

Low-Earth Orbit Satellites: Great Idea but Not for Everything – And Not Cheap

Investors have been needlessly spooked about new satellite technology. Individual satellites are cheap, but thousands must be deployed and periodically replaced. So satellites are competitive – and welcome – but only in limited situations.

By Steven S. Ross / *Broadband Communities*

The first round of bidding for the FCC's Rural Digital Opportunity Fund subsidies began October 29. On the table is \$16 billion to be distributed over 10 years. There are 386 qualified bidders, including major carriers such as Verizon, Cox Communications, Consolidated Communications, Altice USA, Frontier Communications, Windstream and CenturyLink (now Lumen). About 50 telecom cooperatives are listed; 190 electric cooperatives also bid, most as members of consortia. Some major national carriers expected to participate, such as AT&T and Comcast, are not. The lowest bid (lowest subsidy per customer the carrier says it needs) wins.

No bidder has attracted as much investor and competitor angst as Space Exploration Technologies, better known as SpaceX. Its Starlink division had about 800 working low-Earth orbit (LEO) satellites in orbit by late October. Traditional telecommunications companies report major pushback from regional banks and from Wall Street equity and hedge funds due to fear stimulated by LEO technology. The concern is unwarranted. So is speculation that SpaceX is due to crash and burn.

Based on my experience following the public docket on this at the FCC, holding a seat at the table at a company that tried to get SpaceX to commit to future service in a vast but sparsely populated area, and guiding many carriers through (free) use of **BROADBAND COMMUNITIES'** financial models, I have a different take on the issue: LEO is a great advance. In the United States, it will be the dominant broadband technology in sparsely populated areas and will have a role in some special circumstances, such as disaster communications and vehicle connectivity. It could eventually serve poor communities worldwide. In short, existing carriers investing in fiber have nothing to fear.

REASONS LEO IS NOT A THREAT

First, SpaceX can launch 60 satellites at a time on a reusable booster. According to SpaceX CEO Elon Musk, the marginal

cost of the booster launch is \$15 million. That may be a low estimate, and it includes a new upper stage (\$10 million), patched fairings, and refurbishment and fuel. It means the marginal cost of each satellite manufactured and delivered to orbit is remarkably low, about \$1 million. But SpaceX envisions launching at least 6,000 satellites (costing roughly \$5 billion) and has asked the FCC for permission to launch as many as 42,000. The costs add up.

Second, it appears that the main market is not the United States, but vast unserved areas in Africa (200 million premises that do not have reliable cell service) and elsewhere. Initially, however, this may be in the form of communities and neighborhoods sharing one LEO satellite antenna or integrating cellular networks because individual LEO subscriptions would still be pricey by African standards.

SpaceX has two sophisticated partners (Amazon and Microsoft) that envision small, local data centers (some even in truck trailers) fed by satellite and possibly landline to provide service to rural businesses and local video hubs. It is unclear how many there would be or whether Amazon will remain a SpaceX customer when (or if) its planned Kuiper satellites are ready.

Much of the world's population may be off the table for SpaceX. In India, a consortium of Hughes Network Systems, Bharti Enterprises and the UK government has an edge because of nationalistic issues. The consortium took over the OneWeb LEO project in bankruptcy. Over the years, Bharti has proven to be a nimble innovator in both technology and financing. For instance, it was the first large cellular carrier to lease its network from others. China has committed mainly to fiber-distributed broadband and 5G, which of course usually requires fiber backhaul anyway.

Third, LEO technology is remarkably unsuited for or marginal in rural but mountainous places, such as Vermont. Homes in these places tend to cluster along roads, even in rural areas, so landline is often competitive. Homes in the valleys usually have restricted horizon views. Mountain ranges also

tend to create bad weather. Ground antennas typically can lock on to any one satellite for only 10 minutes, even with clear horizons.

LEO also is generally unsuited for cities because of horizon and apartment connection issues and customer saturation. SpaceX has said roughly 30 users can comfortably share a channel given the spectrum SpaceX has licensed so far and needs to use worldwide.

SpaceX initially got FCC permission last spring for a million customer antennas. It wants to raise that to 5 million and launch more satellites to serve them. Right now, SpaceX can reliably serve only areas in Canada and the northern United States.

COMPARING THE CAPEX

Let's say that each satellite can service 300 subscribers in any one orbital trip and that SpaceX's initial constellation of 6,000 satellites is in place at \$1 million each. That's about \$5 billion for a "network" serving about 2 million premises, for an initial capital cost of \$2,500 for each premises. To that, add the ground antenna. SpaceX says it's charging its beta customers \$500 plus taxes and shipping for the antenna, mount and Wi-Fi gateway and \$99 per month for service. This is good but far less revenue per satellite than the annual \$30 million per year Musk once floated. A more realistic calculation: Multiply 300 subscribers times an optimistic tenfold oversubscription rate times \$1,000 to \$1,200 per year customer revenue, and the total is \$3 million per year per satellite. Using the satellites' laser communication to bounce traffic from one to another would raise this but not likely by a factor of 10. In addition, SpaceX hopes to compete with transoceanic fiber, but that's unlikely to add much revenue given current and predicted prices and bandwidth availability in existing undersea fiber cables.

Fiber in multiple-dwelling-unit buildings costs about \$1,000 per apartment. In an amortizing lease for the network build, that is about \$20 per month for financing costs. After five to seven years, the network deployer would own the network.

By contrast, in extremely rural areas with five potential and four signed customers per mile, fiber costs \$5,000 to \$6,000 per premises served. The fiber service offers greater bandwidth with better reliability and lower latency. The fiber plant would need better electronics every seven years or so, for a few hundred dollars per premises served. In that time, at least two satellites would exhaust their maneuvering fuel or fail in other ways, doubling the capital cost per premises served. Indeed, SpaceX itself has, on occasion, put its cost for this first phase at \$10 billion, not \$5 billion – not including development costs. It's no wonder SpaceX is seeking FCC subsidy, at least for initial ground station subscription costs.

This is also why LEO really is competitive only in sparsely populated areas, for special services during emergencies and in moving vehicles, or in poor countries where entire communities can share a ground antenna and Wi-Fi gateway.

In the United States, how big a market exists in sparsely populated areas? More than one might imagine. I've been using random forest AI routines to detect patterns in all 1.7 million census blocks with at least one person living in them. There are many caveats about what one can conclude with this dataset, but there are more than 2 million premises in areas with four or fewer premises per road mile. If I include temporary housing, such as dorms for farm seasonal workers, vacation sites that don't show up on the census but are on the Geological Survey maps and so forth, I get 3 million. All the numbers include Native American reservation land.

Among my data issues is that main roads often are the boundaries between blocks, and my routines have to "learn" that the premises on different sides of the road are totaled correctly per mile even if in different blocks. There are services that match up tax maps, billing addresses, school kids and other live inhabitants, centroids of parcels and so forth. I have not gotten to the point where I'd swap data with such services, but I might do so eventually. The FCC has been trying to clean this up as well.

With luck, the FCC will issue new Form 477 requirements asking for better data.

I can see how SpaceX and its competitors can make their own economic cases better – again, by bouncing traffic off multiple satellites to take advantage of capacity at night and over oceans, for instance, or improving bandwidth and channel space for each satellite. But it all boils down to LEO being a wonderful technology that simply cannot replace ground networks, especially fiber networks, in most places.

In investor-speak, it will not lead to massive stranding of fiber assets and therefore should not cause much, if any, angst among investors in fiber networks. Satellites are just not that cheap.

That has led SpaceX to adopt some odd approaches for its broadband business. The price SpaceX wants to charge U.S. subscribers is fairly high for 150 Mbps/40 Mbps if customers have alternatives. This apparently does not leave much margin for sharing profit with third parties.

As a result, SpaceX is seeking subsidies under RDOF and wants to do everything itself, all the way down to sales and customer service. It wants to "own" customers even though it has nothing else to sell to them yet. Maybe Tesla tractors? SpaceX stock? Trips to Mars? Here on Earth, even experienced broadband providers often rely on the experience of local third parties.

Ultimately, the biggest competition may be H.R.2, which passed the House and has a small chance of passing the Senate in a lame duck session. It includes \$101 billion for broadband and \$1.4 trillion for transportation projects. It would be sold as a great jobs and stimulus bill, more useful than simply paying people not to work until COVID-19 dangers pass.

Wall Street might panic about H.R.2. How might existing carriers, after massive entertainment investments they are beginning to write off, benefit or be hurt by investments in satellites and rural broadband subsidies? They should gain entertainment customers but may lose some pricing power on rural network services. ❖

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