## INDEPENDENT TELCOS

# **Modeling the Cost Of Rural Fiber Deployment**

An important new study of independent telco FTTH deployments provides a cost model that both providers and policymakers can use.

By Masha Zager 

Broadband Properties

n 2009 and early 2010, the Omnibus Broadband Initiative team that developed the National Broadband Plan for the Federal Communications Commission released estimates of the cost of deploying fiber to all American homes. These estimates, which seemed surprisingly high to people who had experience with FTTH buildouts, convinced policymakers - and the news-

#### **VANTAGE POINT RISES TO** THE CHALLENGE

Vantage Point Solutions, an engineering firm based in Mitchell, S.D., has extensive experience designing FTTH networks. When Larry Thompson, Vantage Point's CEO, studied the FCC numbers, he concluded that they did not reflect his experience of rural construction costs.

Vantage Point was then working

develop a model that could help predict costs of future rural fiber deployments. The available data was for network builds in 227 rural areas and 209 town areas. (The towns are typically small towns outside metropolitan areas.)

In addition to Vantage Point, several other firms participated in the study: Consortia Consulting of Lincoln, Neb.; Rolka, Loube, Saltzer Associates of Harrisburg, Pa.; and Stone Environmental of Montpelier, Vt.

Mining its extensive database of rural fiber-to-the-home deployments, the engineering firm Vantage Point Solutions developed a cost model that is generally applicable to rural areas of the United States.

paper-reading public - that fiber to the home should not be an important part of the plan.

Of course, there was dissent. For example, Calix, the FTTH electronics vendor that has worked with more than half the rural telcos deploying fiber in the U.S., presented evidence to the FCC that its estimates were too high. Broadband Properties discussed the unreasonableness of the FCC's numbers in these pages and in Take It to the Bank, the editor's blog on www.bbpmag.com. However, no solid basis existed for estimating actual costs – or for deciding, from a policy standpoint, in which areas fiber deployment made sense.

with the Nebraska Rural Independent Companies, a group of 19 telcos, to prepare comments on FCC notices of proposed rulemaking. Thompson recalls, "When we sat down with the Nebraska group, rather than complaining, we asked what we could do that was better."

The group decided to sponsor an analysis of FTTH deployments by 63 independent telcos for which Vantage Point already had detailed data and then

#### **DEPLOYMENT COSTS -**WHAT WAS INCLUDED

For the analysis, Vantage Point considered the cost in each area of engineering the network, purchasing and installing electronics for central offices and customer premises, purchasing spare parts and miscellaneous materials, and purchasing and installing mainline and drop fiber optic cables and fiber management equipment. Mainline fiber cables were generally sized to accommodate anticipated growth.

Vantage Point did not consider the costs of upgrading middle-mile networks, even though such upgrades are needed in many areas to enable FTTH networks to deliver high-speed Internet connections at a reasonable cost. Thompson explains that because the policy debate centered on the local loop, his primary concern was to estimate the costs involved in upgrading local loops.

#### **About the Author**

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Nearly all the deployers in the Vantage Point study had used direct-buried fiber, though they had placed some fiber in existing conduit in town areas and strung a small amount on utility poles. In addition, nearly all deployers dedicated a fiber from the central office to each customer, either because they had placed their PON splitters in central offices or, in a few cases, had used pointto-point technology.

#### **ANALYSIS OF VANTAGE POINT RECORDS**

In addition to cost records, Vantage Point had access to other critical data physical measurements of the lengths of fiber deployed as well as the number of locations (homes, businesses or multiple dwelling units) that were connected to fiber. In most cases, there was one subscriber per location.

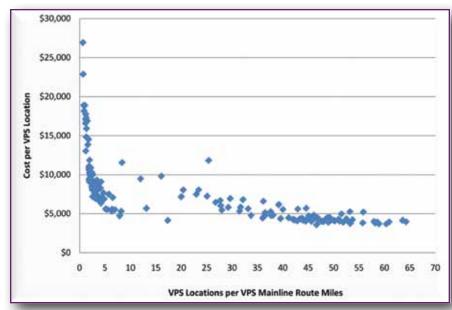
To begin the analysis, Vantage Point compared overall, inflation-adjusted costs for each of the 436 areas with the number of locations per square mile and per route mile. As the graph shows, the cost per location was strongly related to density. Linear density (locations per route mile) proved to be a much better predictor of costs than area density (locations per square mile) - a finding that accords with common sense, even though area density is the measurement more commonly used in telecommunications planning.

A regression analysis yielded the following cost equation:

Cost per location = \$4,430 + \$12,911 \* (route miles/locations)

In other words, for each subscriber location there is a large fixed cost for equipment, installation and so forth, plus a share of the cost of the outside plant, which takes the fiber from the central office to the subscriber location. In this study, the outside plant for all 436 deployments accounted for about 58 percent of the total construction cost, but in any particular area, the cost per location of outside plant depended on how many locations shared the cost.

In a town, the second component may be very small, and therefore the cost per location is relatively low - even though outside-plant costs per mile are



Cost per Location by Route Density

actually much higher in towns because town projects require more conduit, more frequent road crossings and more coordination with other utilities. Out in the country, the cost per mile is lower, but with few locations on each route, the cost per location may be very high. Because the population density varied so much, overall costs per location were double in the rural areas - \$9,286 compared with \$4,438 in towns.

The explanatory power of this equation was very high: R-squared is 0.87, meaning that linear density alone explains 87 percent of the variation in cost per location.

#### **USING PUBLIC DATA**

Performing this initial analysis demonstrated that the costs of FTTH deployment were highly predictable. However, the model does not actually help telcos or government agencies predict fiber deployment costs unless they first count the locations to be connected and then

design and measure fiber routes to all those locations.

For a model to be generally applicable, it would have to make use of readily available data rather than requiring an engineering study of each potential deployment area. Thus, Vantage Point's next step was to identify public variables that correlated closely with the variables in its model.

For the number of locations, the company tried substituting the number of households as measured by the U.S. Census Bureau. This approach would not have worked in metropolitan areas, where households typically can choose among two or three broadband providers and many do not take fiber services. However, in the rural regions covered in this study, the number of subscriber locations is closely related to the number of households. Thompson explains, "Most of these deployments were by incumbents whose cables were 40 years old and needed to be replaced, so they put a

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### Thompson hopes to augment the model with data from additional deployments. Rural FTTH deployers that would like to contribute data are invited to participate.

drop in every location. We were assuming there would be 100 percent service."

That assumption proved to be valid. Changing the "locations" variable to "households" caused very little change in the cost model.

To replace the number of mainline fiber route miles with a public variable, Vantage Point first substituted road miles, based on GIS data and a national database of streets. This substitution assumed that houses or businesses were located along every road in the area and that fiber could be deployed along all roads. As it turned out, these assumptions were not entirely accurate. Vantage Point then adjusted the road mileage to eliminate unpopulated areas and road types that were unlikely to support utility rights-of-way.

With census households and adjusted road miles replacing locations and mainline fiber route miles, the equation changed slightly:

Cost per household = \$5,042 + \$13,134 \* (adjusted road miles/ households)

#### **REFINING THE MODEL**

Using the new equation, any rural telco could now estimate fiber deployment costs from readily available data without doing an engineering study - a great benefit. However, the explanatory power of

the new equation was not quite as good as that of the original equation; it accounted for only 82.5 percent of the variation in FTTH construction costs, compared with 87 percent for the first equation.

So Vantage Point looked for additional variables beyond road miles per household that might help it estimate deployment costs more precisely. After testing a number of possibilities, the company identified the total number of households, the frost index, the percentage of wetlands, the soil texture and the number of intersections as statistically significant variables. All had small effects on total cost, compared with the effect of route density. Still, adding them into the equation raised the model's explanatory power back to nearly 87 percent.

The final cost modeling equation looks like this:

Cost per household = \$3,072 + \$13,365 \* (adjusted road miles/ households) - 0.8867 \* households + \$25.04 \* frost index + \$17,700 \* wetlands percentage + \$1,376 \* soils texture + \$165.40 \* road intersection frequency

The absolute number of households has a small negative effect on cost per household because there is an economyof-scale effect - managing a larger project is slightly more cost-efficient than managing a smaller project.

The remaining four variables reflect physical conditions that make construction more difficult: Frost days shorten the construction season. Fiber construction in wetlands requires additional approvals and specialized techniques. Rocky soils and certain kinds of dense soils are harder to dig. Finally, road intersections slow fiber construction and impose other costs.

#### **USING THE MODEL**

In January, Thompson, along with another consultant who participated in the study and two representatives of the Nebraska Rural Independent Companies, presented the model to staff members of the FCC Wireline Competition Bureau. They explained that the model could help rural providers predict capital expenditures and could help policymakers evaluate the national cost of deploying a highcapacity terrestrial broadband network.

In addition, they said, the model could be used to develop an upper limit on "reasonable" capital expenditures for telcos subject to rate-of-return regulation and to help choose among competing recipients in light of funding limitations.

"We were very warmly received by the FCC," Thompson says. "The FCC was extremely positive. They were very excited - they'd never seen any sort of analysis with the level of accuracy that we appear to have."

Thompson hopes to continue the study to make the model still more useful. "There are rough edges we're working to refine," he explains. For example, the "soils texture" variable does not seem to reflect actual costs in rocky and clay soil areas, and an enhanced measure of soil difficulty might improve the model's accuracy.

Most important, however, is augmenting the data set with results from additional deployments. One limitation of the current data is that the 63 telcos whose data was used are located in 15 upper central and southeastern states. The West Coast, Southwest and Northeast are not well represented, and the model may be less applicable to those regions. Vantage Point has invited other engineering companies and telcos to contribute their data and help build a truly national cost model. BBP

### **RESOURCES AND CALL** FOR PARTICIPANTS

Detailed reports from Vantage Point about this cost-modeling project are available on the Rural tab of the Broadband Properties website at www. bbpmag.com/mt12.php.

To participate in the project by contributing data about additional FTTH deployments, contact Larry Thompson at larry.thompson@vantagepnt.com.