BEFORE THE IDAHO PUBLIC UTILITIES COMMISSION

In the Matter of the Investigation to	**)**	
Determine An Appropriate Cost Model Using	**)**	**Case No. GNR-T-97-22**
Forward-Looking Economic Costs for	**)**	
Calculating the Costs of Basic	**)**	
Telecommunications Services in Idaho	**)**	

DIRECT TESTIMONY OF

BEN JOHNSON, PH.D.

February 17, 1998

Introduction

Q. Would you please state your name and address?

A. Ben Johnson, 1234 Timberlane Road, Tallahassee, Florida 32312.

Q. Have you prepared an exhibit in support of your testimony?

A. Yes, Exhibit ___ (BJ-1), consisting of 9 maps, 28 reports, the User Documentation for the Telecom Economic Cost Model, and an appendix describing my qualifications, is attached to my testimony. This exhibit was prepared under my supervision and is true and correct to the best of my knowledge. In addition, I have attached to my testimony a compact disk (CD) containing the Telecom Model, along with a variety of different sample cost studies. All of these studies are consistent with the request of the Commission Staff in its Memorandum of January 20, 1998.

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

A. The Commission has announced its intention to adopt a forward-looking telecommunications cost model in order to assist in the determination of the appropriate level and distribution of universal service funding in the State of Idaho. In its Notice of Inquiry, Notice of Prehearing Conference, and Order 27269 in this docket, the Commission invited interested parties to submit cost models for the Commission's consideration in this regard. Ben Johnson Associates, Inc. is the developer of the Telecom Economic Cost Model, one of the few models which are capable of being used for this purpose. At the Commission's request, and at its expense, we are submitting our model for consideration in this proceeding. My testimony is in direct support of this submission.

Q. How is your testimony organized?

A. Following this introduction, my testimony has four main sections. In the first, I describe the general properties of telecommunications cost models and indicate in general terms how the Telecom Economic Cost Model differs from its two primary competitors. In the second section I explain some of the specific characteristics of the Telecom Model which make it relatively accurate and realistic on the one hand and relatively flexible and easy to use and modify on the other hand. In the third section of my testimony I present the results of some preliminary model runs prepared using the Telecom Model, and briefly explain some of our results. Finally, in the fourth section of my testimony, I offer my recommendations on what criteria the Commission should use in making its final choice of a model for universal service support purposes.

I. Overview Comparison of the Cost Models

Q. Please turn to the first section of your testimony. For the federal jurisdiction, the FCC is currently trying to decide between Hatfield and BCPM, having rejected an earlier release of your model. Can you explain why the Telecom Model did not survive the FCC's cut?

A. Yes. Version 4.1 of the Telecom Model was one of the three models reviewed by the FCC's Federal-State Joint Board on Universal Service in late 1996 and early 1997 in CC Docket 96-45. The other two models were the Benchmark Proxy Cost Model (BCPM), currently sponsored by U.S.West, Bell South and the local exchange operations of Sprint, and the Hatfield model, sponsored by AT&T and MCI. I will sometimes collectively refer to the latter two models as the "national proxy models."

The Telecom Model was dropped from further consideration, in the FCC's words, "because the proponents have never provided nationwide estimates of universal service support using that model." [FCC 97256, III.A.10.] We still have not prepared such nationwide estimates, since the focus of our modeling efforts is entirely on the state level. Of course, like the national proxy models, the Telecom Model has continued to evolve, and the present release (version 5.1) embodies substantial improvements over earlier versions, especially in regard to the geographic aspects of the network modeling process. However, because of our state-specific orientation we have no reason to model the entire country.

From our cost modeling work in Idaho and half a dozen other states, we know that any such national modeling effort is fraught with difficulty. The geographic and other attributes of each state are sufficiently unique that it is difficult, if not impossible, to develop a single cost study which accurately models every part of every state. This is particularly true for the proponents of the national proxy models, who are attempting to maintain consistency of methodology and data sources and are working within time and budget constraints. As one narrows the focus to individual wire centers within each state, it becomes apparent that the "one size fits all" approach, uniformly applied across the entire country, involves limitations and compromises which reduce the usefulness and accuracy of the resulting cost estimates.

Unlike the national proxy models, the current version of the Telecom Model utilizes a state-of-the-art geographic information system (GIS) approach. The great advantage of our GIS approach is that it permits very detailed and precise mapping of individual customer locations and of the feeder network connecting customers to the wire center. The accuracy and precision of this part of the modeling process is limited only by the time and resource constraints. Improvements in the geographic modeling process can be readily achieved, if necessary, by gathering additional data and by using human judgment to refine the initial results. Once the basic data have been assembled and analyzed, further adjustments and refinements are possible, in order to improve the accuracy of the cost estimates. However, assembling the GIS data requires working with some very large data sets, even for a small state. As a practical matter, we do not begin assembling GIS data for a state unless we have specific cause to do so.

Q. Isn't the Telecom model like the national proxy models in many ways?

A. Yes. All three models share many general characteristics. All three models provide hundreds of user-adjustable input choices, process these inputs through numerous different algorithms, and generate outputs that can be summarized in one or more reports. They all rely primarily on publicly available data rather than proprietary data, all three models place their core logic, or algorithms, in one or more Excel spreadsheets, and they rely upon Visual Basic to automate various functions. All three models attempt to satisfy the FCC's 10 criteria for acceptable universal service cost models, and they all rely upon the same data sources to identify specific wire centers (locations are taken from Bellcore's LERG data base, and estimates of the approximate wire center boundaries are taken from the same BLR data used by the national proxy models. Finally, to the extent their inputs can be reconciled, their outputs tend to be similar--at least when the results are reported at a high enough level of aggregation (e.g. for an entire state).

Q. If the three models share so many characteristics, does it matter which one the Commission adopts?

A. Yes. While there are many similarities, there are also differences. The models are not equally capable of developing precise cost estimates for specific locations within each state. These differences can translate into different rates or support payments for specific locations within each state. If the cost of providing service in sparsely populated areas is overestimated, due to modeling errors or inappropriate inputs, excessive levels of support may be provided, which may encourage uneconomic entry and bloat the size of the universal service fund. Conversely, if costs and support levels are set too low, this could create a barrier to entry that will discourage investment by competitive carriers, and possibly threaten the quality and availability of service in rural, high cost areas. The cost of improving and refining the cost estimates is relatively small, at least in comparison with the amount of money that may potentially flow through a universal service funding mechanism. Hence, it is appropriate to take the additional time and effort required to develop highly accurate and realistic estimates of the forward-looking cost of providing telephone services in each specific area within the state.

II. Unique Features of the Telecom Economic Cost Model

Q. Please turn to the second section of your testimony. What features of the Telecom Model set it apart from the national proxy models?

A. The unique features of the Telecom Model include the following:

1. Dozens of different types of cost can be estimated. The national proxy models estimate one or two types of cost.
2. Costs can be estimated for up to thirty different residential, business and

special access customer categories, including a variety of different services. The national proxy models do not have this degree of flexibility.

3. Carrier market shares can be specified in great detail, ranging from an incumbent carrier serving 100 percent of the market (a monopolist) to a specialized competitive carrier that only serves certain specific types of customers within limited geographic areas (a niche carrier). The national proxy models do not model market shares explicitly and cannot accommodate this full range of variation in carrier characteristics.

4. The mix of fiber and copper cable can be modeled using a variety of different approaches, including true cost minimization. The national proxy models offer fewer options in this regard; most notably, they do not allow the user to determine the lowest cost configuration for each wire center.

5. The model relies upon Geographic Information System to identify the locations of customers, feeder segments, and distribution areas.

6. The distribution areas in each wire center can be grouped into two user-specified zones. This provides a convenient way of accurately identifying the high cost portions of each carrier's service area. The national proxy models do not provide a comparable feature. They only report costs for wire centers as a whole, and for Census Block Groups--which are extremely numerous, and do not have any consistent relationship with the factors which influence telephone network design.

7. An integrated data base stores all of the inputs and outputs associated with each study produced by the Telecom Model. This enables the user to generate numerous different reports with varying degrees of detail and emphasis. The national proxy models have much more limited reporting capabilities.

Q. Let's examine each of these features in turn. First, what kinds of costs does the Telecom Model estimate?

A. Whereas the national proxy models are generally limited to estimating the long-run total cost (LRTC) of universal service and the TELRIC of unbundled service elements, the Telecom Model offers a wide variety of additional options. For example, it can estimate a dozen different varieties of long-run stand-alone cost, numerous different types of total service long-run incremental cost (TSLRIC), and several types of long-run marginal cost.

The TSLRIC and TELRIC options are typically used in developing cost-based pricing of services and UNEs, respectively. The TSLRIC option allows computation of the additional cost of expanding (or contracting) the network to serve (or not serve) a specified block of customers, a particular geographic zone, a specific service, or virtually any combination of specific customers, zones and services. Stand-alone costs are typically used in developing ceiling prices. Economies of scope 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 LRSAC and TLSRIC results will display this phenomenon, and be useful in establishing appropriate prices.

Marginal costs are of particular interest to economists, because it focuses on the effect of very small changes in output occurring at the point in the total cost curve where decisions are being made. The Telecom Model develops marginal cost estimates by producing an iterative series of total cost estimates, over a range of output volumes. It then computes the slope of the total cost curve within this range. These cost estimates can be useful in predicting the lower limit on price levels in an intensely competitive market (e.g., during a price war). Marginal cost studies can also be useful in answering questions about a firm's profit-maximizing point of production--i.e., at what price level would marginal revenue equal marginal cost? It can also be useful in establishing the floor price for specific services under a price-capping or alternative price regulation regime.

Finally, the total cost option computes the total cost of a network serving all categories of customers and all services, within both geographic zones in the wire center. This is the general approach used by the national proxy models, and is likely to be particularly useful in establishing the overall size of a universal service fund.

Q. Inasmuch as all three models provide long-run total cost estimates, and this is the type of cost which is of primary interest in developing a universal service fund, are the Telecom Model's additional options of any relevance here?

A. Yes. First, the stand alone cost and TSLRIC options are useful in gaining additional insight into the geographic patterns of costs within the state. We have prepared some cost studies which analyze the stand alone cost of serving zone 1 (the distribution areas which are relatively close to the wire center, and which typically have somewhat higher than average density). For comparison, we also prepared some studies which analyze the stand alone cost of serving zone 2 (distribution areas which are farther from the wire center, and which generally have lower density). Collectively, these studies provide additional insights into the relative costs of serving these different geographic areas, without relying upon cost allocation procedures (which tend to be controversial, and are necessarily somewhat arbitrary). Similarly, we prepared some TSLRIC studies which focus on the incremental cost of adding zone 2 distribution areas to a network which would otherwise only serve zone 1, and for comparison we prepared some reports that focus on the incremental cost of adding zone 1 to a network which would otherwise only serve zone 2.

Second, in the months and years ahead the Commission will need to deal with other costing situations and issues in which the ability to obtain more than one type of cost study will undoubtedly be helpful. The Commission will want to rely upon costing procedures that are consistent and compatible both internally and externally, while ensuring that it has the full range of economic cost information potentially available from a flexible, state-of-the-art cost model. As the Commission noted in its *Notice of Inquiry, Notice of Prehearing Conference, and Order 27269* in this docket,

> At this time, the Commission believes that the selection of a model should serve two purposes. First, it will be used to determine the cost of providing support for universal service in high-cost areas of the state of Idaho. Second, it will be used as an aid to determine the costs of providing individual services and unbundled network elements in the context of future arbitration, mediation, and negotiations of interconnection agreements betweem individual telecommunications providers. [p. 3.]

The FCC also recognized the further uses of the selected model in its Universal Service Order:

> We ... encourage a state, to the extent possible and consistent with the [FCC's 10] criteria, to use its ongoing proceedings to develop permanent unbundled network element prices as a basis for its universal service cost study. *This would reduce duplication and diminish arbitrage opportunities that might arise from inconsistencies between the methodologies for setting unbundled network element prices and for determining universal service support levels.* In particular, we wish to avoid situations in which, because of different methodologies used for pricing unbundled network elements and determining universal service support, a carrier could receive support for the provision of universal service that differs from the rate it pays to acquire access to the unbundled network elements needed to provide universal service... [¶ 250, notes omitted, emphasis added.]

The versatility of the Telecom Model may not seem especially significant within the context of a single issue like universal service, but will be quite beneficial over the course of numerous different proceedings concerning a variety of different issues.

Q. Please discuss the second feature you mentioned. How does the model treat customer groups and service categories?

A. This is another feature of the model that may not be significant in the context of a universal service fund, but which can be quite helpful in other proceedings. It allows the user to separately analyze up to 30 different classifications of residential, business, and special access customers. Users have almost complete flexibility in targeting the specific groups of customers or services which are of interest in a particular context. For example, a study might focus on the distinction between residence customers who purchase ordinary flat rated service and those who purchase local measured service. The model can not only differentiate differences in their switching costs (measured service customers tend to place fewer calls), but it can also isolate other costing nuances, such as differences in the geographic areas where these different types of customers tend to be located.

Another important policy issue the Commission must deal with has been termed 'rate rebalancing.' Because the model can calculate various different types of economic costs for many different services and elements, it can provide important insights into this issue. For instance, it can be helpful in analyzing the relationships between switched access costs and rates and between residence and business local exchange costs and rates. In regard to these types of issues, the Telecom Model offers the Commission a much wider range of information than other available models. For example, the Commission may find TSLRIC and marginal cost data useful when judging the lower bound of reasonable access rates, while it may find the stand alone cost data particularly useful when judging the upper bounds of reasonable access rates. Similarly, with a bit of coaxing, the model can provide detailed cost information for numerous different classifications of business customers (e.g., single line, key, PBX, and Centrex). It can even be used to estimate the cost of a contract service arrangement provided to a single customer in a handful of specific geographic locations.

Q. Would you please elaborate on the third feature you mentioned, relating to carrier market shares?

A. Yes. Economies of scale and scope can cause per-unit costs to vary widely with the size of the network. As telecom markets become more competitive, it will become increasingly important to consider how a carrier's costs are related to its market share, as well as the geographic scope of its facilities.

The Telecom Model will build a network optimally sized to serve any specified portion of the overall market. In the studies submitted with this testimony, we used the default value of 100 percent market share, and thus the model built a network optimally sized for serving all of the customers in the each geographic area. However, if a lesser market share is specified, the model will build a smaller network in that geographic area, one just large enough to serve that percentage of the customers. It should be apparent that a market share of, say, 25 percent, distributed over the entire wire center will translate into substantially higher per-unit costs than will a market share of 100 percent. Particularly in rural areas, it costs nearly as much to install cable to serve every fourth house along a road as it does to serve every house.

Q. Is it realistic to assume that a smaller carrier will serve a uniform percentage of every market?

A. No. Because they can't take full advantage of economies of scale, competitive carriers are unlikely to build facilities uniformly across all markets. To the contrary, they are likely to target particular customer groups, and geographic areas, where they believe their prospects are the brightest. The Telecom Model is sufficiently flexible to allow for costing of even highly specialized competitive carriers, serving specific niche markets. Through the judicious use of the "niche specific" option, the user can analyze virtually any situation, including a "cream skimming" scenario in which the carrier builds its own network facilities to serve a particular share of certain limited market niches. The Telecom Model's capabilities in this regard are unmatched.

Such market-related information could prove valuable to the Commission's future deliberations concerning rural exemptions, as provided for under both the FCC's regulations and state law. Cost study results may reveal that some rural markets are not susceptible to effective competition, because competitive entry into these markets may drive up costs per-line to unacceptably high levels. This type of information may be particularly useful in evaluating competing claims concerning requests for continued rural exemptions.

Q. Would you next discuss the fourth feature you mentioned--the way in which your model handles feeder technology choices?

A. Yes. Three distinct feeder technologies should be considered in a long-run cost study: analog copper, digital loop carrier (DLC) on copper and DLC on fiber.

In this regard, the Telecom Model is exceptionally flexible and powerful. The user can choose amongst five different options: (1) a combination of analog copper and DLC on copper (for long loops); (2) a network consisting entirely of fiber feeder cables; (3) a combination of copper and fiber feeder based upon engineering criteria regarding total loop length; (4) a mix of copper and fiber cable based upon engineering criteria concerning cumulative feeder length; and (5) a cost-minimizing mix of technologies. With the latter option, the model selects and deploys the cost minimizing technology or combination of technologies on each feeder segment and identifies the least costly locations (nodes) for remote digital loop carrier (DLC) electronics. The model identifies the least-cost solution by systematically sorting through thousands of potential configurations, segment by segment and node by node, searching for the least costly combinations, taking into account all of the relevant costs. For instance, the model recognizes that manhole and conduit costs can be reduced along routes where fiber optic cable is deployed. However, this option requires a higher level of computing power, and is much more time consuming, than the others. We are currently in the process of developing improvements to this option in an effort to reduce these computing requirements, and thus have not included it in the version which has been submitted with this testimony.

Q. Please discuss the fifth feature you mentioned earlier--reliance on geographic information systems data. To begin, what is a geographic information system (GIS)?

A. A GIS is a computerized data handling and processing system which is capable of storing and using data describing places on the Earth's surface. It enables the user to analyze the spatial relationships between different data sets using location as the common attribute. User defined data layers can be combined to produce a map or perform spatial analysis functions as long as each layer is registered to a common geographic referencing system (e.g., latitude and longitude).

Central to a GIS (and distinguishing it from a computer mapping system that produces only graphic output) is a data base system linking spatial data to geographic information for map features. It is based on three types of data elements: polygons, lines, and points. Behind each element is a table of attributes describing each map feature and its relationship to other features. Any item stored in the tabular data base can be used for spatial analysis and mapping purposes in conjunction with any other map features and associated attributes. Thus a wide range of spatial and tabular information can be analyzed, stored, and updated with minimal effort and expense.

Q. In the Telecom Model, how is the GIS concept applied?

A. The Telecom model begins with GIS data relating to three key concepts: feeder segments, nodes, and distribution areas. The model uses GIS-based data describing soil conditions, telecom demand characteristics, and other attributes which are subsequently organized around distribution areas (DAs). These DAs are subsets of the wire center serving areas, which are approximately equivalent to the geographic areas served by each existing wire center. The model can use GIS-based data specifying the exact boundaries of the wire center, if such data are available. Normally, however, as in this case, an approximation of that boundary is used instead, derived from data supplied by BLR--the same data source used by the national proxy models.

The distribution areas are connected to the wire center central office using a series of feeder segments. It isn't necessary to tell the model the exact routing of each feeder segment; it is sufficient to indicate the sequence of segments which connect to each other, and which ultimately connect to the central office. Each segment of feeder cable connects to the next segment of feeder cable at a "node," which is typically the same point where a feeder/distribution interface exists--where a feeder segment connects to distribution cable. Within the Telecom Model, these points are described as "DA nodes." Most feeder segments connect at "DA nodes," but can also connect at "non DA nodes" unassociated with any particular distribution area.

The Telecom Model can model long-run economic costs in a context where none of the geographic attributes of the existing network are retained except the latitude and longitude of the wire center (this is the "scorched node" approach favored by the FCC, and the one that we used here). Alternatively, if the necessary proprietary data is available, the model can also develop costs for a network in which various geographic attributes of the existing network (e.g., the latitude and longitude of DA nodes) are retained.

Q. How are the GIS data typically processed?

A. We begin with telephone numbers and addresses from the white page listings. These data are normally disaggregated into residence, business and government listings. To the extent feasible, we identify the exact geographic location (latitude and longitude) of each listing. The listing source data (PhoneCD) will include latitude and longitude data for some listings; this is supplemented with address matching using zip+4 and street segment data where possible. However, some listings include no address information, or addresses which cannot be accurately geo-coded (e.g. rural route numbers). In wire centers where this is a serious problem, estimating techniques are used to place the listing data in locations which are believed to be representative of actual customer locations.

We use the geo-coded listing data in conjunction with the approximate boundaries of the wire center serving areas (from BLR) to define the geographic boundaries of each distribution area, to locate the latitude and longitude of each DA node, and to connect each DA node to its respective wire center by way of a series of feeder segments. This process is entirely data driven and is accomplished using ArcInfo GIS software on a largely automated basis (ArcInfo software, developed by Environmental Systems Research Institute of Redlands, California is the industry-leading GIS software).

I have prepared a series of maps relating to the four sample wire centers, which illustrate the results of this process. These maps are included at the front of my exhibit. The first map for each wire center is in color; it shows rivers (black lines), roads (blue lines) a schematic diagram of the feeder segments (brown lines) and the dividing lines between the various distribution areas (orange lines). The blue and green dots indicate the approximate location of the customers served by each wire center, as derived from white page listings. The residential locations are shown in green, business locations are in blue. The black and white maps shows the location of the wire center, the approximate boundaries of each individual distribution area (DA) within the wire center, the DA nodes, and all of the feeder segments used to connect the DA nodes to the wire center. The second and third maps differ slightly, in that the second identifies the individual feeder segments while the third page identifies the DA nodes.

As shown, the feeder segments, nodes and distribution areas are identified by numerical codes. The feeder segment codes can be readily identified by the fact that they are long numbers with many zeros at the end. The nodes at the end of each of these feeder segments are identified by numbers that generally don't end with many zeros. These codes are also used to identify the distribution areas served by the nodes. The codes shown on the black and white maps are used throughout the detailed reports generated by the Telecom Model. It should be noted that the codes used to identify feeder segments and DA nodes are meaningful only when matched to a specific wire center--which can be identified by its name or CLLI code. For example, all wire centers have a feeder segment numbered 100000000. Thus, to uniquely identify a specific segment it is necessary to note both the wire center name or CLLI code and the segment number. When the proper matching has been accomplished, it is possible to precisely match the cost estimates generated by the Telecom Model with specific neighborhoods within each wire center serving area. This can be helpful in gaining a deeper understanding of the cost results, and in refining and improving the cost estimates.

Q. Can the network routing and design be further refined by using a less computerized, more labor-intensive approach?

A. Yes. With additional time and effort, an outside plant engineer could potentially develop a more accurate feeder network than one developed through our largely automated approach, since it does not consider all of the different nuances and variables that would be considered by an engineer. Although the distribution areas and feeder networks developed in ArcInfo are adequate for most purposes, it should be recognized that further refinement is possible. If the network design in each wire center were manually refined, I would anticipate the cost estimates would tend to decline slightly.

Q. You say that the basic line data are derived from white page listings. Since special access lines do not appear in such listings, how do you estimate their costs?

A. Special access service is a problem for any cost model which relies upon public information, because it is very difficult to accurately estimate the location of customers that use special access lines, or the magnitude of their usage of this service. For purposes of this filing, we have followed two different approaches. In most of the sample studies, we have excluded non-switched (special access) lines. This has a tendency to slightly elevate the level of average cost per line, since it ignores the additional economies of scale and scope which are available when the same network provides both switched and special services. For other studies, we included an estimate of the overall number of non-switched working loops, spread through the various distribution areas at locations in proportion to the number of business and government listings. While the correlation is obviously less than perfect, these data do provide a rough indication of the likely location of special access customers. Consistent with this simplified approach, we treated these loops as if they were all being used for voice grade analog private lines. This provides a reasonable estimate of the impact of special access lines on the size of the cables which are used to provide both switched and non-switched services. However, it simplifies away the complexities associated with estimating the mix of actual special access line types (analog, DS0, DS1, and DS3) within each wire center. Although both of the sample approaches used in preparing this filing are simplified, I would note that the Telecom Model can accommodate much more detailed modeling of special access services, particularly if additional data are obtained from the local exchange carrier concerning the specific mix and geographic location of the special access lines provided within each wire center.

Q. Returning to the modeling process, how are the GIS data incorporated into the Telecom Model?

A. The ArcInfo GIS software is used to organize and summarize relevant data concerning each feeder segment and distribution area. This data is subsequently input into the Telecom Model. The GIS data includes spatial characteristics of the network, such as feeder segment length and distribution area size (square miles), the number of residence, business, and government listings within each distribution area, and indicators of the spatial distance of these listings to the DA node. Additional GIS data include indicators of the soil type, bedrock depth and hardness, groundwater depth, and road density along each feeder segment route, and analogous data for each distribution area. This information is used in the Telecom Model to estimate the cost and the type of structures (aerial/underground/buried) which would be used to install feeder and distribution cables within each portion of each wire center.

Q. What makes your GIS approach superior ?

A. With regard to geographic data, our approach offers greater flexibility and power than any other model we are aware of. It can develop costs for virtually any geographic unit, ranging from a wire center serving area, to specific zones served by each wire center, to a specific neighborhood or distribution area. Normally, the smallest geographic area modeled would be a distribution area. The model can readily accommodate the fact that distribution areas can vary widely in size. In an urban wire center, a single distribution area will typically encompass 200 customers or more, and each distribution area will represent perhaps 1 percent to 5 percent of the overall wire center serving area. In more rural locations, a distribution area will typically cover a larger geographic area but encompass fewer customers. A typical rural wire center can have distribution areas serving as few as a dozen customers; each distribution area would encompass perhaps 3 percent to 10 percent of the overall wire center serving area. I provide these statistics for illustrative purposes only; the specifics can and will vary, depending upon the geographic data used in running the model. The potential variability of this underlying geographic data can be quite substantial.

The Telecom Model's GIS approach can overcome the inherent limitations of census block groups (CBGs) or census blocks. Some of the deficiencies in the CBG approach have recently been conceded by the sponsors of BCPM, who are making an effort to move to a more precise approach:

> In order to accurately determine the cost of serving customers in rural, insular and high cost areas it will be necessary to go below the level of the CBG. These are precisely the areas where costs are the highest, and the need for accurately targeting the support is the greatest.... Ideally, the geographic unit utilized should be at a level at which the costs of serving customers within it does not differ significantly. [Joint Comments of BellSouth Corporation, BellSouth Telecommunications, Inc., U S WEST, Inc., and Sprint Local Telephone Companies to FCC, *Further Notice of Proposed Rulemaking Sections III.C.1.* CC Dockets 96-45, 97-160, p. 14.]

In this regard, I wish to emphasize that the GIS data are inputs to the model, not outputs from the model. To the extent there are limitations or weaknesses in some of the GIS data which we used in running the Telecom Model in this proceeding, these weaknesses can readily be overcome with additional effort. The Telecom Model can use virtually any geographic data source, provided those data can be converted into a GIS compatible format. As better data sources are developed (e.g., exact geographic locations of customers in remote areas) the accuracy of the Telecom Model cost estimates can be readily improved without necessarily requiring any changes to the model itself.

Q. You indicated that the Telecom Model can use the local exchange company's actual route data. In that case, would your results be different from the ILEC's embedded cost data, as reflected in its accounting records?

A. Yes. Even if the ILEC's existing facility locations were used in the Telecom Model, there would still be numerous differences between the resulting cost estimates and the embedded costs. The embedded and forward looking networks would likely differ with regard to cable sizes, cable technology (copper/fiber mix), location and type of remote electronics, etc.

Q. Would you please discuss the sixth feature you mentioned earlier--the ability to analyze user-specified zones within each wire center?

A. Yes. As I have explained, wire centers can differ widely in the number of lines they serve and in the geographic areas they cover. But analogous variations are also present within the individual wire centers. Cost estimates that are developed for wire centers as a whole will fail to reveal whether there are both low cost and high cost areas within some of the individual wire centers. A finer-grain approach is needed to determine which customers will be eligible for high-cost support and which will not. For this purpose, the output of the Telecom Model can be analyzed in terms of individual distribution areas, census blocks, census block groups, or other relatively small geographic areas. The disadvantage is that any such analysis will involve numerous small areas, which are difficult to interpret or respond to. As an alternative, the Telecom Model offers the option of grouping the distribution areas within each wire center into two zones. This provides a highly manageable degree of granularity for reporting purposes, and facilitates a variety of other analyses (e.g., stand-alone cost estimates can separately be prepared for each zone).

Q. How are the zone designations typically used?

A. Zone 1 is typically used to designate distribution areas in the immediate vicinity of the central office or end office switch (usually those with the highest density). Zone 2 is usually designated to encompass a larger geographic area, with greater loop lengths and a lower concentration of customers.

While the zone designations are normally related to distance from the wire center (since loop length is the major determinant of loop cost), users are not limited to this approach. In this case, we have further specified that distribution areas within zone 1 must include at least 30 lines; all others are placed in zone 2. However, the zone designation can be specified individually for each DA on some entirely different basis for purposes of a particular study (e.g., the presence or absence of facilities-based competition).

Q. Can zone 2 costs be studied as incremental to zone 1 costs, or conversely?

A. Yes. Once zone identities have been established on the basis of the chosen criterion (e.g., distance from the central office, or service available from a facilities based competitor), the model can answer such questions as the following: “Given the cost of a network serving only zone 1, what is the additional (incremental) cost of building out that network to serve zone 2 as well? As far as I know, the Telecom Model is the only model with this capability; yet questions like this lie at the heart of the issue of universal service support.

Q. Finally, would you explain the seventh feature you mentioned--the model's ability to generate a wide range of reports?

A. Yes. The Telecom Model offers far more exhaustive reporting capabilities than the national proxy models. It allows the user to create dozens of different reports that summarize the inputs and outputs of a study in tabular form, with varying levels of detail. I have provided a list of the currently available reports as part of my exhibit, along with some samples.

III. Results of Idaho Studies

Q. Can you explain how you adapted your model to Idaho?

A. Yes. We used the Telecom Model to separately estimate costs for the four wire centers specified in the Commission's instructions, as well as others. All of the studies we have submitted with this testimony were made using the inputs specified on page 3 of Staff's Cost Model Memorandum of January 20, 1998. To provide the Commission with an indication of the impact of varying other inputs, we prepared three different sets of default inputs. Those labeled "high" tend to result in relatively high cost estimates, those labeled "low" tend to result in relatively low cost estimates, and those labeled "mid" fall tend to fall between these two examples.

Q. Have you provided some samples of output from The Telecom Model?

A. Yes. The Telecom Model can produce enormous volumes of output, which can seem overwhelming to those who aren't thoroughly familiar with the model. Because the emphasis in this phase of the proceeding is on selecting a particular cost model, rather than reaching a final conclusion concerning specific cost results, the approach I have used in preparing my exhibit is to provide a wide array of sample cost studies and reports. While this may seem confusing, I felt it was important to emphasize by example the flexibility and versatility of the Telecom Model. In confronting tough policy issues, the Commission will find that the Telecom Model can often provide several different perspectives on the issue, rather than a single perspective.

Since the array of sample numbers in my exhibit may be rather confusing, below I have selected a few key examples, which the Commission might find helpful in getting a feel for the overall level of costs estimated by the model.

The four wire centers selected by the Commission Staff contain approximately one-fifth of U S WEST's lines in Idaho, and demonstrate that wide variations exist in the level of long run total cost per line. Rural wire centers tend to have higher costs than urban wire centers; there are many high cost rural wire centers in Idaho, as reflected in the overall statewide averages.

U S West Wire Centers
Long Run Total Cost (LRTC) per line per Month

	IPUC 4	69 wc's
Low	$15.24	$20.17
Mid	$19.00	$27.58
High	$26.10	$38.86

As can be seen from the above table, as a group the four selected wire centers have somewhat lower costs than the average of all wire centers--not surprising, since two of the four are urban (Boise Main and Pocatello North). Many areas in Idaho have high costs, including all of Castleford and portions of American Falls. For instance, using the mid inputs, monthly distribution costs per line (LRTC) average $11.61 (a substantial portion of the $27.58 figure listed above). However, this statewide figure encompasses a wide range of costs for individual wire centers. In the Boise Main wire center, distribution costs are just $3.14 per month; in Castleford they are $67.13. Distribution costs can even vary widely within a single wire center, as demonstrated by the American Falls example, where Zone 1 averages $4.29 per month while Zone 2 averages $200.05.

Q. You discussed zones earlier in your testimony. To gain a better appreciation of how the Telecom Model could be useful, can you explain how the Commission might use the zone concept in creating and administering a universal service fund?

A. As previously discussed The Telecom Model allows the distribution areas within each wire center to be grouped into two zones. The criteria used in establishing these zones can be defined by the Commission. For purposes of the sample results provided with this filing, we specified that distribution areas within zone 1 must include at least 30 lines, and the DA node must be located within 6,500 feet of the wire center. All other DAs were placed in zone 2. Under this definition, distribution costs in zone 2 the range was from a low of $2.89 in Boise Main to $399.42 in Montpelier. Distribution costs in zone 1 vary from a low in Boise Main of $1.79 to a high in Lewisville-Menan of $76.23. For Lewisville-Menan there were only 35 lines in zone 1, just above the cutoff we selected for illustrative purposes. By adjusting these two criteria (distance from the wire center and number of lines per DA), the Commission can quickly and easily sort DAs into logical groupings that have a reasonable degree of homogeneity.

For example, the Commission might organize all 69 U S West wire centers into five groups, and provide for two zones within each such group. This would translate into a total of 10 distinct costing categories. While some of this analysis can be handled automatically, by sorting the wire centers and adjusting the zone criteria, further refinements can be made manually, to ensure a reasonably high degree of homogeneity within each of these 10 categories. Once this had been accomplished, the 10 relatively homogeneous categories could then be used in analyzing costs and distributing universal service funds. Such an approach would allow the Commission to strike a reasonable balance between an extremely heterogeneous or disaggregated USF System (e.g. one built around individual distribution areas or CBGs), and one which involves a high degree of averaging (e.g. one which barely meets the FCC's minimum criteria, by sorting wire centers into three groups).

In fashioning a universal service fund the Commission needs to look at trade-offs among the benchmark rate, the size of the fund, the degree of administrative complexity, and the potential impact on carriers and customers. An important factor in balancing these considerations is the appropriate geographic definition of the areas eligible for support, since this can dramatically affect the size of the fund. The Telecom Model provides considerable flexibility in this regard, allowing the Commission to strike an appropriate balance between competing policy considerations.

Q. What do the variations in zone costs say about Idaho's telephone system?

A. In the state's most urban areas, costs do not vary significantly between zones--for example the LRTC distribution costs for Boise West are $2.56 for zone 1 and $2.81 for zone 2. On the other hand, in some of the smaller cities and towns the differences in LRTC distribution costs between zone 1 and zone 2 are much wider--for example in Soda

Springs, the zone 1 cost is $4.56 and the zone 2 cost is $108.11. The Telecom Model can quickly and efficiently highlight these types of cost variations, helping the Commission gain a deeper understanding of the tradeoffs involved in designing a state universal service fund.

IV. Recommendations

Q. Please turn to the fourth and final section of your testimony. In its Cost Model Memorandum of January 20, 1998, Staff requested that "each party provide its own specific and practical advice on how it believes the Commission should go about choosing a model." [p. 5.] What is your response?

A. Staff's follow-up to the quote above clarifies the request: "What is sought is a pointed answer to the question of what determines whether a cost model is appropriate for use in Idaho." [Id.] In my opinion, the Commission should focus on the following criteria:

- Potential for developing the most accurate and precise cost estimates.
- Potential for assisting the Commission with the entire range of telecommunications cost related regulatory issues.
- Potential for further refinement and improvement by the Commission and interested parties as additional data is gathered and modeling experience is gained.
- Lack of built-in bias.

Q. Does this conclude your testimony, prefiled on February 17, 1998?

A. Yes, it does.