Government Information Quarterly 31 (2014) 78–83

Contents lists available at ScienceDirect

Government Information Quarterly

journal homepage: www.elsevier.com/locate/govinf

Persistence of the middle mile problem for rural local exchange carriers

Victor Glass *, Joseph Prinzivalli, Stela Stefanova

National Exchange Carrier Association, 80 South Jefferson Road, Whippany, NJ 07981, USA

ARTICLE INFO

Available online 14 June 2013

Keywords:
Middle mile
Broadband
ISP
RLEC
Internet backbone

ABSTRACT

Cost of middle mile bandwidth is declining, but the bandwidth required to meet the needs of broadband subscribers is increasing. The Federal Communications Commission (FCC) has set a Broadband Availability Target of 4 Mbps downstream speed, but average speeds provided to customers in rural areas fall short of this target, indicating a need for more investment in bandwidth capacity. The cost of these upgrades will be substantial and may prove to be a barrier to providing greater speeds to subscribers. We also find that higher capacity and packet technology provide cost savings for the middle mile connections. Population density and geography alone do not explain differences in middle mile costs.

1. Introduction

The FCC and interested parties recognize that middle mile connections – those between an internet service provider and the internet backbone – are potentially costly bottlenecks that could undermine the FCC's plan to make a 4 Mbps downstream and 1 Mbps upstream broadband connection universally available.[1] Several plans submitted to the FCC such as the State Members' Plan and the Rural Association Plan recommend that universal service funding be extended to support middle mile connections in rural areas.[2] In its Further Notice, the FCC sought comments on the benefits and costs of providing support for "middle mile" facilities.[3] The FCC wanted to know for smaller carriers what proportion of costs to deploy broadband networks are attributable to middle mile costs today, and how to impose costs limits on middle mile costs going forward.

This paper documents that the cost of middle mile upgrades required to meet the FCC's broadband availability target will be substantial and may prove to be a barrier to providing greater speeds to subscribers. We also find that higher capacity and packet technology provide cost savings for the middle mile connections. Population density and geography alone do not explain differences in middle mile costs.

This paper is organized as follows. Section 2 reviews the NECA studies that have documented the middle mile challenge. It is the only set of studies that contain snapshots of the MM capacity and cost issues for high-cost rural markets. Section 3 documents NECA's 2010 survey efforts to quantify the MM rural market in response to an FCC Public Notice. Section 4 presents survey summaries with commentary. Section 6 provides estimates of increased middle mile capacity and middle mile cost required to accommodate rapid video growth. The last section summarizes our conclusions.

2. Previous studies and filings

The National Exchange Carrier Association (NECA)[4] has been analyzing middle mile costs since the RLECs participating in its pooling process began deploying broadband service. The objective was to see to what extent middle mile connections are roadblocks to universal broadband availability in areas served by RLECs. Prior to the most recent survey (described in Section 3), NECA conducted a middle mile simulation, two middle mile data collections, and a middle mile data filing for the FCC. As far as we know, these are the only set of studies that analyze the problem at different points in time. They suggest enormous progress has been made in lowering middle mile transport costs and increasing the capacity of these connections. These studies also show that although transport costs per Mbps are decreasing broadband speed requirements are increasing.

2.1. NECA's first middle mile study

In 2001, NECA released its first middle mile study that estimated the cost of transporting broadband traffic using a simulation model (Glass, 2001). The middle mile network was defined as the transmission

* Corresponding author.
E-mail address: vglass@neca.org (V. Glass).

[1] *Connect America Fund* et al., WC Docket No. 10-90 et al., Report and Order and Further Notice of Proposed Rulemaking, FCC 11-161 (rel. Nov. 18, 2011) (*USF/ICC Transformation Order*).

[2] Comments of NECA, OPASTCO, NTCA, and WTA (Rural Associations), WC Docket No. 10-90, et al. (filed April 18, 2011) and Comments by the State Members of the Federal State Joint Board on Universal Service (State Members), WC Docket No. 10-90, et al. (filed May 2, 2011).

[3] *Connect America Fund* et al., WC Docket No. 10-90 et al., Report and Order and Further Notice of Proposed Rulemaking, FCC 11-161 (rel. Nov. 18, 2011) (*USF/ICC Transformation Order*).

[4] The National Exchange Carrier Association, Inc. (NECA) prepares interstate access tariffs, administers related revenue pools, and collects certain high-cost loop data. More than 1000 local telephone companies participate in NECA's access charge revenue pools.

0740-624X/$ – see front matter
http://dx.doi.org/10.1016/j.giq.2013.02.005

facility that extends from the internet service provider (ISP) premises to the node of an internet backbone service provider. Transport costs were estimated by assuming that all ISPs within a study area aggregate their traffic at a common switch and jointly ship the traffic to a common ISP hub. From there, the traffic is shipped using a common pipe to the internet backbone node (IBN).

The simulation relied on very conservative assumptions that tended to lower transport costs per customer.[5]

The results showed that at the existing 0.5% DSL penetration rate, DSL middle mile transport costs were extremely high, $134.65 per DSL per month on average, for ISPs operating in a telephone company serving area with 5000 or fewer telephone lines and the distance to the nearest IBN was between 40 and 200 miles. The cost dropped to $53 per DSL per month on average when the local telephone company served more than 25,000 lines. When DSL penetration rose to 15%, transport costs declined from $134 per DSL per month to $20 per DSL per month for the telephone company serving area with 5000 or fewer lines, and dropped from $53 to $11 per DSL per month for the 25,000 plus lines telephone company category. The results suggested economies of scale and distance from an IBN were important factors affecting DSL transport costs.

2.2. NECA's 2003 follow-up middle mile study

Because the first study relied on simulated data, NECA surveyed 200 serving wire centers to test the accuracy of the simulation model and its output, and the follow-up study confirmed the first middle mile study produced reasonable transport length and was conservative for estimating transport costs (Glass, Chang, & Petukhova, 2003).

The survey had five sections. The first contained general information on a telephone company's serving wire centers (SWCs), the ISP, and the availability of internet broadband access. The second section concentrated on ISP network configurations (trunk capacity and connection points), the transport cost from ISP to IBN, and the level of DSL demand. The third and fourth sections collected data on SWCs with and without an ISP physically present. The fifth section collected information on factors affecting an ISP's decision to offer DSL in a particular area.

The survey was completed and provided information on 200 SWCs that reflected the population reasonably well. The survey results showed that at a 10% penetration rate, the average penetration rate at the time of the study, the average ISP transport cost from the ISP to the IBN was $45 per line per month. The simulation's estimate was $28 per line per month, conservative as expected (Glass et al., 2003, Table 6).

The survey also showed that low profit potential caused by low market density, low average family income, and distance between lines and the nearest switching office explained why certain ISPs did not offer DSL access to the internet.

2.3. Middle and second mile regulatory filing

Both studies found that middle mile transport costs were a barrier to universal broadband deployment. The market evolved rapidly in the ensuing years. The typical broadband service grew from 200 Kbps in 2002 to 1–3 Mbps as typical offerings in 2008. The Federal Communications Commission (FCC) requested middle mile data to determine whether the extent of the middle mile problem (FCC, 2009). To collect relevant data, the FCC's Public Notice asked many questions about middle mile and second mile transport, including the capacity required to provide end-users with adequate internet connectivity, the availability and pricing of capacity, how capacity requirements vary with usage characteristics, and the technology options available for middle mile and second mile capacity.

To answer questions in the FCC's Public Notice, NECA drew on preliminary data collected from RLECs in its Company Services Questionnaire and Advanced Services Demand data request (NECA, 2009). NECA found that rural areas have high middle mile and second mile costs that could be barriers to broadband deployment. Although there was wide variation in costs, there were patterns that emerged. Middle mile costs generally were lower as the capacity of the transport facility increased, particularly when RLECs used Ethernet technology.

3. 2010 Broadband services and middle mile survey

In 2010, NECA surveyed its pool members and their ISP affiliates about their middle mile configurations, last mile and second mile capabilities, and ISP operations costs. With over 500 responses to the survey, the data provide a good representation of RLEC broadband capabilities and middle mile arrangements. The middle mile section of the survey asked about the capacity of the transmission facility that connects the ISP to the internet backbone, the technology used (e.g., copper or fiber), the type of interface, the peak downstream in-service bandwidth, and the associated costs. These questions were asked about the primary and alternate middle mile facilities. Another section of the survey asked about the DSL Access Service Connection Point. The third section asked about the ILEC's last mile broadband services and capabilities. The fourth section asked about the ISP's operating budget and charges paid to the ILEC for access to the DSL network and the DSL Access Service Connection Point.

4. 2010 Middle mile survey results

Table 1 displays median values of companies' average middle mile costs, average capacities, and oversubscription by type of facility.[6] Oversubscription occurs when a service provider sells more capacity than is available on a facility with the expectation that not all subscribers will send traffic over the facility at the same time. For instance, an oversubscription rate of 20 on a DS1 facility (with a capacity of 1.544 Mbps) means the service provider has sold 30.88 Mbps worth of capacity to all subscribers.

One can draw several conclusions from Table 1, all pointing to economies associated with high capacity and packet-based middle mile connections. First, the median monthly middle mile cost per broadband line dropped dramatically from the $45 average cost NECA documented in 2003.[7] The median cost per broadband line across all facilities is now $5.25.[8] Second, the median monthly middle mile cost per broadband line tends to decrease as capacity of the middle mile facility increases. For instance, RLECs using a DS1 facility pay $13.20 per broadband line per month to their middle mile provider, whereas RLECs using an OC12/48/192 facility pay $4.07.[9] Third,

[5] The number of digital subscriber line (DSL) customers in a telephone company serving area used in the simulation was at or above current demand levels. Penetration rates were assumed up to 15%, even though they averaged around 0.5% at that time. Only one ISP operated in a serving area. There was only one DSL Access Service Connection Point (CP) in the telephone company's serving area where all Internet traffic was handed off to the ISP. The ISP's hub site where it aggregates traffic from several telephone company serving areas was at the nearest Regional Bell Operating Company switch in the territory where an IBN resided. The traffic at the ISP hub went to the nearest IBN. The prices charged to ISPs by local and long distance carriers were calculated at the maximum discounted tariff rate.

[6] We use medians rather than weighted averages, so that large RLECs in a category do not dominate the results. The table compares medians and gives the center point of the distribution of values within each category.

[7] Costs are shown per broadband line because ISPs handle DSL traffic as well as traffic from other providers such as cable operators. The two earlier NECA studies reported cost per DSL.

[8] The value reported in NECA's regulatory filing was $5.56, using data collected in 2009 from a different sample of companies (NECA, 2009). On a facility by facility basis, some of the costs in the new study are higher than they were in 2009, while others are lower.

[9] A DS1 facility has a capacity of 1.544 Mbps, whereas DS3 has a capacity of 44.736 Mbps, 28 times the capacity of DS1. An OCn facility has a capacity equivalent to n DS3 facilities.