Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC

In the Matter of

Rural Digital Opportunity Fund
Connect America Fund

WC Docket No. 19-126
WC Docket No. 10-90

COMMENTS OF THE FIBER BROADBAND ASSOCIATION

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September 20, 2019
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INTRODUCTION AND SUMMARY

The Fiber Broadband Association (“FBA”)\(^1\) hereby submits these comments in response to the Federal Communications Commission’s (“FCC” or “Commission”) Notice of Proposed Rulemaking (“NPRM”) in the above-captioned proceeding establishing the Rural Digital Opportunity Fund (“RDOF”) and seeking comment on its framework, including whether its weighting methodology will achieve the Commission’s goals to “encourage the deployment of higher speed services” or whether the Commission should adopt an alternative weighting methodology that “balance[s] the objectives of maximizing [the Commission’s] limited budget and guard[s] against widening the digital divide by ensuring that rural Americans do not fall further behind those living in urban areas.”\(^2\) FBA applauds the Commission’s effort to build on

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\(^1\) FBA is a not for profit trade association with more than 250 members, including telecommunications, computing, networking, system integration, engineering, and content-provider companies, as well as traditional service providers, utilities, and municipalities. Its mission is to accelerate deployment of all-fiber access networks by demonstrating how fiber-enabled applications and solutions create value for service providers and their customers, promote economic development, and enhance quality of life. A complete list of FBA members can be found on the organization’s website: https://www.fiberbroadband.org/.

the success of the Connect America Fund Phase II (“CAF II”) auction and further support the deployment of modern, high-speed communications networks to unserved consumers.

When the Commission established its weighting methodology for the CAF II auction, its goals were to make the most efficient use of its limited budget by maximizing auction participation to drive down prices and reflect the value of higher tier and lower latency services. To analyze whether the CAF II auction in fact met these goals, FBA commissioned a study by the business consulting firm Cartesian. As discussed herein, Cartesian found that the Commission’s weighting methodology did not maximize participation in the auction, especially among gigabit tier providers. As a result, bidding in the auction was not as competitive as it could have been, and thus the Commission provided more support than optimal to winning bidders.

Just as with the CAF II auction, the RDOF auction also seeks to “prioritize faster, gigabit speeds,” while ensuring that support is awarded cost-effectively. Because the performance tier

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3 Connect America Fund et al., WC Docket Nos. 10-90, 14-58, Report and Order and Order on Reconsideration, 32 FCC Rcd 1624 (2017) (“CAF II FNPRM Order”).

4 Cartesian is a consulting firm specialized in the technology, media and telecom (TMT) sector. It analyzes data and builds models for, and provides strategic advice to, communications providers to assist them in network planning, operations, and marketing.

5 NPRM at ¶¶ 12, 14. Chairman Pai has also frequently expressed the value of gigabit deployments:
   • In 2018, he championed rule changes that would reduce barriers to deploying such networks. Accelerating Wireline Broadband Deployment by Removing Barriers to Infrastructure Investment, Accelerating Wireless Broadband Deployment by Removing Barriers to Infrastructure Investment, WC Dkt. No. 17-84, WT Dkt. No. 17-79, 33 FCC Rcd 7705, 7818 (rel. Aug. 3, 2018).
discounts in the CAF II auction did not result in the most cost-efficient outcome, FBA asked Cartesian to develop a non-arbitrary weighting methodology that would achieve the Commission’s goals. Cartesian recommended a methodology based on the relative difference in the consumer benefits produced by each performance tier, which it first calculated and then translated into weights for each performance tier. According to this methodology, the discounts from the gigabit tier to the baseline low latency and baseline high latency tiers should be 70 points and 85 points, respectively. Cartesian finds these discounts will maximize participation, the Commission’s budget, and the deployment of gigabit services, which will ensure rural Americans can access critical benefits and keep pace with their urban counterparts.

I. THE CAF II PERFORMANCE TIER DISCOUNTS DID NOT MAXIMIZE THE FCC’S BUDGET AND THE DEPLOYMENT OF HIGH-SPEED, LOW LATENCY SERVICES

When the Commission established the CAF II performance tier discounts, it said that the weights “attempt to leverage [the Commission’s] finite budget to achieve speeds that are scalable to meet the evolving needs of consumers over the 10-year term.” To maximize the budget, the Commission said that “every bidder—no matter the service tier or latency—must have the opportunity to exert competitive pricing pressure on every other bidder.” To achieve scalable

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6 CAF II FNPRM Order at 1629.
7 Id. at 1630.
speeds, the Commission said the weights “should strive to reflect the value of higher-speed and lower-latency services to consumers.”

FBA commissioned Cartesian to analyze the CAF II auction’s results to determine if the performance tier discounts maximized the Commission’s budget and reflected the value of higher-speed and lower-latency services to consumers. While the auction awarded support significantly below the reserve prices to bring higher performance broadband service to unserved areas, the study found that a greater point spread between the higher and lower performance tier discounts would have resulted in lower winning bids, more locations served, and higher performance service at each location. In short, the Commission could have gotten more bang for its buck.

According to the study, “the weights did not maximize participation in the auction, especially from providers that could offer the highest performance gigabit service, and thus did not distribute support most efficiently.” Specifically, 80% of locations in the auction did not receive bids from gigabit providers, and less than 2.4% received bids from two or more gigabit providers. Ultimately, only 19% of locations were awarded at the gigabit performance tier.

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8 Id.

9 Prior to the CAF II auction, ACA expressed concern that the discounts set by the Commission would not maximize participation. Reply Comments of ACA at 4 (filed Aug. 5, 2016); Letter from Thomas Cohen, Counsel to the American Cable Association, to Marlene H. Dortch, Secretary, FCC, at 2 (filed Feb. 6, 2017).

10 Appendix A: Cartesian Weighting Study at 2.

11 Id.

12 Id. at 4.

While the Commission intended for its performance tier discounts to “giv[e] all service providers the opportunity to place competitive bids, regardless of the technology they intend to use to meet their obligations,” that turned out not to be the case for gigabit providers in most locations. The study indicates that gigabit tier providers concluded that they did not have a reasonable chance to win at a price that gave them an adequate business case for deploying their service. In other words, the discounts used by the Commission did not adequately reflect the value of each performance tier.

The study also found that, among the gigabit providers that did participate in the auction, most were electric cooperatives. This is consistent with the conclusion that the discount did not provide an adequate business case for the gigabit tier. Gigabit deployments by electric co-ops represent a uniquely viable business case because co-ops can leverage their existing infrastructure to build their fiber network within their footprint at lower costs. The lower costs allowed them to make bids that were more competitive with providers in other service tiers, increasing their chances of winning. However, other potential gigabit providers lacked similar advantages, did not have a viable business case, and opted not to bid. That is why the vast majority of locations did not receive gigabit tier bids despite co-op participation in the auction.

The reduced participation of gigabit tier providers prevented the Commission from achieving its desired goal of maximizing competitive bidding in the auction to drive down prices.

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14 CAF II FNPRM Order at 1633.
15 It is also the case that the Commission did not properly capture the costs of deploying service at each performance tier.
16 Appendix A: Cartesian Weighting Study at 4.
17 Id.
18 See CAF II Auction Results at 4 (showing that 81% of locations in the auction were awarded at either the minimum, baseline, or above baseline tiers).
Instead, the providers that won the auction at lower performance tiers were able to prevail at a higher price than they might have bid had competition been maximized. In short, in many cases, the Commission overpaid support for the winning service.

Since competitive bidding was not maximized, neither was the Commission’s budget. Had prices been driven down, the funds saved could have been used to support service in other areas. The Cartesian study concluded that “[i]ncreased participation by other gigabit providers would likely have pushed down ultimate support levels for many locations, thereby increasing the number of locations that [could have been] served within the budget.”

Additionally, more competition from gigabit tier providers would have increased their opportunity to win, resulting in higher tier service being provided to more consumers.

Because Cartesian’s study of the performance tier discounts in the CAF II auction showed that the Commission could have achieved a better outcome, FBA asked Cartesian to develop a weighting methodology that would maximize participation at all tiers, resulting in greater competition and more efficient use of the Commission’s budget.

II. TO MAXIMIZE THE RDOF BUDGET AND THE DEPLOYMENT OF HIGH-SPEED, LOW LATENCY SERVICES, THE COMMISSION SHOULD ADOPT DISCOUNTS THAT REFLECT THE RELATIVE BENEFITS OF EACH PERFORMANCE TIER

Just as with the CAF II auction, the RDOF NPRM expresses the Commission’s desire that the discounts it uses “reflect [its] preference for higher speeds, higher usage allowances, and low latency.” Accordingly, the Commission proposes to maintain the “90-point spread between the best and least performing tiers” by increasing the discount of the above baseline tier

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19 Id.

20 NPRM at ¶ 25.
by 10 points, the baseline low latency tier by 5 points, and the baseline high latency tier by 20 points. The Commission is seeking comment on whether its new methodology will “encourage the deployment of higher speed services” or whether the Commission should adopt an alternative weighting methodology. Commenters proposing alternative methodologies were asked to explain how their proposals would “balance the objectives of maximizing [the Commission’s] limited budget and guarding against widening the digital divide by ensuring that rural Americans do not fall further behind those living in urban areas.” FBA proposes that the Commission increase the discount of lower tier services to better reflect the relative value of the higher tier services. FBA demonstrates below how its methodology will not only maximize the Commission’s budget and close the digital divide but will do so by encouraging deployment of higher speed, lower latency services with significant capacity.

To determine how the Commission could set performance tier discounts to maximize auction participation, FBA asked Cartesian to conduct a bottom-up analysis of the CAF II auction. Based on its analysis, Cartesian was able to develop a non-arbitrary weighting methodology centered on the relative benefits of each performance tier, which ensures “that the ratio of support to benefit is constant across technologies.”

As the basis for its analysis, Cartesian first identified seven categories of use cases—or benefits—that are available to consumers that have access to broadband internet:

1. **Telecommuting**, *i.e.*, remote work, collaboration over long distances.

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21 *Id.* The Commission also plans to remove the minimum 10/1 performance tier. *Id.* at ¶ 24.

22 *Id.* at ¶¶ 25, 27.

23 *Id.* at ¶ 27.

24 Appendix A: Cartesian Weighting Study at 12.
2. **Remote Health & Learning**, *i.e.*, online education, health monitoring and remote communication with teachers and doctors.

3. **E-Commerce**, *i.e.*, online shopping and other remote communication with sellers.

4. **Streaming Video**, *i.e.*, entertainment such as over-the-top video services.

5. **Cloud Storage and Computing**, *i.e.*, remote access to non-local data storage and computing power.

6. **Gaming and Social Media**, *i.e.*, online access to interactive entertainment and social communications.

7. **Two-Way Video Streaming**, *i.e.*, real-time video communication and upload of user-created media.²⁵

Cartesian then calculated the average maximum monetary benefit range per household (“HH”) that corresponds with each use case, when broadband speed is not a constraint, and the sources of those benefits (*see Figure 1*).²⁶ For example, “telecommuting” has an annual household monetary benefit range of $250-300 from transportation savings and reduced facilities cost while cloud storage and computing has an annual monetary benefit range of $20-30 from reduced direct spending on computing capacity.²⁷ Cartesian also determined the different connectivity needs for each use case, since services offering slower speeds and higher latency cannot supply the bandwidth for all use cases.²⁸

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²⁵ *Id.* at 7.
²⁶ *Id.* at 8.
²⁷ *Id.*
²⁸ *Id.*
Using the estimated annual household benefit per use case, Cartesian then calculated the average annual household benefit from each broadband technology based on which technologies could deliver the bandwidth for each use case (see Figure 2). Thus, for example fiber has an estimated annual household benefit of $800-825 because “[a]ll-fiber connections provide reliable symmetrical gigabit capability, with as much throughput as is needed for all the use cases.” Conversely, baseline satellite service has an estimated annual household benefit of $100-125 because “[s]atellite connections are slower, high-latency and are therefore inadequate for many use cases.”

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29 Id.
30 Id. at 9.
31 Id.
32 Id.
Figure 2: Monetary Benefits by Technology

<table>
<thead>
<tr>
<th>Estimated Benefit</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiber</td>
<td>$800-825</td>
</tr>
<tr>
<td>Cable</td>
<td>$625-675</td>
</tr>
<tr>
<td>Baseline DSL</td>
<td>$250-300</td>
</tr>
<tr>
<td>Minimum DSL</td>
<td>$175-200</td>
</tr>
<tr>
<td>Fixed Wireless</td>
<td>$200-250</td>
</tr>
<tr>
<td>Baseline Satellite</td>
<td>$100-125</td>
</tr>
<tr>
<td>Minimum Satellite</td>
<td>$50-100</td>
</tr>
</tbody>
</table>

Cartesian next mapped the benefits by technology to the performance tiers in the CAF II auction based on the anticipated bidding participation mix of each technology per tier using data from past auctions (see Figure 3). For example, 80% of bids in the gigabit tier came from fiber providers and 20% from cable providers, making $780 the average annual benefit per household for service provided in that tier.

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33 Id.
34 Id. at 10.
35 Id.
To determine the discount by performance tier, Cartesian applied the estimated benefits per service tier to a weighting formula that allocated support for each tier and latency level proportionally to the benefits of the gigabit tier. The formula is as follows:

\[
\text{Weight} = 100 \times (100\% - \left( \frac{\text{Service Tier Benefit}}{\text{Gigabit Benefit}} \right))
\]

where 100\% represents the maximum possible benefit. Thus, the discount for the baseline low latency tier was calculated as follows:

\[
100\% - \left( \frac{\$249}{\$780} \right) = 100\% - 31.9\% = 68.1\% \approx 70
\]

The full set of discounts calculated by Cartesian are represented in Figure 4, which also shows the CAF II and proposed RDOF discounts for comparison.

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36 Id.
37 Id. at 11.
38 Id.
The Cartesian study presents a non-arbitrary methodology that maximizes the Commission’s budget. By setting discounts based on the relative benefit received at each performance tier, Cartesian concluded that its “recommended weights are expected to encourage increased bidding—especially among high performance gigabit providers—which would make the auction more competitive.”\textsuperscript{40} The increased competition would, in turn, drive down prices, which will free up funds to provide service to more locations.

The outcome of an auction using the Cartesian discounts will also serve to close the digital divide and ensure that rural Americans keep pace with their urban counterparts. As Cartesian concluded, the recommended weights will “ensure the greatest number of unserved households are connected with high speed broadband”\textsuperscript{41} because it will increase the chances that higher speed, lower latency services can make winning bids. Those higher-tier services will allow rural Americans to access all the benefits that Cartesian identified in its study, particularly those that are “critical to economic opportunity, job creation, education and civic

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|}
\hline
Service Tier & CAF II Weights & FCC’s Proposed RDOF Weights & Cartesian Weights \\
\hline
Gigabit Low Latency & 0 & 0 & 0 \\
\hline
Above Baseline Low Latency & 15 & 25 & 15 \\
\hline
Baseline Low Latency & 45 & 50 & 70 \\
\hline
Baseline High Latency & 70 & 90 & 85 \\
\hline
\end{tabular}
\caption{Weighting Methodologies\textsuperscript{39}}
\end{table}

\textsuperscript{39} Id. at 12; NPRM at ¶ 25.
\textsuperscript{40} Appendix A: Cartesian Weighting Study at 2.
\textsuperscript{41} Id.
engagement—namely, telecommuting, remote health and learning, and e-commerce—but that are not viable use cases in baseline tiers. Additionally, winning gigabit deployments will prevent rural Americans from falling behind because they can provide speeds to meet consumer demand well-beyond the 10-year support term.

CONCLUSION

Through the RDOF auction, the Commission seeks to maximize its limited budget and support deployments that reflect its preference for higher speeds, higher usage allowances, and low latency, which will serve to close the digital divide. By analyzing the participation in and results of the CAF II auction, Cartesian was able to develop a non-arbitrary weighting methodology to determine performance tier discounts based on the relative benefits of each tier, which is substantially greater for gigabit services, when compared to lower speed and higher latency services. Based on this methodology, Cartesian determined that the discount from the gigabit tier to the baseline low latency tier should be 70 points and the discount to the baseline high latency tier should be 85 points. Cartesian concluded that these discounts will maximize participation, the Commission’s budget, and the deployment of gigabit services, allowing rural Americans to take advantage of critical benefits and preventing them from falling behind their urban counterparts. For these reasons, the Commission should adopt the discounts produced by the non-arbitrary Cartesian methodology detailed above.

42 NPRM at ¶ 1.
43 Appendix A: Cartesian Weighting Study at 8-9.
Respectfully Submitted,

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September 20, 2019
Appendix A
Executive Summary

The FCC will soon begin the process of allocating support for providers to bring broadband connectivity to millions of unserved locations over the next decade.

- The FCC’s objective is “to balance its preference for higher-quality services with its objective to use the finite universal service budget effectively.” (FCC Order on Reconsideration Jan. 2018)

- In the 2018 CAF Phase II auction, the FCC employed a set of weights designed to discount bids for lower performance broadband technologies and efficiently deploy $1.98 billion of budgeted support to the greatest number of unserved households.

- We find that the weights did not maximize participation in the auction, especially from providers that could offer the highest performance gigabit service, and thus did not distribute support most efficiently.

- We conducted a bottom-up analysis to determine a revised set of weights that scale by the amount of tangible socioeconomic benefits associated with each connection technology.

- Our recommended weights are expected to encourage increased bidding – especially among high performance gigabit providers – which would make the auction more competitive.

- Our weights also should produce results that provide consumers with greater tangible benefits while maximizing the use and efficiency of limited universal service support to ensure the greatest number of unserved households are connected with high speed broadband.
FCC Definition of Baseline Broadband Service

The FCC periodically redefines the baseline broadband speed – given market trends, we expect an upgrade to 100Mbps\(^1\) in the near future.

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\(^1\) 100Mbps is the maximum downstream speed of VDSL2 (without bonding) and DOCSIS 2.0, and falls within a reasonable range of future estimates of aggregate speed.

Source: Cartesian, FCC, Akamai
CAF Phase II Auction 903 Gigabit Participation

Despite rapidly growing demand for high speeds, the weights used by the FCC in its CAF Phase II auction did not encourage meaningful participation by providers offering gigabit services.

**Gigabit Bidder Analysis**

- **Number of Locations**
  - 780.9K
  - 170.0K
  - 20.2K
  - 3.0K

- **Number of Gigabit Providers Bidding**
  - 0
  - 1
  - 2
  - 3

- **Gigabit Provider Breakdown**
  - Small Regional Electric Co-op: 54.2%
  - Other Gigabit Provider: 45.8%

**Comments**

- Few areas saw gigabit bids, and no areas saw bids from more than 3 gigabit providers.
- Many of the gigabit bidders were regional electric co-ops, who had unique viable business cases because of synergies with existing networks and service footprints.
- Increased participation by other gigabit providers would likely have pushed down ultimate support levels for many locations, thereby increasing the number of locations that can be served within the budget.
- More participation would have a spill-over effect as providers move to expand new locations that are near-network and viable to win.

A new weighting methodology should better assess the relative benefits of technologies at each performance tier.

Source: Cartesian, FCC

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Recap: FCC CAF Phase II Auction 903

The FCC allocated the CAF Phase II budget by using a descending clock auction for each census block group it offered

- Reserve Price
- Clock Percentage
- Service Tier Weight
- Latency Weight

= Implied Support*

**Reserve Price:**
Set for each census block group according to the Connect America Phase II Cost Model

**Example Census Block Group:**
010010201001

**County:** Autaga
**State:** Alabama
**Reserve Price:** $259

**Clock Percentage:**
For the first round of bidding, set at 100% plus the highest weights of anyone bidding that block group, and descending by 10 percentage points each round the CBG remains competitive

<table>
<thead>
<tr>
<th>Round</th>
<th>Base Clock %:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100% + T + L</td>
</tr>
<tr>
<td>2</td>
<td>90% + T + L</td>
</tr>
<tr>
<td>3</td>
<td>80% + T + L</td>
</tr>
<tr>
<td>4</td>
<td>70% + T + L</td>
</tr>
</tbody>
</table>

Math representation:

\[
\text{Implying Support} = \text{Reserve Price} \times \text{Clock Percentage} - \text{Service Tier Weight} - \text{Latency Weight}
\]

**Service Tier Weight:**
Bid penalty assessed based on speed of service offered

<table>
<thead>
<tr>
<th>Tier (Speed, Mbps)</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gigabit (&gt;1 Gbps)</td>
<td>0</td>
</tr>
<tr>
<td>Above Baseline (&gt;100 Mbps)</td>
<td>15</td>
</tr>
<tr>
<td>Baseline (&gt;25 Mbps)</td>
<td>45</td>
</tr>
<tr>
<td>Minimum (&gt;10 Mbps)</td>
<td>65</td>
</tr>
</tbody>
</table>

**Latency Weight:**
Bid penalty assessed based on latency of service offered

<table>
<thead>
<tr>
<th>Latency (ms)</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>High (&lt;750 ms)</td>
<td>25</td>
</tr>
<tr>
<td>Low (&lt;100 ms)</td>
<td>0</td>
</tr>
</tbody>
</table>

Providers keep bidding for a census block group until the implied support drops below what they are willing to receive to connect locations there – a block is won when only one provider remains

* Capped at reserve price for a CBG
Source: Cartesian, FCC
Recap: Bid Example

We have outlined an example CAF auction round with four illustrative bidders dropping off on different rounds depending on their desire to accept support at that level.

<table>
<thead>
<tr>
<th>Round (Clock %)</th>
<th>Provider A Gigabit low latency (0 weight)</th>
<th>Provider B Above baseline low latency (15 tier weight)</th>
<th>Provider C Baseline low latency (45 tier weight)</th>
<th>Provider D¹ Minimum high latency (65 tier + 25 latency weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (190%)¹</td>
<td>(190 – 0)% * $443 → $443²</td>
<td>(190 – 15)% * $443 → $443²</td>
<td>(190 – 45)% * $443 → $443²</td>
<td>(190 – 90)% * $443 → $443</td>
</tr>
<tr>
<td>2 (180%)</td>
<td>(180 – 0)% * $443 → $443²</td>
<td>(180 – 15)% * $443 → $443²</td>
<td>(180 – 45)% * $443 → $443²</td>
<td>(180 – 90)% * $443 → $399</td>
</tr>
<tr>
<td>9 (110%)</td>
<td>110% * $443 → $443²</td>
<td>95% * $443 → $421</td>
<td>65% * $443 → $289</td>
<td>20% * $443 → $89</td>
</tr>
<tr>
<td>10 (100%)</td>
<td>100% * $443 → $443</td>
<td>85% * $443 → $377</td>
<td>55% * $443 → $244</td>
<td>N/A</td>
</tr>
<tr>
<td>11 (90%)</td>
<td>90% * $443 → $399</td>
<td>N/A</td>
<td>45% * $443 → $199</td>
<td>N/A</td>
</tr>
<tr>
<td>12 (80%)</td>
<td>N/A</td>
<td>N/A</td>
<td>35% * $443 → $155</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Provider C wins the census block group

The FCC’s overarching objective is to deploy high-performance broadband to unserved locations within its limited support budget.

¹ Set at 190 since the highest weight of a bidder is 90 (Provider D).
² Implied support capped at reserve price of $443.
³ The provider stopped bidding after this round because the amount of support implied by its bid in the next round would have been too low.

Source: Cartesian, FCC
Bottom-up Analysis to Determine Auction Weights

We propose a bottom-up weighting methodology that takes into account tangible socioeconomic benefits produced by different access technologies

Delivery Technology Aspects

<table>
<thead>
<tr>
<th>Benefits to consumers due to availability of broadband access services</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Different broadband access technologies provide different levels of socioeconomic benefit to end users that can be quantified, as outlined in our previously completed study on the consumer benefits of faster broadband¹</td>
</tr>
<tr>
<td>• We applied an updated version of the same framework, segmenting consumer benefits into 7 use cases:</td>
</tr>
<tr>
<td>‣ <strong>Telecommuting</strong> – remote work, collaboration over long distances</td>
</tr>
<tr>
<td>‣ <strong>Remote health &amp; learning</strong> – online education, health monitoring and remote communication with teachers and doctors</td>
</tr>
<tr>
<td>‣ <strong>E-commerce</strong> – online shopping and other remote communication with sellers</td>
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<tr>
<td>‣ <strong>Streaming video</strong> – entertainment such as over-the-top video services</td>
</tr>
<tr>
<td>‣ <strong>Cloud storage and computing</strong> – remote access to non-local data storage and computing power</td>
</tr>
<tr>
<td>‣ <strong>Gaming and social media</strong> – online access to interactive entertainment and social communications</td>
</tr>
<tr>
<td>‣ <strong>Two-way video streaming</strong> – real-time video communication and upload of user-created media</td>
</tr>
</tbody>
</table>

Source: Cartesian, FCC
## Estimated Savings by Use Case

Different use cases bring on different amounts of monetary benefit

<table>
<thead>
<tr>
<th>Use Case</th>
<th>Est. Annual Benefit / HH*</th>
<th>Connectivity Needs</th>
<th>Sources of Benefit</th>
</tr>
</thead>
</table>
| Telecommuting**            | $250-300                  | Efficient collaboration and low-latency video conferencing                          | • Savings on fuel, vehicle and other transportation costs  
                                |                           |                                                                                                     | • Reduced facilities costs                                                                             |
| Remote Health & Learning** | $50-100                   | Video conferencing with doctor/instructor, web-based tools and applications          | • Savings on transportation  
                                |                           |                                                                                                     | • Reduced direct costs of doctor visits  
                                |                           |                                                                                                     | • Reduced educational housing costs                                                                   |
| E-Commerce**               | $100-120                  | Research, comparison shopping and purchasing, including video reviews                | • Time and cost savings for purchasing decisions  
                                |                           |                                                                                                     | • Reduced transportation costs                                                                         |
| Streaming Video            | $20-50                    | Standard definition and 4K video streaming for entertainment                         | • Reduced transportation costs  
                                |                           |                                                                                                     | • Reduced direct spending on video entertainment                                                        |
| Cloud Storage and Computing| $20-30                    | Storage, file syncing, and throughput for remote machine use                        | • Reduced direct spending on computing capacity                                                         |
| Gaming and Social Media    | $10-20                    | Low-latency connection for responsiveness, including rich media and video interactions | • Reduced transportation costs  
                                |                           |                                                                                                     | • Reduced direct spending on interactive media and communication                                      |
| Two-Way Video Streaming    | $150-200                  | Low-latency video interaction                                                       | • Reduced transportation costs for personal and family visits, etc.                                      |

**Total Possible Benefit of High Speed Broadband**  

$605-825

*Assumed to be the maximum benefit that could be unlocked when broadband speeds are not a constraint on the use case

**Especially important in rural areas to drive commerce and jobs.

Source: Cartesian, FCC
Benefit Detail

Using estimated benefits per use case, we scored each access technology on its suitability, and quantified total benefits per access tech.

<table>
<thead>
<tr>
<th>Estimated Benefit</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiber</td>
<td>$800-825</td>
</tr>
<tr>
<td>Cable</td>
<td>$625-675</td>
</tr>
<tr>
<td>Baseline DSL</td>
<td>$250-300</td>
</tr>
<tr>
<td>Minimum DSL</td>
<td>$175-200</td>
</tr>
<tr>
<td>Fixed Wireless</td>
<td>$200-250</td>
</tr>
<tr>
<td>Baseline Satellite</td>
<td>$100-125</td>
</tr>
<tr>
<td>Minimum Satellite</td>
<td>$50-100</td>
</tr>
</tbody>
</table>

Note: All dollar amounts per subscriber per year.
Source: Cartesian, FCC
Mapping of Broadband Access Tech to Auction Service Tiers

Resulting socioeconomic effectiveness per broadband access medium was mapped to FCC defined service tiers based on the participating mix of technologies per tier in past auctions.

<table>
<thead>
<tr>
<th>Service Category</th>
<th>Fiber</th>
<th>Cable</th>
<th>Baseline DSL</th>
<th>Minimum DSL</th>
<th>Fixed Wireless</th>
<th>Baseline Satellite</th>
<th>Minimum Satellite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gigabit, Low Latency</td>
<td>80%</td>
<td>20%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Above Baseline, Low Latency</td>
<td>-</td>
<td>100%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Baseline, Low Latency</td>
<td>-</td>
<td>5%</td>
<td>5%</td>
<td>-</td>
<td>90%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Minimum, Low Latency</td>
<td>-</td>
<td>-</td>
<td>5%</td>
<td>60%</td>
<td>40%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Baseline, High Latency</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>100%</td>
<td>-</td>
</tr>
<tr>
<td>Minimum, High Latency</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>100%</td>
<td>-</td>
</tr>
</tbody>
</table>

* Attribution percentages estimated based on anticipated mix of broadband technologies to be engaged in bidding process.

* Takes into account results from previous auction.

* Taken as midpoint of range of benefits.

Source: Cartesian, FCC
Weight Calculation Methodology

We employed a methodology to derive weights based on benefits brought on by access service tier and latency.

### Example Weight Calculation: Baseline, Low Latency

<table>
<thead>
<tr>
<th>Current Annual Benefits by Service Tier</th>
<th>Service Category Benefit</th>
<th>Gigabit Benefit</th>
<th>Service Category Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gigabit, Low Latency</td>
<td>$780</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Above Baseline, Low Latency</td>
<td>$650</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline, Low Latency</td>
<td>$249</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum, Low Latency</td>
<td>$203</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline, High Latency</td>
<td>$113</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum, High Latency</td>
<td>$75</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Calculation Details

- **Baseline, Low Latency**
  - Current Benefit: $249
  - Gigabit Benefit: $780
  - Weight: $249 / $780 = 31.9%
  - Remaining: 100% - 31.9% = 68.1%

- **Our weightings allocate support in any specific round of the auction proportionally to the benefits of that combination of tier and latency compared to gigabit**

Source: Cartesian

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New Weightings

We based new suggested weightings on the relative amount of benefit created by each service category – this ensures that the ratio of support to benefit is constant across technologies.

<table>
<thead>
<tr>
<th>Service Category</th>
<th>FCC Weights</th>
<th>Cartesian-Modified Weights</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gigabit, Low Latency</td>
<td>0</td>
<td>0</td>
<td>Weights for gigabit and above baseline service did not change, reflecting their high amounts of consumer benefit</td>
</tr>
<tr>
<td>Above Baseline, Low Latency</td>
<td>15</td>
<td>15</td>
<td>Given the significantly lower consumer benefit provided by technologies relative to gigabit and above baseline speeds, previous weights were too low – the updated weights more accurately reflect the discrepancy in consumer benefit contribution</td>
</tr>
<tr>
<td>Baseline, Low Latency</td>
<td>45</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Minimum, Low Latency</td>
<td>65</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Baseline, High Latency</td>
<td>70</td>
<td>85</td>
<td>The FCC’s weightings did not go far enough in penalizing baseline-level satellite providers, given that they do not enable many use cases necessary in the next 10 years – the penalty is now closer to that of the minimum satellite tier</td>
</tr>
<tr>
<td>Minimum, High Latency</td>
<td>90</td>
<td>90</td>
<td></td>
</tr>
</tbody>
</table>

Further analysis can predict the impact of these weights on the prior auction and determine whether further adjustments would be needed.

Source: Cartesian, FCC, RISE Acreo