of end user switched access lines and the number of DS1 trunks which carry interoffice traffic to and from those lines. We used a factor of 150, which is equivalent to 24 x 6.25 where 24 represents the number of voice grade circuits per DS1 circuit and the number 6.25 represents an approximation of the typical number of voice equivalent end user lines per voice equivalent interoffice trunk.

Q. What is the "Stand Alone Ratio"?

A. This is a ratio which was used in developing the stand alone cost studies. It is approximately equivalent to the volume of intrastate switched access traffic as a percentage of total switched traffic (including local and interstate traffic). It was based upon SLU or DEM ratio for each carrier (or a proxy for this ratio, where the actual factor was not available).

Q. You mentioned that the monthly costs are converted into costs per minute. Can you briefly describe this process?

A. Yes. The monthly recurring transport costs are stated on a per circuit basis, then divided by 10,044 trunk minutes per month to calculate the transport costs per minute. We have also provided the cost study results on a per circuit mile basis. Similarly, for carriers with mileage bands in their tariff we provided the costs organized into mileage bands corresponding to their existing tariff structure.

<u>Missouri Switched Access Rates and Costs</u>

INTRASTATE SWITCHED ACCESS COSTS

Q. Do you have an exhibit which summarizes your cost results?

A. Yes. Schedule 1 provides the results of the Staff cost studies for the Large ILECs, Small ILECs, and CLECs. Page 1 summarizes the costs for these three categories of carriers on a group basis. The first column provides the Stand Alone costs, the middle two columns provide the fully distributed costs, and the final column provides the TSLRIC results. The remaining pages of Schedule use the same columns to present the detailed results for individual carriers. Page 2 provides the common line (loop and port) costs, page 4 provides the end office switching costs, page 6 provides the tandem switching costs, page 8 provides the local transport costs and page 10 provides the total intrastate switched access costs (excluding tandem switching).

Q. Can you briefly comment on the overall results of your costs studies?

A. Yes. As can be expected, the stand alone costs are much higher than the corresponding fully distributed costs, while the TSLRIC results are always the lowest. This pattern is clearly evident in the total costs shown on page 1, as well as the corresponding totals for individual carriers. It follows directly from the fact that the first study analyzes the cost of providing switched access service on a stand alone basis, requiring this service to bear the full burden of equipment which is normally used in providing multiple different services. The costs presented in the middle columns are more consistent with the philosophy of cost recovery which has traditionally been followed in the telecommunications industry, whereby each service is expected to cover a portion of the shared costs of the network (with the remaining portion being recovered from local exchange, custom calling, and other services). Finally, the TSLRIC results are very low, because this study only considers the amount by which the carrier's costs would decline if switched access service were not provided. Thus, it excludes loop costs, the minimum, fixed costs of switching and other costs which are needed in order to provide intrastate switched access service, but which would be incurred even if this service not provided by the carrier.

The differences between these different cost studies can be traced directly to differences in the treatment of the benefits of economies of scope (the efficiencies which arise when multiple services are provided using the same network facilities). The stand alone cost study (shown in the first column) doesn't give intrastate switched access service any of these benefits. The second column gives this service a pro-rata share of these benefits (in proportion to the number of minutes used by each service) while the third column gives intrastate switched access service a somewhat smaller share of the benefits.

The reasoning behind the "weighted" column can be traced to the pattern of cost recovery which occurs in competitive markets, where joint costs are recovered in proportion to the strength of the demand for various products. Thus, for example, if heavy cream is perceived to be more valuable than skim milk, purchasers of cream will pay a greater than pro-rata portion of the costs of feeding and milking cows. Applying this logic to the telecommunications industry, regulators have frequently concluded that long distance minutes should bear a greater than pro-rata share of the joint and common costs of the network, to reflect the higher perceived value of long distance minutes relative to local minutes.

Finally, the TSLRIC methodology gives intrastate switched access the full benefit of economies of scope, since none of the burden of the shared facilities is attributed to this service. Undoubtedly, that is one of the reasons why the TSLRIC methodology is so popular with parties who advocate reducing switched access rates.

Q. Can you elaborate on the results for the various types of carriers?

A. Yes. As a broad generalization, the total cost per minute incurred by the CLECs tends to be lower than the corresponding totals incurred by many of the incumbent carriers, while the costs incurred by the smallest, most rural ILECs tend to be the highest of all. Of course, exceptions exist for specific carriers and/or specific categories of cost. For instance, the fully distributed cost of end office switching developed in the CLEC studies is similar to the level developed in the small ILEC studies.

Q. Can you provide any insights into the common line results for the various types of carriers?

A. Yes. The common line costs for the individual ILECs are shown on Page 2 of Schedule 1. As shown, the stand alone costs for Sprint, Verizon and Southwestern Bell (SWBT) are similar. However, the corresponding costs for Alltel and Century Tel are considerably higher. This follows directly from the lower density, more rural characteristics of the latter two carriers' service area. Not surprisingly, the common line costs incurred by the small ILECs tend to be substantially higher than those of the largest ILECs in the state. The same basic pattern holds true for both of the fully distributed cost studies.

Under the TSLRIC methodology, the common line costs are close to zero for all of the carriers. The only reason the last column isn't zero is that it includes a minuscule amount of common overhead costs. One can plausibly argue that on an incremental basis <u>no</u> costs would be incurred in the common line category, since the loop and port are needed in order to provide interstate switched access, local exchange and other services even if intrastate switched access were not provided. However, the methodology we have adopted for purposes of this study places a small amount of common costs in each category, in recognition of the fact that common overhead costs do vary somewhat with the size and complexity of a carrier's operations. As the number of services increases, executive salaries, accounting costs, tariff development and maintenance costs, billing and collection costs, marketing costs, and other miscellaneous overhead costs tend to increase somewhat–even if no additional facilities are needed in order to provide the additional service in question. Hence, our estimate of the TSLRIC costs is very small, but not zero.

Because this category consists entirely of joint or shared costs, the differences in treatment of shared costs in the various studies translates into a very broad spread between the stand alone and TSLRIC results. This has important implications for the Commission's policy and pricing decisions. More specifically, the results suggest that the Commission has broad discretion in setting prices for the recovery of these costs. Recall that economic theory suggests that the stand alone results should be viewed as the pricing ceiling while the TSLRIC results should be viewed as the floor. In this category, the study results display an extremely wide spread between the ceiling and the floor. Unless the Commission concludes that prices ought to be set somewhere towards the middle of this range, it will find that prices can be set at very low levels, or at very high levels, without violating either the floor or the ceiling.

If the Commission were to decide that IXCs should have access to the ILECs networks without making any substantial contribution towards the costs of the loops and ports which are used in processing their calls, such a policy is feasible, and would be consistent with at least one view of the underlying structure of network costs. Conversely, if the Commission were to decide that IXCs should pay a larger share of the loop and port costs than they do under current rates, a policy shift of that type would also be feasible, and it would not necessarily require moving rates above the level which would be incurred if IXCs were to install their own facilities to reach their customers on a stand alone basis.

Q. Do the results of the switching cost studies follow the same pattern as the common line costs?

A. No. There are many differences in the cost patterns. A careful review of page 3 in comparison with page 2 reveals that carriers with the highest common line costs don't necessarily have the highest switching costs. Similarly, while Alltel's stand alone and fully distributed common line costs are much higher than those of Sprint the same pattern doesn't hold when comparing these two carriers' switching costs. Alltel's stand alone and TSLRIC switching results are somewhat less than those of Sprint, while its fully distributed switching costs are about the same. In general, carriers serving large urban areas benefit from larger numbers of customers and higher traffic volumes, which allows them to purchase larger switches and to spread the cost of those switches over larger numbers of minutes. Thus, for example, it isn't surprising that SWBT has switching costs per minute which are a fraction of the level incurred by most of the smaller ILECs.

The Tandem Switching Costs are shown on page 4. It should be noted that many of the smaller LECs do not operate a tandem switch. To the extent IXCs use a tandem to connect with end users served by these smaller LECs, this function is performed by a connecting carrier, such as SWBT.

Q. The last category is local transport. Will you please summarize these cost results?

A. Yes. Local transport costs for the individual carriers are shown on page 5. Once again, the per-minute costs incurred by the Small ILECs tend to be higher than the costs incurred by the Large ILECs, at least under the stand alone and fully distributed approaches. Under the pure TSLRIC method all of the cost results tend to be very low, and there is relatively little difference in the level of costs incurred by different size carriers. This follows logically from the fact that under the TSLRIC approach, most of the fixed costs of the transport facilities are excluded from the analysis, since these costs would be incurred even if intrastate switched access service weren't provided. When speaking of the relatively high level of per-unit costs incurred in rural areas, the assumption is generally being made that the getting started and fixed costs of network equipment have to be spread over relatively small volumes. However, these costs have relatively little impact on a properly developed TSLRIC study, and thus the problems resulting from spreading fixed costs over a small number of units don't arise to the same extent as with a stand alone or fully distributed costing approach.

Q. Now that you have discussed each of the individual switched access cost components, can you briefly summarize the total cost for each ILEC?

A. Yes. For comparison purposes, I have excluded tandem costs, since some of the carriers do not operate a tandem switch. The total switched access costs are shown on page 6. As shown, of the five Large ILECS , SWBT generally has the lowest costs, while Alltel has the highest stand alone and fully distributed costs. Sprint and Verizon generally have the next lowest costs under all of the methodologies, while Century Tel generally incurs the second highest level of costs. However, under the pure TSLRIC methodology, the computed costs for all of the carriers are very low and the differences between carriers are not extreme.

The pattern for the other carriers is somewhat similar, in that costs computed on a pure TSLRIC basis are extremely low for all carriers, regardless of their circumstances. In fact, when averaging the individual carriers together, the Large ILECs, the Small ILECs and the CLECs all have costs that total around one half cent per minute.

COMPARISON OF MISSOURI INTRASTATE COSTS WITH RATES

Q. Up to this point you have been discussing your cost results. Did you also gather information concerning the carriers' existing rates for switched access service?

A. Yes. Schedule 2, consisting of 9 pages, presents the existing intrastate switched access rates for individual Large ILECS, Small ILECS, and CLECS operating in Missouri. Page 1 provides a summary of the average rates for these carrier groups. Pages 2 and 3 provide the common line rates for individual carriers, pages 4 and 5 provide the end office switching rates and pages 6 and 7 provide the transport rates for these carriers. On pages 8 and 9, the separate rate components for each carrier are combined to show the total rate paid on a typical intrastate switched access minute. The Missouri intrastate rates were taken from copies of the switched access service tariffs on file with the Commission, or obtained from the carriers' web sites.

Of the 5 largest ILECs in Missouri, only two have a Line Termination rate component. Most of the other 34 ILECs include a separate Line Termination rate component in their tariff. For ease of comparison, I have incorporated the Line Termination rates into the End Office Switching rates listed in Schedule 1. All but 4 of the 42 companies have Local Transport rates that vary by mileage band for Feature Groups A & B. However, for Feature Groups C & D, only 9 of the companies have rates that vary by mileage band. Some of the carriers charge a uniform rate per minute, while others charge rates which vary proportionately with distance (e.g. per minute-mile). For ease of comparison, I have focused on the rates for Feature Groups C & D. In most cases we used a uniform assumption of 25 miles, but for some of the large ILECs we used slightly different mileage assumption, consistent with the average distance from that ILEC's end offices to the nearest tandem.

Q. Can you briefly comment on the rates shown on Schedule 2?

A. Yes. While the thrust of this investigation is focused on the cost of providing access service, it is also useful to look at the rates which are currently being charged for this service. As the Commission knows, the Large ILECs tend to charge lower rates than the small ILECs. This discrepancy is most pronounced for SWBT, which charges about 3 cents for a typical switched access minute, while some of the smaller ILECs charge as much as 14 cents a minute. Although Alltel and Century Tel have been grouped with SWBT, the rates charged by these carriers are more like those of the Small ILECs than those of SWBT. On average, the Small ILECs charge a total of 9.70 cents per access minute, which is more than a penny higher than the total rate charged by Verizon (8.09 cents) and a couple of cents less than the total rates charged by Alltel and Century Tel (11.18 cents and 11.66 cents, respectively). Sprint charges a total of 9.92 cents, which is very similar to the total rate charged by the average Small ILEC (9.70 cents).

The access rates charged by the CLECS are generally equal to or less than the corresponding rates charged by the incumbent carrier in their serving area. Since the CLECs tend to operate in the areas served by the Large ILECs, their rates are capped at the level charged by the Large ILECs.

Q. Do you have any comments concerning the individual rate components?

A. Yes. The CCL rates are shown on Page 2 of Schedule 2. Of the five Large ILECS, SWBT's rates are by far the lowest, with Verizon second and Century Tel third. Not surprisingly, the smaller carriers tend to charge higher rates. However, some of the Small ILEC's have CCL rates which are amongst the lowest in the state. In fact, Goodman, Lathrop, Ozark and Rock Port all have CCL rates that are lower than those charged by SWBT.

The End Office Switching rates are shown on Page 4 of Schedule 2. The SWBT rates again tend to be substantially less than the rates charged by the other ILECs. At $.00834 per switched access minute, SWBT's rate is just 36% of the second lowest rate charged by a Large ILEC ($.02282 charged by Sprint). It is also worth noting that many of the ILECs charge the same LS2 and Line Termination rates. For ease of comparison, these sub-components have been combined on Schedule 2.

The Local Transport rates are shown on Page 6 of Schedule 2. SWBT again has the lowest rate. Verizon is second, Alltel third and Sprint fourth. Two of the Small ILECs (Choctaw and Orchard Farm) have transport rates which are lower than those charged by SWBT.

Q. Did you compare the companies' current switched access rates to the costs developed in your various studies?

A. Yes I did. Those results are summarized on Schedules 3 and 4. Schedule 3 states the relative magnitude of the existing rates, stated as a percent of costs, while Schedule 4 makes a similar comparison, looking at the data from the opposite perspective: the costs are analyzed as a percent of the existing rates. In both schedules, page 1 provides a summary comparison for the Large ILECs, the Small ILECs, and CLECs on a group basis. The remaining pages provide detailed, carrier-specific comparisons. Pages 2 and 3 focus on common line rates and costs, pages 4 and 5 focus on end office switching rates and costs and pages 6 and 7 focus on transport rates and costs. Pages 8 and 9 combine all of these categories together to compare total costs with total rates.

Q. Can you briefly comment on the comparison of current rates as a percent of costs?

A. Yes, as shown on Schedule 3, many of the existing End Office Switching rates and Local Transport rates exceed the corresponding stand alone costs. Since stand alone costs are generally viewed as a rate ceiling, this result is somewhat surprising, and it suggests the need for substantial rate reductions, at least in these two categories. When all of the different rate elements are totaled together, the comparison looks more reasonable. In total, the existing rates generally do not exceed stand alone costs, and thus one cannot say that IXCs are having to subsidize other customers on an overall basis. However, some of the transport and switching rates currently exceed the corresponding stand alone costs, and thus IXCs paying these rates can be said to be subsidizing end use customers or other carriers. None of the individual rates are less than TSLRIC costs, and thus it is fair to say that none of the existing rates falls below this price floor. In total, the switched access rates range from as little as 15% to as high as 81% of stand alone costs for the Small ILECs, with an average of 26%. On an overall basis, the existing rates look much more reasonable when viewed in comparison with fully distributed costs, but some of the carriers are currently recovering less than 50% of their fully distributed cost, while others are recovering more than 200% of their fully distributed cost. In the case of ** ** the total rate even exceeds our estimate of their total stand alone cost.

Q. Can you comment specifically on the CCL rate comparison?

A. Yes. The Carrier Common Line rate is designed to provide a contribution towards the cost of the loop and port which are used in connecting end users to IXCs. The existing CCL rates are generally a small percentage of the stand alone costs. Of the five Large ILECs, SWBT's rates recover the lowest percent of stand alone costs ** **, while Century Tel, Verizon and Alltel all recover about ** ** and Sprint recovers approximately ** ** of their respective stand alone costs. Similar discrepancies also exist within the group of Small ILECs. Some of these carriers recover less than 10% of their stand alone common line costs from IXCs, while others recover a much higher fraction. None of the existing rates falls below TSLRIC, which can be viewed as a pricing floor. This is hardly surprising, of course, since these costs don't vary much with the addition or deletion of individual services offered, and thus in a properly developed TSLRIC study the common line costs will be close to zero. As mentioned earlier, the only costs included in the TSLRIC study for this category were a small allowance for billing and collection and other common costs.

Q. Can you comment further on the end office switching and transport rates in comparison to costs?

A. Yes. Pages 4 through 7 of Schedule 3 demonstrate that for all of the Missouri carriers, the current intrastate switching rates substantially exceed the cost of providing this service, regardless of which type of costs are considered. The fact that most of the existing switching rates exceed fully distributed costs by a wide margin, and they even exceed stand alone costs strongly suggests this is an area where substantial rate reductions would be appropriate. In each instance the rates being charged by these companies are also higher than their respective Pro Rata and Weighted fully distributed costs and 10 to 20 times the TSLRIC cost.

Similar conclusions can be reached with regard to the local transport rates, as shown on Pages 6 and 7 of Schedule 3. This data shows that many of the carriers are charging more than 100% of the stand alone cost of providing this service. Similarly, the data reveals that the existing rates of many of these carriers exceed fully distributed cost by extremely wide margins. In fact, none of the carriers currently have rates which are close to the fully distributed cost, even when using a weighted allocation procedure (which allocates a greater than pro rata share of costs to the switched access category). Since the CLEC rates are similar to the ILEC rates, a similar pattern is shown for these carriers–their transport rates are currently set at levels which greatly exceed the forward looking cost of providing this function.

COMPARISON OF MISSOURI INTRASTATE RATES WITH RATES IN OTHER JURISDICTIONS

Q. The cost evidence suggests that in many cases the existing rates are not closely aligned with costs. Have you gathered any other data which might be useful to the Commission in evaluating the existing rate levels?

A. Yes. In judging whether some of the existing rates should be reduced, and if so how substantial a reduction might be appropriate, the Commission may find it useful to look at the rates in other jurisdictions. Accordingly, to provide some additional perspective, we gathered comparable rate data for the interstate switched access rates charged by the carriers operating in Missouri, as well as intrastate switched access rates which are currently in effect in various other state jurisdictions.

All of this data could potentially be useful to the Commission in determining whether this proceeding should lead into an investigation into potential changes in the existing rates. Most of the interstate rates were obtained from the FCC's web site. Some of the larger carriers have tariff data available on their web sites. This was the primary source relied upon for obtaining the other intrastate rates.

Q. Would you please discuss the results of your research concerning existing switched access rates in comparison with the interstate jurisdiction?

A. Yes. Page 1 of Schedule 5 of my exhibit summarizes this information. The first column summarizes the current intrastate switched access rates of large and small Missouri ILECs. The second column summarizes the analogous rates charged by these carriers in the interstate jurisdiction. The third column compares these two sets of rates, stating the intrastate rates as a percent of the corresponding interstate rates. The final column looks at the same comparison from the other direction, stating the interstate rates as a percentage of the intrastate rates. The remaining pages are organized around the various rate components. Pages 2 and 3 compare the CCL rates, pages 4 and 5 compare the end office switching rates, pages 6 and 7 compare transport rates, and pages 8 and 9 compare these rates on a total basis.

Although the largest ILECs maintain their own interstate tariffs, 35 of the Missouri carriers have adopted the National Exchange Carrier Association (NECA) interstate access service tariff. Two additional carriers have adopted the NECA CCL rate component. I was unable to locate the interstate rates for one Missouri LEC (Citizens Telephone Company). I was able to obtain switched access tariff data in several other states for Alltel, Sprint, Qwest, Verizon, SWBT, Bell South and several Ameritech companies.

As I mentioned earlier, the Missouri intrastate rates were generally taken from copies of the switched access service tariffs on file with the Commission. Most of the interstate rates were obtained from the FCC's web site. Some of the larger carriers have tariff data available on their web sites. This was the primary source relied upon for obtaining the other intrastate rates.

Q. How do the Missouri intrastate rates compare with the rates these carriers charge in the interstate jurisdiction?

A. They are much higher. For instance, on a total basis SWBT's intrastate rates are 946% of its interstate rates. Compared on the same basis, Verizon's intrastate rates are 2028% of its interstate rates, Sprint's intrastate rates are 1159% of its interstate rates, Alltel's interstate rates are 653% of its interstate rates and Century Tel's intrastate rates are 313% of its interstate rates. A similar, but not as extreme, pattern exists with the small ILEC rates. On average, this group of carriers is charging intrastate rates which are 654% of their interstate rates.

Q. Do you have any comments concerning the CCL rate component in the interstate jurisdiction?

A. The FCC has been phasing out this rate element. In part, this has been accomplished by reducing the overall level of access charges, and in part by shifting revenue responsibility from IXCs to end users (through the subscriber line charge which is added to local exchange customers' bills). I compared the average intrastate originating and terminating rates applicable to inter-LATA traffic to the average of the originating and terminating premium interstate rate. The results of this comparison are shown on Pages 4 and 5 of Schedule 5.

Q. Why did you choose to compare the inter-LATA rate rather than the intra-LATA rate?

A. Most, if not all, interstate calls cross LATA boundaries, and thus the interstate rates can be thought of as inter-LATA rates. In turn, the intrastate inter-LATA rate is the most comparable rate to consider. For many of the carriers, the intrastate inter-LATA and intra-LATA rates are identical.

Q. What did this comparison reveal about the interstate and intrastate CCL rates?

A. Some of the large ILECs no longer charge an interstate CCL rate. Nearly all of the other carriers charge CCL rates in the interstate jurisdiction which are lower than their intrastate CCL rate. In virtually every case, the intrastate rate exceeded the interstate CCL rate by a very wide margin. In fact, the differences range from a low of 105% for Goodman Telephone Company to a high of 1906% for Sprint.

Q. Can you briefly summarize your comparison of the End Office Switching rates?

A. Yes. The intrastate tariff has two rates for End Office Switching: LS1 (Local Switching 1) is applicable to Feature Groups A & B and LS2 (Local Switching 2) is applicable to Feature Groups C & D. The interstate tariffs also have LS1 and LS2 rates, but the rates are the same. The rate varies depending on whether premium or non-premium service is provided. I compared the intrastate LS2 rate applicable to Feature Groups C & D to the premium interstate rate. This comparison is shown on Pages 5 and 6. It shows that in this category the companies' intrastate rates are again much higher than their interstate rates. The small ILECs' rates were, on average, 191%

greater than their interstate rates. The discrepancy is even greater for the large ILECs in Missouri: on average, their intrastate switching rates were 526% greater than their interstate rates. SWBT's intrastate rate is 285% of its interstate rate, while Verizon's intrastate rate is 1068% of its interstate rate.

Q. Are there differences between the local transport rate components in the interstate and intrastate jurisdictions?

A. Yes. As I mentioned earlier, in the intrastate jurisdiction the Local Transport rates applicable to Feature Groups A & B can differ from those applicable to Feature Groups C & D. Also, some carriers' rates vary proportionally with distance, while others vary by mileage band, and some are flat rated (not varying with distance). In the interstate jurisdiction the Local Transport rate is generally comprised of a facility rate which is applied on a per minute per mile basis, a termination rate which is applied on a per minute per termination basis, and a tandem switching rate which is applied on a per minute per tandem basis.

Q. Given the differences in the interstate and intrastate tariffs, how did you compare the transport rates?

A. Because tandem switching isn't provided by all carriers in Missouri, I excluded the tandem switching component from the comparisons. I combined the facility and termination rate component of the interstate tariffs and compared that rate to the corresponding intrastate FGC & FGD rate. To deal with the distance variations, I prepared comparisons using three different mileage assumptions: 5 miles, 25 miles and 75 miles. The approach I used here is slightly different than the one used in the context of the cost to rate comparisons, where I used a typical distance of 25 miles for most of the carriers, and used mileages of approximately 62, 23, 29, and 23 miles for Century Tel, SWBT, Sprint and Verizon respectively. Alltel's Local Transport rate does not vary by mileage. In the rate to rate comparisons, I used uniform assumptions of 5, 25 and 75 miles.

Q. What were the results of these comparisons?

A. At the assumed distance of 5 miles, which is set forth on Pages 7 and 8 of Schedule 5, all of the companies' intrastate rates were significantly greater than their interstate rates. The variance ranged from 102% for Century Tel, BPS, Cass County and Ozark to 8065% for SWBT. On average, the small ILEC's intrastate rates were 515% greater than their interstate rates at 5 miles. The large ILEC's intrastate rates averaged 590% higher than their interstate rates at 5 miles.

The results at 25 miles were generally similar, although not quite as extreme. For all but two of the companies, the intrastate rates were greater than the interstate rates, as shown on pages 9 and 10 of Schedule 5. The interstate rates of Choctaw and Orchard Farm exceeded their intrastate rates at 25 miles by 224% and 177% respectively. SWBT again had the greatest differential, at 3521%. Craw-Kan and Mark Twain had the lowest differential at 103% each. The small ILEC rates were 200% greater on average and the large ILEC rates were 325% greater.

At 75 miles, most, but not all, of the small ILECs' interstate rates are greater than their intrastate rates, as shown on pages 11 and 12 of Schedule 5. On average, the small ILECs charge intrastate rates which are 158% greater than their interstate rates. The intrastate rates charged by the large ILECs exceed their interstate rates by an average of 273%. Alltel was the only large ILEC whose interstate rate was greater than its intrastate rate. This occurs because Alltel's intrastate rate does not vary by mileage while its interstate rate does vary on this basis.

Q. You stated previously that you compared the Missouri intrastate rates to the intrastate rates of various other companies in other states. Would you please summarize those comparisons?

A. Yes. I obtained rates from 44 of the 50 states. The rates charged in other states are generally comprised of the same elements as the Missouri companies' rates. The Missouri rates are generally higher. Rates for the other states are set forth on Schedule 6. The total rates range from a low of $0.0029 to a high of $0.0998 with an overall average of $0.0240. The average rate of the Missouri large ILECs is close to the high end of the national range and considerably higher than the average of the other states. The average rate of the small Missouri ILECs is also much higher than the average rate charged by the ILECs in other states. However, the latter comparison must be viewed with caution, since the rate data from other states was obtained from large ILECs.

Q. What were the results of the CCL rate comparison?

A. The results of this comparison were generally consistent with the results of the comparisons with the intrastate cost data, as well as the interstate rate data. As shown on Schedule 6, Pages 4 through 6, the average rate in other states is $0.0093 (taking into consideration those states where the rate is zero). The average intrastate rate of the 5 large Missouri ILECs is $0.0445, which is substantially higher than the average rate charged in the other intrastate jurisdictions. Particularly for the small ILECs, these comparisons must be viewed with caution, since the bulk of the rates we obtained from other states are for large ILECs. However, it is worth noting that the average intrastate rate for the small ILECs in Missouri is greater than the highest CCL rate listed for other states–the $0.0539 rate charged by Sugar Land Telephone, an Alltel affiliate in Texas.

Q. Were the results of the End Office Switching rate comparison similar to those of the CCL comparison?

A. Yes. Although exceptions undoubtedly exist, the Missouri rates generally seem to be higher than those charged in other states. The average rate of the Missouri large ILECs is 199% of the average of the rates we were able to obtain from other states. The average rate of the small ILECs is 210% of the average rates we found in the other states. The rates from the other states are set forth on Pages 7 through 9 of Schedule 6.

Q. When you compared interstate and intrastate Local Transport rates you did several calculations using different mileage assumptions. Did you do similar calculations for the other states' rates?

A. Yes, I did three different comparisons using the same 5, 25 and 75 mile assumptions. Under each assumption, the intrastate rates of the Missouri ILECs were greater than the rates for the other states. The following table summarizes those results.

Table 5

	5 Miles	25 Miles	75 Miles
Other States	$0.0012	$0.0027	$0.0063
Missouri - Large	$0.0083	$0.0138	$0.0308
Mo. % of Other States	592%	411%	389%

CONCLUSION

Q. Have you reached any conclusions about the current level of intrastate Missouri rates?

A. Yes. The cost data we have developed suggests that the Missouri intrastate rates are rather high, relative to costs. In fact, in some instances the switching and transport rates actually exceed our estimate of stand alone costs–which strongly suggests there is reason to be concerned that the existing rates may be higher than appropriate. The rate comparisons with other jurisdictions tends to reinforce this conclusion. In most cases the existing Missouri intrastate rates are substantially above the level charged in other jurisdictions. Of course, to the extent any changes in rates might be contemplated, there are other policy issues which would need to be debated and resolved before any action could appropriately be taken. For instance, the Commission would need to determine whether a carrier's overall level of rates is excessive, or whether reductions in certain rates might appropriately be offset by increases in other rates. Needless to say, these types of issues go well beyond the scope of this proceeding, which is an investigation into the costs of providing access service. Potential rate changes would more appropriately be analyzed in the context of a different proceeding.

Q. Does this complete your direct testimony which was pre-filed on July 1, 2002?

A. Yes, it does.

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

In the Matter of an Investigation of the Actual Costs Incurred in Providing Exchange Access Service and the Access Rates to be Charged by Competitive Local Exchange Telecommunications Companies in the State of Missouri.	)	Case No. TR-2001-65

AFFIDAVIT OF BEN JOHNSON, PhD.

STATE OF MISSOURI)
)
COUNTY OF COLE)

Ben Johnson, PhD., of lawful age, on his oath states: that he has participated in the preparation of the foregoing written testimony in question and answer form, consisting of 136 pages of testimony to be presented in the above case, that the answers in the attached written testimony were given by him; that he has knowledge of the matters set forth in such answers; and that such matters are true to the best of his knowledge and belief.

Ben Johnson, PhD.

Subscribed and sworn to before me this 26th day of June, 2002.

Elizabeth K. Denefield
MY COMMISSION # CC871523 EXPIRES
September 14, 2003
BONDED THRU TROY FAIN INSURANCE INC.

Elizabeth K. Denefield
Notary Public

My commission expires 9/14/2003.