and that 20 of those miles traverse a particular microgrid. Since (20 miles / 60 miles) = .333, 1/3 of the household and business line data is associated with that particular microgrid. At the end of phase one of the grid process, the total census housing unit and PNR business line data associated with a wire center have been apportioned to each of the microgrids comprising that serving wire center.

B. Reaggregating Microgrids into Grids

The second phase of the grid process entails aggregating these microgrids into larger grids as appropriate. The ultimate size of the larger grids depends upon housing and business line data and technological constraints on the reasonable size of CSAs. In general, the largest ultimate grid size is 1/25th of a degree latitude and longitude in size or approximately, 12,000 to 14,000 feet per side.[8] Hereafter, grids 1/25th of a degree latitude and longitude are referred to as macrogrids. The macrogrid constrains the maximum copper distribution length from the DLC to the customer to 12,000 feet, in most cases. Occasionally, however, due to placement of the DLC or re-aggregation of the isolated grids (discussed later), the length of a cable from the DLC to the customer may exceed 12,000 feet. In these cases cable gauge is adjusted from 26 to 24 gauge to accommodate distribution cable lengths up to 18,000 feet.

The ultimate grid size utilized essentially reflects the manner in which customers are clustered. Modeling grids that vary in size is tantamount to allowing clusters of customers associated with a particular CSA to vary in density and dispersion.

The algorithm for determining the ultimate grids is actually a multistage process built to satisfy engineering constraints, minimize processing time, and simplify computer code. The following provides the essence of the grid algorithm. The derivation of grids is essentially an iterative process where partitioning occurs if the number of lines within a

[8] Ultimate grids may exceed this size if isolated grids are combined with grids 12,000 feet by 14,000 feet per side to generate an ultimate grid. (This is discussed later.)

grid is too large, or if other technological constraints become binding. The macrogrid is partitioned into smaller grids, if warranted, based on household and business line data associated with the underlying microgrids, and CSA guidelines. The iterative process partitions the macrogrid into four equally sized subgrids. In some instances, these subgrids, which are 1/50th of a degree latitude and longitude in size, become the ultimate size for that composite of microgrids. In other instances, the number of lines within a subgrid is still too large. In those instances, additional sub-partitioning occurs for the subgrids. Additional sub-partitioning continues to occur until all grids satisfy line size and technological constraints. The smallest grid allowed is the 1/200th of a degree latitude and longitude, the microgrid. The resulting ultimate grids have a composite household and business line count equal to the sum of the household and business lines for the associated underlying microgrids.

IV. Design Distribution Plant Within Each Grid

A. Engineering Standards

The engineering protocols most central to the design of BCPM 3.1 include an average maximum loop length for each CSA that is less than 12,000 feet. To ensure attainment of this standard, the maximum ultimate grid size is typically constrained to 1/25th of a degree latitude and longitude (approximately 12,000 feet by 14,000 feet). (Section 5.3.3 provides an in-depth discussion of BCPM 3.1's grid design.) The design of the ultimate grids ensures that the maximum copper loop length from the DLC site to the customer for any individual customer should not exceed 18,000 feet. A copper loop greater than 18,000 feet must be loaded or electronically extended at a substantial cost. The FCC clearly stated in its May 8, 1997 Order on Universal Service that no loaded loops are permitted.[9]

[9] FCC Report and Order, "In the Matter of Federal-State Joint Board on Universal Service," CC Docket No. 96-45, Released May 8, 1997, Paragraph 250, criterion 1 of the FCC's 10 criteria.

These constraints also ensure compliance with standard AT&T/Lucent and US practices covering loop resistance and electrical (dB) loss.

B. Establishing Distribution Quadrants Within Each Grid

Once the ultimate grids have been established, each ultimate grid,[10] with the exception of the ultimate grids that remain microgrids in size, is divided into four potential DAs.[11] The ultimate grid is quaded into four distribution quadrants at the road centroid of the ultimate grid which corresponds to the DLC site. Once the distribution quadrant is formed, data on the road network is used to size the appropriate DA within each non-empty distribution quadrant. For modeling purposes, the DA is a square centered about the road centroid of the distribution quadrant whose area is equal to the area encompassed by a 500 foot buffer along each side of the roads within the distribution quadrant.[12] No DA is placed within a distribution quadrant that does not have any roads, i.e. a non-populated distribution quadrant. Since this road-reduced area varies in size and location among distribution quadrants within an ultimate grid, this design is referred to as the "Floating Distribution Area". Within each of these floating DAs, all of the distribution quadrant customer data, apportioned at the microgrid level for housing units and business lines, is passed to the distribution algorithms for cable design.

Such an approach provides a reasonable model of the required telecommunications network facilities for two reasons. First, households and businesses typically reside near roads and centering the distribution quadrant of the distribution area about the center of the roads establishes network facilities closer to where customers are

---

[10] Since data is not defined below the microgrid level, the microgrid cannot be segmented into quadrants.

[11] Ultimate grids which are equivalent to a microgrid in size, are treated as a single distribution quadrant, i.e. a single DA. This typically occurs in denser, urban areas.

[12] In cases where an ultimate grid remains the size of a microgrid, a 500 foot buffer along the roads within a microgrid typically corresponds to an area that is greater than the area of the microgrid. In such cases, the area of the DA is not reduced in size. The Model constrains the area of the DA so that it does not exceed the area of the microgrid.

located than does the geographic center of the distribution quadrant. Second, rights of way for telecommunications structure generally exist near roadways. This approach reduces requisite network facilities, given customers' actual location.

C. Distribution Area Design

In determining the number of FDIs to install in an ultimate grid, the Model reviews the cable sizing used in the Grid. When the distribution cable sizing exceeds 1,200 pairs, the Model places an FDI at the road centroid within each populated distribution quadrant. Thus, the FDI is placed at the center of the DA.

If there are no roads, and therefore, no population located within a particular distribution quadrant, no distribution plant is placed in that distribution quadrant. Feeder cable, consisting of horizontal and vertical connecting cable, links the DLC to the FDI within non-empty quadrants.

When the distribution cable sizing does not exceed 1,200 pairs, the Model allows for cost savings from placing fewer FDIs. More precisely, for ultimate grids that are served by distribution cables totaling less than 600 pairs, the algorithm essentially computes the cost of placing a single FDI within those ultimate grids. This is tantamount to co-locating the FDI with the DLC.

For ultimate grids containing line demand between 600 and 1,200 lines, the algorithm essentially computes the cost of placing two FDIs within those ultimate grids.

The final piece of distribution cable, the drop, extends from the branch cable to the middle of the customer's lot and is capped at 500 feet. Lot size within a distribution quadrant is based on the distribution quadrant's average lot size, determined by dividing the road reduced area of the distribution quadrant by the number of locations, i.e. housing unit structures and business locations, within that distribution quadrant. Thus, lot size may vary across distribution quadrants within an ultimate grid.

As a reasonableness check on cable requirements, the Model constrains the total length of cables (including the backbone, branch, vertical and horizontal connecting cables) within a distribution quadrant to not exceed the length of the road network in that distribution quadrant.

E. Distribution Cable Requirements

The Model assumes two pairs for a resident unit and six pairs for a business unit. These assumptions are in compliance with the "interfaced cable sizing guidelines " contained in the AT&T/Lucent Practices.[13] The number of cable pairs per resident and business unit is a user adjustable input.

[13] As suggested in the practices, the BCPM sponsors have taken a liberal approach to the business line allocation, assuming six rather than 5 lines per business.