



February 8, 2021

Via ECFS

The Honorable Acting Chairwoman Jessica Rosenworcel
The Honorable Commissioner Brendan Carr
The Honorable Commissioner Geoffrey Starks
The Honorable Commissioner Nathan Simington
Federal Communications Commission
45 L Street NE
Washington, DC 20554

Re: ***Ex Parte* Filing by Fiber Broadband Association and NTCA–The Rural Broadband Association in WC Docket No. 19-126 – Rural Digital Opportunity Fund and OEA Docket No. 20-34 – Rural Digital Opportunity Fund Auction**

Dear Acting Chairwoman Rosenworcel and Commissioners Carr, Starks, and Simington:

The Federal Communications Commission’s (“Commission”) Rural Digital Opportunity Fund (“RDOF”) program has the potential to bring robust broadband service to millions of unserved locations throughout the country – but only if recipients of support actually deliver on their promises. In a recent letter, 44 Senators and 116 Representatives highlighted both the promise of the program and the need for the Commission to review the long-form applications filed by the winning bidders in the RDOF auction “to validate that each provider in fact has the technical, financial, managerial, operational skills, capabilities, and resources to deliver the services that they have pledged for every American they plan to serve regardless of the technology they use.”¹ The Fiber Broadband Association (“FBA”) and NTCA – The Rural Broadband Association (“NTCA”) agree with these Members of Congress. The Commission faces a daunting but essential task in ensuring that winning bidders can meet their public interest obligations and not strand these unserved consumers. And, the stakes become greater when a bidder won the rights to serve hundreds of thousands of unserved locations and intends to use technologies and network infrastructure not yet proven in the market – especially when it may not be discerned for years to come whether those technologies will evolve to the point where they can in fact satisfy the bidder’s RDOF commitments.

¹ Letter from Senators Amy Klobuchar and John Thune and Representatives James E. Clyburn and Tim Walberg *et al.* to the Honorable Ajit Pai, Chairman, Federal Communications Commission (Jan. 19, 2021).

One such winning bidder is Space Exploration Technologies Corp. (“SpaceX” a/k/a “Starlink”), the only bidder using Low Earth Orbiting (“LEO”) satellites, which won the rights to provide voice and 100/20 Mbps broadband service with low latency to 642,925 locations in 35 States and which has not yet deployed its full constellation of satellites and ground stations and has just begun to offer commercial service. The general public and communications engineers alike, including at FBA and NTCA member companies, often marvel at SpaceX’s plans and efforts; yet, those with engineering experience know there is often a large gap between theoretical and actual network performance. To assist the Commission in discerning theory from reality and ensure unserved consumers receive what SpaceX promises, FBA and NTCA have commissioned Cartesian, a business consulting firm, to conduct an engineering analysis of SpaceX’s potential to meet its RDOF public interest obligations – which is no small task given that: (a) SpaceX has provided limited information publicly about its network and the performance capabilities; (b) SpaceX’s network plans and performance capabilities continue to shift; and (c) actions by the Commission in pending and future proceedings may cause SpaceX’s plans to change further. Nonetheless, based upon information that is publicly available and as things stand now, FBA and NTCA charged Cartesian to:

1. Identify technical (network) parameters that are essential to analyzing whether SpaceX is likely to meet the RDOF public interest obligations (e.g., providing 100/20 Mbps service to the required locations by the end of year six) in serving 642,925 locations in 35 States;
2. Determine whether SpaceX has published sufficient information about technical (network) parameters and whether these parameters will remain sufficiently stable during the 10 year period such that one can analyze whether it is likely to meet the RDOF public interest obligations;
3. To the extent possible, develop a methodology to analyze whether SpaceX is likely to meet the RDOF public interest obligations;
4. Use available information about SpaceX’s technical (network) parameters and the methodology to the extent possible to analyze whether SpaceX is likely to meet the RDOF public interest requirements; and
5. Analyze whether the Commission’s existing performance testing regime is sufficient to determine whether SpaceX’s actual performance meets the public interest obligations over the course of the 10-year term of support or whether additional steps should be taken to capture accurately the network’s performance.

The results of Cartesian's work are attached. In brief, Cartesian's model illustrates, based on assumptions that accept the timing and performance of SpaceX's network as set forth in its public announcements:²

If SpaceX Serves Only RDOF Locations, It Fails to Meet the RDOF Public Interest Requirements on a Nationwide Basis

-- If SpaceX were to engineer its network to serve only the requisite number of RDOF locations and then serve no other locations (*i.e.*, the network is engineered to serve 70% of 642,925 locations), Cartesian estimates that 56% of SpaceX's RDOF locations in the low capacity case (average bandwidth usage of 15.3 Mbps per location) and 57% of locations in the high capacity case (average bandwidth usage of 20.8 Mbps per customer)³ will experience service degradation during peak times and not meet the RDOF public interest requirements; further, Cartesian estimates that 25–29% of locations will receive an average of less than 10 Mbps of bandwidth during peak times.

If SpaceX Serves Only RDOF Locations, It Fails by a Substantial Degree to Meet the RDOF Public Interest Requirements in the Eastern Region, but Does Meet the Requirements in the Mountain and Midwest Regions

-- If SpaceX were to engineer its network to serve only the requisite number of RDOF locations and then serve no other locations, Cartesian estimates that it would not meet the RDOF public interest requirements during peak demand in over half of locations, concentrated in the Eastern region, which is where the density of its RDOF locations is the greatest. By contrast, in the Mountain and Midwest regions, if SpaceX devotes all of its capacity only to RDOF Locations and serves no other customers, Cartesian estimates that

² The base case of the model assumes SpaceX is able to meet its goal of 12,000 satellites before the mandated RDOF completion date and that SpaceX will optimize its satellite coverage by both prioritizing uplinks from ground stations to satellites to which few other users can connect and allocating capacity to attempt to satisfy RDOF requirements in all areas before distributing surplus capacity. The model also assumes all subscribers within range of a satellite can connect to that satellite, but it does not account for terrain and other serviceability considerations, which may limit performance. The model sets throughput capacity of a single satellite at 20 Gbps per previous SpaceX public statements (although other filings imply that the maximum capacity could be only 10 Gbps), and it assumes that all SpaceX satellites will be authorized to use its full licensed spectrum at all altitudes (although it is possible SpaceX may not gain approval for a certain portion of its satellites to be at a low enough altitude to support our assumed 500-km coverage radius).

The base case is consistent with the information provided in SpaceX's February 3, 2021 FCC filing. (*See* Petition of Starlink Services, LLC for Designation as an Eligible Telecommunications Carrier, WC Docket No. 09-197 (Feb. 3, 2021) ("Starlink ETC Petition").

³ Cartesian used two scenarios for anticipated growth in average peak demand per subscriber based on Openvault, Cisco, and Cartesian estimates: a conservative low case with a 20% CAGR; and a high case using Cisco's 30% CAGR, reducing this by 1.5% points each year. The model adds 25% headroom to accommodate spikes in demand. By 2030, the capacity required is 22.0 – 28.6 Mbps per subscriber. SpaceX's 6-year build period is likely to be concluded by 2028; Cartesian estimates that capacity required in 2028 to be between 15.3 and 20.8 Mbps. This average peak demand accounts for users not online in the busy hour.

SpaceX would meet its public interest obligations due to the low population density and the higher satellite density in northern latitudes.

If SpaceX Serves Both RDOF Locations and a Reasonable Number of Non-RDOF Rural Locations,⁴ the Shortfall in the Eastern Region Increases Materially, and Congestion Occurs for Locations in the Mountain and Midwest Regions -- If SpaceX also were to serve non-RDOF locations in relatively rural areas, Cartesian estimates that the shortfall in the Eastern region increases materially with just an uptake of 10% of the locations in these areas (high capacity case). In the Mountain and Midwest regions, Cartesian estimates that congestion at peak usage begins to increase at a 10% uptake and increases materially at 20% uptake (high capacity case).

If SpaceX Serves Both RDOF Locations and Allocates 50% of its Capacity to Non-RDOF Locations,⁵ Congestion at RDOF Locations Increases Dramatically -- Cartesian did not model other kinds of potential customers for SpaceX beyond those noted above. From SpaceX's public announcements, however, it appears that the company is exploring service for US defense applications, various industries (*e.g.*, oil and gas exploration), and vehicle broadband. In the scenario where it is generally assumed that only 50% of average satellite capacity is allocated to RDOF locations, Cartesian estimates that only 5-8% of those RDOF locations receive sufficient bandwidth allocation during peak hours.

Because of SpaceX's Unique Network Configuration and Operations, the FCC Will Need to Adjust and Increase its Oversight of SpaceX's Compliance with RDOF Deployment and Network Performance Requirements – To begin with, SpaceX's network is not aligned with State boundaries, which are the areas that the Commission uses to assess RDOF compliance. Further, SpaceX's satellites are equipped with multiple phased array antennae, which allow the fleet to dynamically allocate satellite capacity as needed. For example, capacity can be steered towards areas of greatest demand and may be reassigned temporarily. Moreover, capacity may be reconfigured on a more permanent basis. As a result of these factors, the Commission will need to closely examine SpaceX's long-form applications to ensure that the requisite deployment is achieved despite not aligning with State boundaries and high expected oversubscription. In addition, the Commission will need to adjust its performance testing regime – which has been constructed largely based upon the notion of testing a fixed amount of capacity deployed and devoted to a fixed location – to account for the dynamic nature of the SpaceX network, *i.e.* testing a small sample may be inadequate to reveal capacity constraints (and service degradation) elsewhere on the network.

⁴ These are "rural" locations (fewer than 500 people per square mile) that have access to broadband service at download speeds between 25-50 Mbps.

⁵ See Starlink ETC Petition at 4 ("Over 10,000 users in the United States and abroad are using the service today.").

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While Cartesian’s estimated results are based upon the best information publicly available and conservative assumptions with respect to factors such as demand, FBA and NTCA recognize that it is entirely possible that information furnished confidentially by SpaceX through the long-form process may provide additional inputs and yield different results. Nonetheless, FBA and NTCA hope at the very least that an analysis of this kind proves useful for the Commission as it considers how to structure and undertake its own review of SpaceX’s long-form applications – that, if nothing else, this presentation is intended to be instructive rather than conclusive in demonstrating the detailed level and types of analysis needed to evaluate the capabilities of a low-earth orbit satellite system to deliver on RDOF commitments. We are prepared to respond to any inquiries you may have or discuss this further.

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Pursuant to Section 1.1206(b) of the Commission’s rules, this letter is being filed electronically.⁶

Respectfully Submitted,



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Attachment: Cartesian Starlink RDOF Assessment

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⁶ 47 C.F.R. § 1.1206(b).