Fundamental FTTH Planning and Design: Part 1

Placement of network elements in the field can have a major effect on deployment costs. Here are some principles to follow.

By David Stallworth ■ OFS

Choosing the right fiber-to-the-home design strategy is very important, but the best strategy in the world may not achieve the desired results if network elements are not placed economically in the field. Years ago, OFS initiated a Fundamental Planning research project to address this issue. The project was later expanded to include the locations of central offices (COs) and nodes. This massive effort led to the development of ideal configurations for outside-plant networks and optimal locations for COs and nodes.

In the study, we developed an ideal solution based on an ideal service area – locations studied. We studied virtually every possible configuration, evaluating multiple feeder routes; different routing techniques, such as parallel routes, perpendicular routes and circular routes; and different cable sizes or route capacities. As the studies progressed, patterns began to emerge that were both intuitive and informative.

THE NODE GOES IN THE MIDDLE

From this study, we reached several general conclusions that have proven over time to define the most economical method for planning CO or node locations and outside-plant network configurations. Some of the conclusions became obvious once they were discovered, and others were revelations that have been further refined over the years. By understanding what an ideal network should look like, a planner can configure a real network to conform to the ideal as much as possible.

The study showed that the most economical location for a CO or node is exactly in the middle of the area it serves (see Figure 3). This position not only yielded the lowest cost for all customers in the serving area but also provided the lowest optical loss to all customers. Most designers consider this an intuitive finding.

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For a square area with uniform density throughout, the ideal node location is in the middle of the area it serves. Let’s call this the geographic economical location (GEL). However, because not all areas have this characteristic, we should

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consider what happens when the density is not uniform. Consider the situation in Figure 4, in which the lower left quadrant, outlined in blue, has a density of 64 homes instead of 32. How would this affect the ideal location for a CO or node?

With uneven density, the ideal location moves from the center of the serving area closer to the denser area, but not all the way there. Clearly, the denser area has more customers and requires more facilities; at the same time, other areas’ costs increase as the CO or node is moved further away. Let’s call the new ideal point the density economical location (DEL).

Of course, the denser the area, the more the ideal will drift toward it, so density plays a role in CO or node location. Figure 5 indicates the effect of the denser area on CO or node location. This is a conceptual drawing that shows the ideal location moving closer to the denser area.

Notice that the DEL is now offset from the GEL. One can develop intricate formulas to calculate the relationship between the two points for an area. In the real world, it is better to understand and apply the relationship than to spend time on detailed calculations because the real world poses still more problems.

Because not many towns or cities are ideal, the planner must make adjustments to fit actual city or area layouts. Experience is important in meshing the
ideal with the actual. For example, on the coast of South Carolina, where I live, we do not have many eastern routes – the Atlantic Ocean is in the way! Valleys are usually oblong and not square, yielding only two possible routes. However, the principles of the ideal world still apply, and planners should make every effort to come as close as possible to the ideal.

There is a very good reason to stay as close as possible to the ideal: As shown in Figure 6, cost rises exponentially as the location moves away from the ideal point.

In building a network, the first step is to locate the GEL point and then adjust it for density. After establishing the DEL, the designer can examine the area to locate appropriate land or rights-of-way. This requires good engineering judgment. Access to a road network is needed for placing cables. In addition, the location should be blended in with the surrounding structures and should be as “green” as practical.

THE PRINCIPLE APPLIES AT ANY SCALE

Though this model was initially developed for CO and node locations, it has additional applications. If optical splitters for a PON are placed in a cabinet, the same question arises: Where should the cabinet be located? The analysis is very similar because the cabinet serves a defined area, and cables need to be laid to all customers in the area. We should expect the findings to be similar if the premises and conclusions are correct.
Figure 7 shows where to place a cabinet to serve a subarea that the designer has identified as having consistent requirements (the subarea may be all residential or all business, for example). Note that the subarea is carved up into even smaller 32-home areas.

The same area is shown in Figure 8, except that a smaller cabinet size is used (160 instead of 320 homes). Even the smaller cabinets are placed in the middle of the areas they serve. Documenting service area boundaries is essential so that facilities can be planned and placed to serve a defined area and not extended past any boundary line.

Even in very small areas, costs rise as the cabinet location moves away from the ideal central location. This principle applies in an active Ethernet deployment where remote nodes are placed in the field: Such nodes should also be in the middle of the areas they serve. The same holds true for optical splitters placed in a distributed manner (distributed splitting means placing a splitter in each 32-home area, typically in a drop closure and spliced to the fibers entering and leaving the closure).

**DISTRIBUTED ARCHITECTURE**

In a distributed 1 x 32 architecture, it is possible to serve at least 256 customers with a single 24-fiber cable by using the optical splitter to full advantage to eliminate dead fibers. The same is true with a cascaded splitter deployment, where a 1 x 4 splitter serves four 1 x 8 splitters spread over the 32-home area: Each splitter should be placed in the middle of the customers or area it serves.

These concepts can be extended still deeper into the network: A drop closure, too, should be placed in the middle of the area or customers it serves. Even though the potential saving from positioning a single drop closure is not large, many drop closures are placed in a network. Adhering to these concepts for all of them may result in an overall smaller cost.

In Part 2 of Fundamental FTTH Planning and Design, we will turn our attention to configuring the fiber routes out of these facilities.

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