current demand, but also anticipated future demand.[192] BCPM adopts this convention. Setting the fill factor at 100 percent in BCPM offsets BCPM's assumption that every household has two lines and the resulting estimation of appropriate cable sizes is sufficient to meet current demand, rather than long term growth.[193]

99. In a meeting with Commission staff, Ameritech raised the issue of whether industry practice is the appropriate guideline for determining fill factors to use in estimating the forward-looking economic cost of providing the services supported by the federal mechanism. Ameritech claims that forward-looking fill factors should reflect enough capacity to provide service for new customers for a few years until new facilities are built, and should account for the excess capacity required for maintenance and testing, defective copper pairs, and churn.[194]

100. We tentatively conclude that the fill factors selected for use in the federal mechanism generally should reflect current demand,[195] and not reflect the industry practice of building distribution plant to meet "ultimate" demand. The fact that industry may build distribution plant sufficient to meet demand for ten or twenty years does not necessarily suggest that these costs should be supported by universal service support mechanisms. This also appears to reflect the assumptions underlying the HAI and BCPM default fill factors. Because the synthesis model designs outside plant to meet current demand in the same manner as the HAI model, we believe the fill factors should be set at less than 100 percent. We tentatively select the HAI defaults for distribution fill factors and tentatively conclude that they reflect the appropriate fill needed to meet current demand. We seek comment on these tentative conclusions.

101. Feeder Fill Factors. In contrast to distribution plant, feeder plant typically is

[192] For example, in an *ex parte* meeting on March 24, 1999, Ameritech representatives said that Ameritech designs distribution plant to meet "ultimate" demand and designs feeder plant that is "growable." *See* Letter from Celia Nogales, Ameritech, to Magalie Roman Salas, FCC, dated March 25, 1999 (Ameritech March 25 *ex parte*).

[193] Commission staff requested that the BCPM sponsors make this change from earlier versions of BCPM to avoid double counting. That is, cable sizing in BCPM is a function of both the number of lines per customer location and the fill factor. In HAI, cable sizing is a function of the number of customer locations and current demand of 1.2 telephones per household.

[194] Ameritech filed data, subject to the protective order in this proceeding, showing how these considerations are used to calculate the actual and forward-looking fill factors in Ameritech's territory. *See* Ameritech March 25 *ex parte*.

[195] We define "current demand" to include a reasonable amount of excess capacity to accommodate short term growth.

designed to meet only current and short term capacity needs.[196] The BCPM copper feeder default fill factors are slightly higher than HAI's, but both the HAI and BCPM default values appear to reflect current industry practice of sizing feeder cable to meet current, rather than long term, demand. Because both the HAI and BCPM default values assume that copper feeder fill reflects current demand, we tentatively select copper feeder fill factors that are the average of the HAI and BCPM default values. We seek comment on these tentative selections.

102. Fiber Fill Factors. Because of differences in technology, fiber fill factors typically are higher than copper feeder fill factors. Standard fiber optic multiplexers operate on four fiber strands: primary optical transmit, primary optical receive, redundant optical transmit, and redundant optical receive. In determining appropriate fiber cable sizes, network engineers take into account this 100 percent redundancy in determining whether excess capacity is needed that would warrant application of a fill factor.[197] Both the HAI and BCPM models use the standard practice of providing 100 percent redundancy for fiber and set the default fiber fill factors at 100 percent. We tentatively conclude that the input value for fiber fill in the federal mechanism should be 100 percent. We seek comment on this tentative conclusion.

C. Structure Costs

1. Background

103. In the *1997 Further Notice*, the Commission sought comment and adopted tentative findings and conclusions on issues relating to the cost of outside plant. The Commission directed the HAI and BCPM proponents to justify fully their default values for their mix of aerial, underground, and buried structure (*i.e.*, plant mix) and sought comment on the input values that will accurately reflect the impact of varying terrain conditions on costs.[198] The Commission noted that "recent installations of outside structure may more closely meet forward-looking design criteria than do historical installations."[199] The Commission found that an efficient carrier will vary its plant mix according to the population density of an area and tentatively concluded that the assignment of plant mix defined by the model should reflect both terrain factors and line density zones.[200] Because burying cable in

[196] *See, e.g.*, Ameritech March 25 *ex parte*.

[197] That is, fiber plant with a 100 percent fill factor has an actual utilization of 50 percent; whereas copper plant with a 50 percent fill factor has an actual utilization of 50 percent.

[198] *1997 Further Notice*, 12 FCC Rcd at 18541.

[199] *1997 Further Notice*, 12 FCC Rcd at 18541.

[200] *1997 Further Notice*, 12 FCC Rcd at 18541.

very rocky areas is costly, for example, the Commission tentatively concluded that relatively more feeder and distribution cable should be assigned to aerial installation for all density zones in wire centers characterized as "hard rock" conditions than in those wire centers with other terrain conditions.[201]

104. Outside plant structure refers to the set of facilities that support, house, guide, or otherwise protect distribution and feeder cable and varies by plant mix. Aerial structure consists of telephone poles, and associated hardware, such as anchors and guys. Buried structure consists of trenches.[202] Underground structure consists of trenches and conduit, and for feeder plant, manholes and pullboxes. As noted, underground cable is placed underground within conduits for added support and protection. Structure costs include the initial capital outlay for physical material associated with outside plant structure, including manholes; conduit, trenches, poles, anchors and guys, and other facilities; the capitalized cost for supplies, delivery, provisioning, right of way fees, taxes, and any other capitalized costs directly attributable to these assets; and the capitalized cost for the labor, engineering, and materials required to install these assets. For example, buried and underground structure costs include capitalized labor, engineering, and material costs for such activities as plowing or trenching, backfilling, boring cable, and cutting and restoring asphalt, concrete, or sod, or any combination of such activities.

105. Both the HAI and BCPM sponsors provide default input values for structure costs that are based upon the opinions of their respective experts, without backup data that allows us to substantiate these values. Although BCPM provides one nationwide set of default values for structure costs, the BCPM sponsors have argued that we should use company-specific inputs and have proposed alternative values for company-specific structure costs in some study areas.[203] In addition, the Commission received other structure cost data from a number of LECs, including data received in response to the structure and cable cost survey developed by staff, which staff is continuing to analyze, as noted above.

2. Issues for Comment

106. The synthesis model uses structure cost tables that identify the per foot cost of structure by type (aerial, buried, or underground), loop segment (distribution or feeder), and terrain conditions (normal, soft rock, or hard rock), for each of the nine density zones. For

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[201] *1997 Further Notice*, 12 FCC Rcd at 18541.

[202] When a plow is used to place buried cable, a separate trench is not required.

[203] *See* Letter from Pete Sywenki, Sprint, to Magalie Roman Salas, FCC, dated June 11, 1998, attachment; BellSouth reply comments dated June 12, 1998, at 2 (arguing only state specific input values are appropriate); Letter from William W. Jordan, BellSouth, to Magalie Roman Salas, FCC, dated August 7, 1998, attachment, Responses to FCC Staff Questions of June 25, 1998, Question 4.

aerial structure, the cost per foot that is entered in the model is calculated by dividing the total installed cost per telephone pole by the distance between poles. As described below, we tentatively conclude that we should use, with certain modifications, the estimates in the NRRI Study for the per foot cost of aerial, underground, and buried structure. In general, these estimates are derived from regression equations that measure the effect on these costs of density, water, soil, and rock conditions.

a. Cost of Aerial Structure

107. We tentatively conclude that we should use the regression equation for aerial structure in the NRRI Study as a starting point.[204] We propose to use this equation to develop proposed input values for the labor and material cost for a 40-foot, class four telephone pole. We develop separate pole cost estimates for normal bedrock, soft bedrock, and hard bedrock.[205] The regression coefficients estimate the combined cost of material and supplies. The NRRI Study reports that the average material price for a 40-foot, class four pole is $213.94.[206] We note that this estimate is very close to results obtained from the data submitted in response to the *1997 Data Request*. According to the Commission staff's analysis of these data, the unweighted average material cost of a 40-foot, class four pole is $213.97, and the weighted average, by line count, is $228.22.[207] We seek comment on this tentative conclusion and analysis.

108. We tentatively conclude that we should add to these estimates the cost of anchors, guys, and other materials that support the poles, because the RUS data from which this regression equation was derived do not include these costs. In the NRRI Study, Gabel and Kennedy used the RUS data to develop the following cost estimates for anchors, guys and other pole-related items: $32.98 in rural areas, $49.96 in suburban areas, and $60.47 in urban areas.[208] We tentatively conclude that these are reasonable estimates for the cost of anchors, guys, and other pole-related items. We seek comment on these tentative conclusions and proposed values.

109. We also tentatively add an estimate for the cost of LEC engineering, which is not reflected in the data from which Gabel and Kennedy derived cost estimates for poles and

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[204] *See* NRRI Study at 52, Table 2-12. This regression equation is set forth in Appendix D, section III.A.

[205] *See* Appendix D, section III.A.

[206] NRRI Study at 51, Table 2-11.

[207] This is slightly higher than the HAI default value of $201.00 for the same height and class pole, and considerably less than the BCPM default value of $368.17

[208] *See* NRRI Study at 55, Table 2-14.

anchors, guys, and pole-related materials. For the reasons described above for copper and fiber cable, we tentatively conclude that we should add a loading of 10 percent to the material and labor cost (net of LEC_engineering) for poles, anchors, guys, and other pole-related items. We seek comment on these tentative conclusions and invite proposals justifying an alternative loading factor for LEC engineering.

110. In order to obtain proposed input values that can be used in the model, we must convert the estimated pole costs into per foot costs for each of the nine density zones. For purposes of this computation, we propose to use for density zones 1 and 2 the per pole cost that we have estimated for rural areas, based on the NRRI Study; for density zones 3 through 7 the per pole cost for suburban areas; and for density zones 8 and 9 the per pole cost for urban areas. We then divide the estimated cost of a pole by the estimated distance between poles. We propose to use the following values for the distance between poles: 250 feet for density zones 1 and 2; 200 feet for zones 3 and 4; 175 feet for zones 5 and 6; and 150 feet for zones 7, 8, and 9. For the most part, these values are consistent with both the HAI and BCPM defaults. We seek comment on these proposals.

b. Cost of Underground Structure

111. We tentatively conclude that we should adopt a similar methodology to estimate the cost of underground structure, as we proposed for the cost of aerial structure. We tentatively conclude that we should use the equation set forth in the appendix as a starting point for this estimate.[209] We propose to use this equation to develop proposed input values for the labor and material cost for underground cable structure. We develop separate cost estimates for underground structure in normal bedrock, soft bedrock, and hard bedrock for density zones 1 and 2.[210] As we did for aerial structure, we tentatively conclude that we should add a loading factor of 10 percent for LEC engineering. We seek comment on these tentative conclusions.

112. We are able to develop directly from the regression equation cost estimates for underground structure only in density zones 1 and 2, because the RUS data is from companies that operate only in those density zones. We tentatively conclude that we should derive cost estimates for density zones 3 through 9 by extrapolating from the estimates for density zone 2. We further tentatively conclude that we should perform such extrapolation based on the

[209] *See* Appendix D, section III.B. This regression equation is based on the RUS data, but was developed after the publication of that report. The NRRI Study does not set forth a regression equation for estimating the cost of underground structure.

[210] This regression equation was developed using underground cost data for density zones 1 and 2. The variable in this equation that represents the density zone of the geographic area in which the underground costs are incurred is not statistically significant at any standard level of significance.

growth rate between density zones in the BCPM and HAI default values for underground and buried structure.[211] Although we would prefer to rely on data specific to the density zone, rather than extrapolated, we tentatively conclude that, based on our current analysis, this is the best data currently available for this purpose.[212] We seek comment on these tentative conclusions. In Appendix D, we describe the proposed method of extrapolation.[213] We seek comment on this proposed method and invite parties to suggest alternative methods for estimating costs in density zones 3 through 9.

c. Cost of Buried Structure

113. We tentatively conclude that we should use the modified equation for estimating the cost of 24-gauge buried copper cable and structure to estimate the cost of buried structure.[214] It is necessary to modify this equation because estimates derived from it include labor and material costs for both buried cable and structure. Appendix D provides further detail on the modified equation.[215] We seek comment on this tentative conclusion.

114. For the reasons described above, we tentatively conclude that we should add a loading of 10 percent for LEC engineering to the estimates generated by the modified equation. We seek comment on this tentative conclusion.

115. We are able to develop directly from the regression equation cost estimates for buried structure only in density zones 1 and 2, because the RUS data is from companies that operate only in those density zones. We tentatively conclude that we should derive cost estimates for density zones 3 through 9 by extrapolating from the estimates for density zone 2. We further tentatively conclude that we should perform such extrapolation based on the same method proposed for estimating the cost of underground structure. We seek comment on these tentative conclusions.[216]

d. Plant Mix

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[211] We propose to use this same extrapolation method for both underground and buried structure.

[212] As noted, staff is continuing to analyze the data received in response to the survey on cable costs and structure.

[213] *See* Appendix D, section III.B.

[214] This equation is set forth in Appendix D, section III.C.

[215] *See* Appendix D, section III.C.

[216] This extrapolation method is described in Appendix D, section III.B.

116. As discussed above, we have tentatively selected input values for the costs of cable and outside plant structure that differ for aerial, buried, and underground cable and structure. Because these cost differences can be significant, the relative amount of plant type in any given area, *i.e.*, the plant mix, plays a significant part in determining total outside plant investment. The synthesis model provides three separate plant mix tables, for distribution, copper feeder, and fiber feeder, which can accept different percentages for each of the nine density zones. Although we tentatively propose using nationwide input values for plant mix, as we have for other input values, we seek comment on an alternative to nationwide plant mix input values, as discussed below.

117. The BCPM sponsors claim that in low densities there generally is a greater percentage of buried plant than underground plant, and conversely, in higher densities there is more underground than buried plant.[217] The BCPM default plant mix values reflect these assumptions. Although the HAI default plant mix values for feeder plant also reflect these assumptions, HAI's assumptions with respect to distribution plant mix are quite different than BCPM's, as discussed below. The HAI sponsors suggest that aerial plant is still the most prevalent plant type, but claim that their default plant mix values reflect an increasing trend toward the use of buried cable in new subdivisions.[218] The HAI default values generally assume that there is more aerial plant than the BCPM default values.[219] The BCPM defaults have separate values for plant mix in hard rock terrain, which generally assume there is slightly more aerial and less buried plant than the normal and soft rock terrain defaults.

118. Distribution Plant. The BCPM default values for distribution plant assume that there is no underground plant in the lowest density zone and the percentage increases with each density zone to 90 percent underground distribution plant in the highest density zone. In contrast, the HAI default values for distribution plant mix place no underground structure in the six lowest density zones and assume that only 10 percent of the structure in the highest density zone is underground.[220] The BCPM default values assume there is no aerial plant in the highest density zone in normal and soft rock terrain, and 10 percent aerial plant in hard rock terrain. In contrast, the HAI default values assume that there is significantly more aerial

[217] BCPM, Loop Inputs Documentation at 49, 54.

[218] HAI Inputs Portfolio at 37. The HAI sponsors quote a 1994 edition of Bellcore's *BOC Notes on the LEC Networks*: "The most common cable structure is still the pole line. Buried cable is now used whenever feasible, but pole lines remain an important structure in today's environment."

[219] In the four lowest density zones, the HAI defaults assume slightly less aerial fiber feeder than the BCPM defaults, but in all other cases, assume more aerial plant than BCPM. In addition, the HAI model provides that a certain percentage of buried plant can be shifted to aerial (and vice versa) based on certain cost minimization routines.

[220] HAI Inputs Portfolio at 36.

cable, 85 percent, in the highest density zone, but notes that this includes riser cable within multi-story buildings and "block cable" attached to buildings, rather than to poles.

119. We tentatively select input values for distribution plant mix that more closely reflect the assumptions underlying BCPM's default values than HAI's default values for several reasons. The synthesis model does not design outside plant that contains either riser cable or block cable, so we do not believe it would be appropriate to assume that there is as high a percentage of aerial plant in densely populated areas as the HAI default values assume. Although our proposed plant mix values assume somewhat less underground structure in the lower density zones than the BCPM default values, we disagree with HAI's assumption that there is very little underground distribution plant and none in the six lowest density zones. We tentatively select the distribution plant mix values set forth in Appendix A, and seek comment on our tentative conclusions. We tentatively propose input values, for the lowest to the highest density zones, that range from zero percent to 90 percent for underground plant; 60 to zero percent for buried plant; and 40 to ten percent for aerial plant.

120. Feeder Plant. The default plant mix percentages for feeder plant are generally similar in the BCPM and the HAI models. Although the BCPM default values vary between normal or soft rock terrain and hard rock terrain, as noted above, and the HAI default values differ between copper and fiber feeder, the plant mix ratios across density zones are similar.[221] For example, both the BCPM default values and the HAI default values assume that there is only five or ten percent of underground feeder plant in the lowest density zone.[222] The HAI defaults assume there is somewhat more aerial feeder cable than the BCPM defaults, except for fiber feeder cable in the four lowest density zones. The BCPM defaults assume there is no aerial feeder plant in the three highest density zones, except in hard rock terrain. Despite these differences, the relative amounts of aerial and buried plant across density zones are generally similar.[223]

121. We tentatively select input values for feeder plant mix, set forth in Appendix A, that generally reflect the assumptions underlying the BCPM and HAI default plant mix

[221] The BCPM default values for copper and fiber feeder are the same.

[222] HAI default values assume five percent underground feeder plant in the lowest density zone for both copper feeder and fiber. BCPM default values assume ten percent underground copper and fiber feeder in normal and soft rock terrain and five percent in hard rock terrain.

[223] For aerial plant, in the lowest to the highest density zones, the BCPM defaults range from 40 to zero percent for normal and soft rock terrain, and from 50 to five percent for hard rock terrain; and the HAI defaults range from 50 to five percent for aerial copper feeder and 35 to five percent for fiber feeder. For buried plant, in the lowest to the highest density zones, the BCPM defaults range from 50 to zero percent for normal and soft rock terrain, and from 45 to zero percent for hard rock terrain; and the HAI defaults range from 45 to five percent for buried copper feeder and 60 to five percent for fiber feeder.

percentages, with certain modifications. We tentatively propose input values, for the lowest to the highest density zones, that range from five percent to 95 percent for underground plant; 50 to zero percent for buried plant; and 45 to five percent for aerial plant. Based on the Commission staff's preliminary review of the structure and cable survey data,[224] the proposed values, unlike the HAI and the BCPM (for normal and soft rock) default values, assume that there is no buried plant in the highest density zone. In contrast to the BCPM defaults, the proposed values assume there is some aerial plant in the three highest density zones. We tentatively find that it is reasonable to assume that there is some aerial feeder plant in all density zones, as HAI does, particularly in light of our assumption that there is no buried feeder in the highest density zone, where aerial placement would be the only alternative to underground plant. Although the HAI sponsors have proposed plant mix values that vary between copper feeder and fiber feeder, they have offered no convincing rationale for doing so. We tentatively conclude that, like the BCPM defaults, our proposed plant mix ratios should not vary between copper feeder and fiber feeder. We seek comment on our tentative conclusions.

122. Alternatives to Nationwide Plant Mix Values. In the *1997 Further Notice*, the Commission tentatively concluded that plant mix ratios should vary with terrain as well as density zones. Because the synthesis model does not provide separate plant mix tables for different terrain conditions, the proposed nationwide plant mix values do not vary by terrain. One method of varying plant mix by terrain would be to add separate plant mix tables, as there are in BCPM, to the synthesis model. We observe that, while the BCPM model provides separate plant mix tables, the BCPM default values reflect only slightly more aerial and less buried plant in hard rock terrain than in normal and soft rock terrain. Another method of varying plant mix would be to use company specific or state specific input values for plant mix as advocated by the BCPM sponsors and other LECs.[225]

123. We generally have chosen not to use study area specific input values in the federal mechanism, and recognize that historical plant mix ratios may not reflect an efficient carrier's plant type choice today. On the other hand, historical plant mix also may reflect terrain conditions that will not change over time. For example, because it is costly to bury cable in hard rock, a carrier serving a very rocky area would tend to use more aerial than buried plant. The Commission staff's analysis of current ARMIS data reveals a great deal of variability in plant mix ratios among the states. In certain state proceedings, U S West has proposed an algorithm for adjusting plant mix to reflect its actual sheath miles as reported in ARMIS. We seek comment on a modified version of this algorithm as an alternative method of determining plant mix percentages.

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[224] The survey is described above. *See supra* para. 53; *see also* App. C.

[225] As noted above, although the BCPM sponsors have provided nationwide default values, they generally advocate company specific input values.

124. The proposed algorithm uses ARMIS 43-08 data on buried and aerial sheath distances and trench distances to allocate model determined structure distance between aerial, buried, and underground structures.[226] The first step is to set the underground structure distance equal to the ARMIS trench distance and to allocate that distance among the density zones on the basis of the nationwide plant mix defaults. Then an initial estimate of aerial plant is calculated as the sum of the synthesis model structure distances by density zone multiplied by the nationwide aerial plant mix defaults. A second estimate of aerial plant is calculated by multiplying structure distance less trench miles by the aerial percentage of total ARMIS sheath miles. Then an adjustment ratio is calculated by dividing the second estimate by the initial estimate. This adjustment ratio is then applied to each density zone to adjust the nationwide default so that the final synthesis model plant mix reflects the study area specific plant mix. The buried plant mix percentage is determined as a residual equal to one minus sum of the underground and aerial percentages. We seek comment on this alternative to nationwide plant mix values. We also invite parties to suggest other alternatives to determine plant mix in the synthesis model.

125. We also seek comment on whether we should allow the synthesis model to choose the plant mix on the basis of minimum annual cost. We note that this optimization would be constrained to reflect the embedded underground plant percentage, because underground plant is typically deployed in relatively dense areas for reasons of public safety. Embedded percentages of aerial and buried plant, on the other hand, may reflect zoning ordinances but we note that these ordinances in turn may reflect purely aesthetic concerns rather than public safety. If we were to determine that we should use study area specific plant mix input values, we seek comment on whether the synthesis model should be permitted to use its optimization feature for percentages of aerial and buried plant.

D. Structure Sharing

1. Background

126. Outside plant structures are generally shared by LECs, cable operators, electric utilities, and others, including competitive access providers and interexchange carriers. To the extent that several utilities may place cables in common trenches, or on common poles, it is appropriate to share the costs of these structures among the various users and assign a portion of the cost of these structures to the LEC.

127. In the *1997 Further Notice*, the Commission tentatively concluded that 100

[226] Structure distance, also known as route distance, measures the distance of the pole line or the trench. Sheath distance measures cable distance. If there is only one cable along a particular route then structure distance and sheath distance are equal. When, however, there is more than one cable along a route, sheath distance will be a multiple of the structure distance.

percent of the cost of cable buried with a cable plow should be assigned to the telephone company.[227] In addition, the Commission also tentatively concluded that Sprint's suggested value of 66 percent is an acceptable aggregate default input value for the percent of costs assigned to the LEC for all other shared facilities.[228] Several commenters disagreed with these tentative conclusions.[229] The Commission also sought comment on AT&T's contention that changes to the regulatory climate will increase the extent to which carriers are required or willing to share structures.[230]

128. Several comments relating to structure sharing values were filed in response to the *1997 Further Notice*.[231] Both the BCPM and HAI models vary the percentage of costs they assume will be shared depending on the type of structure (aerial, buried, or underground) and line density. The model proponents differ significantly, however, on their assumptions as to the extent of sharing and, therefore, assignment of structure cost to the LEC.[232]

2. Issues for Comment

129. We tentatively adopt the following structure sharing percentages that represent the percentage of structure costs to be assigned to the LEC. For aerial structure, we tentatively assign 50 percent of structure cost in density zones 1-6 and 35 percent of the costs in density zones 7-9 to the LEC. For underground and buried structure, we tentatively assign 90 percent of the cost in density zones 1-2, 85 percent of the cost in density zone 3, 65 percent of the cost in density zones 4-6, and 55 percent of the cost in density zones 7-9 to the LEC.[233]

130. We believe that the structure sharing percentages that we tentatively adopt reflect a reasonable percentage of the structure costs that should be assigned to the LEC. We

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[227] *1997 Further Notice*, 12 FCC Rcd at 18547, para. 80.

[228] *1997 Further Notice*, 12 FCC Rcd at 18548, para. 81.

[229] *See* AT&T/MCI Sept. 24 comments at 12-13; Florida PSC Sept. 24 comments at 6-7; GTE Sept. 24 comments at 9.

[230] *1997 Further Notice*, 12 FCC Rcd at 18548, para. 82.

[231] *See, e.g.*, AT&T/MCI Sept. 24 comments; Bell Atlantic Sept. 24 comments; GTE Sept. 24 comments.

[232] *See* HAI Dec. 11, 1997 submission, App. B at 57; BCPM Jan. 31, 1997 submission, Att. 9. The BCPM sponsors assume that an efficient telephone company will benefit only marginally from sharing. The HAI sponsors assume that utilities will engage in substantial sharing with telephone companies, and generally assigns between 25% and 50% of the cost of shared facilities to the LEC.

[233] *See* Appendix A for a complete list of the input values that we tentatively adopt in this Further Notice.

note that our tentative conclusions reflect the general consensus among commenters that structure sharing varies by structure type and density. While disagreeing on the extent of sharing, the majority of commenters agree that sharing occurs most frequently with aerial structure and in higher density zones.[234] For example, no commenter attributes more than 50 percent of the cost of aerial structure to the LEC. The sharing values that we tentatively adopt reflect these guidelines. In addition, we note that the Washington Utilities and Transportation Commission has adopted structure sharing values that are similar to those that we tentatively adopt.[235] We also note that the sharing values that we tentatively adopt fall within the range of values proposed by HAI and BCPM.

131. In addition, we agree with the Nebraska Public Service Commission that there are some opportunities for sharing even in the lowest density zones.[236] As noted by the Nebraska Commission, "[e]ven in these more remote regions of the state, there will be some opportunities for sharing as new homes and businesses are constructed."[237] We therefore do not assign 100 percent of the cost of buried or underground structure to the LEC in the lowest density areas, as suggested by the BCPM proponents.

132. We seek comment on the tentative conclusions set forth in this section. In addition, we seek comment on AT&T's contention that the structure sharing percentages should reflect the potential for sharing, rather than the LEC's embedded sharing practice.[238]

E. Serving Area Interfaces

1. Background

133. A serving area interface (SAI) is a centrally located piece of network equipment that acts as a physical interface between a copper feeder cable connecting a wire

[234] *See, e.g.*, HAI Dec. 11, 1997 submission, App. B at 57; BCPM Jan. 31, 1997 submission, Att. 9; Montana State Cost Study at 46-47.

[235] *See* Washington USF Proceeding, Docket No. UT-980311(a), App. D.

[236] Letter from Frank E. Landis, Nebraska Public Service Commission, to Magalie Roman Salas, FCC, dated May 22, 1998 (Nebraska State Cost Study) at 5.

[237] Nebraska State Cost Study at 5.

[238] AT&T Sept. 24 comments at 12-13. For example, AT&T contends changes in the regulatory climate have increased the extent to which carriers are required or are willing to share structures.

center and neighborhood distribution copper cables.[239] The model includes copper cable and SAI investment only when there are no DLC or T1 terminals.[240] The model input table lists prices for indoor and outdoor SAIs of various sizes.[241] An indoor SAI is generally used in multi-unit buildings housing business establishments or residential accommodations. The construction of an outdoor SAI involves the additional cost of metal cabinets for housing protection and connection materials. Thus, the cost of constructing an outdoor SAI tends to be somewhat higher than the cost of constructing an indoor SAI. Consequently, an outdoor SAI is generally used only when there is no place to house an indoor SAI.

134. Both the sponsors of BCPM and HAI have submitted default input values for indoor and outdoor SAI costs. In addition, Sprint submitted cost estimates for a 7200 pair indoor SAI.[242] Because the cost of a SAI depends on the cost of its components, we tentatively conclude that, in the absence of contract data between the LECs and suppliers, it is necessary to evaluate the cost of these components. Our analysis therefore begins with a review of the data and justifications submitted by the HAI sponsors and Sprint regarding the cost of the components that comprise a 7200 pair indoor SAI.[243]

135. On or around November 25, 1998, Commission staff posted preliminary ranges of SAI input values on the Commission's Web site to elicit comment and empirical data from interested parties on the cost of SAIs.[244] Commission staff also conducted a workshop on December 11, 1998, to discuss the posted preliminary inputs.[245]

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[239] Generally, when a neighborhood is located near a wire center, copper feeder cable, using analog transmission, is deployed to connect the wire center to the SAI. From the SAI, copper cables of varying gauge extend to all of the customer premises in the neighborhood.

[240] Both indoor and outdoor SAI investments are a function of the total number of pairs, both feeder and distribution, that the SAI terminates.

[241] The current version of the model supports eighteen SAI sizes. SAI capacities currently supported are 7200, 5400, 4200, 3600, 3000, 2400, 2100, 1800, 1200, 900, 600, 400, 300, 200, 100, 50, 25 and 1 line facilities.

[242] *Indoor SAI Cost Analysis,* submitted by Sprint - Local Telecommunications Division, July 30, 1998.

[243] We note that the BCPM defaults do not specify estimates for the cost of SAI components.

[244] *Workshop Public Notice* at 2. Commission staff used BCPM default inputs as the low end of the ranges for both indoor and outdoor SAIs, and Sprint's cost estimates as the high end of the range for indoor SAIs. The high end of the range for outdoor SAIs represented staff's analysis of state-approved SAI parameters. Staff's preliminary ranges for SAI costs did not include HAI inputs because staff concluded that HAI had not included all of the materials and splicing required to install this equipment.

[245] *See Common Carrier Bureau Releases Preliminary Common Input Values to Facilitate Selection of Final Input Values for the Forward-Looking Cost Model for Universal Service*, Public Notice, CC Docket Nos. 96-45, 97-160, DA 99-295 (rel. Feb. 5, 1999) (*Preliminary Input Values Public Notice*); *Workshop Public Notice*. *See*

2. Issues for Comment

a. Cost of a 7200 Pair SAI

136. Our proposed approach takes into account the cost of the following SAI components for a 7200 pair indoor SAI: building entrance splicing and distribution splicing; protectors; tie cables; placement of feeder blocks; placement of cross-connect jumpers/punch down; and placement of distribution blocks. Of these, we tentatively conclude that protector and splicing costs are the main drivers of SAI costs, and cross-connect costs and feeder block and distribution block installation costs greatly contribute to the difference in Sprint's and the HAI proponents' indoor SAI costs.[246] Based upon the following analysis of the record regarding these costs, we propose a total cost of $21,708 for the 7200 pair indoor SAI.[247] We seek comment on this tentative analysis.

137. Protector Costs. The cost of the protector is the single greatest contributor to the difference in Sprint's and HAI's indoor SAI costs. HAI proposes a cost of $2.00 per pair for protector material, and Sprint initially proposed a $6.62 cost per pair for protector material. In its review of Sprint's proposed cost, staff concluded that all of the parts identified in Sprint's proposal may not be necessary for SAI construction. Staff also believed, however, that HAI's proposal was for less than a fully functional SAI, and found HAI's proposed cost to be too low. Having analyzed the *ex parte* submissions, staff proposed a cost of $4.00 per pair for protector material.[248] In its February 4, 1999, *ex parte* submission, Sprint agreed that $4.00 is a reasonable estimate of the cost. We tentatively adopt this

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also, Preliminary Input Values Handouts, dated December 11, 1998.

[246] *See* Appendix D, section IV for a breakdown of costs for each component calculated to derive the proposed cost of a 7200 pair DLC.

[247] The following is a break-down of costs for a 7200 SAI size:

Building Entrance Splicing	$1,014.00
Protectors	$12,520.00
Placement of Feeder Blocks	$930.00
Placement of Cross Connects	$4,067.00
Placement of Distribution Blocks	$2,363.00
Placement of 41 each 100 Pair Distribution Tie Cables	$187.00
Distribution Splicing	$627.00
Total	$21,708.00

[248] Preliminary Input Values Handouts, dated December 11, 1998.

proposed value and seek comment.[249]

138. Splicing and Labor Rates. HAI and Sprint propose different splicing rates, but do not dispute splice set-up time. The HAI sponsors propose a splicing rate of 300 pairs per hour, while Sprint argues for a splicing rate of 100 pairs per hour.[250] We believe that HAI's proposed rate is a reasonable splicing rate under optimal conditions, and therefore, we tentatively conclude that Sprint's proposed rate is too low. We note that the HAI sponsors have submitted a letter from AMP Corporation, a leading manufacturer of wire connectors, in support of the HAI rate.[251] We recognize, however, that splicing under average conditions does not always offer the same achievable level of productivity as suggested by the HAI sponsors. For example, splicing is not typically accomplished under controlled lighting or on a worktable. Having accounted for such variables, we propose to adjust the splicing rate to 250 pairs per hour. We also propose a $60.00 per hour labor rate for splicing, which is within the range of filings on the record.[252] We seek comment on these proposed values.[253]

139. Cross-Connect Costs. The cross-connect is the physical wire in the SAI that connects the feeder and distribution cable. Sprint asserts that the "jumper" method generally will be employed to cross-connect in a SAI. In contrast, HAI suggests that the "punch down" method is generally used to cross-connect. We tentatively conclude that neither the jumper method nor the punch down method is used exclusively in SAIs. In buildings with high churn rates, such as commercial buildings, carriers may be more likely to use the jumper method. On the other hand, in residential buildings, where changes in service are less likely, carriers may be more likely to use the less expensive punch down method. Based on the record, it appears that both methods are commonly used, and that neither is used substantially more than the other. Therefore, we tentatively conclude that we should assume that each

[249] Appendix D shows how we use this value to estimate the total cost of protectors in a 7200 pair indoor SAI. *See* Appendix D, section IV.

[250] *See* Letter from Chris Frentrup, MCI WorldCom, to Magalie Roman Salas, FCC, dated January 21, 1999. On January 20, 1999, the sponsors of HAI provided a demonstration of splicing, in support of their splicing rate. Letter from Kenneth Cartmell, U S West, dated February 8, 1999, to Magalie Roman Salas, FCC; Letter from Pete Sywenki, Sprint, to Magalie Roman Salas, FCC, dated February 4, 1999.

[251] *See* attachment to letter from Chris Frentrup, Senior Economist, MCI WorldCom, to Magalie Roman Salas, FCC, dated January 21, 1999.

[252] The $60.00 per hour rate is the prevalent labor rate for mechanical apprentices.

[253] Appendix D, shows how the proposed splicing and labor rates are used in calculating the cost of a 7200 pair indoor SAI. *See* Appendix D, section IV.

method will be used half the time. We seek comment on this tentative conclusion.[254] In particular, we invite parties to justify a particular allocation between the jumper and punch down methods.

140. Feeder Block and Distribution Block Installation Rates. Sprint proposes an installation rate of 60 pairs per hour, while the HAI sponsors propose 400 pairs per hour. Because neither feeder block installation nor distribution block installation is a complicated procedure, we tentatively conclude that Sprint's rate of 60 pairs per hour is too low. We recognize, however, that installation conditions are not always ideal. Like splicing, feeder block and distribution block installations are not typically accomplished under controlled lighting or on a worktable. Having accounted for such variables, we propose a rate of 200 pairs per hour. We seek comment on this proposed value.[255]

b. Cost of Other SAI Sizes

141. Because we currently do not have similar component-by-component data for other SAI sizes, we propose to determine the costs of the other SAI sizes by extrapolating from the cost of the 7200 pair indoor SAI. We believe that this is a reasonable approach because there is a linear relationship between splicing and protection costs, which are the main drivers of cost, and the number of pairs in the SAI. We look to the HAI data to determine the relationship in cost among the various sizes of SAI. Specifically, we develop a ratio of our proposed cost for a 7200 pair indoor SAI to the cost proposed by HAI. We then propose to apply this ratio, 2.25, to the values submitted by the HAI sponsors for other sizes of indoor and outdoor SAIs. Applying this factor, we tentatively adopt the cost estimates for indoor and outdoor SAIs contained in Appendix A. We propose to use the HAI, rather than BCPM data, in this manner because BCPM has not submitted estimates for all of the SAI sizes used in the model. We note that using the BCPM data in this way would result in roughly the same estimates. We seek comment on these tentative conclusions and proposed values.

F. Digital Loop Carriers

1. Background

142. A digital loop carrier (DLC) is a piece of network equipment that converts a digital signal carried on optical fiber cable to an analog, electrical signal that is carried on

[254] Appendix D shows how this tentative conclusion is used to determine proposed costs for a 7200 pair SAI. *See* Appendix D, section IV.

[255] Appendix D show how this proposed value is used in the calculation of a 7200 pair SAI.

copper cable and is compatible with customers' telephones.[256] Because of the high cost of DLCs, a single DLC is shared among a number of customers. The model uses fiber cable and DLCs whenever it calculates that this configuration is cheaper than using copper cable or when the distance exceeds the maximum copper loop length. When using DLCs, the model determines the size and number of DLCs that should be installed at a location, based on cost minimization and engineering constraints. In designing outside plant, the model uses five different sizes of DLCs.[257] In order to run the model, a user must input the fixed and per-line cost for each of these DLC sizes. The total cost of a particular DLC is determined by multiplying the number of lines connected to the DLC times the per-line cost of the DLCs, and then adding the fixed cost of the DLC.

2. Issues for Comment

143. Both the sponsors of BCPM and HAI have submitted default values for DLC costs. Because these values are based on the opinions of experts without data to enable us to substantiate these opinions, however, we tentatively conclude that we should not rely on these data. We also tentatively conclude that the most reliable data on DLC costs available to the Commission at this time are the contract data submitted to the Commission in response to the *1997 Data Request*, and in *ex parte* submissions following the December 11, 1998 workshop. We seek comment on these tentative conclusions.

144. Following their submission of DLC data to the Commission in response to the *1997 Data Request*, US West, Bell South, and ATU resubmitted their data on the record in this proceeding.[258] At the December 11, 1998 workshop, staff of the Common Carrier Bureau

[256] Optical fiber cable carries a digital signal that is incompatible with most customers' telephone equipment, but the quality of the signal degrades less with distance compared to a signal carried on copper wire. Generally, when a neighborhood is located too far from the wire center to be served by copper cables alone, an optical fiber cable will be deployed to a point within the neighborhood, where a DLC will be placed to convert incoming digital signals to analog signals and outgoing analog signals to digital. From the DLC, copper cables of varying gauge extend to all of the customer premises in the neighborhood.

[257] The current version of the model supports a fifth DLC size in addition to those already supported. DLC capacities currently supported are 2016, 1344, 672, 96, and 24 line facilities.

[258] In response to the *1997 Data Request*, Ameritech, Bell Atlantic (including NYNEX), Bell South, SBC, US West, GTE, Sprint, ATU, and PRTC originally submitted data to the Commission on DLC costs in 1997. Bell South and US West resubmitted their data on the record of this proceeding subject to the *Protective Order*. Letter from William W. Jordan, Bell South, to Magalie Roman Salas, FCC, dated March 15, 1999; Letter from Robert B. McKenna, US West, to Magalie Roman Salas, FCC, dated March 8, 1999. Letter from Alane C. Weixel, counsel for ATU, to Magalie Roman Salas, FCC, dated May 6, 1999 (ATU May 6, 1999 *ex parte*).

discussed the DLC costs data on the record in this proceeding.[259] In an effort to elicit further discussion of DLC input values, staff presented a template of the components of a typical DLC. The HAI sponsors, GTE, and Aliant submitted data using the template of DLC costs.[260] Staff found the data submitted by the HAI sponsors to be significantly lower than the contract data on the record, and staff concluded that it would be inappropriate to use it, especially as no support was provided in justification. Because the data submitted by the companies are based on actual costs incurred in purchasing DLCs, we tentatively conclude that they are more reliable than the opinions proffered, and, therefore, should be used to estimate the cost of DLCs. Although we would prefer to have a larger sampling of data, we note that the data represent the costs incurred by several of the largest non-rural carriers, as well as two of the smallest non-rural carriers. We also note that, throughout this proceeding, the Commission has repeatedly requested cost data on DLCs.[261] We believe that we are using the best data available on the record to determine the cost of DLCs.[262]

145. We note that ATU asserts that material handling and shipping costs should be added to the DLC prices reflected in the contract it submitted. ATU suggests that these costs could represent up to 10 percent of the material cost of a DLC.[263] It is unclear whether the DLC data submitted by other parties include these costs. We seek comment on the extent, if any, to which we should increase our proposed estimates for DLCs to reflect material handling and shipping costs.

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[259] *See Material Cost Workshop - Digital Loop Carrier Equipment "Template for Determining DLC Cost"* handout.

[260] Letter from W. Scott Randolph, GTE, to Magalie Roman Salas, FCC, dated February 11, 1998; Letter from Robert A. Mazer & Albert Shuldiner, Counsel for Aliant, to Magalie Roman Salas, FCC, dated February 8, 1998. The HAI sponsors filed an *ex parte* letter with DLC cost information using a different template. Letter from Chris Frentrup, MCI WorldCom, to Magalie Roman Salas, FCC, Docket No. 96-45, 97-160, dated January 21, 1999 (following their January 20, 1999 presentation). US West and Sprint filed responses to the HAI presentation on February 8, 1999 and February 4, 1999, respectively.

[261] In addition to the data submitted in response to the *1997 Data Request*, and following the December 11, 1998 workshop, the Bureau requested further data on DLC costs in the *1997 Further Notice* and in the *Inputs Public Notice*. *See also Preliminary Input Values Public Notice*.

[262] Only US West, Bell South, and ATU presented their contract data from the *1997 Data Request* in a format that staff could use. Some of the data and comments that were submitted in response to the *1997 Data Request*, but not re-filed on the record under the *Protective Order*, could not be used because the data were either inadequate or presented in a format from which staff could not extract relevant information.

[263] ATU May 6, 1999 *ex parte*. ATU also suggests that costs for placement, installation, and testing should be added to the DLC material costs it submitted. We note that these site preparation costs are already separately accounted for in the model.

146. We recognize that the cost of purchasing and installing a DLC changes over time. Such changes occur because of improvements in the methods and components used to produce DLCs, changes in both capital and labor costs, and changes in the functionality requirements of DLCs. Thus, we believe it is appropriate to adjust the contract data to reflect 1999 prices. In order to capture changes in the cost of purchasing and installing DLCs over time, we propose a 2.6 percent annual reduction in both fixed DLC cost and per line DLC cost. This proposed rate is based on the change in cost calculated for electronic digital switches over a four year period. We believe that the change in the cost of these switches over time is a reasonable proxy for changes in DLC cost, because they are both types of digital telecommunications equipment. We also note that the 2.6 percent figure is a conservative estimate, based on the change in cost of remote switches. Our analysis suggests that the change in cost of host switches over the past four years is much higher. Finally, we note that use of the current consumer price index results in a similar figure over four years.[264] The indexed amount is based on the effective date of the contracts. Based upon an average of the contract data submitted on the record, adjusted for cost changes over time, we tentatively adopt the cost estimates for DLCs contained in Appendix A. We seek comment on this proposed analysis and the proposed values.

VI. SWITCHING AND INTEROFFICE FACILITIES

A. Background

147. The central office switch provides the connection between a subscriber's local loop and the outside world. Modern digital switches provide voice, data, and video signals connecting telephones, fax machines, and computers on the public switched network.[265] In order to accomplish this, a telephone network must connect customer premises to a switching facility, ensure that adequate capacity exists in that switching facility to process all calls, and interconnect the switching facility with other switching facilities to route calls to their destination. A wire center is the location of the switching facility.[266] The infrastructure to interconnect the wire centers is known as the "interoffice" network, and the carriage of traffic among wire centers is known as "transport."

148. In the *Universal Service Order*, the Commission stated that "[a]ny network function or element, such as . . . switching, transport or signaling, necessary to provide

[264] *See infra* para. 226.

[265] The functions performed by the switch for local service include: line termination; line monitoring; usage call processing, routing, and completion; interconnection to other carriers; billing and maintenance; and vertical services and features. We note that not all of these functions are supported by universal service.

[266] The wire center boundaries define the area in which all customers are connected to a given wire center.

supported services must have an associated cost."[267] In the *1997 Further Notice*, the Commission sought comment on issues that affect the input values relating to the forward-looking economic cost of switching and interoffice transport.[268] The *Switching and Transport Public Notice* established several guidelines relating to switching, the design of the interoffice network, and interoffice cost attributable to providing supported services.[269] In the *Platform Order*, the Commission concluded that the federal mechanism should incorporate, with certain modifications, the HAI 5.0a switching and interoffice facilities module.[270]

149. Both HAI and BCPM have provided default input values for estimating the forward-looking economic cost of switching and interoffice network.[271] On November 25, 1998, the Bureau announced the release of preliminary input values on its Web site.[272] On December 1, 1998, the Bureau held a public workshop designed to elicit comment on the switching inputs values to be used in the federal mechanism.[273] On February 5, 1999, the Bureau released a set of revised preliminary input values that included switching and interoffice transport values to facilitate the review and selection of final input values.[274]

150. In this section, we tentatively adopt and seek comment on the inputs associated with the installation and purchase of new switches, the use of the LERG to identify host-remote switch relationships, and other switching and interoffice input issues that have been raised by commenters. The remaining switching and interoffice-related input values that we

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[267] *Universal Service Order*, 12 FCC Rcd at 8913, para. 250 (criterion two).

[268] *1997 Further Notice*, 12 FCC Rcd at 18560-66, paras. 121-38.

[269] *Switching and Transport Public Notice* at 2-6. The Bureau guidelines established that: (1) the models permit individual switches to be identified as host, remote, or stand-alone; (2) switching investment costs should be separately estimated for host, remote, and stand-alone switches; (3) models should include switch capacity constraints; (4) all of the line-side port costs and a percentage of usage costs should be assigned to the cost of providing the supported service; and (5) models should accommodate an interoffice network that is capable of connecting switches designated as hosts and remotes in a way that is compatible with capabilities of equipment and technology that are available today and current engineering practices. *Id.*

[270] *Platform Order*, 13 FCC Rcd at 21354, para. 75.

[271] *See* Letter from Richard N. Clarke, AT&T, to Magalie Roman Salas, FCC, dated February 3, 1998 (HAI Feb. 3 submission) App. B; BCPM April 30, 1998 submission, Switch Model Inputs.

[272] *See Workshop Public Notice* at 2.

[273] *See Workshop Public Notice*. The December 1, 1998 workshop addressed issues relating to switching and expenses.

[274] *Preliminary Input Values Public Notice.*

tentatively adopt in this Further Notice are provided in Appendix A.[275]

B. Issues for Comment

1. Switch Costs

151. We now examine the inputs associated with the purchase and installation of new switches. Specifically, we must select values for the fixed and per-line cost of host and remote switches, respectively.

152. Switch Cost Data. Both the sponsors of BCPM and HAI have submitted default values for switch costs. To a large extent, however, these values are based on non-public information or opinions of their experts, but without data that enable us adequately to substantiate those opinions. Consistent with the recommendation of the Joint Board and criterion eight in the *Universal Service Order*, we tentatively conclude that we should not rely on these submissions because the underlying data are not sufficiently open and available to the public. We also tentatively conclude that it is not necessary to rely on this information, because the Commission, in conjunction with the work of Gabel and Kennedy,[276] the Bureau of Economic Analysis (BEA) of the Department of Commerce, and the U.S. Department of Agriculture Rural Utility Service (RUS), has compiled publicly available data on the cost of purchasing and installing switches. This information was gathered from depreciation reports filed by LECs at the Commission and from reports made by LECs to RUS.

153. The depreciation data contains, for each switch reported: the model designation of the switch; the year the switch was first installed; and the lines of capacity and book-value cost of purchasing and installing each switch at the time the depreciation report was filed with the Commission.[277] The RUS data contains, for each switch reported: the switch type (i.e., host or remote); the number of equipped lines; cost at installation; and year of installation.[278]

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[275] These inputs values are generally agreed upon by the parties or have not been disputed.

[276] David Gabel and Scott Kennedy, *Estimating the Cost of Switching and Cables Based on Publicly Available Data*, The National Regulatory Research Institute, NRRI 98-09, April 1998 (NRRI Study).

[277] Until 1996 large incumbent LECs were required to file depreciation rate reports with the Commission pursuant to 47 C.F.R. § 43.43. Prior to filing these reports, companies generally submit depreciation rate studies that include data for each digital switch in operation. See Appendix E of this Further Notice for a description of the data set and an explanation of adjustments made to the data.

[278] Many small telephone companies receive financial assistance from RUS, which requires these companies to report the payments made for new switches. See Appendix E for a description of the RUS data and an explanation of adjustments made to the data.

154. The sample that we propose to use to estimate switch costs includes 1,060 observations. The sample contains 921 observations selected from the depreciation data, which provide information on the costs of purchasing and installing switches gathered from 20 states. The sample also contains 139 observations selected from the RUS data, which provide information from across the nation on the costs of small switches purchased and installed by rural carriers. The combined sample represents purchases of both host and remote switches, with information on 468 host switches and 592 remote switches, and covers switches installed between 1989 and 1996. This set of data represents the most complete public information available to the Commission on the costs of purchasing and installing new switches.

155. In response to the *1997 Data Request*, the Commission received a second set of information pertaining to 1,486 switches. Upon analysis, however, Commission staff identified one or more problems with most of the data submitted: missing switch costs; zero or negative installation costs; zero or blank line counts; unidentifiable switches; or missing or inconsistent Common Language Local Identification (CLLI) codes. After excluding these corrupted observations, 302 observations remained. The remaining observations represented switches purchased by only four companies. We tentatively conclude that the data set we propose to use is superior to the data set obtained in response to the *1997 Data Request*, both in terms of the number of usable observations and the number of companies represented in the data set. We seek comment on this tentative conclusion.

156. Following the December 1, 1999 workshop, three companies voluntarily submitted further data regarding the cost of purchasing and installing switches.[279] Because these submissions were received late in the process, Commission staff has not had sufficient time to analyze the quality and content of the information. We seek comment on the use of this data set as a substitute or complement to the data set we propose.

157. Adjustments to the Data. The cost figures reported in the depreciation information reflect the costs of purchasing and installing new switches. While the RUS cost data also contain information on purchasing and installing new switches, they do not include: (1) the cost associated with purchasing and installing the main distribution frame (MDF); (2) the cost associated with purchasing and installing power equipment; (3) the cost of connecting each remote switch to its respective host switch; and (4) LEC engineering costs.[280] In order

[279] BellSouth January 29, 1999 *ex parte*, Sprint February 5, 1999 *ex parte*, and GTE February 22, 1999 *ex parte*.

[280] Letter from W. Scott Randolph, GTE, to Magalie Roman Salas, FCC dated December 18, 1998 (GTE Dec. 18 *ex parte*) at 5 and 6; NRRI Study at 97 and 102; Letter from Pete Sywenki, Sprint, to Magalie Roman Salas, FCC, dated December 22, 1998 (Sprint Dec. 22 *ex parte*) at 13-21; Letter from Richard Clarke, AT&T, to Magalie Roman Salas, FCC, dated January 7, 1999 (AT&T Jan. 7 *ex parte*) at 1.

to make the depreciation and RUS information comparable, we propose to add estimates of these four components to the switch costs reported in the RUS information. These additions are discussed below. We seek comment on this proposed approach.

158. In order to account for the cost of MDF equipment omitted from the RUS information, AT&T recommends using the HAI 5.0a default value of $12 per line for MDF. We tentatively conclude that $12 per line is a reasonable cost for purchasing and installing MDF equipment.[281] No party contests this value. We seek comment on this tentative conclusion and invite commenters to submit alternative values.

159. In order to account for the cost of central office power equipment omitted from the RUS information, AT&T recommends using the HAI 5.0a default values for these inputs. We tentatively use the following input values for power equipment: $12,000 for switches with 0-999 lines; $40,000 for switches with 1,000-4,999 lines; and $74,500 for switches with 5,000-25,000 lines. These values are derived from a range of values on the record in this proceeding, including state cost studies.[282] We seek comment on the values we tentatively adopt and invite commenters to submit alternative values.

160. Gabel and Kennedy estimate that the average cost of terminating a remote on a host switch is $27,598.[283] Relying on this estimate, we tentatively conclude that $27,598 should be added to the cost of each remote switch reported in the RUS data. We seek comment on this tentative conclusion and invite commenters to submit alternative values.

161. Gabel and Kennedy also recommend, based on a data analysis undertaken by RUS, that the cost of switches reported in the RUS data should be increased by 8 percent in order to account for the cost of LEC engineering.[284] Relying on those estimates, we tentatively conclude that 8 percent should be added to the total cost, including MDF, power, and remote connection costs, of each switch reported in the RUS data. We note that the proposed value is based on the only information on the record on this issue. We seek comment on this tentative conclusion and invite commenters to submit alternative values.

162. We tentatively conclude that switch costs should be estimated based on a sample of public data that includes both RUS and depreciation data. As noted, this

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[281] AT&T Jan. 7 *ex parte* at 1.

[282] *See, e.g.*, Commonwealth of Kentucky, *An Inquiry Into Universal Service Funding Issues*, Administrative Case No. 360 (1998) App. F at 14 (Kentucky Cost Study); *Compliance Proceeding for Implementation of the Texas High Cost Universal Service Plan*, Order No. 30, Project No. 18515 (August 24, 1998).

[283] NRRI Study at 102-104.

[284] *Id.*

information represents the broadest range of data publicly available for both small and large switches. We seek comment on the appropriateness of merging the two data sets..

163. Methodology. In order to determine the reasonable forward-looking cost of switches, based on the selected data set, we propose to employ regression analysis. In the process of estimation, we propose, where appropriate, to make adjustments to the information compiled by the above parties. These proposed modifications to the data and estimation techniques used by the Commission are discussed below.

164. We tentatively conclude that the cost of a switch should be estimated as a linear function of the number of lines connected to the switch, the type of switch installed (i.e., host or remote), and the date of installation. We adopt a linear function based on examination of the data and statistical evidence. Sprint recommends using a non-linear function, such as the log-log function, to take into account the declining marginal cost of a switch as the number of lines connected to it increases.[285] We tentatively conclude that the linear function we adopt provides a better fit with the data than the log-log function. A discussion of the effect of time and type of switch on switch cost is presented below. We seek comment on these tentative conclusions.

165. Based upon an analysis of the data and the record, we tentatively conclude that the fixed cost (i.e., the base getting started cost of a switch, excluding costs associated with connecting lines to the switch) of host switches and remote switches differ, but the per-line variable cost (i.e., the costs associated with connecting additional lines to the switch) of host and remote switches are approximately the same. This is consistent with statistical

[285] Sprint Dec. 22 *ex parte* at 12. Sprint criticized the Commission's preliminary switch regression presented in the December 1998 workshop based on the "R-squared" statistical goodness of fit criterion. However, after adjusting for data transformations associated with moving to a log-log specification, the R-squared of a log-log regression (0.54) suggested by Sprint is lower than the R-squared in the linear regression (0.78). Specifically, we note that the R-squared measure resulting from a regression employing a log-log functional form is not directly comparable to the R-squared measure from a linear regression. In order for the two measures to be comparable, the R-squared measure computed from the log-log regression must be computed using observed and predicted cost measures, not the logs of these measures. We also note that the log-log regression we employed is of the form:

$$Ln(Cost) = a_1 + a_2*Ln(Lines) + a_3*Host + a_4*Ln(Time) + a_5*Ln(Lines)*Ln(Time) + a_6*Host*Ln(Time) + e$$

where Ln(x) denotes the natural log of x. Because Sprint did not make these necessary adjustments, we believe that their criticism of the use of a linear function is misplaced. For a discussion of the "R-squared" statistical goodness of fit criterion and a discussion of log-log specifications, see William H. Greene, *Econometric Analysis*, 192-193 and 251 (1990).

evidence[286] and the comments of the HAI sponsors.[287] We seek comment on this tentative conclusion.

166. Accounting for Changes in Cost Over Time. We recognize that the cost of purchasing and installing switching equipment changes over time. Such changes result, for example, from improvements in the methods used to produce switching equipment, changes in both capital and labor costs, and changes in the functional requirements that switches must meet for basic dial tone service. In order to capture changes in the cost of purchasing and installing switching equipment over time, we propose to modify the data to adjust for the effects of inflation, and explicitly incorporate variables in the regression analysis that capture cost changes unique to the purchase and installation of digital switches. We describe this process below.

167. To the extent that the general level of prices in the economy change over time, the purchasing power of a dollar, in terms of the volume of goods and services it can purchase, will change. In order to account for such economy-wide inflationary effects, we propose to multiply the cost of purchasing and installing each switch in the data set by the gross-domestic-product chain-type price index[288] for 1997 and then divide by the gross-domestic-product chain-type price index for the year in which the switch was installed, thereby converting all costs to 1997 values.[289]

168. In order to account for cost changes unique to switching equipment, we

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[286] *See* General Wald Test for omitted variables in Ramu Ramanathan, *Introductory Econometrics with Applications* 170 (1989).

[287] Letter from Richard Clarke, AT&T, to Magalie Roman Salas, FCC, dated January 7, 1999 (AT&T Jan. 7 *ex parte*) at 1. "The primary difference between a host switch and remote switch is in the extent and complexity of the `getting started equipment,' associated with each type of switch (e.g., switch central processor functions, SS7 non-scaleable equipment, maintenance and testing, call recording for billing purposes, etc.). Because most of these functions for lines terminating a remote switch are performed at that switch's host, very little of this type of `getting started' equipment is required at the remote. In contrast, the scaleable equipment used to terminate lines and trunks and to perform basic call processing is essentially the same at the host and remote. In fact, the line units used by Lucent 5E Remote Switching Modules are identical to those used by 5E host or stand-alone switches. Similarly, the line cards used in Nortel DMS 100 host or stand-alone switches are the same as those used in DMS 100 remotes, or in DMS 10 host or remote switches." *Id.*

[288] The gross-domestic-product chain-type price index, which tracks economy-wide inflation, is published monthly by the Bureau of Economic Analysis of the U.S. Department of Commerce in the Survey of Current Business.

[289] Figures are adjusted after estimation for both realized and expected inflation between 1997 and 1999. *See* Appendix E for an explanation of these adjustments.

propose to enter time terms directly into the regression equation.[290] GTE expresses concern that, under certain specifications of time, the regression equation produces investments for remote switch "getting started" costs that are negative and that such specifications overstate the decline in switch costs.[291] The HAI sponsors also caution that the historical large percentage price declines seen in recent years may not continue.[292] We tentatively conclude that the reciprocal form of time in the regression equation proposed would satisfy these concerns by yielding projections of switch purchase and installation costs that are positive yet declining over time.

169. Ameritech and GTE advocate the use of the Turner Price Index,[293] which is an index designed to measure the changing cost of telecommunications plant, to convert the embedded cost information contained in the depreciation data to costs measured in current dollars.[294] We note, however, that this index and the data underlying it are not on the public record. We prefer to rely on public data when available. Moreover, we tentatively conclude it is not necessary to rely on this index to convert switch costs to current dollars. As described in the preceding paragraph, the Commission has proposed to account for costs explicitly in the estimation process, rather than adopt a surrogate such as the Turner Price Index. We seek comment on this proposed approach. In addition, we seek comment on the potential impact of increased use of packet switches, including the possibility that manufacturers will reduce the price of circuit switches to maintain market share.

170. Treatment of Switch Upgrades. The book-value costs recorded in the depreciation data include both the cost of purchasing and installing new equipment and the cost associated with installing and purchasing subsequent upgrades to the equipment over time. Upgrades costs will be a larger fraction of reported book-value costs in instances where the book-value costs of purchasing and installing switching equipment are reported well after the initial installation date of the switch. In order to estimate the costs associated with the purchase and installation of new switches, and exclude the costs associated with upgrading switches, we propose to remove from the data set those switches installed more than three years prior to the reporting of their associated book-value costs. We believe that this

[290] Time was added to the regression in reciprocal form as an independent variable to measure fixed cost changes unique to remote switches. Then, a time term was added in conjunction with the host identifier variable to measure the fixed cost changes unique to host switches. A time term was also added in conjunction with the line variable, in order to measure cost changes unique to line additions on switches.

[291] GTE Dec. 18 *ex parte* at 4.

[292] AT&T Jan. 7 *ex parte* at 4.

[293] The index is published semi-annually by AUS consultants.

[294] See Ameritech Dec. 16, 1998 comments at 5; GTE Dec. 18, 1998 *ex parte* at 4.

restriction would eliminate switches whose book values contain a significant amount of upgrade costs, and recognizes that, when ordering new switches, carriers typically order equipment designed to meet short-run demand.

171. We tentatively conclude that we should reject the suggestion of Ameritech, GTE, and Sprint that the costs associated with purchasing and installing switching equipment upgrades should be included in our cost estimates.[295] The model platform we adopted is intended to use the most cost-effective forward-looking technology available at a particular period of time. The installation costs of switches, as configured by us above, reflect the most cost-effective forward-looking technology for meeting industry performance requirements. Switches, augmented by upgrades, may provide carriers the ability to meet performance requirements, but do so at greater costs. Therefore, such augmented switches do not constitute cost-effective forward-looking technology. In addition, as industry performance requirements change over time, so will the costs of purchasing and installing new switches. The historical cost data employed in this proposed analysis reflect such changes over time, as do the time-trended cost estimates. We seek comment on this tentative conclusion.

172. Additional Variables. Several parties contend that additional independent variables should be included in our regression equation. Some of the recommended variables include minutes of use, calls, digital line connections, vertical features, and regional, state, and vendor-specific identifiers.[296] For the purposes of this analysis, our proposed model specification is limited to include information that is in both the RUS and depreciation data sets. Neither data set includes information on minutes of use, calls, digital line connections, vertical features, or differences between host and stand-alone switches. Nor do they contain detail sufficient to allow us to obtain such information from other sources. State and regional identifiers are not included in the proposed regression because we only have depreciation data on switches from 20 states. Thus, we could not accurately estimate region-wide or state-wide differences in the cost of switching. Our proposed model specification also does not include vendor-specific variables or variables distinguishing host switches from stand-alone switches because the model platform does not distinguish between different types of switches.

173. Switch Cost Estimates. Using the regression analysis discussed above, we tentatively adopt the fixed cost (in 1999 dollars) of a remote switch as $186,400 and the fixed cost (in 1999 dollars) of both host and stand-alone switches as $447,000. We tentatively adopt the additional cost per line (in 1999 dollars) for remote, host, and stand-alone switches

[295] Ameritech Dec. 16, 1998 comments at 4-5; GTE Dec. 18, 1998 *ex parte* at 4-5; Sprint Dec. 22, 1998 *ex parte* at 5-7.

[296] GTE Dec. 18, 1998 *ex parte* at 5; Sprint Dec. 22, 1998 *ex parte* at 13; Ameritech Dec. 16, 1998 comments at 6.

as $83.[297] We seek comment on these tentative conclusions.

2. Use of the Local Exchange Routing Guide (LERG)

174. We tentatively conclude that the Local Exchange Routing Guide (LERG) database should be used to determine host-remote switch relationships in the federal universal service mechanism.[298] In the *1997 Further Notice*, the Commission requested "engineering and cost data to demonstrate the most cost-effective deployment of switches in general and host-remote switching arrangements in particular."[299] In the *Switching and Transport Public Notice*, the Bureau concluded that the model should permit individual switches to be identified as host, remote, or stand-alone switches.[300] The Bureau noted that, although stand-alone switches are a standard component of networks in many areas, current deployment patterns suggest that host-remote arrangements are more cost-effective than stand-alone switches in certain cases.[301] No party has placed on the record in this proceeding an algorithm that will determine whether a wire center should house a stand-alone, host, or remote switch.[302]

175. In the *Platform Order*, we concluded that the federal mechanism should incorporate, with certain modifications, the HAI 5.0a switching and interoffice facilities module.[303] In its default mode, HAI assumes a blended configuration of switch technologies to develop switching cost curves.[304] HAI also allows the user the option of designating, in an

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[297] See Appendix E for regression results, and an explanation of how cost estimates are derived from these results.

[298] The LERG is a database of switching information maintained by Bellcore that includes the existing host-remote relationships. The HAI proponents have placed on the record the portion of the LERG that identifies the host-remote relationships. Letter from Chris Frentrup, MCI, to Magalie Roman Salas, FCC, dated September 14, 1998 (MCI Sept. 14 *ex parte*).

[299] *1997 Further Notice*, 12 FCC Rcd at 18560-61, para. 122.

[300] *Switching and Transport Public Notice* at 2. Switches can be designated as either host, remote, or stand-alone switches. Both a host and a stand-alone switch can provide a full complement of switching services without relying on another switch. A remote switch relies on a host switch to supply a complete array of switching functions and to interconnect with other switches.

[301] *Switching and Transport Public Notice* at 2-3.

[302] *Platform Order*, 13 FCC Rcd at 21355, para. 76.

[303] *Platform Order*, 13 FCC Rcd at 21354-55, para. 75.

[304] HAI Feb. 3, 1998 submission, Model Description at 58.

input table, specific wire center locations that house host, remote, and stand-alone switches. When the host-remote option is selected, switching curves that correspond to host, remote, and stand-alone switches are used to determine the appropriate switching investment. The LERG database could be used as a source to identify the host-remote switch relationships. In the *Platform Order*, we stated that "[i]n the inputs stage of this proceeding we will weigh the benefits and costs of using the LERG database to determine switch type and will consider alternative approaches by which the selected model can incorporate the efficiencies gained through the deployment of host-remote configurations."[305]

176. The majority of commenters support the use of the LERG database as a means of determining the deployment of host and remote switches.[306] These commenters contend that the use of the LERG to determine host-remote relationships will incorporate the accumulated knowledge and efficiencies of many LECs and engineering experts in deploying the existing switch configurations.[307] Commenters also contend that an algorithm that realistically predicts this deployment pattern is not feasible using publicly available data and would be "massive and complex."[308] The HAI proponents argue, however, that use of the LERG to identify host-remote relationships may reflect the use of embedded technology, pricing, and engineering practices.[309] Although the HAI proponents oppose the use of the LERG, they have taken steps to ensure that the LERG database is compatible with use in the switching module in the synthesis model.[310]

177. We tentatively conclude that the LERG database is the best source currently available to determine host-remote switch relationships in the federal universal service mechanism. As noted above, no algorithm has been placed on the record to determine whether a wire center should house a stand-alone, host, or remote switch. In addition, a

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[305] *Platform Order*, 13 FCC Rcd at 21355, para. 76.

[306] *See, e.g.*, Aliant *Switching and Transport Public Notice* comments at 2; BellSouth et al. *Switching and Transport Public Notice* comments, att. 1 at 1-2; GTE *Switching and Transport Public Notice* comments at 11; Bell Atlantic *Switching and Transport Public Notice* reply comments at 2.

[307] Bell Atlantic *Switching and Transport Public Notice* reply comments, att. 1 at 2; BellSouth et al. *Switching and Transport Public Notice* reply comments, att. 1 at 2-3.

[308] *See, e.g.*, AT&T/MCI *Switching and Transport Public Notice* comments at 6; BellSouth et al. *Switching and Transport Public Notice* reply comments, att. 1 at 2.

[309] Letter from Richard N. Clarke, AT&T, to Magalie Roman Salas, FCC, dated January 6, 1998 at 11 (AT&T Jan. 6 *ex parte*). For example, the HAI sponsors contend that factors influencing the placement of switches, such as line demand, switch prices, and life cycle costs, may have changed over time.

[310] *See* MCI Sept. 14 *ex parte*; Letter from Richard N. Clarke, AT&T, to Magalie Roman Salas, FCC, dated September 16, 1998 (AT&T Sept. 16 *ex parte*).

majority of commenters agree that development of such an algorithm would be difficult using publicly available data.[311] We tentatively conclude that the use of the LERG to identify the host-remote switch relationships is superior to HAI's averaging methodology which may not, for example, accurately reflect the fact that remote switches are more likely to be located in rural rather than urban areas. We therefore tentatively agree with the BCPM proponents and other commenters that use of the LERG is the most feasible alternative currently available to incorporate the efficiencies of host-remote relationships in the federal universal service mechanism. We seek comment on these tentative conclusions. In particular, we encourage parties to comment on any alternative source or methodology that will identify host-remote switch relationships on a forward-looking basis.

3. Other Switching and Interoffice Transport Inputs

178. General. Several commenters assert that the depreciation studies on which the Commission relied to develop switch costs include all investments necessary to make a switch operational.[312] These investments include telephone company engineering and installation, the main distribution frame (MDF), the protector frame (often included in the MDF), and power costs.[313] To avoid double counting these investments, both as part of the switch and as separate input values, the model proponents agree that the MDF/Protector investment per line and power input values should be set at zero.[314] In addition, commenters agree that the Switch Installation Multiplier should be set at 1.0.[315] We agree that including these investments both as part of the switch cost and as separate investments would lead to double counting of these costs. We therefore tentatively conclude that the MDF/Protector investment per line and power input values should be set at zero. We further tentatively conclude that the Switch Installation Multiplier should be set at 1.0. We seek comment on these tentative conclusions.

179. Analog Line Offset. We tentatively conclude that the "Analog Line Circuit Offset for Digital Lines" input should be set at zero. The HAI proponents contend that the switch investment in the model should be adjusted downward to reflect the cost savings

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[311] *See, e.g.*, Ameritech *Switching and Transport Public Notice* comments at 3; AT&T/MCI *Switching and Transport Public Notice* comments at 6; BellSouth et al. *Switching and Transport Public Notice* comments att. 1 at 1-2; GTE *Switching and Transport Public Notice* at 11-12.

[312] AT&T Jan. 7 *ex parte*; GTE Dec. 18 *ex parte* at 5-7; Sprint Dec. 22 *ex parte* at 9.

[313] AT&T Jan. 7 *ex parte*; Sprint Dec. 22 *ex parte* at 9.

[314] AT&T Jan. 7 *ex parte*; GTE Dec. 18 *ex parte* at 5-6; Sprint Dec. 22 *ex parte* at 9.

[315] *See, e.g.*, AT&T Jan. 7 *ex parte*; GTE Dec. 18 *ex parte* at 6.

associated with terminating digital, rather than analog, lines.[316] The HAI proponents assert that this cost savings is due primarily to: (1) the elimination of a MDF and protector frame termination; and (2) the economic efficiencies of terminating multiple lines on a DS-1 trunk termination instead of individual analog line terminations. Further, HAI contends that the depreciation data on which the Commission relied in developing switch investments do not reflect adequately the cost savings that would be realized if "60+% of lines are terminated on DLC - as occurs in the TELRIC models."[317] HAI contends that the depreciation data used to determine costs reflect the use of only approximately 15 percent digital lines.[318]

180. The HAI proponents suggest that the analog line offset input should be set to $15.00 per line to reflect additional savings in switch investment for terminating digital lines in the model.[319] The BCPM proponents and GTE recommend setting the analog line offset to zero.[320] Sprint contends that the analog line offset is inherent in the switching curve in the model, thus making this input unnecessary.[321] Sprint argues that an unknown mixture of analog and digital lines are taken into consideration in developing the switch curve.[322] GTE asserts that the analog offset must be set to zero to "track with the switching inputs."[323]

181. We note that the record contains no basis on which to quantify savings beyond those taken into consideration in developing the switch cost. We also note that the depreciation data used to determine the switch costs reflect the use of digital lines. The

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[316] AT&T Jan. 7 *ex parte*. The HAI proponents contend that the cost of terminating digital lines is significantly less expensive than terminating analog lines.

[317] AT&T Jan. 7 *ex parte*.

[318] AT&T Jan. 7 *ex parte*.

[319] AT&T Jan. 7 *ex parte*. The HAI proponents reach this value by first concluding that the total switch cost savings for digital lines should be approximately $20.00 per line. HAI calculates this cost savings as follows: (1) $12.00 for the MDF/Protectors that are not needed in the switch for incoming lines terminated on DLC; and (2) $8.00 per-line "efficiencies" (e.g., greater usage concentration, eliminated line cards, and lower cost to terminate trunks carrying DLC lines). Next, HAI concludes that the average fraction of digital lines included in the "historical" data is roughly 15% (or one quarter of the 60% digital line usage engineered in the model). The HAI proponents then deduct from the $20.00 value, one quarter of the digital line usage savings that is already taken into consideration in the historical data, to arrive at the analog line offset value of $15.00 per line.

[320] GTE Dec. 18 *ex parte* at 6; Sprint Dec. 22 *ex parte* at 12; Sprint Jan. 8 *ex parte* at 15.

[321] Sprint Dec. 22 *ex parte* at 12.

[322] Sprint Dec. 22 *ex parte* at 12.

[323] GTE Dec. 18 *ex parte* at 6.

switch investment value will therefore reflect savings associated with digital lines. We also note that HAI's proposed analog line offset of $15.00 per line is based on assumptions that are neither supported by the record nor easily verified. For example, it is not possible to determine from the depreciation data the percentage of lines that are served by digital connections. It is therefore not possible to verify HAI's estimate of the digital line usage in the "historical" data. In addition, HAI provides little support for its conclusion that there is a $20.00 per line cost savings using digital lines. HAI merely attributes a portion of this estimate to certain "efficiencies" realized from terminating digital rather than analog lines. In the absence of more explicit support of HAI's position, we tentatively conclude that the Analog Line Circuit Offset for Digital Lines should be set at zero. We seek comment on this tentative conclusion.

182. Switch Capacity Constraints. We tentatively adopt the HAI default switch capacity constraint inputs as proposed in the HAI 5.0a model documentation.[324] The forward-looking cost mechanism contains switch capacity constraints based on the maximum line and traffic capabilities of the switch. The HAI proponents now recommend increasing the switch line and traffic capacity constraints above the HAI input default values for those inputs.[325] HAI contends that the default input values no longer reflect the use of the most current technology.[326] For example, HAI contends that the maximum equipped line size per switch should be increased from 80,000 to 100,000 lines.[327]

183. We tentatively conclude that the original HAI switch capacity constraint default values are reasonable for use in the federal mechanism. We note that commenters have reviewed these values and are in general agreement with the HAI default values.[328] For example, we note that the HAI and BCPM default values for maximum equipped lines per switch are identical at 80,000 lines per switch.[329] We also note that the HAI model documentation indicates that the 80,000 line assumption was based on a conservative estimate "recognizing that planners will not typically assume the full capacity of the switch can be

[324] HAI Feb. 3, 1998 submission, App. B at 38-39.

[325] AT&T Jan. 7 *ex parte*. The HAI proponents included the updated switch capacity constraints in a table attached to the Jan. 7 *ex parte*.

[326] AT&T Jan. 7 *ex parte*.

[327] AT&T Jan. 7 *ex parte*.

[328] *See, e.g.*, BellSouth *Inputs Public Notice* reply comments at Exhibit 2-13; BCPM Inputs Portfolio at 34-36.

[329] *See* HAI Dec. 11 submission, Model Inputs at 80; BCPM April 30, 1998 submission, Switching Model Inputs at 34.

used."[330] The HAI proponents therefore selected the 80,000 line limitation as the maximum equipped line size value with the knowledge that the full capacity of the switch may be higher.[331] We seek comment on our tentative conclusion.

184. Switch Port Administrative Fill. We tentatively adopt a switch port administrative fill factor of 94 percent. HAI defines the switch port administrative fill as "the percent of lines in a switch that are assigned to subscribers compared to the total equipped lines in a switch."[332] HAI assigns a switch port administrative fill factor of 98 percent in its default input values.[333] The BCPM default value for the switch percent line fill is 88 percent.[334]

185. The BCPM proponents contend that switches have significant unassigned capacity due to the fact that equipment is installed at intervals to handle one to three years' growth.[335] BCPM most recently contends that U S WEST and BellSouth have company-wide average fills in the range of 76 percent.[336] Sprint, on behalf of the BCPM proponents, now recommends an average fill factor of 80 percent.[337]

186. We note that the switch port administrative fill factor of 94 percent has been adopted in several state universal service proceedings and is supported by the Georgetown

[330] *See* HAI Dec. 11 submission, Model Inputs at 80.

[331] In addition, we note that a decision to adopt the revised HAI values for maximum equipped lines per switch would have only a minimal impact on the overall forward-looking cost estimation because less than 2 percent of wire centers have more than 80,000 lines. A review of the data indicates that, of the 12,506 wire centers served by non-rural LECs, only 189 (1.5 percent) have more than 80,000 lines and 57 (0.5 percent) have more than 100,000 lines. *See* HAI Feb. 3, 1998 model submission.

[332] HAI Dec. 11, 1997 submission, Inputs Portfolio at 80.

[333] HAI Dec. 11, 1997 submission, Inputs Portfolio at 80.

[334] BCPM April 30, 1998 submission, Switch Model Inputs at 20-21. BCPM defines Switch Percent Line Fill as the ratio between the number of working lines on the switch and the total number of lines for which the switch is engineered.

[335] Sprint Dec. 22 *ex parte* at 17.

[336] Sprint Dec. 22 *ex parte* at 18.

[337] Sprint Dec. 22 *ex parte* at 18.

Consulting Group, a consultant of BellSouth.[338] We also note that this value falls within the range established by the HAI and BCPM default input values. The BCPM model documentation established a switch line fill default value of 88 percent that included "allowances for growth over an engineering time horizon of several years."[339] BCPM has provided no additional evidence to support its revised value of 80 percent. We therefore tentatively adopt a switch port administrative fill factor of 94 percent. We seek comment on this tentative value.

187. Trunking. We tentatively conclude that the switch module should be modified to disable the computation that reduces the end office investment by the difference in the interoffice trunks and the 6:1 line to trunk ratio. In addition, we tentatively adopt the HAI suggested input value of $100.00 for the trunk port investment, per end.

188. The HAI switching and interoffice module developed switching cost curves using the Northern Business Information (NBI) publication, "U.S. Central Office Equipment Market: 1995 Database."[340] These investment figures were then reduced per line to remove trunk port investment based on NBI's implicit line to trunk ratio of 6:1.[341] The actual number of trunks per wire center is calculated in the transport calculation, and port investment for these trunks is then added back into the switching investments.

189. The BCPM proponents contend that, under the HAI trunk investment approach, raising the per-trunk investment leads to a decrease in the switch investment per line under the HAI approach, "despite a reasonable and expected increase" in the investment per line.[342] The BCPM proponents argue that the trunk port input value should be set at zero to avoid producing "contradictory" results.[343] GTE also notes that the selection of the trunk port input value creates a dilemma in that it is used to reduce the end office investment, as noted above, and to develop a tandem switch investment.[344] GTE recommends that the switch module be

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[338] BellSouth *Inputs Public Notice* reply comments at Exhibit 2-13; Kentucky Cost Study App. F at 13; Louisiana Public Service Commission, *State Forward-Looking Cost Studies for Federal Universal Service Support* (May 19, 1998) (Louisiana Cost Study).

[339] BCPM April 30, 1998 submission, Switch Model Inputs at 20-21.

[340] HAI Dec. 11, 1997 submission, Model Description at 52.

[341] HAI Dec. 11, 1997 submission, Model Description at 53.

[342] Sprint Dec. 22 *ex parte* at 10.

[343] Sprint Dec. 22 *ex parte* at 10.

[344] GTE Dec. 18 *ex parte* at 6.

modified by disabling the computation that reduces the end office investment by the difference in the computed interoffice trunks and the 6:1 line to trunk ratio.[345] The HAI sponsors agree that the trunk port calculation should be deactivated in the switching module.[346]

190. We agree with commenters that the trunk port input creates inconsistencies in reducing the end office investment. We do not, however, agree with the suggestion of the BCPM sponsors to simply set this input value at zero. As noted by GTE, this input value is also used to calculate the tandem switch investment.[347] Consistent with the suggestions by GTE and the HAI sponsors, we tentatively conclude that the switch module should be modified to disable the computation that reduces the end office investment by the difference in the computed interoffice trunks and the 6:1 line to trunk ratio.

191. Because the trunk port input value is also used to determine the tandem switch investment, we must determine the trunk port, per end investment.[348] The HAI input value for trunk port investment per end is $100.00.[349] GTE and Sprint contend that this value should be much higher -- ranging from $200.00 to $500.00.[350] BellSouth notes that four states have issued orders addressing the cost of the trunk port for universal service.[351] These states estimate the cost of the trunk port ranging from $62.73 to $110.77.[352] We tentatively conclude that the record supports the adoption of a trunk port investment per end of $100.00, as suggested by the HAI sponsors. As noted above, this value is consistent with the findings of several states and BellSouth. In addition, GTE and Sprint provide no data to support their proposed trunk port investment value. We therefore tentatively adopt the HAI suggested input value of $100.00 for the trunk port investment, per end. We seek comment on our

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[345] GTE Dec. 18 *ex parte* at 6.

[346] Letter from Chris Frentrup, MCI, to Magalie Roman Salas, FCC, dated Feb. 9, 1999 (MCI Feb. 9 *ex parte*) at 24.

[347] GTE Dec. 18 *ex parte* at 6.

[348] HAI defines this input as the "per trunk equivalent investment in switch trunk port at each end of a trunk." HAI Dec. 11, 1997 submission, Appendix B (HM 5.0 Inputs, Assumptions, and Default Values) at 46.

[349] HAI Dec. 11, 1997 submission, Inputs Portfolio at 102.

[350] GTE Dec. 18 *ex parte* at 6; Sprint Dec. 22 *ex parte* at 10.

[351] Letter from William W. Jordan, BellSouth, to Magalie Roman Salas, FCC, dated August 7, 1998 (BellSouth Aug. 7 *ex parte*) Attachment to Question 1 at 5, 9, 13, 17 (dated July 15, 1998). The four states are Kentucky, Louisiana, North Carolina, and South Carolina.

[352] *Id.*

tentative conclusions.

VII. EXPENSES

192. In this section, we address the inputs in the model related to expenses, including general support facilities (GSF) expenses. In light of the criteria identified in the *Universal Service Order*, the Commission intends to select inputs that will result in a reasonable allocation of joint and common costs for non-networked related costs such as GSF, plant specific and non-specific expenses, and corporate and customer operations. The Commission seeks to develop an appropriate methodology for estimating these types of expenses to "ensure that the forward-looking economic cost [calculated by the federal mechanism] does not include an unreasonable share of the joint and common costs for non-supported services."[353]

A. Background

193. GSF costs and expenses include the investment and expenses related to vehicles, land, buildings, and general purpose computers. Other expenses (that are not associated with GSF) include: plant specific expenses,[354] plant non-specific expenses,[355] corporate operations expenses,[356] and customer services expenses.[357] For purposes of this *Further Notice*, costs associated with common support services (often called overhead expenses) refer to plant non-specific expenses, corporate operations expenses, and customer service expenses.

194. In the *1997 Further Notice*, the Commission sought comment on how to remove costs for nonregulated activities from costs for regulated activities in order to incorporate the appropriate amount of GSF investment and expenses in estimating the costs of providing the supported services.[358] The Commission tentatively concluded that GSF expenses should vary by state with respect to land values because a large share of GSF expenses is attributable to the cost of land.

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[353] *Platform Order*, 13 FCC Rcd at 21357, para. 81.

[354] Plant specific expenses include the cost of maintaining telecommunications plant and equipment.

[355] Plant non-specific expenses include the cost of engineering, network operations, and power expenses.

[356] Corporate operations expenses include the cost of administration, human resources, legal, and accounting expenses.

[357] Customer service expenses include the cost of marketing, billing, and directory listing expenses.

[358] *1997 Further Notice*, 12 FCC Rcd at 18569, para. 148.

195. In the *Further Notice*, the Commission also sought comment on how to establish forward-looking expenses in the selected federal mechanism.[359] The Commission specifically sought comment on which expenses should be calculated on a per-line basis and which should be calculated as a percentage of investment. The Commission also sought comment on whether there are measures other than lines and investment to which specific expenses should be tied.[360] With respect to plant specific expenses, the Commission sought comment on whether maintenance expense estimates should depend upon plant mix and, in particular, whether an increase in the use of aerial cable also increases maintenance expenses, and whether plant specific expenses should vary with such characteristics as climate or soil type.[361] In addition, the Commission asked commenters to identify the complete set of forward-looking expenses for which universal service support should be available.[362]

196. In the *Platform Order*, we adopted HAI's algorithm for calculating expenses and GSF costs, as modified to provide some additional flexibility in calculating expenses offered by the BCPM sponsors.[363] With this added flexibility, the model allows the user to estimate expenses as either a per-line amount or as a percentage of investment. We noted that many of the questions regarding how best to calculate expenses will be resolved in the input selection phase of this proceeding.[364]

B. Issues for Comment

1. Plant Specific Operations Expenses

197. We first address the inputs related to plant specific operations.[365] Plant specific operations expenses are the expense costs related to the maintenance of specific kinds of telecommunications plant.[366]

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[359] *1997 Further Notice*, 12 FCC Rcd at 18572-73, para. 157.

[360] *1997 Further Notice*, 12 FCC Rcd at 18572, 18574-77, paras. 157, 162, 165, 168, 171.

[361] *1997 Further Notice*, 12 FCC Rcd at 18574, para. 162.

[362] *1997 Further Notice*, 12 FCC Rcd at 18574-77, paras. 162, 165, 168, 171.

[363] *Platform Order*, 13 FCC Rcd at 21357, para. 81.

[364] *Platform Order*, 13 FCC Rcd at 21360, para. 87.

[365] Note that plant-specific operations expenses include general support facilities (GSF) expenses.

[366] Plant specific operations expenses correspond to the following ARMIS 43-03 report accounts:

6110 - Network Support Expense

198. Nationwide Estimates. We tentatively conclude that we should adopt input values that reflect the average expenses that will be incurred by non-rural carriers, rather than a set of company-specific maintenance expense estimates. We make this tentative conclusion for a number of reasons. First, we note that this tentative conclusion is consistent with a recommendation of the state Joint Board members.[367] Second, we have not been able to obtain current cost-to-book cost ratios for each ARMIS reporting firm, which would be necessary to calculate company or study area specific expense-to-investment ratios in the proposed methodology described below. Further, we tentatively conclude that the use of national or regional averages for input factors is more consistent with the forward-looking nature of the high cost model because it mitigates the rewards to less efficient companies. We seek comment on these tentative conclusions. Parties advocating the use of company-specific values or other alternatives to nationwide or regional estimates should identify the method and data readily available to firms that would be used to estimate plant-specific expenses. Commenters should also indicate how their proposal is consistent with the goal of estimating forward-looking costs. We note that the proposed expense estimates in Appendix A are nationwide averages.

199. In support of the use of company-specific factors, a number of commenters and workshop participants argue that maintenance expenses vary widely by geographic area and the type of plant installed. Others contend that plant-specific expenses are highly dependent

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6120 - General Support Expense
6210 - COE Switch
    6212 - COE Digital Electronic Switch only
6220 - Operator Systems
6230 - COE Transmission
    6231 - Radio Systems
    6232 - COE Circuit - DDS
    6232 - COE Circuit - Other than DDS
6310 - Information Origination/Termination
    6311 - Station Apparatus (only)
6341 - Large PBX
6351 - Public Telephone
6362 - Other Terminal Equipment
6411 - Poles
6421.1 - Aerial Cable - Metallic (Copper)
6421.2 - Aerial Cable - Fiber
6422.1 - Underground Cable - Metallic (Copper)
6422.2 - Underground Cable - Fiber
6423.1 - Buried Cable - Metallic (Copper)
6423.2 - Buried Cable - Fiber
6441 - Conduit Systems

[367] *See* State High Cost Report at 21; *1997 Further Notice*, 12 FCC Rcd at 18574, para. 161.

on regional wage rate differentials. At this time, we have been unable to verify significant regional differences among study areas or between companies based solely on labor rate variations using the publicly available ARMIS expense account data for plant-specific maintenance costs. Nonetheless, we believe that expenses vary by the type of plant installed. The synthesis model takes this variance into account because, as investment in a particular type of plant varies, the associated expense cost also varies. We seek comment on the degree to which regional wage rate differentials exist and are significant. We ask parties to suggest independent data sources on variations of wage rates between regions. We seek comment on a methodology that permits such distinctions without resorting to self-reported information from companies.

200. One possible approach would be to use indexes calculated by the President's Pay Agent for calculating locality pay differentials for Federal employees.[368] Under this methodology, we would first calculate a baseline expense factor for the labor-related portion of each plant-specific expense account according to a formula which is based on the sum of an expense factor for that category by study area, a weight representing the total investment in a study area, and the regional wage differential deflator calculated in the Pay Agent's report applicable to the study area.[369] The baseline expense would then be disaggregated to each wire center or study area using the deflator. We seek comment both on the validity of this approach as well as on the specific implementation.

201. We also tentatively conclude that we should not adopt different expense estimates for small, medium, and large non-rural companies on a per line basis. In order to determine if economies of scale should be a factor in plant-specific expenses, Commission staff tested whether significant differences in maintenance expenses per line could be discerned from segmenting companies into small carriers with less than 500,000 access lines, medium carriers with between 500,000 and 5,000,000 access lines, and those large carriers with over 5,000,000 access lines.[370] We have found no significant differences in the expense factor per-line or per-investment estimates based on these criteria. Therefore, to estimate costs associated with an efficient network as determined by the forward-looking mechanism, we tentatively conclude that plant-specific maintenance factors should be estimated on a national basis. We seek comment on these tentative conclusions.

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[368] *Report on Locality-based Comparability Payments for the General Schedule,* Annual Report of the President's Pay Agent, Appendix II, 1995.

[369] The baseline expense factor is calculated according to the formula $E_i = \sum_j e_{ij} w_j r_j$ where E_i is the baseline expense factor for category i, e_{ij} is the expense factor for category i and for study area j, w_j is a weight based on the number of switched lines in study area j, and r_j is the regional deflator from the Pay Agent's report for the region most applicable to study area j.

[370] We note that the data used for this analysis is available on the Commission's Web site at http://www.fcc.gov.

202. Methodology. Commenters advocate two methods of estimating plant specific operations expenses. The BCPM sponsors contend that all expenses should be calculated on a per-line basis. The BCPM default estimates for these accounts are based on a survey of companies. The HAI sponsors argue that expenses should be calculated as a percentage of investment. Specifically, the HAI sponsors assert that plant specific operations expenses should be calculated as a fixed percentage of investment.

203. Although we agree with the HAI sponsors that plant specific operations expenses should be estimated as a percentage of investment, we tentatively decline to adopt the flat percentages they advocate. By using ARMIS investment values that are not converted to current levels, the flat-rate method proposed by the HAI sponsors does not attempt to use forward-looking estimates. We also tentatively decline to adopt the per-line BCPM default estimates. Based on a private survey of companies, the BCPM values fail to comply with criterion eight identified in the *Universal Service Order*, because the underlying data for these values are not open to and verifiable by the public nor made available under the *Protective Order*.[371] In contrast to the BCPM proposal, the methodology that we tentatively adopt here is primarily based on readily identifiable and publicly available ARMIS data. Although ARMIS data reflect the embedded costs incurred by incumbent LECs, we take steps in our proposed methodology to convert these costs to forward-looking estimates, as described below. We note that this methodology was proposed by Commission staff in the public workshop on maintenance expenses on December 10, 1998.

204. In order to estimate forward-looking plant specific operations expenses, we have considered the requirements set forth in the *Platform Order*, and information provided in workshops, comments and *ex-partes*. We tentatively conclude that the input values for each plant specific operations expense account should be calculated as the ratio of booked expense to current investment. These expense-to-investment ratios would then be multiplied in the model by the model-derived investment for each investment account or group of accounts, to produce an estimate of the plant specific operations expenses.

205. Our proposed methodology for estimating expense to investment ratios consists of four steps. First, staff obtained from some of the ARMIS-filing companies, account-specific current cost to book cost (current-to-book) ratios for the related investment accounts. The current-to-book ratio is a tool that is used to restate the historic, financial account balance on a company's books, which reflects investment decisions made over many years, to present day replacement cost.[372] For each account or sub-account, a current-to-book ratio is

[371] Protective Order, 13 FCC Rcd at 13910.

[372] An example of a current-to-book ratio for a facility would be defined as the ratio of the current cost of a facility divided by its embedded cost. Therefore, if a pole cost $200 to install in 1980, and $400 today, the current-to-book ratio is $400/$200 = 2.0.

developed by first revaluing each type of equipment at its current replacement cost. The sum of these current costs are then divided by the total, embedded cost account balance. The resulting current-to-book ratio will be greater than one if current costs are rising relative to the historic costs and less than one if current costs are declining. Current-to-book ratios for the years ending 1995 and 1996 were provided by the following five holding companies: Ameritech, Bell Atlantic, Bell South, GTE, and Southwestern Bell.[373] Although we would prefer to have data from more companies, the other ARMIS-filing carriers informed us that, they either no longer maintain this type of information, or never used current-to-book ratios for accounting purposes.[374]

206. Second, staff calculated composite current-to-book ratios for each account. For each study area of the five holding companies that provided current-to-book ratios, we obtained year-end 1995 and 1996 investment balances from ARMIS for the plant accounts consistent with the aforementioned plant-specific expense accounts.[375] Study area-specific

[373] The current-to-book ratios submitted by these companies are proprietary information subject to provisions in the *Protective Order* and therefore are not re-produced here.

[374] We note that the five carriers that provided current-to-book ratios account for 66 percent of plant specific expenses and 70 percent of the investment reflected in ARMIS.

[375] Investment balances were obtained from the following plant accounts:

2112 - 2116 - Network Support Investment
2121 - 2124 - General Support Investment
2210 - COE Switch
    2212 - COE Digital Electronic Switch only
2230 - COE Transmission
    2231 - Radio Systems
    2232 - COE Circuit - DDS
    2232 - COE Circuit - Other than DDS
2310 - Information Origination/Termination
    2311 - Station Apparatus
    2341 - Large PBX
    2351 - Public Telephone
    362 - Other Terminal Equipment
2410 - Cable and Wire Facilities
    2411 - Poles
    2421.1 - Aerial Cable - Metallic (Copper)
    2421.2 - Aerial Cable - Fiber
    2422.1 - Underground Cable - Metallic (Copper)
    2422.2 - Underground Cable - Fiber
    2423.1 - Buried Cable - Metallic (Copper)
    2423.2 - Buried Cable - Fiber
    2241 - Conduit Systems

current-to-book ratios for the two periods were multiplied by the 1995 and 1996 ARMIS investments in each account to derive the forward-looking, "current," year-end 1995 and 1996 investment levels by account and by study area. The ARMIS and current investments were then summed separately, by year and by account, for all study areas of the five holding companies. The resulting total current investment (by year and by account for the sum of all study areas) was then divided by the total ARMIS investment (by year and by account for the sum of all study areas) producing two sets of composite current-to-book ratios (year end 1995 and 1996).

207. Third, to calculate the expense-to-investment ratios for the plant-specific operations expense accounts, staff obtained total, year-end 1995 and 1996 investment account balances from the ARMIS 43-03 reports for all ARMIS-filing companies. To make these embedded account balances forward-looking, staff next multiplied each investment account balance for each year by the current-to-book ratios for the same year developed earlier. The 1995 and 1996 "current" balances for each account were then averaged by adding the two years together and dividing by two.

208. Finally, from the 1996 ARMIS 43-03 report, staff obtained the 1996 balances for each plant-specific operations expense account for all ARMIS-filing companies. The expense account balances were divided by their respective average "current" investment to obtain expense-to-investment ratios. We tentatively conclude that these expense-to-investment ratios should be applied in the mechanism to the model-derived investment balances to obtain forward-looking plant-specific operations expense estimates. The industry-wide expense-to-investment ratios are listed in Appendix A. We seek comment on these proposed input values, tentative conclusions, and the proposed methodology outlined above.

209. Converting Expense Estimates to Current Values. We recognize that plant specific expenses will change over time. Because we initially used data from 1996 in the methodology described above, we tentatively conclude that it is appropriate to adjust this data to account for inflation and changes in productivity by obtaining revised 1997 current-to-book ratios from those companies providing data. In addition, we tentatively conclude that we should use the most current ARMIS data available necessary for the maintenance factor methodology. Because expense and investment balances for 1998 are not available from ARMIS at this time, we have also not been able to include them in calculating the plant-specific maintenance factors. We tentatively conclude that we should use these data in the final computation of expense estimates. We seek comment on these tentative conclusions.

210. GSF Investment. GSF investment includes buildings, motor vehicles, and general purpose computers. The synthesis model uses a three-step algorithm to estimate GSF for each study area. First, the model calculates a GSF investment ratio for each GSF account by dividing the ARMIS investment for the account by the ARMIS total plant in service (TPIS). Second, the model calculates a preliminary estimate GSF investment for each

account by multiplying the GSF investment ratio for that account times the model's estimate of TPIS.[376] Finally, the model reduces each of the preliminary GSF investment estimates by multiplying by one of two factors, which are the same as those used in the HAI model.[377]

211. We tentatively conclude that the model's preliminary estimate of GSF investment should be reduced, because only a portion of GSF investment is related to the cost of providing the services supported by the federal mechanism. We also tentatively conclude that the synthesis model should not use the same factors as those used in the HAI model. The HAI sponsors, who developed the expense module in the synthesis model, have not shown why these particular factors should be used for this purpose. Instead, we tentatively conclude that total GSF investment should be reduced by factors that reflect the percentage of customer operations, network operations, and corporate operations used to provide the supported services.[378] We seek comment on these tentative conclusions.

2. Common Support Service Expenses

212. We next address common support service expenses, which are comprised of corporate operations, customer service expenses, and plant non-specific expenses. Corporate operations expenses are those costs associated with general administrative, executive planning, human resources, legal, and accounting expenses for total company operations. Customer service expenses include marketing, billing, operator services, directory listing, and directory

[376] As calculated by the model, TPIS excludes GSF investment, while ARMIS TPIS includes GSF investment. HAI Dec. 11, 1997 submission.

[377] These two factors are one minus either the Total Operations General Support Allocator (Total Operations Allocator) or the Office Worker General Support Allocator (Office Worker Allocator). The Total Operations Allocator is applied to the Motor Vehicles, Garage Work Equipment, and Other Work Equipment accounts, while the Office Worker Allocator is applied to the Furniture, Office Equipment, Buildings and General Purpose Computer accounts. *See* HAI Dec. 11, 1997 submission. Each of these allocators is a fraction. The Total Operations Allocator is the ratio of the sum of customer operations expenses and corporate operations expenses to total operating expenses. The Office Worker Allocator is the ratio of the sum of corporate operations expenses and network operations expenses to the sum of customer operations expenses, corporate operations expenses and network operations expenses.

[378] We tentatively conclude that the Office Worker Allocator should equal the ratio of the sum of customer operations expenses, network operations expenses, and corporate operations expenses assigned to supported services, to the sum of those expenses calculated on a total regulated basis. In principle the Total Operations Allocator should equal the Office Worker Allocator. Due to equations embedded in the HAI expense module, however, the total operations general support allocator is set equal to one minus the office worker general support allocator. We tentatively conclude that GSF investment should be calculated as the product of the Office Worker Allocator, calculated on a nationwide basis, and the preliminary GSF investment, which is calculated on a study area specific basis.

assistance costs.[379] Plant non-specific expenses are common network operations and maintenance-type of expenses, including engineering, network operations, power and testing expenses, that are considered general or administrative overhead to plant operations.[380] Commission staff held public workshops where they sought comment on various paradigms and econometric estimation techniques used to calculate these factors. Commission staff also discussed possible methods for subtracting non-recurring costs from expense estimates and for adjusting estimates for inflation and potential wage differentials.[381]

213. Per-Line Basis. Common support services are costs that cannot readily be associated with any particular maintenance expense or investment account. As a result, we tentatively conclude that these expenses (unlike plant-specific expenses) should be estimated

[379] Corporate operations and customer services include the following ARMIS accounts and their subaccounts:

6610 - Marketing Total
- 6611 - Product Management
- 6612 - Sales
- 6613 - Product Advertising

6620 - Service Expense Total
- 6621 - Call Completion (Operator Service Expense)
- 6622 - Number Services (Directory Publishing Expense)
- 6623 - Customer Services

6710 - Executive and Planning Total
- 6711 - Executive
- 6712 - Planning

6720 - General and Administrative
- 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

[380] Non-specific plant expenses include the following ARMIS expense accounts:

6510 - Other Property Plant and Equipment Expense

6530 - Network Operations
- 6531 - Power
- 6532 - Testing

[381] See *1997 Further Notice*, 12 FCC Rcd at 18578, para 173.

on a per-line basis, as advocated by the BCPM sponsors.[382] We tentatively conclude that the HAI sponsors have failed to justify their proposal that expense estimates for certain accounts be based on a percentage of ARMIS-reported expenses or a percentage of total capital costs and operations expenses.[383] We seek comment on these tentative conclusions.

214. Nationwide Estimates. Commenters such as Aliant, Sprint, GTE, and Bell South have argued for the inclusion of all accounts, and have argued further that these types of corporations and customer service expenses are inherently company specific in nature and should be evaluated in this manner. We tentatively conclude that inputs for corporate operations, customer services, and plant non-specific expenses should also be estimated on a nationwide basis rather than a more disaggregated basis. We seek comment on this tentative conclusion.

215. Costs associated with plant non-specific expenses used to supply and run network operations by definition cannot be directly allocated to individual maintenance or investment accounts. Commenters have suggested that these types of expenses may vary among carriers and between study areas. They argue that these differences may be a result of company specific plant configurations, geographic and labor demographic variables, one-time exogenous costs, and non-recurring adjustments such as re-engineering expenses. They further argue that administrative support expense differences are also a function of regional wage differentials and plant specifications. As stated earlier, we cannot at this time distinguish significant differences in regional wage differentials for administrative services based solely on ARMIS expense data for these accounts. Further, costs associated with corporate overhead and customer services accounts are not directly linked to specific company investment levels. We tentatively conclude that, for forward-looking cost estimates, these types of administrative and service expenses are less dependent on carrier physical plant or geographic differentials than those that also correlate to company size (number of lines) and

[382] BCPM model default values on a per-line per-month basis are the following:

Aggregate USOA Account	BCPM Default Values
Other PP & E (6510)	$ 0.03
Network Operations (6530)	1.33
Marketing (6610)	0.35
Service Exp./Customer Operations (6620)	2.42
xec., Planning, G&A (6700)	2.29
Total Per-Line Per-Month Expenses	$ 6.42

[383] For example, the HAI sponsors propose that network operations expense be estimated at 50 percent of ARMIS-reported network operations expense. Corporate overhead expense was estimated to be 10.4 percent of the total of capital costs and operations expenses as a default value. *See 1997 Further Notice*, 12 FCC Rcd at 18572, 18577, paras. 164, 170.

demand (minutes of use), which were used as estimation variables to develop the model inputs. We seek further comment on this analysis.

216. We also tentatively conclude that we should not adopt different estimates for small, medium, and large high cost non-rural companies for common support service expenses. As with plant specific expenses, Commission staff tested whether statistically significant differences in common support service expenses per line could be determined from segmenting companies into small carriers with less than 500,000 access lines, medium carriers with between 500,000 and 5,000,000 access lines, and those large carriers with over 5,000,000 access lines. We have further reviewed whether expense estimates varied due to the total number of Dial Equipment Minutes (DEMs) reported by companies in addition to the number of lines. As with the plant-specific accounts, we could find no significant differences in the expense factor per-line based on these criteria. Therefore, consistent with the forward-looking costs associated with an efficient network as determined by the federal mechanism, we tentatively conclude that we should estimate these non-specific network operations expenses on a nationwide, per-line basis. We seek comment on this tentative conclusion.

217. Data Source. Following standard economic analysis and forecasting methods, we propose to use publicly available 1996 ARMIS expense data[384] and minutes of use information from NECA,[385] by study area, to estimate the portion of these company-wide expenses to be covered by universal service support. We believe that consolidation of this data produces a sufficient number of observations by study area for each of these accounts.[386] Public data for 1996 was used in this analysis in order to compare the estimates obtained with proprietary information received from a previous data request. We note that this methodology was proposed by Commission staff in a public workshop on December 1, 1998. We seek comment on this proposal.

218. Regression Methodology. Using standard multi-variate regression analysis, we developed two different specifications to determine the portion of corporate and customer operations and plant non-specific expenses subject to universal service support. Each equation estimates total expenses per total lines as a function of switched lines per total lines,

[384] Data was taken from 1996 ARMIS 43-01, Subject to Separations (Column F) for Accounts 6610, 6620, 6710 and 6720. Data was taken from 1996 ARMIS 43-03, Subject to Separations (Column M) for Accounts 6510 and 6530. Line counts were taken from 1996 ARMIS 43-08, Table III, Total Switched Lines (Column DJ) and Total Access Lines (Column DM).

[385] Dial Equipment Minutes of Use (DEMS) for 1996 were taken from NECA, available on the Commission's Web site at http://www.fcc.gov/Bureaus/Common_Carrier/Reports/FCC-State_Link/neca.html.

[386] See Appendix F for further explanation of the data sources used and the method for consolidating study areas between data sets to reconcile the number of observations for the variables used in the regression equations.

special lines per total lines, and toll minutes per total lines, either in combination (Specification 1) or separated between intrastate toll and interstate toll minutes per total lines (Specification 2).[387]

219. Each specification has been chosen to separate the portion of expenses that could be estimated as attributable to special access lines and toll usage, which are not supported by the high cost mechanism, rather than switched lines and local usage. Commission staff found from an earlier formulation that, when the model included both a switched line component and a local usage component, the number of switched lines and local DEMs were so highly correlated that it did not increase the explanatory power of the model to include both variables. As a result, we tentatively conclude that we should not include local dial equipment minutes per total lines as an explanatory variable, despite suggestions by a number of workshop participants and commenters. Because both regression equations produce reasonable estimates, and in order to prevent any potential advantage to firms which might have a different mix of toll minutes, we propose to use the average of the estimates from the two specifications. We seek further comment on this proposed regression methodology.

220. Removal of One-Time and Non-Supported Expenses. In order to eliminate the impact of one-time non-recurring expenses on forward-looking estimates, we have sought verifiable public information on exogenous costs and those that are recovered through non-recurring charges and tariffs. These include specific one time charges for the cost of mergers, acquisitions, and process re-engineering. We also sought to estimate the cost of providing permanent number portability, network and interexchange carrier connection, disconnection, and re-connection (i.e., churn) costs. Other recurring functions that we have attempted to identify include vertical features expenses, billing and collection expense not related to supported services, operational support systems and other expenses associated with providing unbundled network elements and wholesale services to competitive local exchange carriers, collocation expenses, and costs associated with SS7 services.

221. Without obtaining proprietary information from carriers, we have been unable to find an objective public data source or discern a systematic method for excluding many of these costs from the expense data used to calculate the input factors. AT&T and MCI WorldCom presented an analysis to Commission staff on January 14, 1999, proposing a method to estimate, non-supported, non-recurring, or one-time expenses for customer, network, and corporate operations expenses. Averaging data for five years (1993-1997) of

[387] Specification 1 used the following regression equation: Expense/Total Lines = β_1 (Switched Lines/Total Lines)+ β_2 (Special Lines/Total Lines)+ β_3 (Toll Minutes/Total Lines). Specification 2 used the following equation: Expense/Total Lines = β_1 (Switched Lines/Total Lines)+ β_2 (Special Lines/Total Lines)+ β_3 (State Toll Minutes/Total Lines)+ β_4 (Interstate Toll Minutes/Total Lines)

corporate Security and Exchange Commission (SEC) 10-K and 10-Q filings, a percentage of corporate and network operations identified as one-time charges were estimated for the BOCs and all Tier One companies. Because the SEC reports do not specifically indicate whether the one-time expenses were actually made during the year(s) indicated, we tentatively conclude that we should not use these figures to adjust the 1996 ARMIS data used in estimating the expense input values. The analysis does indicate, however, that one-time expenses for corporate operations can be significant and should be estimated, if possible.[388] Because this type of data detail is not publicly available from ARMIS or easily reconcilable from other public company financial reports to individual account expenses for a specific year, we invite comment on how to identify and estimate these expenses.

222. We tentatively conclude that, if it is determined that expense estimates to be used as inputs in the high-cost mechanism are to be revised annually, as suggested by various parties,[389] one-time non-recurring costs should be systematically excluded. We further recommend that, to the extent possible, efforts be made to use current information supplied and verified by the companies, if none can be found independently, to more accurately reflect forward-looking expenses. We seek comment on this tentative conclusion and recommendation.

223. Removal of Non-Supported Expenses. Cost reductions were made for continuous non-supportable services which could be identified and estimated from publicly available (ARMIS) expense data. Expense adjustments were made to calculated input values for marketing expenses. Though the HAI sponsors and state Joint Board members suggested that marketing expenses be excluded entirely,[390] commenters and workshop participants noted that Section 214 of the Communications Act requires eligible telecommunications carriers to advertise the availability of residential local exchange and universal service supported services.[391]

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[388] According to the analysis, on average, approximately 20 percent of yearly corporate operations expenses consisted of non-recurring charges for costs relating to merger and acquisitions and workforce restructuring over the five year period. Network Operations one-time charges for things such as process re-engineering were also calculated using the same methodology. On average, 2.6 percent of yearly Network Operations expenses were attributed to non-recurring charges.

[389] See *1997 Further Notice*, 12 FCC Rcd at 18578, para. 173.

[390] Both the HAI sponsors as well as the State Joint Board indicated that all marketing expenses be excluded. *See 1997 Further Notice*, 12 FCC Rcd at 18576, paras. 166, 167. *See also*, Letter from Chris Fentrup, MCI-Worldcom to Magalie Roman Salas, FCC, dated January 15, 1999.

[391] Section 214 (e)(1)(B) of the Communications Act states that eligible telecommunications carriers shall, throughout the service area for which the designation of universal service support is received, "advertise the availability of such services and the charges therefor using media of general distribution." 47 USC § 214(e)(1)(B).

224. We tentatively conclude that an analysis made by Economics and Technology, Inc., regarding the disaggregation of marketing and advertising expenses made by companies for basic telephone service, is the most accurate method on the record for apportioning marketing expenses between supported and non-supported services. This analysis attributes an average of 95.6 percent of company marketing costs to non-supported customers or activities, such as vertical and new services.[392] We seek comment on this proposed analysis for estimating marketing expenses.

225. We also propose adjustments for non-supported service costs related to coin operations and collection, published directory, access billing, interexchange carrier office operation, and service order processing,[393] which are associated with specific expense accounts used in the regression analysis. Under this methodology, percentage reductions would be made to the estimated coefficients for those accounts using calculations based on a time trend analysis of average ARMIS 43-04 expense data[394] for five years (1993-1997). We seek comment on this proposed methodology.

226. Converting Expenses to 1999 Values. In order to bring forward the 1996 data relied upon for estimating common support service expenses, we propose to use a 6.0 percent productivity factor for each year (1997 and 1998) to reduce the estimated input values for each account. The 6.0 percent productivity factor is based on the 6.5 percent "X-factor" used in the Commission's price cap methodology.[395] We note that the D.C. Circuit Court of Appeals recently reversed and remanded for further explanation the Commission's decision to select 6.0 percent as the first component of the X-factor.[396] In light of that remand, we seek

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[392] *See* Further Comments of the National Cable Television Association Inc., CC Docket 96-45, Appendix 3A. The adjustment for supported local loop Marketing Expenses was made by deducting 95.6 percent of estimated expenses, maintaining 4.4 percent of Account 6610. See further discussion in Appendix F for calculations of expense reductions.

[393] A deduction was made for average expenses relating to Coin Collection and Administration, Carrier Access Billing, and Other Customer Services Total at -12.46 percent from the Customer Services Subaccount 6623, maintaining 87.54 percent of the costs associated with this account. See discussion in Appendix F for the calculations and methodology of expense reductions.

[394] ARMIS 43-04 Accounts Subject to Separations, Basic Local Loop and Other Related Services for Total Customer Operations Expense.

[395] Under price cap regulation, the productivity (X) factor includes a .50 percent (.005) Consumer Productivity Dividend (CPD), which is used as a supplement to calculated productivity measures to assure that consumers additionally benefit from price cap rules through lower access charge rates. Thus, for universal service calculations, this dividend was subtracted from expected productivity increases or cost savings that can be experienced each year (1997 and 1998) by firms that may provide universal service.

[396] *United States Telephone Association v. FCC*, No. 97-1469 (D.C. Cir. May 21, 1999).

comment on whether we should continue to adjust our expense input values to reflect productivity gains. If we determine that such adjustment is appropriate, we may want to use an alternative method of estimating productivity. We seek comment on what other measures we could use to adjust our expense data for gains in productivity. We further propose to add an inflation factor for each year based on the fixed weighted Gross Domestic Product Price Index (GDP-PI) for 1997 (2.1120 percent) and for 1998 (2.1429 percent).[397] Thus, we propose a net reduction of 3.888 percent for 1997 and 3.8571 percent for 1998 when using the 6.0 percent productivity factor. We seek comment on this method for converting expenses to 1999 values.

227. Estimates of Corporate Operations, Customer Operations, and Plant Non-Specific Expenses. Appendix A contains a summary of the proposed per-line, per-month input figures for both plant non-specific expenses, corporate operations, and customer operations adjusted expenses as calculated using the aforementioned methodology. We seek comment on these proposed values.[398]

VIII. CAPITAL COSTS

228. In this section, we address the inputs in the model related to capital costs: depreciation, cost of capital, and annual charge factors.

A. Depreciation

1. Background

[397] These inflation factors provided by the Department of Commerce were used by price cap companies in their annual tariff filings to the Commission to allow an increase in revenues for the years 1997 and 1998 under the price cap regulatory mechanism and access reform rules.

[398] Input values for common support service expenses are reproduced here:

Aggregate USOA Account		Adjusted Expense Inputs
Other PP & E (6510)	$	0.07
Network Operations (6530)		1.35
Marketing (6610)		0.02
Service Exp./Customer Operations (6620)		1.07
Exec., Planning, G&A (6700)		2.60
Totals Per-Line Per-Month	$	5.11