

Old-Fashioned Thrift

Memo to community broadband folks: Mind your money.

By Dan Grossman / *NetAccess Futures*

Good engineering has an element of old-fashioned thrift. Remember these old sayings? “Use it up, wear it out, make it do or do without.” “A penny saved is a penny earned.” “Waste not, want not.” “Money doesn’t grow on trees.” “Take care of the pennies, and the dollars will take care of themselves.” “The bitterness of poor quality outlasts the sweetness of low price.” For capital-intensive infrastructure projects, thrift is a paramount virtue.

All too often, community broadband deployments cost more than they have to for reasons that add little value.

BROADBAND COMMUNITIES readers understand the difficulty of funding these vital projects. Municipalities that seek to build broadband infrastructure must cobble together financing plans from various sources of money. Finding the money requires time and effort. Fundraising sometimes falls short of project cost estimates, killing or delaying projects. Potential lenders and bond ratings agencies scrutinize time to positive cash flow. Funding a broadband project can affect other community priorities. Most important, the public ultimately pays the project cost – it’s their money and their trust.

For those reasons, every dollar of capital expense and future operating expenses must be spent wisely. This is more than an admonishment to spend money ethically and responsibly. Public officials must have a clear-eyed understanding of what the project is supposed to accomplish. They must eliminate or postpone anything not critical to that mission, and they must optimize for low life-cycle cost with high value.

Proponents of community broadband often see it as a way to create competition, overthrow

the incumbent monopolies, enable anybody to create killer applications, unlock hidden creativity, actuate democracy, revolutionize the economy, empower citizens and save the world. Pragmatically, those are not goals that communities need to set for themselves. They have a concrete, immediate problem: lack of adequate broadband service at reasonable prices with good customer support. This problem, with its familiar litany of symptoms – frustrated citizens, businesses impeded or driven away, kids doing their homework in the library parking lot at night, adults unable to telecommute, depressed property values, and so forth – is self-evident. Solving it should be the laser-like focus of the business plan, network architecture and budget.

Overreaching goals and technology misunderstandings lead planners into fallacies, which lead to overly expensive projects. Here are some examples:

- **“As long as we’re putting in fiber, we might as well put in lots of it in fat cables. Who knows what we might want it for later?”** Fiber-rich deployment is appropriate where traffic is highly aggregated and connectivity is limited to relatively few end points: in the middle mile, in the long haul, between data centers and for enterprise customers. It doesn’t scale well to residential and small-business access networks, which must fan out over broad geographies. The lifetime cost of more fiber in these applications mounts quickly for a lot of not-always-obvious reasons. In addition, a looming global supply shortage of optical fiber portends higher prices for high-fiber-count cables in the near future. Last-mile

networks should be designed relatively fiber-lean, with reasonable margin for growth.

- **“Every customer should have a dedicated point-to-point fiber all the way from the home to our point of presence ...”** In urban centers, home-run architectures are sometimes the lowest-cost solutions. They are also justified for large customers, such as large office buildings, data centers, hospitals, universities and wireless systems. However, for community broadband projects that primarily serve residences and small businesses, shared fiber passive optical networks (PONs) are usually the most cost-effective architecture. This is because sharing fiber enables fiber-lean design. It is particularly true in rural and semirural areas because of the distances involved. Home-run architectures can dramatically inflate project cost – sometimes by more than 100 percent!
- **“... so they get a first-class experience.”** Dedicated fiber does not offer a perceptibly better customer experience than properly engineered shared fiber. The reasons are complex, as I explained in an article in the October 2014 issue of this magazine. In short, a fiber’s bandwidth is either used or unused at any instant of time. Each customer actually uses only a tiny fraction of the available bandwidth. If that bandwidth is shared, more can be

For residences and small businesses, sharing fiber on a passive optical network can provide excellent service quality today and in the future for a reasonable construction cost.

used and less is wasted. With proper engineering, there’s almost always more bandwidth available than is being used at a given time. This kind of resource sharing is how the Internet works and is the main reason for its success. There’s no reason the first mile should be any different.

- **“... because we’re building an open-access network.”** Some broadband network plans require open access, in which infrastructure is owned by a network provider (NP) and shared by multiple service providers (SPs), which offer Internet and other services to retail



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Virtual local area networks can enable customers on open-access PONs to choose among multiple service providers.

customers. This requirement recognizes that infrastructure tends to be what economists call a “natural monopoly”: Capital cost, rights-of-way and market dilution present high barriers to new competitors. Open access brings consumers the benefits of competition for services, which are not natural monopolies. Open access can also simplify community broadband business plans by assigning ownership of lots of headaches to the SPs, which are often better able to deal with them.

The boundary between the NP and the SPs can be drawn in several different ways. Some involve dedicating a point-to-point fiber from each customer to an NP-owned interconnection point to which the customer’s chosen SP connects its own dedicated fiber. These approaches, in addition to incurring the higher cost of dedicated fiber, present a number of operational problems. For example, when competition incents customers to switch SPs, change orders have to be executed by manually disconnecting and reconnecting fibers. Determining responsibility for problems can be tricky and often ends up in a finger-pointing contest between SP and NP.

A preferable approach is for the NP to connect to the SPs using “virtual open access.” Virtual local area networks (VLANs) are a standard Ethernet feature that is integral to common FTTH technologies. A VLAN can be thought of as a bit pipe. The NP supplies VLANs to connect each customer to the SP of its choice. Change orders are performed entirely through software. Virtual open access has significantly lower capital and operating costs and fewer headaches than physical open-access approaches. As a bonus, virtual open access makes it easy for a customer to use a single physical connection to buy services from more than one SP (for example, one for family use and one for a home office).

- **“... because symmetrical bandwidth is an absolute requirement.”** Aggregated residential and small-business customers consume much more traffic than they generate. This fact is well confirmed by measurements of live networks and easily explained by application requirements, consumer behavior and typical small-business needs. No foreseeable application is likely to change that. In fact, growing mass-market penetration of 4K/UHDTV video will *increase* asymmetry.

Some FTTH technologies have asymmetrical data rates for cost optimization (not because of a sinister industry plot). The engineering rationale is complex, having to do

with the manufacturing costs of various kinds of lasers and the way light travels through fiber. Other FTTH technologies attain bit rate symmetry either at higher cost or by unnecessarily restricting the downstream bit rate to match the most cost-effective upstream rate.

Asymmetrical data rates do not preclude symmetrical services. Many providers use GPON, which has data rates of 2.5 Gbps in the downstream direction and 1.25 Gbps upstream, to offer 50/50, 100/100, 500/500 and even 1000/1000 Mbps services. They do this by taking advantage of bandwidth sharing and the asymmetry of user traffic.

- **“... because some of our customers are more than 20 km (12 miles) from our point of presence.”** First, the old 20 km limit on PON technology has been updated based on advances in technology and manufacturing and has also been made more flexible. The current guidelines include both distance and split ratio (the maximum number of possible customers on a PON):
 - 20 km (12 mi) at 64:1 split ratio
 - 30 km (18 mi) at 32:1
 - 37 km (23 mi) at 16:1
 - 44 km (27 mi) at 8:1.

Reaches beyond 44 km are uncommon and affect few customers in very remote areas. It is especially difficult to make a business case for serving these customers – yet sometimes serving them is unavoidable. There are several solutions to this problem. Vendors offer various kinds of reach extenders that can allow customers to be as much as 60 km (37 mi) from the point of presence. Small optical line terminator units can be sited closer to clusters of remote customers so they may be served by PONs. Sometimes a point-to-point solution is most appropriate to reach a few outlying customers while PONs serve the remaining customers. The best approach should be selected by engineering cost analysis. A few problematic locations should not be allowed to adversely affect the economics of a deployment.

- **“Gigabit is so passé. We’re going to offer 10G.”** If bragging rights and one-upping other communities are the primary objectives, then go for it. However, equipment is significantly more expensive – by multiples of 1.5 to 3 for 10 Gbps and 5 to 8 for 40 Gbps per fiber. Few customers can utilize 1 Gbps service, never mind 10 Gbps. In addition, as I explained in my earlier **BROADBAND COMMUNITIES** article, 10 Gbps doesn’t even necessarily offer 10 times the performance of 1 Gbps.

At present, the most cost-effective approach is to market a 1 Gbps (or lower) “flagship” service tier to residential and small- to medium-business customers along with a few less-expensive, slower tiers for the many customers who don’t want to pay for gigabit rates. Enterprise customers that need multigigabit service can be accommodated with either 10 Gbps PON or spare point-to-point fiber. These customers are much less price-sensitive than consumers and small businesses, and they are accustomed to paying



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high prices, so more expensive installation processes and equipment can be justified by higher prices.

Of course, a business case might develop in the future for higher-rate service tiers if demand arises and as equipment prices decline. The standards bodies that specify PON technology require that each new generation work on the same fiber infrastructure as previous generations and that multiple generations be able to coexist. The service providers that dominate these committees insist on coexistence and slow migration to protect their significant investments in PON infrastructure and equipment. This means that when higher-rate technology becomes justified, it can be seamlessly transitioned into the existing network.

- **“We can shave costs later.”** Be careful. Procurement is no place to go cheap. For example, bargain-basement fiber made from inferior materials deteriorates in as little as 10 years. Some off-price equipment comes with little technical support or suffers from poor-quality software, components or manufacturing. Lowball construction bidders are likely to cut corners, leading to cost overruns, rework, poor documentation, future maintenance problems and conflicts with property owners. On the other hand, innovative materials, tools and construction techniques

Watch out for bargain-basement fiber, off-price equipment and lowball construction bidders. Innovative, high-quality products are more economical in the long run.

can significantly reduce labor costs relative to traditional methods. RFIs, budgets and RFPs should reflect these genuine savings and not assume nickel-and-diming.

- **“We can’t afford paid experts. Some of our volunteers have science and technology backgrounds. (Or “Some of our staff know something about networking.”) They’ll figure it out.”** Community broadband efforts often start with activists who volunteer their time and know-how or with an electric utility. Occasionally, a volunteer or staffer might be a telecom or cable company. Or there might be a volunteer on the equipment vendor side of the telecom industry. Not many community projects are fortunate enough to have those technology committees tend to consist of information technology professionals, software developers, technology enthusiasts, engineers and scientists in unrelated disciplines. Although these people may be highly intelligent and knowledgeable in their own fields, they lack specialized knowledge of FTTH technologies and FTTH engineering economics. Without guidance from subject matter experts, they are likely to lose their way and fall into the traps discussed above. Some technology committees spin their wheels in poorly informed arguments and thus can’t agree on direction, make decisions, determine next steps or generate actionable plans. Not bringing in appropriate expertise in the planning stages of these projects is “penny wise, pound foolish.”

Managing the cost side of the balance sheet is essential to the success of a community broadband project. The keys are to have a clear-eyed focus on immediate community needs and a realistic projection of future needs, to dismiss misinformation and hyperbole, to obtain good advice about technology options and to use all that to make cost-effective decisions. ❖

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